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From: Thomas Carpenter [Carpenter.Thomas@epamail.epa.gov]
Sent: 9/20/2018 8:05:56 PM
To: Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]
CC: Bright, Wanda [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b783537affbc46119372799bdbac87e4-Bright, Wanda]; Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]; Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]; Cunningham, Laticia [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=fdd1c2c631114f0e81a0325b0a9026b4-LCunning]; Starks, Angela [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=86dcf1927b9d4c499ec4b750926b0c53-AStarks]
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Meeting Material Request

Date Submitted:09/20/2018

(See attached file: API_Comments_ETBE-TBA_SAB_2018-09-20_unsigned.pdf)

3 pp., 256358 bytes

Jessica Ryman-Rasmussen, PhD,DABT

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VIA Email

September 20, 2018

Mr. Thomas Carpenter
Sr. Biologist and Designated Federal Officer
U.S. EPA: Office of the Administrator, Science Advisory Staff Office
1200 Pennsylvania Ave, NW (1400R)
Washington, DC 20460-4164

RE: Notification of a Public Teleconference of the Chartered Scientific Advisory Board (SAB) [FRL-9983-39-OA]

Dear Mr. Carpenter:

The American Petroleum Institute (API) is pleased to submit written comments regarding the Public Teleconference of the Chartered Scientific Advisory Board (SAB) [FRL-9983-39-OA]. These comments pertain to the Advisory Activities Discussed of the IRIS Assessment for Ethyl Tertiary Butyl Ether (ETBE) and the IRIS Assessment for tert-Butyl Alcohol (tert-butanol) as well as the 08-30-2018 Drat Review of EPA's Draft Toxicological Review of Ethyl Tertiary Butyl Ether and Draft Toxicological Review of tert-Butyl Alcohol.

API is a national trade association that represents all facets of the oil and natural gas industry, with 625 plus members that include large integrated companies, as well as exploration and production, refining, marketing, pipeline and marine businesses, and service and supply firms. As a core component of our business model, we prioritize the promotion of public health and environmental safety while ensuring a strong, viable and sustainable U.S. oil and natural gas economy. Many API members are impacted by IRIS assessments. API advocates for risk assessment processes that use the best available science, are transparent, and provide opportunities for public engagement.

API is requesting that EPA's Science Advisory Board (SAB) Staff remedy the situation in which the SAB was unable to reach consensus on critical aspects of the IRIS assessments for ETBE and TBA by supporting a subsequent SAB that includes pathology expertise and/or supporting a recommendation that EPA/IRIS hold a transparent scientific workshop that includes expert pathologists in order to resolve these critical issues.

The rationale for this request is subsequently described and defended in detail.

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In the 8-30-2018 SAB draft report[1] the SAB was unable to reach consensus on the human relevance of the kidney effects of ETBE and tBA as indicated by the following:

> *"Regarding noncancer kidney outcomes from exposure to ETBE, the SAB did not reach consensus on an oral reference dose. The difference in opinion is based on the extent of confidence in a CPN-based mechanism for these ETBE effects. Similarly, the SAB did not reach a consensus regarding the oral reference dose for noncancer kidney outcomes for tBA. The difference in opinion relates to the extent of confidence in CPN and/or alpha 2μ-globulin -based mechanisms for these tBA effects."*[2]
>
> *"A consensus was not reached for tBA concerning the scientific support for the conclusion that male rat kidney tumors are relevant to human hazard identification."*[2]
>
> *"No consensus, however, was reached regarding the EPA's calculation of inhalation unit risk (IUR) for ETBE. Some members conclude that the data are not suitable for developing an IUR due to a potential lack of biological relevance for ETBE. Other members note that the data are appropriate for dose-response analysis for ETBE."*[2]

As a result, the IRIS Program is now in the very unfortunate position of not having consensus support from independent scientific peer review for key endpoints used in the ETBE and TBA assessments. Going forward, this can reasonably be anticipated to increase the level of difficulty for the IRIS Program in defending its risk assessments at a time in its history when it is already under a high level of scrutiny and pressure.

According to a 2002 document produced by the US EPA Science Advisory Board (SAB)[3]:

> "*The goal of the panel formation process is to assemble an appropriate panel of experts to provide sound, independent, balanced, and useful scientific and technical advice"*
>
> and
>
> *"Expertise, knowledge, and experience are primary factors that determine whether an individual is invited to serve on a SAB Panel."*[4]

---

[1] Review of EPA's Draft Assessments titled Toxicological Review of Ethyl Tertiary Butyl Ether and Toxicological Review of *tert*-Butyl Alcohol (*tert*-Butanol). 8-30-2018.
[2] *Ibid.* Page 2.
[3] Overview of the Panel Formation Process at the Environmental Protection Agency Science Advisory Board. EPA-SAB-EC-02-010. September 2002.
https://yosemite.epa.gov/sab/sabproduct.nsf/WebFiles/OverviewPanelForm/$File/ec02010.pdf
[4] *Ibid.* Page 9.

API has previously noted in written comments[5] that there was no apparent representation of expertise in pathology on this SAB and that this is also inconsistent with EPA's Peer Review Handbook.

API therefore requests the SAB Staff to remedy this situation in which the SAB was unable to reach consensus on critical aspects of these IRIS assessments by supporting a subsequent SAB that includes pathology expertise and/or supporting a recommendation that EPA/IRIS hold a transparent scientific workshop that includes expert pathologists in order to resolve these critical issues. API notes that if a scientific workshop were to be recommended, it could be expanded to include other substances that cause similar kidney effects in rodents, as these endpoints are applicable to substances other than ETBE and TBA.

Sincerely,

Jessica Ryman-Rasmussen, PhD, DABT

[5] Written comments submitted by Jessica Ryman-Rasmussen on behalf of the American Petroleum Institute (API). https://yosemite.epa.gov/sab/sabproduct.nsf/520B0D5561CA43668525825000637CE0/$File/API_Comments_ETBE-TBA_CAAC_03-13-2018_unsigned_final.pdf

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From: Thomas Carpenter [Carpenter.Thomas@epamail.epa.gov]
Sent: 9/19/2018 9:28:13 PM
To: Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]
CC: Bright, Wanda [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b783537affbc46119372799bdbac87e4-Bright, Wanda]; Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]; Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]; Cunningham, Laticia [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=fdd1c2c631114f0e81a0325b0a9026b4-LCunning]; Starks, Angela [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=86dcf1927b9d4c499ec4b750926b0c53-AStarks]
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(See attached file: SAB_roster_05092018.pdf) 4 pp., 45889 bytes

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Sent: 9/12/2018 6:25:19 PM
To: Bright, Wanda [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b783537affbc46119372799bdbac87e4-Bright, Wanda]; Brooks, Lisette [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ea5714d1470a434f822b9d999cba5ced-Brooks, Lisette]
CC: Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]; Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]; Cunningham, Laticia [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=fdd1c2c631114f0e81a0325b0a9026b4-LCunning]; Starks, Angela [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=86dcf1927b9d4c499ec4b750926b0c53-AStarks]; Bloomer, Bryan [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=18e2ed4508564c3f89428feb38673af9-Bloomer, Bryan]
Subject: Unsigned report ready to be transmitted to the Administrator
Attachments: SAB RTR Panel Report Final 12Sep2018.docx

Click here to open the Final Report Request

The report referenced above, Review of EPA's draft technical report entitled Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysi, has been approved by the chartered committee and needs a report number and signature applied for the report to be sent to the Administrator.

It is a final report for project 15-07 and more reports are not expected for this project.

Final Report Request

Date Submitted:09/12/2018

Fiscal Year of Report	2018
Original Study?	
CMS Number	
Already Reviewed By	Khanna Johnston
Are minutes for meetings tagged to this project/these projects certified and submitted?	
CMS assignment (Name/AAship/position use semicolons to separate):	
Report Signed Date:	

(See attached file: SAB RTR Panel Report Final 12Sep2018.docx)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
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[DATE]

EPA-SAB-18-xxx

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Review of EPA's draft technical report entitled *Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*

Dear Acting Administrator Wheeler:

The Science Advisory Board was asked by EPA's Office of Air Quality Planning and Standards to review the EPA draft document titled, *Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis* (May 2017). The draft RTR methods document describes the EPA's methods for conducting initial risk screening analyses in the Clean Air Act mandated assessment of "residual risk", i.e., the risks remaining after application of maximum achievable control technology pursuant to the National Emission Standards for Hazardous Air Pollutants under Title I of the Clean Air Act.

The SAB Risk and Technology Review Methods Review Panel deliberated on the charge questions specific to the Agency's draft RTR methods document during a June 29-30, 2017, face-to-face meeting and discussed the SAB panel's draft report in a subsequent conference call on December 5, 2017. The charge questions focused on eight topics within the Agency's draft RTR methods document, including: a three-tiered multipathway screening approach used in the RTR screening analyses; a risk equivalency factor methodology; fishing, lake and pond assumptions; lake data, plume rise, and meteorological data; a gardener scenario; environmental risk screening methodology; inhalation risk assessment enhancements; and the census block receptor check tool. The enclosed report provides the SAB's consensus advice and recommendations in response to the charge questions. This letter briefly conveys the major findings.

The SAB commends the EPA on the technical quality of the draft RTR document and the effort it has put into developing the residual risk screening methodology. The SAB finds that the overall methodology and specifically the revisions since 2009 are for the most part appropriate and improve the assessment capabilities; opportunities for improvement are documented in the SAB's report. The SAB concludes that

the EPA's approach has the potential to achieve the Agency's goal to rapidly and effectively screen facilities, and to focus EPA time and resources on sites of most concern from a public health point of view.

Insufficient detail was provided in the Agency's draft RTR methods document for the SAB to assess the overall operational effectiveness of the screening methodology such as how many facilities are screened out by each of the three tiers. Some data were provided later by the EPA that did help the SAB to understand the screening efficacy. The SAB recommends the EPA compile summaries of RTR analyses applied in regulatory activities for inclusion in future RTR methodology report documents. Furthermore, in future screening analyses the EPA should compare, for specific facilities, the screening model output to field data where available. These "ground truthing" studies should be included in the next RTR methods document and provided to future reviewers for consideration.

Concerning the lifetime average daily dose (LADD) estimates when calculating exposure equivalency factors, EPA's empirical correlation is a logical step in creating the read-across approach used by the Agency. However, the read-across approach for environmental fate is less well-tested and accepted and thus deserves further consideration[1]. The SAB notes that this read-across extrapolation of environmental fate could be refined and has identified two options for the EPA to consider for improving the LADD estimates.

The SAB finds that the inclusion of the domestic gardener scenario is appropriate, though an evaluation of how many people this applies to should be conducted to determine the efficacy of the addition. The accuracy of dispersion and deposition results from the TRIM.FaTE model should be evaluated by comparing them with the results from a more technically robust dispersion model, such as AERMOD. In addition, while incorporation of turbulence in determining urban/rural selection in dispersion modeling is appropriate, the SAB recommends a different approach suggesting a more physically-based model such as AERMOD and the use of meteorological reanalysis data for both surface-air and upper-air wind speeds. Finally, the SAB finds that the EPA's reliance on census-block centroid locations as surrogates for where people live might not always be sufficient to ensure that receptors are representative of residential areas near facilities, and thus the SAB recommends that additional, reproducible methods should be evaluated.

The SAB recommends the EPA explore a transition for its screening methodology from using single-point estimates of uncertain input values to using distributions for these values. Probabilistic analyses combining the effects of distributions of multiple input values would result in a coherent analysis from which arithmetic means and "conservative fractiles" (e.g., a 90th percentile) could be derived. While in the interim sensitivity analyses on uncertain input values could be performed, the shift to a probabilistic analysis framework would provide a more robust foundation for the screening methodology in higher tiers.

In summary, the SAB supports the framework and direction of refinements EPA has been making to the screening methodology for the residual risk portion of RTR analyses. The SAB appreciates the opportunity to provide the EPA with advice on this important subject. We look forward to receiving the EPA's response.

---

[1] Physicochemical, human health and/or environmental properties may be predicted from information from tests conducted on reference substance(s) within the group, referred to as source substance(s), by interpolation to other substances in the group, referred to as target substance(s). This approach is called "read-across." (https://echa.europa.eu/documents/10162/13628/raaf_en.pdf)

Sincerely,

Dr. Michael Honeycutt, Chair
Science Advisory Board

Dr. Jay Turner, Chair
Risk and Technology Review Methods
Review Panel

Enclosure

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to the problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use. Reports of the EPA Science Advisory Board are posted on the EPA website at http://www.epa.gov/sab.

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Acronyms and Abbreviations

AERMOD	AMS/EPA Regulatory [Dispersion] Model
AMS	American Meteorological Society
ATSDR	Agency for Toxic Substances and Disease Registry minimum risk levels
AEGL	Acute Exposure Guidelines Limits
ANPRM	Advanced Notice of Proposed Rulemaking
BaP	benzo(a)pyrene
CalEPA	California Environmental Protection Agency
EEF	exposure equivalency factor
ERA	Ecological Risk Assessment
ERPG	Emergency Response Planning Guidelines
HAP	Hazardous Air Pollutant
K_{ow}	the *n*-octanol/water partition coefficient
IRIS	Integrated Risk Assessment System
LADD	lifetime average daily dose
MACT	Maximum Achievable Control Technology
MTBE	Methyl Tertiary Butyl Ether
NATA	National Air Toxics Assessment
NEI	National Emissions Inventory
NESHAP	National Emission Standard for Hazardous Air Pollutants
NHANES	National Health and Nutrition Examination Survey
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Testing
NPRM	Notice of Proposed Rulemaking
NWS	National Weather Service
OAQPS	Office of Air Quality Planning and Standards
OPP	Office of Pesticide Programs
OSHA	Occupational Safety and Health Administration
OEHHA	Office of Environmental Health Hazard Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PB-HAP	Persistent Bioaccumulative - Hazardous Air Pollutant
POM	Polycyclic Organic Matter
REF	risk equivalency factor
RTR	Risk and Technology Review
SAB	Science Advisory Board
TEF	toxicity equivalency factor
TEQ	Toxic Equivalents
TRIM.FaTE	Total Risk Integrated Methodology - Fate, Transport and Ecological Exposure
UCL	Upper Confidence Limit
USDA	US Department of Agriculture
USGS	US Geological Survey

1. EXECUTIVE SUMMARY

This report was prepared by the U.S. EPA Science Advisory Board (SAB.) The Board convened the Risk and Technology Review (RTR) Methods Review Panel for initial deliberations in response to a request by EPA's Office of Air Quality Planning and Standards (OAQPS) to review their draft document entitled, "*Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*" (U.S. EPA 2017). This document (hereinafter referred to as the "Agency's draft RTR methods document") describes portions of the methods used to assess "residual risk" i.e., the potential risks remaining after application of maximum achievable control technology (MACT) pursuant to the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations.

Screening methodologies are used to quickly identify those facilities in a source category that have little potential for human health multipathway or environmental risk, while also identifying those facilities where a refined multipathway or environmental risk assessment may be needed. The Agency's draft RTR methods document describes several improvements to the screening methods.

The SAB reviewed the draft RTR methods document as requested by considering eight charge questions posed by the EPA (See Appendix A). The SAB provides comments on the RTR screening methods and does not address the regulatory implications of the methods or the document. The SAB also notes that no methods were submitted for review regarding the technology portion of the RTR analysis called for by the NESHAP regulations, nor were charge questions posed regarding the technology review methods to be applied by the EPA.

The SAB RTR Methods Review Panel deliberated on responses to the charge questions specific to the Agency's draft RTR methods document during a face-to-face meeting on June 29-30, 2017, and discussed its draft report in a subsequent conference call on December 5, 2017. The Chartered SAB conducted a quality review of this document on May 31, 2018. The charge questions focused on eight topics within the Agency's draft RTR methods document, including: *the three-tiered multipathway screening approach used in the RTR analyses; the risk equivalency factor methodology; fishing, lake and pond assumptions; lake data, plume rise, and meteorological data; the gardener scenario; environmental risk screening methodology; inhalation risk assessment enhancements; and the census block receptor check tool.*

This Executive Summary highlights the SAB's major findings and recommendations. The SAB commends the EPA on the technical quality of the draft RTR methods document and the thought and effort it has put into developing the residual risk screening methodology. The SAB finds that the overall methodology and specifically the revisions since 2009, are reasonable and should improve the EPA's assessment capabilities. The comments and recommendations offered below are intended to assist EPA staff as they seek to improve their RTR assessments going forward and are not meant to detract from the screening and assessment efforts to date.

The SAB agrees that the three-tier multipathway risk screening approach, starting with health protective parameters and moving to more site-specific parameters in later tiers, is reasonable and logical. The SAB finds the expansion of the endpoints for the environmental risk screen is reasonable and the benchmarks and use of a tiered screening system are

justified. Overall, the screening methodology has the potential to achieve the EPA's goal to quickly screen facilities, and to focus Agency time and resources on sites of most concern from a public health point of view.

The SAB recommends that future RTR methods documents be written for a primary audience envisioned as a risk assessor trying to reproduce the results of an EPA RTR risk assessment screening, rather than for the audience of peer reviewers.

The SAB finds summary information about overall performance of the methods and case studies to be missing from the report or inadequate for a comprehensive assessment of the methods described. For example, the SAB could not assess the overall operational effectiveness of the screening methods, such as how many facilities are screened out compared to those facilities passed on for more detailed analysis. The SAB very strongly recommends the EPA compile summaries of RTR analyses applied in regulatory activities and include the summaries in future RTR documents for review by the Board. In addition, analysis of the results by source category may indicate that some types of facilities screen out earlier than others and it may point out risk drivers, sensitive parameters and key features that could be refined to improve the screening analysis for particular source categories in the future.

In future screening analyses the EPA should compare, for specific facilities, the screening model output with field data, where available. For example, field measurement data on relevant persistent bioaccumulative hazardous air pollutants (PB-HAPs) in atmospheric deposition, soil, water, and fish could be used to validate key screening model outputs, especially in the Tier 3 evaluation. These "ground truth" studies must be included in the next RTR methods document and provided to future SAB reviewers for consideration.

Data quality considerations are important in RTR assessments. Experience has shown that significant errors can occur in RTR input data, which in turn, can skew risk results, sometimes by material, policy-relevant margins. Accurate input data are the bedrock foundation on which all RTR risk analyses build. The SAB recognizes EPA's past efforts to ensure RTR input data accuracy, and strongly supports and encourages such efforts. Building on the substantial efforts that EPA staff have already made, EPA could further develop and expand its affirmative efforts to ensure RTR input data accuracy. The possibility of such errors and their policy implications should continue to be considered when conducting RTR risk analyses and interpreting results.

The SAB recommends the EPA examine refinements to the tiered screening methodology by conducting sensitivity studies to identify the key input values that drive the risk estimates. EPA also should evaluate the use of probabilistic analyses to estimate more accurately the overall risks. In cases where these input values are uncertain but appropriate, distributions for these parameters could be constructed; probabilistic analysis would provide a more robust foundation for the screening methodology.

Regarding the risk equivalency factor (REF) calculation, the SAB supports the toxicity equivalency factor (TEF) read-across approach as it is well accepted for dioxins and carcinogenic polycyclic aromatic hydrocarbons (PAHs). For the exposure equivalency factor (EEF) estimate, the read-across approach, for environmental fate and transport, is not as well tested and thus deserves further consideration. EPA's empirical correlation between the *n*-octanol/water partition coefficient (K_{ow}) and lifetime average daily dose (LADD) for chemicals

with sufficient data is a logical step in creating the read-across approach used by the EPA. However, K_{ow} is an imperfect predictor of LADD and incorporation of other factors (e.g., environmental persistence and molecular weight) may improve the estimates. The SAB finds this read-across extrapolation approach could be refined and has identified two options for the EPA to consider for improving the EEF estimates.

The SAB also finds the REF method would greatly benefit from better explanation, documentation and statistical analysis in terms of: (a) documentation of TEFs, including consideration of whether assigning a TEF for carcinogenic activity is appropriate for PAHs not currently identified as carcinogens; and (b) documentation of the methods for the EEF derivation.

The SAB is generally supportive of the assumptions used for human fishing behavior in the refined fishing scenario and offers several specific suggestions for improving the data used, the model versions used, and how to document studies used by the EPA for the data and modeling methods.

Tier 3 screening introduces refinements to the treatment of air pollutant dispersion and deposition. EPA should consider the use of plume-rise models other than those described in the Agency's draft RTR methods document and could test and demonstrate the reliability of plume rise adjustments. The accuracy of dispersion and deposition results from the TRIM.FaTE model should be evaluated by comparing them with the results from a more technically robust dispersion model, such as AERMOD. The SAB suggests EPA evaluate the selection of urban vs. rural terrain in the inhalation risk assessments by comparing TRIM.FaTE-derived screening results to those calculated by a more physically-based model such as the regularly updated AERMOD. For this and other air dispersion and transport modeling, the SAB recommends that EPA consider the use of meteorological reanalysis data for both surface-air and upper-air wind speeds.

The SAB agrees that the proposed gardener scenario is an appropriate addition to both Tier 2 and Tier 3 screening evaluation. However, it is important to distinguish between the gardener and the subsistence farmer. The gardener scenario improves the characterization of potential risk in both rural and urban environments for those who take part in this activity, however the SAB urges the EPA to gather data characterizing the population engaged in this activity and the primary exposure routes in order to evaluate the efficacy of this scenario.

The Agency should consult with colleagues across the EPA who have data and models for addressing parameters used in the screening analysis. For example, the SAB understands the Agency has data or models available for parameters such as lake outflow, chemical runoff and erosion.

The SAB found the methodology for identifying the pollutants to be included in the environmental risk screening activities are clearly stated and the criteria used to prioritize the chemicals are found to be appropriate. The SAB is concerned that selenium is not included as a chemical to screen and recommends that it be added in future RTR screening analyses.

The SAB agrees that characterizing the terrain as urban versus rural and incorporating the effects of turbulence as a dispersion modeling input is appropriate. This refinement has significant value because it avoids the overly conservative assumption of applying the "rural"

assumption to all facilities. However, the SAB disagrees with the Agency's draft RTR methods document on the procedure of choice and recommends using a land use-based procedure utilizing national land cover data (NLCD).

The SAB finds that insufficient information was provided about the census block receptor check tool, especially regarding criteria used to determine the number and placement of new receptors. The SAB is concerned that the process would not be reproducible if another risk assessor were to subsequently model a facility. Overall, the SAB finds that, while the method's reliance on census block centroid locations may in some cases be sufficient for screening, care must be taken that receptors are well-placed to be representative of residential areas near the facilities. To facilitate tool transparency and results reproducibility, EPA could develop protocols to enable risk assessors to exercise their professional judgment in verifying the tool-based receptor placements and document the decision process for placement (e.g., using Google Earth imagery and preliminary risk calculations) so as to be reproducible by independent expert analysts.

In summary, the SAB supports the framework and direction of refinements EPA has been making to the screening methodology for the residual risk portion of RTR analyses. In many cases, the SAB supports the methodological details used by the EPA; and in other cases, the SAB recommends considering refinements or alternative approaches.

By the EPA's accounting, provided in response to inquiry by the SAB, for the five most recent RTR analyses conducted prior to June 2017, Tier 1 on average screened out 30% of the affected facilities, and the Tier 2 fisher and farmer scenarios on average screened out 60% and 70%, respectively, of the affected facilities. This demonstrates a commitment to effectively manage EPA resources and focus attention on the subset of facilities that are not deemed low-risk based on the screening analysis. However, insufficient information was provided in the RTR methodology report for the SAB to evaluate the overall efficacy of the EPA's methods. EPA's multi-tiered risk screening approach appears designed intending that: (a) high-risk facilities are not prematurely screened out (with adverse public health or environmental implications) and (b) low-risk facilities are not unnecessarily retained for more detailed analysis (with adverse EPA resource implications). The SAB strongly calls for data to be developed and presented in future method reports that indicate how many facilities may be screened out prematurely and how many may be passed on to a full-scale risk assessment that should have been screened out in the screening analysis.

2. INTRODUCTION

EPA's Office of Air Quality Planning and Standards (OAQPS) requested that the Science Advisory Board (SAB) review the draft document, "*Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*" (U.S. EPA 2017). This document (hereinafter referred to as the "Agency's draft RTR methods document") describes the EPA's recent and proposed refinements to the screening methods for assessing "residual risk" i.e., the risks remaining after application of maximum achievable control technology (MACT) under Title I of the Clean Air Act (CAA).

The CAA establishes a two-stage regulatory process for addressing emissions of hazardous air pollutants (HAPs) from stationary sources. In the first stage, the CAA requires EPA to develop technology-based standards connected to MACT for categories of industrial sources. EPA must review each MACT standard at least every eight years and revise them as necessary. This is the technology review portion of RTR. In the second stage of the process, EPA is required to assess the health and environmental risks that remain after MACT has been applied. EPA must develop standards to address these remaining potential risks if necessary to protect the public health with an ample margin of safety or to prevent adverse environmental effects. This second stage of the RTR is known as the residual risk review and must be completed within eight years of promulgation of the initial MACT standards for each source category.

The EPA, in order to streamline and standardize the residual risk review for the large number of affected source categories, has developed a process by which it: (1) conducts a risk assessment using currently available source and emissions data; (2) requests public comment on the source and emissions data, along with preliminary risk assessment results, through an Advance Notice of Proposed Rule Making (ANPRM); (3) addresses comments received on the ANPRM; and (4) revises the risk assessment as needed. The results of the revised risk assessment are intended to support proposals and promulgation of technology- and risk-based regulatory decisions through a transparent, science based, notice-and-comment rulemaking process.

The Agency's draft RTR methods document describes revisions to the screening methods used when conducting the risk portion of Risk and Technology Review assessments. These assessments evaluate the effects of industrial HAPs emissions on public health and the environment. Screening methods are used to quickly identify, for a particular RTR source category, those facilities that have little potential for human health risk via multipathway exposure or little potential for environmental risk, while also identifying those facilities where a refined risk assessment may be needed.

Previous internal EPA and external peer review panels have reviewed aspects of the RTR methodology, as documented in the following reports:

1) The *Residual Risk Report to Congress* (U.S. EPA 1999), a document describing the EPA's overall analytical and policy approach to evaluating residual risk in the context of setting NESHAP standards, was issued to Congress in 1999 following an SAB peer review. Many of the design features of the RTR assessment methods were described in

this report, although individual elements have been refined over the subsequent two decades.

2) Individual residual risk assessments – several internal peer reviews and one external peer review were conducted on risk assessments for individual source categories, including Coke Ovens (U.S. EPA 2018a), Perchloroethylene Dry Cleaning (U.S. EPA 2018b), and Halogenated Solvent Cleaners (downloadable from: U.S. EPA 2018c). Each of these assessments used emission estimates from the National Emissions Inventory (NEI), human exposure modeling at the census block level, dose-response methodologies, and risk characterization like those for the ongoing and planned RTR assessments.
3) The National Air Toxics Assessment, or NATA, for 1996 was peer-reviewed by the SAB in 2001-2002 (U.S. EPA SAB 2001). NATA 1996 was a comprehensive and cumulative risk assessment designed to include all mobile sources, small and large industrial sources, and background contributions to air toxics. Because of significant uncertainties, the SAB did not believe that it was appropriate for regulatory purposes. For example, the 1996 assessment had census block-level data resolution available, but the analysis was performed at the census tract level. This approach was refined in subsequent assessments.
4) The AMS/EPA Regulatory [Dispersion] Model (AERMOD), a source-to-receptor air quality dispersion model, was the subject of significant interagency cooperation and peer review. It is now EPA's preferred local-scale air dispersion model for industrial sources of air pollution (U.S. EPA 2018d).
5) The individual dose-response values used in RTR assessments have been the subject of peer reviews through the agencies that developed them (including EPA, through its Integrated Risk Information System, or IRIS; the California Environmental Protection Agency, or CalEPA; and the Agency for Toxic Substances and Disease Registry, or ATSDR). EPA proposes to select dose-response values for long-term exposures from these sources in the same priority order it used for NATA (i.e., IRIS, then ATSDR, then CalEPA). For acute exposure toxicity, EPA arrays several indices without prioritization; this is a source of potentially significant, yet usually unquantified, uncertainty. (IRIS - U.S. EPA 2018e, ATSDR - ATSDR 2018, CalEPA -CalEPA 2018)
6) An earlier peer review of multipathway risk assessment methodologies was conducted by the SAB in 2000 (U.S. EPA SAB 2000).
7) A consultation on EPA's updated methods for developing emissions inventories and characterizing human exposure was conducted by the SAB in 2006. The final SAB letter to Administrator Johnson transmitted the Board's comments (U.S. EPA SAB 2007).
8) A review of the updated and expanded risk assessment approaches and methods used in the RTR program was completed in 2009 (U.S. EPA SAB 2010). This methodology was highlighted to the SAB utilizing two RTR source categories: Petroleum Refining Sources MACT I and Portland Cement Manufacturing.

The focus of this review of the Agency's RTR methods document is on several updates and enhancements of the previous versions that were reviewed as documented above. The most important revisions and enhancements since the last SAB review include the following:

- a tiered multipathway screening methodology that determines whether the potential for multipathway human health risk from persistent and bioaccumulative HAP (PB-HAP) emitted from RTR source categories is low or whether more analysis is needed;

- a tiered environmental screening methodology that determines whether the potential exists for adverse ecological effects from PB-HAP and the acid gases hydrogen chloride (HCl) and hydrogen fluoride (HF) emitted from RTR source categories;
- the potential addition to the screening methodology of a new multipathway exposure scenario to estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables; and
- enhancements to the previously reviewed inhalation risk screening methodology that allow more accurate modeling of air concentrations where populations reside and better characterization of air dispersion near sources.

The SAB was asked to review the current draft RTR methods document by considering eight charge questions posed by the EPA. The SAB provided comments on the RTR methods and did not address the regulatory implications of the method or the report. The SAB Risk and Technology Review (RTR) Methods Review Panel met in a public meeting on June 29 – 30, 2017 in Arlington, VA, to review the Agency's draft RTR method document. The SAB Panel held a subsequent teleconference on December 5, 2017, to discuss its draft advisory report. The Chartered SAB conducted a quality review of this report on May 31, 2018. The specific charge questions to the SAB are presented in the next chapter, along with the SAB's responses.

3. RESPONSE TO INDIVIDUAL CHARGE QUESTIONS

3.1 The Three-Tiered Multipathway Screening Approach

Charge Question 1. Does the SAB find that the three-tiered multipathway risk screening approach appropriately eliminates from further consideration those facilities unlikely to emit PB-HAP in concentrations resulting in appreciable multipathway risk and identifies those facilities where additional multipathway analysis may be warranted? Does the SAB have specific suggestions for improvement of the risk screening methodology?

RTR risk assessments provide the basis for decision making on whether a more stringent standard is necessary to protect human health and the environment after implementation of a NESHAP for a specific source category. The risk assessment process is both time and resource intensive. Therefore, EPA first screens affected facilities to determine whether a full-scale facility-specific risk assessment is warranted. Since the 2009 SAB review of RTR methods, the EPA has developed a three-tiered multipathway screening approach that progressively replaces health-protective default assumptions with location and facility specific data. The goal is to "screen out" minimal risk facilities such that only potentially high-risk facilities remain in the pool for further analysis.

EPA's screening methodology for ingestion risks uses a multipathway, tiered approach. Models are used to simulate the transport and fate of HAPs emitted from specific facilities in the source category being assessed. Modeling outputs include estimates of contaminants in the environment and estimates of human health risks primarily from the ingestion of HAPs from food products such as vegetables, fruit, meat, and fish because the focus of this tiered screening is on persistent and bioaccumulative toxicants.

The SAB agrees that the three-tier multipathway risk screening approach, starting with generic health protective parameters and moving to more site-specific and realistic parameters in later tiers, is appropriate. Its general structure is consistent with a long history of EPA multi-tiered risk screening approaches designed with the intent that: (a) high-risk facilities are not prematurely screened out (with adverse public health or environmental implications) and (b) low-risk facilities are not unnecessarily retained for more detailed analysis (with adverse EPA resource implications). While the SAB finds the overall approach is appropriate and has the potential to achieve the EPA's goals, as noted below the overall effectiveness is not clear. EPA should evaluate the current effectiveness and refinements to improve effectiveness.

Based on the information presented in the draft RTR methods document, the effectiveness of the screening methodology could not be confirmed. The SAB strongly calls for data to be developed and presented in future method reports that indicate how many facilities may be screened out prematurely and how many may be passed on to a full-scale risk assessment that should have been screened out in the screening analysis.

Screening efficacy could be examined in two ways. First, the operational effectiveness could be evaluated by reviewing the number of facilities screened out by each tier. While this information was not provided in the Agency's draft RTR methods document, EPA

subsequently reported that for the five most-recent RTR analyses conducted (at the time of the EPA's correspondence on November 9, 2017), Tier 1 on average screened out 30% of the affected facilities, and the Tier 2 fisher and farmer scenarios on average screened out 60% and 70%, respectively, of the affected facilities. More information included in the report would have been useful when assessing the appropriateness of modeling inputs and assumptions. An analysis of the tier-specific screening efficacy should be conducted for each source category (i.e., an examination of prior RTRs which used the current approach to screening) to assess whether some types of industrial facilities screen out earlier than others. This analysis may point out the risk drivers, sensitive parameters and key features that could be refined to conduct better screening analysis for particular source categories in going forward. Second, the best way to evaluate the three-tiered approach in a scientific manner is to "ground-truth" the evaluations, using monitoring data from either new sites or previously evaluated sites. This type of validation would require focused and deliberate study, yet it would represent an improvement in the understanding of screening procedures. For example, available monitoring data on PB-HAPs in atmospheric deposition, soil, water, and fish could be used to examine the effectiveness of higher-tiered screening and in particular to validate key points in the Tier 3 evaluation.

EPA's tiered approach is geared towards protecting the most highly exposed subpopulations – combined subsistence fishers and farmers and their children who also ingest soil. The first tier is intended to be quite health protective and SAB concurs that it is conservative. Page 15 of the Agency's draft RTR methods document highlights some of the more health-protective assumptions in the Tier 1 screening scenario. However, many assumptions are not transparent in the Agency's draft RTR methods document, making it impossible to assess if there are opportunities for refinement of those assumptions. For example, EPA should list the key assumptions used for the watershed characteristics that enhance chemical loading to the lake and farm via erosion and runoff e.g., it is not clear how the chemical is loaded into the lake and the assumptions for the volume of water transporting the chemical into the lake. This is a particularly relevant example because the scenario does not change across the tiers and there might be opportunities for refinements.

There is concern about the specific values selected for the modeling parameters, both individually and in combination. The use of multiple high-end health protective parameters can result in an excessive overestimate of potential risk. While each health-protective assumption on its own may seem reasonable, combining or overlaying multiple health protective assumptions can lead to more conservatism than is intended. An unintentionally high and unnecessary degree of conservatism likely renders the tiered risk screening ineffective, or at best inefficient. EPA should consider possible refinements to Tier 1 if the overestimation of risk is such that obviously low-risk sites are not screened out.

The SAB recommends the EPA examine refinements to the tiered screening methodology by conducting sensitivity studies to identify the key input values that drive the risk estimates. This could be used to refine Tier 1 if desired and is particularly relevant to Tiers 2 and 3. As one example, the EPA could conduct a sensitivity analysis on the impact of runoff assumptions on modeled human health risk and consider refining the health-protective Tier 1 runoff parameters as the screen moves to Tier 2 and to Tier 3. As the EPA conducts these evaluations, it should have the flexibility to adjust its methods and the parameters as needed

to ensure health-protective yet efficient RTR screening occurs in future RTR screening analyses.

EPA should evaluate the use of probabilistic analyses, perhaps initially through case studies on Tiers 2 and 3 analyses, to more accurately estimate overall risks. As previously stated, sensitivity analyses can be used to identify key input values that drive the risk estimates. In cases where these input values are also uncertain, probabilistic analysis would provide a more robust foundation for the screening methodology. This would require assessing whether enough data are available to construct distributions for the input parameters. If so, then probabilistic analysis combining the effects of distributions of multiple input values would result in a coherent analysis from which arithmetic means and operationally-defined "conservative fractiles" (e.g. a 90th percentile) could be derived.

Overarching data quality considerations are important in RTR assessments. Errors can occur in RTR input data which in turn can skew risk results, sometimes by material, policy-relevant margins. Data errors can be caused by such factors as reporting mistakes by individual facilities and undetected, incorrect information in publicly-available national, regional, and local emission inventories. The SAB recognizes the fundamental importance of accurate input data as a bedrock foundation on which all RTR risk analyses build. The SAB recognizes EPA's past efforts to ensure RTR input data accuracy, and strongly supports and encourages such efforts. Building on the substantial efforts that EPA staff have already made, EPA could further develop and expand its affirmative efforts to ensure RTR input data accuracy. Possible approaches to reducing such errors were discussed during the panel's public deliberations and are documented in the public records of the meetings available on the EPA website (EPA 2018f). The possibility of such errors and their policy implications should continue to be considered when conducting RTR risk analyses and interpreting results.

Additional comments and recommendations are as follows.

- If EPA seeks to further refine the Tier 1 screening of low-risk facilities, it might reconsider the current approach of combining exposures for farming and fishing on top of other conservative assumptions regarding weather conditions, deposition and runoff. It is unlikely that the same person consumes <u>all</u> food categories from media located close to the facility and these media receive the conservative-estimate high-end chemical loading rates day after day.
- Although there are refinements to the air modeling at Tiers 2 and 3, there is no comparable refinement of chemical runoff and erosion from the watershed. EPA does not provide any information on parameters and assumptions made (including the pond scenario) and thus the SAB cannot provide detailed comments on potential refinements to these models.
- TRIM.FaTE (U.S. EPA 2002) is used to model air dispersion. EPA should indicate if this model has been updated since 2002, and why EPA chose this model over AERMOD, which has been continuously improved and updated many times over the years (as recently as January 2017). It may be useful for EPA to compare estimates based on TRIM.FaTE and AERMOD for a range of representative scenarios.
- As discussed in more detail in the response to Charge Question 3, there is a complicated reasoning underlying the Tier 2 sustainable fishing scenario. Perhaps

EPA found it necessary to introduce such details at Tier 2 to be able to screen out low-risk facilities. For the purposes of Tier 2, however, it seems that simpler worst-case assumptions could be made that simplify the approach. The SAB recommends the EPA consider other data available to make more realistic assumptions, such as the most recent National Health and Nutrition Examination Survey (NHANES CDC 2018.), to estimate fish consumption.

- Many of the pathways are related to those used by the EPA Office of Pesticide Programs (OPP), which are based on U. S. Department of Agriculture (USDA) Cropland Data Layer and more recent (2005-2010) NHANES dietary consumption data. These could be used to inform EPA's RTR screening approaches[2]
- Regarding some of the individual parameters, from the documentation provided it wasn't clear whether the breastfeeding exposure or other early life pathways would adequately cover these sensitive early life stages. The potential impact of seasonal changes in food-sourcing should also be considered although it was recognized that fishing and gardening/farming can be year-round activities in certain parts of the country.
- The focus only on cancer risk for dioxins and benzo[a]pyrene may underestimate early life (e.g., breastfeeding) risks given these are short-term exposures whose lifetime average daily dose (LADD) will be diluted by the rest of the lifetime at lower exposure. Table 3.2 indicates that non-cancer endpoints are "not critical" for these chemical classes; this is a pre-judgement that should be further explored, especially for early life exposures. The SAB notes that benzo[a]pyrene has a very recent RfD on IRIS that is based upon an early life developmental effect (U.S. EPA 2018g).
- Several polycyclic aromatic hydrocarbons (PAHs) with toxicity equivalency factors (TEF) are not generally considered carcinogens (e.g., pyrene, phenanthrene, fluorene, fluoranthene, and acenaphthalene). These compounds do not appear on the lists of relative potency factors used by EPA (U.S. EPA, 1993) nor are they presented in lists published elsewhere (e.g., Nisbet and Lagoy 1992). These early 1990s references are still relevant as demonstrated by EPA's 2017 IRIS toxicological review for benzo(a)pyrene which refers to the EPA's 1993 guidance as the source of PAH relative potency factors (U.S. EPA 2018h). In addition, the PAHs in question are not listed as carcinogenic by the International Agency for Research on Cancer (IARC) or the National Toxicology Program (NTP) of the U.S. Department of Health and Human Services. The TEF approach for pyrene, phenanthrene, fluorene, fluoranthene, acenaphthalene and several other PAHs should be reconsidered.
- The draft RTR methods document should be modified to be more explicit about the decision-making on transitioning from Tier 1 to Tier 2, and from Tier 2 to Tier 3, particularly with regards to evaluating the potential risks associated with multiple chemicals and combining hazard quotients and risks. In addition, the basis for the inclusion and exclusion of particular chemicals, for example lead, should be more clearly stated.
- Page 16 of the draft RTR methods document indicates that "dermal absorption of originally airborne chemicals similarly has been shown to be a relatively minor

[2] https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm; https://www.agcensus.usda.gov/Publications/2012/Online_Resources/Ag_Atlas_Maps/; https://www.epa.gov/sites/production/files/2015-09/documents/deem-user-guide-sep30-14.pdf); https://www.epa.gov/sites/production/files/2016-05/documents/public_webinar_overview_of_the_draft_bes_final.pdf

exposure pathway compared with other pathways" and cites one report from 2000 and another from 2006, to support the statement. The EPA should investigate whether the evidence still supports that conclusion and applies to all classes of chemicals. More recently, several studies have suggested that dermal absorption of certain classes of chemicals in indoor air can contribute significantly to a person's overall dose (Weschler and Nazaroff, 2012, 2014; Morrison et al., 2016).

- The SAB supports the EPA's decision to separate subsistence farmers and subsistence fishers in Tier 2.
- The SAB notes that by conducting the analysis on a chemical-by-chemical basis, limited by law to the industrial category under RTR evaluation, multiple sources of a chemical emitted nearby from other industrial source categories may contribute to cumulative effects and chemical interactions because of multiple exposures. The cumulative risk may be missed by the human health risk screening conducted following the RTR method being reviewed.

3.2 Risk Equivalency Factor Methodology

Charge Question 2. Does the SAB find that the risk equivalency factor methodology appropriately accounts for differences in the environmental fate and transport among polycyclic organic matter (POM) and dioxin congeners?

Previously the RTR screening methods did not account for differences in environmental transport and fate among POM or dioxin congeners in the Tier 1 screening approach. All POM congeners were assumed to be transported, partition, and degrade in the environment identical to benzo(a)pyrene (BaP), and all dioxins were assumed to exhibit the same transport and fate as 2,3,7,8-TCDD. Since 2009 when the RTR Methodology was last reviewed by the SAB, the EPA has significantly refined its approach. Section 3.1.2 of the Agency's draft RTR methods document describes a new risk equivalency factor (REF) methodology that includes an exposure-equivalency factor (EEF) to reflect an individual chemical's transport and fate relative to the index chemical for each group (i.e., BaP for POM and 2,3,7,8-TCDD for dioxin).

The REF methodology has been incorporated as a screening tool into the residual risk assessment of stationary sources. It grapples with a common problem when dealing with complex mixtures – the evaluation of components with poorly characterized environmental fate and toxic effects. The SAB appreciates that when data gaps preclude inclusion of a chemical component of POM in a risk assessment, this component is often assumed to contribute zero exposure and risk. Rather than create such an underestimation, EPA has provided a screening methodology to fill such data gaps and thus include the full array of targeted POM constituents. In general, the SAB finds the overall approach to potentially be appropriate with more work needed to address concerns as described below.

The REF methodology consists of two read-across approaches[3] – one to handle toxicology data gaps, and the other to handle information gaps regarding environmental transport and

[3] Physicochemical, human health and/or environmental properties may be predicted from information from tests conducted on reference substance(s) within the group, referred to as source substance(s), by interpolation to other substances in the group, referred to as target substance(s). This approach is called "read-across." (https://echa.europa.eu/documents/10162/13628/raaf_en.pdf)

fate. The SAB agrees with the toxicity equivalency factor (TEF) approach as it is well accepted for dioxins and carcinogenic PAHs. The SAB has not checked all the tabulated values for representativeness but notes that some of the PAHs given TEF factors by EPA are not typically considered to be carcinogenic; this was discussed in the SAB's response to Charge Question 1. The selection of TEFs for these and other PAHs is not provided in the Agency's draft RTR methods document and should be documented with references in Table 3.4.

The read-across approach for environmental fate is less well tested and accepted and thus deserves further consideration. EPA's proposed EEF is based upon a fundamental chemical property – K_{ow}. This property helps determine certain aspects of environmental fate such as uptake into fish, beef and dairy, but there are numerous other fate behaviors which it does not predict such as metabolism, biodegradation, environmental half-life and several types of phase transitions and partitioning. Thus, it is perhaps overly optimistic to expect K_{ow} by itself to have high concordance with exposure dose.

EPA's empirical correlation between K_{ow} and LADD for chemicals with sufficient data (RTR methods report Figure 3.2. U.S. EPA 2017) is a logical step in creating the read-across approach. However, as suggested above, K_{ow} is an imperfect predictor of LADD. Figure 3.2 shows the relationship between K_{ow} and LADD for 14 POM analytes for which there are more complete data. There is considerable variability around the regression line in Fig 3.2; this variability is currently unexplored but may arise from uncertainty and variability in the underlying parameters that influence the LADD including not only K_{ow} but also intermedia partition coefficients, molecular weight, half-life, potential for biodegradation, etc. The variability around the regression line is up to two orders of magnitude and thus the calculated EEF may substantially underestimate the LADD for some undefined members of data-poor chemical classes.

The SAB finds this read-across extrapolation of environmental fate could benefit from a refined approach and has identified two options for improving the EEF estimate as follows.

- Conduct further statistical evaluation of the relationship between K_{ow} and LADD to generate an upper bound on the regression slope and then apply this to derive EEFs for data poor chemicals.
- Conduct further evaluation of the underlying transport and fate parameters to develop distributions for each influential parameter and then perform a probabilistic analysis that replaces the Fig 3.2 regression slope; EPA can then make a transparent choice of which percentile of the distribution of LADDs for a given K_{ow} (and/or additional parameters) will be used in evaluating exposure and risk for data-poor POMs.

The SAB also finds the current documentation of key parameter inputs to the fate, transport and bioaccumulation model for PB-HAPs is not adequately described. The range of potential values and key citations should be presented in an appendix for all the modeled PB-HAPs. The document states that the EEF will change based upon environmental and geospatial conditions (e.g., Page 19, paragraph 1) but examples of this dynamic relationship are not provided, which further precludes a full review. For example, how are the effects of age/weathering incorporated to account for the loss of lighter dioxin congeners over time or with distance?

The SAB notes that in Table 3.4, the products of the EEF and TEF values do not always equal the corresponding REF. Perhaps rounding prior to the multiplication causes these differences. Whatever the reason, the product of column multiplication should be mathematically consistent to avoid the impression that the table contains incorrect values.

In summary, the SAB finds that the REF would benefit from better explanation, documentation and statistical analysis in terms of: (a) documentation of TEFs (Table 3.4), including consideration of whether the TEF for carcinogenic activity is appropriate for certain PAHs not traditionally considered as carcinogens; and (b) documentation of the methods for EEF derivation, especially with respect to better analysis of the relationship between EEF and key environmental fate characteristics of each chemical (K_{ow}, environmental persistence, molecular weight, etc.) potentially including a probabilistic analysis and, at a minimum, more complete statistical treatment of the relationship between K_{ow} and LADD.

3.3 Fishing, lake and pond assumptions

> *Charge Question 3: Does the SAB find that the assumptions for human fishing behavior used in the refined fisher scenario, the assumptions about PB-HAP deposition to lakes, and the assumptions on the ability of ponds and lakes to sustain populations of fish are appropriate?*

The Tier 2 multipathway screening scenario replaces some of the assumptions in the Tier 1 screen and is considered more realistic than Tier 1. Specifically, site-specific information is used for the locations of potentially fishable lakes and for meteorology. In addition, the Tier 2 assessment includes: a screening configuration that assesses the fisher and farmer exposure scenarios separately; and an estimation of lake productivity and fish population dynamics. The consideration is that a fisher might catch and consume fish from more than one nearby contaminated lake because more than one lake might be needed to catch enough fish for subsistence living. The approach at this level of screening analysis also attempts to account for PB-HAP deposition into a lake from multiple facilities in the same RTR source category.

3.3.1 Human fishing behavior and sustainability of fish populations in ponds and lakes

The SAB finds the assumptions used for human fishing behavior in the refined fishing scenario to be appropriate with caveats as noted below, while the assumptions concerning sustainability of fish populations in ponds and lakes may be inappropriately conservative. Assuming all parameters (such as size of the lake needed to support fish of a given size, assumptions about fish populations, etc.) are correct, the approach used seems reasonable. The equations seem appropriate and the assumptions appear to be properly managed. However, the SAB finds that most of the assumptions/parameters are possibly too conservative to achieve the objective of effective risk screening and suggests that more realistic ingestion rates and other model parameters be considered. For example, the Tier 2 method limits the fish consumption rate from a local water body due to potential depletion of fish by a single subsistence fisherman. The end result of a number of assumptions and productivity calculations is that no more than 1 gram fish/acre of waterbody can be sustainably removed per day (page 40, lines 7-9). In comparison, in one study the productivity of lakes was 82 kg/hectare/year (N=22 lakes, Randall et al. 1995) which converts to 90 g/acre/day. This 90-fold difference indicates the EPA should reconsider lake

productivity and how to relate it to fish consumption estimates for a specific lake. Furthermore, with some of the contaminants examined, fish will not take up 100% of the chemical. Also, the chemicals considered will have different toxicodynamic and toxicokinetic properties in the fish, making the half-life of some chemicals (PABs/dioxins) much shorter than values assumed. These issues will affect exposure estimates in the fisher population.

There is considerable heterogeneity across lakes and the SAB has concerns with the presumed universality of some of the assumptions invoked for the analysis. For example, the analysis assumes: 21% of the fish biomass are piscivores; benthic fish account for 17.5% and pelagic fish account for 3.5% of total fish biomass; humans consume 50:50% from benthic and pelagic piscivores (note some people consume pan fish); and total fish biomass is 40 g fish ww/m^2. It seems likely that rather than fixed values these parameters have a wide range of occurrence in actual lakes. Also, as explained in the appendix of the Agency's draft RTR methods document, benthic fish collection is usually higher than pelagic species (although pelagic are preferred by consumers) due to the general species abundance. The SAB recommends that the EPA document and justify these assumptions.

The SAB encourages the EPA to consider other data available to make more realistic assumptions such as using the most recent NHANES data to estimate fish consumption. Additionally, the EPA might be able to refine the assumptions on chemical runoff and erosion from the watershed by using relevant U.S. Geological Survey (USGS) data that are available for the region of interest (U.S.G.S. 2018). As another example, the EPA Risk-Screening Environmental Indicators (RSEI) Model is part of the Toxics Release Inventory (TRI) program and is primarily used as a transport and fate model to estimate concentrations, hazard level and risk of air pollutants covered by the TRI. However, RSEI also has a model that estimates transport and fate of TRI releases to water bodies including both direct releases and transfers between wastewater plants. The primary data product is toxicity-weighted concentrations downstream of TRI discharges. These data are available by stream segment. The Office of Pollution Prevention and Toxics could presumably prepare data specific to the modeler's needs. Alternatively, the RSEI Water Microdata can also be accessed online (U.S. EPA 2018i).

The SAB struggled with understanding some of the RTR modeling inputs/assumptions. This process may become more transparent if the data are presented with information about how studies were included or excluded, how data were prioritized and selected for use, how the evidence was weighted, etc. The appendices to the EPA report achieve this goal to a certain extent but are incomplete.

3.3.2 PB-HAP deposition to lakes

The SAB could not determine whether the assumptions for PB-HAP deposition to lakes are appropriate for the following reasons. Regarding PB-HAP transport and deposition, air dispersion models recommended by EPA, such as AERMOD, have been continuously improved and updated many times over the years (as recently as January 2017). Such models have been used by many users in a variety of regulatory applications and have been subject to rigorous performance evaluation by EPA and the scientific community to test and demonstrate their accuracy. The SAB recommends clarification of the extent to which TRIM.FaTE has been updated since 2002, when its technical support document was released. Assuming AERMOD is valid for the use cases of interest, the reliability of TRIM.FaTE's air

dispersion component should be assessed by comparing to AERMOD for a variety of scenarios. Also, the EPA may seek to consult with EPA Office of Pesticide Programs (OPP) Environmental Fate and Effects Division (EFED) since they have developed models with different tiered assumptions about runoff into ponds.

It is unclear how accurately PB-HAP deposition is calculated by TRIM.FaTE. Additional information is needed to demonstrate the accuracy (or for a screening methodology, to evaluate how conservative the assumptions are) of such deposition estimates and their implications to the reliability of fish consumption exposure estimates. EPA should test and demonstrate for a range of representative scenarios the reliability of TRIM.FaTE air concentration and deposition estimates.

Finally, the SAB recommends conducting a sensitivity analysis of the distribution of critical parameters at higher tiers. The use of multiple health-protective assumptions/parameters is likely to overestimate the actual risks, probably by a substantial margin. Furthermore, a probabilistic analysis should provide a more accurate and transparent estimate regarding uncertainty of the risks and may be appropriate at higher tiers.

3.4 Lake data, plume rise, and meteorological data

> *Charge Question 4: Does the SAB find the methods used for evaluations of (1) lake data, (2) plume rise, and (3) time-series meteorological and time-series plume-rise data are appropriate?*

When the Tier 2 screening analysis indicates that further evaluation is warranted, the EPA applies the Tier 3 screening approach described in Section 3.3 of the Agency's draft RTR methods document. The method includes three individual refinements to the Tier 2 methods that are conducted in a step-wise fashion. The refinements include: further analysis of the affected lakes identified in the Tier 2 screen; analysis of plume rise resulting in PB-HAPs lost to the upper atmosphere; and the use of time-series meteorology from meteorological data stations and modeled effective chemical release heights.

3.4.1 Lake data

The SAB finds the method to evaluate lake data to be generally appropriate and indicates items for refinement. The SAB supports the use of up-to-date land-use data to more accurately represent exposures that occur through lake media. EPA should consider relying less on analyses that are time-intensive and that depend on analysts' subjective judgments. Web or GIS searches, as described in the Agency's draft RTR methods document, may be useful to produce input data. A guiding principle should be "documented and reproducible" such that independent experts can understand the data and methods applied by EPA analysts and can reproduce the results.

EPA should consider the use of data streams that can be automated so that ongoing land use changes can be incorporated. Widely available data sets include the National Land Cover Database (NLCD) and USGS Digital Elevation Model (DEM). The SAB cautions EPA against *a priori* exclusion of wetland influenced lakes, which may host fish.

3.4.2 Plume rise

The SAB believes the plume rise methodology may be inappropriate in some cases EPA should evaluate the use of plume-rise models other than those described in the Agency's draft RTR methods document screening procedure. An example is Briggs (1984) and the documentation of AERMOD (Cimorelli *et al.* 2004) which thoroughly discusses plume rise and contains other citations.

For this and other dispersion and transport modeling, the SAB recommends that EPA consider the use of meteorological reanalysis data for both surface-air and upper-air wind speeds. These data can overcome some uncertainties when weather stations are far from the modeled site.

3.4.3 Time series meteorological and plume-rise data

The SAB believes that the hour-by-hour response treatment is not yet justified. Furthermore, the corresponding time-series meteorological and time-series plume-rise data used in the hour-by-hour treatment may be inappropriate in some cases.

First, EPA should be cautious about undue oversimplification of complex atmospheric processes. Full or partial penetration of a plume through the top of the mixed layer depends on many complex factors including plume momentum, plume buoyancy, stack release height and exit conditions, depth of the mixed layer, inversion strength, and atmospheric stability. These processes may vary with time, as meteorological factors evolve over the course of a day, possibly causing plume re-entrainment or rapid fumigation. Atmospheric processes governing plume penetration are more complex than can be adequately represented by a simple comparison of inversion height with effective plume height (which includes plume rise).

Second, the Agency's draft RTR methods document indicates that hour-by-hour data from the closest meteorological station should be used. These data may not reflect specific microclimatic conditions at the site, including topography, directional valley orientations, and specific inversion conditions that can differ from those at the station. For accurate screening, these local conditions should be considered.

EPA should test and demonstrate the reliability of the proposed adjustment by comparing screening results as implemented using TRIM.FaTE to those calculated by a more physically realistic model, such as AERMOD. Indeed, the SAB suggests EPA evaluate the additional accuracy perceived to result from implementing hour-by-hour adjustments. The suggested procedure requires extensive data manipulation yet has not been validated, whereas with a moderate additional investment the screening could be done with a validated and accepted model such as AERMOD.

The SAB also has two overarching recommendations addressing issues which were not specifically called out in the charge questions.

- EPA should consider that the quantity of emissions in the National Emission Inventory (NEI) may differ from reality, either because of upset conditions, or because self-reporting does not always suffice. The location of emissions may also be different than

reported. These inaccuracies may have important effects on predicted exposures and should be assessed to the extent practicable.

- The SAB recommends that EPA consider sensitivity analysis to determine the parameters and assumptions that have the greatest effect on predicted exposures, especially at the higher tiers. Identification of factors that dominate risk and uncertainty could guide future screening analyses by providing justification to obtain detailed input data for those factors. Furthermore, probabilistic analysis would provide a framework to estimate confidence bounds.

3.5 The gardener scenario

Charge Question 5: Does the SAB find the assumptions and approaches laid out for application in the gardener scenario to be appropriate? Does the SAB find that adding the gardener scenario to Tier 3 would improve our ability to characterize ingestion risks for urban and rural environments?

The Agency's draft RTR methods document includes a new exposure pathway added to the EPA methods (Section 3.4) – a gardening exposure scenario added to the multipathway screen. This scenario is intended to better characterize multipathway risk and the EPA suggested it will significantly improve the screening for locations where the presence of a subsistence farm is either unlikely (in urban areas) or difficult to confirm based on the characterization of land use surrounding a facility.

The gardener scenario is described on pages 59-62 of the Agency's draft RTR methods document. EPA is proposing to implement this scenario as part of Tiers 2 and 3 in locations where at least some individuals are likely to consume homegrown produce. The SAB was asked to comment on the assumptions used and whether the addition of the scenario would improve characterization of ingestion risk in both urban and rural environments. In general, the SAB finds that the gardener scenario is an appropriate addition to both Tier 2 and Tier 3 evaluation thereby developing a more useful model system for screening.

Regarding the first component of the charge question – the appropriateness of assumptions and approaches in the scenario – the SAB's response focuses on the media ingested by the gardener. EPA has selected ingestion routes like those experienced by subsistence farmers. These categories include direct ingestion of soil, ingestion of protected fruits and vegetables, ingestion of root vegetables, and ingestion of breastmilk (although intake rates for the latter are not presented in Tables 3-18 and 3-19). These appear to be appropriate and sufficiently distinct to provide coverage of the appropriate sources of soil ingestion and contaminants contained in soil. EPA distinguishes intake of gardeners from farmers by noting that meat products and dairy products are not likely to be sources for the gardeners (Table 3-17).

The SAB suggests including chicken eggs in the gardener scenario as many gardeners also keep egg-laying chickens. The SAB also notes that the gardening scenario appears to use many of the same assumptions about diet as the subsistence farmer, suggesting that the gardening scenario does not add much value to the tiered approach. The SAB therefore suggests that it is especially important to distinguish between the gardener and the subsistence farmer.

EPA has separated gardeners into two categories – rural and urban. The approach seems reasonable, especially given differing intake rates for urban and rural gardeners. The

assumptions that a rural gardener would have enough land to develop a subsistence, or near-subsistence, garden while the urban gardener would not seem, on face value, to be valid. Following this reasoning, EPA uses an upper (90th) percentile estimate for intake rate of home-grown vegetables for the rural gardener but a central tendency home-grown vegetables intake rate for urban gardeners (See Table 3-19 for the intake rates). Both intake rates are taken from the Exposure Factors Handbook and appear to be justified as EPA's best assessment of such rates.

Regarding soil intake rates, gardener soil intake rates were matched to those of farmers, consistent with the notion that gardens in both rural and urban settings must be tended, affording gardeners with intimate soil contact and thus intake. Further, in the rural setting, the farmer-specific rates for surface runoff-related contamination would be used while this term would not be used in urban settings. The farmer-specific rates are less health-protective in the sense that it focuses only on agricultural runoff. In urban settings, runoff may occur from other sources (e.g., industrial facilities and roadways) and might well be considered important. The SAB suggests that these additional urban sources be considered and matched with those of the rural settings.

Except for the surface runoff component, the assumptions made above are health-protective but not unreasonably so even when compared to earlier assumptions (e.g., Charge Question 3). The SAB notes that including the same assumptions for multiple tiers likely results in little effective screening. Further, the assumptions may offer too much health protection and thereby reduce the screening utility of the tool. In addition, the SAB suggests alternative- and higher- soil intake rates for the adult gardener.

Regarding the second component of this charge question, inclusion of the gardener scenario is appropriate because it improves the characterization of the potential risk in both rural and urban environments for those who take part in this activity.

3.6 Environmental risk screening methodology

> *Charge Question 6. Does the SAB find that the environmental risk screening approach is appropriate for identifying facilities whose PB-HAP emissions may have the potential to cause adverse environmental effects? Specifically, does the SAB find that the pollutants (Section 4.2.1), ecological assessment endpoints (Section 4.2.2), and benchmarks (Section 4.3) that are included in the environmental risk screen are appropriate? Does the SAB have specific suggestions for improvement with regard to any aspect of this environmental risk screening methodology?*

Charge Question 6 addresses the information provided in Chapter 4 of the Agency's draft RTR methods document (and supporting appendices) that describes the environmental risk screen that was developed to provide a systematic, scientifically defensible, and efficient approach that EPA can use to screen for potential adverse environmental effects associated with emissions of HAPs from facilities in RTR source categories. It is designed so that the screen can be run quickly and with minimal additional data gathering by drawing on existing data, models, and modeling results, including those developed for the human health multipathway risk screen. The overall methodology was reviewed by the SAB in 2009. The material in Chapter 4 of the Agency's draft RTR methods document focused on

those aspects that have been refined/revised since the last review. The revised aspects include:

- Modeled environmental concentrations are compared to ecological benchmarks, not human health thresholds, for all pollutants included in the screen;
- An evaluation of HAPs for potential inclusion in the screen was conducted;
- The environmental risk screen was expanded to include the following additional environmental HAPs: cadmium, hydrogen fluoride, lead, arsenic, and additional POMs;
- The number of ecological endpoints and effect levels that are evaluated was expanded;
- A literature review was conducted to identify the most up-to-date ecological benchmarks; and
- Tiers were added to the environmental risk screen for PB-HAP that are parallel to the tiers in the multipathway human exposure screen.

The SAB finds that the overall methodology and specifically the revisions since 2009 are appropriate and improve the ecological assessment capabilities. It represents a comprehensive approach that builds upon, and uses, the screening tools used in the health assessment/screening (i.e., TRIM.FaTE, AERMOD). As noted below, the SAB offers several recommendations and comments towards refining the approach.

The methodology for identifying the pollutants to be included in the screening activities are clearly stated and the criteria used to prioritize the chemicals are judged to be appropriate with the following considerations to be taken into account. The SAB is concerned that selenium is not included as a chemical to screen. Selenium is an essential trace element which is toxic at elevated concentrations. Elevated exposure can lead to selenosis. Selenates and selenites are particularly toxic forms of selenium (Hamilton, 2004). Given selenium's potentially important role in ecological impacts, the SAB recommends it be considered. In addition, it is not clear that BaP is the most appropriate POM chemical to use in the ecological analysis. There may be more important POM molecules (lower molecular weights) to use in this screening and further analysis is recommended. Furthermore, the emission rates presented in Table 4.1 are for base year 2005, and they need to be updated to reflect recent emissions data. Also, on page 67 line 21 there is reference to "99.9% of national emissions" but the basis is not clear (mass, toxicity or some other basis).

The SAB finds the expansion of ecological assessment endpoints appropriate and that the benchmarks, and the use of a tier system, are justified. The Agency's draft RTR methods report and appendices document the processes and assumptions used to identify the endpoints and benchmarks. Overall, the calculation of potential risks is robust and follows current scientific methodologies. As the amount and diversity of information analyzed in identifying the endpoints and benchmarks is vast, it would be helpful to clarify when most sensitive or most exposed species are used. In addition, the SAB notes that the overall approach would be strengthened by allowing site-specific variables to be added during the assessments, as some sites may have very specific sensitive species. Using a less sensitive receptor in a screening methodology runs the risk of underestimating the impact to the environment in those regions.

Tables 4.2 (endpoints) and 4.3 (benchmarks) are critical to the screening process. Values in these tables are likely to change over time as new information becomes available so it is important that they be viewed as tables requiring continuous development and a process should be identified by the EPA to continuously review and update them. Furthermore, many of the studies listed are from the 1980s-1990s and are compilation reviews from earlier publications. Notations should be made in the table or the text as to why the benchmark value was chosen. Many of the benchmarks have multiple studies (chronic / acute) with varying methodologies and results. The SAB recommends the EPA consider grading studies based on Klimisch score, a method of assessing the reliability of toxicological studies, mainly for regulatory purposes.

The SAB finds that the general methodology of the tiered approach and the use of TRIM.FaTE and AERMOD are appropriate. The SAB notes the simplicity of the air dispersion treatment in TRIM.FaTE and encourages the advancement of incorporating AERMOD analysis within the TRIM.FaTE framework. The use of reanalysis meteorological data is recommended to improve the meteorological fields used in the analysis. As stated elsewhere in this report, the analysis would also benefit from considering the implementation of a probabilistic approach.

The SAB recommends that analysis elements performed under the environmental risk screen be incorporated in the farmer screen (e.g., utilizing the deposition to soils).

The following additional specific recommendations regarding endpoints and benchmarks are provided:

- The SAB suggests EPA consider indirect HCl effects by evaluating the concentrations of chloride from a facility relative to background chloride concentrations contributing to loss of surface water acid neutralizing capacity or soil base saturation. Critical loads of acidity have been developed (NADP 2018) for the U.S. and the acidity associated with estimated chloride deposition could be compared to these critical load values.
- Mercury targets may need to be updated or expanded to protect communities of predator animals associated with bioaccumulation of methylmercury and to reflect broader wildlife impacts[4] (e.g., song birds.)
- The water quality and soil criteria (Table 4-1) for mercury are very high. This is particularly true for water where concentrations are typically on the order of nanograms per liter (ng/L). For example, the sediment clean-up values for Onondaga Lake, NY– a mercury contaminated site – are 2.2 μg/g for probable effective concentration based on macroinvertebrate toxicity testing and 0.8 μg/g for bioaccumulation-based sediment quality. The SAB suggests EPA consider criteria values for water and sediment/soil for contaminants that have been established for hazardous waste clean-up at sites around the U.S. for several contaminants.

3.7 Inhalation risk assessment enhancements

[4] http://www.briloon.org/uploads/Library/item/265/file/Hidden%20Risk.pdf https://www.crcpress.com/Environmental-Contaminants-in-Biota-Interpreting-Tissue-Concentrations/Beyer-Meador/p/book/9781420084054https://www.niehs.nih.gov/research/supported/assets/docs/a_c/bioscience_508.pdf

Charge Question 7: Does the SAB find that the Urban/Rural Dispersion Selection Enhancement Tool is an appropriate procedure for identifying facilities to be modeled using the urban option in AERMOD?

In previous chronic inhalation risk assessments, the EPA assumed the land surrounding each facility was rural. The 2009 SAB review (U.S. EPA SAB 2010) indicated additional development was appropriate. Chapter 5 of the Agency's draft RTR methods document is an enhancement to the chronic inhalation risk assessment that the EPA contends accounts for the variation in urban to rural characteristics of the land surrounding each evaluated facility. The goal of the improvement is to better characterize pollutant dispersion near sources.

The urban/rural dispersion selection enhancement tool provides a way to specify atmospheric turbulence within a model domain to allow AERMOD to more accurately model pollution dispersion. The tool currently provides two options. The Agency's draft RTR methods document evaluates the differences in model results using these two methods and proposes using the census (population density)-based designation of "urban" ("HEM default procedure") as the preferred method.

The SAB agrees that incorporating the effects of turbulence as a model input is appropriate and of significant value because it avoids the overly conservative assumption of applying the "rural" assumption to all facilities. However, the SAB disagrees with the Agency's draft RTR methods document on the procedure of choice and recommends the land use procedure which uses the National Land Cover Database (NLCD). This procedure directly measures the feature that controls turbulence, unlike the HEM default procedure which relies on a secondary effect – an aggregated population density metric – that may not correlate well in highly industrialized areas with dense concentrations of buildings, pavement and other structures yet little residential land. The land use procedure provides a more accurate assessment for the selection, and the Agency's draft RTR methods document does not offer a compelling explanation of the benefits from using the HEM default procedure. The land use procedure also more directly aligns with EPA's 2005 Guidelines on Air Quality Models as stated on page 121 (last paragraph) in the Agency's draft RTR methods document; the guidelines list specific land use types to be considered, rather than population density.

Using the land use procedure is not significantly more difficult or time/resource intensive than the HEM default procedure, so any logistical advantage of the HEM default procedure is minimal. Analysis can be automated using Model Builder or Python scripting in ArcGIS. Problems described in the Agency's draft RTR methods document associated with the land use procedure misclassifying facilities with significant coverage by water bodies inside the model domain can be addressed in the GIS procedures, and the SAB recommends that this be included in the procedure to avoid misclassifying heavily developed areas near large water bodies as "rural."

Because the inhalation risk assessment is a location-based estimate using modeled ambient concentrations and is not population-weighted, the use of population density via the HEM default procedure is less appropriate than using land use. In addition, the land use procedure finds fewer urban areas than the HEM default procedure, indicating the latter misclassifies turbulence in some cases.

The SAB also notes that the quality of the NLCD data makes it possible to express the "urban

nature" of the model domain as a continuous variable, rather than a binary "yes/no" value. Such a calculation adds little to the time and difficulty of the GIS procedures used to calculate the variable. It provides a measure of the intensity of "urban" character for each area considered and could also be used to characterize the geographic variation of turbulence within a given model domain. There are different ways to use this type of metric in modeling; it is not certain whether EPA modeling tools can use that variation, but it might be useful in future versions of the modeling and represents a "best practices" approach for gathering input data, particularly if it is only a little more difficult or expensive to do so. Using this approach with successive versions of the NLCD, which is updated every four years, allows for tracking land cover change over time.

If EPA adopts this more nuanced use of the NLCD, the SAB suggests the EPA consider including NLCD class 22 (low intensity developed) in identifying "urban" in this context. This class is defined as 20-44% impervious surfaces and it correlates very well with residential land use when compared to other high-resolution datasets. Class 22 is used in screening methods in California and has been shown to be of value in characterizing or measuring fine scale heterogeneity in other contexts (Chabaeva and Civco 2004; Smith et al. 2010).

Another alternative is the use of a regular NLCD derivative product – the percent impervious surface data layer which is produced for each NLCD generation, as is a measure of the net change in imperviousness between NLCD generations. Use of these metrics are generally as cost effective as using population density and have the advantage of being updated more often than the census. The SAB looks forward to reviewing and commenting on the approach eventually adopted.

Regardless of the urban/rural dispersion selection procedure that is used, the automatically-generated designation should be manually evaluated with the final choice of urban/rural dispersion a matter of professional judgment based on 'facts on the ground.' In cases where a material difference in estimated potential risk exists between urban and rural dispersion and professional judgement is used to overrule the selection tool's designation, EPA should document and justify this decision.

3.8 The census block receptor check tool

> *Charge Question 8: Does the SAB find that the Census Block Receptor Check Tool and associated enhancements are an appropriate method for identifying and adjusting model receptors to ensure the receptors are representative of residential locations?*

Section 5.2 of the Agency's draft methods document describes an enhancement made to the chronic inhalation risk assessment – the addition of the Census Block Receptor Check Tool. The rationale for the new tool is that the block centroid does not always represent residential locations. The HEM-3 model calculates ambient air concentrations at census block centroid locations as surrogates for population exposure. If the centroid is located outside of the block polygon, then the U.S. Census Bureau provides the longitude and latitude of an internal point near the geometric centroid that falls inside the block polygon. The points are not weighted or reflective of the population distribution. Census blocks vary in size depending on population density. In urban areas, a census block may be equivalent to a city block bounded on all sides by a street. In sparsely populated areas, a census block is often irregularly shaped with streams, property lines, and rural roads as boundaries. In the 2009 review conducted by the

SAB (U.S. EPA SAB 2010) it was noted that census block centroids might not always be an appropriate surrogate for residential locations. The Census Block Receptor Check Tool was developed to address this concern. This new tool identifies two examples when internal centroid points may not be a good surrogate for where populations reside and provides options to address this.

The first scenario is for block centroids located within 300 meters of emission points, which may be within the facility grounds and not where there are residents. The tool user would be able to view these receptors and delete them if they are on the facility property. The second scenario focuses on large and irregularly shaped census blocks, where the centroid may be farther away from population centers. If blocks with an area greater than 2.6 km^2 are identified within 1 km of a facility, aerial images of the blocks can be examined using the tool to determine if the centroid receptor needs to be relocated and other receptors added to represent multiple residential locations.

The SAB finds the Census Block Receptor Check Tool to be an appropriate framework, but the precise methodology underlying the tool may be unreliable in some cases. The SAB offers recommendations for improving the method, but also encourages the Agency to consider an alternative approach.

The EPA report does not provide enough information about the tool, especially regarding criteria that would be used to determine the number and placement of new receptors. For example, the statement "If residential locations cannot be represented by a single receptor (that is, the residences are spread over the block), additional receptors are added for residences nearer to the facility than the centroid" (page 140, lines 15-17) is vague and the method appears to be *ad hoc*. The SAB is concerned that the process would not be reproducible if another risk assessor were to subsequently model that facility. The choice of a 300-meter buffer from an emission source is also somewhat arbitrary. Furthermore, the impact of these changes is not obvious. The Agency's draft RTR methods report should include more detailed examples of how risk estimates change based on these enhancements compared to the default block centroid method.

Overall, the SAB believes that methods predominantly relying on census block centroid locations – including cases where the enhancement tool is applied – can in some cases be reliable, but additional effort is needed to verify that receptors are representative of residential areas near the facilities. One approach would be to review satellite imagery within 1 km of all facilities, not just those in identified large census blocks, and manually add receptors as needed to appropriately represent population centers. However, any manual placement would be subjective and likely not reproducible between risk assessors. The SAB recommends the Agency evaluate an alternative approach that uses the same 2011 National Land Cover data used for the Urban/Rural Dispersion Selection Enhancement tool to automate the process of identifying population centers. The NLCD data is available at a high spatial resolution (30 m) and receptors could be placed in areas of developed land use classes 22-24. Aerial photos (e.g. Google Earth™) can then be used to check that the land use-based placement of receptors is appropriate. If professional judgement is used to select the location then the RTR screening analysis documentation should include sufficient information such that another expert could follow the reasoning and reproduce the selection.

If the EPA prefers to continue using census block centroids as nearby exposure receptors, then the SAB recommends additional enhancements to make the tool less *ad hoc*. For example, facilities are better represented as polygons than points. Satellite imagery can be used to estimate the facility boundary and then GIS procedures could be used to exclude centroids located within the boundary. In such cases, satellite imagery could then be used to add alternative receptors to replace the deleted centroid and ensure nearby residences are represented. It is noted that this procedure would not be needed if receptors were placed at actual population locations using land use data as recommended.

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5. APPENDIX A: CHARGE TO THE SAB

May 26, 2017

MEMORANDUM

SUBJECT: Request for SAB Peer Review of the document: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis"

FROM: Erika N. Sasser, Director /s/
Health and Environmental Impacts Division
Office of Air Quality Planning and Standards (C504-02)

TO: Christopher Zarba, Director
EPA Science Advisory Board Staff Office (1400F)

EPA's Office of Air Quality Planning and Standards is requesting a peer review by the Science Advisory Board (SAB) on the document: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis." This report describes specific screening methodologies that have evolved since the SAB last reviewed the RTR risk assessment methods in 2009. The screening methodologies are used to quickly identify those facilities in particular RTR source categories that have little potential for human health multipathway or environmental risk, while also identifying those facilities where a refined multipathway or environmental risk assessment may be needed. This report also describes the potential addition of a new multipathway exposure scenario that can estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables, as well as several improvements to EPA's chronic inhalation risk assessment methodology. The application of the updated risk assessment screens and methodologies is highlighted in this report through the presentation of example facilities emitting hazardous air pollutants.

The case study analysis and accompanying documentation were prepared by staff in the EPA's Office of Air Quality Planning and Standards. The document is being made publicly available on the Agency's website at the following address:
https://www3.epa.gov/ttn/atw/rrisk/rtrpg.html.

Attached is the charge to the Science Advisory Board. It includes background information on the screening methodologies and identifies the questions and issues we would like the Science Advisory Board to address in their peer review of the methods.

Attachment:
Peer Review Charge

Attachment

Charge to the Science Advisory Board for their review of the "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis"

Office of Air Quality Planning and Standards
Office of Air and Radiation

Background:

The Clean Air Act (CAA) establishes a two-stage regulatory process for addressing emissions of hazardous air pollutants (HAP) from stationary sources. In the first stage, the CAA requires the EPA to develop technology-based standards for categories of industrial sources. We have largely completed the required Maximum Achievable Control Technology (MACT) standards with about 112 MACT standards being issued to date for stationary major sources of HAP. In the second stage of the regulatory process, EPA must review each MACT standard at least every eight years and revise them as necessary, "taking into account developments in practices, processes and control technologies." We call this requirement the "technology review." EPA is also required to complete a one-time assessment of the human health and environmental risks that remain after sources come into compliance with MACT. If additional risk reductions are deemed necessary to protect public health with an ample margin of safety or to prevent adverse environmental effects that are judged to be "significant and widespread", EPA must develop standards to address these remaining risks. For each source category for which EPA issued MACT standards, the residual risk stage must be completed within eight years of promulgation of the initial MACT standard. Since the initial technology review requirement coincides in deadline with the risk review requirement, EPA generally combines these two requirements into one rulemaking activity, calling this the "risk and technology review" process, or simply RTR. In this way, the results of the risk review can be potentially informative to the technology review process, and vice versa.

Because RTR assessments are used for regulatory purposes, and because components of our screening analyses have evolved over time, EPA periodically seeks the Science Advisory Board's (SAB) review (see below). For the current review, we seek the SAB's input on the specific enhancements made to our risk assessment methodologies, particularly with respect to multipathway and environmental screening methodologies, since the last SAB review was completed in 2009. Facilities that do not screen out may be the subject of refined multipathway risk assessments, which 1) are conducted for a single facility at a time; 2) are very costly; 3) and can take several months to complete. Thus, we consider these screens to be an important step in the RTR risk assessment process that helps the agency to maximize the use of its resources and, when appropriate, to facilitate its communication with stakeholders.

Previous Relevant Peer Reviews

Previous peer reviews have covered various elements associated with the RTR process. A brief summary of each peer review is provided:

1) The *Residual Risk Report to Congress*, a document describing the Agency's overall analytical and policy approach to setting residual risk standards, was issued to Congress in 1999 following an SAB peer review. Many of the design features of the RTR assessment methodology were described in this report, although individual elements have been improved over time. The final SAB advisory is available at http://www.epa.gov/ttn/oarpg/t3/reports/risk_rep.pdf).

2) A peer review of multipathway risk assessment methodologies for RTR was conducted by the EPA's SAB in 2000. The final SAB advisory is available at http://yosemite.epa.gov/sab/sabproduct.nsf/1F1893E27059DB55852571B9004730F7/$Fi_le/ecadv05.pdf.

3) A consultation on EPA's updated methods for developing emissions inventories and characterizing human exposure was conducted by SAB in 2006. The final SAB advisory is available at https://yosemite.epa.gov/sab%5Csabproduct.nsf/33152C83D29530F08525730D006C3ABF/$File/sab-07-009.pdf.

4) A review of the updated and expanded risk assessment approaches and methods used in the RTR program was completed in 2009. This methodology was highlighted to the SAB utilizing two RTR source categories: Petroleum Refining Sources MACT I and Portland Cement Manufacturing. The final SAB advisory is available at https://yosemite.epa.gov/sab/sabproduct.nsf/0/b031ddf79cffded38525734f00649caf!Ope_nDocument&TableRow=2.3#2.

5) The individual dose-response assessment values used in the RTR assessment have themselves been the subject of peer reviews through the agencies that developed them (including EPA, through its Integrated Risk Information System, or IRIS; the California Environmental Protection Agency, or CalEPA; and the Agency for Toxic Substances and Disease Registry, or ATSDR).

We are not asking the SAB panel to duplicate or comment on previously reviewed methodologies, but rather to evaluate whether the specific enhancements to previously reviewed methodologies as described below are appropriate and scientifically credible.

Goals of This Review

We are seeking a scientific peer review of the updated screening methodologies. We are also seeking a scientific peer review of several specific enhancements to our chronic inhalation risk assessment that serve to reduce some of the uncertainties identified by EPA in the last SAB review. These updates and enhancements are outlined in the report: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis" (the report).

The most important revisions and enhancements to our methodologies since the last SAB review include the following:

1) A tiered multipathway screening methodology that determines whether the potential for multipathway risk from persistent and bioaccumulative HAP (PB-HAP)[5]1 emitted from RTR source categories is low or whether more analysis is needed.

2) A tiered environmental screening methodology that determines whether the potential exists for adverse environmental effects from PB-HAP and the acid gases hydrogen chloride (HCl) and hydrogen fluoride (HF) emitted from RTR source categories.

3) The potential use of a new multipathway exposure scenario that can be used to estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables.

4) Enhancements to our previously reviewed inhalation risk assessment that allow us to more accurately model air concentrations where populations actually reside and to better characterize the dispersion of the air in the vicinity of sources.

Charge questions for the Panel's consideration:

There are eight charge questions for this peer review, each of which has been placed in a box below. These eight questions concern three topic areas that cover the most important revisions and enhancements to our methodology since the last SAB review.

Multipathway Human Health Risk Screening Methodology (Chapters 2 and 3):

In RTR assessments, EPA considers ingestion risks using a multipathway approach, in which we model the dispersion, transport, and fate of HAPs emitted from facilities in specific source categories in the environment and estimate human health risks resulting from the ingestion of HAPs from food products, such as vegetables, fruit, meat, and fish.

Since the 2009 SAB review of RTR methods, we refined our original one-tier multipathway screen to include a three-tiered multipathway screening approach that progressively replaces health-protective default assumptions with location-specific data. Since full-scale facility-specific multipathway assessments are time consuming and expensive, the tiered screening approach "screens out" low-risk facilities for which no additional analysis is needed, so that only facilities with potentially higher risk remain in the pool for further analysis.

Chapter 2 of the report provides an overview of the tiered multipathway screening methodology, including a brief description of each multipathway screening tier. The technical detail on each tier of the multipathway screen is laid out in Chapter 3 of the report.

Charge Question 1: Does the SAB find that the three-tiered multipathway risk screening approach appropriately eliminates from further consideration those facilities unlikely to emit PB-HAP in concentrations resulting in appreciable multipathway risk and identifies those facilities where additional multipathway analysis may be warranted? Does the SAB have specific suggestions for improvement of the risk screening methodology?

Tier 1

The multipathway screen previously reviewed by SAB did not account for differences in environmental fate and transport among POM or dioxin congeners (i.e., all POM congeners were assumed to move, partition, and degrade in the environment as BaP does, and all dioxins were assumed to exhibit the same fate and transport as 2,3,7,8-TCDD). Section 3.1.2 of the Report describes the new risk equivalency factor (REF) approach that includes an exposure-equivalency factor (EEF) that reflects an individual chemical's fate and transport relative to the index chemical for each group (BaP for POM and 2,3,7,8-TCDD for dioxin).

Charge Question 2: Does the SAB find that the risk equivalency factor methodology appropriately accounts for differences in the environmental fate and transport among polycyclic organic matter (POM) and dioxin congeners?

Tier 2

Section 3.2 of the report describes the Tier 2 multipathway screening scenario, in which some of the health-protective assumptions in the Tier 1 screen are replaced with more site- specific information. Specifically, in the Tier 2 assessment, site-specific information is used for the locations of potentially fishable lakes and meteorology. In addition, the Tier 2 assessment includes:

- A screening configuration that assesses the fisher and farmer exposure scenarios separately (see Sections 3.2.1.2 and 3.2.1.3).
- An estimation of lake productivity (see Section 3.2.2.2).
- The consideration that a fisher might catch and consume fish from more than one nearby contaminated lake, because more than one lake might be needed to catch enough fish for subsistence living (see Section 3.2.2.3).
- An approach that accounts for PB-HAP deposition into a lake from multiple facilities in the same RTR source category (see Section 3.2.2.3).

Charge Question 3: Does the SAB find that the assumptions for human fishing behavior used in the refined fisher scenario, the assumptions about PB-HAP deposition to lakes, and the assumptions on the ability of ponds and lakes to sustain populations of fish are appropriate?

Tier 3

The Tier 3 screening approach described in Section 3.3 of the report consists of three individual refinements to Tier 2 that are conducted in a step-wise fashion. These refinements include:

- Further analysis of the affected lakes identified in the Tier 2 screen (Section 3.3.1).
- Analysis of plume rise resulting in PB-HAPs lost to the upper atmosphere (Section 3.3.2).
- The use of time-series meteorology and effective release heights (Section 3.3.3).

Section 3.4 of the report describes a gardening exposure scenario we are considering adding to the Tier 3 multipathway screen. The gardening exposure scenario could help us to better characterize multipathway risk in some instances, especially in locations where the presence of a subsistence farm is either unlikely (e.g., in urban areas) or difficult to confirm based on the characterization of land use surrounding a facility.

Charge Question 4: Does the SAB find the methods used for evaluations of (1) lake data, (2) plume rise, and (3) time-series meteorological and time-series plume-rise data are appropriate?

Charge Question 5: Does the SAB find the assumptions and approaches laid out for application in the gardener scenario to be appropriate? Does the SAB find that adding the gardener scenario to Tier 3 would improve our ability to characterize ingestion risks for urban and rural environments?

Environmental Risk Screening Methodology (Chapter 4):

Chapter 4 of the report describes the environmental risk screen that was developed to provide a systematic, scientifically defensible, and efficient approach that EPA can use to screen for potential adverse environmental effects associated with emissions of HAPs from facilities in RTR source categories. The screen can be run quickly and with minimal additional data gathering by drawing on existing data, models, and modeling results, including those developed for the human health multipathway risk screen.

The revised environmental risk screen presented in the report builds on and enhances the methods the SAB reviewed in 2009 as follows:

- Modeled environmental concentrations are compared to ecological benchmarks, not human health thresholds, for all pollutants included in the screen.
- A systematic evaluation of HAPs for potential inclusion in the screen was conducted.
- The environmental risk screen was expanded to include the following additional environmental HAPs: cadmium, hydrogen fluoride, lead, arsenic, and additional POMs.
- The number of ecological endpoints and effect levels that we evaluate was expanded.
- A comprehensive literature review was conducted to identify the most up-to-date ecological benchmarks.
- Tiers were added to the environmental risk screen for PB-HAP that are parallel to the tiers in the multipathway screen.

Charge Question 6: Does the SAB find that the environmental risk screening approach is appropriate for identifying facilities whose PB-HAP emissions may have the potential to cause adverse environmental effects? Specifically, does the SAB find that the pollutants (Section 4.2.1), ecological assessment endpoints (Section 4.2.2), and benchmarks (Section 4.3) that are included in the environmental risk screen are appropriate? Does the SAB have specific suggestions for improvement with regard to any aspect of this environmental risk screening methodology?

Inhalation Risk Assessment Enhancements (Chapter 5):

Urban/Rural Dispersion Selection Tool
In previous chronic inhalation risk assessments, we assumed the land surrounding each facility was rural. Since the most recent SAB review in 2009, we developed an urban/rural enhancement to the chronic inhalation risk assessment that allows us to account for the urban/rural characteristics of the land surrounding each evaluated facility, and therefore, to better characterize the dispersion of pollutants near sources (Section 5.1).

Charge Question 7: Does the SAB find that the Urban/Rural Dispersion Selection Enhancement Tool is an appropriate procedure for identifying facilities to be modeled using the urban option in AERMOD?

Census Block Receptor Check Tool
In its 2009 review, the SAB noted that census block centroids might not always be an appropriate surrogate for residential locations. For example, when the census block centroid is located on industrial property ("on-site"), or when a census block is large and the centroid is far from where populations actually reside, using the centroid may not be appropriate. Since 2009, we developed the census block receptor enhancement (Section 5.2) that allows us to model air concentrations more accurately where populations actually reside. Specifically, the new enhancement automatically identifies census block centroids that might be located on facility, and census blocks that are very large. When onsite or large blocks are identified, we add new receptors, delete census block centroids, or move census block centroids to represent residential locations more accurately.

Charge Question 8: Does the SAB find that the Census Block Receptor Check Tool and associated enhancements are an appropriate method for identifying and adjusting model receptors to ensure the receptors are representative of residential locations?

Message

From: Wanda Bright [Bright.Wanda@epamail.epa.gov]
Sent: 9/13/2018 4:25:43 PM
To: Brooks, Lisette [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ea5714d1470a434f822b9d999cba5ced-Brooks, Lisette]
CC: Bright, Wanda [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b783537affbc46119372799bdbac87e4-Bright, Wanda]; Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]; Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]; Cunningham, Laticia [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=fdd1c2c631114f0e81a0325b0a9026b4-LCunning]; Starks, Angela [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=86dcf1927b9d4c499ec4b750926b0c53-AStarks]; Bloomer, Bryan [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=18e2ed4508564c3f89428feb38673af9-Bloomer, Bryan]
Subject: Report ready to be posted to the Web.
Attachments: EPA-SAB-18-003 .pdf; EPA-SAB-18-003 .docx

Click here to open the Final Report Request

The report referenced above, Review of EPA's draft technical report entitled Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysi, number EPA-SAB-18-003, has been transmitted to the Administrator and is ready to be posted on the web

It is a final report for project 15-07 and more reports are not expected.

It does represent the last work planned for the authorizing panel/committee.

Final Report Request

Date Submitted:09/12/2018

	EPA-SAB-18-003
Fiscal Year of Report	2018
Original Study?	
CMS Number	SAB-18-001-0787
Already Reviewed By	Khanna Johnston
Are minutes for meetings tagged to this project/these projects certified and submitted?	
CMS assignment (Name/AAship/position use semicolons to separate):	OAR
Report Signed Date:	

(See attached file: EPA-SAB-18-003 .pdf) PDF, 47 pp., 502,237 bytes

(See attached file: EPA-SAB-18-003 .docx)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON D.C. 20460

February 11, 2019

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

EPA-SAB-18-003

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Review of EPA's draft technical report entitled *Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*

Dear Acting Administrator Wheeler:

The Science Advisory Board was asked by EPA's Office of Air Quality Planning and Standards to review the EPA draft document titled, *Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis* (May 2017). The draft RTR methods document describes the EPA's methods for conducting initial risk screening analyses in the Clean Air Act mandated assessment of "residual risk", i.e., the risks remaining after application of maximum achievable control technology pursuant to the National Emission Standards for Hazardous Air Pollutants under Title I of the Clean Air Act.

The SAB Risk and Technology Review Methods Review Panel deliberated on the charge questions specific to the Agency's draft RTR methods document during a June 29-30, 2017, face-to-face meeting and discussed the SAB panel's draft report in a subsequent conference call on December 5, 2017. The charge questions focused on eight topics within the Agency's draft RTR methods document, including: a three-tiered multipathway screening approach used in the RTR screening analyses; a risk equivalency factor methodology; fishing, lake and pond assumptions; lake data, plume rise, and meteorological data; a gardener scenario; environmental risk screening methodology; inhalation risk assessment enhancements; and the census block receptor check tool. The enclosed report provides the SAB's consensus advice and recommendations in response to the charge questions. This letter briefly conveys the major findings.

The SAB commends the EPA on the technical quality of the draft RTR document and the effort it has put into developing the residual risk screening methodology. The SAB finds that the overall methodology and specifically the revisions since 2009 are for the most part appropriate and improve the assessment capabilities; opportunities for improvement are documented in the SAB's report. The SAB concludes that the EPA's approach has the potential to achieve the Agency's goal to rapidly and effectively screen facilities, and to focus EPA time and resources on sites of most concern from a public health point of view.

Insufficient detail was provided in the Agency's draft RTR methods document for the SAB to assess the overall operational effectiveness of the screening methodology such as how many facilities are screened out by each of the three tiers. Some data were provided later by the EPA that did help the SAB to understand the screening efficacy. The SAB recommends the EPA compile summaries of RTR analyses applied in regulatory activities for inclusion in future RTR methodology report documents. Furthermore, in future screening analyses the EPA should compare, for specific facilities, the screening model output to field data where available. These "ground truthing" studies should be included in the next RTR methods document and provided to future reviewers for consideration.

Concerning the lifetime average daily dose (LADD) estimates when calculating exposure equivalency factors, EPA's empirical correlation is a logical step in creating the read-across approach used by the Agency. However, the read-across approach for environmental fate is less well-tested and accepted and thus deserves further consideration[1]. The SAB notes that this read-across extrapolation of environmental fate could be refined and has identified two options for the EPA to consider for improving the LADD estimates.

The SAB finds that the inclusion of the domestic gardener scenario is appropriate, though an evaluation of how many people this applies to should be conducted to determine the efficacy of the addition. The accuracy of dispersion and deposition results from the TRIM.FaTE model should be evaluated by comparing them with the results from a more technically robust dispersion model, such as AERMOD. In addition, while incorporation of turbulence in determining urban/rural selection in dispersion modeling is appropriate, the SAB recommends a different approach suggesting a more physically-based model such as AERMOD and the use of meteorological reanalysis data for both surface-air and upper-air wind speeds. Finally, the SAB finds that the EPA's reliance on census-block centroid locations as surrogates for where people live might not always be sufficient to ensure that receptors are representative of residential areas near facilities, and thus the SAB recommends that additional, reproducible methods should be evaluated.

The SAB recommends the EPA explore a transition for its screening methodology from using single-point estimates of uncertain input values to using distributions for these values. Probabilistic analyses combining the effects of distributions of multiple input values would result in a coherent analysis from which arithmetic means and "conservative fractiles" (e.g., a 90th percentile) could be derived. While in the interim sensitivity analyses on uncertain input values could be performed, the shift to a probabilistic analysis framework would provide a more robust foundation for the screening methodology in higher tiers.

[1] Physicochemical, human health and/or environmental properties may be predicted from information from tests conducted on reference substance(s) within the group, referred to as source substance(s), by interpolation to other substances in the group, referred to as target substance(s). This approach is called "read-across." (https://echa.europa.eu/documents/10162/13628/raaf_en.pdf)

In summary, the SAB supports the framework and direction of refinements EPA has been making to the screening methodology for the residual risk portion of RTR analyses. The SAB appreciates the opportunity to provide the EPA with advice on this important subject. We look forward to receiving the EPA's response.

Sincerely,

/Signed/

Dr. Michael Honeycutt, Chair
Science Advisory Board

/Signed/

Dr. Jay Turner, Chair
Risk and Technology Review Methods Review Panel

Enclosure

NOTICE

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Acronyms and Abbreviations

AERMOD	AMS/EPA Regulatory [Dispersion] Model
AMS	American Meteorological Society
ATSDR	Agency for Toxic Substances and Disease Registry minimum risk levels
AEGL	Acute Exposure Guidelines Limits
ANPRM	Advanced Notice of Proposed Rulemaking
BaP	benzo(a)pyrene
CalEPA	California Environmental Protection Agency
EEF	exposure equivalency factor
ERA	Ecological Risk Assessment
ERPG	Emergency Response Planning Guidelines
HAP	Hazardous Air Pollutant
K_{ow}	the *n*-octanol/water partition coefficient
IRIS	Integrated Risk Assessment System
LADD	lifetime average daily dose
MACT	Maximum Achievable Control Technology
MTBE	Methyl Tertiary Butyl Ether
NATA	National Air Toxics Assessment
NEI	National Emissions Inventory
NESHAP	National Emission Standard for Hazardous Air Pollutants
NHANES	National Health and Nutrition Examination Survey
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Testing
NPRM	Notice of Proposed Rulemaking
NWS	National Weather Service
OAQPS	Office of Air Quality Planning and Standards
OPP	Office of Pesticide Programs
OSHA	Occupational Safety and Health Administration
OEHHA	Office of Environmental Health Hazard Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PB-HAP	Persistent Bioaccumulative - Hazardous Air Pollutant
POM	Polycyclic Organic Matter
REF	risk equivalency factor
RTR	Risk and Technology Review
SAB	Science Advisory Board
TEF	toxicity equivalency factor
TEQ	Toxic Equivalents
TRIM.FaTE	Total Risk Integrated Methodology - Fate, Transport and Ecological Exposure
UCL	Upper Confidence Limit
USDA	US Department of Agriculture
USGS	US Geological Survey

1. EXECUTIVE SUMMARY

This report was prepared by the U.S. EPA Science Advisory Board (SAB.) The Board convened the Risk and Technology Review (RTR) Methods Review Panel for initial deliberations in response to a request by EPA's Office of Air Quality Planning and Standards (OAQPS) to review their draft document entitled, "*Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*" (U.S. EPA 2017). This document (hereinafter referred to as the "Agency's draft RTR methods document") describes portions of the methods used to assess "residual risk" i.e., the potential risks remaining after application of maximum achievable control technology (MACT) pursuant to the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations.

Screening methodologies are used to quickly identify those facilities in a source category that have little potential for human health multipathway or environmental risk, while also identifying those facilities where a refined multipathway or environmental risk assessment may be needed. The Agency's draft RTR methods document describes several improvements to the screening methods.

The SAB reviewed the draft RTR methods document as requested by considering eight charge questions posed by the EPA (See Appendix A). The SAB provides comments on the RTR screening methods and does not address the regulatory implications of the methods or the document. The SAB also notes that no methods were submitted for review regarding the technology portion of the RTR analysis called for by the NESHAP regulations, nor were charge questions posed regarding the technology review methods to be applied by the EPA.

The SAB RTR Methods Review Panel deliberated on responses to the charge questions specific to the Agency's draft RTR methods document during a face-to-face meeting on June 29-30, 2017, and discussed its draft report in a subsequent conference call on December 5, 2017. The Chartered SAB conducted a quality review of this document on May 31, 2018. The charge questions focused on eight topics within the Agency's draft RTR methods document, including: *the three-tiered multipathway screening approach used in the RTR analyses; the risk equivalency factor methodology; fishing, lake and pond assumptions; lake data, plume rise, and meteorological data; the gardener scenario; environmental risk screening methodology; inhalation risk assessment enhancements; and the census block receptor check tool.*

This Executive Summary highlights the SAB's major findings and recommendations. The SAB commends the EPA on the technical quality of the draft RTR methods document and the thought and effort it has put into developing the residual risk screening methodology. The SAB finds that the overall methodology and specifically the revisions since 2009, are reasonable and should improve the EPA's assessment capabilities. The comments and recommendations offered below are intended to assist EPA staff as they seek to improve their RTR assessments going forward and are not meant to detract from the screening and assessment efforts to date.

The SAB agrees that the three-tier multipathway risk screening approach, starting with health protective parameters and moving to more site-specific parameters in later tiers, is reasonable and logical. The SAB finds the expansion of the endpoints for the environmental risk screen is reasonable and the benchmarks and use of a tiered screening system are

justified. Overall, the screening methodology has the potential to achieve the EPA's goal to quickly screen facilities, and to focus Agency time and resources on sites of most concern from a public health point of view.

The SAB recommends that future RTR methods documents be written for a primary audience envisioned as a risk assessor trying to reproduce the results of an EPA RTR risk assessment screening, rather than for the audience of peer reviewers.

The SAB finds summary information about overall performance of the methods and case studies to be missing from the report or inadequate for a comprehensive assessment of the methods described. For example, the SAB could not assess the overall operational effectiveness of the screening methods, such as how many facilities are screened out compared to those facilities passed on for more detailed analysis. The SAB very strongly recommends the EPA compile summaries of RTR analyses applied in regulatory activities and include the summaries in future RTR documents for review by the Board. In addition, analysis of the results by source category may indicate that some types of facilities screen out earlier than others and it may point out risk drivers, sensitive parameters and key features that could be refined to improve the screening analysis for particular source categories in the future.

In future screening analyses the EPA should compare, for specific facilities, the screening model output with field data, where available. For example, field measurement data on relevant persistent bioaccumulative hazardous air pollutants (PB-HAPs) in atmospheric deposition, soil, water, and fish could be used to validate key screening model outputs, especially in the Tier 3 evaluation. These "ground truth" studies must be included in the next RTR methods document and provided to future SAB reviewers for consideration.

Data quality considerations are important in RTR assessments. Experience has shown that significant errors can occur in RTR input data, which in turn, can skew risk results, sometimes by material, policy-relevant margins. Accurate input data are the bedrock foundation on which all RTR risk analyses build. The SAB recognizes EPA's past efforts to ensure RTR input data accuracy, and strongly supports and encourages such efforts. Building on the substantial efforts that EPA staff have already made, EPA could further develop and expand its affirmative efforts to ensure RTR input data accuracy. The possibility of such errors and their policy implications should continue to be considered when conducting RTR risk analyses and interpreting results.

The SAB recommends the EPA examine refinements to the tiered screening methodology by conducting sensitivity studies to identify the key input values that drive the risk estimates. EPA also should evaluate the use of probabilistic analyses to estimate more accurately the overall risks. In cases where these input values are uncertain but appropriate, distributions for these parameters could be constructed; probabilistic analysis would provide a more robust foundation for the screening methodology.

Regarding the risk equivalency factor (REF) calculation, the SAB supports the toxicity equivalency factor (TEF) read-across approach as it is well accepted for dioxins and carcinogenic polycyclic aromatic hydrocarbons (PAHs). For the exposure equivalency factor (EEF) estimate, the read-across approach, for environmental fate and transport, is not as well tested and thus deserves further consideration. EPA's empirical correlation between the *n*-octanol/water partition coefficient (K_{ow}) and lifetime average daily dose (LADD) for chemicals

with sufficient data is a logical step in creating the read-across approach used by the EPA. However, K_{ow} is an imperfect predictor of LADD and incorporation of other factors (e.g., environmental persistence and molecular weight) may improve the estimates. The SAB finds this read-across extrapolation approach could be refined and has identified two options for the EPA to consider for improving the EEF estimates.

The SAB also finds the REF method would greatly benefit from better explanation, documentation and statistical analysis in terms of: (a) documentation of TEFs, including consideration of whether assigning a TEF for carcinogenic activity is appropriate for PAHs not currently identified as carcinogens; and (b) documentation of the methods for the EEF derivation.

The SAB is generally supportive of the assumptions used for human fishing behavior in the refined fishing scenario and offers several specific suggestions for improving the data used, the model versions used, and how to document studies used by the EPA for the data and modeling methods.

Tier 3 screening introduces refinements to the treatment of air pollutant dispersion and deposition. EPA should consider the use of plume-rise models other than those described in the Agency's draft RTR methods document and could test and demonstrate the reliability of plume rise adjustments. The accuracy of dispersion and deposition results from the TRIM.FaTE model should be evaluated by comparing them with the results from a more technically robust dispersion model, such as AERMOD. The SAB suggests EPA evaluate the selection of urban vs. rural terrain in the inhalation risk assessments by comparing TRIM.FaTE-derived screening results to those calculated by a more physically-based model such as the regularly updated AERMOD. For this and other air dispersion and transport modeling, the SAB recommends that EPA consider the use of meteorological reanalysis data for both surface-air and upper-air wind speeds.

The SAB agrees that the proposed gardener scenario is an appropriate addition to both Tier 2 and Tier 3 screening evaluation. However, it is important to distinguish between the gardener and the subsistence farmer. The gardener scenario improves the characterization of potential risk in both rural and urban environments for those who take part in this activity, however the SAB urges the EPA to gather data characterizing the population engaged in this activity and the primary exposure routes in order to evaluate the efficacy of this scenario.

The Agency should consult with colleagues across the EPA who have data and models for addressing parameters used in the screening analysis. For example, the SAB understands the Agency has data or models available for parameters such as lake outflow, chemical runoff and erosion.

The SAB found the methodology for identifying the pollutants to be included in the environmental risk screening activities are clearly stated and the criteria used to prioritize the chemicals are found to be appropriate. The SAB is concerned that selenium is not included as a chemical to screen and recommends that it be added in future RTR screening analyses.

The SAB agrees that characterizing the terrain as urban versus rural and incorporating the effects of turbulence as a dispersion modeling input is appropriate. This refinement has significant value because it avoids the overly conservative assumption of applying the "rural"

assumption to all facilities. However, the SAB disagrees with the Agency's draft RTR methods document on the procedure of choice and recommends using a land use-based procedure utilizing national land cover data (NLCD).

The SAB finds that insufficient information was provided about the census block receptor check tool, especially regarding criteria used to determine the number and placement of new receptors. The SAB is concerned that the process would not be reproducible if another risk assessor were to subsequently model a facility. Overall, the SAB finds that, while the method's reliance on census block centroid locations may in some cases be sufficient for screening, care must be taken that receptors are well-placed to be representative of residential areas near the facilities. To facilitate tool transparency and results reproducibility, EPA could develop protocols to enable risk assessors to exercise their professional judgment in verifying the tool-based receptor placements and document the decision process for placement (e.g., using Google Earth imagery and preliminary risk calculations) so as to be reproducible by independent expert analysts.

In summary, the SAB supports the framework and direction of refinements EPA has been making to the screening methodology for the residual risk portion of RTR analyses. In many cases, the SAB supports the methodological details used by the EPA; and in other cases, the SAB recommends considering refinements or alternative approaches.

By the EPA's accounting, provided in response to inquiry by the SAB, for the five most recent RTR analyses conducted prior to June 2017, Tier 1 on average screened out 30% of the affected facilities, and the Tier 2 fisher and farmer scenarios on average screened out 60% and 70%, respectively, of the affected facilities. This demonstrates a commitment to effectively manage EPA resources and focus attention on the subset of facilities that are not deemed low-risk based on the screening analysis. However, insufficient information was provided in the RTR methodology report for the SAB to evaluate the overall efficacy of the EPA's methods. EPA's multi-tiered risk screening approach appears designed intending that: (a) high-risk facilities are not prematurely screened out (with adverse public health or environmental implications) and (b) low-risk facilities are not unnecessarily retained for more detailed analysis (with adverse EPA resource implications). The SAB strongly calls for data to be developed and presented in future method reports that indicate how many facilities may be screened out prematurely and how many may be passed on to a full-scale risk assessment that should have been screened out in the screening analysis.

2. INTRODUCTION

EPA's Office of Air Quality Planning and Standards (OAQPS) requested that the Science Advisory Board (SAB) review the draft document, "*Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*" (U.S. EPA 2017). This document (hereinafter referred to as the "Agency's draft RTR methods document") describes the EPA's recent and proposed refinements to the screening methods for assessing "residual risk" i.e., the risks remaining after application of maximum achievable control technology (MACT) under Title I of the Clean Air Act (CAA).

The CAA establishes a two-stage regulatory process for addressing emissions of hazardous air pollutants (HAPs) from stationary sources. In the first stage, the CAA requires EPA to develop technology-based standards connected to MACT for categories of industrial sources. EPA must review each MACT standard at least every eight years and revise them as necessary. This is the technology review portion of RTR. In the second stage of the process, EPA is required to assess the health and environmental risks that remain after MACT has been applied. EPA must develop standards to address these remaining potential risks if necessary to protect the public health with an ample margin of safety or to prevent adverse environmental effects. This second stage of the RTR is known as the residual risk review and must be completed within eight years of promulgation of the initial MACT standards for each source category.

The EPA, in order to streamline and standardize the residual risk review for the large number of affected source categories, has developed a process by which it: (1) conducts a risk assessment using currently available source and emissions data; (2) requests public comment on the source and emissions data, along with preliminary risk assessment results, through an Advance Notice of Proposed Rule Making (ANPRM); (3) addresses comments received on the ANPRM; and (4) revises the risk assessment as needed. The results of the revised risk assessment are intended to support proposals and promulgation of technology- and risk-based regulatory decisions through a transparent, science based, notice-and-comment rulemaking process.

The Agency's draft RTR methods document describes revisions to the screening methods used when conducting the risk portion of Risk and Technology Review assessments. These assessments evaluate the effects of industrial HAPs emissions on public health and the environment. Screening methods are used to quickly identify, for a particular RTR source category, those facilities that have little potential for human health risk via multipathway exposure or little potential for environmental risk, while also identifying those facilities where a refined risk assessment may be needed.

Previous internal EPA and external peer review panels have reviewed aspects of the RTR methodology, as documented in the following reports:

1) The *Residual Risk Report to Congress* (U.S. EPA 1999), a document describing the EPA's overall analytical and policy approach to evaluating residual risk in the context of setting NESHAP standards, was issued to Congress in 1999 following an SAB peer review. Many of the design features of the RTR assessment methods were described in

this report, although individual elements have been refined over the subsequent two decades.

2) Individual residual risk assessments – several internal peer reviews and one external peer review were conducted on risk assessments for individual source categories, including Coke Ovens (U.S. EPA 2018a), Perchloroethylene Dry Cleaning (U.S. EPA 2018b), and Halogenated Solvent Cleaners (downloadable from: U.S. EPA 2018c). Each of these assessments used emission estimates from the National Emissions Inventory (NEI), human exposure modeling at the census block level, dose-response methodologies, and risk characterization like those for the ongoing and planned RTR assessments.
3) The National Air Toxics Assessment, or NATA, for 1996 was peer-reviewed by the SAB in 2001-2002 (U.S. EPA SAB 2001). NATA 1996 was a comprehensive and cumulative risk assessment designed to include all mobile sources, small and large industrial sources, and background contributions to air toxics. Because of significant uncertainties, the SAB did not believe that it was appropriate for regulatory purposes. For example, the 1996 assessment had census block-level data resolution available, but the analysis was performed at the census tract level. This approach was refined in subsequent assessments.
4) The AMS/EPA Regulatory [Dispersion] Model (AERMOD), a source-to-receptor air quality dispersion model, was the subject of significant interagency cooperation and peer review. It is now EPA's preferred local-scale air dispersion model for industrial sources of air pollution (U.S. EPA 2018d).
5) The individual dose-response values used in RTR assessments have been the subject of peer reviews through the agencies that developed them (including EPA, through its Integrated Risk Information System, or IRIS; the California Environmental Protection Agency, or CalEPA; and the Agency for Toxic Substances and Disease Registry, or ATSDR). EPA proposes to select dose-response values for long-term exposures from these sources in the same priority order it used for NATA (i.e., IRIS, then ATSDR, then CalEPA). For acute exposure toxicity, EPA arrays several indices without prioritization; this is a source of potentially significant, yet usually unquantified, uncertainty. (IRIS - U.S. EPA 2018e, ATSDR - ATSDR 2018, CalEPA -CalEPA 2018)
6) An earlier peer review of multipathway risk assessment methodologies was conducted by the SAB in 2000 (U.S. EPA SAB 2000).
7) A consultation on EPA's updated methods for developing emissions inventories and characterizing human exposure was conducted by the SAB in 2006. The final SAB letter to Administrator Johnson transmitted the Board's comments (U.S. EPA SAB 2007).
8) A review of the updated and expanded risk assessment approaches and methods used in the RTR program was completed in 2009 (U.S. EPA SAB 2010). This methodology was highlighted to the SAB utilizing two RTR source categories: Petroleum Refining Sources MACT I and Portland Cement Manufacturing.

The focus of this review of the Agency's RTR methods document is on several updates and enhancements of the previous versions that were reviewed as documented above. The most important revisions and enhancements since the last SAB review include the following:

- a tiered multipathway screening methodology that determines whether the potential for multipathway human health risk from persistent and bioaccumulative HAP (PB-HAP) emitted from RTR source categories is low or whether more analysis is needed;

- a tiered environmental screening methodology that determines whether the potential exists for adverse ecological effects from PB-HAP and the acid gases hydrogen chloride (HCl) and hydrogen fluoride (HF) emitted from RTR source categories;
- the potential addition to the screening methodology of a new multipathway exposure scenario to estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables; and
- enhancements to the previously reviewed inhalation risk screening methodology that allow more accurate modeling of air concentrations where populations reside and better characterization of air dispersion near sources.

The SAB was asked to review the current draft RTR methods document by considering eight charge questions posed by the EPA. The SAB provided comments on the RTR methods and did not address the regulatory implications of the method or the report. The SAB Risk and Technology Review (RTR) Methods Review Panel met in a public meeting on June 29 – 30, 2017 in Arlington, VA, to review the Agency's draft RTR method document. The SAB Panel held a subsequent teleconference on December 5, 2017, to discuss its draft advisory report. The Chartered SAB conducted a quality review of this report on May 31, 2018. The specific charge questions to the SAB are presented in the next chapter, along with the SAB's responses.

3. RESPONSE TO INDIVIDUAL CHARGE QUESTIONS

3.1 The Three-Tiered Multipathway Screening Approach

Charge Question 1. Does the SAB find that the three-tiered multipathway risk screening approach appropriately eliminates from further consideration those facilities unlikely to emit PB-HAP in concentrations resulting in appreciable multipathway risk and identifies those facilities where additional multipathway analysis may be warranted? Does the SAB have specific suggestions for improvement of the risk screening methodology?

RTR risk assessments provide the basis for decision making on whether a more stringent standard is necessary to protect human health and the environment after implementation of a NESHAP for a specific source category. The risk assessment process is both time and resource intensive. Therefore, EPA first screens affected facilities to determine whether a full-scale facility-specific risk assessment is warranted. Since the 2009 SAB review of RTR methods, the EPA has developed a three-tiered multipathway screening approach that progressively replaces health-protective default assumptions with location and facility specific data. The goal is to "screen out" minimal risk facilities such that only potentially high-risk facilities remain in the pool for further analysis.

EPA's screening methodology for ingestion risks uses a multipathway, tiered approach. Models are used to simulate the transport and fate of HAPs emitted from specific facilities in the source category being assessed. Modeling outputs include estimates of contaminants in the environment and estimates of human health risks primarily from the ingestion of HAPs from food products such as vegetables, fruit, meat, and fish because the focus of this tiered screening is on persistent and bioaccumulative toxicants.

The SAB agrees that the three-tier multipathway risk screening approach, starting with generic health protective parameters and moving to more site-specific and realistic parameters in later tiers, is appropriate. Its general structure is consistent with a long history of EPA multi-tiered risk screening approaches designed with the intent that: (a) high-risk facilities are not prematurely screened out (with adverse public health or environmental implications) and (b) low-risk facilities are not unnecessarily retained for more detailed analysis (with adverse EPA resource implications). While the SAB finds the overall approach is appropriate and has the potential to achieve the EPA's goals, as noted below the overall effectiveness is not clear. EPA should evaluate the current effectiveness and refinements to improve effectiveness.

Based on the information presented in the draft RTR methods document, the effectiveness of the screening methodology could not be confirmed. The SAB strongly calls for data to be developed and presented in future method reports that indicate how many facilities may be screened out prematurely and how many may be passed on to a full-scale risk assessment that should have been screened out in the screening analysis.

Screening efficacy could be examined in two ways. First, the operational effectiveness could be evaluated by reviewing the number of facilities screened out by each tier. While this information was not provided in the Agency's draft RTR methods document, EPA

subsequently reported that for the five most-recent RTR analyses conducted (at the time of the EPA's correspondence on November 9, 2017), Tier 1 on average screened out 30% of the affected facilities, and the Tier 2 fisher and farmer scenarios on average screened out 60% and 70%, respectively, of the affected facilities. More information included in the report would have been useful when assessing the appropriateness of modeling inputs and assumptions. An analysis of the tier-specific screening efficacy should be conducted for each source category (i.e., an examination of prior RTRs which used the current approach to screening) to assess whether some types of industrial facilities screen out earlier than others. This analysis may point out the risk drivers, sensitive parameters and key features that could be refined to conduct better screening analysis for particular source categories in going forward. Second, the best way to evaluate the three-tiered approach in a scientific manner is to "ground-truth" the evaluations, using monitoring data from either new sites or previously evaluated sites. This type of validation would require focused and deliberate study, yet it would represent an improvement in the understanding of screening procedures. For example, available monitoring data on PB-HAPs in atmospheric deposition, soil, water, and fish could be used to examine the effectiveness of higher-tiered screening and in particular to validate key points in the Tier 3 evaluation.

EPA's tiered approach is geared towards protecting the most highly exposed subpopulations – combined subsistence fishers and farmers and their children who also ingest soil. The first tier is intended to be quite health protective and SAB concurs that it is conservative. Page 15 of the Agency's draft RTR methods document highlights some of the more health-protective assumptions in the Tier 1 screening scenario. However, many assumptions are not transparent in the Agency's draft RTR methods document, making it impossible to assess if there are opportunities for refinement of those assumptions. For example, EPA should list the key assumptions used for the watershed characteristics that enhance chemical loading to the lake and farm via erosion and runoff e.g., it is not clear how the chemical is loaded into the lake and the assumptions for the volume of water transporting the chemical into the lake. This is a particularly relevant example because the scenario does not change across the tiers and there might be opportunities for refinements.

There is concern about the specific values selected for the modeling parameters, both individually and in combination. The use of multiple high-end health protective parameters can result in an excessive overestimate of potential risk. While each health-protective assumption on its own may seem reasonable, combining or overlaying multiple health protective assumptions can lead to more conservatism than is intended. An unintentionally high and unnecessary degree of conservatism likely renders the tiered risk screening ineffective, or at best inefficient. EPA should consider possible refinements to Tier 1 if the overestimation of risk is such that obviously low-risk sites are not screened out.

The SAB recommends the EPA examine refinements to the tiered screening methodology by conducting sensitivity studies to identify the key input values that drive the risk estimates. This could be used to refine Tier 1 if desired and is particularly relevant to Tiers 2 and 3. As one example, the EPA could conduct a sensitivity analysis on the impact of runoff assumptions on modeled human health risk and consider refining the health-protective Tier 1 runoff parameters as the screen moves to Tier 2 and to Tier 3. As the EPA conducts these evaluations, it should have the flexibility to adjust its methods and the parameters as needed

to ensure health-protective yet efficient RTR screening occurs in future RTR screening analyses.

EPA should evaluate the use of probabilistic analyses, perhaps initially through case studies on Tiers 2 and 3 analyses, to more accurately estimate overall risks. As previously stated, sensitivity analyses can be used to identify key input values that drive the risk estimates. In cases where these input values are also uncertain, probabilistic analysis would provide a more robust foundation for the screening methodology. This would require assessing whether enough data are available to construct distributions for the input parameters. If so, then probabilistic analysis combining the effects of distributions of multiple input values would result in a coherent analysis from which arithmetic means and operationally-defined "conservative fractiles" (e.g. a 90th percentile) could be derived.

Overarching data quality considerations are important in RTR assessments. Errors can occur in RTR input data which in turn can skew risk results, sometimes by material, policy-relevant margins. Data errors can be caused by such factors as reporting mistakes by individual facilities and undetected, incorrect information in publicly-available national, regional, and local emission inventories. The SAB recognizes the fundamental importance of accurate input data as a bedrock foundation on which all RTR risk analyses build. The SAB recognizes EPA's past efforts to ensure RTR input data accuracy, and strongly supports and encourages such efforts. Building on the substantial efforts that EPA staff have already made, EPA could further develop and expand its affirmative efforts to ensure RTR input data accuracy. Possible approaches to reducing such errors were discussed during the panel's public deliberations and are documented in the public records of the meetings available on the EPA website (EPA 2018f). The possibility of such errors and their policy implications should continue to be considered when conducting RTR risk analyses and interpreting results.

Additional comments and recommendations are as follows.

- If EPA seeks to further refine the Tier 1 screening of low-risk facilities, it might reconsider the current approach of combining exposures for farming and fishing on top of other conservative assumptions regarding weather conditions, deposition and runoff. It is unlikely that the same person consumes <u>all</u> food categories from media located close to the facility and these media receive the conservative-estimate high-end chemical loading rates day after day.
- Although there are refinements to the air modeling at Tiers 2 and 3, there is no comparable refinement of chemical runoff and erosion from the watershed. EPA does not provide any information on parameters and assumptions made (including the pond scenario) and thus the SAB cannot provide detailed comments on potential refinements to these models.
- TRIM.FaTE (U.S. EPA 2002) is used to model air dispersion. EPA should indicate if this model has been updated since 2002, and why EPA chose this model over AERMOD, which has been continuously improved and updated many times over the years (as recently as January 2017). It may be useful for EPA to compare estimates based on TRIM.FaTE and AERMOD for a range of representative scenarios.
- As discussed in more detail in the response to Charge Question 3, there is a complicated reasoning underlying the Tier 2 sustainable fishing scenario. Perhaps

EPA found it necessary to introduce such details at Tier 2 to be able to screen out low-risk facilities. For the purposes of Tier 2, however, it seems that simpler worst-case assumptions could be made that simplify the approach. The SAB recommends the EPA consider other data available to make more realistic assumptions, such as the most recent National Health and Nutrition Examination Survey (NHANES CDC 2018.), to estimate fish consumption.

- Many of the pathways are related to those used by the EPA Office of Pesticide Programs (OPP), which are based on U. S. Department of Agriculture (USDA) Cropland Data Layer and more recent (2005-2010) NHANES dietary consumption data. These could be used to inform EPA's RTR screening approaches[2]
- Regarding some of the individual parameters, from the documentation provided it wasn't clear whether the breastfeeding exposure or other early life pathways would adequately cover these sensitive early life stages. The potential impact of seasonal changes in food-sourcing should also be considered although it was recognized that fishing and gardening/farming can be year-round activities in certain parts of the country.
- The focus only on cancer risk for dioxins and benzo[a]pyrene may underestimate early life (e.g., breastfeeding) risks given these are short-term exposures whose lifetime average daily dose (LADD) will be diluted by the rest of the lifetime at lower exposure. Table 3.2 indicates that non-cancer endpoints are "not critical" for these chemical classes; this is a pre-judgement that should be further explored, especially for early life exposures. The SAB notes that benzo[a]pyrene has a very recent RfD on IRIS that is based upon an early life developmental effect (U.S. EPA 2018g).
- Several polycyclic aromatic hydrocarbons (PAHs) with toxicity equivalency factors (TEF) are not generally considered carcinogens (e.g., pyrene, phenanthrene, fluorene, fluoranthene, and acenaphthalene). These compounds do not appear on the lists of relative potency factors used by EPA (U.S. EPA, 1993) nor are they presented in lists published elsewhere (e.g., Nisbet and Lagoy 1992). These early 1990s references are still relevant as demonstrated by EPA's 2017 IRIS toxicological review for benzo(a)pyrene which refers to the EPA's 1993 guidance as the source of PAH relative potency factors (U.S. EPA 2018h). In addition, the PAHs in question are not listed as carcinogenic by the International Agency for Research on Cancer (IARC) or the National Toxicology Program (NTP) of the U.S. Department of Health and Human Services. The TEF approach for pyrene, phenanthrene, fluorene, fluoranthene, acenaphthalene and several other PAHs should be reconsidered.
- The draft RTR methods document should be modified to be more explicit about the decision-making on transitioning from Tier 1 to Tier 2, and from Tier 2 to Tier 3, particularly with regards to evaluating the potential risks associated with multiple chemicals and combining hazard quotients and risks. In addition, the basis for the inclusion and exclusion of particular chemicals, for example lead, should be more clearly stated.
- Page 16 of the draft RTR methods document indicates that "dermal absorption of originally airborne chemicals similarly has been shown to be a relatively minor

[2] https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm; https://www.agcensus.usda.gov/Publications/2012/Online_Resources/Ag_Atlas_Maps/; https://www.epa.gov/sites/production/files/2015-09/documents/deem-user-guide-sep30-14.pdf); https://www.epa.gov/sites/production/files/2016-05/documents/public_webinar_overview_of_the_draft_bes_final.pdf

exposure pathway compared with other pathways" and cites one report from 2000 and another from 2006, to support the statement. The EPA should investigate whether the evidence still supports that conclusion and applies to all classes of chemicals. More recently, several studies have suggested that dermal absorption of certain classes of chemicals in indoor air can contribute significantly to a person's overall dose (Weschler and Nazaroff, 2012, 2014; Morrison et al., 2016).

- The SAB supports the EPA's decision to separate subsistence farmers and subsistence fishers in Tier 2.
- The SAB notes that by conducting the analysis on a chemical-by-chemical basis, limited by law to the industrial category under RTR evaluation, multiple sources of a chemical emitted nearby from other industrial source categories may contribute to cumulative effects and chemical interactions because of multiple exposures. The cumulative risk may be missed by the human health risk screening conducted following the RTR method being reviewed.

3.2 Risk Equivalency Factor Methodology

Charge Question 2. Does the SAB find that the risk equivalency factor methodology appropriately accounts for differences in the environmental fate and transport among polycyclic organic matter (POM) and dioxin congeners?

Previously the RTR screening methods did not account for differences in environmental transport and fate among POM or dioxin congeners in the Tier 1 screening approach. All POM congeners were assumed to be transported, partition, and degrade in the environment identical to benzo(a)pyrene (BaP), and all dioxins were assumed to exhibit the same transport and fate as 2,3,7,8-TCDD. Since 2009 when the RTR Methodology was last reviewed by the SAB, the EPA has significantly refined its approach. Section 3.1.2 of the Agency's draft RTR methods document describes a new risk equivalency factor (REF) methodology that includes an exposure-equivalency factor (EEF) to reflect an individual chemical's transport and fate relative to the index chemical for each group (i.e., BaP for POM and 2,3,7,8-TCDD for dioxin).

The REF methodology has been incorporated as a screening tool into the residual risk assessment of stationary sources. It grapples with a common problem when dealing with complex mixtures – the evaluation of components with poorly characterized environmental fate and toxic effects. The SAB appreciates that when data gaps preclude inclusion of a chemical component of POM in a risk assessment, this component is often assumed to contribute zero exposure and risk. Rather than create such an underestimation, EPA has provided a screening methodology to fill such data gaps and thus include the full array of targeted POM constituents. In general, the SAB finds the overall approach to potentially be appropriate with more work needed to address concerns as described below.

The REF methodology consists of two read-across approaches[3] – one to handle toxicology data gaps, and the other to handle information gaps regarding environmental transport and

[3] Physicochemical, human health and/or environmental properties may be predicted from information from tests conducted on reference substance(s) within the group, referred to as source substance(s), by interpolation to other substances in the group, referred to as target substance(s). This approach is called "read-across." (https://echa.europa.eu/documents/10162/13628/raaf_en.pdf)

fate. The SAB agrees with the toxicity equivalency factor (TEF) approach as it is well accepted for dioxins and carcinogenic PAHs. The SAB has not checked all the tabulated values for representativeness but notes that some of the PAHs given TEF factors by EPA are not typically considered to be carcinogenic; this was discussed in the SAB's response to Charge Question 1. The selection of TEFs for these and other PAHs is not provided in the Agency's draft RTR methods document and should be documented with references in Table 3.4.

The read-across approach for environmental fate is less well tested and accepted and thus deserves further consideration. EPA's proposed EEF is based upon a fundamental chemical property – K_{ow}. This property helps determine certain aspects of environmental fate such as uptake into fish, beef and dairy, but there are numerous other fate behaviors which it does not predict such as metabolism, biodegradation, environmental half-life and several types of phase transitions and partitioning. Thus, it is perhaps overly optimistic to expect K_{ow} by itself to have high concordance with exposure dose.

EPA's empirical correlation between K_{ow} and LADD for chemicals with sufficient data (RTR methods report Figure 3.2. U.S. EPA 2017) is a logical step in creating the read-across approach. However, as suggested above, K_{ow} is an imperfect predictor of LADD. Figure 3.2 shows the relationship between K_{ow} and LADD for 14 POM analytes for which there are more complete data. There is considerable variability around the regression line in Fig 3.2; this variability is currently unexplored but may arise from uncertainty and variability in the underlying parameters that influence the LADD including not only K_{ow} but also intermedia partition coefficients, molecular weight, half-life, potential for biodegradation, etc. The variability around the regression line is up to two orders of magnitude and thus the calculated EEF may substantially underestimate the LADD for some undefined members of data-poor chemical classes.

The SAB finds this read-across extrapolation of environmental fate could benefit from a refined approach and has identified two options for improving the EEF estimate as follows.

- Conduct further statistical evaluation of the relationship between K_{ow} and LADD to generate an upper bound on the regression slope and then apply this to derive EEFs for data poor chemicals.
- Conduct further evaluation of the underlying transport and fate parameters to develop distributions for each influential parameter and then perform a probabilistic analysis that replaces the Fig 3.2 regression slope; EPA can then make a transparent choice of which percentile of the distribution of LADDs for a given K_{ow} (and/or additional parameters) will be used in evaluating exposure and risk for data-poor POMs.

The SAB also finds the current documentation of key parameter inputs to the fate, transport and bioaccumulation model for PB-HAPs is not adequately described. The range of potential values and key citations should be presented in an appendix for all the modeled PB-HAPs. The document states that the EEF will change based upon environmental and geospatial conditions (e.g., Page 19, paragraph 1) but examples of this dynamic relationship are not provided, which further precludes a full review. For example, how are the effects of age/weathering incorporated to account for the loss of lighter dioxin congeners over time or with distance?

The SAB notes that in Table 3.4, the products of the EEF and TEF values do not always equal the corresponding REF. Perhaps rounding prior to the multiplication causes these differences. Whatever the reason, the product of column multiplication should be mathematically consistent to avoid the impression that the table contains incorrect values.

In summary, the SAB finds that the REF would benefit from better explanation, documentation and statistical analysis in terms of: (a) documentation of TEFs (Table 3.4), including consideration of whether the TEF for carcinogenic activity is appropriate for certain PAHs not traditionally considered as carcinogens; and (b) documentation of the methods for EEF derivation, especially with respect to better analysis of the relationship between EEF and key environmental fate characteristics of each chemical (K_{ow}, environmental persistence, molecular weight, etc.) potentially including a probabilistic analysis and, at a minimum, more complete statistical treatment of the relationship between K_{ow} and LADD.

3.3 Fishing, lake and pond assumptions

> *Charge Question 3: Does the SAB find that the assumptions for human fishing behavior used in the refined fisher scenario, the assumptions about PB-HAP deposition to lakes, and the assumptions on the ability of ponds and lakes to sustain populations of fish are appropriate?*

The Tier 2 multipathway screening scenario replaces some of the assumptions in the Tier 1 screen and is considered more realistic than Tier 1. Specifically, site-specific information is used for the locations of potentially fishable lakes and for meteorology. In addition, the Tier 2 assessment includes: a screening configuration that assesses the fisher and farmer exposure scenarios separately; and an estimation of lake productivity and fish population dynamics. The consideration is that a fisher might catch and consume fish from more than one nearby contaminated lake because more than one lake might be needed to catch enough fish for subsistence living. The approach at this level of screening analysis also attempts to account for PB-HAP deposition into a lake from multiple facilities in the same RTR source category.

3.3.1 Human fishing behavior and sustainability of fish populations in ponds and lakes

The SAB finds the assumptions used for human fishing behavior in the refined fishing scenario to be appropriate with caveats as noted below, while the assumptions concerning sustainability of fish populations in ponds and lakes may be inappropriately conservative. Assuming all parameters (such as size of the lake needed to support fish of a given size, assumptions about fish populations, etc.) are correct, the approach used seems reasonable. The equations seem appropriate and the assumptions appear to be properly managed. However, the SAB finds that most of the assumptions/parameters are possibly too conservative to achieve the objective of effective risk screening and suggests that more realistic ingestion rates and other model parameters be considered. For example, the Tier 2 method limits the fish consumption rate from a local water body due to potential depletion of fish by a single subsistence fisherman. The end result of a number of assumptions and productivity calculations is that no more than 1 gram fish/acre of waterbody can be sustainably removed per day (page 40, lines 7-9). In comparison, in one study the productivity of lakes was 82 kg/hectare/year (N=22 lakes, Randall et al. 1995) which converts to 90 g/acre/day. This 90-fold difference indicates the EPA should reconsider lake

productivity and how to relate it to fish consumption estimates for a specific lake. Furthermore, with some of the contaminants examined, fish will not take up 100% of the chemical. Also, the chemicals considered will have different toxicodynamic and toxicokinetic properties in the fish, making the half-life of some chemicals (PABs/dioxins) much shorter than values assumed. These issues will affect exposure estimates in the fisher population.

There is considerable heterogeneity across lakes and the SAB has concerns with the presumed universality of some of the assumptions invoked for the analysis. For example, the analysis assumes: 21% of the fish biomass are piscivores; benthic fish account for 17.5% and pelagic fish account for 3.5% of total fish biomass; humans consume 50:50% from benthic and pelagic piscivores (note some people consume pan fish); and total fish biomass is 40 g fish ww/m^2. It seems likely that rather than fixed values these parameters have a wide range of occurrence in actual lakes. Also, as explained in the appendix of the Agency's draft RTR methods document, benthic fish collection is usually higher than pelagic species (although pelagic are preferred by consumers) due to the general species abundance. The SAB recommends that the EPA document and justify these assumptions.

The SAB encourages the EPA to consider other data available to make more realistic assumptions such as using the most recent NHANES data to estimate fish consumption. Additionally, the EPA might be able to refine the assumptions on chemical runoff and erosion from the watershed by using relevant U.S. Geological Survey (USGS) data that are available for the region of interest (U.S.G.S. 2018). As another example, the EPA Risk-Screening Environmental Indicators (RSEI) Model is part of the Toxics Release Inventory (TRI) program and is primarily used as a transport and fate model to estimate concentrations, hazard level and risk of air pollutants covered by the TRI. However, RSEI also has a model that estimates transport and fate of TRI releases to water bodies including both direct releases and transfers between wastewater plants. The primary data product is toxicity-weighted concentrations downstream of TRI discharges. These data are available by stream segment. The Office of Pollution Prevention and Toxics could presumably prepare data specific to the modeler's needs. Alternatively, the RSEI Water Microdata can also be accessed online (U.S. EPA 2018i).

The SAB struggled with understanding some of the RTR modeling inputs/assumptions. This process may become more transparent if the data are presented with information about how studies were included or excluded, how data were prioritized and selected for use, how the evidence was weighted, etc. The appendices to the EPA report achieve this goal to a certain extent but are incomplete.

3.3.2 PB-HAP deposition to lakes

The SAB could not determine whether the assumptions for PB-HAP deposition to lakes are appropriate for the following reasons. Regarding PB-HAP transport and deposition, air dispersion models recommended by EPA, such as AERMOD, have been continuously improved and updated many times over the years (as recently as January 2017). Such models have been used by many users in a variety of regulatory applications and have been subject to rigorous performance evaluation by EPA and the scientific community to test and demonstrate their accuracy. The SAB recommends clarification of the extent to which TRIM.FaTE has been updated since 2002, when its technical support document was released. Assuming AERMOD is valid for the use cases of interest, the reliability of TRIM.FaTE's air

dispersion component should be assessed by comparing to AERMOD for a variety of scenarios. Also, the EPA may seek to consult with EPA Office of Pesticide Programs (OPP) Environmental Fate and Effects Division (EFED) since they have developed models with different tiered assumptions about runoff into ponds.

It is unclear how accurately PB-HAP deposition is calculated by TRIM.FaTE. Additional information is needed to demonstrate the accuracy (or for a screening methodology, to evaluate how conservative the assumptions are) of such deposition estimates and their implications to the reliability of fish consumption exposure estimates. EPA should test and demonstrate for a range of representative scenarios the reliability of TRIM.FaTE air concentration and deposition estimates.

Finally, the SAB recommends conducting a sensitivity analysis of the distribution of critical parameters at higher tiers. The use of multiple health-protective assumptions/parameters is likely to overestimate the actual risks, probably by a substantial margin. Furthermore, a probabilistic analysis should provide a more accurate and transparent estimate regarding uncertainty of the risks and may be appropriate at higher tiers.

3.4 Lake data, plume rise, and meteorological data

> *Charge Question 4: Does the SAB find the methods used for evaluations of (1) lake data, (2) plume rise, and (3) time-series meteorological and time-series plume-rise data are appropriate?*

When the Tier 2 screening analysis indicates that further evaluation is warranted, the EPA applies the Tier 3 screening approach described in Section 3.3 of the Agency's draft RTR methods document. The method includes three individual refinements to the Tier 2 methods that are conducted in a step-wise fashion. The refinements include: further analysis of the affected lakes identified in the Tier 2 screen; analysis of plume rise resulting in PB-HAPs lost to the upper atmosphere; and the use of time-series meteorology from meteorological data stations and modeled effective chemical release heights.

3.4.1 Lake data

The SAB finds the method to evaluate lake data to be generally appropriate and indicates items for refinement. The SAB supports the use of up-to-date land-use data to more accurately represent exposures that occur through lake media. EPA should consider relying less on analyses that are time-intensive and that depend on analysts' subjective judgments. Web or GIS searches, as described in the Agency's draft RTR methods document, may be useful to produce input data. A guiding principle should be "documented and reproducible" such that independent experts can understand the data and methods applied by EPA analysts and can reproduce the results.

EPA should consider the use of data streams that can be automated so that ongoing land use changes can be incorporated. Widely available data sets include the National Land Cover Database (NLCD) and USGS Digital Elevation Model (DEM). The SAB cautions EPA against *a priori* exclusion of wetland influenced lakes, which may host fish.

3.4.2 Plume rise

The SAB believes the plume rise methodology may be inappropriate in some cases EPA should evaluate the use of plume-rise models other than those described in the Agency's draft RTR methods document screening procedure. An example is Briggs (1984) and the documentation of AERMOD (Cimorelli *et al.* 2004) which thoroughly discusses plume rise and contains other citations.

For this and other dispersion and transport modeling, the SAB recommends that EPA consider the use of meteorological reanalysis data for both surface-air and upper-air wind speeds. These data can overcome some uncertainties when weather stations are far from the modeled site.

3.4.3 Time series meteorological and plume-rise data

The SAB believes that the hour-by-hour response treatment is not yet justified. Furthermore, the corresponding time-series meteorological and time-series plume-rise data used in the hour-by-hour treatment may be inappropriate in some cases.

First, EPA should be cautious about undue oversimplification of complex atmospheric processes. Full or partial penetration of a plume through the top of the mixed layer depends on many complex factors including plume momentum, plume buoyancy, stack release height and exit conditions, depth of the mixed layer, inversion strength, and atmospheric stability. These processes may vary with time, as meteorological factors evolve over the course of a day, possibly causing plume re-entrainment or rapid fumigation. Atmospheric processes governing plume penetration are more complex than can be adequately represented by a simple comparison of inversion height with effective plume height (which includes plume rise).

Second, the Agency's draft RTR methods document indicates that hour-by-hour data from the closest meteorological station should be used. These data may not reflect specific microclimatic conditions at the site, including topography, directional valley orientations, and specific inversion conditions that can differ from those at the station. For accurate screening, these local conditions should be considered.

EPA should test and demonstrate the reliability of the proposed adjustment by comparing screening results as implemented using TRIM.FaTE to those calculated by a more physically realistic model, such as AERMOD. Indeed, the SAB suggests EPA evaluate the additional accuracy perceived to result from implementing hour-by-hour adjustments. The suggested procedure requires extensive data manipulation yet has not been validated, whereas with a moderate additional investment the screening could be done with a validated and accepted model such as AERMOD.

The SAB also has two overarching recommendations addressing issues which were not specifically called out in the charge questions.

- EPA should consider that the quantity of emissions in the National Emission Inventory (NEI) may differ from reality, either because of upset conditions, or because self-reporting does not always suffice. The location of emissions may also be different than

reported. These inaccuracies may have important effects on predicted exposures and should be assessed to the extent practicable.

- The SAB recommends that EPA consider sensitivity analysis to determine the parameters and assumptions that have the greatest effect on predicted exposures, especially at the higher tiers. Identification of factors that dominate risk and uncertainty could guide future screening analyses by providing justification to obtain detailed input data for those factors. Furthermore, probabilistic analysis would provide a framework to estimate confidence bounds.

3.5 The gardener scenario

Charge Question 5: Does the SAB find the assumptions and approaches laid out for application in the gardener scenario to be appropriate? Does the SAB find that adding the gardener scenario to Tier 3 would improve our ability to characterize ingestion risks for urban and rural environments?

The Agency's draft RTR methods document includes a new exposure pathway added to the EPA methods (Section 3.4) – a gardening exposure scenario added to the multipathway screen. This scenario is intended to better characterize multipathway risk and the EPA suggested it will significantly improve the screening for locations where the presence of a subsistence farm is either unlikely (in urban areas) or difficult to confirm based on the characterization of land use surrounding a facility.

The gardener scenario is described on pages 59-62 of the Agency's draft RTR methods document. EPA is proposing to implement this scenario as part of Tiers 2 and 3 in locations where at least some individuals are likely to consume homegrown produce. The SAB was asked to comment on the assumptions used and whether the addition of the scenario would improve characterization of ingestion risk in both urban and rural environments. In general, the SAB finds that the gardener scenario is an appropriate addition to both Tier 2 and Tier 3 evaluation thereby developing a more useful model system for screening.

Regarding the first component of the charge question – the appropriateness of assumptions and approaches in the scenario – the SAB's response focuses on the media ingested by the gardener. EPA has selected ingestion routes like those experienced by subsistence farmers. These categories include direct ingestion of soil, ingestion of protected fruits and vegetables, ingestion of root vegetables, and ingestion of breastmilk (although intake rates for the latter are not presented in Tables 3-18 and 3-19). These appear to be appropriate and sufficiently distinct to provide coverage of the appropriate sources of soil ingestion and contaminants contained in soil. EPA distinguishes intake of gardeners from farmers by noting that meat products and dairy products are not likely to be sources for the gardeners (Table 3-17).

The SAB suggests including chicken eggs in the gardener scenario as many gardeners also keep egg-laying chickens. The SAB also notes that the gardening scenario appears to use many of the same assumptions about diet as the subsistence farmer, suggesting that the gardening scenario does not add much value to the tiered approach. The SAB therefore suggests that it is especially important to distinguish between the gardener and the subsistence farmer.

EPA has separated gardeners into two categories – rural and urban. The approach seems reasonable, especially given differing intake rates for urban and rural gardeners. The

assumptions that a rural gardener would have enough land to develop a subsistence, or near-subsistence, garden while the urban gardener would not seem, on face value, to be valid. Following this reasoning, EPA uses an upper (90th) percentile estimate for intake rate of home-grown vegetables for the rural gardener but a central tendency home-grown vegetables intake rate for urban gardeners (See Table 3-19 for the intake rates). Both intake rates are taken from the Exposure Factors Handbook and appear to be justified as EPA's best assessment of such rates.

Regarding soil intake rates, gardener soil intake rates were matched to those of farmers, consistent with the notion that gardens in both rural and urban settings must be tended, affording gardeners with intimate soil contact and thus intake. Further, in the rural setting, the farmer-specific rates for surface runoff-related contamination would be used while this term would not be used in urban settings. The farmer-specific rates are less health-protective in the sense that it focuses only on agricultural runoff. In urban settings, runoff may occur from other sources (e.g., industrial facilities and roadways) and might well be considered important. The SAB suggests that these additional urban sources be considered and matched with those of the rural settings.

Except for the surface runoff component, the assumptions made above are health-protective but not unreasonably so even when compared to earlier assumptions (e.g., Charge Question 3). The SAB notes that including the same assumptions for multiple tiers likely results in little effective screening. Further, the assumptions may offer too much health protection and thereby reduce the screening utility of the tool. In addition, the SAB suggests alternative- and higher- soil intake rates for the adult gardener.

Regarding the second component of this charge question, inclusion of the gardener scenario is appropriate because it improves the characterization of the potential risk in both rural and urban environments for those who take part in this activity.

3.6 Environmental risk screening methodology

> *Charge Question 6. Does the SAB find that the environmental risk screening approach is appropriate for identifying facilities whose PB-HAP emissions may have the potential to cause adverse environmental effects? Specifically, does the SAB find that the pollutants (Section 4.2.1), ecological assessment endpoints (Section 4.2.2), and benchmarks (Section 4.3) that are included in the environmental risk screen are appropriate? Does the SAB have specific suggestions for improvement with regard to any aspect of this environmental risk screening methodology?*

Charge Question 6 addresses the information provided in Chapter 4 of the Agency's draft RTR methods document (and supporting appendices) that describes the environmental risk screen that was developed to provide a systematic, scientifically defensible, and efficient approach that EPA can use to screen for potential adverse environmental effects associated with emissions of HAPs from facilities in RTR source categories. It is designed so that the screen can be run quickly and with minimal additional data gathering by drawing on existing data, models, and modeling results, including those developed for the human health multipathway risk screen. The overall methodology was reviewed by the SAB in 2009. The material in Chapter 4 of the Agency's draft RTR methods document focused on

those aspects that have been refined/revised since the last review. The revised aspects include:

- Modeled environmental concentrations are compared to ecological benchmarks, not human health thresholds, for all pollutants included in the screen;
- An evaluation of HAPs for potential inclusion in the screen was conducted;
- The environmental risk screen was expanded to include the following additional environmental HAPs: cadmium, hydrogen fluoride, lead, arsenic, and additional POMs;
- The number of ecological endpoints and effect levels that are evaluated was expanded;
- A literature review was conducted to identify the most up-to-date ecological benchmarks; and
- Tiers were added to the environmental risk screen for PB-HAP that are parallel to the tiers in the multipathway human exposure screen.

The SAB finds that the overall methodology and specifically the revisions since 2009 are appropriate and improve the ecological assessment capabilities. It represents a comprehensive approach that builds upon, and uses, the screening tools used in the health assessment/screening (i.e., TRIM.FaTE, AERMOD). As noted below, the SAB offers several recommendations and comments towards refining the approach.

The methodology for identifying the pollutants to be included in the screening activities are clearly stated and the criteria used to prioritize the chemicals are judged to be appropriate with the following considerations to be taken into account. The SAB is concerned that selenium is not included as a chemical to screen. Selenium is an essential trace element which is toxic at elevated concentrations. Elevated exposure can lead to selenosis. Selenates and selenites are particularly toxic forms of selenium (Hamilton, 2004). Given selenium's potentially important role in ecological impacts, the SAB recommends it be considered. In addition, it is not clear that BaP is the most appropriate POM chemical to use in the ecological analysis. There may be more important POM molecules (lower molecular weights) to use in this screening and further analysis is recommended. Furthermore, the emission rates presented in Table 4.1 are for base year 2005, and they need to be updated to reflect recent emissions data. Also, on page 67 line 21 there is reference to "99.9% of national emissions" but the basis is not clear (mass, toxicity or some other basis).

The SAB finds the expansion of ecological assessment endpoints appropriate and that the benchmarks, and the use of a tier system, are justified. The Agency's draft RTR methods report and appendices document the processes and assumptions used to identify the endpoints and benchmarks. Overall, the calculation of potential risks is robust and follows current scientific methodologies. As the amount and diversity of information analyzed in identifying the endpoints and benchmarks is vast, it would be helpful to clarify when most sensitive or most exposed species are used. In addition, the SAB notes that the overall approach would be strengthened by allowing site-specific variables to be added during the assessments, as some sites may have very specific sensitive species. Using a less sensitive receptor in a screening methodology runs the risk of underestimating the impact to the environment in those regions.

Tables 4.2 (endpoints) and 4.3 (benchmarks) are critical to the screening process. Values in these tables are likely to change over time as new information becomes available so it is important that they be viewed as tables requiring continuous development and a process should be identified by the EPA to continuously review and update them. Furthermore, many of the studies listed are from the 1980s-1990s and are compilation reviews from earlier publications. Notations should be made in the table or the text as to why the benchmark value was chosen. Many of the benchmarks have multiple studies (chronic / acute) with varying methodologies and results. The SAB recommends the EPA consider grading studies based on Klimisch score, a method of assessing the reliability of toxicological studies, mainly for regulatory purposes.

The SAB finds that the general methodology of the tiered approach and the use of TRIM.FaTE and AERMOD are appropriate. The SAB notes the simplicity of the air dispersion treatment in TRIM.FaTE and encourages the advancement of incorporating AERMOD analysis within the TRIM.FaTE framework. The use of reanalysis meteorological data is recommended to improve the meteorological fields used in the analysis. As stated elsewhere in this report, the analysis would also benefit from considering the implementation of a probabilistic approach.

The SAB recommends that analysis elements performed under the environmental risk screen be incorporated in the farmer screen (e.g., utilizing the deposition to soils).

The following additional specific recommendations regarding endpoints and benchmarks are provided:

- The SAB suggests EPA consider indirect HCl effects by evaluating the concentrations of chloride from a facility relative to background chloride concentrations contributing to loss of surface water acid neutralizing capacity or soil base saturation. Critical loads of acidity have been developed (NADP 2018) for the U.S. and the acidity associated with estimated chloride deposition could be compared to these critical load values.
- Mercury targets may need to be updated or expanded to protect communities of predator animals associated with bioaccumulation of methylmercury and to reflect broader wildlife impacts[4] (e.g., song birds.)
- The water quality and soil criteria (Table 4-1) for mercury are very high. This is particularly true for water where concentrations are typically on the order of nanograms per liter (ng/L). For example, the sediment clean-up values for Onondaga Lake, NY– a mercury contaminated site – are 2.2 μg/g for probable effective concentration based on macroinvertebrate toxicity testing and 0.8 μg/g for bioaccumulation-based sediment quality. The SAB suggests EPA consider criteria values for water and sediment/soil for contaminants that have been established for hazardous waste clean-up at sites around the U.S. for several contaminants.

3.7 Inhalation risk assessment enhancements

[4] http://www.briloon.org/uploads/Library/item/265/file/Hidden%20Risk.pdf https://www.crcpress.com/Environmental-Contaminants-in-Biota-Interpreting-Tissue-Concentrations/Beyer-Meador/p/book/9781420084054https://www.niehs.nih.gov/research/supported/assets/docs/a_c/bioscience_508.pdf

Charge Question 7: Does the SAB find that the Urban/Rural Dispersion Selection Enhancement Tool is an appropriate procedure for identifying facilities to be modeled using the urban option in AERMOD?

In previous chronic inhalation risk assessments, the EPA assumed the land surrounding each facility was rural. The 2009 SAB review (U.S. EPA SAB 2010) indicated additional development was appropriate. Chapter 5 of the Agency's draft RTR methods document is an enhancement to the chronic inhalation risk assessment that the EPA contends accounts for the variation in urban to rural characteristics of the land surrounding each evaluated facility. The goal of the improvement is to better characterize pollutant dispersion near sources.

The urban/rural dispersion selection enhancement tool provides a way to specify atmospheric turbulence within a model domain to allow AERMOD to more accurately model pollution dispersion. The tool currently provides two options. The Agency's draft RTR methods document evaluates the differences in model results using these two methods and proposes using the census (population density)-based designation of "urban" ("HEM default procedure") as the preferred method.

The SAB agrees that incorporating the effects of turbulence as a model input is appropriate and of significant value because it avoids the overly conservative assumption of applying the "rural" assumption to all facilities. However, the SAB disagrees with the Agency's draft RTR methods document on the procedure of choice and recommends the land use procedure which uses the National Land Cover Database (NLCD). This procedure directly measures the feature that controls turbulence, unlike the HEM default procedure which relies on a secondary effect – an aggregated population density metric – that may not correlate well in highly industrialized areas with dense concentrations of buildings, pavement and other structures yet little residential land. The land use procedure provides a more accurate assessment for the selection, and the Agency's draft RTR methods document does not offer a compelling explanation of the benefits from using the HEM default procedure. The land use procedure also more directly aligns with EPA's 2005 Guidelines on Air Quality Models as stated on page 121 (last paragraph) in the Agency's draft RTR methods document; the guidelines list specific land use types to be considered, rather than population density.

Using the land use procedure is not significantly more difficult or time/resource intensive than the HEM default procedure, so any logistical advantage of the HEM default procedure is minimal. Analysis can be automated using Model Builder or Python scripting in ArcGIS. Problems described in the Agency's draft RTR methods document associated with the land use procedure misclassifying facilities with significant coverage by water bodies inside the model domain can be addressed in the GIS procedures, and the SAB recommends that this be included in the procedure to avoid misclassifying heavily developed areas near large water bodies as "rural."

Because the inhalation risk assessment is a location-based estimate using modeled ambient concentrations and is not population-weighted, the use of population density via the HEM default procedure is less appropriate than using land use. In addition, the land use procedure finds fewer urban areas than the HEM default procedure, indicating the latter misclassifies turbulence in some cases.

The SAB also notes that the quality of the NLCD data makes it possible to express the "urban

nature" of the model domain as a continuous variable, rather than a binary "yes/no" value. Such a calculation adds little to the time and difficulty of the GIS procedures used to calculate the variable. It provides a measure of the intensity of "urban" character for each area considered and could also be used to characterize the geographic variation of turbulence within a given model domain. There are different ways to use this type of metric in modeling; it is not certain whether EPA modeling tools can use that variation, but it might be useful in future versions of the modeling and represents a "best practices" approach for gathering input data, particularly if it is only a little more difficult or expensive to do so. Using this approach with successive versions of the NLCD, which is updated every four years, allows for tracking land cover change over time.

If EPA adopts this more nuanced use of the NLCD, the SAB suggests the EPA consider including NLCD class 22 (low intensity developed) in identifying "urban" in this context. This class is defined as 20-44% impervious surfaces and it correlates very well with residential land use when compared to other high-resolution datasets. Class 22 is used in screening methods in California and has been shown to be of value in characterizing or measuring fine scale heterogeneity in other contexts (Chabaeva and Civco 2004; Smith et al. 2010).

Another alternative is the use of a regular NLCD derivative product – the percent impervious surface data layer which is produced for each NLCD generation, as is a measure of the net change in imperviousness between NLCD generations. Use of these metrics are generally as cost effective as using population density and have the advantage of being updated more often than the census. The SAB looks forward to reviewing and commenting on the approach eventually adopted.

Regardless of the urban/rural dispersion selection procedure that is used, the automatically-generated designation should be manually evaluated with the final choice of urban/rural dispersion a matter of professional judgment based on 'facts on the ground.' In cases where a material difference in estimated potential risk exists between urban and rural dispersion and professional judgement is used to overrule the selection tool's designation, EPA should document and justify this decision.

3.8 The census block receptor check tool

> *Charge Question 8: Does the SAB find that the Census Block Receptor Check Tool and associated enhancements are an appropriate method for identifying and adjusting model receptors to ensure the receptors are representative of residential locations?*

Section 5.2 of the Agency's draft methods document describes an enhancement made to the chronic inhalation risk assessment – the addition of the Census Block Receptor Check Tool. The rationale for the new tool is that the block centroid does not always represent residential locations. The HEM-3 model calculates ambient air concentrations at census block centroid locations as surrogates for population exposure. If the centroid is located outside of the block polygon, then the U.S. Census Bureau provides the longitude and latitude of an internal point near the geometric centroid that falls inside the block polygon. The points are not weighted or reflective of the population distribution. Census blocks vary in size depending on population density. In urban areas, a census block may be equivalent to a city block bounded on all sides by a street. In sparsely populated areas, a census block is often irregularly shaped with streams, property lines, and rural roads as boundaries. In the 2009 review conducted by the

SAB (U.S. EPA SAB 2010) it was noted that census block centroids might not always be an appropriate surrogate for residential locations. The Census Block Receptor Check Tool was developed to address this concern. This new tool identifies two examples when internal centroid points may not be a good surrogate for where populations reside and provides options to address this.

The first scenario is for block centroids located within 300 meters of emission points, which may be within the facility grounds and not where there are residents. The tool user would be able to view these receptors and delete them if they are on the facility property. The second scenario focuses on large and irregularly shaped census blocks, where the centroid may be farther away from population centers. If blocks with an area greater than 2.6 km^2 are identified within 1 km of a facility, aerial images of the blocks can be examined using the tool to determine if the centroid receptor needs to be relocated and other receptors added to represent multiple residential locations.

The SAB finds the Census Block Receptor Check Tool to be an appropriate framework, but the precise methodology underlying the tool may be unreliable in some cases. The SAB offers recommendations for improving the method, but also encourages the Agency to consider an alternative approach.

The EPA report does not provide enough information about the tool, especially regarding criteria that would be used to determine the number and placement of new receptors. For example, the statement "If residential locations cannot be represented by a single receptor (that is, the residences are spread over the block), additional receptors are added for residences nearer to the facility than the centroid" (page 140, lines 15-17) is vague and the method appears to be *ad hoc*. The SAB is concerned that the process would not be reproducible if another risk assessor were to subsequently model that facility. The choice of a 300-meter buffer from an emission source is also somewhat arbitrary. Furthermore, the impact of these changes is not obvious. The Agency's draft RTR methods report should include more detailed examples of how risk estimates change based on these enhancements compared to the default block centroid method.

Overall, the SAB believes that methods predominantly relying on census block centroid locations – including cases where the enhancement tool is applied – can in some cases be reliable, but additional effort is needed to verify that receptors are representative of residential areas near the facilities. One approach would be to review satellite imagery within 1 km of all facilities, not just those in identified large census blocks, and manually add receptors as needed to appropriately represent population centers. However, any manual placement would be subjective and likely not reproducible between risk assessors. The SAB recommends the Agency evaluate an alternative approach that uses the same 2011 National Land Cover data used for the Urban/Rural Dispersion Selection Enhancement tool to automate the process of identifying population centers. The NLCD data is available at a high spatial resolution (30 m) and receptors could be placed in areas of developed land use classes 22-24. Aerial photos (e.g. Google Earth™) can then be used to check that the land use-based placement of receptors is appropriate. If professional judgement is used to select the location then the RTR screening analysis documentation should include sufficient information such that another expert could follow the reasoning and reproduce the selection.

If the EPA prefers to continue using census block centroids as nearby exposure receptors, then the SAB recommends additional enhancements to make the tool less *ad hoc*. For example, facilities are better represented as polygons than points. Satellite imagery can be used to estimate the facility boundary and then GIS procedures could be used to exclude centroids located within the boundary. In such cases, satellite imagery could then be used to add alternative receptors to replace the deleted centroid and ensure nearby residences are represented. It is noted that this procedure would not be needed if receptors were placed at actual population locations using land use data as recommended.

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5. APPENDIX A: CHARGE TO THE SAB

May 26, 2017

MEMORANDUM

SUBJECT: Request for SAB Peer Review of the document: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis"

FROM: Erika N. Sasser, Director /s/
Health and Environmental Impacts Division
Office of Air Quality Planning and Standards (C504-02)

TO: Christopher Zarba, Director
EPA Science Advisory Board Staff Office (1400F)

EPA's Office of Air Quality Planning and Standards is requesting a peer review by the Science Advisory Board (SAB) on the document: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis." This report describes specific screening methodologies that have evolved since the SAB last reviewed the RTR risk assessment methods in 2009. The screening methodologies are used to quickly identify those facilities in particular RTR source categories that have little potential for human health multipathway or environmental risk, while also identifying those facilities where a refined multipathway or environmental risk assessment may be needed. This report also describes the potential addition of a new multipathway exposure scenario that can estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables, as well as several improvements to EPA's chronic inhalation risk assessment methodology. The application of the updated risk assessment screens and methodologies is highlighted in this report through the presentation of example facilities emitting hazardous air pollutants.

The case study analysis and accompanying documentation were prepared by staff in the EPA's Office of Air Quality Planning and Standards. The document is being made publicly available on the Agency's website at the following address:
https://www3.epa.gov/ttn/atw/rrisk/rtrpg.html.

Attached is the charge to the Science Advisory Board. It includes background information on the screening methodologies and identifies the questions and issues we would like the Science Advisory Board to address in their peer review of the methods.

Attachment:
Peer Review Charge

Attachment

Charge to the Science Advisory Board for their review of the "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis"

Office of Air Quality Planning and Standards
Office of Air and Radiation

Background:

The Clean Air Act (CAA) establishes a two-stage regulatory process for addressing emissions of hazardous air pollutants (HAP) from stationary sources. In the first stage, the CAA requires the EPA to develop technology-based standards for categories of industrial sources. We have largely completed the required Maximum Achievable Control Technology (MACT) standards with about 112 MACT standards being issued to date for stationary major sources of HAP. In the second stage of the regulatory process, EPA must review each MACT standard at least every eight years and revise them as necessary, "taking into account developments in practices, processes and control technologies." We call this requirement the "technology review." EPA is also required to complete a one-time assessment of the human health and environmental risks that remain after sources come into compliance with MACT. If additional risk reductions are deemed necessary to protect public health with an ample margin of safety or to prevent adverse environmental effects that are judged to be "significant and widespread", EPA must develop standards to address these remaining risks. For each source category for which EPA issued MACT standards, the residual risk stage must be completed within eight years of promulgation of the initial MACT standard. Since the initial technology review requirement coincides in deadline with the risk review requirement, EPA generally combines these two requirements into one rulemaking activity, calling this the "risk and technology review" process, or simply RTR. In this way, the results of the risk review can be potentially informative to the technology review process, and vice versa.

Because RTR assessments are used for regulatory purposes, and because components of our screening analyses have evolved over time, EPA periodically seeks the Science Advisory Board's (SAB) review (see below). For the current review, we seek the SAB's input on the specific enhancements made to our risk assessment methodologies, particularly with respect to multipathway and environmental screening methodologies, since the last SAB review was completed in 2009. Facilities that do not screen out may be the subject of refined multipathway risk assessments, which 1) are conducted for a single facility at a time; 2) are very costly; 3) and can take several months to complete. Thus, we consider these screens to be an important step in the RTR risk assessment process that helps the agency to maximize the use of its resources and, when appropriate, to facilitate its communication with stakeholders.

Previous Relevant Peer Reviews

Previous peer reviews have covered various elements associated with the RTR process. A brief summary of each peer review is provided:

1) The *Residual Risk Report to Congress*, a document describing the Agency's overall analytical and policy approach to setting residual risk standards, was issued to Congress in 1999 following an SAB peer review. Many of the design features of the RTR assessment methodology were described in this report, although individual elements have been improved over time. The final SAB advisory is available at http://www.epa.gov/ttn/oarpg/t3/reports/risk_rep.pdf).

2) A peer review of multipathway risk assessment methodologies for RTR was conducted by the EPA's SAB in 2000. The final SAB advisory is available at http://yosemite.epa.gov/sab/sabproduct.nsf/1F1893E27059DB55852571B9004730F7/$Fi_le/ecadv05.pdf.

3) A consultation on EPA's updated methods for developing emissions inventories and characterizing human exposure was conducted by SAB in 2006. The final SAB advisory is available at https://yosemite.epa.gov/sab%5Csabproduct.nsf/33152C83D29530F08525730D006C3ABF/$File/sab-07-009.pdf.

4) A review of the updated and expanded risk assessment approaches and methods used in the RTR program was completed in 2009. This methodology was highlighted to the SAB utilizing two RTR source categories: Petroleum Refining Sources MACT I and Portland Cement Manufacturing. The final SAB advisory is available at https://yosemite.epa.gov/sab/sabproduct.nsf/0/b031ddf79cffded38525734f00649caf!Ope_nDocument&TableRow=2.3#2.

5) The individual dose-response assessment values used in the RTR assessment have themselves been the subject of peer reviews through the agencies that developed them (including EPA, through its Integrated Risk Information System, or IRIS; the California Environmental Protection Agency, or CalEPA; and the Agency for Toxic Substances and Disease Registry, or ATSDR).

We are not asking the SAB panel to duplicate or comment on previously reviewed methodologies, but rather to evaluate whether the specific enhancements to previously reviewed methodologies as described below are appropriate and scientifically credible.

Goals of This Review

We are seeking a scientific peer review of the updated screening methodologies. We are also seeking a scientific peer review of several specific enhancements to our chronic inhalation risk assessment that serve to reduce some of the uncertainties identified by EPA in the last SAB review. These updates and enhancements are outlined in the report: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis" (the report).

The most important revisions and enhancements to our methodologies since the last SAB review include the following:

1) A tiered multipathway screening methodology that determines whether the potential for multipathway risk from persistent and bioaccumulative HAP (PB-HAP)[51] emitted from RTR source categories is low or whether more analysis is needed.

2) A tiered environmental screening methodology that determines whether the potential exists for adverse environmental effects from PB-HAP and the acid gases hydrogen chloride (HCl) and hydrogen fluoride (HF) emitted from RTR source categories.

3) The potential use of a new multipathway exposure scenario that can be used to estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables.

4) Enhancements to our previously reviewed inhalation risk assessment that allow us to more accurately model air concentrations where populations actually reside and to better characterize the dispersion of the air in the vicinity of sources.

Charge questions for the Panel's consideration:

There are eight charge questions for this peer review, each of which has been placed in a box below. These eight questions concern three topic areas that cover the most important revisions and enhancements to our methodology since the last SAB review.

Multipathway Human Health Risk Screening Methodology (Chapters 2 and 3):

In RTR assessments, EPA considers ingestion risks using a multipathway approach, in which we model the dispersion, transport, and fate of HAPs emitted from facilities in specific source categories in the environment and estimate human health risks resulting from the ingestion of HAPs from food products, such as vegetables, fruit, meat, and fish.

Since the 2009 SAB review of RTR methods, we refined our original one-tier multipathway screen to include a three-tiered multipathway screening approach that progressively replaces health-protective default assumptions with location-specific data. Since full-scale facility-specific multipathway assessments are time consuming and expensive, the tiered screening approach "screens out" low-risk facilities for which no additional analysis is needed, so that only facilities with potentially higher risk remain in the pool for further analysis.

Chapter 2 of the report provides an overview of the tiered multipathway screening methodology, including a brief description of each multipathway screening tier. The technical detail on each tier of the multipathway screen is laid out in Chapter 3 of the report.

Charge Question 1: Does the SAB find that the three-tiered multipathway risk screening approach appropriately eliminates from further consideration those facilities unlikely to emit PB-HAP in concentrations resulting in appreciable multipathway risk and identifies those facilities where additional multipathway analysis may be warranted? Does the SAB have specific suggestions for improvement of the risk screening methodology?

Tier 1

The multipathway screen previously reviewed by SAB did not account for differences in environmental fate and transport among POM or dioxin congeners (i.e., all POM congeners were assumed to move, partition, and degrade in the environment as BaP does, and all dioxins were assumed to exhibit the same fate and transport as 2,3,7,8-TCDD). Section 3.1.2 of the Report describes the new risk equivalency factor (REF) approach that includes an exposure-equivalency factor (EEF) that reflects an individual chemical's fate and transport relative to the index chemical for each group (BaP for POM and 2,3,7,8-TCDD for dioxin).

Charge Question 2: Does the SAB find that the risk equivalency factor methodology appropriately accounts for differences in the environmental fate and transport among polycyclic organic matter (POM) and dioxin congeners?

Tier 2

Section 3.2 of the report describes the Tier 2 multipathway screening scenario, in which some of the health-protective assumptions in the Tier 1 screen are replaced with more site- specific information. Specifically, in the Tier 2 assessment, site-specific information is used for the locations of potentially fishable lakes and meteorology. In addition, the Tier 2 assessment includes:

- A screening configuration that assesses the fisher and farmer exposure scenarios separately (see Sections 3.2.1.2 and 3.2.1.3).
- An estimation of lake productivity (see Section 3.2.2.2).
- The consideration that a fisher might catch and consume fish from more than one nearby contaminated lake, because more than one lake might be needed to catch enough fish for subsistence living (see Section 3.2.2.3).
- An approach that accounts for PB-HAP deposition into a lake from multiple facilities in the same RTR source category (see Section 3.2.2.3).

Charge Question 3: Does the SAB find that the assumptions for human fishing behavior used in the refined fisher scenario, the assumptions about PB-HAP deposition to lakes, and the assumptions on the ability of ponds and lakes to sustain populations of fish are appropriate?

Tier 3

The Tier 3 screening approach described in Section 3.3 of the report consists of three individual refinements to Tier 2 that are conducted in a step-wise fashion. These refinements include:

- Further analysis of the affected lakes identified in the Tier 2 screen (Section 3.3.1).
- Analysis of plume rise resulting in PB-HAPs lost to the upper atmosphere (Section 3.3.2).
- The use of time-series meteorology and effective release heights (Section 3.3.3).

Section 3.4 of the report describes a gardening exposure scenario we are considering adding to the Tier 3 multipathway screen. The gardening exposure scenario could help us to better characterize multipathway risk in some instances, especially in locations where the presence of a subsistence farm is either unlikely (e.g., in urban areas) or difficult to confirm based on the characterization of land use surrounding a facility.

Charge Question 4: Does the SAB find the methods used for evaluations of (1) lake data, (2) plume rise, and (3) time-series meteorological and time-series plume-rise data are appropriate?

Charge Question 5: Does the SAB find the assumptions and approaches laid out for application in the gardener scenario to be appropriate? Does the SAB find that adding the gardener scenario to Tier 3 would improve our ability to characterize ingestion risks for urban and rural environments?

Environmental Risk Screening Methodology (Chapter 4):

Chapter 4 of the report describes the environmental risk screen that was developed to provide a systematic, scientifically defensible, and efficient approach that EPA can use to screen for potential adverse environmental effects associated with emissions of HAPs from facilities in RTR source categories. The screen can be run quickly and with minimal additional data gathering by drawing on existing data, models, and modeling results, including those developed for the human health multipathway risk screen.

The revised environmental risk screen presented in the report builds on and enhances the methods the SAB reviewed in 2009 as follows:

- Modeled environmental concentrations are compared to ecological benchmarks, not human health thresholds, for all pollutants included in the screen.
- A systematic evaluation of HAPs for potential inclusion in the screen was conducted.
- The environmental risk screen was expanded to include the following additional environmental HAPs: cadmium, hydrogen fluoride, lead, arsenic, and additional POMs.
- The number of ecological endpoints and effect levels that we evaluate was expanded.
- A comprehensive literature review was conducted to identify the most up-to-date ecological benchmarks.
- Tiers were added to the environmental risk screen for PB-HAP that are parallel to the tiers in the multipathway screen.

Charge Question 6: Does the SAB find that the environmental risk screening approach is appropriate for identifying facilities whose PB-HAP emissions may have the potential to cause adverse environmental effects? Specifically, does the SAB find that the pollutants (Section 4.2.1), ecological assessment endpoints (Section 4.2.2), and benchmarks (Section 4.3) that are included in the environmental risk screen are appropriate? Does the SAB have specific suggestions for improvement with regard to any aspect of this environmental risk screening methodology?

Inhalation Risk Assessment Enhancements (Chapter 5):

Urban/Rural Dispersion Selection Tool
In previous chronic inhalation risk assessments, we assumed the land surrounding each facility was rural. Since the most recent SAB review in 2009, we developed an urban/rural enhancement to the chronic inhalation risk assessment that allows us to account for the urban/rural characteristics of the land surrounding each evaluated facility, and therefore, to better characterize the dispersion of pollutants near sources (Section 5.1).

Charge Question 7: Does the SAB find that the Urban/Rural Dispersion Selection Enhancement Tool is an appropriate procedure for identifying facilities to be modeled using the urban option in AERMOD?

Census Block Receptor Check Tool
In its 2009 review, the SAB noted that census block centroids might not always be an appropriate surrogate for residential locations. For example, when the census block centroid is located on industrial property ("on-site"), or when a census block is large and the centroid is far from where populations actually reside, using the centroid may not be appropriate. Since 2009, we developed the census block receptor enhancement (Section 5.2) that allows us to model air concentrations more accurately where populations actually reside. Specifically, the new enhancement automatically identifies census block centroids that might be located on facility, and census blocks that are very large. When onsite or large blocks are identified, we add new receptors, delete census block centroids, or move census block centroids to represent residential locations more accurately.

Charge Question 8: Does the SAB find that the Census Block Receptor Check Tool and associated enhancements are an appropriate method for identifying and adjusting model receptors to ensure the receptors are representative of residential locations?

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON D.C. 20460

September 13, 2018

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

EPA-SAB-18-003

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Review of EPA's draft technical report entitled *Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*

Dear Acting Administrator Wheeler:

The Science Advisory Board was asked by EPA's Office of Air Quality Planning and Standards to review the EPA draft document titled, *Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis* (May 2017). The draft RTR methods document describes the EPA's methods for conducting initial risk screening analyses in the Clean Air Act mandated assessment of "residual risk", i.e., the risks remaining after application of maximum achievable control technology pursuant to the National Emission Standards for Hazardous Air Pollutants under Title I of the Clean Air Act.

The SAB Risk and Technology Review Methods Review Panel deliberated on the charge questions specific to the Agency's draft RTR methods document during a June 29-30, 2017, face-to-face meeting and discussed the SAB panel's draft report in a subsequent conference call on December 5, 2017. The charge questions focused on eight topics within the Agency's draft RTR methods document, including: a three-tiered multipathway screening approach used in the RTR screening analyses; a risk equivalency factor methodology; fishing, lake and pond assumptions; lake data, plume rise, and meteorological data; a gardener scenario; environmental risk screening methodology; inhalation risk assessment enhancements; and the census block receptor check tool. The enclosed report provides the SAB's consensus advice and recommendations in response to the charge questions. This letter briefly conveys the major findings.

The SAB commends the EPA on the technical quality of the draft RTR document and the effort it has put into developing the residual risk screening methodology. The SAB finds that the overall methodology and specifically the revisions since 2009 are for the most part appropriate and improve the assessment capabilities; opportunities for improvement are documented in the SAB's report. The SAB concludes that the EPA's approach has the potential to achieve the Agency's goal to rapidly and effectively screen facilities, and to focus EPA time and resources on sites of most concern from a public health point of view.

Insufficient detail was provided in the Agency's draft RTR methods document for the SAB to assess the overall operational effectiveness of the screening methodology such as how many facilities are screened out by each of the three tiers. Some data were provided later by the EPA that did help the SAB to understand the screening efficacy. The SAB recommends the EPA compile summaries of RTR analyses applied in regulatory activities for inclusion in future RTR methodology report documents. Furthermore, in future screening analyses the EPA should compare, for specific facilities, the screening model output to field data where available. These "ground truthing" studies should be included in the next RTR methods document and provided to future reviewers for consideration.

Concerning the lifetime average daily dose (LADD) estimates when calculating exposure equivalency factors, EPA's empirical correlation is a logical step in creating the read-across approach used by the Agency. However, the read-across approach for environmental fate is less well-tested and accepted and thus deserves further consideration[1]. The SAB notes that this read-across extrapolation of environmental fate could be refined and has identified two options for the EPA to consider for improving the LADD estimates.

The SAB finds that the inclusion of the domestic gardener scenario is appropriate, though an evaluation of how many people this applies to should be conducted to determine the efficacy of the addition. The accuracy of dispersion and deposition results from the TRIM.FaTE model should be evaluated by comparing them with the results from a more technically robust dispersion model, such as AERMOD. In addition, while incorporation of turbulence in determining urban/rural selection in dispersion modeling is appropriate, the SAB recommends a different approach suggesting a more physically-based model such as AERMOD and the use of meteorological reanalysis data for both surface-air and upper-air wind speeds. Finally, the SAB finds that the EPA's reliance on census-block centroid locations as surrogates for where people live might not always be sufficient to ensure that receptors are representative of residential areas near facilities, and thus the SAB recommends that additional, reproducible methods should be evaluated.

The SAB recommends the EPA explore a transition for its screening methodology from using single-point estimates of uncertain input values to using distributions for these values. Probabilistic analyses combining the effects of distributions of multiple input values would result in a coherent analysis from which arithmetic means and "conservative fractiles" (e.g., a 90th percentile) could be derived. While in the interim sensitivity analyses on uncertain input values could be performed, the shift to a probabilistic analysis framework would provide a more robust foundation for the screening methodology in higher tiers.

[1] Physicochemical, human health and/or environmental properties may be predicted from information from tests conducted on reference substance(s) within the group, referred to as source substance(s), by interpolation to other substances in the group, referred to as target substance(s). This approach is called "read-across." (https://echa.europa.eu/documents/10162/13628/raaf_en.pdf)

In summary, the SAB supports the framework and direction of refinements EPA has been making to the screening methodology for the residual risk portion of RTR analyses. The SAB appreciates the opportunity to provide the EPA with advice on this important subject. We look forward to receiving the EPA's response.

Sincerely,

/Signed/

Dr. Michael Honeycutt, Chair
Science Advisory Board

/Signed/

Dr. Jay Turner, Chair
Risk and Technology Review Methods Review Panel

Enclosure

NOTICE

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Acronyms and Abbreviations

AERMOD	AMS/EPA Regulatory [Dispersion] Model
AMS	American Meteorological Society
ATSDR	Agency for Toxic Substances and Disease Registry minimum risk levels
AEGL	Acute Exposure Guidelines Limits
ANPRM	Advanced Notice of Proposed Rulemaking
BaP	benzo(a)pyrene
CalEPA	California Environmental Protection Agency
EEF	exposure equivalency factor
ERA	Ecological Risk Assessment
ERPG	Emergency Response Planning Guidelines
HAP	Hazardous Air Pollutant
K_{ow}	the *n*-octanol/water partition coefficient
IRIS	Integrated Risk Assessment System
LADD	lifetime average daily dose
MACT	Maximum Achievable Control Technology
MTBE	Methyl Tertiary Butyl Ether
NATA	National Air Toxics Assessment
NEI	National Emissions Inventory
NESHAP	National Emission Standard for Hazardous Air Pollutants
NHANES	National Health and Nutrition Examination Survey
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Testing
NPRM	Notice of Proposed Rulemaking
NWS	National Weather Service
OAQPS	Office of Air Quality Planning and Standards
OPP	Office of Pesticide Programs
OSHA	Occupational Safety and Health Administration
OEHHA	Office of Environmental Health Hazard Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PB-HAP	Persistent Bioaccumulative - Hazardous Air Pollutant
POM	Polycyclic Organic Matter
REF	risk equivalency factor
RTR	Risk and Technology Review
SAB	Science Advisory Board
TEF	toxicity equivalency factor
TEQ	Toxic Equivalents
TRIM.FaTE	Total Risk Integrated Methodology - Fate, Transport and Ecological Exposure
UCL	Upper Confidence Limit
USDA	US Department of Agriculture
USGS	US Geological Survey

1. EXECUTIVE SUMMARY

This report was prepared by the U.S. EPA Science Advisory Board (SAB.) The Board convened the Risk and Technology Review (RTR) Methods Review Panel for initial deliberations in response to a request by EPA's Office of Air Quality Planning and Standards (OAQPS) to review their draft document entitled, "*Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*" (U.S. EPA 2017). This document (hereinafter referred to as the "Agency's draft RTR methods document") describes portions of the methods used to assess "residual risk" i.e., the potential risks remaining after application of maximum achievable control technology (MACT) pursuant to the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations.

Screening methodologies are used to quickly identify those facilities in a source category that have little potential for human health multipathway or environmental risk, while also identifying those facilities where a refined multipathway or environmental risk assessment may be needed. The Agency's draft RTR methods document describes several improvements to the screening methods.

The SAB reviewed the draft RTR methods document as requested by considering eight charge questions posed by the EPA (See Appendix A). The SAB provides comments on the RTR screening methods and does not address the regulatory implications of the methods or the document. The SAB also notes that no methods were submitted for review regarding the technology portion of the RTR analysis called for by the NESHAP regulations, nor were charge questions posed regarding the technology review methods to be applied by the EPA.

The SAB RTR Methods Review Panel deliberated on responses to the charge questions specific to the Agency's draft RTR methods document during a face-to-face meeting on June 29-30, 2017, and discussed its draft report in a subsequent conference call on December 5, 2017. The Chartered SAB conducted a quality review of this document on May 31, 2018. The charge questions focused on eight topics within the Agency's draft RTR methods document, including: *the three-tiered multipathway screening approach used in the RTR analyses; the risk equivalency factor methodology; fishing, lake and pond assumptions; lake data, plume rise, and meteorological data; the gardener scenario; environmental risk screening methodology; inhalation risk assessment enhancements; and the census block receptor check tool.*

This Executive Summary highlights the SAB's major findings and recommendations. The SAB commends the EPA on the technical quality of the draft RTR methods document and the thought and effort it has put into developing the residual risk screening methodology. The SAB finds that the overall methodology and specifically the revisions since 2009, are reasonable and should improve the EPA's assessment capabilities. The comments and recommendations offered below are intended to assist EPA staff as they seek to improve their RTR assessments going forward and are not meant to detract from the screening and assessment efforts to date.

The SAB agrees that the three-tier multipathway risk screening approach, starting with health protective parameters and moving to more site-specific parameters in later tiers, is reasonable and logical. The SAB finds the expansion of the endpoints for the environmental risk screen is reasonable and the benchmarks and use of a tiered screening system are

justified. Overall, the screening methodology has the potential to achieve the EPA's goal to quickly screen facilities, and to focus Agency time and resources on sites of most concern from a public health point of view.

The SAB recommends that future RTR methods documents be written for a primary audience envisioned as a risk assessor trying to reproduce the results of an EPA RTR risk assessment screening, rather than for the audience of peer reviewers.

The SAB finds summary information about overall performance of the methods and case studies to be missing from the report or inadequate for a comprehensive assessment of the methods described. For example, the SAB could not assess the overall operational effectiveness of the screening methods, such as how many facilities are screened out compared to those facilities passed on for more detailed analysis. The SAB very strongly recommends the EPA compile summaries of RTR analyses applied in regulatory activities and include the summaries in future RTR documents for review by the Board. In addition, analysis of the results by source category may indicate that some types of facilities screen out earlier than others and it may point out risk drivers, sensitive parameters and key features that could be refined to improve the screening analysis for particular source categories in the future.

In future screening analyses the EPA should compare, for specific facilities, the screening model output with field data, where available. For example, field measurement data on relevant persistent bioaccumulative hazardous air pollutants (PB-HAPs) in atmospheric deposition, soil, water, and fish could be used to validate key screening model outputs, especially in the Tier 3 evaluation. These "ground truth" studies must be included in the next RTR methods document and provided to future SAB reviewers for consideration.

Data quality considerations are important in RTR assessments. Experience has shown that significant errors can occur in RTR input data, which in turn, can skew risk results, sometimes by material, policy-relevant margins. Accurate input data are the bedrock foundation on which all RTR risk analyses build. The SAB recognizes EPA's past efforts to ensure RTR input data accuracy, and strongly supports and encourages such efforts. Building on the substantial efforts that EPA staff have already made, EPA could further develop and expand its affirmative efforts to ensure RTR input data accuracy. The possibility of such errors and their policy implications should continue to be considered when conducting RTR risk analyses and interpreting results.

The SAB recommends the EPA examine refinements to the tiered screening methodology by conducting sensitivity studies to identify the key input values that drive the risk estimates. EPA also should evaluate the use of probabilistic analyses to estimate more accurately the overall risks. In cases where these input values are uncertain but appropriate, distributions for these parameters could be constructed; probabilistic analysis would provide a more robust foundation for the screening methodology.

Regarding the risk equivalency factor (REF) calculation, the SAB supports the toxicity equivalency factor (TEF) read-across approach as it is well accepted for dioxins and carcinogenic polycyclic aromatic hydrocarbons (PAHs). For the exposure equivalency factor (EEF) estimate, the read-across approach, for environmental fate and transport, is not as well tested and thus deserves further consideration. EPA's empirical correlation between the *n*-octanol/water partition coefficient (K_{ow}) and lifetime average daily dose (LADD) for chemicals

with sufficient data is a logical step in creating the read-across approach used by the EPA. However, K_{ow} is an imperfect predictor of LADD and incorporation of other factors (e.g., environmental persistence and molecular weight) may improve the estimates. The SAB finds this read-across extrapolation approach could be refined and has identified two options for the EPA to consider for improving the EEF estimates.

The SAB also finds the REF method would greatly benefit from better explanation, documentation and statistical analysis in terms of: (a) documentation of TEFs, including consideration of whether assigning a TEF for carcinogenic activity is appropriate for PAHs not currently identified as carcinogens; and (b) documentation of the methods for the EEF derivation.

The SAB is generally supportive of the assumptions used for human fishing behavior in the refined fishing scenario and offers several specific suggestions for improving the data used, the model versions used, and how to document studies used by the EPA for the data and modeling methods.

Tier 3 screening introduces refinements to the treatment of air pollutant dispersion and deposition. EPA should consider the use of plume-rise models other than those described in the Agency's draft RTR methods document and could test and demonstrate the reliability of plume rise adjustments. The accuracy of dispersion and deposition results from the TRIM.FaTE model should be evaluated by comparing them with the results from a more technically robust dispersion model, such as AERMOD. The SAB suggests EPA evaluate the selection of urban vs. rural terrain in the inhalation risk assessments by comparing TRIM.FaTE-derived screening results to those calculated by a more physically-based model such as the regularly updated AERMOD. For this and other air dispersion and transport modeling, the SAB recommends that EPA consider the use of meteorological reanalysis data for both surface-air and upper-air wind speeds.

The SAB agrees that the proposed gardener scenario is an appropriate addition to both Tier 2 and Tier 3 screening evaluation. However, it is important to distinguish between the gardener and the subsistence farmer. The gardener scenario improves the characterization of potential risk in both rural and urban environments for those who take part in this activity, however the SAB urges the EPA to gather data characterizing the population engaged in this activity and the primary exposure routes in order to evaluate the efficacy of this scenario.

The Agency should consult with colleagues across the EPA who have data and models for addressing parameters used in the screening analysis. For example, the SAB understands the Agency has data or models available for parameters such as lake outflow, chemical runoff and erosion.

The SAB found the methodology for identifying the pollutants to be included in the environmental risk screening activities are clearly stated and the criteria used to prioritize the chemicals are found to be appropriate. The SAB is concerned that selenium is not included as a chemical to screen and recommends that it be added in future RTR screening analyses.

The SAB agrees that characterizing the terrain as urban versus rural and incorporating the effects of turbulence as a dispersion modeling input is appropriate. This refinement has significant value because it avoids the overly conservative assumption of applying the "rural"

assumption to all facilities. However, the SAB disagrees with the Agency's draft RTR methods document on the procedure of choice and recommends using a land use-based procedure utilizing national land cover data (NLCD).

The SAB finds that insufficient information was provided about the census block receptor check tool, especially regarding criteria used to determine the number and placement of new receptors. The SAB is concerned that the process would not be reproducible if another risk assessor were to subsequently model a facility. Overall, the SAB finds that, while the method's reliance on census block centroid locations may in some cases be sufficient for screening, care must be taken that receptors are well-placed to be representative of residential areas near the facilities. To facilitate tool transparency and results reproducibility, EPA could develop protocols to enable risk assessors to exercise their professional judgment in verifying the tool-based receptor placements and document the decision process for placement (e.g., using Google Earth imagery and preliminary risk calculations) so as to be reproducible by independent expert analysts.

In summary, the SAB supports the framework and direction of refinements EPA has been making to the screening methodology for the residual risk portion of RTR analyses. In many cases, the SAB supports the methodological details used by the EPA; and in other cases, the SAB recommends considering refinements or alternative approaches.

By the EPA's accounting, provided in response to inquiry by the SAB, for the five most recent RTR analyses conducted prior to June 2017, Tier 1 on average screened out 30% of the affected facilities, and the Tier 2 fisher and farmer scenarios on average screened out 60% and 70%, respectively, of the affected facilities. This demonstrates a commitment to effectively manage EPA resources and focus attention on the subset of facilities that are not deemed low-risk based on the screening analysis. However, insufficient information was provided in the RTR methodology report for the SAB to evaluate the overall efficacy of the EPA's methods. EPA's multi-tiered risk screening approach appears designed intending that: (a) high-risk facilities are not prematurely screened out (with adverse public health or environmental implications) and (b) low-risk facilities are not unnecessarily retained for more detailed analysis (with adverse EPA resource implications). The SAB strongly calls for data to be developed and presented in future method reports that indicate how many facilities may be screened out prematurely and how many may be passed on to a full-scale risk assessment that should have been screened out in the screening analysis.

2. INTRODUCTION

EPA's Office of Air Quality Planning and Standards (OAQPS) requested that the Science Advisory Board (SAB) review the draft document, "*Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis*" (U.S. EPA 2017). This document (hereinafter referred to as the "Agency's draft RTR methods document") describes the EPA's recent and proposed refinements to the screening methods for assessing "residual risk" i.e., the risks remaining after application of maximum achievable control technology (MACT) under Title I of the Clean Air Act (CAA).

The CAA establishes a two-stage regulatory process for addressing emissions of hazardous air pollutants (HAPs) from stationary sources. In the first stage, the CAA requires EPA to develop technology-based standards connected to MACT for categories of industrial sources. EPA must review each MACT standard at least every eight years and revise them as necessary. This is the technology review portion of RTR. In the second stage of the process, EPA is required to assess the health and environmental risks that remain after MACT has been applied. EPA must develop standards to address these remaining potential risks if necessary to protect the public health with an ample margin of safety or to prevent adverse environmental effects. This second stage of the RTR is known as the residual risk review and must be completed within eight years of promulgation of the initial MACT standards for each source category.

The EPA, in order to streamline and standardize the residual risk review for the large number of affected source categories, has developed a process by which it: (1) conducts a risk assessment using currently available source and emissions data; (2) requests public comment on the source and emissions data, along with preliminary risk assessment results, through an Advance Notice of Proposed Rule Making (ANPRM); (3) addresses comments received on the ANPRM; and (4) revises the risk assessment as needed. The results of the revised risk assessment are intended to support proposals and promulgation of technology- and risk-based regulatory decisions through a transparent, science based, notice-and-comment rulemaking process.

The Agency's draft RTR methods document describes revisions to the screening methods used when conducting the risk portion of Risk and Technology Review assessments. These assessments evaluate the effects of industrial HAPs emissions on public health and the environment. Screening methods are used to quickly identify, for a particular RTR source category, those facilities that have little potential for human health risk via multipathway exposure or little potential for environmental risk, while also identifying those facilities where a refined risk assessment may be needed.

Previous internal EPA and external peer review panels have reviewed aspects of the RTR methodology, as documented in the following reports:

1) The *Residual Risk Report to Congress* (U.S. EPA 1999), a document describing the EPA's overall analytical and policy approach to evaluating residual risk in the context of setting NESHAP standards, was issued to Congress in 1999 following an SAB peer review. Many of the design features of the RTR assessment methods were described in

this report, although individual elements have been refined over the subsequent two decades.

2) Individual residual risk assessments – several internal peer reviews and one external peer review were conducted on risk assessments for individual source categories, including Coke Ovens (U.S. EPA 2018a), Perchloroethylene Dry Cleaning (U.S. EPA 2018b), and Halogenated Solvent Cleaners (downloadable from: U.S. EPA 2018c). Each of these assessments used emission estimates from the National Emissions Inventory (NEI), human exposure modeling at the census block level, dose-response methodologies, and risk characterization like those for the ongoing and planned RTR assessments.
3) The National Air Toxics Assessment, or NATA, for 1996 was peer-reviewed by the SAB in 2001-2002 (U.S. EPA SAB 2001). NATA 1996 was a comprehensive and cumulative risk assessment designed to include all mobile sources, small and large industrial sources, and background contributions to air toxics. Because of significant uncertainties, the SAB did not believe that it was appropriate for regulatory purposes. For example, the 1996 assessment had census block-level data resolution available, but the analysis was performed at the census tract level. This approach was refined in subsequent assessments.
4) The AMS/EPA Regulatory [Dispersion] Model (AERMOD), a source-to-receptor air quality dispersion model, was the subject of significant interagency cooperation and peer review. It is now EPA's preferred local-scale air dispersion model for industrial sources of air pollution (U.S. EPA 2018d).
5) The individual dose-response values used in RTR assessments have been the subject of peer reviews through the agencies that developed them (including EPA, through its Integrated Risk Information System, or IRIS; the California Environmental Protection Agency, or CalEPA; and the Agency for Toxic Substances and Disease Registry, or ATSDR). EPA proposes to select dose-response values for long-term exposures from these sources in the same priority order it used for NATA (i.e., IRIS, then ATSDR, then CalEPA). For acute exposure toxicity, EPA arrays several indices without prioritization; this is a source of potentially significant, yet usually unquantified, uncertainty. (IRIS - U.S. EPA 2018e, ATSDR - ATSDR 2018, CalEPA -CalEPA 2018)
6) An earlier peer review of multipathway risk assessment methodologies was conducted by the SAB in 2000 (U.S. EPA SAB 2000).
7) A consultation on EPA's updated methods for developing emissions inventories and characterizing human exposure was conducted by the SAB in 2006. The final SAB letter to Administrator Johnson transmitted the Board's comments (U.S. EPA SAB 2007).
8) A review of the updated and expanded risk assessment approaches and methods used in the RTR program was completed in 2009 (U.S. EPA SAB 2010). This methodology was highlighted to the SAB utilizing two RTR source categories: Petroleum Refining Sources MACT I and Portland Cement Manufacturing.

The focus of this review of the Agency's RTR methods document is on several updates and enhancements of the previous versions that were reviewed as documented above. The most important revisions and enhancements since the last SAB review include the following:

- a tiered multipathway screening methodology that determines whether the potential for multipathway human health risk from persistent and bioaccumulative HAP (PB-HAP) emitted from RTR source categories is low or whether more analysis is needed;

- a tiered environmental screening methodology that determines whether the potential exists for adverse ecological effects from PB-HAP and the acid gases hydrogen chloride (HCl) and hydrogen fluoride (HF) emitted from RTR source categories;
- the potential addition to the screening methodology of a new multipathway exposure scenario to estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables; and
- enhancements to the previously reviewed inhalation risk screening methodology that allow more accurate modeling of air concentrations where populations reside and better characterization of air dispersion near sources.

The SAB was asked to review the current draft RTR methods document by considering eight charge questions posed by the EPA. The SAB provided comments on the RTR methods and did not address the regulatory implications of the method or the report. The SAB Risk and Technology Review (RTR) Methods Review Panel met in a public meeting on June 29 – 30, 2017 in Arlington, VA, to review the Agency's draft RTR method document. The SAB Panel held a subsequent teleconference on December 5, 2017, to discuss its draft advisory report. The Chartered SAB conducted a quality review of this report on May 31, 2018. The specific charge questions to the SAB are presented in the next chapter, along with the SAB's responses.

3. RESPONSE TO INDIVIDUAL CHARGE QUESTIONS

3.1 The Three-Tiered Multipathway Screening Approach

Charge Question 1. Does the SAB find that the three-tiered multipathway risk screening approach appropriately eliminates from further consideration those facilities unlikely to emit PB-HAP in concentrations resulting in appreciable multipathway risk and identifies those facilities where additional multipathway analysis may be warranted? Does the SAB have specific suggestions for improvement of the risk screening methodology?

RTR risk assessments provide the basis for decision making on whether a more stringent standard is necessary to protect human health and the environment after implementation of a NESHAP for a specific source category. The risk assessment process is both time and resource intensive. Therefore, EPA first screens affected facilities to determine whether a full-scale facility-specific risk assessment is warranted. Since the 2009 SAB review of RTR methods, the EPA has developed a three-tiered multipathway screening approach that progressively replaces health-protective default assumptions with location and facility specific data. The goal is to "screen out" minimal risk facilities such that only potentially high-risk facilities remain in the pool for further analysis.

EPA's screening methodology for ingestion risks uses a multipathway, tiered approach. Models are used to simulate the transport and fate of HAPs emitted from specific facilities in the source category being assessed. Modeling outputs include estimates of contaminants in the environment and estimates of human health risks primarily from the ingestion of HAPs from food products such as vegetables, fruit, meat, and fish because the focus of this tiered screening is on persistent and bioaccumulative toxicants.

The SAB agrees that the three-tier multipathway risk screening approach, starting with generic health protective parameters and moving to more site-specific and realistic parameters in later tiers, is appropriate. Its general structure is consistent with a long history of EPA multi-tiered risk screening approaches designed with the intent that: (a) high-risk facilities are not prematurely screened out (with adverse public health or environmental implications) and (b) low-risk facilities are not unnecessarily retained for more detailed analysis (with adverse EPA resource implications). While the SAB finds the overall approach is appropriate and has the potential to achieve the EPA's goals, as noted below the overall effectiveness is not clear. EPA should evaluate the current effectiveness and refinements to improve effectiveness.

Based on the information presented in the draft RTR methods document, the effectiveness of the screening methodology could not be confirmed. The SAB strongly calls for data to be developed and presented in future method reports that indicate how many facilities may be screened out prematurely and how many may be passed on to a full-scale risk assessment that should have been screened out in the screening analysis.

Screening efficacy could be examined in two ways. First, the operational effectiveness could be evaluated by reviewing the number of facilities screened out by each tier. While this information was not provided in the Agency's draft RTR methods document, EPA

subsequently reported that for the five most-recent RTR analyses conducted (at the time of the EPA's correspondence on November 9, 2017), Tier 1 on average screened out 30% of the affected facilities, and the Tier 2 fisher and farmer scenarios on average screened out 60% and 70%, respectively, of the affected facilities. More information included in the report would have been useful when assessing the appropriateness of modeling inputs and assumptions. An analysis of the tier-specific screening efficacy should be conducted for each source category (i.e., an examination of prior RTRs which used the current approach to screening) to assess whether some types of industrial facilities screen out earlier than others. This analysis may point out the risk drivers, sensitive parameters and key features that could be refined to conduct better screening analysis for particular source categories in going forward. Second, the best way to evaluate the three-tiered approach in a scientific manner is to "ground-truth" the evaluations, using monitoring data from either new sites or previously evaluated sites. This type of validation would require focused and deliberate study, yet it would represent an improvement in the understanding of screening procedures. For example, available monitoring data on PB-HAPs in atmospheric deposition, soil, water, and fish could be used to examine the effectiveness of higher-tiered screening and in particular to validate key points in the Tier 3 evaluation.

EPA's tiered approach is geared towards protecting the most highly exposed subpopulations – combined subsistence fishers and farmers and their children who also ingest soil. The first tier is intended to be quite health protective and SAB concurs that it is conservative. Page 15 of the Agency's draft RTR methods document highlights some of the more health-protective assumptions in the Tier 1 screening scenario. However, many assumptions are not transparent in the Agency's draft RTR methods document, making it impossible to assess if there are opportunities for refinement of those assumptions. For example, EPA should list the key assumptions used for the watershed characteristics that enhance chemical loading to the lake and farm via erosion and runoff e.g., it is not clear how the chemical is loaded into the lake and the assumptions for the volume of water transporting the chemical into the lake. This is a particularly relevant example because the scenario does not change across the tiers and there might be opportunities for refinements.

There is concern about the specific values selected for the modeling parameters, both individually and in combination. The use of multiple high-end health protective parameters can result in an excessive overestimate of potential risk. While each health-protective assumption on its own may seem reasonable, combining or overlaying multiple health protective assumptions can lead to more conservatism than is intended. An unintentionally high and unnecessary degree of conservatism likely renders the tiered risk screening ineffective, or at best inefficient. EPA should consider possible refinements to Tier 1 if the overestimation of risk is such that obviously low-risk sites are not screened out.

The SAB recommends the EPA examine refinements to the tiered screening methodology by conducting sensitivity studies to identify the key input values that drive the risk estimates. This could be used to refine Tier 1 if desired and is particularly relevant to Tiers 2 and 3. As one example, the EPA could conduct a sensitivity analysis on the impact of runoff assumptions on modeled human health risk and consider refining the health-protective Tier 1 runoff parameters as the screen moves to Tier 2 and to Tier 3. As the EPA conducts these evaluations, it should have the flexibility to adjust its methods and the parameters as needed

to ensure health-protective yet efficient RTR screening occurs in future RTR screening analyses.

EPA should evaluate the use of probabilistic analyses, perhaps initially through case studies on Tiers 2 and 3 analyses, to more accurately estimate overall risks. As previously stated, sensitivity analyses can be used to identify key input values that drive the risk estimates. In cases where these input values are also uncertain, probabilistic analysis would provide a more robust foundation for the screening methodology. This would require assessing whether enough data are available to construct distributions for the input parameters. If so, then probabilistic analysis combining the effects of distributions of multiple input values would result in a coherent analysis from which arithmetic means and operationally-defined "conservative fractiles" (e.g. a 90th percentile) could be derived.

Overarching data quality considerations are important in RTR assessments. Errors can occur in RTR input data which in turn can skew risk results, sometimes by material, policy-relevant margins. Data errors can be caused by such factors as reporting mistakes by individual facilities and undetected, incorrect information in publicly-available national, regional, and local emission inventories. The SAB recognizes the fundamental importance of accurate input data as a bedrock foundation on which all RTR risk analyses build. The SAB recognizes EPA's past efforts to ensure RTR input data accuracy, and strongly supports and encourages such efforts. Building on the substantial efforts that EPA staff have already made, EPA could further develop and expand its affirmative efforts to ensure RTR input data accuracy. Possible approaches to reducing such errors were discussed during the panel's public deliberations and are documented in the public records of the meetings available on the EPA website (EPA 2018f). The possibility of such errors and their policy implications should continue to be considered when conducting RTR risk analyses and interpreting results.

Additional comments and recommendations are as follows.

- If EPA seeks to further refine the Tier 1 screening of low-risk facilities, it might reconsider the current approach of combining exposures for farming and fishing on top of other conservative assumptions regarding weather conditions, deposition and runoff. It is unlikely that the same person consumes <u>all</u> food categories from media located close to the facility and these media receive the conservative-estimate high-end chemical loading rates day after day.
- Although there are refinements to the air modeling at Tiers 2 and 3, there is no comparable refinement of chemical runoff and erosion from the watershed. EPA does not provide any information on parameters and assumptions made (including the pond scenario) and thus the SAB cannot provide detailed comments on potential refinements to these models.
- TRIM.FaTE (U.S. EPA 2002) is used to model air dispersion. EPA should indicate if this model has been updated since 2002, and why EPA chose this model over AERMOD, which has been continuously improved and updated many times over the years (as recently as January 2017). It may be useful for EPA to compare estimates based on TRIM.FaTE and AERMOD for a range of representative scenarios.
- As discussed in more detail in the response to Charge Question 3, there is a complicated reasoning underlying the Tier 2 sustainable fishing scenario. Perhaps

EPA found it necessary to introduce such details at Tier 2 to be able to screen out low-risk facilities. For the purposes of Tier 2, however, it seems that simpler worst-case assumptions could be made that simplify the approach. The SAB recommends the EPA consider other data available to make more realistic assumptions, such as the most recent National Health and Nutrition Examination Survey (NHANES CDC 2018.), to estimate fish consumption.

- Many of the pathways are related to those used by the EPA Office of Pesticide Programs (OPP), which are based on U. S. Department of Agriculture (USDA) Cropland Data Layer and more recent (2005-2010) NHANES dietary consumption data. These could be used to inform EPA's RTR screening approaches[2]
- Regarding some of the individual parameters, from the documentation provided it wasn't clear whether the breastfeeding exposure or other early life pathways would adequately cover these sensitive early life stages. The potential impact of seasonal changes in food-sourcing should also be considered although it was recognized that fishing and gardening/farming can be year-round activities in certain parts of the country.
- The focus only on cancer risk for dioxins and benzo[a]pyrene may underestimate early life (e.g., breastfeeding) risks given these are short-term exposures whose lifetime average daily dose (LADD) will be diluted by the rest of the lifetime at lower exposure. Table 3.2 indicates that non-cancer endpoints are "not critical" for these chemical classes; this is a pre-judgement that should be further explored, especially for early life exposures. The SAB notes that benzo[a]pyrene has a very recent RfD on IRIS that is based upon an early life developmental effect (U.S. EPA 2018g).
- Several polycyclic aromatic hydrocarbons (PAHs) with toxicity equivalency factors (TEF) are not generally considered carcinogens (e.g., pyrene, phenanthrene, fluorene, fluoranthene, and acenaphthalene). These compounds do not appear on the lists of relative potency factors used by EPA (U.S. EPA, 1993) nor are they presented in lists published elsewhere (e.g., Nisbet and Lagoy 1992). These early 1990s references are still relevant as demonstrated by EPA's 2017 IRIS toxicological review for benzo(a)pyrene which refers to the EPA's 1993 guidance as the source of PAH relative potency factors (U.S. EPA 2018h). In addition, the PAHs in question are not listed as carcinogenic by the International Agency for Research on Cancer (IARC) or the National Toxicology Program (NTP) of the U.S. Department of Health and Human Services. The TEF approach for pyrene, phenanthrene, fluorene, fluoranthene, acenaphthalene and several other PAHs should be reconsidered.
- The draft RTR methods document should be modified to be more explicit about the decision-making on transitioning from Tier 1 to Tier 2, and from Tier 2 to Tier 3, particularly with regards to evaluating the potential risks associated with multiple chemicals and combining hazard quotients and risks. In addition, the basis for the inclusion and exclusion of particular chemicals, for example lead, should be more clearly stated.
- Page 16 of the draft RTR methods document indicates that "dermal absorption of originally airborne chemicals similarly has been shown to be a relatively minor

[2] https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm; https://www.agcensus.usda.gov/Publications/2012/Online_Resources/Ag_Atlas_Maps/; https://www.epa.gov/sites/production/files/2015-09/documents/deem-user-guide-sep30-14.pdf); https://www.epa.gov/sites/production/files/2016-05/documents/public_webinar_overview_of_the_draft_bes_final.pdf

exposure pathway compared with other pathways" and cites one report from 2000 and another from 2006, to support the statement. The EPA should investigate whether the evidence still supports that conclusion and applies to all classes of chemicals. More recently, several studies have suggested that dermal absorption of certain classes of chemicals in indoor air can contribute significantly to a person's overall dose (Weschler and Nazaroff, 2012, 2014; Morrison et al., 2016).

- The SAB supports the EPA's decision to separate subsistence farmers and subsistence fishers in Tier 2.
- The SAB notes that by conducting the analysis on a chemical-by-chemical basis, limited by law to the industrial category under RTR evaluation, multiple sources of a chemical emitted nearby from other industrial source categories may contribute to cumulative effects and chemical interactions because of multiple exposures. The cumulative risk may be missed by the human health risk screening conducted following the RTR method being reviewed.

3.2 Risk Equivalency Factor Methodology

Charge Question 2. Does the SAB find that the risk equivalency factor methodology appropriately accounts for differences in the environmental fate and transport among polycyclic organic matter (POM) and dioxin congeners?

Previously the RTR screening methods did not account for differences in environmental transport and fate among POM or dioxin congeners in the Tier 1 screening approach. All POM congeners were assumed to be transported, partition, and degrade in the environment identical to benzo(a)pyrene (BaP), and all dioxins were assumed to exhibit the same transport and fate as 2,3,7,8-TCDD. Since 2009 when the RTR Methodology was last reviewed by the SAB, the EPA has significantly refined its approach. Section 3.1.2 of the Agency's draft RTR methods document describes a new risk equivalency factor (REF) methodology that includes an exposure-equivalency factor (EEF) to reflect an individual chemical's transport and fate relative to the index chemical for each group (i.e., BaP for POM and 2,3,7,8-TCDD for dioxin).

The REF methodology has been incorporated as a screening tool into the residual risk assessment of stationary sources. It grapples with a common problem when dealing with complex mixtures – the evaluation of components with poorly characterized environmental fate and toxic effects. The SAB appreciates that when data gaps preclude inclusion of a chemical component of POM in a risk assessment, this component is often assumed to contribute zero exposure and risk. Rather than create such an underestimation, EPA has provided a screening methodology to fill such data gaps and thus include the full array of targeted POM constituents. In general, the SAB finds the overall approach to potentially be appropriate with more work needed to address concerns as described below.

The REF methodology consists of two read-across approaches[3] – one to handle toxicology data gaps, and the other to handle information gaps regarding environmental transport and

[3] Physicochemical, human health and/or environmental properties may be predicted from information from tests conducted on reference substance(s) within the group, referred to as source substance(s), by interpolation to other substances in the group, referred to as target substance(s). This approach is called "read-across." (https://echa.europa.eu/documents/10162/13628/raaf_en.pdf)

fate. The SAB agrees with the toxicity equivalency factor (TEF) approach as it is well accepted for dioxins and carcinogenic PAHs. The SAB has not checked all the tabulated values for representativeness but notes that some of the PAHs given TEF factors by EPA are not typically considered to be carcinogenic; this was discussed in the SAB's response to Charge Question 1. The selection of TEFs for these and other PAHs is not provided in the Agency's draft RTR methods document and should be documented with references in Table 3.4.

The read-across approach for environmental fate is less well tested and accepted and thus deserves further consideration. EPA's proposed EEF is based upon a fundamental chemical property – K_{ow}. This property helps determine certain aspects of environmental fate such as uptake into fish, beef and dairy, but there are numerous other fate behaviors which it does not predict such as metabolism, biodegradation, environmental half-life and several types of phase transitions and partitioning. Thus, it is perhaps overly optimistic to expect K_{ow} by itself to have high concordance with exposure dose.

EPA's empirical correlation between K_{ow} and LADD for chemicals with sufficient data (RTR methods report Figure 3.2. U.S. EPA 2017) is a logical step in creating the read-across approach. However, as suggested above, K_{ow} is an imperfect predictor of LADD. Figure 3.2 shows the relationship between K_{ow} and LADD for 14 POM analytes for which there are more complete data. There is considerable variability around the regression line in Fig 3.2; this variability is currently unexplored but may arise from uncertainty and variability in the underlying parameters that influence the LADD including not only K_{ow} but also intermedia partition coefficients, molecular weight, half-life, potential for biodegradation, etc. The variability around the regression line is up to two orders of magnitude and thus the calculated EEF may substantially underestimate the LADD for some undefined members of data-poor chemical classes.

The SAB finds this read-across extrapolation of environmental fate could benefit from a refined approach and has identified two options for improving the EEF estimate as follows.

- Conduct further statistical evaluation of the relationship between K_{ow} and LADD to generate an upper bound on the regression slope and then apply this to derive EEFs for data poor chemicals.
- Conduct further evaluation of the underlying transport and fate parameters to develop distributions for each influential parameter and then perform a probabilistic analysis that replaces the Fig 3.2 regression slope; EPA can then make a transparent choice of which percentile of the distribution of LADDs for a given K_{ow} (and/or additional parameters) will be used in evaluating exposure and risk for data-poor POMs.

The SAB also finds the current documentation of key parameter inputs to the fate, transport and bioaccumulation model for PB-HAPs is not adequately described. The range of potential values and key citations should be presented in an appendix for all the modeled PB-HAPs. The document states that the EEF will change based upon environmental and geospatial conditions (e.g., Page 19, paragraph 1) but examples of this dynamic relationship are not provided, which further precludes a full review. For example, how are the effects of age/weathering incorporated to account for the loss of lighter dioxin congeners over time or with distance?

The SAB notes that in Table 3.4, the products of the EEF and TEF values do not always equal the corresponding REF. Perhaps rounding prior to the multiplication causes these differences. Whatever the reason, the product of column multiplication should be mathematically consistent to avoid the impression that the table contains incorrect values.

In summary, the SAB finds that the REF would benefit from better explanation, documentation and statistical analysis in terms of: (a) documentation of TEFs (Table 3.4), including consideration of whether the TEF for carcinogenic activity is appropriate for certain PAHs not traditionally considered as carcinogens; and (b) documentation of the methods for EEF derivation, especially with respect to better analysis of the relationship between EEF and key environmental fate characteristics of each chemical (K_{ow}, environmental persistence, molecular weight, etc.) potentially including a probabilistic analysis and, at a minimum, more complete statistical treatment of the relationship between K_{ow} and LADD.

3.3 Fishing, lake and pond assumptions

> *Charge Question 3: Does the SAB find that the assumptions for human fishing behavior used in the refined fisher scenario, the assumptions about PB-HAP deposition to lakes, and the assumptions on the ability of ponds and lakes to sustain populations of fish are appropriate?*

The Tier 2 multipathway screening scenario replaces some of the assumptions in the Tier 1 screen and is considered more realistic than Tier 1. Specifically, site-specific information is used for the locations of potentially fishable lakes and for meteorology. In addition, the Tier 2 assessment includes: a screening configuration that assesses the fisher and farmer exposure scenarios separately; and an estimation of lake productivity and fish population dynamics. The consideration is that a fisher might catch and consume fish from more than one nearby contaminated lake because more than one lake might be needed to catch enough fish for subsistence living. The approach at this level of screening analysis also attempts to account for PB-HAP deposition into a lake from multiple facilities in the same RTR source category.

3.3.1 Human fishing behavior and sustainability of fish populations in ponds and lakes

The SAB finds the assumptions used for human fishing behavior in the refined fishing scenario to be appropriate with caveats as noted below, while the assumptions concerning sustainability of fish populations in ponds and lakes may be inappropriately conservative. Assuming all parameters (such as size of the lake needed to support fish of a given size, assumptions about fish populations, etc.) are correct, the approach used seems reasonable. The equations seem appropriate and the assumptions appear to be properly managed. However, the SAB finds that most of the assumptions/parameters are possibly too conservative to achieve the objective of effective risk screening and suggests that more realistic ingestion rates and other model parameters be considered. For example, the Tier 2 method limits the fish consumption rate from a local water body due to potential depletion of fish by a single subsistence fisherman. The end result of a number of assumptions and productivity calculations is that no more than 1 gram fish/acre of waterbody can be sustainably removed per day (page 40, lines 7-9). In comparison, in one study the productivity of lakes was 82 kg/hectare/year (N=22 lakes, Randall et al. 1995) which converts to 90 g/acre/day. This 90-fold difference indicates the EPA should reconsider lake

productivity and how to relate it to fish consumption estimates for a specific lake. Furthermore, with some of the contaminants examined, fish will not take up 100% of the chemical. Also, the chemicals considered will have different toxicodynamic and toxicokinetic properties in the fish, making the half-life of some chemicals (PABs/dioxins) much shorter than values assumed. These issues will affect exposure estimates in the fisher population.

There is considerable heterogeneity across lakes and the SAB has concerns with the presumed universality of some of the assumptions invoked for the analysis. For example, the analysis assumes: 21% of the fish biomass are piscivores; benthic fish account for 17.5% and pelagic fish account for 3.5% of total fish biomass; humans consume 50:50% from benthic and pelagic piscivores (note some people consume pan fish); and total fish biomass is 40 g fish ww/m^2. It seems likely that rather than fixed values these parameters have a wide range of occurrence in actual lakes. Also, as explained in the appendix of the Agency's draft RTR methods document, benthic fish collection is usually higher than pelagic species (although pelagic are preferred by consumers) due to the general species abundance. The SAB recommends that the EPA document and justify these assumptions.

The SAB encourages the EPA to consider other data available to make more realistic assumptions such as using the most recent NHANES data to estimate fish consumption. Additionally, the EPA might be able to refine the assumptions on chemical runoff and erosion from the watershed by using relevant U.S. Geological Survey (USGS) data that are available for the region of interest (U.S.G.S. 2018). As another example, the EPA Risk-Screening Environmental Indicators (RSEI) Model is part of the Toxics Release Inventory (TRI) program and is primarily used as a transport and fate model to estimate concentrations, hazard level and risk of air pollutants covered by the TRI. However, RSEI also has a model that estimates transport and fate of TRI releases to water bodies including both direct releases and transfers between wastewater plants. The primary data product is toxicity-weighted concentrations downstream of TRI discharges. These data are available by stream segment. The Office of Pollution Prevention and Toxics could presumably prepare data specific to the modeler's needs. Alternatively, the RSEI Water Microdata can also be accessed online (U.S. EPA 2018i).

The SAB struggled with understanding some of the RTR modeling inputs/assumptions. This process may become more transparent if the data are presented with information about how studies were included or excluded, how data were prioritized and selected for use, how the evidence was weighted, etc. The appendices to the EPA report achieve this goal to a certain extent but are incomplete.

3.3.2 PB-HAP deposition to lakes

The SAB could not determine whether the assumptions for PB-HAP deposition to lakes are appropriate for the following reasons. Regarding PB-HAP transport and deposition, air dispersion models recommended by EPA, such as AERMOD, have been continuously improved and updated many times over the years (as recently as January 2017). Such models have been used by many users in a variety of regulatory applications and have been subject to rigorous performance evaluation by EPA and the scientific community to test and demonstrate their accuracy. The SAB recommends clarification of the extent to which TRIM.FaTE has been updated since 2002, when its technical support document was released. Assuming AERMOD is valid for the use cases of interest, the reliability of TRIM.FaTE's air

dispersion component should be assessed by comparing to AERMOD for a variety of scenarios. Also, the EPA may seek to consult with EPA Office of Pesticide Programs (OPP) Environmental Fate and Effects Division (EFED) since they have developed models with different tiered assumptions about runoff into ponds.

It is unclear how accurately PB-HAP deposition is calculated by TRIM.FaTE. Additional information is needed to demonstrate the accuracy (or for a screening methodology, to evaluate how conservative the assumptions are) of such deposition estimates and their implications to the reliability of fish consumption exposure estimates. EPA should test and demonstrate for a range of representative scenarios the reliability of TRIM.FaTE air concentration and deposition estimates.

Finally, the SAB recommends conducting a sensitivity analysis of the distribution of critical parameters at higher tiers. The use of multiple health-protective assumptions/parameters is likely to overestimate the actual risks, probably by a substantial margin. Furthermore, a probabilistic analysis should provide a more accurate and transparent estimate regarding uncertainty of the risks and may be appropriate at higher tiers.

3.4 Lake data, plume rise, and meteorological data

> *Charge Question 4: Does the SAB find the methods used for evaluations of (1) lake data, (2) plume rise, and (3) time-series meteorological and time-series plume-rise data are appropriate?*

When the Tier 2 screening analysis indicates that further evaluation is warranted, the EPA applies the Tier 3 screening approach described in Section 3.3 of the Agency's draft RTR methods document. The method includes three individual refinements to the Tier 2 methods that are conducted in a step-wise fashion. The refinements include: further analysis of the affected lakes identified in the Tier 2 screen; analysis of plume rise resulting in PB-HAPs lost to the upper atmosphere; and the use of time-series meteorology from meteorological data stations and modeled effective chemical release heights.

3.4.1 Lake data

The SAB finds the method to evaluate lake data to be generally appropriate and indicates items for refinement. The SAB supports the use of up-to-date land-use data to more accurately represent exposures that occur through lake media. EPA should consider relying less on analyses that are time-intensive and that depend on analysts' subjective judgments. Web or GIS searches, as described in the Agency's draft RTR methods document, may be useful to produce input data. A guiding principle should be "documented and reproducible" such that independent experts can understand the data and methods applied by EPA analysts and can reproduce the results.

EPA should consider the use of data streams that can be automated so that ongoing land use changes can be incorporated. Widely available data sets include the National Land Cover Database (NLCD) and USGS Digital Elevation Model (DEM). The SAB cautions EPA against *a priori* exclusion of wetland influenced lakes, which may host fish.

3.4.2 Plume rise

The SAB believes the plume rise methodology may be inappropriate in some cases EPA should evaluate the use of plume-rise models other than those described in the Agency's draft RTR methods document screening procedure. An example is Briggs (1984) and the documentation of AERMOD (Cimorelli *et al.* 2004) which thoroughly discusses plume rise and contains other citations.

For this and other dispersion and transport modeling, the SAB recommends that EPA consider the use of meteorological reanalysis data for both surface-air and upper-air wind speeds. These data can overcome some uncertainties when weather stations are far from the modeled site.

3.4.3 Time series meteorological and plume-rise data

The SAB believes that the hour-by-hour response treatment is not yet justified. Furthermore, the corresponding time-series meteorological and time-series plume-rise data used in the hour-by-hour treatment may be inappropriate in some cases.

First, EPA should be cautious about undue oversimplification of complex atmospheric processes. Full or partial penetration of a plume through the top of the mixed layer depends on many complex factors including plume momentum, plume buoyancy, stack release height and exit conditions, depth of the mixed layer, inversion strength, and atmospheric stability. These processes may vary with time, as meteorological factors evolve over the course of a day, possibly causing plume re-entrainment or rapid fumigation. Atmospheric processes governing plume penetration are more complex than can be adequately represented by a simple comparison of inversion height with effective plume height (which includes plume rise).

Second, the Agency's draft RTR methods document indicates that hour-by-hour data from the closest meteorological station should be used. These data may not reflect specific microclimatic conditions at the site, including topography, directional valley orientations, and specific inversion conditions that can differ from those at the station. For accurate screening, these local conditions should be considered.

EPA should test and demonstrate the reliability of the proposed adjustment by comparing screening results as implemented using TRIM.FaTE to those calculated by a more physically realistic model, such as AERMOD. Indeed, the SAB suggests EPA evaluate the additional accuracy perceived to result from implementing hour-by-hour adjustments. The suggested procedure requires extensive data manipulation yet has not been validated, whereas with a moderate additional investment the screening could be done with a validated and accepted model such as AERMOD.

The SAB also has two overarching recommendations addressing issues which were not specifically called out in the charge questions.

- EPA should consider that the quantity of emissions in the National Emission Inventory (NEI) may differ from reality, either because of upset conditions, or because self-reporting does not always suffice. The location of emissions may also be different than

reported. These inaccuracies may have important effects on predicted exposures and should be assessed to the extent practicable.

- The SAB recommends that EPA consider sensitivity analysis to determine the parameters and assumptions that have the greatest effect on predicted exposures, especially at the higher tiers. Identification of factors that dominate risk and uncertainty could guide future screening analyses by providing justification to obtain detailed input data for those factors. Furthermore, probabilistic analysis would provide a framework to estimate confidence bounds.

3.5 The gardener scenario

Charge Question 5: Does the SAB find the assumptions and approaches laid out for application in the gardener scenario to be appropriate? Does the SAB find that adding the gardener scenario to Tier 3 would improve our ability to characterize ingestion risks for urban and rural environments?

The Agency's draft RTR methods document includes a new exposure pathway added to the EPA methods (Section 3.4) – a gardening exposure scenario added to the multipathway screen. This scenario is intended to better characterize multipathway risk and the EPA suggested it will significantly improve the screening for locations where the presence of a subsistence farm is either unlikely (in urban areas) or difficult to confirm based on the characterization of land use surrounding a facility.

The gardener scenario is described on pages 59-62 of the Agency's draft RTR methods document. EPA is proposing to implement this scenario as part of Tiers 2 and 3 in locations where at least some individuals are likely to consume homegrown produce. The SAB was asked to comment on the assumptions used and whether the addition of the scenario would improve characterization of ingestion risk in both urban and rural environments. In general, the SAB finds that the gardener scenario is an appropriate addition to both Tier 2 and Tier 3 evaluation thereby developing a more useful model system for screening.

Regarding the first component of the charge question – the appropriateness of assumptions and approaches in the scenario – the SAB's response focuses on the media ingested by the gardener. EPA has selected ingestion routes like those experienced by subsistence farmers. These categories include direct ingestion of soil, ingestion of protected fruits and vegetables, ingestion of root vegetables, and ingestion of breastmilk (although intake rates for the latter are not presented in Tables 3-18 and 3-19). These appear to be appropriate and sufficiently distinct to provide coverage of the appropriate sources of soil ingestion and contaminants contained in soil. EPA distinguishes intake of gardeners from farmers by noting that meat products and dairy products are not likely to be sources for the gardeners (Table 3-17).

The SAB suggests including chicken eggs in the gardener scenario as many gardeners also keep egg-laying chickens. The SAB also notes that the gardening scenario appears to use many of the same assumptions about diet as the subsistence farmer, suggesting that the gardening scenario does not add much value to the tiered approach. The SAB therefore suggests that it is especially important to distinguish between the gardener and the subsistence farmer.

EPA has separated gardeners into two categories – rural and urban. The approach seems reasonable, especially given differing intake rates for urban and rural gardeners. The

assumptions that a rural gardener would have enough land to develop a subsistence, or near-subsistence, garden while the urban gardener would not seem, on face value, to be valid. Following this reasoning, EPA uses an upper (90th) percentile estimate for intake rate of home-grown vegetables for the rural gardener but a central tendency home-grown vegetables intake rate for urban gardeners (See Table 3-19 for the intake rates). Both intake rates are taken from the Exposure Factors Handbook and appear to be justified as EPA's best assessment of such rates.

Regarding soil intake rates, gardener soil intake rates were matched to those of farmers, consistent with the notion that gardens in both rural and urban settings must be tended, affording gardeners with intimate soil contact and thus intake. Further, in the rural setting, the farmer-specific rates for surface runoff-related contamination would be used while this term would not be used in urban settings. The farmer-specific rates are less health-protective in the sense that it focuses only on agricultural runoff. In urban settings, runoff may occur from other sources (e.g., industrial facilities and roadways) and might well be considered important. The SAB suggests that these additional urban sources be considered and matched with those of the rural settings.

Except for the surface runoff component, the assumptions made above are health-protective but not unreasonably so even when compared to earlier assumptions (e.g., Charge Question 3). The SAB notes that including the same assumptions for multiple tiers likely results in little effective screening. Further, the assumptions may offer too much health protection and thereby reduce the screening utility of the tool. In addition, the SAB suggests alternative- and higher- soil intake rates for the adult gardener.

Regarding the second component of this charge question, inclusion of the gardener scenario is appropriate because it improves the characterization of the potential risk in both rural and urban environments for those who take part in this activity.

3.6 Environmental risk screening methodology

> *Charge Question 6. Does the SAB find that the environmental risk screening approach is appropriate for identifying facilities whose PB-HAP emissions may have the potential to cause adverse environmental effects? Specifically, does the SAB find that the pollutants (Section 4.2.1), ecological assessment endpoints (Section 4.2.2), and benchmarks (Section 4.3) that are included in the environmental risk screen are appropriate? Does the SAB have specific suggestions for improvement with regard to any aspect of this environmental risk screening methodology?*

Charge Question 6 addresses the information provided in Chapter 4 of the Agency's draft RTR methods document (and supporting appendices) that describes the environmental risk screen that was developed to provide a systematic, scientifically defensible, and efficient approach that EPA can use to screen for potential adverse environmental effects associated with emissions of HAPs from facilities in RTR source categories. It is designed so that the screen can be run quickly and with minimal additional data gathering by drawing on existing data, models, and modeling results, including those developed for the human health multipathway risk screen. The overall methodology was reviewed by the SAB in 2009. The material in Chapter 4 of the Agency's draft RTR methods document focused on

those aspects that have been refined/revised since the last review. The revised aspects include:

- Modeled environmental concentrations are compared to ecological benchmarks, not human health thresholds, for all pollutants included in the screen;
- An evaluation of HAPs for potential inclusion in the screen was conducted;
- The environmental risk screen was expanded to include the following additional environmental HAPs: cadmium, hydrogen fluoride, lead, arsenic, and additional POMs;
- The number of ecological endpoints and effect levels that are evaluated was expanded;
- A literature review was conducted to identify the most up-to-date ecological benchmarks; and
- Tiers were added to the environmental risk screen for PB-HAP that are parallel to the tiers in the multipathway human exposure screen.

The SAB finds that the overall methodology and specifically the revisions since 2009 are appropriate and improve the ecological assessment capabilities. It represents a comprehensive approach that builds upon, and uses, the screening tools used in the health assessment/screening (i.e., TRIM.FaTE, AERMOD). As noted below, the SAB offers several recommendations and comments towards refining the approach.

The methodology for identifying the pollutants to be included in the screening activities are clearly stated and the criteria used to prioritize the chemicals are judged to be appropriate with the following considerations to be taken into account. The SAB is concerned that selenium is not included as a chemical to screen. Selenium is an essential trace element which is toxic at elevated concentrations. Elevated exposure can lead to selenosis. Selenates and selenites are particularly toxic forms of selenium (Hamilton, 2004). Given selenium's potentially important role in ecological impacts, the SAB recommends it be considered. In addition, it is not clear that BaP is the most appropriate POM chemical to use in the ecological analysis. There may be more important POM molecules (lower molecular weights) to use in this screening and further analysis is recommended. Furthermore, the emission rates presented in Table 4.1 are for base year 2005, and they need to be updated to reflect recent emissions data. Also, on page 67 line 21 there is reference to "99.9% of national emissions" but the basis is not clear (mass, toxicity or some other basis).

The SAB finds the expansion of ecological assessment endpoints appropriate and that the benchmarks, and the use of a tier system, are justified. The Agency's draft RTR methods report and appendices document the processes and assumptions used to identify the endpoints and benchmarks. Overall, the calculation of potential risks is robust and follows current scientific methodologies. As the amount and diversity of information analyzed in identifying the endpoints and benchmarks is vast, it would be helpful to clarify when most sensitive or most exposed species are used. In addition, the SAB notes that the overall approach would be strengthened by allowing site-specific variables to be added during the assessments, as some sites may have very specific sensitive species. Using a less sensitive receptor in a screening methodology runs the risk of underestimating the impact to the environment in those regions.

Tables 4.2 (endpoints) and 4.3 (benchmarks) are critical to the screening process. Values in these tables are likely to change over time as new information becomes available so it is important that they be viewed as tables requiring continuous development and a process should be identified by the EPA to continuously review and update them. Furthermore, many of the studies listed are from the 1980s-1990s and are compilation reviews from earlier publications. Notations should be made in the table or the text as to why the benchmark value was chosen. Many of the benchmarks have multiple studies (chronic / acute) with varying methodologies and results. The SAB recommends the EPA consider grading studies based on Klimisch score, a method of assessing the reliability of toxicological studies, mainly for regulatory purposes.

The SAB finds that the general methodology of the tiered approach and the use of TRIM.FaTE and AERMOD are appropriate. The SAB notes the simplicity of the air dispersion treatment in TRIM.FaTE and encourages the advancement of incorporating AERMOD analysis within the TRIM.FaTE framework. The use of reanalysis meteorological data is recommended to improve the meteorological fields used in the analysis. As stated elsewhere in this report, the analysis would also benefit from considering the implementation of a probabilistic approach.

The SAB recommends that analysis elements performed under the environmental risk screen be incorporated in the farmer screen (e.g., utilizing the deposition to soils).

The following additional specific recommendations regarding endpoints and benchmarks are provided:

- The SAB suggests EPA consider indirect HCl effects by evaluating the concentrations of chloride from a facility relative to background chloride concentrations contributing to loss of surface water acid neutralizing capacity or soil base saturation. Critical loads of acidity have been developed (NADP 2018) for the U.S. and the acidity associated with estimated chloride deposition could be compared to these critical load values.
- Mercury targets may need to be updated or expanded to protect communities of predator animals associated with bioaccumulation of methylmercury and to reflect broader wildlife impacts[4] (e.g., song birds.)
- The water quality and soil criteria (Table 4-1) for mercury are very high. This is particularly true for water where concentrations are typically on the order of nanograms per liter (ng/L). For example, the sediment clean-up values for Onondaga Lake, NY– a mercury contaminated site – are 2.2 μg/g for probable effective concentration based on macroinvertebrate toxicity testing and 0.8 μg/g for bioaccumulation-based sediment quality. The SAB suggests EPA consider criteria values for water and sediment/soil for contaminants that have been established for hazardous waste clean-up at sites around the U.S. for several contaminants.

3.7 Inhalation risk assessment enhancements

[4] http://www.briloon.org/uploads/Library/item/265/file/Hidden%20Risk.pdf https://www.crcpress.com/Environmental-Contaminants-in-Biota-Interpreting-Tissue-Concentrations/Beyer-Meador/p/book/9781420084054https://www.niehs.nih.gov/research/supported/assets/docs/a_c/bioscience_508.pdf

Charge Question 7: Does the SAB find that the Urban/Rural Dispersion Selection Enhancement Tool is an appropriate procedure for identifying facilities to be modeled using the urban option in AERMOD?

In previous chronic inhalation risk assessments, the EPA assumed the land surrounding each facility was rural. The 2009 SAB review (U.S. EPA SAB 2010) indicated additional development was appropriate. Chapter 5 of the Agency's draft RTR methods document is an enhancement to the chronic inhalation risk assessment that the EPA contends accounts for the variation in urban to rural characteristics of the land surrounding each evaluated facility. The goal of the improvement is to better characterize pollutant dispersion near sources.

The urban/rural dispersion selection enhancement tool provides a way to specify atmospheric turbulence within a model domain to allow AERMOD to more accurately model pollution dispersion. The tool currently provides two options. The Agency's draft RTR methods document evaluates the differences in model results using these two methods and proposes using the census (population density)-based designation of "urban" ("HEM default procedure") as the preferred method.

The SAB agrees that incorporating the effects of turbulence as a model input is appropriate and of significant value because it avoids the overly conservative assumption of applying the "rural" assumption to all facilities. However, the SAB disagrees with the Agency's draft RTR methods document on the procedure of choice and recommends the land use procedure which uses the National Land Cover Database (NLCD). This procedure directly measures the feature that controls turbulence, unlike the HEM default procedure which relies on a secondary effect – an aggregated population density metric – that may not correlate well in highly industrialized areas with dense concentrations of buildings, pavement and other structures yet little residential land. The land use procedure provides a more accurate assessment for the selection, and the Agency's draft RTR methods document does not offer a compelling explanation of the benefits from using the HEM default procedure. The land use procedure also more directly aligns with EPA's 2005 Guidelines on Air Quality Models as stated on page 121 (last paragraph) in the Agency's draft RTR methods document; the guidelines list specific land use types to be considered, rather than population density.

Using the land use procedure is not significantly more difficult or time/resource intensive than the HEM default procedure, so any logistical advantage of the HEM default procedure is minimal. Analysis can be automated using Model Builder or Python scripting in ArcGIS. Problems described in the Agency's draft RTR methods document associated with the land use procedure misclassifying facilities with significant coverage by water bodies inside the model domain can be addressed in the GIS procedures, and the SAB recommends that this be included in the procedure to avoid misclassifying heavily developed areas near large water bodies as "rural."

Because the inhalation risk assessment is a location-based estimate using modeled ambient concentrations and is not population-weighted, the use of population density via the HEM default procedure is less appropriate than using land use. In addition, the land use procedure finds fewer urban areas than the HEM default procedure, indicating the latter misclassifies turbulence in some cases.

The SAB also notes that the quality of the NLCD data makes it possible to express the "urban

nature" of the model domain as a continuous variable, rather than a binary "yes/no" value. Such a calculation adds little to the time and difficulty of the GIS procedures used to calculate the variable. It provides a measure of the intensity of "urban" character for each area considered and could also be used to characterize the geographic variation of turbulence within a given model domain. There are different ways to use this type of metric in modeling; it is not certain whether EPA modeling tools can use that variation, but it might be useful in future versions of the modeling and represents a "best practices" approach for gathering input data, particularly if it is only a little more difficult or expensive to do so. Using this approach with successive versions of the NLCD, which is updated every four years, allows for tracking land cover change over time.

If EPA adopts this more nuanced use of the NLCD, the SAB suggests the EPA consider including NLCD class 22 (low intensity developed) in identifying "urban" in this context. This class is defined as 20-44% impervious surfaces and it correlates very well with residential land use when compared to other high-resolution datasets. Class 22 is used in screening methods in California and has been shown to be of value in characterizing or measuring fine scale heterogeneity in other contexts (Chabaeva and Civco 2004; Smith et al. 2010).

Another alternative is the use of a regular NLCD derivative product – the percent impervious surface data layer which is produced for each NLCD generation, as is a measure of the net change in imperviousness between NLCD generations. Use of these metrics are generally as cost effective as using population density and have the advantage of being updated more often than the census. The SAB looks forward to reviewing and commenting on the approach eventually adopted.

Regardless of the urban/rural dispersion selection procedure that is used, the automatically-generated designation should be manually evaluated with the final choice of urban/rural dispersion a matter of professional judgment based on 'facts on the ground.' In cases where a material difference in estimated potential risk exists between urban and rural dispersion and professional judgement is used to overrule the selection tool's designation, EPA should document and justify this decision.

3.8 The census block receptor check tool

> *Charge Question 8: Does the SAB find that the Census Block Receptor Check Tool and associated enhancements are an appropriate method for identifying and adjusting model receptors to ensure the receptors are representative of residential locations?*

Section 5.2 of the Agency's draft methods document describes an enhancement made to the chronic inhalation risk assessment – the addition of the Census Block Receptor Check Tool. The rationale for the new tool is that the block centroid does not always represent residential locations. The HEM-3 model calculates ambient air concentrations at census block centroid locations as surrogates for population exposure. If the centroid is located outside of the block polygon, then the U.S. Census Bureau provides the longitude and latitude of an internal point near the geometric centroid that falls inside the block polygon. The points are not weighted or reflective of the population distribution. Census blocks vary in size depending on population density. In urban areas, a census block may be equivalent to a city block bounded on all sides by a street. In sparsely populated areas, a census block is often irregularly shaped with streams, property lines, and rural roads as boundaries. In the 2009 review conducted by the

SAB (U.S. EPA SAB 2010) it was noted that census block centroids might not always be an appropriate surrogate for residential locations. The Census Block Receptor Check Tool was developed to address this concern. This new tool identifies two examples when internal centroid points may not be a good surrogate for where populations reside and provides options to address this.

The first scenario is for block centroids located within 300 meters of emission points, which may be within the facility grounds and not where there are residents. The tool user would be able to view these receptors and delete them if they are on the facility property. The second scenario focuses on large and irregularly shaped census blocks, where the centroid may be farther away from population centers. If blocks with an area greater than 2.6 km^2 are identified within 1 km of a facility, aerial images of the blocks can be examined using the tool to determine if the centroid receptor needs to be relocated and other receptors added to represent multiple residential locations.

The SAB finds the Census Block Receptor Check Tool to be an appropriate framework, but the precise methodology underlying the tool may be unreliable in some cases. The SAB offers recommendations for improving the method, but also encourages the Agency to consider an alternative approach.

The EPA report does not provide enough information about the tool, especially regarding criteria that would be used to determine the number and placement of new receptors. For example, the statement "If residential locations cannot be represented by a single receptor (that is, the residences are spread over the block), additional receptors are added for residences nearer to the facility than the centroid" (page 140, lines 15-17) is vague and the method appears to be *ad hoc*. The SAB is concerned that the process would not be reproducible if another risk assessor were to subsequently model that facility. The choice of a 300-meter buffer from an emission source is also somewhat arbitrary. Furthermore, the impact of these changes is not obvious. The Agency's draft RTR methods report should include more detailed examples of how risk estimates change based on these enhancements compared to the default block centroid method.

Overall, the SAB believes that methods predominantly relying on census block centroid locations – including cases where the enhancement tool is applied – can in some cases be reliable, but additional effort is needed to verify that receptors are representative of residential areas near the facilities. One approach would be to review satellite imagery within 1 km of all facilities, not just those in identified large census blocks, and manually add receptors as needed to appropriately represent population centers. However, any manual placement would be subjective and likely not reproducible between risk assessors. The SAB recommends the Agency evaluate an alternative approach that uses the same 2011 National Land Cover data used for the Urban/Rural Dispersion Selection Enhancement tool to automate the process of identifying population centers. The NLCD data is available at a high spatial resolution (30 m) and receptors could be placed in areas of developed land use classes 22-24. Aerial photos (e.g. Google Earth™) can then be used to check that the land use-based placement of receptors is appropriate. If professional judgement is used to select the location then the RTR screening analysis documentation should include sufficient information such that another expert could follow the reasoning and reproduce the selection.

If the EPA prefers to continue using census block centroids as nearby exposure receptors, then the SAB recommends additional enhancements to make the tool less *ad hoc*. For example, facilities are better represented as polygons than points. Satellite imagery can be used to estimate the facility boundary and then GIS procedures could be used to exclude centroids located within the boundary. In such cases, satellite imagery could then be used to add alternative receptors to replace the deleted centroid and ensure nearby residences are represented. It is noted that this procedure would not be needed if receptors were placed at actual population locations using land use data as recommended.

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5. APPENDIX A: CHARGE TO THE SAB

May 26, 2017

MEMORANDUM

SUBJECT: Request for SAB Peer Review of the document: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis"

FROM: Erika N. Sasser, Director /s/
Health and Environmental Impacts Division
Office of Air Quality Planning and Standards (C504-02)

TO: Christopher Zarba, Director
EPA Science Advisory Board Staff Office (1400F)

EPA's Office of Air Quality Planning and Standards is requesting a peer review by the Science Advisory Board (SAB) on the document: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis." This report describes specific screening methodologies that have evolved since the SAB last reviewed the RTR risk assessment methods in 2009. The screening methodologies are used to quickly identify those facilities in particular RTR source categories that have little potential for human health multipathway or environmental risk, while also identifying those facilities where a refined multipathway or environmental risk assessment may be needed. This report also describes the potential addition of a new multipathway exposure scenario that can estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables, as well as several improvements to EPA's chronic inhalation risk assessment methodology. The application of the updated risk assessment screens and methodologies is highlighted in this report through the presentation of example facilities emitting hazardous air pollutants.

The case study analysis and accompanying documentation were prepared by staff in the EPA's Office of Air Quality Planning and Standards. The document is being made publicly available on the Agency's website at the following address:
https://www3.epa.gov/ttn/atw/rrisk/rtrpg.html.

Attached is the charge to the Science Advisory Board. It includes background information on the screening methodologies and identifies the questions and issues we would like the Science Advisory Board to address in their peer review of the methods.

Attachment:
Peer Review Charge

Attachment

Charge to the Science Advisory Board for their review of the "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis"

Office of Air Quality Planning and Standards
Office of Air and Radiation

Background:

The Clean Air Act (CAA) establishes a two-stage regulatory process for addressing emissions of hazardous air pollutants (HAP) from stationary sources. In the first stage, the CAA requires the EPA to develop technology-based standards for categories of industrial sources. We have largely completed the required Maximum Achievable Control Technology (MACT) standards with about 112 MACT standards being issued to date for stationary major sources of HAP. In the second stage of the regulatory process, EPA must review each MACT standard at least every eight years and revise them as necessary, "taking into account developments in practices, processes and control technologies." We call this requirement the "technology review." EPA is also required to complete a one-time assessment of the human health and environmental risks that remain after sources come into compliance with MACT. If additional risk reductions are deemed necessary to protect public health with an ample margin of safety or to prevent adverse environmental effects that are judged to be "significant and widespread", EPA must develop standards to address these remaining risks. For each source category for which EPA issued MACT standards, the residual risk stage must be completed within eight years of promulgation of the initial MACT standard. Since the initial technology review requirement coincides in deadline with the risk review requirement, EPA generally combines these two requirements into one rulemaking activity, calling this the "risk and technology review" process, or simply RTR. In this way, the results of the risk review can be potentially informative to the technology review process, and vice versa.

Because RTR assessments are used for regulatory purposes, and because components of our screening analyses have evolved over time, EPA periodically seeks the Science Advisory Board's (SAB) review (see below). For the current review, we seek the SAB's input on the specific enhancements made to our risk assessment methodologies, particularly with respect to multipathway and environmental screening methodologies, since the last SAB review was completed in 2009. Facilities that do not screen out may be the subject of refined multipathway risk assessments, which 1) are conducted for a single facility at a time; 2) are very costly; 3) and can take several months to complete. Thus, we consider these screens to be an important step in the RTR risk assessment process that helps the agency to maximize the use of its resources and, when appropriate, to facilitate its communication with stakeholders.

Previous Relevant Peer Reviews

Previous peer reviews have covered various elements associated with the RTR process. A brief summary of each peer review is provided:

1) The *Residual Risk Report to Congress*, a document describing the Agency's overall analytical and policy approach to setting residual risk standards, was issued to Congress in 1999 following an SAB peer review. Many of the design features of the RTR assessment methodology were described in this report, although individual elements have been improved over time. The final SAB advisory is available at http://www.epa.gov/ttn/oarpg/t3/reports/risk_rep.pdf).

2) A peer review of multipathway risk assessment methodologies for RTR was conducted by the EPA's SAB in 2000. The final SAB advisory is available at http://yosemite.epa.gov/sab/sabproduct.nsf/1F1893E27059DB55852571B9004730F7/$Fi le/ecadv05.pdf.

3) A consultation on EPA's updated methods for developing emissions inventories and characterizing human exposure was conducted by SAB in 2006. The final SAB advisory is available at https://yosemite.epa.gov/sab%5Csabproduct.nsf/33152C83D29530F08525730D006C3ABF/$File/sab-07-009.pdf.

4) A review of the updated and expanded risk assessment approaches and methods used in the RTR program was completed in 2009. This methodology was highlighted to the SAB utilizing two RTR source categories: Petroleum Refining Sources MACT I and Portland Cement Manufacturing. The final SAB advisory is available at https://yosemite.epa.gov/sab/sabproduct.nsf/0/b031ddf79cffded38525734f00649caf!Ope nDocument&TableRow=2.3#2.

5) The individual dose-response assessment values used in the RTR assessment have themselves been the subject of peer reviews through the agencies that developed them (including EPA, through its Integrated Risk Information System, or IRIS; the California Environmental Protection Agency, or CalEPA; and the Agency for Toxic Substances and Disease Registry, or ATSDR).

We are not asking the SAB panel to duplicate or comment on previously reviewed methodologies, but rather to evaluate whether the specific enhancements to previously reviewed methodologies as described below are appropriate and scientifically credible.

Goals of This Review

We are seeking a scientific peer review of the updated screening methodologies. We are also seeking a scientific peer review of several specific enhancements to our chronic inhalation risk assessment that serve to reduce some of the uncertainties identified by EPA in the last SAB review. These updates and enhancements are outlined in the report: "Screening Methodologies to Support Risk and Technology Reviews (RTR): A Case Study Analysis" (the report).

The most important revisions and enhancements to our methodologies since the last SAB review include the following:

1) A tiered multipathway screening methodology that determines whether the potential for multipathway risk from persistent and bioaccumulative HAP (PB-HAP)[5]1 emitted from RTR source categories is low or whether more analysis is needed.

2) A tiered environmental screening methodology that determines whether the potential exists for adverse environmental effects from PB-HAP and the acid gases hydrogen chloride (HCl) and hydrogen fluoride (HF) emitted from RTR source categories.

3) The potential use of a new multipathway exposure scenario that can be used to estimate ingestion risk for members of urban or rural households who consume contaminated homegrown fruits and vegetables.

4) Enhancements to our previously reviewed inhalation risk assessment that allow us to more accurately model air concentrations where populations actually reside and to better characterize the dispersion of the air in the vicinity of sources.

Charge questions for the Panel's consideration:

There are eight charge questions for this peer review, each of which has been placed in a box below. These eight questions concern three topic areas that cover the most important revisions and enhancements to our methodology since the last SAB review.

Multipathway Human Health Risk Screening Methodology (Chapters 2 and 3):

In RTR assessments, EPA considers ingestion risks using a multipathway approach, in which we model the dispersion, transport, and fate of HAPs emitted from facilities in specific source categories in the environment and estimate human health risks resulting from the ingestion of HAPs from food products, such as vegetables, fruit, meat, and fish.

Since the 2009 SAB review of RTR methods, we refined our original one-tier multipathway screen to include a three-tiered multipathway screening approach that progressively replaces health-protective default assumptions with location-specific data. Since full-scale facility-specific multipathway assessments are time consuming and expensive, the tiered screening approach "screens out" low-risk facilities for which no additional analysis is needed, so that only facilities with potentially higher risk remain in the pool for further analysis.

Chapter 2 of the report provides an overview of the tiered multipathway screening methodology, including a brief description of each multipathway screening tier. The technical detail on each tier of the multipathway screen is laid out in Chapter 3 of the report.

Charge Question 1: Does the SAB find that the three-tiered multipathway risk screening approach appropriately eliminates from further consideration those facilities unlikely to emit PB-HAP in concentrations resulting in appreciable multipathway risk and identifies those facilities where additional multipathway analysis may be warranted? Does the SAB have specific suggestions for improvement of the risk screening methodology?

Tier 1

The multipathway screen previously reviewed by SAB did not account for differences in environmental fate and transport among POM or dioxin congeners (i.e., all POM congeners were assumed to move, partition, and degrade in the environment as BaP does, and all dioxins were assumed to exhibit the same fate and transport as 2,3,7,8-TCDD). Section 3.1.2 of the Report describes the new risk equivalency factor (REF) approach that includes an exposure-equivalency factor (EEF) that reflects an individual chemical's fate and transport relative to the index chemical for each group (BaP for POM and 2,3,7,8-TCDD for dioxin).

Charge Question 2: Does the SAB find that the risk equivalency factor methodology appropriately accounts for differences in the environmental fate and transport among polycyclic organic matter (POM) and dioxin congeners?

Tier 2

Section 3.2 of the report describes the Tier 2 multipathway screening scenario, in which some of the health-protective assumptions in the Tier 1 screen are replaced with more site- specific information. Specifically, in the Tier 2 assessment, site-specific information is used for the locations of potentially fishable lakes and meteorology. In addition, the Tier 2 assessment includes:

- A screening configuration that assesses the fisher and farmer exposure scenarios separately (see Sections 3.2.1.2 and 3.2.1.3).
- An estimation of lake productivity (see Section 3.2.2.2).
- The consideration that a fisher might catch and consume fish from more than one nearby contaminated lake, because more than one lake might be needed to catch enough fish for subsistence living (see Section 3.2.2.3).
- An approach that accounts for PB-HAP deposition into a lake from multiple facilities in the same RTR source category (see Section 3.2.2.3).

Charge Question 3: Does the SAB find that the assumptions for human fishing behavior used in the refined fisher scenario, the assumptions about PB-HAP deposition to lakes, and the assumptions on the ability of ponds and lakes to sustain populations of fish are appropriate?

Tier 3

The Tier 3 screening approach described in Section 3.3 of the report consists of three individual refinements to Tier 2 that are conducted in a step-wise fashion. These refinements include:

- Further analysis of the affected lakes identified in the Tier 2 screen (Section 3.3.1).
- Analysis of plume rise resulting in PB-HAPs lost to the upper atmosphere (Section 3.3.2).
- The use of time-series meteorology and effective release heights (Section 3.3.3).

Section 3.4 of the report describes a gardening exposure scenario we are considering adding to the Tier 3 multipathway screen. The gardening exposure scenario could help us to better characterize multipathway risk in some instances, especially in locations where the presence of a subsistence farm is either unlikely (e.g., in urban areas) or difficult to confirm based on the characterization of land use surrounding a facility.

Charge Question 4: Does the SAB find the methods used for evaluations of (1) lake data, (2) plume rise, and (3) time-series meteorological and time-series plume-rise data are appropriate?

Charge Question 5: Does the SAB find the assumptions and approaches laid out for application in the gardener scenario to be appropriate? Does the SAB find that adding the gardener scenario to Tier 3 would improve our ability to characterize ingestion risks for urban and rural environments?

Environmental Risk Screening Methodology (Chapter 4):

Chapter 4 of the report describes the environmental risk screen that was developed to provide a systematic, scientifically defensible, and efficient approach that EPA can use to screen for potential adverse environmental effects associated with emissions of HAPs from facilities in RTR source categories. The screen can be run quickly and with minimal additional data gathering by drawing on existing data, models, and modeling results, including those developed for the human health multipathway risk screen.

The revised environmental risk screen presented in the report builds on and enhances the methods the SAB reviewed in 2009 as follows:

- Modeled environmental concentrations are compared to ecological benchmarks, not human health thresholds, for all pollutants included in the screen.
- A systematic evaluation of HAPs for potential inclusion in the screen was conducted.
- The environmental risk screen was expanded to include the following additional environmental HAPs: cadmium, hydrogen fluoride, lead, arsenic, and additional POMs.
- The number of ecological endpoints and effect levels that we evaluate was expanded.
- A comprehensive literature review was conducted to identify the most up-to-date ecological benchmarks.
- Tiers were added to the environmental risk screen for PB-HAP that are parallel to the tiers in the multipathway screen.

Charge Question 6: Does the SAB find that the environmental risk screening approach is appropriate for identifying facilities whose PB-HAP emissions may have the potential to cause adverse environmental effects? Specifically, does the SAB find that the pollutants (Section 4.2.1), ecological assessment endpoints (Section 4.2.2), and benchmarks (Section 4.3) that are included in the environmental risk screen are appropriate? Does the SAB have specific suggestions for improvement with regard to any aspect of this environmental risk screening methodology?

Inhalation Risk Assessment Enhancements (Chapter 5):

Urban/Rural Dispersion Selection Tool
In previous chronic inhalation risk assessments, we assumed the land surrounding each facility was rural. Since the most recent SAB review in 2009, we developed an urban/rural enhancement to the chronic inhalation risk assessment that allows us to account for the urban/rural characteristics of the land surrounding each evaluated facility, and therefore, to better characterize the dispersion of pollutants near sources (Section 5.1).

Charge Question 7: Does the SAB find that the Urban/Rural Dispersion Selection Enhancement Tool is an appropriate procedure for identifying facilities to be modeled using the urban option in AERMOD?

Census Block Receptor Check Tool
In its 2009 review, the SAB noted that census block centroids might not always be an appropriate surrogate for residential locations. For example, when the census block centroid is located on industrial property ("on-site"), or when a census block is large and the centroid is far from where populations actually reside, using the centroid may not be appropriate. Since 2009, we developed the census block receptor enhancement (Section 5.2) that allows us to model air concentrations more accurately where populations actually reside. Specifically, the new enhancement automatically identifies census block centroids that might be located on facility, and census blocks that are very large. When onsite or large blocks are identified, we add new receptors, delete census block centroids, or move census block centroids to represent residential locations more accurately.

Charge Question 8: Does the SAB find that the Census Block Receptor Check Tool and associated enhancements are an appropriate method for identifying and adjusting model receptors to ensure the receptors are representative of residential locations?

Message

From: Carpenter, Thomas [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=C286CF1692FA46DC9636A7C49C0925B8-CARPENTER, THOMAS]
Sent: 10/12/2018 7:27:41 PM
To: Kuhn, Kevin [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be20941b4c1144b8b3635e4df015924a-Kuhn, Kevin]
CC: Johnston, Khanna [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=4ee74eeb7ad744e58f6dbf7d2f20243b-Johnston, Khanna]; Brennan, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=78caa4c8d91743c887c1bb5dc8cdb369-Thomas Brennan]; Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]; Shallal, Suhair [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e8249aa5a03d450bbe0d29d3f7603084-Shallal, Suhair]; Dunlap, David [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=591eb15a268249dda0c05a7451f765c3-Dunlap, Dav]
Subject: RE: Science Advisory Board General Briefing
Attachments: Deliberative Process / Ex. 5

Kevin,
Please find attached the items we spoke about during yesterday's briefing. Deliberative Process / Ex. 5

Deliberative Process / Ex. 5

As always, let us know I you have additional needs.
Best
Tom

-----Original Appointment-----
From: Johnston, Khanna
Sent: Wednesday, September 26, 2018 1:46 PM
To: Johnston, Khanna; Brennan, Thomas; Carpenter, Thomas; Shallal, Suhair; Yeow, Aaron; Gentry, Nathan; Dunlap, David
Cc: Kuhn, Kevin
Subject: Science Advisory Board General Briefing
When: Thursday, October 11, 2018 2:00 PM-3:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: RRB, 3rd Floor, SAB Office 31150, SABSO Conference Room

Deliberative Process / Ex. 5

Date: Thursday, October 11, 2018 11:00am
Purpose: General Briefing on the Science Advisory Board, Clean Air Scientific Advisory Committee, and an Overview of Membership Process
Time: 45min (60m Blocked)
Location: RRB 31150-SAB Conf. Rm. (3rd Floor)

> **DIRECTIONS:** Please turn Right when you come off the Elevator, walk past the Office of International Tribal Affairs (OITA) Reception Desk, turn Left, walk down the Hall to Science Advisory Board (SAB), ring the doorbell at the glass door.

BACKGROUND: Tom Carpenter, SAB DFO will share a general overview of the SAB, Aaron Yeow will provide a general overview of the CASAC, and Susan Shallal and Tom Brennan will provide a very general overview of where we are on the FY2019 SAB Membership Cycle.
Invitees Required: DAA TBD; Director Tom Brennan; DFO Tom Carpenter; DFO Aaron Yeow; DFO Sue Shallal
Optional: COS Elizabeth Blackburn; SA Kevin Kuhn; DD Khanna Johnston, SAB

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 9/11/2018 12:52:54 PM
To: Brennan, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=78caa4c8d91743c887c1bb5dc8cdb369-Thomas Brennan]
Subject: E&E News PM - Wheeler's calendar sheds light on industry meetings

EPA

Wheeler's calendar sheds light on industry meetings

Kevin Bogardus and Corbin Hiar, E&E News reporters

Published: Monday, September 10, 2018

Acting EPA Administrator Andrew Wheeler (left) attends a meeting at the National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Mich., last month. @EPAAWheeler/Twitter

Acting EPA Administrator Andrew Wheeler's private calendar shows a range of industry interests were scheduled to meet with him during his early months as deputy chief at the agency.

The schedule, obtained by E&E News under the Freedom of Information Act, offers more detail than his public calendar posted on EPA's website about who met with Wheeler and what they discussed while he served as second in command.

The 330-page document starts at April 20, when Wheeler was sworn in at EPA, and ends at July 6, which was former Administrator Scott Pruitt's last day at the agency after he resigned under a crush of ethics allegations.

Wheeler's private calendar also discloses meetings that were not previously known.

On the morning of June 5, Wheeler had a meeting about emissions regulations for heavy-polluting glider kits — new truck cabs with refurbished diesel engines — that the Obama EPA had sought to limit.

Wheeler's private calendar shows that he met with former securities lawyer and Trump EPA transition official Steve Milloy and with Jon Toomey, a lobbyist for glider kit maker Fitzgerald Peterbilt. The subject listed was "Meeting with Steve Milloy," and Milloy's meeting request was similarly vague.

"Hi, Andrew, I'd like to request a meeting for next week," Milloy said.

Wheeler's public calendar for that day is less informative. The time slot from 11 to 11:30 a.m., when he met with Milloy and Toomey, says only that he was in a "General Discussion."

"Multiple topics pertaining to the Agency were discussed in this meeting, hence 'general discussion,'" EPA spokesman James Hewitt told E&E News.

Milloy, who has advocated for keeping glider kits on the market, confirmed in a brief phone interview this afternoon that glider kits were a focus of that meeting.

"I was helping out as a friend," Milloy told E&E News when asked about his connection to Fitzgerald. "It was pro bono work."

The following month, on Pruitt's last day, the agency said it wouldn't enforce a production cap on the high-emission trucks. Wheeler has since withdrawn that order, but EPA is moving forward with a proposed repeal of the glider kit rule (*E&E News PM*, July 18).

Wheeler's calendar while he was EPA's No. 2 show he was slated to meet with a number of lobbyists and trade group officials with business before the agency.

Some of those scheduled meetings include the American Forest & Paper Association, American Chemistry Council, National Ocean Industries Association and U.S. Chamber of Commerce's Global Energy Institute. Wheeler was also slated to meet or host calls with executives for oil and gas giant ConocoPhillips, engine maker Cummins Inc., and powerhouse utility Duke Energy.

On June 14, Wheeler was scheduled to meet with two well-known Clean Air Act attorneys, Bill Brownell and Joe Stanko of Hunton Andrews Kurth, for a "Meet and Greet."

Brownell was among the attorneys who argued in a federal appeals court that the Obama administration's Clean Power Plan should be overturned.

Before he became EPA's acting chief, Wheeler was scheduled for several meetings with staff throughout the agency. He also had time slated to connect with other Trump administration officials, including Francis Brooke, the White House energy adviser.

It wasn't all industry meetings for Wheeler. Some environmental groups made it onto the agenda.

Wheeler was also scheduled for a "Meet and Greet" with Collin O'Mara, president and CEO of the National Wildlife Federation, on June 21. In addition, he was slated to attend a Chesapeake Bay Commission meeting on May 3.

"Administrator Wheeler is open to meeting with all stakeholders," Hewitt said.

Wheeler also had meetings about the renewable fuel standard, including with organizations that had previously paid for his lobbying or consulting work.

E&E News first reported Wheeler's meetings with biofuel makers Darling Ingredients Inc. and Archer Daniels Midland, or ADM (*Greenwire*, July 26).

But his personal calendar shows more information on those meetings and reveals further contacts with past clients. EPA has defended the meetings, saying since Wheeler didn't work with those clients during the two years prior to his joining the agency, he is allowed to meet with them and remain in line with President Trump's ethics pledge (*E&E News PM*, July 27).

The previously reported May 24 meeting with ADM and two other biofuel groups was "regarding the current negotiations on the year round E-15 and RIN credits for ethanol exports deal," according to the calendar.

May also appears to have included two other scheduled biofuels-related meetings. One was to feature the head of the Renewable Fuels Association trade group. Another was scheduled with Frank Love, the CEO of Love's Travel Stops, to talk about how his 450 truck stops have made "considerable investment in biodiesel and renewable natural gas covered by the Renewable Fuel Standard," according to the personal calendar.

ADM had additional meetings slated with Wheeler, the calendar shows. On June 26, an executive from the agribusiness giant was slated to meet with the then-deputy administrator to "discuss the timing/importance of the 2019 renewable volume obligations." That meeting was to include the head of trade group Growth Energy, another former client.

Later that day, Wheeler had a previously reported meeting with former client Darling Ingredients about the "biomass-based diesel requirements under the Renewable Fuels Standard." The calendar says it included a top Darling official and Andy Ehrlich, a lobbyist at the firm Total Spectrum who previously represented Darling at Faegre Baker Daniels alongside Wheeler.

On June 22, Wheeler also met with Wayne Nastri, an EPA Region 9 administrator under President George W. Bush and executive officer for the South Coast Air Quality Management District. Wheeler had lobbied for the Southern California air pollution regulator in 2010.

EPA officials cast as Senate Dems in mock hearing

Wheeler's schedule also shows EPA's internal workings as it faces scrutiny from Capitol Hill.

On June 15, Wheeler and his colleagues were asked to attend a nomination "mock hearing," in which Trump's political appointees would play members of the Senate Environment and Public Works Committee, according to the calendar.

The meeting was organized by Tony Frye, a former Capitol Hill staffer who joined EPA's congressional affairs shop last year.

A notice sent to Wheeler and other top EPA staffers stipulated which agency officials would be playing which senators for the 90-minute session. The only Republican represented was to be committee Chairman John Barrasso of Wyoming. He was to be played by Christian Palich, who was president of the Ohio Coal Association before joining EPA's congressional affairs staff.

Byron Brown, EPA's then-deputy chief of staff for policy, would play the committee's top Democrat, Sen. Tom Carper of Delaware. EPA chief of staff Ryan Jackson would play Sen. Jeff Merkley (D-Ore.), Frye would depict Sen. Ben Cardin (D-Md.), Deputy General Counsel Justin Schwab would play Sen. Bernie Sanders (I-Vt.) and Sen. Sheldon Whitehouse (D-R.I.) would be portrayed by air official Mandy Gunasekara.

Others cast in the mock hearing were policy chief Brittany Bolen as Sen. Kirsten Gillibrand (D-N.Y.), congressional affairs aide Aaron Ringel as Sen. Cory Booker (D-N.J.), Deputy Assistant Administrator for Research and Development Richard Yamada as Sen. Ed Markey (D-Mass.), enforcement chief Susan Bodine as Sen. Tammy Duckworth (D-Ill.), and policy counsel Drew Feeley as Sen. Chris Van Hollen (D-Md.).

It's unclear whether the mock hearing took place and which nominees, if any, it was intended to benefit.

EPA's press office didn't respond to a request for comment about the June 15 meeting.

Click here to read Wheeler's private calendar.

Reporters Robin Bravender, Zack Colman, Maxine Joselow and Mike Soraghan contributed.

Message

From: Thomas Carpenter [Carpenter.Thomas@epamail.epa.gov]
Sent: 8/29/2018 2:24:37 PM
CC: Bright, Wanda [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b783537affbc46119372799bdbac87e4-Bright, Wanda]; Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]
Subject: Request Submitted for Draft Report
Attachments: Biogenic_Carbon_ Qual_Rev-8-29-18.pdf

A Draft Report Request has been submitted for your review

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DATE

EPA-SAB-19-xxx

The Honorable Andrew Wheeler
Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Subject: SAB review of *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014)

Dear Acting Administrator Wheeler:

The EPA Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014) ("2014 Framework"). The 2014 Framework considers the scientific and technical issues associated with accounting for emissions of carbon dioxide (CO_2) from biogenic feedstocks used at stationary sources.

The purpose of the 2014 Framework was to develop a method for calculating the adjustment, or Biogenic Assessment factor, for carbon emissions associated with the combustion of biogenic feedstocks by taking into account the biological carbon cycle effects associated with growth, harvest, and processing of these feedstocks. The BAF is an accounting term developed by EPA for use in the Framework. The BAF is a mathematical adjustment to denote the offset to stack emissions. It reflects a biogenic feedstock's net carbon emissions after taking into account its sequestration of carbon in regrown biomass or soil and emissions that might have occurred with an alternate fate had the biomass not been used for fuel.

The 2014 Framework is a revision of the 2011 Framework, which the SAB previously reviewed. The SAB notes that the 2014 Framework incorporated some of the SAB's prior advice and advanced the analytical foundation for making determinations about the net contribution of biogenic feedstocks to CO_2 in the atmosphere. Specifically, the 2014 Framework has incorporated the SAB's prior advice as follows:

- It has adopted an alternate fate approach (i.e., a counterfactual evaluation of what the net biogenic atmospheric contribution might have been if the feedstocks were not used for energy) to the collection and use of waste-derived feedstocks, including avoided methane (CH_4) emissions.
- It includes a discussion of the trade-offs inherent in the selection of a temporal scale for considering net emissions.
- It has developed representative BAFs by feedstock and region rather than facility-specific BAFs.

- It includes a review of existing approaches to addressing leakage, the phenomenon by which efforts to reduce emissions in one place affect market prices that shift emissions to another location.
- It offers an approach to construct an anticipated baseline that allows assessment of the additional CO_2 emissions to, or uptake from, the atmosphere that can be attributed to biogenic feedstocks as a result of changes in biomass feedstock demand.

The 2014 Framework does not, however, provide the policy context, specific BAF calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. The BAF is inherently a *construct* designed to evaluate the importance of the stack emissions of CO2 at a given time relative to their climate impacts at some point in the future when some of the emitted CO2 will have been sequestered by regrowth of the biogenic feedstocks. As such, that construct depends upon the future point of interest, which is explicitly a policy decision. Policies designed to affect change in emissions or impacts in the short term will need to be evaluated over the short term, and thus, the relevant time-period for the BAF computation will be that same short term. Feedstocks will have different BAF values depending on the policy-driven relevant time-period.

While the SAB agreed with many of the recommendations developed by the Biogenic Carbon Emissions Panel in previous drafts of the report, it disagreed with the extended time frame used for the analysis. There was extended discussion between the SAB and the Biogenic Carbon Emissions Panel over the significance of the time horizon used to calculate BAFs. The Panel recommended that a general principle for determining the time horizon for BAF calculations should be to select a time horizon that fully accounts for the temporal dynamics for all feedstocks to accommodate the Agency's policy neutral approach. During quality reviews the SAB disagreed with this recommendation noting that for policy initiatives that consider shorter time horizons it may be inappropriate to use a BAF calculated to incorporate nearly all carbon stock effects over time. The SAB favors selecting the time horizon for calculating the BAF to comport with the policy time horizon under consideration. The Panel's previous reports remain available on the SAB webpage.

In addition to the relevant time frame, a policy context would have provided other information necessary to the assessment of the science underpinning the BAFs, such as the scale of demand for biogenic feedstocks and the anticipated time frame for that demand and eligible feedstocks to meet it. As we stated in our 2012 report and we reiterate here: this SAB review would have been enhanced if the Agency offered a specific regulatory application that, among other things, provided explicit proposed BAF calculations and defined the applicable boundaries regarding upstream and downstream emissions in the feedstock life cycles. The 2014 Framework lacks specificity and is written in a way that is too generic, with too many possibilities that would require assessment of different underlying science. Rather than offering a lengthy menu of calculation options, the EPA Framework needs to define its scenarios and justify those choices. This would enable SAB to evaluate the science underpinning those decisions and justifications. Since the policy context is expected to alter the choices various actors will make and these choices will alter the assumptions included in the models used to predict biomass-associated emissions and sequestration, it is not possible to evaluate the proposed model assumptions in the absence of a policy context. For proper scientific evaluation, the Framework needs to be applied in a specific policy context with specific BAF calculations and clearly defined boundaries for EPA's regulatory authority. EPA should provide this application to SAB for review. If multiple policy contexts

are under consideration, EPA should provide multiple sets of applications, calculations, and boundary assertions for review.

Despite this significant limitation, the SAB offers overarching suggestions for moving forward with a framework for assessing the BAFs of biogenic feedstocks. In addition to specific responses to EPA's charge questions, the SAB offers general guidance regarding the calculation of BAFs. EPA's equations were based on emissions (fluxes) with some adjustment terms to account for carbon mass escaping the system between the point of assessment and the point of emissions. In the enclosed report, the SAB offers an alternative formulation based on changes in terrestrial (non-atmospheric) carbon stocks (or pools) such as the live stocks in biomass, dead stocks, soil stocks, etc., that explicitly incorporates the principle of conservation of mass. While the carbon-stock-based accounting system results in a similar formula for BAF as the EPA's emissions-based approach, it offers multiple advantages: it is typically inventoried and modeled by the scientific community; it can be aggregated and rearranged as needed or further subdivided; and it is appropriately constrained by conservation of mass and therefore can be assessed using mass balance calculations. Although this alternative formulation provides these benefits, other important modeling issues l remain. These include selecting appropriate temporal or spatial boundaries, considering variability among classes of feedstocks, accounting for non-CO_2 greenhouse gases such as nitrous oxide and methane, and quantifying stocks and fluxes that are difficult to measure or estimate.

As an additional caveat, the SAB is aware that the EPA report and this review are focused only on accounting for carbon dioxide related to the use of biomass for electricity generation. Neither EPA nor the SAB evaluated other concerns like forest conservation, biodiversity, and ecosystem services. If, for example, biomass pellets were sourced from old growth forests, this would pose unique risks that would not be reflected in a BAF calculated for net effects on carbon dioxide. We offer this caution about the model boundaries as defined by EPA's method and identified in the SAB review. In addition, we recognize that biodiversity and ecosystem health are valid concerns worthy of a whole different analysis and policy response.

Finally, EPA did not ask the SAB for feedback on its modeling approach. We think this was an oversight, given that modeling is critical to the development of the BAF and different modeling approaches can yield different results. The 2014 Framework employed an integrated model that captures economic and biophysical dynamics and interactions for some of its alternative BAF calculations; however, EPA did not offer explicit justification for its modeling choices derived from articulated criteria. In addition, the sensitivity of BAF responses to some underlying features of the model was not examined by the SAB. Thus, we conclude EPA should identify and evaluate its criteria for choosing a model or models and examine the sensitivity of BAF estimates to key modeling features.

The SAB appreciates the opportunity to provide advice on the 2014 Framework and looks forward to your response.

Sincerely,

Enclosure

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board (SAB), a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The SAB is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names of commercial products constitute a recommendation for use. Reports of the SAB are posted on the EPA Web site at http://www.epa.gov/sab.

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Acronyms and Abbreviations

AVOIDEMIT	Avoided Emissions
BACT	Best Available Control Technology
BAF	Biogenic Assessment Factor
BAU	Business as Usual
CH4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DOE	Department of Energy
EPA	Environmental Protection Agency
FASOM	Forestry and Agricultural Sector Optimization Model
GHG	Greenhouse Gas
GROW	Term in EPA's BAF equation representing net feedstock growth (or removals)
GWP	Global Warming Potential
PSD	Prevention of Significant Deterioration
N_2O	Nitrous Oxide
SAB	Science Advisory Board
USDA	U.S. Department of Agriculture

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1. EXECUTIVE SUMMARY

The EPA requested the SAB to review a revised science-based framework for accounting for biogenic carbon emissions, which the agency defines as "CO_2 emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, digestion, fermentation, decomposition, or processing of biologically based materials."[1] The goal of the 2014 Framework is to evaluate biogenic CO_2 emissions from stationary sources that use biogenic feedstocks, given the ability of green plants to remove CO_2 from the atmosphere through photosynthesis. The 2014 Framework and its 2011 predecessor introduced the concept of a Biogenic Assessment Factor (BAF), which is the adjustment for carbon emissions associated with the combustion of biogenic feedstocks to reflect net emissions to the atmosphere. The BAF is an accounting term developed in the Framework to denote the offset to stack emissions (mathematical adjustment) that reflects net carbon emissions after taking into account the sequestration of carbon in regrown biomass or soil and emissions that might have occurred with an alternate fate had the biomass not been used for fuel.

Importance of the Policy Context

The questions before the agency in 2011 and in 2014 and presented for the SAB's review, were whether and how to consider biogenic greenhouse gas (GHG) emissions and decisions about best available control technology (BACT) for CO_2 emissions from bioenergy. The BAF is defined by its use for policy goals and thus evaluation of this construct for a science-based regulatory framework in the absence of a policy context is not useful. Rather than assume a policy context or evaluate the charge questions across numerous putative policy contexts, the SAB focused on providing a summary of the fundamental science underlying the development of science-based policies for assigning CO_2 emission factors to bioenergy feedstocks.

Region- and Feedstock-Specific Biogenic Assessment Factors, baselines and modeling

As recommended previously by the SAB, BAFs should be feedstock-specific and region-specific and not facility-specific. Facility-specific BAFs are conceptually and practically challenging to estimate due to the absence of well-defined spatial boundaries for feedstock supply to each facility and the role of market-induced effects on land use, on biomass production and market demand for fiber, and on carbon stocks across space. To obtain a region-specific BAF for feedstocks, it is necessary to address region-specific, feedstock-specific demand for biomass and to assess the impact of this increased demand for biomass on net carbon stocks. Projections of these interactions can be obtained from diverse model types, from simple empirically and statistically-based models, to complex integrated assessment models that integrate biophysical and/or economic factors. The more complex the model, the greater the dependence of outputs on input assumptions; thus, sensitivity and uncertainty analyses are needed to adequately interpret the results from complex models. Often, simple models are best.

In general, the BAF for a class of feedstock should be estimated for the average effect of the last increment of demand for that feedstock. Changes in demand for biomass feedstocks should be assessed

[1] https://19january2017snapshot.epa.gov/climatechange/carbon-dioxide-emissions-associated-bioenergy-and-other-biogenic-sources_.html

based on historical data on forest carbon stocks, resource use, and observed information on current and planned expansions to facilities using biogenic feedstocks. There is no single answer to what these BAFs should be, as not all biogenic emissions are carbon neutral nor net additional to the atmosphere, and assuming so is inconsistent with the underlying science.

To compare changes in any system over time there must be a reference scenario (without increased demand for bioenergy or other uses of the feedstock) against which to assess the net impacts on the variable of interest, in this case carbon stocks. In 2012, the SAB recommended a future anticipated baseline approach to capture the *additional* CO_2 emissions to, or uptake from, the atmosphere created by any increased use of biomass for energy. The EPA acknowledged this limitation of its earlier approach and included a future anticipated baseline analysis along with a reference point approach in its 2014 Framework. The reference point approach, if adjusted at regular intervals (e.g., every 5 to 10 years) to account for any additional regional sequestration, would address the SAB's earlier concerns, allowing for the more direct establishment of a baseline while capturing additional increases in carbon stocks.

Regardless of the model structure chosen (reference baseline or future anticipated baseline), validation and evaluation of the model will be critical. Model validation is essential to assessing the model's ability to replicate observed phenomenon over time. Similarly, understanding model sensitivity to input parameters and assumptions is important with respect to assessing model applicability over time. The model selected for estimating BAFs should be reviewed and updated at regular intervals using observed changes in economic and land use conditions that may be due to increased biomass/fiber demand or other related conditions, as well as the latest scientific information on biophysical and biogeochemical properties of feedstocks. The appropriate review interval should be selected based on the timeframe of the policy as well as the timeframe associated with updates to the underlying data.

In the 2014 Framework, the EPA has offered illustrative simulations of future biophysical and economic conditions employing the Forestry and Agricultural Sector Optimization Model (FASOM) to determine the incremental GHG emissions of increased biomass feedstock demand compared to a "business as usual" approach (i.e., the reference baseline scenario without demand for bioenergy). Such models have not been validated for this application, and heavy reliance on them is unwarranted.

Alternate Fate Approach for Waste-Derived Feedstocks

In 2012, the SAB recommended that the EPA consider the alternate fate of feedstocks diverted from the waste stream, whether they might decompose over a long period of time, whether they would be deposited in anaerobic landfills, whether they are diverted from recycling and reuse, etc. In the 2014 Framework, the agency has conducted extensive alternate-fate calculations. However, by drawing a narrow boundary around point-source emissions, the agency neglected significant considerations that affect the greenhouse gas footprint of alternative solid waste management scenarios including:

- the potential alternate fate of municipal solid waste, e.g. electrical energy generation by capturing landfill gas and associated fugitive emissions or direct combustion.
- carbon storage associated with landfills, and a landfill baseline that is inconsistent with regulatory practice.
- waste treatment options might change if current energy recovery uses were considered.
- methane emissions for woody mill residuals.

A more complete analysis is required to ensure that the net greenhouse gas emissions are well defined.

Temporal Scale (Charge Question 1)

A sustained increased demand for bioenergy by stationary facilities in a region is likely to trigger changes in carbon stocks through one or more pathways that could generate a new (steady-state) equilibrium stock of carbon that may be higher or lower than the current stock of carbon on the land. The demand for biomass for bioenergy can affect carbon stocks by increasing harvesting intensity for standing biomass, diverting biomass from other non-energy products and landfills, converting land from other uses to plant new biomass feedstocks for the future, and utilizing residues that might otherwise decay. Each of these responses may differ over time, and thus, the overall effect of all these responses together on demand for biogenic feedstocks may differ over time. Therefore, the time period selected for the analysis can strongly affect the assessed impact of an increased demand for bioenergy by stationary facilities on carbon stocks and net emissions of carbon dioxide to the atmosphere. The selection of the time period for assessment is not a scientific question, but rather is closely associated with the policy objectives being addressed by the application of a BAF to a stationary source. For example, if the goal is to limit peak planetary warming versus a goal of controlling emissions of greenhouse gases in 2050, the same feedstock in the same region could have widely varying impacts on terrestrial carbon stocks because the timeframe defining the endpoint of the analysis would differ. Since BAFs are defined by the policy objectives, there are no scientific criteria by which to pick a single 'right' timeframe for their determination (Ocko et al 2017). Computing a cumulative BAF over any period of time requires accounting for the positive and negative impacts on stocks over time to determine the net biogenic effect. A cumulative BAF is preferable to an instantaneous (or annual) BAF because the use of biogenic feedstocks can trigger changes in carbon stocks that manifest beyond the period in which the feedstock is consumed by a stationary facility.

Stock-Based Accounting Preferred to Emissions-Based Accounting

Carbon accounting associated with determining BAFs should be based on changes in carbon stocks on the land rather than changes in carbon emissions (as used in EPA's 2011 and 2014 Frameworks). A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated, subject to validation via mass balance and an existing comprehensive system of empirical measurements is already in place for the US. The stock-based approach comports with the current conventions in carbon accounting which essentially use input-output tracking of carbon throughout a system with well-defined boundaries. These stocks can be aggregated and rearranged as needed, and it is appropriately constrained by conservation of mass and therefore can be assessed using mass balance calculations. In theory, a stock-based formulation should yield the same BAF as an emissions-based approach, but the stock-based approach is simpler and more transparent.

Two Cumulative Biogenic Assessment Factor Approaches

There are two alternative approaches to calculating a cumulative BAF and the implications of these different approaches should be further considered. Until the implications of the differences are better understood, we support EPA's cumulative BAF (which we designate as BAF_T) approach, i.e., the difference in carbon stocks *at the end of the time horizon T*. A second approach was developed by members of the Biogenic Carbon Emissions Panel which takes into account the time course of CO_2 emissions by accumulating the annual differences in carbon stocks on the land *over the time horizon T*. By accumulating annual differences across the projection period, the alternative cumulative BAF metric

(designated as $BAF_{\sum T}$) attempts to incorporate "residence time" in the sense that it is a proxy for the length of time carbon stays in the atmosphere until it is modified by changing stocks of carbon on the land. (See Figures 1 and 2)

Scales of Biomass Use and Modeling Approach (Charge Question 2)

In general, the BAF for the feedstock in a region should be estimated for the average effect of the last increment of demand for biomass from that feedstock in that region. Projections for aggregate demand for all biomass changes should be bounded by historical data on resource use, observed information on current and planned expansions to facilities using biogenic feedstocks, and reasonable projections of cost-effective deployment of biogenic energy resources consistent with policy.

In addition, regular retrospective evaluations of observed levels of demand and the mix of feedstocks would enable revisions to EPA's estimates of feedstock demand changes. Retrospective evaluations of BAF performance will be important for understanding how effective the modeling has been, regardless of the complexity of the deployed models. Thus, projections about biomass demand should be revised based on actual outcomes, and these updated demands should be used to inform modeling that generates BAFs.

Recommendations

1. Full development of a biogenic carbon accounting approach requires a specific-policy objective to which BAFs will be deployed. With that specificity, the accounting can be refined to ensure maximum effectiveness relative to that objective, while minimizing transaction costs.

2. Changes in carbon stocks (e.g., live and dead biomass, soil, products, material lost in transport and waste), should be used to account for biogenic carbon, rather than an emissions (flux-based) approach.

3. The direction and magnitude of the impact of a feedstock on terrestrial carbon stocks depends on the time horizon considered. There is no single optimal time horizon.

4. The SAB suggests exploration of two cumulative BAF metrics that deal with time differently. Until the implications of the comparison are clear, the SAB recommends using the metric proposed by EPA, i.e., net changes in stock over a specified time.

5. EPA should identify and evaluate its criteria for choosing a model and modeling features that affect BAF outcomes. EPA should explore the sensitivity of BAFs to different modeling assumptions, transaction costs, and uncertainties in model input parameters.

2. INTRODUCTION

2.1. Background

EPA's Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (U.S. EPA 2014).

The purpose of the 2014 Framework is to develop a method for calculating the adjustment, or BAF, for CO_2 emissions associated with the use of biogenic feedstocks, taking into account the biological carbon cycle associated with the growth, harvest, and processing of plant biomass. This mathematical adjustment to stack emissions is needed because of the unique ability of biological systems to sequester CO_2 from the atmosphere through photosynthesis in living biomass, to sequester carbon in dead biomass and soil, and to release CO_2 through respiration and biologically-mediated decay of organic matter. These attributes of ecosystems mean that there can be wide variation in the net effect of using bioenergy on emissions of carbon dioxide to the atmosphere and thus it is scientifically indefensible to assume all bioenergy has no net carbon dioxide emissions to the atmosphere, or the reverse, that all emissions represent a net addition to the atmosphere. The BAF is an accounting term developed in the Framework to estimate the net CO_2 emissions to the atmosphere over a specified period of time associated with burning biomass to produce energy. These net emissions reflect the changes in carbon stocks of above and below ground biomass (live and dead), soils, and wastes. The 2014 Framework is a revision of the 2011 Framework (U.S. EPA 2011), which the SAB previously reviewed (U.S. EPA SAB 2012).

The EPA's charge to the SAB (Appendix A) requests advice and recommendations on its revised 2014 Framework, which was developed with consideration of the SAB's 2012 recommendations as well as the latest information and input from the scientific community and other stakeholders. The EPA asked the SAB to review and offer recommendations on specific technical elements of the 2014 Framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions that could be quantified through calculation of a BAF.

To conduct the present review, the SAB Staff Office reconstituted the Biogenic Carbon Emissions Panel (Appendix B), which had reviewed the 2011 Framework. That panel met multiple times between March 2015 and August 2017. The Panel presented a draft report (February 2016) to the SAB for quality review. The SAB quality review was conducted in March 2016; this quality review resulted in requested revisions from the Panel. The revised draft report (June 2017) was reviewed by the Board in 2017. The 2017 revision of the report was not approved by the SAB based on the deliberations of the quality review. This report is a product of SAB's direct efforts and utilizes portions of the Panel's report. Previous drafts of the panel's report are retained on the SAB website and available here.

3. OVERARCHING COMMENTS

This section addresses issues that lie outside the scope of EPA's charge questions.

3.1. Policy Context

For its review of the 2011 Framework, the SAB requested and was given a policy context for the biogenic CO_2 accounting framework. The SAB was told that the 2011 Framework was intended to guide the determination of CO_2 emissions from regulated stationary sources under the Clean Air Act, specifically those facilities receiving a prevention of significant deterioration (PSD) air permit and that were required to conduct a best available control technology (BACT) analysis for CO_2 emissions. The question before the agency, and hence the SAB, was whether and how to consider biogenic greenhouse gas (GHG) emissions in reaching thresholds for permitting and decisions about BACT for CO_2 emissions from bioenergy.

The agency has removed this policy context from its 2014 Framework, and the EPA's charge questions seek general guidance on issues related to the choice of temporal, spatial and production scale for determining BAFs in a policy-neutral context. In the absence of a specific policy context, this review was limited to providing general comments about how to consider the questions posed. Answers to the specific questions posed will vary with the policy context, most notably the appropriate time period over which to determine the net biogenic emissions, and to a lesser degree, the appropriate geographical scale for consideration and the regulated entity.

A policy context would be helpful to clarify if the proposed procedures will account for the emissions of all greenhouse gases that alter the climate. If this is the case, then it will be important to account for the effect of biogenic feedstocks on non-CO_2 gases such as N_2O and CH_4, to examine how the emission or uptake of these gases differ across space, time, and feedstocks, and to examine how these gases influence BAFs. Given the large difference in the mean residence time of these gases in the atmosphere, their relative importance can vary widely over different time horizons. If the climate impacts over 20 or 40 years is of concern then methane and black carbon emissions could be very important, while if the period of concern is hundreds of years, their importance will drop significantly (Shoemaker, et. al., 2013). Non-CO_2 gases are particularly important for feedstocks grown with nitrogen fertilizer and for waste materials from landfills.

Recommendation

- Biogenic carbon accounting will vary depending on the policy context, particularly in selection of the time horizon and geographic scope. Thus, future efforts to define specific biogenic accounting factors should be conducted in a policy-specific context, with the objectives and relevant time frame specified. It is inappropriate to use default assumptions, including assuming there are no net emissions or that all emissions are additive.

3.2. Baseline Approach

To compare change in any system over time, there must be a baseline or reference scenario against which to assess changes due to an incremental and sustained demand for biogenic feedstocks, allowing

different scenarios to be compared. The EPA assesses the estimated net change in land-based biogenic CO_2 fluxes and/or carbon stocks between two points in time. In the 2012 SAB report, we noted temporal problems with the reference point baseline approach. The EPA has acknowledged this in its 2014 Framework and included a future anticipated baseline analysis alternative along with a reference point approach. The limitations of a reference point approach can be reduced by deploying a shifting reference point (updated at regular intervals using empirical data (e.g. every 5 or 10 years)), which is designed to capture increased regional carbon stocks.

The SAB's 2012 advice on the anticipated baseline approach explored the use of complex modeling in order to try to capture interactions among the market, land use, investment decisions, and emissions and ecosystem feedbacks, and to construct a counter-factual scenario that does not include increased bioenergy use. In the case of long rotation feedstocks, bioenergy demand can affect carbon stocks in many ways including the ages at which trees are harvested, the diversion of forest biomass from traditional forest product markets to bioenergy, and the rates of afforestation and deforestation. The complexity of such a modeling approach makes it difficult to parameterize and validate. The lack of empirical data regarding many of these relationships and the resulting uncertainties pose a significant challenge to use of this type of model in a regulatory context. Estimating the net effect of these changes on carbon stocks requires a model that integrates market demand and supply conditions with biophysical conditions that determine growth of forest biomass, losses via decomposition, carbon sequestration and fluxes due to harvests and land use change and incorporates the spatial variability in these effects across the U.S. Employing models of this complexity is likely beyond the capabilities of many practitioners.

Also, consistent with the SAB's 2012 recommendations, the EPA has now moved toward a "representative factor" approach that would include an assessment of the biogenic landscape attributes (type of feedstock, region where produced). The EPA initially considered calculating a BAF for an individual stationary facility; however, the data needs for a facility-specific approach were daunting if they were to be accurate (e.g., case-specific measurements and calculations of carbon stocks and fluxes and chain-of-custody carbon accounting, integration of land use changes on a broader landscape level). EPA's use of a representative factor approach is an advance in its accounting methodology, although overly-broad feedstock categories may not reflect important extant or likely future variation in feedstock production or processing (e.g., roundwood in the Southeast, logging residues in the Pacific Northwest, and corn stover in the Corn Belt). The overall approach is a positive development, but caution is required to ensure such inclusiveness does not produce perverse outcomes, e.g. feedstocks with large positive net emissions to the atmosphere lumped together with those with more limited net emissions. The EPA should evaluate the "representativeness" of the factors and refine the approach over time with additional data.

As stated in 2012, there are tradeoffs between ease of implementation (transaction costs), precision (getting it right at every location versus overall accuracy), and policy effectiveness (ensuring that the policy objectives are being met). We continue to recognize the difficulty of undertaking an anticipated baseline approach, and practicality should be an important consideration in the agency's decision making. All methods considered should be subject to an evaluation of the costs of implementation and compliance and weighed against any increase in accuracy and precision that they might yield. Ultimately it is critical that there is a balance between accuracy and minimization of implementation costs.

Recommendation

- The EPA should identify and evaluate its criteria for choosing a model (simple or complex) and its underlying assumptions with regards to how both affect BAFs. In addition, the EPA should periodically update and validate the selected model to incorporate the latest scientific knowledge while ensuring that the model outcomes are consistent with empirical observations (e.g. shifts in measured carbon stocks as determined the Forest Inventory Analysis program). Any model chosen should be subject to sensitivity analysis to evaluate its efficacy under different conditions and to identify data needs and prioritize future research.

3.3. Alternate Fate Approach for Waste-Derived Feedstocks

In 2012, the SAB recommended that the EPA consider alternative fates (i.e., if not used as fuel) of waste-derived feedstocks diverted from the waste stream, e.g., whether these feedstocks might decompose over a long period of time, whether they would be deposited in anaerobic landfills, whether they would be diverted from recycling and reuse, etc. In the 2014 Framework, the EPA has conducted extensive alternate fate calculations; however, the agency drew a narrow boundary around point source emissions and neglected other significant considerations that affect the GHG footprint of alternative municipal solid waste management scenarios. Specifically, the EPA neglected to quantify a potential alternate fate of municipal solid waste through landfill-derived methane combustion. Under the Clean Air Act New Source Performance Standards, the EPA requires landfills above a certain size to, at a minimum, collect and control landfill gas (e.g., through flaring). As such, a baseline of direct venting is misleading, although almost all these facilities are likely to produce large emissions of methane, even when in compliance with current regulations (Lamb et al 2016: www.epa.gov/lmop/basic-information-about-landfill-gas).

The relative rankings of BAFs across waste treatment options assessed in the 2014 Framework might change considerably if a more complete accounting were undertaken (e.g., energy recovery from landfill-derived methane and combustion of waste, and carbon storage associated with landfills). For example, one public commenter provided an example showing the effect on BAFs of incorporating methane emissions for woody mill residuals (National Council for Air and Stream Improvement 2015).

3.4. Temporal and spatial considerations in Biogenic Assessment Factor Calculations

The goal of the Framework reviewed by the SAB is to account for effects of biogenic feedstocks on terrestrial carbon stocks. BAFs are a carbon accounting method based on expected future changes in carbon stocks (measured in tons of carbon) due to the use of biogenic feedstocks by a stationary facility. They are designed to assess the net contribution of CO_2 from a stationary facility that uses biogenic feedstocks, due to shifts of terrestrial carbon to the atmosphere over a specified period of time. The time scale selected will vary depending on policy objectives (e.g. a mitigation of climate change in 2050 or 2100, or minimizing global temperature change resulting from greenhouse gas emissions). Over the selected time period, all greenhouse gas impacts – both positive and negative – should be accounted for (as completely as is feasible).

Stationary facilities require a continuous supply of feedstock, thus a landscape approach for accounting of impacts on carbon stocks is more appropriate than a stand-level approach. A landscape approach expands the boundaries of analysis to include all effects and recognizes that there is uptake as well as

loss of carbon associated with the production of feedstocks concurrently occurring across the landscape. It is the overall balance of losses and credits that determine carbon stock effects. Moreover, economic considerations will determine the size of the landscape providing feedstocks over time and the potential for land-use changes that can positively or negatively impact carbon stocks. As noted by Cintas et al. (2016), "assessment at the landscape scale integrates the effects of all changes in the forest management and harvesting regime that take place in response to – experienced or anticipated – bioenergy demand. Taken together, these changes may have a positive, negative or neutral influence on the development of forest carbon balances." Landscape level accounting of effects of forest-based feedstocks on carbon stocks can result in a net gain or loss of carbon stocks in the near to medium term; a carbon debt could be followed by a carbon dividend or the other way around.

BAFs are a carbon accounting tool for assessing emissions from facilities that burn biomass and are not life cycle assessments of net greenhouse gas emissions or their climate change effects. The distinction is that not all indirect systemic effects are considered in the BAF. We also underscore our caution that the net accumulation of forest and soil carbon over time should not be assumed to occur automatically or to be permanent; rather, growth and accumulation should be monitored and evaluated for changes resulting from management, policy, market forces, or natural causes. If such monitoring demonstrates changes that are not included in the model used to develop the BAF, the BAF should be updated to align with the empirical data.

Recommendation

- Stationary facilities require a continuous supply of feedstock, thus a landscape approach is required for accounting for the impacts of feedstock demand on carbon stocks.

RESPONSES TO EPA'S CHARGE QUESTIONS

3.5. Temporal/spatial Scale for Biogenic Accounting

Charge Question 1: What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

There are a couple of factors that impact the BAF over time. The first is that the increased demand for bioenergy in a region could potentially be met by a variety of feedstocks obtained from the agricultural and forestry sectors, including annual and perennial agricultural crops, short rotation woody biomass and pulpwood, and crop and forest residues. The additional biomass might come from several sources: diversion from non-energy products and landfills, converting land from other uses to plant feedstocks for biomass, utilization of residues that would otherwise decay over some period of time. The effect of increased demand for biomass on carbon stocks will depend on the mix of these feedstocks demanded and the scale of demand for these feedstocks.

Second, feedstocks differ in their rate of regrowth, yield, potential to sequester carbon in biomass and soils, decay rates after harvest, and the type of land-use change that accompanies their production. These effects continue after the feedstock has been consumed by a stationary facility. We therefore recommend computing a cumulative BAF over the relevant time horizon. This cumulative BAF would be based on

the difference in carbon stocks between the reference (baseline) scenario and the increased biomass feedstock demand scenario and would vary with the time horizon selected by the policy context.

Key principles for calculating changes in the net carbon stocks should include: (1) the positive and negative impacts of demand for biomass over time, (2) a system-wide approach to account for direct and indirect effects, and (3) consistency across regions. Selecting different time horizons for different feedstocks would be inappropriate since carbon emissions generated by differing feedstocks are equivalent in their impact on the climate.

To fully account for all positive and negative terrestrial effects over time, we recommend using the "emissions horizon" as described by the 2014 Framework applied to a specific policy objective. As defined by the EPA, this "emissions horizon" is the period of time during which the carbon fluxes resulting from actions taking place today actually occur …" (U.S. EPA 2014). If the goal is to have an effect on greenhouse gas emissions by a certain date, then the impacts aggregated by that date are the relevant metric, and that date is the appropriate time horizon. Accordingly, there is no single time horizon that will effectively address all policies or feedstocks since feedstock effects are time-dependent and desired outcomes for policy changes target different time horizons. The SAB does not support a single time horizon as appropriate for determining BAFs, because the computed values can vary significantly over differing time horizons.

Some suggest that the time horizon should be the length of time it would take for the effect of increased demand for biogenic feedstock on the carbon cycle to reach a steady-state. This occurs when the difference in carbon stocks between the increased biomass feedstock demand scenario and the reference scenario is no longer changing or when the difference is approaching an asymptote. This could result in a very long time horizon being selected, potentially hundreds of years if all feedstocks across all regions were to be included. The selection of such a time horizon would mean that for policy objectives with shorter time horizons (e.g., meeting an emissions target by 2050), the accounting would not align with relevant effects of biomass energy on the policy outcome.

Several factors determine the difference in carbon stocks between the reference scenario and the increased biomass feedstock demand scenario. A major factor is the "speed" with which carbon stocks respond after harvest; this is determined, for example, by the speed with which a feedstock regrows and can be harvested again, the mix of feedstocks produced, and the rate at which soil carbon stocks change. Thus, the mix of feedstocks used can influence the shape of the curve and when it reaches equilibrium. For example, if the mix of feedstocks consists of agricultural and short rotation trees then it is likely that stocks will establish new regional equilibrium relatively quickly.

Previous studies have shown that estimates of the effects of biomass harvest on carbon stocks depend on the spatial scale of consideration (stand level or landscape level), the initial conditions of carbon stock on the land (e.g., managed forestland, old growth forestland, or agricultural land), the management practices used, and the time horizon over which effects are measured (Walker et al., 2010; Jonker et al., 2014; Mitchell et al., 2012; Galik and Abt, 2012; Ter-Mikaelian et al., 2015). Harvest of an existing forest stand for use as a feedstock results in an immediate reduction of carbon on the site; the amount of carbon lost at the stand level is directly related to the intensity of the disturbance. At a stand level, harvest followed by regrowth (most US forests regenerate without intervention/planting) usually results

in a cycle of loss followed by gain. The amount of carbon regained on the site can vary: in some cases, all is regained, in others only part is regained, and in others, more can be gained than is released.

Since stationary facilities require a continuous supply of feedstock, multiple stands will be disturbed in a regulated manner (i.e., completely asynchronously), and the order in which losses and gains occur becomes meaningless at the landscape level because both simultaneously occur; thus, the operative issue is the overall balance between losses and gains of carbon at the landscape scale. Thus, stand level accounting is not relevant to the calculation of BAFs. If harvest does not exceed the rate of carbon accumulation, the landscape-level carbon stocks are stable or increasing. However, there could be a net loss of carbon to the atmosphere at the landscape level, compared with the reference scenario, if trees are harvested at younger ages or if trees that would otherwise have been unharvested are harvested.

Biomass, particularly from forest sources, is also used for producing non-energy products. The demand for bioenergy can lead to a diversion of biomass from those products to energy use and lead to an immediate reduction in carbon stocks in products. It is also possible that anticipation of future demand for biomass by stationary facilities can lead to land conversion, reforestation and retention, or accumulation of carbon stocks in a growing forest. In general terms, the amount of either net loss or net gain of carbon on the landscape is influenced by changes in many factors including those influencing net primary production and removals, and the net effect can be expected to vary over time.
When agricultural feedstocks that are harvested annually from land under continuous production, the time lag between harvest, CO_2 emissions from conversion to energy, and regrowth on land is likely to be close to one year, and the harvested carbon will be fully regained, with no net impact on above-ground carbon stocks. The production of these feedstocks may directly affect carbon stocks below-ground by increasing or decreasing soil carbon stocks relative to the use of the land in the reference scenario. The demand for bioenergy can also affect carbon stocks by leading to a change in the use of land which could either release carbon stored in the land (for example if permanent grasslands are converted to annual agricultural production) or accumulate carbon on the land (for example through reforestation as annual cropland is converted back to forests).

Recommendation

- The impact of a feedstock on terrestrial carbon stocks depends on the time horizon considered. A cumulative BAF is preferred because it will capture and integrate all expected negative and positive carbon effects over the policy-relevant time period.

Charge Question 1(a): Should the temporal scale for computing biogenic assessment factors vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.

Charge Question 1(a)(i). If temporal scales for computing biogenic assessment factors vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?

Charge Question 1(a)(ii). Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?

Charge Question 1(a)(iii). Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default biogenic assessment factors versus crafting policy specific biogenic assessment factors?

Charge Question 1(b). Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?

The responses to questions 1(a), 1(a)(i), 1(a)(ii), 1(a)(iii), and 1(b) are combined because these questions all relate to goals or criteria that may affect choices of differing temporal scales for calculating BAFs. The 2014 Framework refers to an "assessment horizon" which may be specified by a particular policy. As described in the overall response to Charge Question 1 (above), the SAB supports the use of time horizons that are defined by a specific policy objective. If there are multiple objectives, there are no overriding scientific principles that can be applied *a priori* to guide alignment among multiple objectives. It may be useful to consider a time horizon that represents the most conservative policy with respect to minimizing net greenhouse gas emissions, but such a guiding framework is the purview of policy, not science.

One could advocate for a host of approaches to selecting a time horizon for evaluation; all would be plausible but not inherently aligned with the objective of the policy being promulgated. At the extremes one could consider only the carbon accounting over the year in which the biomass was combusted; such an approach would mean that almost all feedstocks would be assigned a BAF close to one, representing no net benefit to reducing atmospheric carbon dioxide concentrations. Conversely one could only consider net impacts on the carbon cycle over several hundred years, which would mean for most feedstocks the BAF would be close to zero, indicating all biogenic emissions being net beneficial to the atmosphere. Neither of these approaches would align with the most likely policy uses of a biogenic accounting framework; however, neither is inherently correct or incorrect.

The time horizon, T, for consideration of carbon stock changes should be chosen based on the policy objective (e.g., minimizing net greenhouse gas emissions or temperature increase by a certain date). The SAB makes no assertion regarding the appropriate policy use of the BAF and thus supports no specific time horizon selected independent of a policy goal.

BAFs are a carbon accounting tool used to measure expected future changes in carbon stocks due to increases in demand for bioenergy over some period of time. Therefore, BAFs should be science based and developed in service of a policy objective, ensuring that they help align actions and outcomes. If the BAF is calculated over a timeframe different from that of the policy objective, a mismatch between the carbon cycle impacts and those desired is likely. In the service of simplicity, a single time horizon may be selected to serve multiple objectives, in which case the tradeoffs need to be explored to ensure the most parsimonious temporal framework is selected and thus dis-benefits to the environment and public health are minimized.

The demand for biomass for bioenergy can affect carbon stocks by increasing harvesting intensity for standing biomass, diverting biomass from other non-energy products and landfills, converting land from other uses to plant feedstocks for biomass in the future, and utilizing residues that might otherwise decay or be incorporated into soils. To capture these time varying impacts of a feedstock on carbon stocks, we recommend an approach for computing a cumulative BAF that accounts for the positive and negative impacts on emissions over time to determine the net biogenic effect. To ensure comparability of BAFs across all feedstocks and regions, we recommend an approach that computes a cumulative BAF using the same policy-informed time horizon, T, for all feedstocks and regions.

Charge Question 1(c). Should calculation of the biogenic assessment factor include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?

Accumulating all effects of the use of a biogenic feedstock over a time horizon is preferred to a marginal or instantaneous ("per period") BAF. (For the purposes of answering this question, the SAB interprets "marginal" to mean "annual" or "per period" so as to distinguish it from the meaning of "marginal" that typically refers to the last unit of emissions or the additional effect of the last unit of biomass.)

As described in the overall response to Charge Question 1 (above), the SAB recommends a cumulative carbon accounting metric; however, there are alternative ways to calculate cumulative BAFs. EPA's cumulative BAF (BAF_T) is one option that reflects the carbon stocks at the end of the time horizon—specifically, changes in carbon stocks by time, T. One can also calculate a cumulative BAF that is based on the accumulation of annual differences in carbon *stocks* on the land *over the time horizon* to T, here called $BAF_{\sum T}$.

The choice of an appropriate cumulative BAF should be informed by a scientific assessment of the dynamics of additions to atmospheric carbon stocks as well as the complexities and uncertainties of these determinations, ensuring the accounting is accurate and verifiable. Both cumulative BAFs attempt to capture net changes in biogenic carbon stocks. A key feature of using carbon stocks is that all terms can be readily aggregated or disaggregated and are still subject to mass balance.

With either approach to evaluating BAFs, caution is advised with projections into the future. A BAF is inherently based on some type of modeling that employs assumptions about the relationship of variables in the future based on current observations. These assumptions may not be robust in the future, thus the simpler the model the more confidence that can often be placed in it (Bucholz et al. 2014). Each BAF will need to be assessed periodically to see if changing conditions warrant a revision.

Carbon accounting for biogenic emissions can either be framed using differences in carbon emissions to the atmosphere or using differences in carbon stocks on the land. Conservation of mass dictates that any carbon taken from the land (through increased harvests or other disturbances) will result, in the near-term, in equivalent increases of carbon in the atmosphere, followed by longer-run changes in water and land-based carbon. Thus, these approaches are compatible, but examining changes in stocks is operationally more direct and can be done periodically, rather than requiring continuous measurements

to be accurate. However, both approaches should account for changes within the boundaries of the analysis, such as import and export of biogenic feedstocks and other associated products.

Long-Term Trends in Biogenic Assessment Factors

Some have suggested that cumulative BAFs might approach zero as T is reached. However, that is only true for $BAF_{\Delta t}$ and not the cumulative BAFs. Mathematically cumulative BAFs are hyperbolic functions once T is reached and have extremely long "tails", representing a period of net CO_2 emissions to the atmosphere.

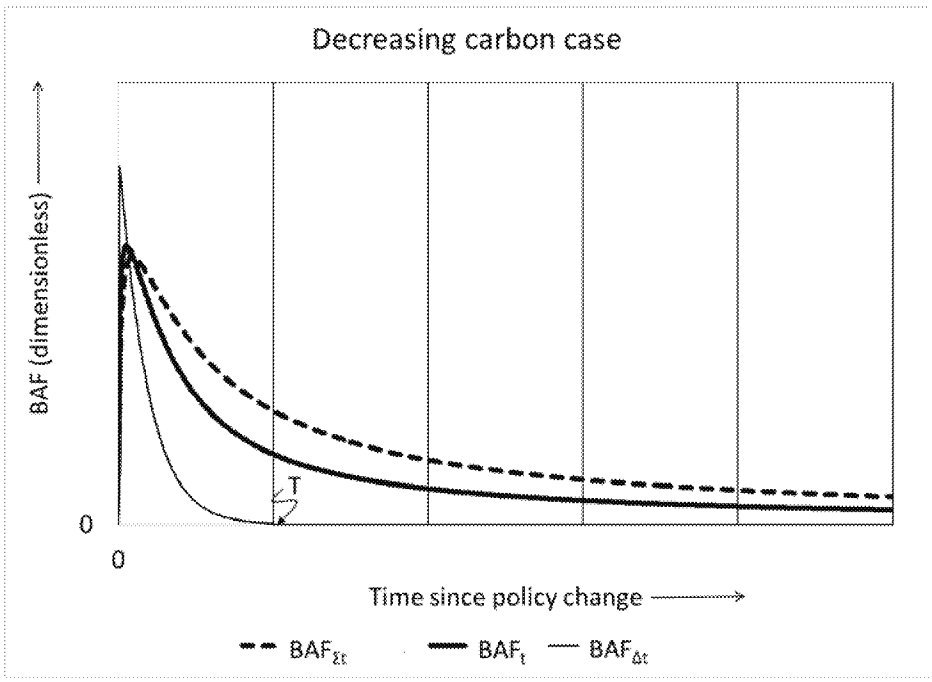

Figure1: Illustration of Long-Term Trend in BAF for a case of decreasing carbon stocks

Figure 1 illustrates the long-term trends in BAFs for the case of decreasing carbon. This is the case in which harvest in a forest landscape is increased to provide biogenic feedstock through more frequent harvesting, or more intensive harvesting over time, or a diversion of harvested wood to bioenergy. As a result of increased use of bioenergy, removals of carbon from the land are higher than that for the reference scenario. The time at which annual changes approach zero is indicated by T. Once T is reached, the $BAF_{\Delta t}$ approaches a value of zero, but BAF_t and $BAF_{\Sigma t}$ are ≈25-35% of their peak value, respectively. Doubling the value of time used for evaluation (i.e., 2 x T) would lead to a BAF being selected that is half that at time T. Thus, the systems that lose carbon will have a positive cumulative BAF for a considerable period of time.

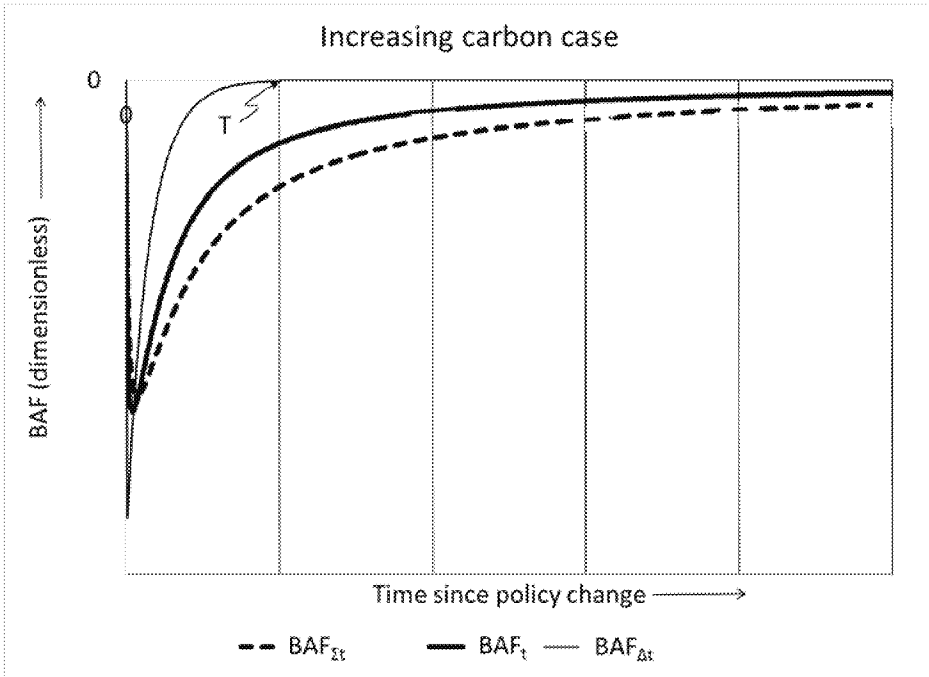

Figure 2: Illustration of Long-Term Trend in BAF for a case of increasing carbon stocks

The same is true for a system that increases carbon stocks as illustrated in Figure 2. Increased input of carbon might occur through the use of a feedstock that grows faster, practices that improve productivity such as irrigation, fertilization, and/or planting on lands that previously had shorter-lived plants. At time T, the $BAF_{\Delta t}$ approaches zero, however, the cumulative BAFs are 25-40% of the maximum value. As with the decreasing case, doubling the time for evaluation (i.e., 2 x T) reduces the cumulative BAFs to roughly half that value because of the hyperbolic nature of the Biogenic Accounting Factor calculation once T is reached.

A shifting projection of the reference baseline that includes a historical time period could be used to reset the baseline periodically based on re-measuring carbon stocks on the landscape, using data from existing inventory programs. This would improve the accuracy of the baseline over time. Future changes in growth-to-harvest ratios could be used to inform the model assumptions and modify the BAF that would be applicable going forward. This would create long-term incentives for sustainable management of land resources. In any accounting framework that assumes future regeneration and regrowth, it is important to periodically test this assumption against actual data as they become available. If assumptions of future regeneration and regrowth are not supported by observations, adjustments need to be made to models that are used to determine BAFs.

Recommendations

- The SAB recommends formulating BAFs based on changes in carbon stocks (terrestrial pools such as live, dead, soil, products, material lost in transport and waste), rather than an emissions-based (flux-based) approach, because the former comports with conventional carbon accounting, has well-defined boundaries, and follows the conservation of mass. Carbon stock measurements have been made for more than a half century in the US offering a robust record of change.

- The SAB suggests consideration of two cumulative BAFs—that proposed by EPA and an alternative metric that takes into account the changes in terrestrial carbon stocks over time. The appropriate cumulative metric for calculating BAFs will depend on the understanding of the carbon system and climate response for which there is uncertainty.

Charge Question 1(d). What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions ex post), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is appropriate to periodically revise the modeling and the BAFs. The goal of such revisions would be to update underlying economic and biophysical assumptions and modeling trends in light of new data to reduce uncertainty and to increase accuracy of the anticipated baseline approach.

A retrospective comparison would compare model-projected behavior to newly available historical observations and estimates, such as regional feedstock demand, land-use changes (e.g., reforestation, management intensity, forest rotations characteristics and conversion of land to other land uses including dedicated energy crops), and forest carbon measurements and estimates (both level and composition). It would be important to re-examine parameters, functional forms, and other assumptions of the modeling approach as part of an *ex post* evaluation.

3.6. Scales of Biomass Use

Charge Question 2: What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?

Charge Question 2(a). Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
Charge Question 2(b). What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?

The responses to questions 2(a) and 2(b) are combined below because both questions relate to the size of the simulated change in demand for biomass feedstocks.

If the EPA's goal is to obtain a region-specific BAF for a feedstock, it will be necessary to project region-specific and feedstock-specific demand for biomass. Since the BAF for a feedstock could differ depending on the method of production (for example, the soil carbon implications of corn stover will depend on the type of tillage practice used and the amount of residue harvested), it will be appropriate to have the BAF for a feedstock in a region reflect the methods used to produce that feedstock. To the extent that BAFs depend on technology and emissions control regulations at a stationary facility in a region, they could also be defined in terms of specific technologies.

Charge Question 2(c). Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?

In the absence of a specific policy to model, the SAB cannot offer general recommendations for a representative scale of demand shock.

Charge Question 2(d). Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?

Charge Question 2(e). For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).

The responses to questions 2(d) and 2(e) are combined because both questions relate to modeling feedstocks in isolation or jointly.

In the absence of a mandate for use of specific feedstocks or incentives for specific types of bioenergy which might be prescribed in a policy framework, and which would inform the feedstock-specific demand that should be modeled, a reasonable approach is to model the aggregate demand for feedstocks. This approach assumes facilities are constantly seeking their least-cost alternative. An aggregate demand could be imposed on the model and used to determine demand for different feedstocks in different regions. This would allocate demand across feedstocks as well as within each category to simulate a given target aggregate demand determined by the market's ability to draw from the least cost combination of feedstocks.

Charge Question 2(f). How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?

Default BAFs would likely vary by the scale of demand. In fact, a single set of default BAFs is unlikely to be robust across a wide range of scales of demand. The scale of demand is likely to influence the mix of feedstocks that is viable to produce because it can be expected to affect the market price of biomass. Low levels of demand for biomass may be met relatively easily by crop residues, forest residues and mill residues; high levels of demand could lead to dramatically increased harvests of forest biomass or production of dedicated energy crops. The BAF of a feedstock in a region can be expected to vary depending on whether there is a 1-million-ton increase in biomass demand or a 1-billion-ton increase in biomass demand.

In the absence of information about the scale of demand, BAFs could be determined for different threshold levels of aggregate demand for biomass and consequent feedstock/region-specific demand.

Charge Question 2(g). Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?

While the methodological framework for different policies could be similar, we expect differences as follows: (1) BAFs that are tied to a particular policy, versus a particular period of time, would be based on simulating the aggregate and feedstock-specific demand that is expected to emanate from that policy, while policy neutral factors would be based on various exogenously specified quantities of demand for biomass and corresponding endogenously determined levels of feedstock specific demand, and (2) different policies may require different production and use practices, and thus result in different biogenic factors. Isolating the extent to which expected increase in demand for biomass and its consequences for CO_2 emissions can be attributed to a specific policy (when there are multiple policies inducing a shift to renewable energy) is likely to be complicated and challenging to convert into policy-specific BAFs. It could also create perverse incentives for feedstock choice to comply with various policies.

Charge Question 2(h). What considerations could be useful when evaluating the performance of the demand shock choice ex post, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

It is likely that the observed feedstock demand in response to a specific policy will differ from the forecast because the policy can be expected to increase demand for feedstocks with lower BAF and decrease demand for feedstocks with a high BAF. Since feedstock-specific demand and the feedstock BAFs are likely to be jointly determined, while the approach proposed above determines them sequentially, divergence between model simulated demand for feedstocks and observations is inevitable.

An evaluation using actual data would also allow revisions to the EPA's estimates of feedstock demand changes (as discussed in response to Question 1d) based on updated data. To improve the performance of the model for assessing BAFs retrospectively, quantities of biomass feedstock (by feedstock category) harvested could be updated with actual outcomes. New data should improve the estimate of the portion of total biomass demand that is attributable to stationary facilities. This information could be used to improve BAFs.

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APPENDIX A: CHARGE TO THE SAB

February 25, 2015

MEMORANDUM

To: **Holly Stallworth, Designated Federal Official**
Science Advisory Board Staff Office

From: Paul Gunning, Director
Climate Change Division

Subject: **Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources and Charge Questions for SAB peer review**

The purpose of this memorandum is to transmit the revised *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources,* related documentation and charge questions for consideration by the Science Advisory Board (SAB) during your upcoming peer review.

In January 2011, the U.S. Environmental Protection Agency (EPA) announced a series of steps it would take to address biogenic CO_2 emissions from stationary sources. EPA committed to conduct a detailed examination of the science and technical issues related to assessing biogenic CO_2 emissions from stationary sources and to develop a framework for evaluating those emissions. The draft study was released in September 2011 and subsequently peer reviewed by the SAB Ad-Hoc Panel on Biogenic Carbon Emissions (SAB Panel). The final peer review report was published September 2012.

To continue advancing the agency's technical understanding of the role that biomass use can play in reducing overall greenhouse gas emissions, the EPA released a second draft of the technical report, *Framework for Assessing Biogenic Carbon Dioxide for Stationary Sources*, in November 2014. This revised report presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions. The revised report takes into account the SAB Panel's peer review recommendations on the draft 2011 Framework as well as the latest information and input from the scientific community and other stakeholders.

The revised framework addressed many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis, including an alternative fate approach for waste-derived feedstocks and certain industrial processing products and byproducts; an evaluation of tradeoffs from using different temporal scales; an improved representation of the framework equation; and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales.

We ask the SAB to review and offer recommendations on specific technical elements of the revised framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions, as identified in the charge accompanying this memo. We look forward to the SAB's review.

Please contact me if you have any questions about the attached study and charge.

Attachments:

1) *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*
2) Technical Appendices
3) Response to the 2011 SAB Panel Peer Review Advisory

Peer Review Charge on the Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

To improve the quality, utility, and scientific integrity of the Framework, EPA is providing this study, *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (November 2014) and related materials to the Science Advisory Board (SAB). The revised report takes into account the SAB Biogenic Carbon Emissions Panel's ("SAB Panel") peer review recommendations[2] on the draft 2011 Framework[3] as well as the latest information and input from the scientific community and other stakeholders. The "Response to SAB" document included in the materials provided for this review discusses and responds to the SAB Panel key points and recommendations, serving as a guide to how the revised framework incorporates their recommendations. This charge narrowly focuses on a few specific remaining questions that were not explicitly addressed in the initial SAB Panel peer review report.

The revised 2014 framework report identifies key scientific and technical factors associated with assessing biogenic CO_2 emissions from stationary sources using biogenic feedstocks, taking into account information about the carbon cycle. It also presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions.

The revised framework and the technical appendices address many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis (Appendices J-L); an alternative fate approach for waste-derived feedstocks (Appendix N); and certain industrial processing products and byproducts (Appendix D Addendum); an evaluation of tradeoffs from using different temporal scales (Appendix B); an improved representation of the framework equation (Appendix F); and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales (Appendices H-N).

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[2] The final peer review report from the SAB Panel on the draft 2011 framework was published on September 28, 2012 (Swackhamer and Khanna, 2011). Information about the SAB peer review process for the September 2011 draft framework is available at http://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886.

[3] The 2011 *Draft Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources* is available at www.epa.gov/climatechange/ghgemissions/biogenic-emissions.html.

As explained in the revised framework introduction and accompanying SAB response document, the revised framework maintains the policy neutral approach from the 2011 draft Framework. It is a technical document that does not set regulatory policy nor does it provide a detailed discussion of specific policy and implementation options. Ultimately, the framework provides a methodological approach for considering, and a technical tool (the framework equation) for assessing, the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources. The revised framework details technical elements that should be considered as appropriate per specific policy applications or biogenic carbon-based feedstock assessments. Therefore, this charge excludes policy and regulatory recommendations or legal interpretation of the Clean Air Act's provisions related to stationary sources.

The revised report does not provide any final values or determinations: it offers indications of different biogenic feedstock production effects per research and analyses conducted, including illustrative example results per specific case study parameters. As discussed by the previous SAB Panel, this report also finds that biophysical and market differences between feedstocks may necessitate different technical approaches. Even using a future anticipated baseline approach, forest- and agriculture-derived feedstock characteristics, and thus analyses and results, may vary per region and per feedstock, and may be influenced by land use change effects. Illustrative analyses conducted for specific waste-derived feedstock case studies using a counterfactual anticipated baseline, as recommended by the SAB Panel, yielded minimal or negative net emissions effects.

This charge focuses on questions that remain regarding whether there are more definitive technical determinations appropriate for parameterizing key elements of the revised framework, regardless of application to a specific policy or program. Specifically, we ask that the SAB Panel examine and offer recommendations on future anticipated baseline specification issues in the context of assessing the extent to which the production, processing, and use of forest- and agriculture-derived biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions – such as appropriate temporal scales and the scale of biogenic feedstock usage (model perturbations or 'shocks') for analyzing future potential bioenergy production changes.

Technical approaches, merits and challenges with applying a future anticipated baseline

Establishing a baseline creates a point of comparison necessary for evaluating changes to a system.[4] Baseline specification can vary in terms of what entity or groups of entities are being analyzed (e.g., industries, economic sectors), temporal and spatial scales, geographic resolution, and, depending on context, environmental issues/attributes (EPA, 2010).[5] The choice of baseline approach can also depend on the question being asked and the goal of the analysis at hand. For example, some GHG analysis may require a baseline against which historic changes of landscape carbon stocks can be measured. Other applications may necessitate a baseline against which the estimated GHG emissions and sequestration associated with potential future changes in related commodity markets and policy arenas. Analyses of

[4] Definitions for baseline vary, including "the reference for measurable quantities from which an alternative outcome can be measured" (IPCC AR4 WGIII, 2007) or "the baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines" (IPCC AR4 WGII, 2007).

[5] Guidelines for Preparing Economics Analyses (NCEE), Chapter 5: http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-05.pdf/$file/EE-0568-05.pdf

the estimated GHG emissions and sequestration effects from changes in biomass use have used different baseline approaches, as well as a wide range of different temporal scales and alternative scenario parameters (Sohngen and Sedjo, 2000; Fargione, 2008; UNFCCC, 2009; Walker et al., 2010; Cherubini et al, 2011; Galik and Abt, 2012; Latta et al., 2013; Walker et al., 2013; AEO, 2014; U.S. EPA, 2014; Miner et al., 2014).

The draft 2011 framework had discussed three different potential baseline approaches – reference point, future anticipated and comparative – and used the reference point baseline in its hypothetical case study applications of the Framework. The SAB Panel in its review stated that "the choice of a fixed reference point may be the simplest to execute, but it does not actually address the question of the extent to which forest stocks would have been growing/declining over time in the absence of a particular bioenergy facility" (SAB Advisory, p. 29). The SAB Panel expressed concern that the reference point baseline does not address the important question of additionality, or what would have been the trajectory of biogenic CO_2 stocks and fluxes in the absence of an activity or activities using biogenic feedstocks for energy, especially in the context of forest-derived feedstocks.[6] "Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach" (SAB Letter, p. 2).

Through public comments to the SAB Panel during the 2011-2012 SAB peer review process, various stakeholders expressed divergent perspectives on the appropriate baseline for the draft 2011 framework report.[7] The revised 2014 framework retains the reference point baseline and adds the anticipated baseline in order to retain adaptability for potential applications, and discusses both approaches at length in the revised report and several technical appendices. However, as the SAB Panel was clear in its previous review of the reference point baseline, EPA has no outstanding technical questions for the SAB Panel on that baseline approach. This charge focuses specifically on remaining technical questions that EPA has on the future anticipated baseline approach.

Part 1 – Future anticipated baseline approach and temporal scale

It is important to consider possible treatments of time and the implications of these treatments in developing strategies for long-term and short-term emissions assessment, because the choice of treatment may have significant impacts on the outcome of an assessment framework application. For the intended use of the revised Framework – assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2

[6] The difference in net atmospheric CO_2 emissions contributions with and without changes in biogenic feedstock use is known as additionality (Murray et al., 2007). Additionality can be determined by assessing the difference in potential net atmospheric CO_2 emissions of a specific level of biogenic feedstock use over a certain period of time (in many cases the business-as-usual [BAU] baseline) versus the net atmospheric CO_2 emissions contributions that would have occurred over the same time period with a different level of biogenic feedstock use (counterfactual scenario), holding other factors and assumptions consistent between scenarios.

[7] The American Forest and Paper Association (AF&PA) supported the reference point baseline (e.g., comments submitted October 2011, March 2012) applied historically (January 2012, March 2012). The National Alliance of Forest Owners (NAFO) stated if certain feedstocks weren't categorically excluded, then the historical reference point baseline should be used (e.g., March 2012, August 2012). The U.S. Department of Agriculture stated preference for a historic baseline approach (May 2012). The Environmental Defense Fund (EDF) (January 2012, May 2012) and NCASI (October 2011, March 2012) both supported the retrospective reference point approach, though also both offered recommendations if an anticipated baseline approach was included (EDF for future anticipated and NCASI for counterfactual). Others, such as Green Power Institute (March 2012), the National Resource Defense Council (NRDC, August 2012), Becker et al. (August 2012), Biomass Energy Resource Center et al. (February 2012), and a group scientists letter to EPA (June 2014) all support some form of the anticipated baseline approach (future anticipated and/or counterfactual).

emissions – there are different elements of time to consider when using a future anticipated baseline approach. These elements can include:

- Emissions horizons, assessment or policy horizons, and reporting periods (i.e., fluxes related to feedstock production may occur over many years to decades, whereas reporting may be the current year and policies may cover only a few years or decades), and
- Differences in temporal characteristics of different feedstocks (i.e., annual crops, short rotation energy crops, and longer rotation forestry systems).
- Changes in biophysical and economic conditions over time may affect or differ from those in future anticipated baseline and scenario estimates.

The SAB Panel in its previous peer review noted that "this is a complicated subject because there are many different time scales that are important for the issues associated with biogenic carbon emissions" (Advisory, page 13). They discussed multiple temporal scales associated with mixing of carbon throughout the different reservoirs on the Earth's surface at the global scale (Advisory, page 13) and climate responses to CO_2 and other greenhouse gases (Advisory, page 15), implications of temporal scales greater and shorter than 100 years, and those related to the growth cycles of different feedstock types (Advisory, page 15). The SAB Panel specifically highlighted considerations for using a 100-year or longer temporal scale for evaluating climate impacts and radiative forcing[8] as well as decay rates and carbon storage in forest ecosystems in the main text as well as in Appendices B-D. However, in its recommendations, including those for developing default BAFs per region, the SAB Panel did not offer recommendations per what temporal scale to use in the specific context of the Framework for its intended use and scope. Instead, the SAB Panel stated that "there is no scientifically correct answer when choosing a time horizon, although the *Framework* should be clear about what time horizon it uses, and what that choice means in terms of valuing long term versus shorter term climate impacts (Advisory, page 15) and recommended that a revised framework "incorporate various time scales and consider the tradeoffs in choosing between different time scales" (Advisory, page 43).

Multiple stakeholders have also weighed in on temporal scales, some with specific recommendations on what temporal scale should/could be used for framework assessments, others with no specific recommendations but emphasizing the importance of time. In various comments submitted during the 2011-2012 SAB process, NAFO supported a 100-year timeframe (March 2012). The National Council for Air and Stream Improvement (NCASI) in October 2011 comments suggested "the need for considerable flexibility in setting the temporal scales for determining the stability of forest carbon stocks. There are a range of circumstances that can cause transient trends in carbon stocks that can obscure the more relevant long-term picture."

Other groups, such as The Wilderness Society (TWS), NRDC, EDF and others, submitted comments supporting consideration of shorter temporal scales. In its comments and example calculations, TWS (in

[8] EPA acknowledges that the long-term climate impacts of shifting from fossil fuel to biogenic energy sources is an important topic for climate change mitigation policy and also recognizes the extensive work being conducted by EPA and throughout the research community on this question. However, EPA's focus here is on a narrower, more targeted goal of developing tools to assess the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic feedstocks at stationary sources. This more narrowly defined assessment is anticipated to be a better fit for the types of program and policy applications in which this framework may potentially be applied.

October 2011 comments) implied support for shorter temporal scales, and stated in later comments that the SAB "text appears biased toward ignoring effects that occur within a 100-year period" (May 2012). NRDC (August 2014) implied support for shorter temporal scales: "even if near-term carbon emissions increases are eventually 'made up' by regrowth over the very long term, the carbon emission from these types of biomass actually exceed those from fossil fuels for decades. This puts use of these types of biomass fuels in conflict with the urgent need for near-term carbon emissions reductions. The time profile of the carbon emission from biogenic fuel sources matters because it is critical to limit near-term global GHG emissions." This perspective was similar to that shared by Becker et al. in their August 2012 comments. EDF (January 2012) suggested a very short temporal scale (in the context of supporting a retrospective reference baseline). Others, such as the Biotechnology Industry Organization (October 2011) simply asked for "clarification on the methodology used to identify the time scale of carbon cycles."

Per the various recommendations above, the revised framework report and the technical appendices include a more detailed discussion of intertemporal tradeoffs inherent in various options for treating emissions over time in the context of assessing biogenic CO_2 emissions from stationary sources. Specifically, the revised report has: a section on key temporal scale considerations (pages 33-38); an appendix dedicated to temporal scale issues (Appendix B), which includes further discussion of temporal scales in the context of future anticipated baselines and decay rates for feedstocks that would have otherwise decayed if not used for energy, and; an appendix describing the background of and modeling considerations for constructing an anticipated baseline approach (Appendix J). Also, illustrative calculations using the future anticipated baseline estimates use future simulations and thereby explicitly incorporate temporal patterns of different feedstocks (e.g., feedstock growth rates, decay rates) into the analysis and shows how results can vary per temporal scale used (as seen in Appendices K and L). The revised framework does not recommend specific temporal scales for framework applications, but rather identifies different elements of and considerations concerning time to provide insights into the potential implications of using different temporal scales.

EPA seeks guidance on the following issues regarding appropriate temporal scales for assessing biogenic CO_2 emissions using a future anticipated baseline, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the previous SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of temporal scale both within and outside of a specific policy context.

Part 1 – Future anticipated baseline approach and temporal scale

1. What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?

    a. Should the temporal scale for computing BAFs vary by policy (e.g., near-term policies with a 10-15 year policy horizon vs. mid-term policies or goals with a 30-50 year policy horizon vs. long-term climate goals with a 100+ year time horizon), feedstocks (e.g.,

long rotation vs. annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.

i. If temporal scales for computing BAFs vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?

ii. Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?

iii. Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default BAFs versus crafting policy specific BAFs?

b. Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?

c. Should calculation of the BAF include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)?

d. What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions *ex post*), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

Part 2 – Scales of biomass use when applying future anticipated baseline approach

EPA seeks guidance on technical considerations concerning how to select model perturbations ('shocks') for future anticipated baseline simulations estimating the net atmospheric contribution of biogenic CO2 emissions from the production, processing, and use of biogenic material at stationary sources, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of model shocks both within and outside of a specific policy context.

2. What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO2 emissions using a future

anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?

a. Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
b. What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?
c. Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?
d. Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?
e. For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).
f. How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?
g. Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?
h. What considerations could be useful when evaluating the performance of the demand shock choice *ex post*, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward

Science Advisory Board (SAB) 8-29-18 Draft Report for Quality Review - Do Not Cite or Quote.
This draft has not been reviewed or approved by the chartered SAB, and does not represent EPA policy.

APPENDIX B: MEMBERS OF THE BIOGENIC CARBON EMISSIONS PANEL

CHAIR

Dr. Madhu Khanna, ACES Distinguished Professor in Environmental Economics, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Urbana, IL

PANEL MEMBERS

Dr. Robert Abt, Professor of Forestry, Department of Forestry and Environmental Resources, College of Natural Resources, North Carolina State University, Raleigh, NC

Dr. Morton Barlaz, Professor, Civil, Construction, and Environmental Engineering, Engineering, North Carolina State University, Raleigh, NC

Dr. Marilyn Buford, National Program Leader, Silviculture Research, Research & Development, USDA Forest Service, Washington, DC

Dr. Mark Harmon, Professor and Richardson Chair, College of Forestry, Oregon State University, Corvallis, OR

Dr. Jason Hill, Associate Professor, Bioproducts and Biosystems Engineering, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota, St. Paul, MN

Dr. John Reilly, Senior Lecturer and Co-Director, Joint Program on the Science and Policy of Global Change, Center for Environmental Policy Research, E19-439L, Massachusetts Institute of Technology, Cambridge, MA

Dr. Charles Rice, Distinguished Professor, Department of Agronomy, Soil Microbiology, Kansas State University, Manhattan, KS

Dr. Steven Rose, Senior Research Economist, Energy and Environmental Analysis Research Group, Electric Power Research Institute, Palo Alto, CA

Dr. Daniel Schrag, Professor of Earth and Planetary Sciences, Harvard University, Cambridge, MA

Dr. Roger Sedjo, Senior Fellow and Director of the Center for Forest Economics and Policy Program, Resources for the Future, Washington, DC

Dr. Ken Skog, Supervisory Research Forester (retired), Economics and Statistics Research, Forest Products Laboratory, USDA Forest Service, Madison, WI

Dr. Tristram West, Ecosystem Scientist, Joint Global Change Research Institute, University of Maryland, College Park, MD

Dr. Peter Woodbury, Senior Research Associate, Department of Crop and Soil Sciences, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY, U.S.A.

1
2 **SCIENCE ADVISORY BOARD STAFF**
3
4 **Dr. Holly Stallworth,** Designated Federal Officer, U.S. Environmental Protection Agency, Washington,
5 DC

Message

From: Johnston, Khanna [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=4EE74EEB7AD744E58F6DBF7D2F20243B-JOHNSTON, KHANNA]
Sent: 10/19/2018 11:58:02 AM
To: Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]
Subject: Re: Greenwire - U.S. Chamber's pick got chairmanship of EPA advisory panel

Beginning to love his style.

Khanna Johnston I Deputy Director I Science Advisory Board I 1200 Pennsylvania Ave. N.W. I Washington DC 20460 I 202.564.2820

On Oct 18, 2018, at 1:34 PM, Yeow, Aaron <Yeow.Aaron@epa.gov> wrote:

AIR POLLUTION

U.S. Chamber's pick got chairmanship of EPA advisory panel

Sean Reilly, E&E News reporter

Published: Thursday, October 18, 2018

The U.S. Chamber of Commerce, which regularly opposes tougher environmental regulations, last year succeeded in placing one of its candidates on a key EPA air quality committee, newly released records show.

Then-EPA chief Scott Pruitt named Tony Cox, a Denver-based consultant, as chairman of the Clean Air Scientific Advisory Committee last fall after a senior U.S. Chamber executive nominated him for a seat on the panel, the records show.

The seven-member committee, often known by its acronym as CASAC, is charged with providing outside expertise to EPA during legally required reviews of the standards for a half-dozen common pollutants. It's now in the early stages of a closely watched assessment of the limits on airborne particulates.

In an email exchange, Cox said he did not know that the chamber was behind his nomination until E&E News contacted him late yesterday. Cox said he had no information on why the powerful business lobby chose him.

"I hope that it was because of my long-standing commitment to applying objective, transparent, data-driven science and analytics to address important risk analysis questions, along with my insistence on following wherever the data lead," he said.

Putting Cox's name in play was Dan Byers, vice president for policy with the chamber's Global Energy Institute. Byers referred questions yesterday to a spokesman, Matt Letourneau. In a

statement, Letourneau said the chamber nominated "preeminent scientists who are experts in their fields with outstanding credentials for EPA's consideration. We had no discussion with these individuals about their views on any particular policy or science issue."

During the Obama administration, the chamber frequently challenged new environmental regulations. In 2013, for example, it went to court in an unsuccessful battle against EPA's decision to tighten particulate standards. It's also a plaintiff in a pending challenge to the agency's 2015 ground-level ozone changes and in a report has denounced limits imposed that same year on hazardous emissions from the brick industry (*E&E Daily*, Feb. 2, 2016).

Cox was among four candidates whom Byers recommended for CASAC, according to the EPA roster released yesterday. Pruitt instead appointed two of the others — air pollution researcher Robert Phalen and S. Stanley Young, an applied statistician from North Carolina — to the Science Advisory Board, another influential panel. Letourneau confirmed that the chamber had nominated the two men for those seats, as well, but said he did not know whether the group had pressed for Cox to be named CASAC chairman.

Phalen is a professor of community and environmental medicine at the University of California, Irvine. Following his appointment to SAB last November, he came under fire for remarks in an earlier interview in which he said, "Modern air is a little too clean for optimum health."

In a letter to Pruitt early this year, Sens. Tom Carper (D-Del.) and Sheldon Whitehouse (D-R.I.) questioned whether both Cox and Young were fit to serve on their respective EPA panels, based on their scientific credentials and their prior work for the oil business and other polluting industries (*Greenwire*, Jan. 9).

Neither Phalen nor Young could immediately be reached for comment this morning. Cox, whose specialty is risk analysis, noted that he has done work for EPA, the World Health Organization and universities, but said he did not recall working for the U.S. Chamber in the course of a 40-year career.

"I have made no commitments to anyone about CASAC," he said, "other than to the administrator and EPA to do my best to assure that we give objective, dispassionate, high-quality scientific advice without regard for politics, policy, or other considerations that go beyond science."

EPA had formally requested nominations for the Clean Air Scientific Advisory Committee in June of last year. The agency released the resulting list of about 130 candidates, as well as those who nominated them, yesterday, almost a year after E&E News requested the roster under the Freedom of Information Act.

The list shows that most of the candidates were university researchers nominated either by other researchers or EPA staff. The only other advocacy groups to make recommendations were the Energy and Environment Legal Institute, an industry-allied organization critical of tighter air pollution regulations, and the American Thoracic Society, which focuses on lung health issues. None of their respective nominees were chosen.

Besides Cox, Pruitt instead selected James Boylan, manager of planning and support for the Georgia Environmental Protection Division's air branch, and Larry Wolk, who was then the executive director of the Colorado Department of Public Health and Environment. Boylan nominated himself, the roster shows, while Wolk was the choice of Richard Yamada, a high-ranking political appointee at the time in EPA's Office of Research and Development.

In all, Yamada offered about 10 nominations. They ranged from Mark Frampton, a retired professor of medicine at the University of Rochester who was named to CASAC last week, to Michael Rohan, an orthopedist in Panama City, Fla.

Carper and Whitehouse had also previously questioned Yamada's role in the selection process. EPA documents showed that he overrode the advice of EPA career staff in pushing for the appointments to Cox and Wolk to the committee, the two lawmakers wrote in a February letter asking the Government Accountability Office to look into whether such involvement was typical (*E&E Daily*, Feb. 15).

Yamada recently left EPA to take a job at the Defense Department. Efforts to reach him were unsuccessful.

Message

From: Thomas Carpenter [Carpenter.Thomas@epamail.epa.gov]
Sent: 10/16/2018 10:25:45 PM
To: Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]
CC: Bright, Wanda [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b783537affbc46119372799bdbac87e4-Bright, Wanda]; Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]; Cunningham, Laticia [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=fdd1c2c631114f0e81a0325b0a9026b4-LCunning]; Starks, Angela [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=86dcf1927b9d4c499ec4b750926b0c53-AStarks]
Subject: Request Submitted for Panel Formation
Attachments: LOCpostSABFY2019.pdf; LOC memo att123 cSAB FY2019.pdf

A Panel Formation Request has been submitted for your review

Click here to open the Panel Formation Request

Panel Formation Request

Date Submitted: 10/16/2018

Has the name of the planned panel or committee been entered in the People Database Vocabulary?	Y
Status of Biosketch	single
List and Biosketches of Candidates:	
(See attached file: LOCpostSABFY2019.pdf)	PDF, 83 pp., 608,065 bytes
Deadline for public comments	11/07/2018
List of Candidates memorandum	
Memorandum will not appear on the web.	
(See attached file: LOC memo att123 cSAB FY2019.pdf)	PDF, 137 pp., 3,556,317 bytes

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

October 16, 2018

SUBJECT: Documentation of the List of Candidates for the FY2018 Chartered Science Advisory Board

FROM: Thomas Carpenter
Designated Federal Officer
U.S. EPA Science Advisory Board Staff Office

THRU: Thomas Brennan
Senior Advisor
U.S. EPA Science Advisory Board Staff Office

TO: Khanna Johnston
Acting Director
U.S. EPA Science Advisory Board Staff Office

The U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Staff Office announced in a Federal Register Notice on July 9, 2018 (83 FR 31752-31753) that it was inviting nominations of experts to be considered for the Administrator's appointment to the Chartered SAB. The SAB is a scientific/technical advisory committee. The objective of the SAB is to provide independent advice and peer review on the scientific and technical aspects of environmental issues to the EPA Administrator. While the SAB reports to the EPA Administrator, congressional committees specified in ERDDAA may ask the EPA Administrator to have the SAB provide scientific advice on a particular issue.

The SAB will review scientific issues, provide independent scientific and technical advice on EPA's major programs, and perform special assignments as requested by Agency officials. The SAB Staff Office sought nominations of experts who have demonstrated experience in the following disciplines: analytical chemistry; benefit-cost analysis; causal inference; complex systems; ecological sciences and ecological assessment; economics; engineering; geochemistry; health sciences; hydrology; hydrogeology; medicine; microbiology; modeling; pediatrics; public health; risk assessment; social, behavioral and decision sciences; statistics; toxicology, and uncertainty analysis.

The SAB Staff Office is especially interested in scientists with the expertise described above who have knowledge and experience in: air quality; agricultural sciences; atmospheric sciences; benefit cost analysis; complex systems; drinking water; energy and the environment; epidemiological risk analyses; water quality; water quantity and reuse; ecosystem services; community environmental health; sustainability; chemical safety; green chemistry; homeland security; uncertainty analysis; and waste management.

Attachment 1 provides the names of candidates along with their relevant expertise. These candidates were identified through the public nomination process or by EPA Staff. Attachment 2 includes the names of candidates who are willing to serve on the SAB and have relevant expertise. The List of Candidates includes 171 individuals and reflects discussions among the Director, the Deputy Director, and the Designated Federal Officer. Attachment 3 is the invitation for public comment on the candidates and biographical sketches for the candidates. Attachment 3 is to be posted on the SAB Website for at least three weeks (21 days) to obtain public comment on the candidates for consideration to serve on the Chartered Science Advisory Board.

Concurred,

Khanna Johnston

Khanna Johnston
Acting Director
EPA Science Advisory Board Staff Office

October 16, 2018

Date

Attachment 1: Nominees for the FY 2019 Annual Membership for the Chartered SAB

Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Aguirre, A. Alonso	Fairfax	VA	George Mason University	Self	Ecological sciences and ecological assessment	Yes
Ahrens, Kurt	Philadelphia	PA	School District of Philadelphia	Self	Causal inference;Complex systems;Modeling;Water quality;Ecosystem services;Sustainability	Yes
Aldy, Joseph	Cambridge	MA	Harvard University	Dr. Robert Stavins, Harvard University	Economics	Yes
Allen, Irving	Blacksburg		Virginia Tech	Self	Benefit-cost analysis;Health sciences;Medicine;Microbiology	Yes
Anderson, Henry	Madison	WI	Wisconsin Division of Public Health	Self, SAB Staff Office	Medicine;Public health;Risk assessment;Toxicology	Yes
Arvai, Joseph	Ann Arbor	MI	University of Michigan	Dr. Terry Yosie, Currently unaffiliated	Benefit-cost analysis;Complex systems;Ecological sciences and ecological assessment;Economics;Modeling;Risk assessment;Social behavioral and decision sciences;Uncertainty analysis;Agricultural sciences;Energy and the environment;Water quality;Ecosystem services;Sustainability	Not Interested
Auvermann, Brent	Amarillo	TX	Texas A&M University	Dr. Richard Yamada	Engineering;Air quality;Agricultural sciences	Yes
Barth, Matthew	Riverside	CA	University of California Riverside	Dean Christopher Lynch, UC Riverside	Complex systems;Engineering;Air quality;Sustainability	Not Interested

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Barton, Hugh A.	Mystic	CT	Independent Consultant	SAB Staff Office	Health sciences;Modeling;Risk assessment;Toxicology	Yes
Bashkin, James	Saint Louis	MO	University of Missouri-St. Louis	Self	Green chemistry	Yes
Becker, Jennifer	Houghton	MI	Michigan Technological University	Dr. David Dzombak, Carnegie Mellon University	Engineering;Microbiology;Modeling;Risk assessment;Drinking water;Water quality	Yes
Beck, Barbara	Cambridge	MA	Gradient Corp.	Dr. Richard Yamada	Risk assessment;Toxicology	Yes
Begley, C. Glenn	Parkville, Victoria	AUS	BioCurate PTY, LTD	Dr. Richard Yamada	Health sciences;Medicine	Yes
Belzer, Richard	Mt. Vernon	VA	Independent consultant	Dr. Richard Yamada	Benefit-cost analysis;Economics;Risk assessment	Yes
Bennear, Lori	Durham	NC	Duke University	Dr. Randall Kramer, Professor of Environmental Economics, Duke University	Benefit-cost analysis;Economics	Yes
Benson, Craig H.	Charlottesville	VA	University of Virginia	Dr. Morton Barlaz, North Carolina State University	Engineering;Geochemistry;Hydrology;Statistics;Uncertainty analysis;Energy and the environment;Sustainability;Waste management	Not Interested
Bergendahl, John	Worcester	MA	Worcester Polytechnic Institute	Self	Engineering;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Sustainability;Waste management	Yes
Botkin, Daniel	San Francisco	CA	University of California, Santa Barbara	Dr. Richard Yamada	Ecological sciences and ecological assessment	Yes

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Brioni, Jorge	Mettawa	IL	AbbVie	Self	Health sciences;Medicine	Not Interested
Brown, Derick G.	Bethlehem	PA	Lehigh University	Self	Complex systems;Engineering;Geochemistry;Microbiology;Modeling;Risk assessment;Statistics;Drinking water;Energy and the environment;Water quality;Waste management	Yes
Bus, James	Midland	MI	Exponent, Inc.	Dr. Richard Yamada	Risk assessment;Toxicology	Yes
Calabrese, Edward	Amhesrt	MA	University of Massachusetts Amherst	Dr. Richard Yamada	Complex systems;Risk assessment	Not Interested
Caneba, Gerard	Houghton	MI	Michigan Tech University	Self	Complex systems;Engineering;Modeling;Atmospheric sciences;Energy and the environment;Water quantity and reuse;Sustainability;Chemical safety;Green chemistry;Waste management	Yes
Cantrell, Louis	LAUREL	MD	Profitable Weather, LLC	Self	Benefit-cost analysis;Complex systems;Modeling;Statistics;Atmospheric sciences	Yes
Champoux, James	Seattle	WA	University of Washington	Self	Analytical chemistry;Causal inference;Health sciences;Medicine;Microbiology;Public health;Community environmental health;Chemical safety	Not Interested

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Chandra, Dhyan	Buffalo	NY	Roswell Park Comprehensive Cancer Center	Self	Toxicology	Yes
Chen, Celia	Hanover	NH	Dartmouth College	Dr. William Suh, NIEHS	Ecological sciences and ecological assessment;Toxicology	Yes
Chitikela, S. Rao	Dublin	OH	RC-WEE Solutions LLC	Self	Benefit-cost analysis;Engineering;Hydrology;Microbiology;Air quality;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Sustainability;Waste management	Yes
Chorghade, Mukund	Hillsborough		THINQ Pharma	Self	Health sciences;Medicine;Public health;Toxicology	Yes
Chorover, Jon	Tucson	AZ	University of Arizona	Self	Analytical chemistry;Complex systems;Geochemistry;Hydrology;Agricultural sciences;Water quality;Chemical safety	Yes
Christy, John R.	Huntsville	AL	University of Alabama in Huntsville	Dr. Richard Yamada	Atmospheric sciences	Yes
Clasen, Thomas	Atlanta	GA	Emory University	Self	Public health	Yes
Clewell, Harvey	Research Triangle	NC	Ramboll Environment and Health	Dr. Richard Yamada, Dr. Michael Honeycutt	Modeling;Risk assessment;Toxicology	Yes
Clore, G. Marius	Bethesda	MD	National Institutes of Health	Dr Attila Szabo, National Institutes of Health	Complex systems;Health sciences;Medicine;Modeling	Not Interested

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Cobb, Kim	Atlanta	GA	Georgia Inst. of Technology	Dr. George Peterson, Georgia Inst of Technology	Geochemistry;Hydrology;Uncertainty analysis;Atmospheric sciences;Energy and the environment;Sustainability	Yes
Cohen, Steven	New York City	NY	Columbia University	Dr. Michael Purdy, Exec VPR: Columbia University, Joel Widder, Federal Science Partners, Dr. Richard Yamada,	Benefit-cost analysis;Ecological sciences and ecological assessment;Risk assessment;Social behavioral and decision sciences;Air quality;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Ecosystem services;Sustainability	Yes
Cooper, Cal	Houston	TX	Apache Corporation	self	Engineering;Energy and the environment	Yes
Cruz-Rivera, Edwin	St. Thomas	VI	University of the Virgin Islands	Self	Ecological sciences and ecological assessment;Microbiology;Water quality	Yes
Cushing, Robert	Sarasota	FL	Carollo Engineers, Inc	Self	Benefit-cost analysis;Engineering;Drinking water;Water quantity and reuse	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Davidson, Eric	Frostburg	MA	University of Maryland Center for Environmental Science	Self	Ecological sciences and ecological assessment;Geochemistry;Agricultural sciences;Atmospheric sciences;Energy and the environment;Water quality;Ecosystem services;Sustainability	Yes
Davis, Alexander	Pittsburgh	PA	Carnegie Mellon University	Self	Causal inference;Social behavioral and decision sciences;Statistics;Energy and the environment	Yes
Davis, Alexander	Pittsburgh	PA	Carnegie Mellon University	Dr. Kathryn Verhoeven, Indiana University	Analytical chemistry;Modeling;Atmospheric sciences	Yes
Dayaratna, Kevin	Washington DC	DC	The Heritage Foundation	Dr. Richard Yamada	Benefit-cost analysis;Modeling;Statistics;Uncertainty analysis	Yes
Dhanasekaran, Danny	Oklahoma City	OK	University of Oklahoma	Dr. Richard Yamada	Public health;Risk assessment;Toxicology	Yes
Dinov, Ivo	Ann Arbor	MI	University of Michigan	Self	Causal inference;Complex systems;Modeling;Public health;Risk assessment;Statistics	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
DuPree, Gabriel	Jacksonville	FL	University of Florida	Self	Benefit-cost analysis;Complex systems;Ecological sciences and ecological assessment;Hydrology;Uncertainty analysis;Air quality;Agricultural sciences;Atmospheric sciences;Energy and the environment;Water quality;Water quantity and reuse;Ecosystem services;Community environmental health;Sustainability;Chemical safety	Yes
Embertson, Nichole M.	Lynden	WA	Whatcom Conservation District	Self	Complex systems;Risk assessment;Air quality;Agricultural sciences;Water quality;Sustainability;Waste management	Yes
Enstrom, James E.	Los Angeles	CA	Scientific Integrity Institute	Dr. Richard Yamada	Complex systems;Health sciences	Yes
Felter, Susan P.	Mason	OH	Procter & Gamble	SAB Staff Office	Risk assessment;Toxicology	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Ferry, John	Columbia		University of South Carolina	Dr. Susan Richardson, University of South Carolina	Analytical chemistry;Complex systems;Ecological sciences and ecological assessment;Engineering;Geochemistry;Hydrology;Hydrogeology;Modeling;Public health;Statistics;Air quality;Agricultural sciences;Atmospheric sciences;Energy and the environment;Water quality;Water quantity and reuse;Ecosystem services;Sustainability;Chemical safety;Waste management	Yes
Fike, David	St. Louis	MO	Washington University	Dr. Jennifer Lodge, Vice Chancellor for Research, Washington University in St. Louis	Geochemistry	Yes
Fournier, Aime	Cambridge	MA	MIT	Self	Benefit-cost analysis;Causal inference;Complex systems;Risk assessment;Statistics;Uncertainty analysis;Atmospheric sciences;Energy and the environment	Yes
Francis, Larijai	Corpus Christi	TX	City of Corpus Christi	Self	Benefit-cost analysis;Engineering;Hydrology;Hydrogeology;Drinking water;Water quantity and reuse	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Frazer, Thomas	Gainesville	FL	University of Florida	Dr. David Norton, University of Florida	Ecological sciences and ecological assessment;Agricultural sciences;Water quality;Water quantity and reuse;Ecosystem services	Yes
Fry, Juliane	Portland	OR	Reed College	Self	Analytical chemistry;Ecological sciences and ecological assessment;Modeling;Public health;Statistics;Uncertainty analysis;Air quality;Atmospheric sciences;Energy and the environment;Community environmental health	Yes
Furtado, Manohar	Pleasanton	CA	Apton Biosystems Inc.	Dr. Manohar Furtado, Manohar R Furtado	Complex systems;Health sciences;Medicine;Microbiology;Drinking water;Homeland security	Yes
Gala, William	San Ramon	CA	Chevron Energy Technology Company	Dr John Giesy, University of Saskatchewan	Ecological sciences and ecological assessment;Risk assessment;Toxicology;Energy and the environment;Water quality;Ecosystem services	Yes
Gibbs, Shawn	Omaha	NE	University of Nebraska Medical Center	Dr. David Allison, Indiana University-Bloomington	Microbiology;Public health;Homeland security;Waste management	Yes

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Goldman, Gretchen	Washington	DC	Union of Concerned Scientists	Self	Engineering;Modeling;Statistics;Uncertainty analysis;Air quality;Epidemiological risk analyses	Yes
Goltz, Mark	Wright Patterson A	CA	Independent Consultant	Self	Engineering;Hydrogeology;Modeling;Water quality	Yes
Gordon, Terry	Tuxedo	NY	New York University School of Medicine	Self	Health sciences;Public health;Toxicology;Air quality;Community environmental health;Chemical safety	Yes
Graham, Wendy	Gainesville	FL	University of Florida	Dr. David Norton, University of Florida	Agricultural sciences;Drinking water;Water quality;Water quantity and reuse	Yes
Greenfield, Jeffrey	Miami	FL	Florida International University	Self	Engineering;Drinking water;Water quantity and reuse;Sustainability	Yes
Griffin, Michael	Pittsbrugh	PA	Carnegie Mellon University	Prof. M Granger Morgan, Carnegie Mellon	Ecological sciences and ecological assessment	Yes
Grimalt, Joan	Barcelona		Institute of Environmental Assessment and Water Research (IDAEA)	Self	Geochemistry;Health sciences	Yes
Grimm, Nancy	Tempe	AZ	Arizona State University	Dr Willem Vermaas, Arizona State University	Complex systems;Ecological sciences and ecological assessment;Geochemistry;Hydrology;Air quality;Water quality;Ecosystem services;Sustainability	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Groover, Richard	Richmond	VA	Reynolds Community College	Self	Ecosystem services	Yes
Guckenheimer, John	Ithaca	NY	Cornell University	Dr. Richard Yamada	Complex systems;Modeling	Yes
Guidotti, Tee	Washington	DC	George Washington University	Mr. William Bruce, American College of Occupational and Environmental Medicine	Public health	Not Interested
Gurian, Patrick	El Paso	TX	University of Texas at El Paso	Self	Complex systems;Engineering;Health sciences;Modeling;Public health;Risk assessment;Drinking water	Not Interested
Haas, Charles	Philadelphia	PA	Drexel University	Self, SAB Staff Office	Engineering;Microbiology;Public health;Risk assessment	Yes
Halloran, Kent	Columbus	OH	Ohio State University	Self	Engineering;Hydrology;Water quality;Water quantity and reuse;Sustainability	Yes
Happer, William			Princeton University	Dr Richard Yamada	Complex systems;Modeling;Risk assessment;Uncertainty analysis	Yes
Hargiss, Christina	Fargo		North Dakota State University	Self	Complex systems;Ecological sciences and ecological assessment;Energy and the environment;Water quality;Water quantity and reuse	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Hayes, Stanley	San Francisco	CA	Ramboll Environ	Self	Modeling;Risk assessment;Uncertainty analysis;Air quality;Atmospheric sciences	Yes
Helble, Joseph	Hanover	NH	Dartmouth College	Carlene Barous, former colleague and mentor to me; friend	Engineering;Energy and the environment	Yes
Henshaw, Jessie	NEW YORK	NY	HDS systems design science	Self	Causal inference;Ecological sciences and ecological assessment;Economics;Ecosystem services;Sustainability	Yes
Hoel, David G.	Charleston	SC	Medical University of South Carolina	Self	Risk assessment	Yes
Hoffman, Mark	Kansas City	MO	Children's Mercy Hospital, University of Missouri Kansas City	Dr. Mark Hoffman, Children's Mercy Hospital - Kansas City	Engineering;Health sciences;Microbiology;Pediatrics;Public health;Sustainability;Homeland security	Yes
Hood, Darryl	Columbus	OH	The Ohio State University	Self	Toxicology	Yes
Hood, Darryl	Columbus	OH	The Ohio State University	Dr Adetona Olorunfemi, The Ohio State University	Community environmental health	Yes
Hufford, Walter R.	Warrendale	PA	Talisman Energy USA Inc. - REPSOL	Dan Beyers, US Chamber of Commerce	Hydrology;Hydrogeology;Energy and the environment	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Humphreys, James	Houston		ABB	Mr. James Humphreys, Self	Analytical chemistry;Complex systems;Engineering;Air quality;Atmospheric sciences;Drinking water;Energy and the environment;Chemical safety	Yes
Hurtt, George	College Park	MD	University of Maryland, College Park	Ms. Rachel Lamb, University of Maryland, College Park	Complex systems;Ecological sciences and ecological assessment;Energy and the environment;Sustainability	Yes
Hu, Zhiqiang	Columbia	MO	University of Missouri	Self	Benefit-cost analysis;Engineering;Geochemistry;Microbiology;Toxicology;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Sustainability;Waste management	Yes
Ioannidis, John	Stanford	CA	Stanford	Dr. Richard Yamada	Medicine;Epidemiological risk analyses	Not Interested
Jacobsen, Grant	Eugene	OR	University of Oregon	Self	Benefit-cost analysis;Causal inference;Economics;Social behavioral and decision sciences;Statistics;Energy and the environment	Yes

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Jasanoff, Sheila	Cambridge	MA	Harvard University	Dr Lawrence Hazelrigg, Florida State University	Benefit-cost analysis;Causal inference;Complex systems;Ecological sciences and ecological assessment;Modeling;Social behavioral and decision sciences;Uncertainty analysis	Not Interested
Jordan, Stephen	Gulf Breeze		U.S. EPA	Dr. Albert Sollod, Tufts University retired	Complex systems;Ecological sciences and ecological assessment;Engineering;Hydrology;Modeling;Risk assessment;Statistics;Toxicology;Uncertainty analysis;Ecosystem services;Sustainability	Not Interested
Juturu, Vijaya	Morristown	NJ	OmniActive Health Technologies Inc.	Self	Health sciences	Yes
Keating, Christopher	Austin	TX	Austin Community College	Mrs. Rebekah Foote, none	Atmospheric sciences;Energy and the environment;Sustainability	Yes
Keating, Christopher	Austin	TX	Austin Community College	Self	Atmospheric sciences;Energy and the environment;Homeland security	Yes
Kersting, Annie B.	Berkeley	CA	Lawrence Livermore National Laboratory	SAB Staff Office	Geochemistry	Yes

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Khubchandani, Jagdish	Muncie	IN	Ball State University	Self	Health sciences;Medicine;Pediatrics;Public health;Risk assessment;Social behavioral and decision sciences;Toxicology;Community environmental health	Yes
Kieft, Jeffrey	Aurora	CO	University of Colorado	Self	Health sciences;Microbiology;Energy and the environment;Sustainability;Green chemistry;Homeland security	Yes
Kinney, Patrick	Boston	MA	Boston University School of Public Health	Self	Public health;Risk assessment;Air quality;Epidemiological risk analyses	Yes
Klein, Levente	Yorktown Heights	NY	IBM T. J. Watson Research Center	PhD Mariana Lazar, New York University	Engineering;Hydrology;Modeling;Air quality;Agricultural sciences;Energy and the environment;Water quality;Sustainability;Homeland security;Waste management	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Koziel, Jacek	Ames	IA	Iowa State University	Self	Analytical chemistry;Complex systems;Ecological sciences and ecological assessment;Engineering;Micro biology;Toxicology;Air quality;Agricultural sciences;Atmospheric sciences;Energy and the environment;Ecosystem services;Community environmental health;Sustainability;Chemical safety;Green chemistry;Waste management	Yes
Krantz, William	Boulder	CO	University of Colorado at Boulder	Self	Complex systems;Ecological sciences and ecological assessment;Engineering;Hydrol ogy;Hydrogeology;Modeling;Dr inking water;Energy and the environment;Water quality;Water quantity and reuse;Sustainability	Yes
Kronenberg, Amy	Berkeley	CA	Lawrence Berkeley National Laboratory	SAB Staff Office	Public health;Toxicology	Yes
Landis, Wayne	Bellingham	WA	Western Washington University	Self, SAB Staff Office	Complex systems;Ecological sciences and ecological assessment;Risk assessment;Ecosystem services	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Lange, Sabine	Austin	TX	Texas Commission on Environmental Quality	Dr. Richard Yamada	Public health;Risk assessment;Toxicology	Yes
Lawler, Desmond F.	Austin	TX	University of Texas	Self, SAB Staff Office	Engineering;Drinking water	Yes
Lenczewski, Melissa	DeKalb	IL	Northern Illinois University	Dr. Gerald Blazey, Northern Illinois University	Geochemistry;Hydrogeology;Microbiology;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Sustainability	Yes
Li, An	Chicago	IL	University of Illinois at Chicago	Self	Analytical chemistry;Geochemistry;Public health;Water quality	Yes
Lohmann, Rainer	Narragansett	RI	University of Rhode Island	Self	Analytical chemistry;Geochemistry;Water quality	Yes
Lowery, Darrin L.	Easton	MD	Chesapeake Watershed Archaeological Research Foundation	Dr. Richard Yamada	Geochemistry;Hydrology	Yes
Lupo, Anthony	University of Missc	MO	University of Missouri	Self	Atmospheric sciences	Yes
Lu, Kun	Chapel Hill	NC	University of North Carolina	Dr. Richard Yamada	Analytical chemistry;Public health;Toxicology	Yes
Mace, Robert E.	San Marcos	TX	Texas State Unversity	SAB Staff Office	Hydrogeology;Water quality;Water quantity and reuse	Yes
Marty, Sue	Midland	MI	The Dow Chemical Company	SAB Staff Office	Public health;Risk assessment;Toxicology	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
McConnell, Charles	Houston	TX	William Marsh Rice University	Self	Benefit-cost analysis;Ecological sciences and ecological assessment;Economics;Risk assessment;Uncertainty analysis;Energy and the environment;Sustainability	Yes
McKean, Deborah			no current affiliation	Self	Risk assessment;Toxicology	Yes
Meredith, Justin	Nashville	TN	Division of Remediation	Self	Risk assessment	Yes
Meselhe, Ehab	New Orleans	LA	Tulane University	Self	Engineering;Hydrology;Modeling	Yes
Moo-Young, H. Keith	Richland	WA	Washington State University, Tri-Cities	Dr H. Keith Moo-Young, Washington State	Engineering;Sustainability;Waste management	Yes
Mora-Zacarias, Miguel	College Station	TX	Texas A&M University	Self	Air quality	Yes
Morgan, Christine	College Station	TX	Texas A&M University	Dr. Elizabeth Stulberg, Alliance of Crop, Soil and Environmental Science Societies	Complex systems;Ecological sciences and ecological assessment;Economics;Hydrology;Modeling;Social behavioral and decision sciences;Agricultural sciences;Ecosystem services;Sustainability	Yes
Morgan, Kevin	Raleigh	NC	Aventis Pharmaceuticals Inc	Dr. S. Stanley Young, CGStat	Modeling;Toxicology;Air quality;Chemical safety	Yes

Attachment 1: Nominees for the FY 2019 Annual Membership for the Chartered SAB

Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Neagu, Carmen	Houston		ABB Inc	Self	Analytical chemistry;Complex systems;Modeling;Risk assessment;Uncertainty analysis;Air quality;Agricultural sciences;Drinking water;Water quality;Chemical safety;Green chemistry;Homeland security;Waste management	Yes
Nespoli, Lisa Marie	Pittsburgh	PA	Covestro LLC	Self	Risk assessment	Yes
Nuckols, John	North Bethesda, M	CO	Colorado State University		Engineering;Modeling;Risk assessment;Agricultural sciences;Drinking water;Epidemiological risk analyses	Yes
Oerther, Daniel	Rolla	MO	Missouri University of Science and Technology	Self	Complex systems;Engineering;Health sciences;Microbiology;Modeling;Public health;Water quality;Community environmental health	Yes
Oris, James	Oxford	OH	Miami University	Dr. John Giesy, Univ Saskatchewan	Analytical chemistry;Ecological sciences and ecological assessment;Risk assessment;Statistics;Toxicology;Water quality	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Orlov, Alexander	Stony Brook	NY	State University of New York, Stony Brook	Dr. Clive Clayton, Stony Brook University	Economics;Engineering;Health sciences;Public health;Risk assessment;Air quality;Drinking water;Energy and the environment;Water quality;Chemical safety;Green chemistry	Yes
Osenberg, Craig			University of Georgia	Dr. Hope Klug, University of Tennessee at Chattanooga	Ecological sciences and ecological assessment;Modeling;Statistics;Ecosystem services;Sustainability	Yes
Otim, Ochan	Playa Del Rey	CA	Environmental Monitoring Division, City of Los Angeles	Self	Analytical chemistry;Risk assessment;Water quality;Water quantity and reuse;Waste management	Yes
Otte, Marinus	Fargo	ND	North Dakota State University	Self	Analytical chemistry;Ecological sciences and ecological assessment;Geochemistry;Hydrology;Toxicology;Agricultural sciences;Water quality;Ecosystem services;Sustainability	Yes
Parkerton, Thomas F.	Houston	TX	ExxonMobil Biomedical Science	SAB Staff Office	Ecological sciences and ecological assessment;Risk assessment	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Pastore, Christopher	Philadelphia	PA	Thomas Jefferson University	Dr. Thomas Twardowski, Thomas Twardowski	Causal inference;Complex systems;Ecological sciences and ecological assessment;Engineering;Uncertainty analysis;Ecosystem services;Sustainability	Yes
Patisaul, Heather	Raleigh	NC	North Carolina State University	Dr. Joseph Laakso, Endocrine Society	Health sciences;Risk assessment;Toxicology	Yes
Paustenbach, Dennis J.	San Francisco	CA	Chemrisk, Inc	Ms. Dana Hollins , Cardno ChemRisk	Health sciences;Modeling;Public health;Risk assessment;Toxicology;Drinking water;Epidemiological risk analyses;Chemical safety	Yes
Peltier, Richard	Amherst	MA	University of Massachusetts	Self	Analytical chemistry;Health sciences;Public health;Air quality;Atmospheric sciences;Community environmental health	Yes
Portier, Kenneth M.	Athens	GA		SAB Staff Office	Public health;Statistics;Toxicology;Epidemiological risk analyses	Yes
Prather, Michael	Irvine	CA	UC Irvine	Self	Analytical chemistry;Complex systems;Modeling;Air quality;Atmospheric sciences	Yes
Ramos, Kenneth	Tucson	AZ	University of Arizona	SAB Staff Office	Medicine;Public health;Toxicology	Yes
Randtke, Stephen J.	Lawrence	KS	University of Kansas	self	Analytical chemistry;Engineering;Drinking water;Water quality;Water quantity and reuse	Yes

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Rangan, Cyrus	Los Angeles	DC	Los Angeles County Department of Public Health	Deputy Director Meghan McGinty, Big Cities Health Coalition/National Association of County and City Health Officials	Medicine;Public health;Risk assessment;Toxicology;Epidemiological risk analyses;Community environmental health	Yes
Ready, Richard	Bozeman	MT	Montana State University	dr. james shortle, Penn State	Benefit-cost analysis;Causal inference;Economics;Social behavioral and decision sciences;Statistics	Yes
Rhomberg, Lorenz	Cambridge	MA	Gradient	Dr. Richard Yamada	Risk assessment;Toxicology	Yes
Richardson, Mary Jo	College Station	TX	Texas A&M University	Dr. Mary Jo Richardson, Texas A and M University	Geochemistry;Atmospheric sciences;Energy and the environment;Sustainability	Yes
Rodewald, Amanda D.	Ithaca	NY	Cornell University	Self, SAB Staff Office	Complex systems;Ecological sciences and ecological assessment;Ecosystem services;Sustainability	Yes
Rodewald, Amanda D.	Ithaca	NY	Cornell University	Dr Kevin Fitzpatrick, University of Arkansas	Ecological sciences and ecological assessment	Yes
Rohrs, Allison	LORETTO	PA	Saint Francis University Institute for Energy	Self	Benefit-cost analysis;Agricultural sciences;Atmospheric sciences;Energy and the environment;Sustainability	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Rosenberg, Andrew A.	Cambridge	MA	Union of Concerned Scientists	Self	Causal inference;Ecological sciences and ecological assessment;Modeling;Statistics;Uncertainty analysis;Ecosystem services;Sustainability	Yes
Rosen, Barry	Detroit	MI	Wayne State University	Self	Health sciences;Microbiology;Toxicology	Yes
Rosol, Thomas	Columbus	OH	Ohio State University	Self	Health sciences;Medicine;Toxicology;Chemical safety	Yes
Ross, Benjamin	Washington	DC	Disposal Safety Inc.	Mr. Peter Hibbard	Hydrogeology;Waste management	Not Interested
Runge, Steven	Conway	AR	University of Central Arkansas	Ms. Laura Young, University of Central Arkansas	Causal inference;Medicine;Microbiology;Epidemiological risk analyses;Chemical safety	Yes
Ruscher, Paul	Tallahassee	FL	Florida State University	Self	Hydrology;Modeling;Air quality;Atmospheric sciences;Energy and the environment	Yes
Sabo-Attwood, Tara L.	Gainesville	FL	University of Florida	SAB Staff Office	Ecological sciences and ecological assessment;Risk assessment;Toxicology	Yes

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Sagers, Cynthia	Tempe	AZ	Arizona State University	Dr. Sethuraman Panchanathan, EVP, Arizona State University	Ecological sciences and ecological assessment;Economics;Engineering;Public health;Agricultural sciences;Atmospheric sciences;Energy and the environment;Community environmental health;Sustainability	Yes
Saiers, James	New Haven	CT	Yale University	Dr. Ingrid Burke, Yale School of Forestry and Environmental Studies	Analytical chemistry;Causal inference;Ecological sciences and ecological assessment;Geochemistry;Hydrology;Drinking water;Energy and the environment;Water quality;Water quantity and reuse	Yes
Sakaji, Richard	El Cerrito	CA	Independent Consultant		Engineering;Public health;Drinking water;Water quality;Water quantity and reuse	Yes
Salvito, Daniel	Woodcliff Lake	NJ	RIFM	Self	Analytical chemistry;Ecological sciences and ecological assessment;Risk assessment;Water quality	Yes
Santelmann, Mary	Corvallis	OR	Oregon State University	Dr. Susan Capalbo, Oregon State University	Ecological sciences and ecological assessment	Yes

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Savitz, David	Providence	RI	Brown University	Self	Causal inference;Health sciences;Public health;Energy and the environment;Epidemiological risk analyses;Community environmental health	Yes
Schneider, David	St. John's		Memorial University	Self	Causal inference;Ecological sciences and ecological assessment;Statistics	Yes
Sherman, Michael	Raleigh	NC	North Carolina Farm Bureau Federation	Dr. Richard Yamada	Agricultural sciences	Yes
Shipp Hilts, Asante	Albany	NY	New York State Department of Health	Dr. Asante Shipp%20Hilts, New York State Department of Health	Health sciences;Public health;Social behavioral and decision sciences;Community environmental health	Yes
Simon, Ted	Winston	GA	University of Georgia	Dan Byers, Global Energy Institute	Modeling;Risk assessment;Toxicology	Yes
Skoglund, Robert	Pittsburgh	PA	Covestro LLC	Self	Public health;Risk assessment;Toxicology;Sustain ability;Green chemistry	Yes
Smith, Eric	Blacksburg	VA	Virginia Tech	Professor%20and%20Head Ron Fricker, Virginia Tech Department of Statistics	Risk assessment;Statistics;Epidemiological risk analyses	Yes
Stevenson, David	Newark	DE	Caesar Rodney Institute	Self	Economics;Energy and the environment	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Stuart, Amy	Tampa	FL	University of South Florida	Dr. James Mihelcic, University of South Florida	Engineering;Health sciences;Modeling;Public health;Statistics;Air quality;Atmospheric sciences;Community environmental health;Sustainability	Yes
Stubblefield, William	Corvallis	OR	Oregon State University	Dr. (Professor and Chair) Craig Marcus, Oregon State University/Dept. Environmental and Molecular Toxicology	Analytical chemistry;Ecological sciences and ecological assessment;Risk assessmentn;Toxicologys;Water qualityn;Chemical safetyn	Yes
Suski, Jamie	Hunt Valley	MD	EA Engineering, Science, Technology, Inc., PBC	Self	Ecological sciences and ecological assessment;Toxicology;Water quality;Ecosystem services	Yes
Tan, Shirlee	Seattle	WA	King County Dept Public Health	Dr. Robert Zoeller, University of Massachusetts	Health sciences;Public health;Risk assessment;Toxicology	Yes
Tharakan, John	Washington	DC	Howard University	Self	Engineering;Hydrology;Microbiology;Air quality;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Sustainability;Green chemistry;Waste management	Yes

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Theis, Thomas	Chicago	IL	University of Illinois at Chicago	Self	Benefit-cost analysis;Ecological sciences and ecological assessment;Engineering;Modeling;Risk assessment;Agricultural sciences;Energy and the environment;Water quality;Ecosystem services;Sustainability;Waste management	Yes
Thomas, Evan	Boulder	CO	University of Colorado at Boulder	Self	Causal inference;Complex systems;Engineering;Public health;Social behavioral and decision sciences;Drinking water;Water quality;Water quantity and reuse;Community environmental health;Sustainability	Yes
Thurston, George	Tuxedo	NY	New York University	Self	Benefit-cost analysis;Engineering;Medicine;Public health;Air quality;Atmospheric sciences;Energy and the environment	Yes

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Tormey, Daniel	Santa Monica	CA	Catalyst Environmental Solutions Corporation	Mr. Rock Zierman, California Independent Petroleum Association	Analytical chemistry;Benefit-cost analysis;Causal inference;Complex systems;Ecological sciences and ecological assessment;Engineering;Geochemistry;Hydrology;Hydrogeology;Modeling;Risk assessment;Uncertainty analysis;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Ecosystem services;Homeland security;Waste management	Yes
Tormey, Daniel	Santa Monica	CA	Catalyst Environmental Solutions Corporation	Mr. Rock Zierman, California Independent Petroleum Association	Analytical chemistry;Benefit-cost analysis;Causal inference;Complex systems;Ecological sciences and ecological assessment;Engineering;Geochemistry;Hydrology;Hydrogeology;Modeling;Risk assessment;Uncertainty analysis;Drinking water;Energy and the environment;Water quality;Water quantity and reuse;Ecosystem services;Waste management	Yes

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Trasande, Leonardo	New York	NY	New York University School of Medicine	Dr. Joseph Laakso, Endocrine Society	Benefit-cost analysis;Economics;Health sciences;Medicine;Pediatrics;Public health	Yes
Trindade, Sergio	New York	NY	SE2T International, Ltd.	Self	Benefit-cost analysis	Yes
Turner, Jay	St. Louis	MO	Washington University	SAB Staff Office	Engineering;Modeling;Air quality	Yes
Tyner, Robin	Exeter	NH	USNA/NPGS/USN	Self	Modeling;Risk assessment;Social behavioral and decision sciences	Yes
Ulsh, Brant	Livermore	CA	M.H. Chew & Associates	Dr. Richard Yamada	Health sciences;Public health	Yes
Uppu, Rao	Baton Rouge	LA	Southern University and A&M College	Self	Toxicology	Yes
Vandenberg, Laura	Amherst	MA	University of Massachusetts - Amherst	Dr. Joseph Laakso, Endocrine Society	Health sciences;Risk assessment;Toxicology	Yes
Vepachedu, Venkata	Exton	PA	Pennsylvania Department of Health, COPA	Self	Analytical chemistry;Health sciences;Microbiology;Public health;Toxicology;Epidemiological risk analyses;Green chemistry	Yes
Viana, Louis R.	San Juan	PR	LRV NY LLC	Dr. Ponisseril Somasundaran, Columbia University	Drinking water;Energy and the environment	Yes
Wauchope, Robert D	Pisgah Forest	NC	USDA-ARS	Self	Analytical chemistry;Hydrology;Modeling;Risk assessment;Agricultural sciences;Water quality;Chemical safety	Yes

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Werth, Charles	Austin	TX	University of Texas at Austin	Self	Engineering;Hydrogeology;Drinking water;Energy and the environment;Water quality;Sustainability;Waste management	Yes
Wiesner, Mark	Durham	NC	Duke University	SAB Staff Office	Engineering;Drinking water;Water quality;Water quantity and reuse	Yes
Williams, David	Corvallis	OR	Oregon State University	Self	Analytical chemistry;Health sciences;Toxicology;Drinking water	Yes
Williams, Lance	Tyler	TX	University of Texas at Tyler	Self	Ecological sciences and ecological assessment	Yes
Williams, Richard A.	McLean	VA	MarginalRegulation	Dr. Richard Yamada	Economics	Yes
Wuebbles, Don	Urbnaa	IL	University of Illinois at Urbana-Champaign	Chancellor Robert Jones, University of Illinois at Urbana-Champaign	Complex systems;Hydrology;Modeling;Risk assessment;Statistics;Uncertainty analysis;Atmospheric sciences	Not Interested
Xu, Xiaohui	College Station	TX	Texas A&M Health Science Center	Dr. Hui Hu, Department of Epidemiology, University of Florida	Causal inference;Health sciences;Medicine;Public health;Air quality;Epidemiological risk analyses	Not Interested

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Person	City	State	Organization	Who Referred	Special Expertise Needed	Interest in Serving
Yang, Raymond	Fort Collins	CO	Colorado State University	Self	Complex systems;Health sciences;Modeling;Public health;Risk assessment;Toxicology;Drinking water;Community environmental health;Chemical safety	Yes
Zhao, Feng	College Park	MD	NOAA	Self	Ecological sciences and ecological assessment;Risk assessment;Agricultural sciences;Energy and the environment;Water quality;Ecosystem services;Sustainability	Yes
Zwiernik, Matthew	East Lansing	MI	Michigan State University	Dr. Richard Yamada	Complex systems;Ecological sciences and ecological assessment;Hydrology	Yes

Attachment 2: Candidates Interested in Serving on the EPA Chartered Science Advisory Board

Person	City	State	Organization	Address Affiliation	Who Referred	Special Expertise Needed	Interested in Serving
Aguirre, A. Alonso	Fairfax	VA	George Mason University	Academic	Self	Ecological sciences and ecological assessment	Yes
Ahrens, Kurt	Philadelphia	PA	School District of Philadelphia	Academic	Self	Causal inference; Complex systems; Modeling; Water quality; Ecosystem services; Sustainability	Yes
Aldy, Joseph	Cambridge	MA	Harvard University	Academic	Dr. Robert Stavins, Harvard University	Economics	Yes
Allen, Irving	Blacksburg	VA	Virginia Tech	Academic	Self	Benefit-cost analysis; Health sciences; Medicine; Microbiology	Yes
Anderson, Henry	Madison	WI	Wisconsin Division of Public Health	State Governement	Self, SAB Staff Office	Medicine; Public health; Risk assessment; Toxicology	Yes
Auvermann, Brent	Amarillo	TX	Texas A&M University	Academic	Dr. Richard Yamada	Engineering; Air quality; Agricultural sciences	Yes
Barton, Hugh A.	Mystic	CT	Independent Consultant	Consultant	SAB Staff Office	Health sciences; Modeling; Risk assessment; Toxicology	Yes
Bashkin, James	Saint Louis	MO	University of Missouri-St. Louis	Academic	Self	Green chemistry	Yes
Becker, Jennifer	Houghton	MI	Michigan Technological University	Academic	Dr. David Dzombak, Carnegie Mellon University	Engineering; Microbiology; Modeling; Risk assessment; Drinking water; Water quality	Yes
Beck, Barbara	Cambridge	MA	Gradient Corp.	Consultant	Dr. Richard Yamada	Risk assessment; Toxicology	Yes
Begley, C. Glenn	Parkville, Victoria	AUS	BioCurate PTY, LTD	Industry	Dr. Richard Yamada	Health sciences; Medicine	Yes
Belzer, Richard	Mt. Vernon	VA	Independent consultant	Consultant	Dr. Richard Yamada	Benefit-cost analysis; Economics; Risk assessment	Yes

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Bennear, Lori	Durham	NC	Duke University	Academic	Dr. Randall Kramer, Professor of Environmental Economics, Duke University	Benefit-cost analysis; Economics	Yes
Bergendahl, John	Worcester	MA	Worcester Polytechnic Institute	Academic	Self	Engineering; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Sustainability; Waste management	Yes
Botkin, Daniel	San Francisco	CA	University of California, Santa Barbara	Academic	Dr. Richard Yamada	Ecological sciences and ecological assessment	Yes
Brown, Derick G.	Bethlehem	PA	Lehigh University	Academic	Self	Complex systems; Engineering; Geochemistry; Microbiology; Modeling; Risk assessment; Statistics; Drinking water; Energy and the environment; Water quality; Waste management	Yes
Bus, James	Midland	MI	Exponent, Inc.	Industry	Dr. Richard Yamada	Risk assessment; Toxicology	Yes
Caneba, Gerard	Houghton	MI	Michigan Tech University	Academic	Self	Complex systems; Engineering; Modeling; Atmospheric sciences; Energy and the environment; Water quantity and reuse; Sustainability; Chemical safety; Green chemistry; Waste management	Yes
Cantrell, Louis	LAUREL	MD	Profitable Weather, LLC	Consultant	Self	Benefit-cost analysis; Complex systems; Modeling; Statistics; Atmospheric sciences	Yes

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Chandra, Dhyan	Buffalo	NY	Roswell Park Comprehensive Cancer Center	Consultant	Self	Toxicology	Yes
Chen, Celia	Hanover	NH	Dartmouth College	Academic	Dr. William Suh, NIEHS	Ecological sciences and ecological assessment; Toxicology	Yes
Chitikela, S. Rao	Dublin	OH	RC-WEE Solutions LLC	Consultant	Self	Benefit-cost analysis; Engineering; Hydrology; Microbiology; Air quality; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Sustainability; Waste management	Yes
Chorghade, Mukund	Hillsborough	NC	THINQ Pharma	Industry	Self	Health sciences; Medicine; Public health; Toxicology	Yes
Chorover, Jon	Tucson	AZ	University of Arizona	Academic	Self	Analytical chemistry; Complex systems; Geochemistry; Hydrology; Agricultural sciences; Water quality; Chemical safety	Yes
Christy, John R.	Huntsville	AL	University of Alabama in		Dr. Richard Yamada	Atmospheric sciences	Yes
Clasen, Thomas	Atlanta	GA	Emory University	Academic	Self	Public health	Yes
Clewell, Harvey	Research Triangle Park	NC	Ramboll Environment and Health	Consultant	Dr. Richard Yamada, Dr. Michael Honeycutt	Modeling; Risk assessment; Toxicology	Yes
Cobb, Kim	Atlanta	GA	Georgia Inst. of Technology	Academic	Dr. George Peterson, Georgia Inst of Technology	Geochemistry; Hydrology; Uncertainty analysis; Atmospheric sciences; Energy and the environment; Sustainability	Yes

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Cohen, Steven	New York City	NY	Columbia University	Academic	Dr. Michael Purdy, Exec VPR: Columbia University, Joel Widder, Federal Science Partners, Dr. Richard Yamada,	Benefit-cost analysis; Ecological sciences and ecological assessment; Risk assessment; Social behavioral and decision sciences; Air quality; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Ecosystem services; Sustainability	Yes
Cooper, Cal	Houston	TX	Apache Corporation	Industry	self	Engineering; Energy and the environment	Yes
Cruz-Rivera, Edwin	St. Thomas	VI	University of the Virgin Islands	Academic	Self	Ecological sciences and ecological assessment; Microbiology; Water quality	Yes
Cushing, Robert	Sarasota	FL	Carollo Engineers, Inc	Consultant	Self	Benefit-cost analysis; Engineering; Drinking water; Water quantity and reuse	Yes
Davidson, Eric	Frostburg	MA	University of Maryland Center for Environmental Science	Academic	Self	Ecological sciences and ecological assessment; Geochemistry; Agricultural sciences; Atmospheric sciences; Energy and the environment; Water quality; Ecosystem services; Sustainability	Yes
Davis, Alexander	Pittsburgh	PA	Carnegie Mellon University	Academic	Self	Causal inference; Social behavioral and decision sciences; Statistics; Energy and the environment	Yes
Davis, Alexander	Pittsburgh	PA	Carnegie Mellon University	Academic	Dr. Kathryn Verhoeven, Indiana University	Analytical chemistry; Modeling; Atmospheric sciences	Yes
Dayaratna, Kevin	Washington DC	DC	The Heritage Foundation	Research	Dr. Richard Yamada	Benefit-cost analysis; Modeling; Statistics; Uncertainty analysis	Yes

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Dhanasekaran, Danny	Oklahoma City	OK	University of Oklahoma	Academic	Dr. Richard Yamada	Public health; Risk assessment; Toxicology	Yes
Dinov, Ivo	Ann Arbor	MI	University of Michigan	Academic	Self	Causal inference; Complex systems; Modeling; Public health; Risk assessment; Statistics	Yes
DuPree, Gabriel	Jacksonville	FL	University of Florida	Academic	Self	Benefit-cost analysis; Complex systems; Ecological sciences and ecological assessment; Hydrology; Uncertainty analysis; Air quality; Agricultural sciences; Atmospheric sciences; Energy and the environment; Water quality; Water quantity and reuse; Ecosystem services; Community environmental health; Sustainability; Chemical safety	Yes
Embertson, Nichole M.	Lynden	WA	Whatcom Conservation District	State	Self	Complex systems; Risk assessment; Air quality; Agricultural sciences; Water quality; Sustainability; Waste management	Yes
Enstrom, James E.	Los Angeles	CA	Scientific Integrity Institute	Academic, Retired	Dr. Richard Yamada	Complex systems; Health sciences	Yes
Felter, Susan P.	Mason	OH	Procter & Gamble	Industry	SAB Staff Office	Risk assessment; Toxicology	Yes

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Ferry, John	Columbia	SC	University of South Carolina	Academic	Dr. Susan Richardson, University of South Carolina	Analytical chemistry; Complex systems; Ecological sciences and ecological assessment; Engineering; Geochemistry; Hydrology; Hydrogeology; Modeling; Public health; Statistics; Air quality; Agricultural sciences; Atmospheric sciences; Energy and the environment; Water quality; Water quantity and reuse; Ecosystem services; Sustainability; Chemical safety; Waste management	Yes
Fike, David	St. Louis	MO	Washington University	Academic	Dr. Jennifer Lodge, Vice Chancellor for Research, Washington University in St. Louis	Geochemistry	Yes
Fournier, Aime	Cambridge	MA	MIT	Academic	Self	Benefit-cost analysis; Causal inference; Complex systems; Risk assessment; Statistics; Uncertainty analysis; Atmospheric sciences; Energy and the environment	Yes
Francis, Larijai	Corpus Christi	TX	City of Corpus Christi	Local Government	Self	Benefit-cost analysis; Engineering; Hydrology; Hydrogeology; Drinking water; Water quantity and reuse	Yes
Frazer, Thomas	Gainesville	FL	University of Florida	Academic	Dr. David Norton, University of Florida	Ecological sciences and ecological assessment; Agricultural sciences; Water quality; Water quantity and reuse; Ecosystem services	Yes

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Fry, Juliane	Portland	OR	Reed College	Academic	Self	Analytical chemistry; Ecological sciences and ecological assessment; Modeling; Public health; Statistics; Uncertainty analysis; Air quality; Atmospheric sciences; Energy and the environment; Community environmental health	Yes
Furtado, Manohar	Pleasanton	CA	Apton Biosystems Inc.	Industry	Dr. Manohar Furtado, Manohar R Furtado	Complex systems; Health sciences; Medicine; Microbiology; Drinking water; Homeland security	Yes
Gala, William	San Ramon	CA	Chevron Energy Technology Company	Industry	Dr John Giesy, University of Saskatchewan	Ecological sciences and ecological assessment; Risk assessment; Toxicology; Energy and the environment; Water quality; Ecosystem services	Yes
Gibbs, Shawn	Omaha	NE	University of Nebraska Medical Center	Academic	Dr. David Allison, Indiana University-Bloomington	Microbiology; Public health; Homeland security; Waste management	Yes
Goldman, Gretchen	Washington	DC	Union of Concerned Scientists	NonGovernmental Association	Self	Engineering; Modeling; Statistics; Uncertainty analysis; Air quality; Epidemiological risk analyses	Yes
Goltz, Mark	Wright Patterson AFB	CA	Independent Consultant	Consultant	Self	Engineering; Hydrogeology; Modeling; Water quality	Yes
Gordon, Terry	Tuxedo	NY	New York University School of Medicine	Academic	Self	Health sciences; Public health; Toxicology; Air quality; Community environmental health; Chemical safety	Yes
Graham, Wendy	Gainesville	FL	University of Florida	Research	Dr. David Norton, University of Florida	Agricultural sciences; Drinking water; Water quality; Water quantity and reuse	Yes

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Greenfield, Jeffrey	Miami	FL	Florida International University	Academic	Self	Engineering; Drinking water; Water quantity and reuse; Sustainability	Yes
Griffin, Michael	Pittsbrugh	PA	Carnegie Mellon University	Academic	Prof. M Granger Morgan, Carnegie Mellon	Ecological sciences and ecological assessment	Yes
Grimalt, Joan	Barcelona	SP	Institute of Environmental Assessment and Water Research	Academic	Self	Geochemistry; Health sciences	Yes
Grimm, Nancy	Tempe	AZ	Arizona State University	Academic	Dr Willem Vermaas, Arizona State University	Complex systems; Ecological sciences and ecological assessment; Geochemistry; Hydrology; Air quality; Water quality; Ecosystem services; Sustainability	Yes
Groover, Richard	Richmond	VA	Reynolds Community College	Academic	Self	Ecosystem services	Yes
Guckenheimer, John	Ithaca	NY	Cornell University	Academic	Dr. Richard Yamada	Complex systems; Modeling	Yes
Haas, Charles	Philadelphia	PA	Drexel University	Academic	Self, SAB Staff Office	Engineering; Microbiology; Public health; Risk assessment	Yes
Halloran, Kent	Columbus	OH	Ohio State University	Academic	Self	Engineering; Hydrology; Water quality; Water quantity and reuse; Sustainability	Yes
Happer, William	Princeton	NJ	Princeton University	Academic	Dr Richard Yamada	Complex systems; Modeling; Risk assessment; Uncertainty analysis	Yes
Hargiss, Christina	Fargo	ND	North Dakota State University	Academic	Self	Complex systems; Ecological sciences and ecological assessment; Energy and the environment; Water quality; Water quantity and reuse	Yes
Hayes, Stanley	San Francisco	CA	Ramboll Environ	Other	Self	Modeling; Risk assessment; Uncertainty analysis; Air quality; Atmospheric sciences	Yes

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Person	City	State	Organization	Address Affiliation	Who Referred	Special Expertise Needed	Interested in Serving
Helble, Joseph	Hanover	NH	Dartmouth College	Academic	Carlene Barous, former colleague and mentor to me; friend	Engineering; Energy and the environment	Yes
Henshaw, Jessie	NEW YORK	NY	HDS systems design science	Research	Self	Causal inference; Ecological sciences and ecological assessment; Economics; Ecosystem services; Sustainability	Yes
Hoel, David G.	Charleston	SC	Medical University of South Carolina	Academic	Self	Risk assessment	Yes
Hoffman, Mark	Kansas City	MO	Children's Mercy Hospital, University of Missouri Kansas City	Research	Dr. Mark Hoffman, Children's Mercy Hospital - Kansas City	Engineering; Health sciences; Microbiology; Pediatrics; Public health; Sustainability; Homeland security	Yes
Hood, Darryl	Columbus	OH	The Ohio State University	Academic	Dr Adetona Olorunfemi, The Ohio State University	Community environmental health	Yes
Hufford, Walter R.	Warrendale	PA	Talisman Energy USA Inc. - REPSOL	Industry	Dan Beyers, US Chamber of Commerce	Hydrology; Hydrogeology; Energy and the environment	Yes
Humphreys, James	Houston	TX	ABB	Industry	Mr. James Humphreys, Self	Analytical chemistry; Complex systems; Engineering; Air quality; Atmospheric sciences; Drinking water; Energy and the environment; Chemical safety	Yes
Hurtt, George	College Park	MD	University of Maryland, College Park	Academic	Ms. Rachel Lamb, University of Maryland, College Park	Complex systems; Ecological sciences and ecological assessment; Energy and the environment; Sustainability	Yes

Attachment 2: Candidates Interested in Serving on the EPA Chartered Science Advisory Board

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Hu, Zhiqiang	Columbia	MO	University of Missouri	Academic	Self	Benefit-cost analysis; Engineering; Geochemistry; Microbiology; Toxicology; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Sustainability; Waste management	Yes
Jacobsen, Grant	Eugene	OR	University of Oregon	Academic	Self	Benefit-cost analysis; Causal inference; Economics; Social behavioral and decision sciences; Statistics; Energy and the environment	Yes
Juturu, Vijaya	Morristown	NJ	OmniActive Health Technologies Inc.	Industry	Self	Health sciences	Yes
Keating, Christopher	Austin	TX	Austin Community College	Academic	Mrs. Rebekah Foote, none	Atmospheric sciences; Energy and the environment; Sustainability	Yes
Kersting, Annie B.	Berkeley	CA	Lawrence Livemore National Laboratory	Resaerch	SAB Staff Office	Geochemistry	Yes
Khubchandani, Jagdish	Muncie	IN	Ball State University	Academic	Self	Health sciences; Medicine; Pediatrics; Public health; Risk assessment; Social behavioral and decision sciences; Toxicology; Community environmental health	Yes
Kieft, Jeffrey	Aurora	CO	University of Colorado	Academic	Self	Health sciences; Microbiology; Energy and the environment; Sustainability; Green chemistry; Homeland security	Yes
Kinney, Patrick	Boston	MA	Boston University School of Public	Academic	Self	Public health; Risk assessment; Air quality; Epidemiological risk analyses	Yes

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Klein, Levente	Yorktown Heights	NY	IBM T. J. Watson Research Center	Industry	PhD Mariana Lazar, New York University	Engineering; Hydrology; Modeling; Air quality; Agricultural sciences; Energy and the environment; Water quality; Sustainability; Homeland security; Waste management	Yes
Koziel, Jacek	Ames	IA	Iowa State University	Academic	Self	Analytical chemistry; Complex systems; Ecological sciences and ecological assessment; Engineering; Microbiology; Toxicology; Air quality; Agricultural sciences; Atmospheric sciences; Energy and the environment; Ecosystem services; Community environmental health; Sustainability; Chemical safety; Green chemistry; Waste management	Yes
Krantz, William	Boulder	CO	University of Colorado at Boulder	Academic, Retired	Self	Complex systems; Ecological sciences and ecological assessment; Engineering; Hydrology; Hydrogeology; Modeling; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Sustainability	Yes
Kronenberg, Amy	Berkeley	CA	Lawrence Berkeley National Laboratory	Research	SAB Staff Office	Public health; Toxicology	Yes
Landis, Wayne	Bellingham	WA	Western Washington University	Academic	Self, SAB Staff Office	Complex systems; Ecological sciences and ecological assessment; Risk assessment; Ecosystem services	Yes
Lange, Sabine	Austin	TX	Texas Commission on Environmental	State	Dr. Richard Yamada	Public health; Risk assessment; Toxicology	Yes
Lawler, Desmond F.	Austin	TX	University of Texas	Academic	Self, SAB Staff Office	Engineering; Drinking water	Yes

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Lenczewski, Melissa	DeKalb	IL	Northern Illinois University	Academic	Dr. Gerald Blazey, Northern Illinois University	Geochemistry; Hydrogeology; Microbiology; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Sustainability	Yes
Li, An	Chicago	IL	University of Illinois at Chicago	Academic	Self	Analytical chemistry; Geochemistry; Public health; Water quality	Yes
Lohmann, Rainer	Narragansett	RI	University of Rhode Island	Academic	Self	Analytical chemistry; Geochemistry; Water quality	Yes
Lowery, Darrin L.	Easton	MD	Chesapeake Watershed Archaeological Research Foundation		Dr. Richard Yamada	Geochemistry; Hydrology	Yes
Lupo, Anthony	University of Missouri	MO	University of Missouri	Academic	Self	Atmospheric sciences	Yes
Lu, Kun	Chapel Hill	NC	University of North Carolina		Dr. Richard Yamada	Analytical chemistry; Public health; Toxicology	Yes
Mace, Robert E.	San Marcos	TX	Texas State Unversity	Academic	SAB Staff Office	Hydrogeology; Water quality; Water quantity and reuse	Yes
Marty, Sue	Midland	MI	The Dow Chemical Company	Industry	SAB Staff Office	Public health; Risk assessment; Toxicology	Yes
McConnell, Charles	Houston	TX	William Marsh Rice University	Academic	Self	Benefit-cost analysis; Ecological sciences and ecological assessment; Economics; Risk assessment; Uncertainty analysis; Energy and the environment; Sustainability	Yes
McKean, Deborah	Sequim	WA	Independent Consultant	Other	Self	Risk assessment; Toxicology	Yes
Meredith, Justin	Nashville	TN	Division of Remediation	State	Self	Risk assessment	Yes
Meselhe, Ehab	New Orleans	LA	Tulane University	Academic	Self	Engineering; Hydrology; Modeling	Yes

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Moo-Young, H. Keith	Richland	WA	Washington State University, Tri-Cities	Academic	Dr H. Keith Moo-Young, Washington State	Engineering; Sustainability; Waste management	Yes
Mora-Zacarias, Miguel	College Station	TX	Texas A&M University	Academic	Self	Air quality	Yes
Morgan, Christine	College Station	TX	Texas A&M University	Academic	Dr. Elizabeth Stulberg, Alliance of Crop, Soil and Environmental Science Societies	Complex systems; Ecological sciences and ecological assessment; Economics; Hydrology; Modeling; Social behavioral and decision sciences; Agricultural sciences; Ecosystem services; Sustainability	Yes
Morgan, Kevin	Raleigh	NC	Aventis Pharmaceuticals Inc	Industry	Dr. S. Stanley Young, CGStat	Modeling; Toxicology; Air quality; Chemical safety	Yes
Neagu, Carmen	Houston	TX	ABB Inc	Industry	Self	Analytical chemistry; Complex systems; Modeling; Risk assessment; Uncertainty analysis; Air quality; Agricultural sciences; Drinking water; Water quality; Chemical safety; Green chemistry; Homeland security; Waste management	Yes
Nespoli, Lisa Marie	Pittsburgh	PA	Covestro LLC	Industry	Self	Risk assessment	Yes
Nuckols, John	North Bethesda, MD	CO	Colorado State University	Academic	Self	Engineering; Modeling; Risk assessment; Agricultural sciences; Drinking water; Epidemiological risk analyses	Yes
Oerther, Daniel	Rolla	MO	Missouri University of Science and Technology	Academic	Self	Complex systems; Engineering; Health sciences; Microbiology; Modeling; Public health; Water quality; Community environmental health	Yes

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Oris, James	Oxford	OH	Miami University	Academic	Dr. John Giesy, Univ Saskatchewan	Analytical chemistry; Ecological sciences and ecological assessment; Risk assessment; Statistics; Toxicology; Water quality	Yes
Orlov, Alexander	Stony Brook	NY	State University of New York, Stony Brook	Academic	Dr. Clive Clayton, Stony Brook University	Economics; Engineering; Health sciences; Public health; Risk assessment; Air quality; Drinking water; Energy and the environment; Water quality; Chemical safety; Green chemistry	Yes
Osenberg, Craig	Athens	GA	University of Georgia	Academic	Dr. Hope Klug, University of Tennessee at Chattanooga	Ecological sciences and ecological assessment; Modeling; Statistics; Ecosystem services; Sustainability	Yes
Otim, Ochan	Playa Del Rey	CA	Environmental Monitoring Division, City of Los Angeles	Local Government	Self	Analytical chemistry; Risk assessment; Water quality; Water quantity and reuse; Waste management	Yes
Otte, Marinus	Fargo	ND	North Dakota State University	Academic	Self	Analytical chemistry; Ecological sciences and ecological assessment; Geochemistry; Hydrology; Toxicology; Agricultural sciences; Water quality; Ecosystem services; Sustainability	Yes
Parkerton, Thomas F.	Houston	TX	ExxonMobil Biomedical Science	Industry	SAB Staff Office	Ecological sciences and ecological assessment; Risk assessment	Yes
Pastore, Christopher	Philadelphia	PA	Thomas Jefferson University	Academic	Dr. Thomas Twardowski, Thomas Twardowski	Causal inference; Complex systems; Ecological sciences and ecological assessment; Engineering; Uncertainty analysis; Ecosystem services; Sustainability	Yes

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Patisaul, Heather	Raleigh	NC	North Carolina State University	Academic	Dr. Joseph Laakso, Endocrine Society	Health sciences; Risk assessment; Toxicology	Yes
Paustenbach, Dennis J.	San Francisco	CA	Chemrisk, Inc	Consultant	Ms. Dana Hollins , Cardno ChemRisk	Health sciences; Modeling; Public health; Risk assessment; Toxicology; Drinking water; Epidemiological risk analyses; Chemical safety	Yes
Peltier, Richard	Amherst	MA	University of Massachusetts	Academic	Self	Analytical chemistry; Health sciences; Public health; Air quality; Atmospheric sciences; Community environmental health	Yes
Portier, Kenneth M.	Athens	GA	Independent Consultant	Consultant	SAB Staff Office	Public health; Statistics; Toxicology; Epidemiological risk analyses	Yes
Prather, Michael	Irvine	CA	UC Irvine	Academic	Self	Analytical chemistry; Complex systems; Modeling; Air quality; Atmospheric sciences	Yes
Ramos, Kenneth	Tucson	AZ	University of Arizona	Academic	SAB Staff Office	Medicine; Public health; Toxicology	Yes
Randtke, Stephen J.	Lawrence	KS	University of Kansas	Academic	self	Analytical chemistry; Engineering; Drinking water; Water quality; Water quantity and reuse	Yes
Rangan, Cyrus	Los Angeles	DC	Los Angeles County Department of Public Health	Local Government	Deputy Director Meghan McGinty, Big Cities Health Coalition/National Association of County and City Health Officials	Medicine; Public health; Risk assessment; Toxicology; Epidemiological risk analyses; Community environmental health	Yes

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Ready, Richard	Bozeman	MT	Montana State University	Academic	Dr. James Shortle, Penn State	Benefit-cost analysis; Causal inference; Economics; Social behavioral and decision sciences; Statistics	Yes
Rhomberg, Lorenz	Cambridge	MA	Gradient	Consultant	Dr. Richard Yamada	Risk assessment; Toxicology	Yes
Richardson, Mary Jo	College Station	TX	Texas A&M University	Academic	Dr. Mary Jo Richardson, Texas A and M University	Geochemistry; Atmospheric sciences; Energy and the environment; Sustainability	Yes
Rodewald, Amanda D.	Ithaca	NY	Cornell University	Academic	Dr Kevin Fitzpatrick, University of Arkansas	Ecological sciences and ecological assessment	Yes
Rohrs, Allison	LORETTO	PA	Saint Francis University Institute for Energy	Academic	Self	Benefit-cost analysis; Agricultural sciences; Atmospheric sciences; Energy and the environment; Sustainability	Yes
Rosenberg, Andrew A.	Cambridge	MA	Union of Concerned Scientists	Academic	Self	Causal inference; Ecological sciences and ecological assessment; Modeling; Statistics; Uncertainty analysis; Ecosystem services; Sustainability	Yes
Rosen, Barry	Detroit	MI	Wayne State University	Academic	Self	Health sciences; Microbiology; Toxicology	Yes
Rosol, Thomas	Columbus	OH	Ohio State University	Academic	Self	Health sciences; Medicine; Toxicology; Chemical safety	Yes
Runge, Steven	Conway	AR	University of Central Arkansas	Academic	Ms. Laura Young, University of Central Arkansas	Causal inference; Medicine; Microbiology; Epidemiological risk analyses; Chemical safety	Yes
Ruscher, Paul	Tallahassee	FL	Florida State University	Academic	Self	Hydrology; Modeling; Air quality; Atmospheric sciences; Energy and the environment	Yes

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Sabo-Attwood, Tara L.	Gainesville	FL	University of Florida	Academic	SAB Staff Office	Ecological sciences and ecological assessment; Risk assessment; Toxicology	Yes
Sagers, Cynthia	Tempe	AZ	Arizona State University	Academic	Dr. Sethuraman Panchanathan, EVP, Arizona State University	Ecological sciences and ecological assessment; Economics; Engineering; Public health; Agricultural sciences; Atmospheric sciences; Energy and the environment; Community environmental health; Sustainability	Yes
Saiers, James	New Haven	CT	Yale University	Academic	Dr. Ingrid Burke, Yale School of Forestry and Environmental Studies	Analytical chemistry; Causal inference; Ecological sciences and ecological assessment; Geochemistry; Hydrology; Drinking water; Energy and the environment; Water quality; Water quantity and reuse	Yes
Sakaji, Richard	El Cerrito	CA	Independent Consultant	Consultant	SAB Staff Office	Engineering; Public health; Drinking water; Water quality; Water quantity and reuse	Yes
Salvito, Daniel	Woodcliff Lake	NJ	RIFM	Other	Self	Analytical chemistry; Ecological sciences and ecological assessment; Risk assessment; Water quality	Yes
Santelmann, Mary	Corvallis	OR	Oregon State University	Academic	Dr. Susan Capalbo, Oregon State University	Ecological sciences and ecological assessment	Yes
Savitz, David	Providence	RI	Brown University	Academic	Self	Causal inference; Health sciences; Public health; Energy and the environment; Epidemiological risk analyses; Community environmental health	Yes
Schneider, David	St. John's	CA	Memorial University	Academic	Self	Causal inference; Ecological sciences and ecological assessment; Statistics	Yes

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Sherman, Michael	Raleigh	NC	North Carolina Farm Bureau Federation	NonGovernmental Association	Dr. Richard Yamada	Agricultural sciences	Yes
Shipp Hilts, Asante	Albany	NY	New York State Department of Health	State	Self	Health sciences; Public health; Social behavioral and decision sciences; Community environmental health	Yes
Simon, Ted	Winston	GA	University of Georgia	Academic	Dan Byers, Global Energy Institute	Modeling; Risk assessment; Toxicology	Yes
Skoglund, Robert	Pittsburgh	PA	Covestro LLC	Industry	Self	Public health; Risk assessment; Toxicology; Sustainability; Green chemistry	Yes
Smith, Eric	Blacksburg	VA	Virginia Tech	Academic	Professor and Head Ron Fricker, Virginia Tech Department of Statistics	Risk assessment; Statistics; Epidemiological risk analyses	Yes
Stevenson, David	Newark	DE	Caesar Rodney Institute	Research	Self	Economics; Energy and the environment	Yes
Stuart, Amy	Tampa	FL	University of South Florida	Academic	Dr. James Mihelcic, University of South Florida	Engineering; Health sciences; Modeling; Public health; Statistics; Air quality; Atmospheric sciences; Community environmental health; Sustainability	Yes
Stubblefield, William	Corvallis	OR	Oregon State University	Academic	Dr. (Professor and Chair) Craig Marcus, Oregon State University/Dept. Environmental and Molecular Toxicology	Analytical chemistry; Ecological sciences and ecological assessment; Risk assessmentn; Toxicologys; Water qualityn; Chemical safetyn	Yes

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Person	City	State	Organization	Address Affiliation	Who Referred	Special Expertise Needed	Interested in Serving
Suski, Jamie	Hunt Valley	MD	EA Engineering, Science, Technology, Inc., PBC	Consultant	Self	Ecological sciences and ecological assessment; Toxicology; Water quality; Ecosystem services	Yes
Tan, Shirlee	Seattle	WA	King County Dept Public Health	Local Government	Dr. Robert Zoeller, University of Massachusetts	Health sciences; Public health; Risk assessment; Toxicology	Yes
Tharakan, John	Washington	DC	Howard University	Academic	Self	Engineering; Hydrology; Microbiology; Air quality; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Sustainability; Green chemistry; Waste management	Yes
Theis, Thomas	Chicago	IL	University of Illinois at Chicago	Academic	Self	Benefit-cost analysis; Ecological sciences and ecological assessment; Engineering; Modeling; Risk assessment; Agricultural sciences; Energy and the environment; Water quality; Ecosystem services; Sustainability; Waste management	Yes
Thomas, Evan	Boulder	CO	University of Colorado at Boulder	Academic	Self	Causal inference; Complex systems; Engineering; Public health; Social behavioral and decision sciences; Drinking water; Water quality; Water quantity and reuse; Community environmental health; Sustainability	Yes
Thurston, George	Tuxedo	NY	New York University	Academic	Self	Benefit-cost analysis; Engineering; Medicine; Public health; Air quality; Atmospheric sciences; Energy and the environment	Yes

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Person	City	State	Organization	Address Affiliation	Who Referred	Special Expertise Needed	Interested in Serving
Tormey, Daniel	Santa Monica	CA	Catalyst Environmental Solutions Corporation	Consultant	Mr. Rock Zierman, California Independent Petroleum Association	Analytical chemistry; Benefit-cost analysis; Causal inference; Complex systems; Ecological sciences and ecological assessment; Engineering; Geochemistry; Hydrology; Hydrogeology; Modeling; Risk assessment; Uncertainty analysis; Drinking water; Energy and the environment; Water quality; Water quantity and reuse; Ecosystem services; Waste management	Yes
Trasande, Leonardo	New York	NY	New York University School of Medicine	Academic	Dr. Joseph Laakso, Endocrine Society	Benefit-cost analysis; Economics; Health sciences; Medicine; Pediatrics; Public health	Yes
Trindade, Sergio	New York	NY	SE2T International,	Consultant	Self	Benefit-cost analysis	Yes
Turner, Jay	St. Louis	MO	Washington	Academic	SAB Staff Office	Engineering; Modeling; Air quality	Yes
Tyner, Robin	Exeter	NH	USNA/NPGS/USN	Other	Self	Modeling; Risk assessment; Social behavioral and decision sciences	Yes
Ulsh, Brant	Livermore	CA	M.H. Chew & Associates	Consultant	Dr. Richard Yamada	Health sciences; Public health	Yes
Uppu, Rao	Baton Rouge	LA	Southern University and A&M College	Academic	Self	Toxicology	Yes
Vandenberg, Laura	Amherst	MA	University of Massachusetts - Amherst	Academic	Dr. Joseph Laakso, Endocrine Society	Health sciences; Risk assessment; Toxicology	Yes
Vepachedu, Venkata	Exton	PA	Pennsylvania Department of Health, COPA	State	Self	Analytical chemistry; Health sciences; Microbiology; Public health; Toxicology; Epidemiological risk analyses; Green chemistry	Yes
Viana, Louis R.	San Juan	PR	LRV NY LLC	Research	Dr. Ponisseril Somasundaran, Columbia University	Drinking water; Energy and the environment	Yes

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Wauchope, Robert D	Pisgah Forest	NC	USDA-ARS	Federal Government	Self	Analytical chemistry; Hydrology; Modeling; Risk assessment; Agricultural sciences; Water quality; Chemical safety	Yes
Werth, Charles	Austin	TX	University of Texas at Austin	Academic	Self	Engineering; Hydrogeology; Drinking water; Energy and the environment; Water quality; Sustainability; Waste management	Yes
Wiesner, Mark	Durham	NC	Duke University	Academic	SAB Staff Office	Engineering; Drinking water; Water quality; Water quantity and reuse	Yes
Williams, David	Corvallis	OR	Oregon State University	Academic	Self	Analytical chemistry; Health sciences; Toxicology; Drinking water	Yes
Williams, Lance	Tyler	TX	University of Texas at Tyler	Academic	Self	Ecological sciences and ecological assessment	Yes
Williams, Richard A.	McLean	VA	MarginalRegulation	Consultant	Dr. Richard Yamada	Economics	Yes
Yang, Raymond	Fort Collins	CO	Colorado State University	Academic	Self	Complex systems; Health sciences; Modeling; Public health; Risk assessment; Toxicology; Drinking water; Community environmental health; Chemical safety	Yes
Zhao, Feng	College Park	MD	National Oceanic Atmospheric Admnistration	Federal Government	Self	Ecological sciences and ecological assessment; Risk assessment; Agricultural sciences; Energy and the environment; Water quality; Ecosystem services; Sustainability	Yes
Zwiernik, Matthew	East Lansing	MI	Michigan State University	Academic	Dr. Richard Yamada	Complex systems; Ecological sciences and ecological assessment; Hydrology	Yes

Attachment 3
Invitation for Public Comment on the List of Candidates for the EPA Chartered Science Advisory Board
October 16, 2018

The U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Staff Office announced in a Federal Register Notice on July 9, 2018 (83 FR 31752-31753) that it was inviting nominations of experts to be considered for the Administrator's appointment to the Chartered SAB. The SAB is a scientific/technical advisory committee. The objective of the SAB is to provide independent advice and peer review on the scientific and technical aspects of environmental issues to the EPA Administrator. While the SAB reports to the EPA Administrator, congressional committees specified in ERDDAA may ask the EPA Administrator to have the SAB provide scientific advice on a particular issue.

The SAB will review scientific issues, provide independent scientific and technical advice on EPA's major programs, and perform special assignments as requested by Agency officials. The SAB Staff Office sought nominations of experts who have demonstrated experience in the following disciplines: analytical chemistry; benefit-cost analysis; causal inference; complex systems; ecological sciences and ecological assessment; economics; engineering; geochemistry; health sciences; hydrology; hydrogeology; medicine; microbiology; modeling; pediatrics; public health; risk assessment; social, behavioral and decision sciences; statistics; toxicology, and uncertainty analysis.

The SAB Staff Office is especially interested in scientists with expertise described above who have knowledge and experience in: air quality; agricultural sciences; atmospheric sciences; benefit-cost analysis; complex systems; drinking water; energy and the environment; epidemiological risk analyses; water quality; water quantity and reuse; ecosystem services; community environmental health; sustainability; chemical safety; green chemistry; homeland security; uncertainty analysis; and waste management.

The SAB Staff Office identified 175 candidates based on their expertise and willingness to serve. We hereby invite public comments on the attached List of Candidates for consideration by the SAB Staff Office. Comments should be submitted to Mr. Thomas Carpenter, Designated Federal Officer no later than November 7, 2018 at carpenter.thomas@epa.gov. E-mail is the preferred mode of receipt. Please be advised that public comments are subject to release under the Freedom of Information Act.

Candidate Biosketches - FY2019 Chartered SAB Annual Membership

Aguirre, A. Alonso

George Mason University

Dr. A. Alonso Aguirre is Chair and Associate Professor at the Department of Environmental Science and Policy at George Mason University in Fairfax, Virginia. He leads a collaborative research program that takes an ecological approach to understanding wildlife diseases and their links to conservation and human health. His research has been instrumental in revealing the impact of emerging diseases of marine wildlife populations. A wildlife biologist and veterinarian by training, he co-founded the emerging discipline of conservation medicine. He edited both seminal books on the topic and co-founded the journal EcoHealth and the International Association of Ecology and Health. He has published over 160 peer-reviewed papers, books and chapters, advised governments of countries in the Americas, Southeast Asia and Western Europe, and briefed the Mexican and U.S. Congress. He currently serves as co-editor the EcoHealth journal, and associate editor of Journal of Wildlife Diseases and the European Journal of Wildlife Management. His research has been funded by the National Science Foundation, United States Agency for International Development, U.S. Department of Agriculture, National Marine Fisheries Service, and other federal agencies and non-profit organizations. The National Academy of Sciences recently appointed Dr. Aguirre to the Board on Life Sciences in recognition of his contributions to the field of wildlife biology, and he has received numerous awards. Previously, he served as the Executive Director of the Smithsonian-Mason School of Conservation in Front Royal, Virginia and as Senior Vice President at EcoHealth Alliance in New York. He has also held appointments at the Consortium for Conservation Medicine, the Center for Environmental Research and Conservation at Columbia University, and the Center for Conservation Medicine at Tufts University Cummings School of Veterinary Medicine.

Ahrens, Kurt

School District of Philadelphia

Dr. Kurt F. Ahrens is an educator and leader of science curriculum development at The U School, an experimental high school in the Innovation Network of the Philadelphia School District. Dr. Ahrens earned a BA with three majors (Integrated Science Program, Neurobiology, and Physics) at Northwestern University and a PhD in Molecular and Cell Biology at UC-Berkeley, where his research focused on reverse engineering mammalian brain circuitry by combining experimental and computational modeling methods. Dr. Ahrens' postdoctoral research in the Physics department at UC-San Diego expanded his research repertoire to include animal behavior, advanced signal processing and statistical analysis methods, and laser-scanning microscopy. After developing in vivo imaging methods for measuring neural activity in genetically modified animals at the Center for Molecular and Behavioral Neuroscience at Rutgers University, Dr. Ahrens established the Systems Neuroscience Laboratory at the Allen Institute for Brain Science, where his research team combined these techniques with electrophysiology and computational analysis methods to begin labeling, monitoring, and deciphering the interactions of countless brain cells in the living organism. He has published his research in peer reviewed journals and has served as a peer reviewer for the Organization for Computational Neuroscience's annual international conference since 2004. Dr. Ahrens shifted to the education profession in 2012, first teaching biology and research methods at Arcadia University, and currently physics, biology and mathematics. Dr. Ahrens was an active member of the citizen committee that crafted a Sustainability Plan for Cheltenham Township, one of the first in Pennsylvania, and he currently serves as the Chairman of the Environmental Advisory Council, where he and his colleagues provide evidence-based advice on water quality, energy infrastructure and usage, local and sustainable food production, and waste management to the municipal government, local businesses and institutions, and residents. He has no research funding.

Biographical sketches of Candidates for 2016 Chartered SAB Annual Membership

Aldy, Joseph

Harvard University

Joseph E. Aldy is an Associate Professor of Public Policy and Faculty Chair of the Mossavar-Rahmani Center for Business and Government Regulatory Policy Program at the Harvard Kennedy School, a University Fellow at Resources for the Future, a Faculty Research Fellow at the National Bureau of Economic Research, and a Senior Adviser at the Center for Strategic and International Studies. He has been a Non-Resident Fellow at the Center on Global Energy Policy at Columbia University, a Visiting Scholar at the Kleinman Center for Energy Policy at the University of Pennsylvania, and a Lone Mountain Fellow at the Property & Environment Research Center. In 2009-2010, he served as the Special Assistant to the President for Energy and Environment at the White House. Aldy previously served as a Fellow at Resources for the Future, Co-Director of the Harvard Project on Climate Agreements, Co-Director of the International Energy Workshop, Treasurer of the Association of Environmental and Resource Economists, and worked on the staff of the President's Council of Economic Advisers as a Senior Economist, Senior Adviser, and Staff Economist. He earned his doctorate in economics from Harvard University, an MEM degree in resource economics and policy from the Nicholas School of the Environment at Duke University, and a bachelor degree in an independently-designed environmental science program from Duke University. Aldy's research focuses on climate change policy, energy policy, and regulatory policy. This includes publications in economics, science, and law journals on valuing mortality risk reduction, the use of market-based instruments to mitigate greenhouse gas emissions, the competitiveness impacts of climate change policy, the design of international environmental agreements, energy efficiency subsidies, renewable power subsidies, and other topics. He is a Member of the Advisory Committee for the Energy and Environment Program at the Alfred P. Sloan Foundation, a Member of the Advisory Board to The Environmental Forum, a Member of the Editorial Advisory Committee of Nature Energy, and a Member of the Advisory Board of the Economics of Energy and Environmental Policy. He is also a Member of the Board of Trustees to the Robert and Patricia Switzer Foundation. He was a Member of the Peer Review Advisory Committee to the Indiana University Corporate Average Fuel Economy Study (led by John Graham). The Administrative Conference of the United States commissioned a report by Aldy on the retrospective review of federal regulations, which included recommendations for agency practice adopted by the ACUS plenary. Government agencies have formally solicited an external peer review by Aldy on a variety of topics, including mortality risk valuation (EPA, Homeland Security, and Transportation), integrated assessment models (Energy and U.S. Global Change Research Program), guidelines for regulatory impact analysis (Health and Human Services), the benefits and costs of regulations (OMB), energy innovation and low-carbon energy policies (National Research Council and Council of Economic Advisers), and academic research projects (National Science Foundation). Over the past two years, Aldy has received funding from the Harvard Kennedy School, the Alfred P. Sloan Foundation, the National Bureau of Economic Research, and Resources for the Future.

Allen, Irving

Virginia Tech

Dr. Irving Allen is a faculty member at Virginia Tech in the Department of Biomedical Sciences and Pathobiology at the Virginia Maryland College of Veterinary Medicine. He is an active scientist with over 20 years of experience conducting research using animal models and human subjects, exploring the intersection between inflammatory diseases, cancer, and the environment. Dr. Allen holds a B.S., M.S., and PhD in Genetics and Molecular Biology, with postdoctoral training in Immunology. Early in his career, he conducted research associated with the role of environmental factors in modulating marine dinoflagellate populations and subsequently worked at Duke University studying complex genetic disorders with environmental influences (including asthma and several neurological

disorders). As his career and training advanced, Dr. Allen's research focus shifted towards exploring the role of the immune system in respiratory and gastrointestinal diseases. Over the last decade, Dr. Allen's research has expanded into studies associated with the biological effects of therapeutic and environmental nanoparticle exposure in the lung and gut. Together, he has contributed to over 60 publications in peer-reviewed journals in his various fields of research, and has broad scientific expertise in multiple areas of relevance to the EPA. Complementing his scientific expertise, he also holds a MBA, with a concentration in Bioscience Management. This allows him to view science from both the research and business perspective. He has a unique working knowledge of cost-benefit analysis and financial modeling associated with conducting basic and applied research. Dr. Allen is a current member and has served in leadership positions in several scientific societies. To date, Dr. Allen's research program has been predominately funded through the National Institutes of Health, Foundation Grants, and Private Industry Support. He has not received previous EPA financial support or served on EPA advisory committees.

Anderson, Henry

Wisconsin Division of Public Health

Dr. Henry A. Anderson, M.D. holds adjunct professorships at the University of Wisconsin-Madison, School of Medicine and Public Health, Department of Population Health Sciences, and the University of Wisconsin Institute for Environmental Studies, Center for Human Studies. In July 2016 he retired from his positions as Wisconsin State Environmental and Occupational Disease Epidemiologist, and Chief Medical Officer in the Wisconsin Division of Public Health, Department of Health Services which he held since 1980. His 35 years of research and programmatic expertise and experience includes public health; preventive, environmental, and occupational medicine; occupational and environmental human health and exposure epidemiology; human health risk assessment; regulatory risk assessment and risk communication. Active research interests include: disease and exposure surveillance systems, cancer and chronic disease epidemiology, reproductive and endocrine health hazards, drinking water contaminants, pesticides and dietary risk assessment including sport fish consumption advisory communication. Dr. Anderson served on the U.S. EPA Science Advisory Board (SAB) Chemical Assessment Advisory Committee from 2013 – 9/2018 and previously served on the EPA National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances. He was chair of the Environmental Health Committee of the U.S. EPA Science Advisory Board, served on the U.S. EPA SAB Executive Committee and is past Chair of the Board of Scientific Councilors for the National Institute of Occupational Safety and Health. He has served on five National Academies of Science Committees including "Toxicity Testing for Assessment of Environmental Agents." He serves on the Presidential Advisory Board on Radiation Worker Compensation. He is associate editor of the American Journal of Industrial Medicine. Dr. Anderson received his M.D. degree in 1972 from the University of Wisconsin-Madison. He was certified in 1977 by the American Board of Preventive Medicine with a sub-specialty in occupational and environmental medicine and in 1983 became a fellow of the American College of Epidemiology. Dr. Anderson was a state government employee until 7/2016 and his research has been supported by the State of Wisconsin and grants from U.S. government agencies, primarily U.S. Department of Health and Human Services/Centers for Disease Control and Prevention and the U.S. Environmental Protection Agency. All EPA and other federal government research support ended with his retirement in 7/2016. Dr. Anderson currently serves on the Presidential Advisory Board on Radiation Worker Compensation (2001-2006 and 2009-current), National Academies of Science Roundtable on Environmental Health Sciences, Research, and Medicine (2011-current) and 2013-2018 on the United States Environmental Protection Agency Science Advisory Board, Chemical Assessment Advisory Committee on which he reviewed Ammonia (2014-2015), Ethylene Oxide (2014-2015), and draft Chloroform, nitrate/nitrite, Ethylbenzene IAPs (2016-2017). Beginning in 1997 he served on various U.S. EPA Science Advisory Board committees including the Executive Committee (1997-2003) and

was chair of the Integrated Human Exposures Subcommittee (1997-2001) and then chair of the Environmental Health Committee (2001-2003). He served on the U.S. EPA's National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances (2006-2012), the U.S. EPA Children's' Health Protection Advisory Council (2004–2009) and the U.S. EPA Endocrine Disruptor Screening and Testing Committee (1997–1999). He was also chair of the Board of Scientific Councilors for the National Institute of Occupational Safety and Health (2004-2006). He served on the Armed Forces Epidemiology Board (1996-2000).

Auvermann, Brent

Texas A&M University

Dr. Brent Auvermann is Professor of Biological and Agricultural Engineering (BAEN) and Extension Specialist with Texas A&M AgriLife. His position with Texas A&M AgriLife consists of a joint appointment, with 65% Extension and 35% research. He also holds an Adjunct Professor appointment at West Texas A&M University. Dr. Auvermann holds a B.S. (1986) and M.S. (1990) in Agricultural Engineering from Texas A&M University, and a Ph.D. in Chemical and Bioresource Engineering from Colorado State University (1996). His research program centers on environmental aspects of concentrated livestock production, with 15 years of work in air pollution. Dr. Auvermann has obtained competitive and special grants in air-quality topics totaling multi-million dollars over the past ten years. His primary research focus has been particulate matter but has also collaborated in research on ammonia, hydrogen sulfide, dispersion modeling, and wet and dry deposition. Dr. Auvermann supervises and chairs graduate thesis/dissertation committees for M.S. and Ph.D. candidates at both Texas A&M University and West Texas A&M University. His office is located in Amarillo, TX, near the heart of the United States' cattle-feeding industry. Since 2007, Dr. Auvermann has operated the "Canonceta" deposition-monitoring sites for the National Atmospheric Deposition Program (NADP site ID: TX43) and the Clean Air Status and Trends Network (CASTNET site ID: PAL190). He has also worked closely with the concentrated dairy industry in Texas, New Mexico, and Arizona with respect to emissions measurement and mitigation techniques.

Barton, Hugh A.

Independent Consultant

Dr. Hugh A. Barton is an independent consultant for applications of systems pharmacology and toxicology to drug discovery and safety evaluation or environmental risk assessment. He provides expert advice on physiologically based pharmacokinetic (PBPK) and pharmacodynamic (PD) models and their implementation for decision-making. Dr. Barton was Associate Research Fellow with Biomedicine Design, Pfizer, Inc. for ten years. His focus in drug discovery was applying translational modeling and simulation to oncology, cardiovascular disease, and neurodegenerative diseases to assess PK, PD, and safety. His pharmacokinetic modeling to support safety evaluation for excipients lead to FDA approval of generic Pfizer docetaxel in 2014. He has more than 25 years of experience in biological modeling with Pfizer, US Environmental Protection Agency and consulting/contract companies, developing computational models for use in biologically based dose-response analyses. Dr. Barton worked in environmental consulting for several years doing site specific risk assessments for hazardous waste sites, air permitting, and other environmental regulatory requirements. He has been adjunct professor at Boston University School of Public Health and in Toxicology at The University of North Carolina at Chapel Hill. He received a B.S. in Life Sciences from the Massachusetts Institute of Technology, Cambridge, MA in 1982 and a Ph.D. in Toxicology from the Department of Applied Biological Sciences at MIT in 1988. Dr. Barton has been President of the Risk Assessment and Biological Modeling Specialty Sections of the Society of Toxicology. He has served as an invited peer-reviewer for organizations including Health Canada, NIEHS, US EPA, NAS/NRC and TERA. He is a member of the US EPA Science Advisory Board's Chemical Assessment Advisory Committee, the Simulations Plus, Inc. Science Advisory Board, and the NRC Committee on

Organohalogen Flame Retardants, and a committee reviewing pesticide PBPK models for Versar under contract to US EPA. He previously served on the NRC Committee on Inorganic Arsenic and WHO IPCS PBPK Modeling working group. He is a reviewer for numerous scientific journals and serves on two editorial boards. Dr. Barton has published more than 50 articles in the scientific literature on physiologically based pharmacokinetic and pharmacodynamic modeling and has received awards from Pfizer, EPA and others for that work and its applications in pharmaceutical safety and risk assessment. Dr. Barton's research currently has no research funding.

Bashkin, James

University of Missouri-St. Louis

Dr. Bashkin is Professor of Chemistry and Biochemistry at the University of Missouri-St. Louis. He was educated at the Universities of Arizona and California-Irvine and received his doctorate from Oxford (UK), followed by postdoctoral studies at Harvard. Half of Dr. Bashkin's career has been spent in the chemical and pharmaceutical industries and half in academia. He was Associate Editor of Green Chemistry for the Royal Society of Chemistry, served on the Editorial Advisory Board of Chemical Reviews for years for the American Chemical Society, and was just appointed to the Editorial Board of the Asian Journal of Green Chemistry. Dr. Bashkin co-invented a process that significantly decreased industrial pollution in the rubber chemical industry, for which he shared Monsanto's highest scientific award and the Presidential Green Chemistry Challenge Award. This chemistry is now practiced worldwide and has changed the economy of the business for the better since it is less polluting and less expensive. He has also served on the EPA-American Chemical Society (ACS) selection committee for the Presidential Green Chemistry Awards, Chaired the International Gordon Research Conference on Green Chemistry, and served on awards and grant committees for the ACS, NSF, and NIH. He has published over 70 papers and hold 16 US patents.

Beck, Barbara

Gradient Corp.

Dr. Beck is a principal at Gradient, an environmental risk sciences consulting firm. She is an expert in toxicology and human health risk assessment for environmental chemicals, especially metals and air pollutants. Her broad experience in risk assessment includes toxicological evaluations of many different chemicals in environmental settings, consumer products, and pharmaceuticals. These projects often lead her to work with other scientists from varying backgrounds, including engineers and chemists, to develop an integrated approach to understanding chemical hazards. Dr. Beck has conducted laboratory studies to refine the understanding of chemical exposure and toxicity, and she has applied study findings in a risk assessment context. She has published over 100 book chapters and journal articles, including the development of health-based criteria for several chemicals and probabilistic exposure models. Several of her publications have received awards from organizations such as the Society of Toxicology's Risk Assessment Specialty Section and the US EPA. She has communicated her work to different audiences, including regulatory agencies, the US Congress, and the public. Dr. Beck's participation in advisory committees and expert panels, such as the National Research Council, the International Life Sciences Institute, and the Watertown, Massachusetts Board of Health, has spanned over thirty years. She is a recipient of the Lifetime Achievement Award from the University of Massachusetts, Amherst, School of Public Health and Health Sciences. She is a fellow and past-president of the Academy of Toxicological Sciences, a Diplomate of the American Board of Toxicology, and a European-Registered Toxicologist. Before joining Gradient, she was Chief of Air Toxics Staff and Regional Expert in Toxicology for US EPA Region I. Prior to that, she was a Fellow in the Interdisciplinary Programs in Health at the Harvard School of Public Health (now the Harvard T.H. Chan School of Public Health). She received her Ph.D. in molecular biology and microbiology from Tufts University and her B.A. in biology from Bryn Mawr College (cum laude).

Becker, Jennifer

Michigan Technological University

Dr. Jennifer G. Becker is an Associate Professor of Environmental Engineering at Michigan Technological University. She holds a B.S. in Environmental Engineering from Michigan Technological University, an M.S. in Civil Engineering from the University of Illinois at Urbana-Champaign, and a Ph.D. in Civil Engineering from Northwestern University. Dr. Becker's research focuses on engineered biological processes for the sustainable treatment of groundwater, wastewater, and residuals. Specifically, she is interested in the bioremediation and environmental fate of hazardous contaminants in the subsurface, the sustainable treatment and management of residuals from municipal wastewater treatment and industrial processes, microbial processes for bioenergy production, and the treatment of emerging pollutants in municipal wastewater. Dr. Becker also has expertise and extensive outreach experience related to animal agricultural practices, their impact on the environment, and the management of their residuals. Core support for Dr. Becker's research has primarily been provided by the federal government via grants from the National Science Foundation (NSF). She is the Past-President of the Association of Environmental Engineering and Science Professors (AEESP) and served on its Board of Directors from 2010 to 2014. Dr. Becker's research has been recognized with the Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the U.S. government on outstanding scientists and engineers beginning their independent careers, as well as a NSF Early Career Development Program (CAREER) Award, the Robert A. Canham Award from the Water Environment Federation, the AEESP/Montgomery Watson Harza Master's Thesis Award (both as the advisor and student), the Junior Faculty Award from the College of Agriculture and Natural Resources, University of Maryland, College Park and several other awards.

Begley, C. Glenn

BioCurate PTY. LTD

Dr. C. Glenn Begley is the Chief Executive Officer of BioCurate Pty. Ltd., a joint venture between Monash University and the University of Melbourne. He also serves as a Scientific/Clinical Advisor for several biotech and pharmaceutical companies. Dr. Begley has over 20 years of clinical experience in medical oncology and hematology. His personal research focused on regulation of hematopoietic cells and translational clinical trials. Recently, he has focused attention on the need to improve the quality of scientific research. His pivotal publications highlighted the need for robust, reproducible research. This has catalyzed an ongoing, broad-based discussion within the scientific community and the lay press. He has numerous invitations to present his work including at the President's Science Council, National Academies Meetings, National Institute of Standards and Technology, and biotech/pharmaceutical companies. He has published over 200 papers that are highly cited (total citations 21, 536; h-index 73; i10 index 180; source Google Scholar, May 2018). He graduated in from the University of Melbourne with M.B., B.S. degrees (MD-equivalent) in 1978, and trained primarily in Melbourne, Australia, at the Walter and Eliza Hall Institute of Medical Research and at the Royal Melbourne Hospital. He is Board Certified in Australia as a Medical Oncologist and Hematologist (F.R.A.C.P.), is a Fellow of the Royal College of Pathologists, United Kingdom, and received an honorary Fellowship from the College of Pathologists, Australia. He has a Ph.D. in cellular and molecular biology from the University of Melbourne. He has received numerous honors and awards, including being elected as the first Foreign Fellow to the American Society of Clinical Investigation in 2000, and to the prestigious Association of American Physicians in 2008. In 2014 he was an inaugural inductee into the "Hall of Fame" at his alma mater, the Royal Melbourne Hospital, and elected to the Australian Academy of Health and Medical Sciences.

Belzer, Richard

Independent consultant

Dr. Richard Belzer has been an independent consultant in regulation, risk, economics and information quality. Previously he was a visiting professor of public policy at Washington University in St. Louis and staff economist in the Office of Information and Regulatory Affairs in the Office of Management and Budget. He received his Ph.D. in public policy from Harvard University (1989), Master's in Public Policy (MPP) from the John F. Kennedy School of Government (now Harvard Kennedy School) (1982), and MS and BS degrees in agricultural economics from the University of California at Davis (1979, 1980). Current original research areas include the measurement and estimation of Type I and Type II errors in the identification, placement, and discipline of children with disabilities; the analysis of benefits and costs from banning glider vehicles from the heavy-duty truck market; the development of statutorily appropriate measures of economic feasibility under the Safe Drinking Water Act; the analysis of variability in pulmonary function testing; the development of objective economic indicators to identify adverse human health effects; the improved use of human health risk assessments as inputs to benefit-cost analysis; the analysis of environmental justice ranking schemes; the analysis of patent law and examination practices; the estimation of potential cost reductions to state Medicaid programs from the substitution of electronic for tobacco cigarettes; and the economic value of subjective quality information in U.S. wine markets. Recent consulting projects have included a benefit-cost analysis of rescinding the ban on gliders from the heavy-duty truck market; reviews of California's proposed drinking water standards for hexavalent chromium and 1, 2, 3-trichloropropane; and the critique of predicted human health impacts and monetized risks attributable to air emissions from new facilities designed to achieve federal regulatory standards. Dr. Belzer is a regular contributor to scholarly professions through journal peer review and service to professional societies. He was elected Treasurer of the Society for Risk Analysis (1998, 2000) and elected Secretary-Treasurer of the Society for Benefit-Cost Analysis (2008, 2010). He earned multiple awards for exemplary performance at OMB, given the SRA's Distinguished Service Award (2003), and named a Fellow of the Cecil and Ida Green Center for the Study of Science and Society (1995). He has not received any grants from EPA, any other government agency, or any private entity. He has conducted independent research on behalf of clients or through self-funding; some projects are jointly funded. His clients since 2015 include: Fitzgerald Glider Kits LLC, the American Chemistry Council, the California Manufacturing Technology Association, the R Street Institute, and Exxon Mobil Biomedical Sciences, Inc.

Bennear, Lori

Duke University

Lori Bennear is the Juli Plant Grainger Associate Professor Energy Economics and Policy at the Nicholas School of the Environment at Duke University and the Associate Director for Educational Programs at the Duke University Energy Initiative. She received her Ph.D. in Public Policy from Harvard University (2004) and also earned an MA in Economics from Yale University (1996) and an AB in Economics and Environmental Studies from Occidental College (1995). Her research focuses on evaluating the effectiveness of flexible environmental policies including information disclosure regulations, management-based regulations, liability regimes, and demand-side management programs. She has applied these evaluations across a range of environmental domains including energy, toxics, and drinking water. Her co-edited book Policy Shock: Recalibrating Risk and Regulation after Oil Spills, Nuclear Accidents and Financial Crises was published by Cambridge University Press in September 2017. She is currently working on developing best practices for adaptive regulation of emerging technologies in the energy domain, with a focus on autonomous vehicles and offshore wind.

Bergendahl, John

Worcester Polytechnic Institute

Dr. John Bergendahl is currently the Director of the Environmental Engineering Program at Worcester Polytechnic Institute, and a tenured Associate Professor in the Department of Civil and Environmental Engineering with a collaborative appointment in Chemical Engineering. John has six years' experience as a practicing engineer in industry, and holds a B.S. in mechanical engineering, an M.S. in environmental engineering, and a Ph.D. in chemical engineering from the University of Connecticut. He conducted postdoctoral research in the Environmental and Water Resources Engineering Program at the University of Texas in Austin. His current research interests are in water quality, water reuse, sustainability, and water-energy relationships; specifically, His research seeks to increase our knowledge of physical and chemical processes for enabling sustainable design of engineered systems including water treatment and wastewater treatment systems, and identification/solution of emerging global water quality threats. John's recent research funding as PI or co-PI has come from the Center for Advanced Research in Drying (NSF and industry funded), Sandia National Laboratories, Triton Systems Inc, and Stantec, Inc. He authored and co-authored 27 peer-reviewed journal articles, participated in 61 professional presentations, authored one textbook and one book chapter, and advised over 8 Ph.D. dissertations, 19 M.S. theses, and 56 Senior engineering projects (some sponsored). He has served on numerous EPA and TRB review panels, and is on the editorial board for Soil and Sediment Contamination, An International Journal. He is also an inducted member of Chi Epsilon and Phi Kappa Phi. Dr. Bergendahl is a registered professional engineer in the State of Connecticut, and has consulted for industry.

Botkin, Daniel

University of California, Santa Barbara

Dr. Daniel B. Botkin is Professor Emeritus, University of California, Santa Barbara, where he was chairman of the Environmental Studies Program. He has also served on the faculty of Yale University's School of Forestry and Environmental Studies; George Mason University (Professor). He has worked on a wide variety of Environmental Science, from helping NASA use its LANDSAT satellite for the first time to study forests; was one of the leaders in establishing the National Science Foundation Long-Term Ecological Research Program. He has directed studies of toxic waste facilities; reserves for many endangered species, from African Elephants to salmon in the U.S. Pacific Northwest; the 1.3 million birds that used Mono Lake, California, threatened by water diversion. Other research: the effects of high levels of radiation on a New York State forest; and long-term studies of the historic data about bowhead whales and other marine mammals. He developed the first successful ecosystem computer model of forests, in use widely around the world. For 50 years, he has worked on the possibility of human-caused climate change. He has received numerous awards, most recently Who's Who Lifetime Achievement Award. He has authored 15 books, including an award-winning Environmental Science textbook. He has testified before both houses of Congress and various state houses. He earned a B.A. from the University of Rochester; a Master's Degree from the University of Wisconsin; and a Ph.D. from Rutgers University (biology/environmental science).

Brown, Derick G.

Lehigh University

Dr. Derick G. Brown is a Professor and Associate Chair of the Department of Civil and Environmental Engineering at Lehigh University. His research is in the experimentation and modeling of complex environmental systems, with a strong focus on environmental biotechnology and the relationships between microbial and physiochemical processes. Example research includes contaminant biodegradation, bacterial interactions with surfaces, and enhanced biological energy production and nutrient recovery from municipal and industrial waste streams. Dr. Brown also has expertise on the fate, transport, risk assessment and management of environmental contaminants,

including pathogenic organisms and complex chemical mixtures. Dr. Brown received a B.S. from Boston University in Aerospace Engineering; an M.S. from University of California, Irvine in Mechanical engineering; and an M.A. and a Ph.D. in Environmental Engineering from Princeton University. He spent eight years in industry working for McDonnell Douglas Space Systems Company (now Boeing) in their Advanced Technology Development division and he has been a faculty member in the Department of Civil and Environmental Engineering at Lehigh University since 2001. Dr. Brown serves or has served on numerous external scientific committees, including the the USEPA Science Advisory Board's Environmental Engineering Committee. He is a Registered Professional Engineer in California and Pennsylvania and is an American Academy of Environmental Engineers and Scientists Board-Certified Environmental Engineer. Dr. Brown's research funding over the past two years includes the National Science Foundation, the Pennsylvania Infrastructure Technology Alliance, the Qatar National Research Fund, and Evoqua Water Technologies. His research has been published in numerous peer-reviewed articles in leading environmental engineering and science journals and Dr. Brown has presented his research at national and international conferences and at invited seminars, panels and workshops.

Bus, James

Exponent, Inc.

Dr. James S. Bus is a Senior Managing Scientist in the Health Sciences Group of Exponent, a leading global consulting firm (May 2013-present). Prior to joining Exponent, Dr. Bus retired from The Dow Chemical Company as Director of External Technology and Fellow in the Toxicology and Environmental Research and Consulting unit (1989-2013). Prior to Dow, he held positions as Associate Director of Toxicology and Director of Drug Metabolism at The Upjohn Company (1986-1989), Senior Scientist at the Chemical Industry Institute of Toxicology (CIIT, 1977-1986), and Assistant Professor of Toxicology, University of Cincinnati (1975-1977). Dr. Bus has served in advisory roles to a variety of institutions including ILSI, ILSI-HESI, The Hamner Institutes (formerly CIIT), American Chemistry Council Long-Research Initiative, and on advisory boards of the EPA (BOSC and Chartered SAB), FDA (NCTR), the National Toxicology Program, and the National Academy of Sciences (BEST). He has served as President of the Society of Toxicology, The American Board of Toxicology, and the Academy of Toxicological Sciences, and in various editorial roles for Toxicology and Applied Pharmacology, Environmental Health Perspectives, and Regulatory Toxicology and Pharmacology. Dr. Bus has received the Society of Toxicology Achievement (1987) and Founders (2010) awards, the Toxicology Forum George H. Scott Award (2013), Rutgers University Robert A. Scala Award (1999), the Michigan State University K.E. Moore Outstanding Alumnus Award), and the International Society of Regulatory Toxicology and Pharmacology International Achievement Award (2015). He received his B.S. in Medicinal Chemistry from the University of Michigan (1971) and PhD in pharmacology from Michigan State University (1975), and currently is an Adjunct Professor in the Dept. Pharmacology and Toxicology at that institution. He has authored/co-authored over 130 publications, books, and scientific reviews. His primary research interests include modes of toxic action of industrial chemicals and pesticides, including the importance of non-linear toxicokinetics as a key consideration for improving the human relevance of in vitro and in vivo toxicity test findings.

Caneba, Gerard

Michigan Tech University

Prof. Gerard T. Caneba is a professor of chemical engineering at Michigan Technological University. He started as a faculty member at Michigan Tech in 1985, and served as director of the Center for Environmentally Benign Functional Materials (CEBFM) in 2007-2015. He finished his bachelor's degree -in 1979 from the University of the Philippines in Quezon City. He was a recipient of a United Nations fellowship for the M.S. degree he obtained from the University of California at Berkeley, CA

in 1982. He finished his Ph.D. in 1985, and became a faculty member at Michigan Tech the same year. He is a small business owner, which is starting to scale-up a process that was developed initially through a P3 (People, Prosperity, and Planet) Phase I project in 2012. He worked with the Michigan Tech-based Center for Clean Industrial and Treatment Technologies (CenCITT) in the 1990s, which culminated in his generation of a report on environmental aspects of polymer products. He was a faculty fellow at Argonne National Laboratory in 2001, and National Aeronautical and Space Administration (NASA)-Johnson Space Center in 2003-2004. He was an active member of the University Senate in 2008-2013 as a Senator-at-Large; he chaired for 5 years its Administrative Policy Committee, which ran the annual evaluation survey of the university president and vice-presidents. He discovered the free-radical retrograde-precipitation polymerization (FRRPP) process, which has been documented in journal articles and two monographs authored or co-authored by him to generate environmentally responsible polymer materials. Most recently (2017-2018), he authored a book that used chemical engineering concepts to propose a new 12-step mechanism of natural climate change, which emanates from deep in the oceans; he analyzed this deterministic mechanism quantitatively with his own set of model calculations backed by experimental data. He has no research funding in the past two years.

Cantrell, Louis

Profitable Weather, LLC

Dr. Louis E. Cantrell Jr. is an American Meteorological Society (AMS) Certified Consulting Meteorologist (CCM) currently serving on the AMS CCM Board. He is presently an advisory consultant to Technology Planning and Integration for Observation office at NOAA/NESDIS Silver Spring, MD. He advises the NOAA Observing System Council and NOAA Research Councils on investments in NOAA's nearly $2.5B annual observing systems portfolio.

Chandra, Dhyan

Roswell Park Comprehensive Cancer Center

Dr. Dhyan Chandra is an Associate Professor of Oncology in the Department of Pharmacology and Therapeutics at Roswell Park Comprehensive Cancer Center, Buffalo, New York. The focus of research in his laboratory is to understand the underlying mechanisms of drug toxicity in cancer and normal cells. The main objectives of his laboratory are to: understand mitochondria-mediated cell death signaling in cancerous and normal cells; and define the role of heat shock proteins in cell survival and death. He has acquired extensive expertise and experience in mitochondrial biology and cell death. These types of research activities will be important in understanding cellular responses to environmental toxicants including toxic metals and radiation, which have been associated with various human diseases including cancer. He has been serving as an expert reviewer for scientific journals and national / international grants funding agencies. He is a member of editorial board of various science journals, and has delivered lectures at scientific conferences and at academic institutions. He earned his PhD degree in the field of radiation and cancer biology from the Jawaharlal Nehru University, New Delhi, India. During his postdoctoral training at the University of Texas MD Anderson Cancer Center, he studied the mitochondrial regulation of cell death in cancer. His research for the last 2 years has been funded by National Institutes of Health.

Chen, Celia

Dartmouth College

Dr. Celia Chen is a Research Professor in the Department of Biological Sciences at Dartmouth College and the Director of the Dartmouth Toxic Metal Superfund Research Program. For the last 23 years, she has studied the fate and effects of metal contaminants in freshwater and estuarine ecosystems particularly the bioaccumulation and trophic transfer of mercury. She has also investigated the effects of multiple stressors on aquatic organisms, including the impacts of changes related to

climate on aquatic food webs. Dr. Chen received a B.A. in Biology at Dartmouth College, M.S. in Biological Oceanography at the University of Rhode Island, and a Ph.D. in Ecology from Dartmouth College. In the Dartmouth Toxic Metals Program, she is also the Core Leader of the Research Translation Core working to communicate scientific information to improve human health and the environment. She has chaired regional and international workshops and meetings on mercury in the environment. She represents Dartmouth College on the United Nations Environment Programme Fate and Transport Partnership and participated in the conferences of the Minamata Convention. She is currently a Review Editor for the journal, Ecohealth, and has been a guest editor of special issues in Environmental Research, Environmental Health Perspectives, Estuaries and Coasts, Ecohealth, Science of the Total Environment, and Ambio. She has published over 70 peer-reviewed papers. She served on the U.S. EPA Science Advisory Board Mercury Panel, the Ecological Processes and Effects Committee, and the Lake Erie Phosphorus Objectives Review Panel. She also has served on the Boards of the North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry, Gelfond Fund at Stony Brook University, and the Scientific Advisory Committee of the Lake Sunapee Protection Association. Her research has recently been supported by the NIEHS, the CDC, the USDA, the USEPA, and the Sea Grant Program of NOAA.

Chitikela, S. Rao

RC-WEE Solutions LLC

Dr. S. Rao Chitikela is a consulting engineer practicing in the water, energy, and environmental compliance specialty areas related to the industrial-manufacturing and municipal water operations. He has significant work experience with both government and private entities, and maintains effective interaction with the academia; currently, he is working with his own firm RC-WEE Solutions LLC. He is a registered professional engineer (P.E.) in the States of OH, IN, MI, PA, DE, NJ, NY, and P.Eng., in Alberta-Canada; also, a Board Certified Environmental Engineer (BCEE) in the Water Supply & Wastewater, and Air Pollution Control specialties. Rao's expertise includes: water and wastewater treatment; air pollution monitoring and control; water infrastructure updating; environmental permitting and auditing; and, energy auditing. His research work included: fate of chemicals in the environment; ammonia emissions of poultry operations; drinking water quality; wastewater and greenhouse gases; air pollutant monitoring, control, and compliance verification; municipal and industrial-manufacturing facilities' environmental permitting and compliance; and, the application of water infrastructure updating via performance infrastructure contracting. He conducted several stakeholder meetings on environmental permitting and negotiations (including enforcement). He was a committee member on 'Chronic Violator Regulation Development' in the State of Delaware (2002). He is an active member of Environmental Permitting, Groundwater Quality, Renewable Energy Technologies, and Sustainability Committees, and Municipal Water Infrastructure Council of the Environmental and Water Resources Institute (EWRI); also, a contact on Government Relations of the American Society of Civil Engineers (ASCE). He is a peer reviewer and, published technical papers and presented on the key topics above. Rao earned his bachelor's, master's, and Ph.D., in Civil Engineering from the Andhra University (India), Nagpur University (India), and University of Delaware (USA), respectively. He did not receive any research grants or funds in the last two (2) years.

Chorghade, Mukund

THINQ Pharma

Dr. Mukund S. Chorghade is President and Chief Scientific Officer, THINQ Pharma / MVRC Research/ Chicago Discovery Solutions. He holds Adjunct Research Professor / Visiting Fellow / Scientist appointments at Harvard, MIT, Princeton, Cambridge, Caltech, Rutgers, Strathclyde and others. He provides synthetic chemistry and chemical development expertise to academic laboratories, agrochemical, pharmaceutical and biopharmaceutical companies. His research interests are in

Traditional Medicine derived New Chemical Entities and his discovery of "chemosynthetic livers" that find utility in drug metabolism, valorization of biomass and environmental remediation. The livers are proprietary oxidative catalysts to conduct and predict metabolic profiling of chemical entities. (in vitro and ex vivo): Metabolites can be synthesized and screened in multi-gram quantities. Dr. Chorghade earned B. Sc. M. Sc. degrees from the University of Poona, and a Ph. D. at Georgetown University. He completed postdoctoral appointments at the University of Virginia and Harvard, visiting scientist appointments at University of British Columbia, College de France / Universite' Louis Pasteur, Cambridge and Caltech and directed research groups at Dow Chemicals, Abbott Laboratories, CytoMed and Genzyme. He received three "Scientist of the Year Awards" and is on the Scientific Advisory Board of several corporations / foundations. He is a Fellow of the American Chemical Society, American Association for the Advancement of Science, American Institute of Chemists and The Royal Society of Chemistry, the Maharashtra, Andhra Pradesh and Telengana Academy of Sciences and has been a featured speaker in national and international symposia that have received favorable press coverage. He was ACS Section Chair (Brazoria 1990) and Northeastern (2007). He is Chair-Elect of the Princeton Section (2018). He is an active participant in ACS' Career Services / Professional Development / Entrepreneurship and the Small Chemicals Businesses Division. He is the Chair of the RSC Committee on Process Chemistry and Technology (2018-9).

Chorover, Jon

University of Arizona

Dr. Jon Chorover is Professor and Head, Department of Soil, Water and Environmental Science at the University of Arizona (UA). He received his B.S. (Environmental Science) from University of Michigan, and M.S. (Forest Science) and Ph.D. (Soil and Water Chemistry) from UC Berkeley, worked as an NSF postdoctoral fellow in Analytical Chemistry at University of Geneva, and was on the faculty of Penn State University before joining the faculty of University of Arizona. His research group explores the biogeochemistry of soil, sediment and water through laboratory and field-based experiments probed with advanced analytical chemistry techniques. Of particular interest is resolving how mineral-organic interactions influence the weathering of soils, the stabilization of organic carbon, and the speciation, mobility and bioaccessibility of pollutants. His research is funded by the National Science Foundation, the National Institute of Environmental Health Sciences, and the Department of Energy. He directs a core analytical chemistry facility, the Arizona Laboratory for Emerging Contaminants and serves as principal investigator of the Santa Catalina Mountains – Jemez River Basin Critical Zone Observatory (http://criticalzone.org/catalina-jemez/), funded by the National Science Foundation.

Christy, John R.

University of Alabama in Huntsville

Dr. John R. Christy is the Director of the Earth System Science Center, Distinguished Professor of Atmospheric Science and Alabama's State Climatologist at the University of Alabama in Huntsville where he has been employed for over 30 years. His responsibilities include managing a science center with over 80 employees working on several research projects ranging from developing and launching space-based instruments to studying impacts of significant weather events in developing countries to high-resolution studies of air pollution (air-chemistry and meteorology) in the Southeast. His own research concerns developing, constructing and refining global and regional climate data records which may be used to test claims of climate variability and change and to understand the climate's sensitivity to various forcing factors, resulting in almost 100 peer-reviewed publications. As State Climatologist he interacts with the government, industry and the public regarding climate resources in Alabama that may be utilized in environmentally and economically sustainable ways. A Fellow of the American Meteorological Society (AMS), Dr. Christy was selected for (a) the AMS Special Award as

co-author of the first satellite-based global bulk-atmosphere temperature record and (b) NASA's Medal for Exceptional Scientific Achievement. He has served on panels of the National Research Council and National Academy of Sciences as well as the Earth Science Subcommittee of the NASA Advisory Council. He has been called to testify before 20 Congressional Hearings and approved as an expert witness in U.S. Federal Court on climate issues. He earned both the M.S. and PhD. Degrees in Atmospheric Sciences from the University of Illinois. Present research is funded by the State of Alabama, NASA and the Department of Energy.

Clasen, Thomas

Emory University

Thomas Clasen, an epidemiologist, is Professor of Environmental Health and Rose Salamone Gangarosa Chair of Sanitation and Safe Water at the Rollins School of Public Health, Emory University where he teaches courses on the critical appraisal of water, sanitation and hygiene research and on US environmental health law and policy. He has led more than $40 million in research on household-level environmental health interventions in low-income countries. His work has been published in leading journals, including The Lancet Global Health, The BMJ, PLOS Med, Environmental Health Perspectives, WHO Bulletin, Epidemiology, and the International Journal of Epidemiology. His research includes randomized controlled field trials to assess the health impact of water, sanitation and household air pollution interventions, systematic reviews of water quality and sanitation interventions to prevent diarrhoeal disease and enteric infection, assessments of water and sanitation interventions in emergency and outbreak response, and cost and cost-effectiveness analyses of water and sanitation interventions in developing countries. His current research includes a multi-country trial to assess the health impact of LPG stoves; a large-scale trial of a program provide water filters and improved cook stoves to lower income populations in Rwanda; a matched-cohort study to evaluate a rural water and sanitation programmes in Orissa, India; and an evaluation of a slum redevelopment intervention in Fiji and Indonesia. Prof. Clasen is the chief advisor to the World Health Organization in developing the first set of Guidelines for Sanitation and Health. Prof. Clasen holds an MSc (Control of Infectious Diseases) and PhD from the University of London; he also holds a JD (Law) from Georgetown University.

Clewell, Harvey

Ramboll Environment and Health

Dr. Harvey J. Clewell is a research scientist with over forty-five years of experience in environmental quality and toxicology research, chemical risk assessment and hazardous materials management. He is currently a Principal Consultant with Ramboll. He received a Master's Degree in Chemistry from Washington University, St. Louis, and a PhD in Toxicology from the University of Utrecht, the Netherlands. He is a Diplomate of the American Board of Toxicology and a Fellow of the Academy of Toxicological Sciences, and holds the position of Visiting Scientist at the University of Utrecht in the Netherlands. He has authored more than 200 peer-reviewed scientific publications and a number of book chapters. He has gained an international reputation for his work on the incorporation of mechanistic data and mode of action information into chemical risk assessments, having played a role in the first uses of physiologically based pharmacokinetic (PBPK) modeling in cancer and non-cancer assessments by EPA, ATSDR, OSHA, and FDA. Dr. Clewell has served on external peer review panels for a number of EPA guidelines, including those for cancer risk assessment, risk characterization, benchmark dose modeling, and dermal absorption, and has participated in chemical-specific reviews conducted by the EPA Scientific Advisory Board and the FIFRA Scientific Advisory Panel. He also served as a member of the ECVAM Scientific Advisory Panel from 2012 to 2016. Over the years he has performed research for a wide variety of clients, including the EPA, FDA, NIEHS, ATSDR, Health Canada, TCEQ, ACC, CEFIC, Pfizer, DuPont, Dow Corning, EPRI, NIPERA, Syngenta and Cosmetics Europe. In 2007 the Society of Toxicology recognized Dr. Clewell with the

Arnold J. Lehman Award for major contributions to chemical safety and risk assessment.

Cobb, Kim

Georgia Inst. of Technology

Dr. Cobb is the Georgia Power Chair and Professor in the School of Earth and Atmospheric Sciences (http://shadow.eas.gatech.edu/~kcobb/) and the Director of the Global Change Program (https://globalchange.gatech.edu) at Georgia Institute of Technology. She is also the ADVANCE Professor for diversity, equity, and inclusion in the College of Science at Georgia Tech. She is the founding Director of the Carbon Reduction Challenge (http://carbonreduction.gatech.edu), which partners students with organizations to reduce greenhouse gas emissions while saving money. She received her B.A. from Yale University in Biology and Geology in 1996, and her Ph.D. in Oceanography from the Scripps Institute of Oceanography in 2002. She spent two years as a Postdoctoral Fellow at Caltech before joining the faculty at Georgia Tech in 2004. She is Editor for Geophysical Research Letters, the flagship journal of the American Geophysical Union, serves on the international CLIVAR Pacific Panel, is Co-Chair of the US CLIVAR Working Group on Water Isotopes, and is a Lead Author for the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Dr. Cobb's research uses corals and cave stalagmites to probe the mechanisms of past, present, and future climate change, with a focus on ocean temperature extremes related to the El Niño-Southern Oscillation. She has sailed on multiple oceanographic cruises to the deep tropics and led caving expeditions in the remote rainforests in Borneo for her geochemical and climate research. In her lab at Georgia Tech, Dr. Cobb and her associates measure the geochemistry of rock samples and water samples from across the world, focusing on trace metal and isotope geochemistry, including radiometric dating techniques. More recently, her research has expanded to include the study of climate change impacts on coral reef ecosystems, as well as "smart" sea level sensor networks for coastal emergency planning and response – projects which have her leading and/or participating in large interdisciplinary research teams. Dr. Cobb received a NSF CAREER Award and a Presidential Early Career Award for Scientists and Engineers in recognition of her research accomplishments, and has received federal funding from NSF and NOAA in support of her research program.

Cohen, Steven

Columbia University

Dr. Cohen is the former Executive Director of Columbia University's Earth Institute, and now serves as a senior advisor for the Institute. He is a former policy analyst and consultant to the U.S. Environmental Protection Agency. Dr. Cohen has served on numerous boards and committees, including the Board of the Pew Faculty Fellowship in International Affairs, the Executive Committee and Committee on Accreditation and Peer Review of the National Association of Schools of Public Affairs and Administration, and the U.S. Environmental Protection Agency's Advisory Council on Environmental Policy and Technology. He currently serves on the Board of Directors of Homes for the Homeless, Board of Directors of the Willdan Group, Inc., Advisory Board of the University of Minnesota's Institute on the Environment, Steering Committee for the Porter School of Environmental Studies at Tel Aviv University. Dr. Cohen also serves on the Judging Committee for the Yidan Prize Foundation and is the Chair of the Lotos Club's Science and Technology Committee. Dr. Cohen is the author of The Sustainable City (2017), Understanding Environmental Policy (2006, 2014), Sustainability Management (2011), The Effective Public Manager (1988, now co-authored in its fifth edition), and the co-author of Sustainability Policy: Hastening the Transition to a Cleaner Economy (2015), The Responsible Contact Manager (2008), Strategic Planning in Environmental Regulation (2005), Tools for Innovators: Creative Strategies for Managing Public Sector Organizations (1998), and Total Quality Management in Government (1993). He has written numerous articles on public management, sustainability management, and environmental policy. Dr. Cohen also writes a weekly blog for the Earth Institute's State of the Planet website.

Cooper, Cal

Apache Corporation

Dr. Cal Cooper is Director of Special Projects and Emerging Technologies at Apache Corporation in Houston, TX. He earned his Ph.D. in Geology and Geophysics from Rice University and did his undergraduate in Geophysical Sciences at the University of Chicago. He has been an industry leader across broad areas of applied sciences. At Apache Corporation since 2009 he has led teams to enable the recycling and use of produced water instead of using fresh water resources for hydraulic fracturing. He has championed the use of inherently safer chemicals and funded innovative ways to produce highly reactive and useful chemicals on-site in processes that maximize safety and minimize risk to humans and eliminate any residual risk to freshwater resources. He has also researched the availability of groundwater resources, especially brackish water in west Texas. His active research includes advanced water treatment systems, innovative carbon based gas separation devices, developing tools for environmental remediation of salts and how to limit seismicity associated with underground injection. He evaluates methane detection and emissions quantification techniques. Dr. Cooper was among the first industry scientists to participate in EPA workshops on Hydraulic Fracturing. He also testified about proposed EPA studies of hydraulic fracturing to the U.S. House Committee on Space, Science and Technology. He played a pivotal role in the realization of FracFocus, the hydraulic fracturing chemical disclosure register, and acted as an advisor to the Groundwater Protection Council. Prior to joining Apache, Dr. Cooper was ConocoPhillips Corporate Science Fellow as well as Chief Geoscientist and Center Manager of Geosciences in the corporate technology organization. He served as the Vice Chairman of the Carbon Capture Project, and on the boards of several thematically related international projects. He has also served on advisory boards for scores of US university programs. Dr. Cooper has not received any funding from non-employer sources since Ph.D. completion.

Cruz-Rivera, Edwin

University of the Virgin Islands

Dr. Edwin Cruz-Rivera is an Associate Professor in the Department of Biological Sciences at the University of the Virgin Islands. He holds a B.S. in Industrial Microbiology from the University of Puerto Rico in Mayagüez and a Ph.D. in Marine Science from the University of North Carolina at Chapel Hill. He has over 20 years of experience in the fields of ecology and marine biology, and has published his research in some of the most prestigious journals in the field. Dr. Cruz-Rivera has been faculty in the USA, the Middle East and Asia before joining the University of the Virgin Islands in 2014. He has taught a variety of courses in ecology, marine biology, zoology, environmental sciences, marine biotechnology, research ethics and general science at both undergraduate and graduate levels. His research interests are in marine ecological and evolutionary processes at various levels of organization, ranging from individuals to ecosystems. His research spans chemical ecology, plant-herbivore/consumer-prey interactions, nutritional ecology, parasite ecology and taxonomy, and invasive species. He has worked in broadly diverse ecosystems, including the North Atlantic, the Chesapeake Bay, the Mediterranean Sea, the tropical Pacific, South Australia, the Red Sea, the Caribbean, brackish lakes in Egypt, and the South African intertidal. Before his academic career, he also served as Executive Director of a public-private partnership aimed at improving drinking water quality in Puerto Rico.

Cushing, Robert

Carollo Engineers, Inc

Dr. Robert Cushing is a Senior Vice President with Carollo Engineers, Inc. In his 21 years with the company, he has been at the forefront of applied research projects for water treatment and improved water quality, as well as studies, plans, designs, cost estimation, and construction of water and sewer infrastructure. Throughout his career, Dr. Cushing has coupled fundamental scientific concepts with

sound engineering practices to provide creative, innovative, and enduring solutions to water and wastewater challenges. Dr. Cushing has practiced nationally, providing service to a broad cross-section of some of the nation's largest and most visible utilities, including New York City and Washington, D.C. Yet he has also provided solutions to smaller agencies with critical and unique water quality challenges, such as the Ouray National Fish Hatchery in Utah. His background and expertise in water and wastewater quality and treatment as well as facility design, construction, and cost estimation, will bring unique and valuable perspectives and insights to the agency and SAB. Dr. Cushing holds a BS in Petroleum Engineering and MS and PhD degrees in Civil Engineering all from the University of Texas at Austin. He is a Registered Professional Engineer and is a Board Certified Environmental Engineer by the American Academy of Environmental Engineers. He has published numerous articles in the peer-reviewed literature and has served on numerous scientific and engineering committees. Dr. Cushing has received no research funding over the past two years.

Davidson, Eric

University of Maryland Center for Environmental Science

Eric A. Davidson is Director and Professor at the Appalachian Laboratory of the University of Maryland Center for Environmental Science. Previously, he was Senior Scientist, President, and Executive Director at the Woods Hole Research Center, Massachusetts. Davidson received a Ph.D. in forestry from North Carolina State University and held post-doctoral positions in soil microbiology and biogeochemistry at University of California-Berkeley and NASA Ames Research Center. He currently serves as President of the 60, 000-member American Geophysical Union and previously was President of its Biogeochemistry section. He is a Fellow of the American Association for the Advancement of Science. He served as the Coordinator of the North American Center for the International Nitrogen Initiative and was the leader of an NSF Research Coordination Network on Reactive Nitrogen in the Environment. The Institute for Scientific Information Clarivate Analytics lists him as a Highly Cited Researcher. Davidson studies the exchange of plant nutrients from land to streams and groundwater, soil carbon dynamics, and the exchange of greenhouse gases between soil and atmosphere. He has worked in forests, cattle pastures, and agricultural fields of Brazil, Central America, Canada, and the USA. Current USDA-funded research focuses on potential "pollution swapping" at an operational farm on the Delmarva Peninsula, where drainage control structures are a best management practice designed to reduce nitrate leaching to ditches, rivers, and the Chesapeake Bay, but could also increase emissions of the greenhouse gases, nitrous oxide and methane. Other recent funding sources include the National Science Foundation, National Park Service, and Maryland Sea Grant. Davidson collaborates on international synthesis projects regarding global budgets of nitrogen and nitrous oxide. Finally, he is co-leading a National Socio-Environmental Synthesis Center project to develop quantitative biophysical and socio-economic indicators of progress toward the Sustainable Development Goal 2 on alleviating hunger and promoting sustainable agriculture.

Davis, Alexander

Carnegie Mellon University

Dr. Alex Davis has worked as an Assistant Professor in the Department of Engineering and Public Policy at Carnegie Mellon University beginning in 2015 after working as a post-doctoral researcher and research scientist from 2012-2015. He has served as chair, co-chair, or committee member for the dissertations of 14 PhD students. His expertise is in individual human decision-making at the technological frontier, where members of the public must understand complex and often uncertain technical issues, then express their preferences for alternative courses of action that involve tradeoffs between cost, risk, and benefit. To do this, Dr. Davis draws on his background in Behavioral Decision Research, an interdisciplinary field that uses psychological and economic perspectives to understand decision-making. His research aims to aid decision-making using technology, risk communication, and interventions. He teaches a Ph.D-level course in data analysis, including the causal evaluation of

policy impacts on socio-economic outcomes, and a course Stochastic Discrete Choice Models focusing on characterizing individual preference based on foundational psychophysical and economic theory dating back to the early 1900's up to the modern era. Dr. Davis has published peer-reviewed articles in Nature Climate Change, the Proceedings of the National Academy of Sciences, Environmental Research Letters, Energy Policy, and the Journal of Experimental Psychology, among others. He earned a B.S. in Psychology with minors in Biology and Mathematics from Northern Arizona University, and an M.S. and Ph.D. from Carnegie Mellon University in Behavioral Decision Research. Dr. Davis' research has been funded by the Richard King Mellon Foundation, the Manufacturing Futures Initiative, the Hillman Foundation, the Center for Machine Learning and Health, the Electric Power Research Institute, and the Swedish Foundation for the Humanities and Social Sciences. He has served as an ad-hoc reviewer and panelist for the National Science Foundation and numerous peer-reviewed journals.

Dayaratna, Kevin

The Heritage Foundation

Kevin D. Dayaratna is Senior Statistician and Research Programmer in The Heritage Foundation's Center for Data Analysis (CDA). An applied statistician, Dayaratna has researched and published on the use of high-powered statistical models in public policy, medical outcomes, business, economics, and even professional sports. Dr. Dayaratna is part of the CDA team that maintains scores of databases and statistical models to support policy research; provides confidential reviews of legislation for members of Congress and the White House; and supplies data and analysis for news organizations. At CDA, Dayaratna instituted the Heritage Energy Model, derived from the Energy Information Administration's National Energy Modeling System, to help policymakers understand the long-term economic effects of energy policy proposals. He has also published extensively on integrated assessment modeling regarding the social cost of carbon, methane, and nitrous oxide. In addition to energy modeling, Dr. Dayaratna also works on statistical modeling pertaining to important climate, tax, labor, health care, welfare, and entitlement policy questions. Regarding energy and climate modeling, Dr. Dayaratna's research has been referenced by both the Obama and Trump administrations. In 2013, Dr. Dayaratna found a mistake in the Obama administration's social cost of carbon modeling, and shortly thereafter, this modeling had been opened up to public comment. In terms of the social cost of carbon and its use in policymaking, Dr. Dayaratna has published both at Heritage and in the peer-reviewed literature, given numerous talks, and has testified twice in front of Congress. Additionally, Dr. Dayaratna's work on energy policy modeling has been recently referenced by the Trump administration. Dayaratna did his undergraduate work at the University of California, Berkeley, majoring in applied mathematics. He also holds a Ph.D. in mathematical statistics as well as two masters' degrees from the University of Maryland, one in business and management and the other in mathematical statistics. Dr. Dayaratna's research has been done as part of his employment at The Heritage Foundation. The Heritage Foundation is a nonprofit 501(c)(3) organization which relies on the financial support of the general public, including individuals, foundations, and corporations. He has also done some independent contract work supported by Lam Research on big data computation.

Dhanasekaran, Danny

University of Oklahoma

Dr. Danny N. Dhanasekaran is the Deputy Director of Basic Cancer research at the Stephenson Cancer Center of the University of Oklahoma. He is also an Endowed Chair and Professor of Cell Biology at the University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma. He has been employed by the University since 2009 and has managed the cancer center's basic research activities and the infrastructure development for cancer research. Dr. Dhanasekaran serves as the Director of NIH-sponsored Center for Biomedical Research Excellence, a federal initiative to increase research infrastructure in Oklahoma. His tenure also includes his professorship at the Temple University

School of Medicine, Philadelphia from 1992 to 2009. Dr. Dhanasekaran has graduated with a M.S. in Molecular Biology and Ph.D. in Biochemistry. His research for the past twenty years has been funded by various Federal agencies including National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), Air Force Research Laboratory (AFRL), Department of Defense (DoD), and Defense Advanced Research Projects Agency (DARPA). He has a strong technical background and research interest in carcinogen identification, chemical and biological effects of carcinogens, their exposure toxicity, and kinetics. He has worked with several federal agencies such as Department of Defense, NASA, and DARPA in monitoring environmental toxicants and detecting water contaminants. Dr. Dhanasekaran has published more than 100 articles in the peer-reviewed literature, serves on numerous external scientific committees, and has provided invited presentations at National and International meetings. He is on the editorial board of several cancer research journals. He has extensive knowledge on federal regulatory and risk assessment issues related to cancer promoting carcinogens and toxicants. He has been granted two patents, one of which is on the detection of chemical toxicants. Dr. Dhanasekaran has been serving as a scientific and technical reviewer for several national and international research agencies. He also serves as an advisor for NIH intramural funding. In addition to participating in scientific meeting and conferences, he has conducted several media interviews.

Dinov, Ivo

University of Michigan

Professor Ivo Dinov is an expert in mathematical modeling, statistical analysis, computational processing, scientific visualization of large datasets (Big Data), and predictive health analytics. He directs the SOCR Resource, the MNORC Integrative Biostatistics and Informatics Core, and the Udall PD Biostatistics and Data Management Core. He co-directs the Center for Complexity and Self-management of Chronic Disease (CSCD Center) and the multi-institutional Probability Distributome Project. Dr. Dinov is an Associate Director for Education and Training, of the Michigan Institute for Data Science (MIDAS). He is a member of the American Statistical Association (ASA), the International Association for Statistical Education (IASE), the American Medical Informatics Association (AMIA), the American Association for the Advancement of Science (AAAS), as well as an Elected Member of the Institutional Statistical Institute (ISI). Dr. Dinov has published over 150 scientific articles in peer-reviewed journals and is the author of the textbook "Data Science and Predictive Analytics". He earned degrees in mathematics and statistics from Sofia University, Michigan Technological University, and Florida State University, and completed a postdoctoral training in computational neuroscience at the University of California, Los Angeles. His recent research is supported in part by the National Science Foundation, the National Institutes of Health, and the Elsie Andresen Fiske Research Fund.

DuPree, Gabriel

University of Florida

Mr. Gabriel Dupree received his Bachelor of Science in Natural Resource Conservation from the University of Florida, where he also completed post-baccalaureate graduate studies in Environmental Policy and Management in Ecological Engineering and was elected to the Student Government Senate. Mr. DuPree has over 13 years of experience in both the public and private sectors working on high profile environmental projects of local, regional, national, and global significance. Geographically, his career experience encompasses the high desert of the West Coast, the Piedmont and Atlantic Coastal Plain of the North and Southeast, prairies and agricultural areas of the Midwest, and subtropical dry forest of Puerto Rico. He worked on the world's largest solar and wind power projects, while also leading numerous environmental compliance field investigations in the nuclear, oil, and natural gas sectors. Mr. DuPree worked at the nation's largest Superfund sites to remediate hazardous waste contamination and at a wide range of military installations across the country,

demonstrating some of the most innovative and cost-effective geophysical and geospatial technologies. Highly skilled in environmental policy analysis, biological monitoring, endangered species assessments, environmental health, and water resources management, Mr. DuPree currently serves as a mayoral appointee on the City of Jacksonville's Environmental Protection Board, where he exercises regulatory authority, oversees the review of environmental permits and enforcement actions, promulgates regulations, and acts as a technical resource for management and staff of the city's Environmental Quality Division. While he is not currently accepting research funding, Mr. DuPree does consider funding requests from citizens that appear before the board. Previously, he served as Vice Chair of the Alachua County Commission's Environmental Protection Advisory Committee advising the County Commission on air quality, water resources and responsible management of public lands. In his spare time, Mr. DuPree enjoys giving back to his community through volunteering, philanthropy, and mentoring.

Embertson, Nichole M.

Whatcom Conservation District

Dr. Nichole Embertson is a Nutrient Management and Air Quality Specialist with the Whatcom Conservation District, adjunct at Washington State University, and Director of the Washington Discovery Farms program. She is also Chair of the Washington State Center for Technical Development working to improve the professional capacity of Conservation District employees. She received her B.S. from Cal Poly, San Luis Obispo, M.S. from University of California at Davis, and Ph.D. from Colorado State University in Animal Science with specialties in Environmental Management of Livestock Systems and Air Quality. Dr. Embertson currently provides technical assistance on nutrient and environmental issues to farmers, agencies and industry professionals alike. She also conducts applied research focused on finding integrated solutions to nutrient management and resource conservation challenges, as well as development of decision support tools such as her innovative manure application risk management system including a real-time manure advisory and on-line nutrient management planning resources for producers. Her goal through Discovery Farms Washington is to help producers discover new and better land management practices for protection of environmental resources. Her projects have been funded by the Washington State Department of Agriculture, Washington State Department of Health, Washington State Conservation Commission, Natural Resource Conservation Service (NRCS), and Environmental Protection Agency (EPA). Her vision, communication style and unique experience makes her very effective in developing useful materials for producers, as well as providing science based input into policy and programing. Dr. Embertson shares her knowledge and expertise through participation on national science panels for USDA-NRCS and the EPA, and in a leadership role for the Livestock and Poultry Environmental Learning Center. She has been awarded both the Northwest and Washington State Conservation District Employee of the year award, NRCS Partnership Award, and Washington State Dairy Federation President's Appreciation Award for her outstanding work and partnership efforts.

Enstrom, James E.

Scientific Integrity Institute

Dr. James E. Enstrom is a retired Research Professor/Researcher from the School of Public Health and Jonsson Comprehensive Cancer Center at the University of California, Los Angeles. He is President of the Scientific Integrity Institute in Los Angeles. He received his BS in physics from Harvey Mudd College, an MS and PhD in elementary particle physics from Stanford University, and a MPH and postdoctoral certificate in epidemiology from UCLA. Dr. Enstrom has authored, primarily as first or sole author, about 50 peer-reviewed articles and book chapters on physics, epidemiology, and scientific integrity. He has received research funding from many sources, including NIH, ACS, UC, private foundations, industry sources, and personal donations. He has received no funding recently, but is still conducting original epidemiologic research by using personal assets in innovative and cost-

effective ways. He has taught graduate classes on environmental health science. He has given numerous lectures on epidemiology and ethics. He has published important articles relating good health practices to reduced mortality and recently has shown that fine particulate matter (PM2.5) is not related to total mortality in the ACS Cancer Prevention Study cohorts (CPS I and CPS II). He is the only independent scientist to obtain and analyze original CPS cohort data. His research shows that the EPA PM2.5 NAAQS is scientifically unjustified and must undergo complete and objective reassessment. His Scientific Integrity Institute website contains thousands of documents on air pollution epidemiology, lifestyle epidemiology, scientific integrity, and critiques of regulations, many of which contain his own research and analysis. He understands air pollution health effects research from the perspectives of both physics and epidemiology and maintains the highest level of integrity. He is a Life Member of the American Physical Society, a Founding Fellow of the American College of Epidemiology, and a current member of the ACE Ethics Committee. In 2015 he received the Heroes of Conscience Award from the American Freedom Alliance in Los Angeles.

Felter, Susan P.

Procter & Gamble

Dr. Susan Felter is a Research Fellow in Procter & Gamble's Central Product Safety organization. She holds a B.S. in Biology from the Massachusetts Institute of Technology and a Ph.D. in Toxicology from the University of Cincinnati. Dr. Felter's primary professional interest is in methods for human health risk assessment. In her Corporate role at P&G, she leads several global teams responsible for the company's methods for human health risk assessment, providing guidance across all geographies and business sectors. She serves on a number of U.S. and European trade association task forces. Prior to joining P&G, Dr. Felter worked for TERA (Toxicology Excellence for Risk Assessment), a nonprofit science organization in Cincinnati, and the U.S. Environmental Protection Agency (Office of Research and Development) where she received the U.S. EPA Bronze Medal for her work in developing the scientific basis to support drinking water regulations for human health. Dr. Felter previously served on the Science Advisory Board of the Food and Drug Administration's National Center for Toxicological Research. She also currently serves on the Science Advisory Board for the Toxicology Forum. She has served as a peer reviewer for the World Health Organization and the National Toxicology Program. Dr. Felter has been a member of the Society of Toxicology since 1996, and has served in elected positions as Secretary-Treasurer of the Risk Assessment Specialty Section, as well as Councilor of the Ohio Chapter of the Society for Risk Analysis. Dr. Felter receives no outside research funding.

Ferry, John

University of South Carolina

Dr. John Ferry has extensive experience in environmental chemistry, including reactive oxygen species, photolysis, advanced oxidation, degradation/transformation of chemicals in the environment, cyanobacterial (algal) toxins, and analytical measurement of environmental contaminants. He has taught environmental chemistry for many years at the University of South Carolina and is one of the most knowledgeable people I have ever met in environmental chemistry. He understands atmospheric chemistry and water chemistry and is very knowledgeable regarding chemical properties. John has served on a STAR Grant review panel several years ago, and is interested in serving on the SAB. He would make an excellent member of the regular SAB or the Chemical Assessment Advisory Committee.

Fike, David

Washington University

Prof. Fike is the InCEES Professor of Biogeochemistry in the Department of Earth & Planetary Sciences at Washington University in St. Louis, where he additionally heads the Environmental

Studies Program and is the Associate Director of the International Center for Energy, Environment, and Sustainability (InCEES). He obtained B.S. degrees from University of Illinois at Urbana-Champaign in engineering physics, astronomy, and geology, respectively. He obtained a Master's of Philosophy in polar studies from Churchill College, Cambridge University in 2002 and a Ph.D. in geochemistry in 2007 from the Massachusetts Institute of Technology. Subsequently, he was as an O.K. Earl postdoctoral fellow at the California Institute of Technology in 2007–2008, before joining the faculty at Washington University in 2009. His current research interests focus on isotope biogeochemistry, particularly understanding the biological, sedimentological, and diagenetic processes that generate and alter isotopic signatures in mineral and organic phases. Metabolic activity imparts diagnostic stable isotopic signatures into biomass and geochemical phases in the environment and preserved in the geologic record. Broadly speaking, his research uses the stable isotopic signatures of carbon and sulfur species to reconstruct the presence and activity of specific metabolic pathways and processes in natural environments. Specifically, he uses these measurements to probe (micro)biological activity and its dependence on the ambient geochemical environment to address: 1) what controls the rates and types of metabolic activity in the environment; 2) how this activity impacts the ambient geochemical environment; 3) how the resulting chemical signatures get preserved over geologic time; and 4) how to extract information from ancient sediments to best reconstruct paleoenvironmental conditions. Prof. Fike's specific approach involves combining diverse measurements collected across a range of spatial and temporal scales to maximize our understanding of organism-environment interactions in natural systems.

Fournier, Aime

MIT

Dr. Fournier obtained a Physics PhD from Yale and has researched for over 15 years, applying physics, statistics, signal processing, high-performance computing and other disciplines to study complex phenomena in geophysics. These study topics include: global climate and numerical methodology (NCAR Climate Division); turbulence (Institute for Mathematics Applied to Geosciences); and uncertainty quantification (UQ) in weather forecasting (NCAR Meteorology Division). As a Senior Research Geophysicist at Schlumberger, he worked with a team of engineers, geologists, geophysicists and managers on various oil & gas exploration contracts. He learned to listen to clients' concerns and effectively connect those concerns with research & development e.g., how to communicate about UQ, and translate UQ into decision guidance. He has served on advisory committees for the National Research Council, NCAR, the National Science Foundation, Schlumberger, the UK Met Office and Yale, been an Associate Editor for the journal Geophysics and a manuscript referee for numerous journals. Since 2015 he holds 2 positions: Research Associate Professor at University of Colorado Denver Department of Mathematical and Statistical Sciences, teaching upper level courses, advising PhD students and researching UQ in wildfire, weather and atmospheric chemistry models (funded by the US Forest Service); and Principal Investigator at MIT Earth Resources Laboratory, leading a small project on carbon sequestration and monitoring, and 2 large projects, on offshore drilling risk assessment, and on deep neural-network learning. All MIT projects are funded by oil & gas industrial sponsors.

Francis, Larijai

City of Corpus Christi

Lj Francis is the City Project Manager for Water Resources at the City of Corpus Christi. In this current role he is responsible for developing and managing projects to address water issues including projected water demands, water supply availability, water use assessments, watershed management plans, and drought contingency serving as the technical expert on water resources projects. He is the City's representative and board member for both the Groundwater Management Area (GMA) 15 and 16, and is the City Liaison/Administrator at Corpus Christi Aquifer Storage and Recovery

Conservation District (CCASRCD). Lj also participates in several stakeholder groups that engage on Water Supply Management and Protection in the Coastal Bend Region. Lj graduated from the University of South Florida's Civil and Environmental Engineering program – accelerated Masters with a concentration in Water Resources Engineering in 2014, currently expecting his PhD in Environmental Engineering at Texas A&M University and Co-Principal Investigator at National Oceanic and Atmospheric Administration.

Frazer, Thomas

University of Florida

Thomas K. Frazer is a Professor and the Director of the School of Natural Resources and Environment at the University of Florida. Dr. Frazer holds a Bachelor's Degree in Fisheries Biology from Humboldt State University and a Master's Degree in Fisheries and Aquatic Sciences from the University of Florida. He earned his Ph.D. in Biological Sciences from the University of California, Santa Barbara. His research addresses contemporary and emerging environmental issues, and is, by nature, interdisciplinary. His work involves collaborators from disparate disciplines, and it includes sampling and experiments conducted across a wide range of spatial and temporal scales. During his tenure at the University of Florida, Dr. Frazer has received substantial research funding to address topics pertaining to water quantity and quality, nutrient dynamics, biogeochemical processes, fish population dynamics, food web interactions, and ecological restoration of degraded ecosystems. Funding sources (past two years only) include the National Science Foundation and St. Johns River Water Management District. He has conducted field research in both freshwater and marine systems around the globe, and he is familiar with a broad suite of environmental and natural resource issues (e.g., eutrophication of fresh, estuarine, and coastal waters; invasive species; and the ecological impacts of contemporary environmental change, including coral bleaching, ocean acidification, and sea level rise). Dr. Frazer has authored and/or co-authored more than 175 peer-reviewed publications, technical reports, and book chapters. He serves as Chief Specialty Editor for the Coral Reef Research section of Frontiers in Marine Science, and he regularly serves as a referee for leading international journals and granting organizations. Dr. Frazer currently holds an at-large seat on the Gulf of Mexico Fisheries Management Council. He is a member of APLU's Board on Oceans, Atmosphere and Climate, and a past member of the US EPA's Oil Spill Research Strategy Review Panel.

Fry, Juliane

Reed College

Dr. Juliane L. Fry is associate professor and department chair of Chemistry at Reed College, as well as a founding faculty member of the College's interdisciplinary Environmental Studies program. Dr. Fry obtained a BS in chemistry from the University of Rochester, a PhD in atmospheric chemistry from the California Institute of Technology, and completed post-doctoral training in atmospheric chemistry at the University of California – Berkeley. She holds a Master's degree in environmental, natural resources and energy law from Lewis and Clark Law School. Dr. Fry teaches general, analytical, and environmental chemistry, and an interdisciplinary course on climate change. Dr. Fry's scientific research program is focused on interactions between anthropogenic air pollution and climate change, in particular via the role of nitrogen oxides in chemical mechanisms of particulate matter production; her interdisciplinary scholarship focuses on regulation of secondary pollutants and the role of science in climate litigation. She has been funded by the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), and the Camille and Henry Dreyfus Foundation, and has authored over 40 peer-reviewed papers and over 80 oral and poster presentations. Dr. Fry is a member of the American Chemical Society and American Geophysical Union, has served on the American Meteorological Society Committee on Atmospheric Chemistry and the Urban Ecology Research Consortium Steering Committee, convened panels for the Association for Environmental Studies and Sciences, and served as a proposal reviewer and panelist for NOAA, the

National Science Foundation, and the Pacific Northwest National Laboratory Environmental and Molecular Sciences Lab. Dr. Fry received an Advanced Study Program Faculty Fellowship from the National Center for Atmospheric Research in 2011, an EPA Early Career Award in 2013, a Fulbright U.S. Scholar Award to the Netherlands in 2016, and the Henry Dreyfus Teacher-Scholar Award in 2017.

Furtado, Manohar

Apton Biosystems Inc.

Currently working to develop a super resolution based sequencing system that will decrease NGS costs by 100-fold. System is also enabled for single molecule multi-omic applications. Areas of domain expertise include research and product development in Oncology, Infectious diseases, and Genetics. Areas of market driven product expertise with food safety, environmental testing, bioproduction safety, animal health, human health, Human identification / CSI, diagnostics and safety. PhD in protein chemistry, post-doc training in molecular virology, PI and on the faculty at Northwestern University. Vice President, Molecular Medicine & Applied Markets at ABI and Life Technology.

Gala, William

Chevron Energy Technology Company

Dr. Gala has worked for Chevron for almost 30 years providing technical support and expert advice to Chevron facilities world-wide on matters related to ecological risk assessment, contaminated sediments, and oil spill response. Dr. Gala was recognized as a Chevron Fellow in 2017 in the field of ecological risk assessment. Dr. Gala has provided technical support for numerous ecological risk assessments and site investigations for Chevron facilities, including agricultural chemical plants, marine and pipeline terminals, production facilities and refineries. Dr. Gala's experience at Chevron has afforded him the opportunity to work on a wide variety of contaminated media (e.g., soil, ground water, surface water, sediments), COPCs (e.g., PAHs, metals, chlorinated pesticides, petroleum products and crude oil) and ecological receptors (aquatic life, benthic community, terrestrial and aquatic wildlife). Dr. Gala received his Ph.D. in Environmental Toxicology and Fisheries and Wildlife from Michigan State University. He was previously involved is collaborative research projects with USGS and Stanford University in areas of passive sampling and in situ treatment of sediment contamination. Recent research efforts have focused on bioavailability of metals in sediments working in collaboration with U Texas and Texas Tech University. He has not received external research funding in the last two years – recent effort is solely funded by internal (Chevron) dollars and was previously appointed to Gulf of Mexico Fisheries Management Council Artificial Substrate Panel and currently serve of the Advisory Board for the California Oiled Wildlife Care Network. He is a long-standing member of the Society of Environmental Toxicology and was involved in several annual meetings organizing committees

Gibbs, Shawn

University of Nebraska Medical Center

Shawn Gibbs is an Associate Professor with the University of Nebraska Medical Center's Department of Environmental, Agricultural & Occupational Health in the College of Public Health. He also serves as the College of Public Health's Director of Masters Programs where he oversees all MS, MPH, and certificate programs. Shawn received a B.S. (1997) in Biology from The Ohio State University, and both a M.S. (2000) and Ph.D. (2002) from the University of Cincinnati in Environmental Science, Water Quality Processes Science. Shawn was a US Fulbright Scholar to Egypt in 2006. He became a Certified Industrial Hygienist (CIH) in 2009. His previous work experience includes three years as a contract Biologist/Toxicologist for the USEPA working on environmental water quality programs. For five years, he was an Assistant Professor at the University of Texas Houston School of Public Health

where his research included water quality and quantity issues along the US-Mexico border, including issues associated with confined animal feeding operations. His research area is environmental exposure assessment, focusing on environmental microbiology. Primary research interests are on environmental bioaerosols (bacterial, antibiotic resistant bacteria, fungal, viral) from both the indoor and ambient environments, and water exposures. This includes source evaluation, source tracking, and methods to reduce exposure. This includes source evaluation, source tracking, and methods to reduce exposure. Shawn is the author of over three dozen peer reviewed articles. He has served as a reviewer for over a dozen peer reviewed journals and has served as grant reviewer for multiple organizations including the USEPA and Fulbright Commission. Shawn has been an author in over three dozen peer review publications. His currently funded projects include the areas of infection control and Water Reuse.

Goldman, Gretchen

Union of Concerned Scientists

Dr. Gretchen T. Goldman has expertise in air pollution exposure science, environmental engineering systems, meteorology, and environmental policy. She received a Ph.D. and M.S. in environmental engineering from the Georgia Institute of Technology and a B.S. in atmospheric science from Cornell University. Her research focused on statistical modeling of urban air pollution for use in epidemiologic studies of acute human health effects. Specifically, Dr. Goldman used geostatistical models to characterize measurement error from air pollution monitoring sites in order to assess the impact of this error on health risk assessments in time-series health studies. Following a postdoctoral research position at Georgia Tech, Dr. Goldman is now the Research Director of the Center for Science and Democracy at the Union of Concerned Scientists. Her work here focuses on a range of issues within science policy studies. She researches how decision making is informed by scientific research and the influences that affect science policy development and implementation. Her areas of study have included the National Ambient Air Quality Standards (NAAQS), scientific integrity at federal agencies, climate change policy, and hydraulic fracturing, among other topics. Dr. Goldman currently serves as the Chair of the Air and Climate Public Advisory Committee (ACPAC) for the Metropolitan Washington Council of Governments (MWCOG), the metropolitan planning organization for the Washington, D.C. region. Dr. Goldman continues to stay active in the academic community, through conferences, publications, and presentations.

Goltz, Mark

Independent Consultant

Dr. Mark N. Goltz is Distinguished Professor Emeritus of Environmental Engineering and Management at the Air Force Institute of Technology. He holds a B.S. in Electrical Engineering from Cornell University, an M.S. in Sanitary Engineering from the University of California, Berkeley, and a Ph.D. in Environmental Engineering and Science, Stanford University. Since 1982 Dr. Goltz has been studying the fate, transport, and remediation of contaminants in groundwater. His research interests include groundwater contamination remediation technologies, fate and transport of organic contaminants in the subsurface, stimulating commercialization of environmental remediation technologies, mathematical modeling of contaminant transport by groundwater, in situ bioremediation of chlorinated organic compounds in the subsurface, scaling-up from the laboratory to the field, physical and chemical water and wastewater treatment technologies, and environmental modeling. His work has included conducting and modeling field demonstrations of innovative contaminated groundwater treatment technologies, as well as investigation of methods to effectively transfer these technologies to commercial use. He recently has conducted research on the application of nanomaterials to remediate contaminated groundwater. Dr. Goltz developed a graduate program in environmental engineering for U.S Air Force officers, and taught in the program for over 20 years. He has consulted on numerous Air Force water pollution problems, and has a unique perspective, due to

his background in both academia and the military. Dr. Goltz is currently conducting a research project funded by the Defense Department's Environmental Security Technology Certification Program. Dr. Goltz is a Registered Professional Engineer in the State of Minnesota and is a Board Certified Environmental Engineer in the American Academy of Environmental Engineers and Scientists. He was a member of the Science Advisory Committee for EPA's Midwest/Great Lakes Hazardous Substance Research Center and currently serves as an environmental engineering program evaluator for the Accreditation Board for Engineering and Technology.

Gordon, Terry

New York University School of Medicine

Dr. Terry Gordon holds the rank of Professor of Environmental Medicine at the New York University (NYU) School of Medicine. He holds a B.S. in Physiology, an M.S. in Toxicology from the University of Michigan, and a Ph.D. in Toxicology from MIT, and was appointed to the faculty of the Department of Environmental Medicine in 1989. He has served as an ad hoc member of grant review panels and/or site visit teams for NIEHS, NIAID, National Coalition for Cancer Research, DOD, Bureau of Mines, NASA, Health Canada, NIOSH/CDC, and the EPA. Dr. Gordon is past Chair of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) committee, a volunteer organization that publishes occupational exposure levels that are used as workplace safety guidelines throughout the world. Dr. Gordon's broad research interest is in inhalation toxicology. The major focus of his research lab is the identification and understanding of the role of genetic host factors in the pathogenesis of the adverse pulmonary effects produced by inhaled environmental and occupational agents. Because inter-individual responses to inhaled particles and gases vary so greatly in both human subjects and test animals, Dr. Gordon has hypothesized that genetic susceptibility factors play a major role in environmental and occupational lung disease. In collaboration with a number of investigators in the department, his laboratory uses classic murine genetics models, computational genomics, and DNA microarrays to identify genes involved in the acute response as well as in the development of tolerance to repeated exposure to inhaled toxicants. Dr. Gordon also plays a major role in the particulate matter (PM) research program at NYU, and was among the first researchers to use concentrator technology to study the adverse cardiopulmonary effects of ambient PM. Dr. Gordon is an active member of the Society of Toxicology (SOT), and has served on the Program, Placement, Membership, and Awards Committees and as President of its Inhalation Specialty Section. He has served as a consultant/author to the EPA on issues of pulmonary toxicology related to the development of various documents, and served on EPA's Clean Air Scientific Advisory Committee (CASAC) Oxides of Nitrogen (NOx) and Sulfur Oxides (SOx) Primary National Ambient Air Quality Standards (NAAQS) Review Panels and is a current member of the PM ad hoc CASAC. Dr. Gordon's current research, supported by NHLBI and NIEHS grants, examines the adverse health effects of environmental and occupational air pollutants, including secondhand smoke from e-cigarettes and hookahs. He is also the Director of NYU's NIEHS-supported Training Grant in Environmental Toxicology.

Graham, Wendy

University of Florida

Dr. Wendy D. Graham is the Carl S. Swisher Eminent Scholar in Water Resources in the Department of Agricultural and Biological Engineering and Director of the Water Institute at the University of Florida, Gainesville. She has a B.S. in environmental engineering from the University of Florida, and a Ph.D. in Civil and Environmental Engineering from the Massachusetts Institute of Technology. Her current research focuses on integrated hydrologic modeling; groundwater resources evaluation and remediation; evaluation of impacts of agricultural production on surface and groundwater quality; evaluation of impacts of climate variability and climate change on hydrologic systems; and stochastic modeling and data assimilation. She has served as principal investigator or co-Principal Investigator

on over $25 million in grants and contracts, has supervised 30 doctoral and master's thesis committees, and has served on more than 60 additional graduate student committees. Dr. Graham served as the Hydrologic Sciences Program Director for the National Science Foundation in 2015-2016, and is currently a member of the National Academy of Sciences Water Science and Technology Board. She served as Chair of the University of Florida Agricultural and Biological Engineering Department from 2003-2006. In her current role as Director of the University of Florida Water Institute she coordinates campus-wide interdisciplinary research, education and outreach programs designed to develop and share new knowledge, and to develop and encourage the implementation of new technology and policy solutions needed to ensure a sustainable water future. In the last two years Dr. Graham has received research funding from: the St Johns River Water Management District, Florida Senate Committee on Environmental Preservation and Conservation, Florida Department of Agriculture and Consumer Services, National Science Foundation, U.S. Department of Agricultural National Institute of Food and Agriculture, Tampa Bay Water, and the North Carolina State University-Department of the Interior Southeast Climate Science Center.

Greenfield, Jeffrey

Florida International University

Dr. Greenfield is an Adjunct Professor in the Civil & Environmental Engineering Dept. at Florida International University (FIU). He is a registered Professional Engineer in several states, a Board Certified Environmental Engineer and a Diplomate Water Resources Engineer. He has been teaching Sr. Environmental Engineering Design, Fluid Mechanics, and Engineering Ethics. In the fall, he will be teaching a combined undergraduate/graduate course on Bioremediation Engineering and will also serve as interim faculty advisor for FIU's Engineers Without Borders (EWB). His fulltime job is a Project Manager in the Engineering Division with Broward County Water & Wastewater Services. He currently is managing a $53M wastewater reclaimed project and several potable water projects which include 1M, 1.5M, and 5 MG ground storage tanks, high service pump stations, standby generators, and new disinfection systems. His professional engineering society leadership positions include former vice chair of the NSPE Licensure & Qualifications Committee, formerly vice chair of the NSPE Committee on Policy & Advocacy, corresponding member of the American Society of Civil Engineers (ASCE) Committee on Licensure, member of the ASCE Committee on Ethical Practice (CEP), member of the NCEEES Environmental Engineering PE Exam Committee for more than 18 years, chair of the American Academy of Environmental Engineers and Scientists Water and Wastewater Subcommittee, past president and state director of the Broward Branch of the Florida Engineering Society, and member and former chair of the Florida Atlantic University Department Advisor Committee for the Department of Civil, Environmental, & Geomatics Engineering. Dr. Greenfield is also a long-time member of the Florida Engineering Society (FES) Committee on Environmental Quality. He has received local and state awards for his engineering society volunteering efforts as well as an adjunct teaching award. He has demonstrated leadership skills for many of the engineering societies of which he has been active including NSPE, FES, AAEES, and ABET.

Griffin, Michael

Carnegie Mellon University

Dr. Griffin is Research Professor Emeritus of Engineering and Public Policy at Carnegie Mellon University (CMU). He has had a long and distinguished career working on a variety of issues in the oil and chemical industries and conducting academic research in the areas of sustainability, life cycle assessment, and ecological and environmental impact assessment. At CMU along with his faculty appointment, he was the Executive Director of the Center for Climate, Energy and Decision Making, Co-Director and Executive Director of the Green Design Institute and had a joint faculty appointment in the Tepper School of Business. Prior to joining the university, he held multiple positions at British

Petroleum, where he directed a microbiology technical service and research group that provided water treatment and corrosion mitigation solutions for the business and developed microbial-based methods to produce biodegradable chemicals and polymers. He later joined Sybron Chemicals as Director of Research where his group provided support for production and bioremediation efforts. He was the Director of Research at the National Environmental Technology Application Corporation and developed methods for evaluating oil spill response tools and products and technical evaluations of various environmental technologies for business and government. Dr. Griffin has published over 70 articles and book chapters of which 50 are in peer-reviewed journals. His current research, with collaboration of colleagues and students at CMU, centers on the analysis of the environmental impacts of energy infrastructure needed to address climate impacts, modeling N2O production in hypoxic events, determining potential impacts of adopting renewable alternative fuels, and addressing uncertainty in life cycle assessment. His has a BS and MS in Biology from the University of Dayton and a PhD in Microbiology from the University of Rhode Island. Research funding for the last 2 years was provided NSF and the CMU-Portugal Program.

Grimalt, Joan

Institute of Environmental Assessment and Water Research (IDAEA)

Dr. Joan O. Grimalt is the director of the geochemistry and pollution group of the Institute of Environmental Assessment and Water Research (IDAEA) from the Spanish Council for Scientific Research (CSIC) in Barcelona. For more than 30 years he has studied organic molecules in the environment to obtain information on the evolution of ecosystems and the impact of organic pollutants in air, water, sediments, soils, organisms and humans in urban and rural areas, rivers, mountains, lakes and marine environments. He has been director of IDAEA for ten years. He has been assessing on environmental pollution management in Catalonia, Spain, France, the United Nations (Geneva), Kuwait and US Research Projects. One outcome of these activities involved the removal of about 750, 000 tons of industrial residues dumped into the Ebro River. He has also been assessing on climate change effects for the Spanish Ministry of Environment and the Spanish Parliament. His expertise in these diverse environmental topics may be useful for the EPA Scientific Advisory Board. He has a lot of experience in communication of environmental topics in tv, radio, and direct talks with the general audience. He earned a BS in chemical engineering from the Sarria Chemical Institute (Barcelona) and a PhD in environmental chemistry from the Autonomous University of Barcelona. He performed postdoctoral research stages in the Oregon State University and the University of Bristol. He has published 680 scientific papers quoted more than 20, 500 times in the scientific literature. H index = 73. He has supervised 47 PhD thesis and 70 master theses to completion. His research for the past two years was funded by the European Union, the Arctic Monitoring and Assessment Program, the Barcelona Health Agency and the Spanish Ministry of Research and Education. He has not received grant funding from EPA. He is not US citizen.

Grimm, Nancy

Arizona State University

Dr. Nancy B. Grimm is Virginia M. Ullman Professor of Ecology and Senior Sustainability Scientist at Arizona State University, where she earned her Ph.D. in 1985. She has held visiting or adjunct appointments at the Center for Advanced Studies in Blanes, Spain, Kellogg Biological Station, National Center for Ecological Analysis and Synthesis, and the University of New Mexico. She was President and is a fellow of the Ecological Society of America (ESA), is a fellow of the American Association for the Advancement of Science and the American Geophysical Union (AGU), and was lead author for the Third National Climate Assessment (NCA). She has served as an NSF program director, a staff scientist for the NCA, and as editor or associate editor for numerous journals; currently, she is an editor of AGU's Earth's Future. International and national advisory board service includes Margalef Prize Selection Committee, the National Research Council's (NRC) Standing

Committee to Advise the US Global Change Research Program, the NRC Standing Committee on Hydrological Sciences, and the Advisory Committee for the Australian CRC for Water Sensitive Cities, among many others. Grimm studies the interaction of climate variation and change, human activities, and ecosystems. Her long-term research focuses on how disturbances (such as flooding or drying) affect the structure and processes of desert streams, how chemical elements move through and cycle within both desert streams and cities, and how storm water infrastructure affects water and material movement across an urban landscape. She was the founding director of the Central Arizona-Phoenix LTER program, an interdisciplinary study by ecologists, engineers, physical and social scientists, and she currently co-directs the Urban Resilience to Extremes Sustainability Research Network. In the latter capacity, she works to help cities develop future visions and strategies to increase resilience in the face of extreme events. Grimm has authored or co-authored over 200 scientific publications and delivered over 100 invited or keynote presentations. Her Google Scholar h-index is 72, with her 2008 Science paper, Global Change and the Ecology of Cities, cited over 3000 times.

Groover, Richard

Reynolds Community College

Dr. Richard Groover has a doctorate in Environmental Science & Public Policy from George Mason University. He is the author of The Environmental Almanac of Virginia, 2nd edition. He is a fellow of the Virginia Academy of Science. He is the treasurer of the Association for Environmental Studies and Science. He is on the Board of Trustees of the Science Museum of Virginia. He was a member of the Governor of Virginia's Climate Commission (2014-2015). He has authored numerous journal articles on ecology and related topics. He is actively researching in the area of aquatic ecology and animal behavior.

Guckenheimer, John

Cornell University

John Guckenheimer retired as Bullis Professor of Mathematics at Cornell University in 2017, where he also served terms as Director of the Center for Applied Mathematics, as Associate Dean of Computing and Information Sciences and Director of Research Programs for the Theory Center. His research investigates nonlinear dynamical systems. This subject unifies phenomena in disparate disciplines by discovering common mathematical foundations. It provides methods used in the study of complex systems. Within mathematics, Guckenheimer has made substantial advances in describing bifurcations – dynamical changes that occur as system parameters are varied – especially within systems that have multiple time scales. As applications, Guckenheimer has investigated recently the unpredictability of El Niño in the tropical Pacific and inferred a controller for human running from motion capture data. Earlier, he used tools from the theory to analyze nonlinear dynamics within the nervous system. He co-chaired a National Research Council committee that produced the 2016 report "Analytic Research Foundations for the Next-Generation Electric Grid." Guckenheimer served as President of the Society for Industrial and Applied Mathematics during 1997-98, was founding chair of its Activity Group in the Life Sciences, and was awarded its Jürgen Moser prize. He was also awarded the American Mathematical Society Steele Prize for mathematical exposition with Philip Holmes for authoring the 1983 book "Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields," that has become a basic reference for the field. Prior to moving to Cornell in 1985, he was a professor at the University of California, Santa Cruz, where he led a California wide effort to create organized research units for nonlinear science. He received a BA from Harvard College and a PhD from the University of California at Berkeley.

Haas, Charles

Drexel University

Dr. Charles N. Haas is the L.D. Betz Professor of Environmental Engineering and head of the Department of Civil, Architectural and Environmental Engineering, at Drexel University, where he has been since 1991. He received his B.S. (Biology) and M.S. (Environmental Engineering) from the Illinois Institute of Technology and his Ph.D. in Environmental Engineering from the University of Illinois at Urbana-Champaign. He has served on the faculties of Rensselaer Polytechnic Institute and the Illinois Institute of Technology prior to joining Drexel. He co-directed the U.S. EPA/Department of Homeland Security University Cooperative Center of Excellence – Center for Advancing Microbial Risk Assessment (CAMRA). He is a fellow of the International Water Association, American Academy for the Advancement of Science, the Society for Risk Analysis, the American Society of Civil Engineers the American Academy of Microbiology and the Association of Environmental Engineering and Science Professors. He is a Board Certified Environmental Engineering Member by eminence of the American Academy of Environmental Engineers. He has received the Dr. John Leal Award and the AP Black Research Award of the American Water Works Association, the distinguished achievement award from the Society of Risk Analysis. and the Clarke Water Prize. Over his career, Professor Haas has specialized in the assessment of risk from and control of human exposure to pathogenic microorganisms, and in particular the treatment of water and wastewater to minimize microbial risk to human health. He has over 225 papers, has recent and current funding from National Science Foundation, U.S. EPA, the Water Environment Research Foundation, and industry. Professor Haas has served on numerous panels of the National Research Council. He is a past member of the Water Science and Technology Board of the National Academies, and the U.S. EPA Board of Scientific Counselors. His primary work focuses on assessment of risk from and control of microorganisms in water, wastes and other environments.

Halloran, Kent

Ohio State University

Mr. Kent Halloran has worked for over 30 years in the field of storm water, potable water, wastewater engineering design and construction. He has also worked as a design and construction engineer in the areas of airport drainage, food processing waste treatment and other industries. He is currently serving as the Ohio State University's water compliance engineer and as an adjunct faculty professor in the Civil, Environmental, and Geodetic Engineering Department. In the past, he has served as the deputy program manager for the City of Fort Wayne's Combined Sewer Capacity Improvement Program and as Interim Program Manager for the City's lift station and storm water programs. He also served as the town engineer for several communities and has promoted the concepts of sustainability throughout his career. He is also pioneering the use of natural systems, such as constructed wetlands, and the conversion of retention basins using native wetland plants to improve storm water retention, increase pollutant removal, and provide pollinator and wetland habitat. He earned a Bachelor of Science in Civil Engineering from The Ohio State University and a Masters of Engineering in Environmental Systems Engineering from Clemson University. He is currently a licensed Professional Engineer in the States of Ohio and Idaho and a Board Certified Environmental Engineer through the American Academy of Environmental Engineers and Scientists. He has also served as a volunteer and Board member for the Friends of the Lower Olentangy Watershed.

Happer, William

Princeton University

Dr. William Happer, Professor Emeritus in the Department of Physics at Princeton University, is a specialist in modern optics, optical and radiofrequency spectroscopy of atoms and molecules, radiation propagation in the atmosphere, and spin-polarized atoms and nuclei. He is also noted for

work in climate-related physics. Dr. Happer received a B.S. degree in Physics from the University of North Carolina in 1960 and the PhD degree in Physics from Princeton University in 1964. He began his academic career in 1964 at Columbia University as a member of the research and teaching staff of the Physics Department. While serving as a Professor of Physics he also served as Co-Director of the Columbia Radiation Laboratory from 1971 to 1976, and Director from 1976 to 1979. In 1980 he joined the faculty at Princeton University. On August 5, 1991 he was appointed Director of Energy Research in the Department of Energy by President George Bush. While serving in that capacity under Secretary of Energy James Watkins, he oversaw a basic research budget of some $3 billion, which included much of the federal funding for high energy and nuclear physics, materials science, magnetic confinement fusion, environmental and climate science, the human genome project, and other areas. He remained at the DOE until May 31, 1993 to help the Clinton Administration during the transition period. He was reappointed Professor of Physics at Princeton University on June 1, 1993, and named Eugene Higgens Professor of Physics and Chair of the University Research Board from 1995 to 2005. From 2003 until his retirement in 2014, he held the Cyrus Fogg Brackett Chair of Physics. From 1987 to 1990 he served as Chairman of the Steering Committee of JASON, a group of scientists and engineers who advise agencies of the Federal Government on matters of defense, intelligence, energy policy and other technical problems. He was a trustee of the MITRE Corporation from 1993 to 2011, he is the Chair of the Board of the Richard Lounsbery Foundation, and he is the President of the CO2 Coalition. From 2002 to 2006 he chaired of the National Research Council's Standing Committee on Improvised Explosive Devices that supported the Joint Improvised Explosive Devices Defeat Organization of the Department of Defense. He was a co-founder in 1994 of Magnetic Imaging Technologies Incorporated (MITI), a small company specializing in the use of laser polarized noble gases for magnetic resonance imaging. He invented the sodium guidestar that is used in astronomical adaptive optics to correct for the degrading effects of atmospheric turbulence. He has published over 200 peer-reviewed scientific papers. He is a Fellow of the American Physical Society, the American Association for the Advancement of Science, and a member of the American Academy of Arts and Sciences, the National Academy of Sciences and the American Philosophical Society. He was awarded an Alfred P. Sloan Fellowship in 1966, an Alexander von Humboldt Award in 1976, the 1997 Broida Prize and the 1999 Davisson-Germer Prize of the American Physical Society, and the Thomas Alva Edison Patent Award in 2000.

Hargiss, Christina

North Dakota State University

Dr. Christina Hargiss is an Assistant Professor at North Dakota (ND) State University in the Natural Resources Management Program. She holds degrees in Natural Resource Management and Science Education. Dr. Hargiss has been conducting research on wetlands and water quality for the past 20 years. During that time her research interests have expanded to also include water use, impacts of energy development on natural resources, environmental education, and urban ecology. Additionally, she is an established expert on environmental law and policy, and the connections between agriculture and natural resources. Recent projects investigated by Dr. Hargiss include assessing change in reference condition wetlands over time, impacts of road dust from energy development on natural resources, potential use of oil-well produced brine as a dust abatement technique, and impacts of brine on clay road binders. Water quality research has focused on source tracking *E. coli* spatially and temporally in stormwater, water quality changes across a gradient of development, evaluating stormwater retention basins water quality during storm events, and assessing harmful algal bacteria. Water use research includes assessing commercial and industrial water use temporally and spatially to determine changes and per capita coefficients across different size municipalities. Funding sources for these projects include the US Geological Survey, US Fish and Wildlife Service, ND State Water Commission, City of Fargo, EPA, ND Department of Health, and ND Soybean Council. Dr. Hargiss currently serves as the President-Elect of the Society of Wetland Scientists North Central Chapter, the

Vice-President of the Board of Directors of River Keepers, a regional non-profit, and on the advisory committee for the ND Envirothon. She is also a member of the National Science Teachers Association, North American Association of Environmental Educators, the Wildlife Society, and regularly reviews manuscripts for several journals including Wetlands, Ecological Indicators, Environmental Monitoring and Assessment, and Aquatic Biology.

Hayes, Stanley

Ramboll Environ

Mr. Stan Hayes has more than 40 years of experience in air-related environmental engineering and science for NAAQS- and air toxics-related purposes, with emphasis on air modeling analysis and health risk assessment. He has an MS degree in Aeronautics & Astronautics and a BS degree in Mechanical Engineering, both from Stanford University. Mr. Hayes is the primary author of more than 70 scientific papers and presentations, and several hundred technical reports on air-related subjects. He is a member of the EPA Science Advisory Board Risk and Technology Review (RTR) Methods Panel. He is a Fellow of the Air & Waste Management Association, for whom he has chaired or co-chaired national and international specialty conferences. He is chair of the Advisory Council of the Bay Area Air Quality Management District, which provides science-based counsel to the Board of Directors, the Executive Officer, and other senior staff. He has provided expert testimony before federal, state and local regulatory agencies and in court. For 25 years, until 2015, Mr. Hayes was a Principal with Ramboll (previously ENVIRON). He is now emeritus, with no regular salary, EPA or other grants, benefits, or firm ownership interest. Over his career, Mr. Hayes has conducted research consulting on NAAQS- and air toxics-related topics for a broad range of private- and public-sector clients, including trade associations (e.g., API and others), individual companies, law firms, and regulatory agencies (e.g., EPA and others). Relevant to the work of CASAC, he has conducted NAAQS-related air quality modeling studies, health risk assessments, exposure analyses, control strategy analyses, nonattainment area plan evaluations, air monitoring data analyses, and regulatory and policy reviews.

Helble, Joseph

Dartmouth College

Joseph J. Helble is Professor and Dean of the Thayer School of Engineering at Dartmouth College. Prior to joining Dartmouth as Dean in 2005, he served as a faculty member and Chair of the Department of Chemical Engineering at the University of Connecticut (UConn), and was also a member of the UConn Environmental Engineering faculty. His research is primarily in the area of air pollution, with specific activities and interests in combustion-derived particulate matter formation and control, mercury, trace metal and air toxics air pollutants, air quality modeling, ambient particulate matter structure, carbon dioxide capture, and particle coalescence. He also initiated a program to produce biodiesel fuel from waste vegetable oil on the UConn campus. Dr. Helble is the author of 100 publications, primarily in the air pollution field, and is a member of the editorial board of the journals Fuel Processing Technology and Environmental Engineering Science. From 2004-2005, Dr. Helble was the holder of the Revelle Fellowship in Global Stewardship from the American Association for the Advancement of Science (AAAS). As the Revelle Fellow, he spent a year working on environmental and technology policy issues in the office of U.S. Senator J. Lieberman. Prior to joining the UConn faculty in 1995, Dr. Helble spent 8 years at Physical Sciences Inc., a small business specializing in environmental and energy technology research and development. He also spent a fellowship period at U.S. EPA headquarters in Washington D.C as a science and policy fellow of AAAS, and received the Barnard Award from AAAS for his work on dioxin as an EPA Fellow in 1993. Dr. Helble is active in the American Association of Aerosol Science, the American Chemical Society, where he is currently Program Chair of the Fuel Chemistry Division for the 2007 national ACS meetings, the American Society for Engineering Education (ASEE), and the science policy

fellowship program of AAAS. He has served on EPA Science Advisory Board panels on air toxics and the first draft report on the environment, and on numerous NSF advisory and review panels in environmental engineering and in combustion. He recently served on the NSF Committee of Visitors (COV) reviewing the combustion program within the NSF Engineering Directorate. Dr. Helble is an elected member of the Connecticut Academy of Science and Engineering. He is a 1982 summa cum laude B.S. graduate of Lehigh University in chemical engineering, and a 1987 chemical engineering Ph.D. graduate of the Massachusetts Institute of Technology.

Henshaw, Jessie

HDS systems design science

Jessie Lydia Henshaw is a research natural systems scientist in New York consulting on patterns of general emerging systems ecology; or more simply, cultures that "blow up" or "take off." Her work began with college physics labs asking why every run of experiments somewhat misbehaves, leading later to her general study of the individuality in emerging systems. At St Lawrence she concentrated on physics and math, Russian studies and arts then took math courses at Stoney Brook and Columbia before turning to architecture at the University of Pennsylvania. There she minored in landscape and presented theses on sustainable town design and microclimates, winning a class medal for structures. After school, she made a portable lab for studying the microclimates of homes, noticing as a general pattern the initial growth period of convection currents was when their systems for releasing energy developed. Work on theory and methods followed mostly at night over 25 years as a New York architect. Her public service work includes comment on hazardous waste storage site placement, restoring a 1890s Opera House as a rural arts center, leading a federal survey of shelters for government in the event of conflict. Her proposals include models for naturally responsive market systems as UN Sustainable Development Goals, suggesting a practical scientific method for giving all decision makers information on their share of the global the impacts of their decisions, a bit ahead of its time but still current. She served two years on a UNEP-FI/WRI technical advisory group, consulting on CO2 risk guidance for the financial industry. Her writings address: whole system accounting; why it is healthy cultures have healthy economies; the organizational limits of economies; the strong coupling of GDP, energy, and CO2; growing societal strains of growing disruptive change; and related subjects.

Hoel, David G.

Medical University of South Carolina

Dr. David G. Hoel is a Distinguished University Professor in the College of Medicine at the Medical University of South Carolina in Charleston. He received an A.B. in both mathematics and statistics from University of California at Berkeley, a Ph.D. in mathematical statistics from University of North Carolina in Chapel Hill and was a post-doctoral fellow in preventive medicine at Stanford University. Prior to joining the Medical University of South Carolina he was Division Director for Risk Assessment at National Institute of Health's (NIH) Institute National Institute of Environmental Health Sciences (NIEHS) in N.C. Dr. Hoel is a Fellow of the American Association for the Advancement of Science (AAAS), a member of the National Academy of Medicine and a National Associate of the National Academies. His awards include the Spiegleman Gold Medal in Public Health and the Ramazzini Award in Environmental and Occupational Health. He has served on 30 National Academy committees and also numerous governmental committees including the Environmental Health Committee and Radiation Advisory Committee of EPA's Science Advisory Board. Specifically, on radiation he was a member of the BEIR V committee of the National Academy of Sciences and the World Health Organization's International Agency for Research on Cancer (IARC)'s cancer monograph committee 100D on radiation and also he was a contributing member of the United Nation's UNSCEAR 2008 report on radiation health effects. Dr. Hoel's research has focused on risk assessment methods with particular interest in low-dose radiation exposures and

cancer. This work has resulted in stays for several years in Hiroshima as a Director at the Radiation Effects Research Foundation (RERF) and recently a RERF Scientific Counselor. Dr. Hoel does not currently have any research grants although previously he has had grant support from both the Department of Energy and from the National Aeronautics and Space Administration (NASA).

Hoffman, Mark

Children's Mercy Hospital, University of Missouri Kansas City

Dr. Mark Hoffman serves as the Chief Research Information officer for Children's Mercy Hospital and as a faculty member of the University of Missouri - Kansas City School of Medicine in the Departments of Pediatrics and Biomedical and Health Informatics. He earned his Ph.D. in Bacteriology from the University of Wisconsin with a minor in Biotechnology and completed an industry internship with a bioinformatics company, DNASTAR. During his 16 years in the electronic health records industry (Cerner) he led initiatives in public health infectious disease surveillance, molecular diagnostics, clinical decision support and the development and application of major (65 million patients) de-identified clinical data warehouse populated by Electronic Health Record (EHR) data. His interdisciplinary background in software engineering and the biological sciences helped him function effectively as the Vice President for Genomics and Research, a group of more than 120 individuals. Dr. Hoffman is an inventor on 17 issued U.S. patents and 3 issued international patents. In his current role at Children's Mercy, Dr. Hoffman is responsible for the development of the software platforms and high-performance computing resources used by the Children's Mercy Genome Center. He works closely with the Children's Mercy Center for Environmental Health and in his personal research is using the de-identified EHR database to investigate health services and epidemiological aspects of lead exposure on a national level. He has delivered a TEDx presentation, "The Envirome: Where Precision Medicine Meets Public Health". Dr. Hoffman has served on multiple federal advisory groups, including the HHS Secretary's Advisory Committee on Genetics, Health and Society task force on the oversight of Genetic Testing (2007) and the CDC sponsored Evaluating Genomic Applications in Practice and Prevention (EGAPP) stakeholders group. Dr. Hoffman is the PI on a CDC funded project to use clinical data warehouses in support of laboratory quality improvement. He has served on the Board of Directors for the Center for Practical Bioethics and other non-profit organizations. His diverse experience in microbiology, data science, engineering, environmental and public health, health sciences, pediatrics and genomics would enable him to contribute to the variety of topics evaluated by the EPA Scientific Advisory Board. His business experience has prepared him to seek consensus and practical solutions to complex problems.

Hood, Darryl

The Ohio State University

Dr. Darryl B. Hood is a nationally recognized expert in the area of Neurotoxicology, particularly with respect to the effects of environmental toxicants on the developing fetus and subsequent effects on learning, memory and behavior. He graduated from Johnson C. Smith University with a B.S. (cum laude) in Biology and Chemistry. He matriculated at Quillen College of Medicine of East Tennessee State University earning a Ph.D. in Biochemistry. Dr. Hood completed postdoctoral training in Biophysics and Molecular Toxicology as a National Science Foundation E.E. Just fellow in the Center in Molecular Toxicology at Vanderbilt University School of Medicine in Nashville, TN. Following his 4-year postdoctoral fellowship, he accepted a faculty position at Meharry Medical College. He recently joined the faculty of the College of Public Health at OSU from Meharry Medical College where he interrogated hypotheses on the mechanisms governing neurotoxicity of environmental chemicals for nearly two decades. Seminal work conducted in his laboratory demonstrated for the first time, the functional impact of in utero exposure to benzo(a)pyrene on later-life behavioral phenotypes mediated by maturing glutamatergic cortical circuits. From his work, the field has learned that postnatal brain development requires input from the environment in order to induce the release of

glutamate and thereby promote critical aspects of synaptic maturation. Dr. Hood is a member of the Environmental Protection Agency's National Environmental Justice Advisory Committee (NEJAC) working group which recently recommended that a reassessment of ambient levels of polycyclic aromatic hydrocarbon emissions from smokestacks be conducted. Once implemented, public policy changes such as this will serve to decrease the adverse health effects associated with environmental exposures in susceptible populations.

Hu, Zhiqiang

University of Missouri

Zhiqiang (Zack) Hu is Professor and Chair of the Department of Civil and Environmental Engineering at the University of Missouri-Columbia. He received his M.S. and Ph.D. degrees at the University of Connecticut and completed his postdoctoral training at Cornell University. He is a registered professional engineer in environmental engineering. Dr. Hu's areas of expertise and research activities include wastewater treatment and biological nutrient removal, environmental nanotechnology and biotechnology, wetlands, algae treatment and water reuse, biofilm formation and control, pathogen detection and removal, emerging renewable energy issues, anaerobic digestion, anaerobic membrane bioreactors, bioreactor landfills, microbial electrolysis systems and bioelectrochemistry, and integrated biochemical and physicochemical treatment. Dr. Hu serve as an EPA Food Quality Protection Act (FQPA) Science Review Board Member, an ad hoc member of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel, US EPA, from 2009 to 2015. He is currently a member of the Advisory Committee, Nano-Micro Conference 2018. He also serves as an academic editor of PLOS ONE, an Associate Editor of Water Environment Research and an ASCE Journal of Hazardous, Toxic, and Radioactive Waste.

Hufford, Walter R.

Talisman Energy USA Inc. - REPSOL

Mr. Walter R. Hufford is the Director of U.S. Government & Regulatory Affairs for Talisman Energy USA Inc., a part of the Repsol Group. He holds a B.S. in Earth Sciences - Geology from Middle Tennessee State University, an M.S. in Geology from Texas A&M University, and a Masters in Management – Business Administration from Pennsylvania State University. Mr. Hufford has 32 years of experience in the energy industry, working with environmental issues associated with both legacy and current operations. He provides internal technical and regulatory support in his company's North America exploration and production operations, and serves on committees with trade organizations at the regional and national level. He has been integral to internal company activities relating to drilling and completions. Mr. Hufford participates on industry and state regulatory committees that address new legislation and rulemaking including oil and gas provisions. Mr. Hufford serves as a corporate advisor regarding hydraulic fracturing, gas migration and stray gas matters. Additionally, Mr. Hufford is a member of the graduate faculty at Texas A&M University as a Professor of Practice teaching graduate level seminar courses. He sits on the board of directors for STRONGER (State Review of Oil, Natural Gas, Environmental Regulations) and has served as a board member with the Pennsylvania Environmental Council and the Pennsylvania Resource Council. His prior experience includes management of multimillion dollar environmental liabilities including nuclear fabrication and disposal sites; chemical plants; petrochemical facilities; manufacturing locations; and refinery projects with complex environmental and liability issues. He has successfully closed hundreds of environmentally-impacted sites regulated at the federal and state level throughout the United States. He served in a leadership role during the 2010 Macondo Deep Water Horizon gulf response, coordinating and advising as a company liaison with the U.S. Coast Guard, EPA, Departments of Homeland Security & Interior, U.S. Fish and Wildlife Service, as well as multiple state regulatory agencies. He also served as a spokesperson for BP's community outreach effort, conducting town hall meetings for residents and elected officials along the Gulf Coast. Mr. Hufford

was selected to present at the EPA 2011 workshops dealing with hydraulic fracturing. Mr. Hufford has received no external research grants from either government agencies, private companies, or foundations during his tenure with Talisman or BP.

Humphreys, James

ABB

I am the North American Product Specialist for the ABB Lewisburg W. Virginia Factory. Currently manufacture Process Gas Chromatographs, Reid Vapor Pressure Analyzers, And MultiWave Photometers IR and UV. I specialize in ensuring customers are compliant with EPA regulations as well as state in local regulations based on technologies available.

Hurtt, George

University of Maryland, College Park

Professor Hurtt received his Ph.D from Princeton University in 1997. From 1998-2010, Dr. Hurtt worked at the University of New Hampshire in the Institute for the Study of Earth Oceans and Space and Department of Natural Resources, finally becoming Chair of the Natural Resources and Earth System Science Ph.D. Program, UNH's largest doctoral program, and Director the Complex Systems Research Center, UNH's main center focused on Earth System Science. In 2010, Dr. Hurtt joined the University of Maryland Department of Geography as Professor & Research Director, and in 2011 he was named Associate Director of the Joint Global Change Research Institute, and Associate Director of Research Innovations at the National Socio-Environmental Synthesis Center (SESYNC). Dr. Hurtt is involved in multiple collaborative research projects including the North American Carbon Program, NASA's Vegetation Structure Working Group, NASA's Carbon Monitoring System, and DOE's Integrated Earth System Modeling project. He previously led the international effort on global land-use harmonization for CMIP5 in preparation for the IPCC 5th assessment, and a NASA interdisciplinary science investigation focused on the role of natural disturbances on the Earth's coupled carbon-climate-human system. He is currently co-chair of the Land Use Model Intercomparison Project (LUMIP) for CMIP6, Science Team Leader for the NASA Carbon Monitoring System, Science Team Member for the NASA-GEDI mission, Associate Editor of Global Biogeochemical Cycles, Guest Editor for Environmental Research Letters, and Contributing Faculty Member to the Global Change Ecology section of Faculty of 1000. He is Chair of the University Research Council, Member of the University Environment Work Group, and leads the UMD/NASA-GSFC Joint Global Carbon Cycle Center.

Jacobsen, Grant

University of Oregon

Dr. Grant Jacobsen is an associate professor at the University of Oregon and the Director of the Master of Public Administration Program. He received an M.A. and Ph.D. in Economics from the University of California-Santa Barbara, where he was a fellow in the National Science Foundation's Economics and Environmental Science IGERT program. His research focuses on the use of applied empirical techniques to evaluate and inform the design of environmental policies. His work has addressed topics related to renewable energy, energy efficiency, air pollution, extraction of natural gas and oil, carbon offsets, climate change awareness, and voluntary environmental protection. He has published articles in leading academic journals, including the Economic Journal, the Review of Economics and Statistics, and the Journal of Public Economics. He is a member of the editorial council of the Journal of Environmental Economics and Management. He has served as a program reviewer for the U.S. Department of Energy and as an adviser to the Eugene Water & Electric Board. Dr. Jacobsen's research has been supported by the W.E. Upjohn Institute for Employment Research.

Juturu, Vijaya

OmniActive Health Technologies Inc.

Dr. Juturu has a doctoral degree in Clinical Nutrition (Cardiovascular Nutrition) from S.V. University in India (1996) and completed her postdoctoral research in Cardiovascular Nutrition at Penn State University (1997-2000). Dr. Juturu is currently working as Director of Clinical Affairs at OmniActive Health Technologies Inc. Her research focuses on the effects of bioactive nutrients on established and emerging risk factors for cardiometabolic syndrome, vision health and inflammation. Her research integrates clinical and basic research including nutrigenomics to evaluate underlying molecular mechanisms of action in disease and health. She conducts preclinical (basic) efficacy, toxicology studies for safety and controlled clinical studies designed to evaluate the role of bioactive nutrients on risk factors in health and disease. These studies have evaluated established and emerging risk factors in health and disease. Dr. Juturu is also as a consultant for consumer research companies and she is an adjunct faculty. She was a consultant and worked for Ocean Spray Cranberries as cardiovascular scientist, Senior Scientist and then as Director of Scientific Affairs at Nutrition 21, Inc., Avon Products, Inc, Unilever cosmetics, United Soybean Board/QUALISOY and the Natural Standard of Integrative Medicine and Cochrane Research Group. Dr. Juturu was the recipient of the Dr. Tinsley R. Harrison Award in 2008 from The Society of Clinical Investigation (SSCI) and the American Journal of Medical Sciences; Dr. Mark Bieber Distinguished Industry Scientist Award in 2008 from the American College of Nutrition; the Young Scientist Award given by the Indian Society of Atherosclerosis Research in 1995; and the Indian Medical Scientist Award in Nutritional Sciences, given by the Indian Council of Medical Research in 1997. She received the Diabetes Education Stipend Award in 2005 and the Diabetes Care Education and Professional Excellence Award in 2007 from the Nutrition in Complementary Care Dietetic Practice Groups of the American Dietetic Association (ADA). She received best communicator award ribbon twice from the Association of Research in Vision and Ophthalmology (ARVO). In addition, she received research and presentation awards from other organizations. Dr. Juturu is the author of several publications including book chapters, patents, and submissions of qualified health claims. She is an invited author, invited speaker, reviewer, council/committee member, and editorial board member for several reputed journals. She was nominated to Board of Editors for three years 2019-2022, Academy of Nutrition and Dietetics. She was nominated as Research and Development Chair for the Medical Nutrition Practice Group of ADA, nominated to HOD/PID research and development, and is working as an Evidence Analysis Library analyst/committee member for Academy of Nutrition and Dietetics, and is involved in a women's working group committee of the American Diabetes Association. Dr. Juturu is a member of numerous professional organizations including the Academy of Nutrition and Dietetics, American Heart Association, American Diabetes Association, ARVO, American Society for Nutritional Sciences, American College of Nutrition, and the American Oil Chemists Society. She is a Fellow of the Academy of Nutrition and Dietetics (FAND) and the American College of Nutrition (FACN.).

Keating, Christopher

Austin Community College

Dr. Christopher F. Keating has an M.S. and the Ph.D. in physics from the University of Texas at Dallas and is currently an adjunct professor of physics at Austin Community College. He has previously served as a professor of physics at the U.S. Coast Guard Academy and the U.S. Naval Academy. His area of research is in planetary geophysics, providing him with an in-depth understanding of a broad range of topics affecting planetary environments. He is a member of the American Geophysical Union (AGU). His work has been published in several peer-reviewed scientific publications and presented at scientific conferences. He has recently been working with ranchers and farmers in the central-Texas area in an effort to be better informed of the issues and problems they face on a daily basis. He has long been engaged in public outreach, speaking at public events,

conducting media interviews, and has authored non-fiction books on science topics for the general public. He personally funds all of his research activities himself and does not receive any financial considerations from any government or industrial organization for his scientific work. In addition to his academic career, Dr. Keating served in the U.S. Navy and Naval Reserve, retiring from the latter in 2012 after 35 years of combined service. His military duties included supervising production teams and service as an in-depth analyst, producing reports that were briefed to all levels of the government. He served on numerous boards, committees, and flag staffs providing scientific and technical expertise for a variety of projects.

Kersting, Annie

Lawrence Livermore National Laboratory

Dr. Annie Kersting is Director of University Relations and Science Education at the Laurence Livermore National Laboratory (LLNL). She holds a B.S. in Geology and Geophysics from the University of California, Berkeley, and an M.S. and Ph.D. in Geology and Geophysics from the University of Michigan. Dr. Kersting previously served as the Director of the Glenn T. Seaborg Institute in the Physical and Life Sciences Directorate, where she focused together with her deputies, Ian Hutcheon and Dawn Shaughessy, on collaborative research between LLNL and the academic community in nuclear forensics, super heavy element discovery and environmental radiochemistry. Dr. Kersting's research interests include the fields of radiochemistry, isotope geochemistry, and environmental chemistry. Her current research focuses on the geochemical mechanisms that control actinide transport in the soil and groundwater, and on identifying the dominant bio-geo-chemical processes and the underlying mechanisms that control actinide (U, Pu, Np, Am) transport. In particular, she is interested in understanding how nanoparticles facilitate transport of contaminants in both the saturated and unsaturated environment. Dr. Kersting was a Board member of the Nuclear and Radiation Studies Board, National Research Council 2010-2012, and a Committee member on the National Academy Sciences National Research Council, Nuclear and Radiation Studies Board Committee from 2006-2007. She served on the Environmental Management Sciences Program Review Panel of the U.S. Department of Energy's Office of Science in 2006, and served as a scientific advisor on the Actinide Migration Committee for Rocky Flats from 2000-2003. Her current research funding comes from the Department of Energy's Office of Science, Biological & Environmental Research. As University of Relations Director, she reports to the Director of Science & Technology in the Director's office.

Khubchandani, Jagdish

Ball State University

Dr. Jagdish Khubchandani is a Professor of Community Health at Ball State University. He also serves as an ad-hoc Biostatistician for the College of Health and has previously served as a fellow of Center for International Development and Global Health Institute at Ball State University. He received his Doctorate in Clinical Medicine from India, Masters in Public Health from Western Kentucky University, and PhD in Health Education and Epidemiology from University of Toledo. Currently, he teaches in the areas of environmental health, global health, social epidemiology, and public health education in community and clinical settings. Within the past decade, he has mentored over 100 students pursuing undergraduate and graduate degrees in the field of public health, nursing, or medicine. In the past 5 years, he has coauthored more than 75 research articles in prestigious journals such as the Lancet, Journal of American Medical Association, and the New England Journal of Medicine on a broad range of issues including morbidity and mortality associated with environmental health problems. Within the past 2 years, Dr. Khubchandani has received research funding from Merck Neuroscience Laboratories and Ball State University Foundation. Previously, he has also mentored racial/ethnic minority students on NSF and NIDDK funded projects. More recently, his research has received widespread attention from prominent media outlets such as Fox News, CNN,

CNBC, MSN, Bloomberg News, Chicago Tribune, WSJ, and Huffington Post. Dr. Khubchandani also serves as an Associate Editor or Editorial Board Member for six journals in the field of public health and biomedical sciences. In 2017, he was also elected Director of the World Association of Medical Editors. Dr. Khubchandani has received many prestigious honors such as the Indiana Governor's Service Learning Award (2012), Hurley Goodall Distinguished Faculty Award (2012), Hero of Health Education (2012) and Open Society Award (2017) from Society for Public Health Education, Outstanding Junior Faculty Award (2014) and Outstanding Diversity Researcher (2017) from Ball State University.

Kieft, Jeffrey

University of Colorado

Dr. Jeffrey Kieft is a tenured Professor and Vice Chair of the Dept. of Biochemistry and Molecular Genetics at the University of Colorado School of Medicine, and Director of the University of Colorado School of Medicine Structural Biology and Biophysics Core Facilities. Dr. Kieft earned his B.S. in Chemistry at West Point, served as a U.S. Army officer, earned a Ph.D. in Chemistry from the University of California Berkeley, then conducted several years of post-doctoral research at Yale University. From 2001-2002, Dr. Kieft was the Roger Revelle/AAAS Fellow in Global Stewardship in the White House Office of Science and Technology Policy (OSTP). There, his portfolio included global climate change, ocean issues, gulf coast hypoxia/eutrophication, green chemistry, container and shipping security, vetting new security technologies, and anthrax spore mitigation. Within OSTP, Dr. Kieft was responsible for preparing congressional testimony, researching and drafting "white papers," chairing or serving on various interagency working groups, traveling to represent the White House in diverse forums, reviewing and analyzing scientific reports, and preparing scientific summaries to aid decision makers. Dr. Kieft then joined the faculty of University of Colorado School of Medicine. His research program focuses on virology, RNA biochemistry, biophysics, and structural biology. In 2009-2016, he received an Early Career Scientist Award from the Howard Hughes Medical Institute (HHMI), given to the top 50 promising biomedical researchers in the nation. He is a Fellow of the American Society of Microbiology, recognizing him as one of the premier scientists in that field. In addition, Dr. Kieft maintains interest in a broad range of scientific topics and in science policy beyond his own research. He is not currently serving on any national advisory committees. His current and recent research funding is from the National Institutes of Health. Professor and Vice Chair

Kinney, Patrick

Boston University School of Public Health

Dr. Kinney has a broad background in environmental health sciences, with specific training and expertise in air pollution exposure assessment, epidemiology, and climate change. He completed his doctoral studies in Environmental Science and Physiology at the Harvard School of Public Health in 1986. As a junior faculty member at New York University, he developed and led epidemiologic research on lung function and inflammatory biomarker changes in relation to chronic exposures to ozone and other air pollutants. Moving to Columbia in 1994, he expanded his research to include community-based studies of traffic pollutant exposures and health outcomes in underprivileged neighborhoods in New York City, leading and contributing to several large-scale studies over the following 22 years. He has contributed to the periodic reviews of the National Ambient Air Quality Standards for ozone and particulate matter, and served on the EPA Clean Air Scientific Advisory Committee for reviews of the Nitrogen Dioxide and Sulfur Dioxide standards. He developed and directed the Climate and Health Program at Columbia, which trains students and postdocs in research on the health dimensions of climate variability and change. He also directed research on indoor and outdoor air quality and health in Africa, including a randomized stove trial in Ghana funded by NIEHS. Current funding sources include the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration. In January 2017, Dr. Kinney was named the

inaugural Beverly A Brown Professor of Urban Health at Boston University.

Klein, Levente

IBM T. J. Watson Research Center

Dr. Levente Klein is a Research Staff Member in the Internet of Things and Industry Solution at the IBM T.J. Watson Research Center, Yorktown Heights, NY. His work at IBM span multiple research topics from material science, nano-optics and wireless sensing solutions with strong focus to apply research technologies to industrial problems. Levente obtain a PHD in Physics from University and Utah and since joining IBM Research in 2006, he developed technologies to enable energy efficient cooling in data centers, monitoring fugitive methane gas in oil and gas industry, and application of wireless sensing solution in agriculture and healthcare. Current research interests focus on environmental monitoring of greenhouse gases, application of wireless sensing in outdoor environment and physics based modeling and analytics. His work was recognized by 3 IBM's Outstanding Technical Achievement award and multiple IBM Research Division Award.

Koziel, Jacek

Iowa State University

Professor Jacek Koziel is a nationally and internationally recognized expert with multidisciplinary knowledge and experience in the following disciplines: air quality, community odor, atmospheric sciences, livestock agriculture, environmental science, analytical chemistry, complex systems on the nexus of food, energy and water; toxicology; benefit-cost analysis; sustainability; chemical safety; green chemistry; and waste management. His work (over 120 articles) was cited more than 2, 500 times (h index = 30, Web of Science). He earned awards for peer-review of more than 175 manuscripts in 65 journals. He has been serving on editorial boards for three journals including Atmosphere, International Journal of Environmental Research and Public Health, and AgriEngineering. Dr. Koziel's work has been featured in Nature, Scientific American, National Geographic, Smithsonian, The Economist, and on the History Channel. He has served as peer-reviewer and panelist for international science funding programs. He earned Ph.D. in Civil Engineering, M.S. degrees in Mechanical Engineering and Environmental Quality Engineering. He is serving at Fulbright Association (Iowa Chapter) and is a member of the American Association for the Advancement of Science, Sigma Xi, American Society of Agricultural and Biological Engineers, and the International Society of Animal Hygiene.

Krantz, William

University of Colorado at Boulder

I received a B.A. (1961) in chemistry from Saint Joseph's College, B.S. (1962) in chemical engineering from the University of Illinois, and a Ph.D. (1968) in chemical engineering from the University of California. I am a licensed Professional Engineer. I have held faculty positions at the University of Colorado, University of Notre Dame, University of Cincinnati, National University of Singapore and Nanyang Technological University (Singapore). I also have worked at Chevron Research and Development (CalTex) and the 3M Company. I presently am serving as a consultant to the Singapore Membrane Technology Center in the area of water desalination and wastewater treatment. I am the author or co-author of 265 technical papers and two recent books, and am co-inventor on 19 patents. I have worked in a broad spectrum of areas spanning several disciplines including chemical, mechanical, civil and environmental engineering, geophysics, and chemistry. I have consulted for several companies as well as the National Institute of Standards and Technology, National Science Foundation, U.S. Air Force, and U.S. Department of Energy.

Kronenberg, Amy

Lawrence Berkeley National Laboratory

Dr. Amy Kronenberg is a Staff Biophysicist at the Lawrence Berkeley National Laboratory. Her research interests include radiation biology, cancer biology, charged particle radiation biophysics and mutagenesis. She has conducted extensive research on molecular mechanisms of mutagenesis and aspects of genomic instability. She is a Council Member of the National Council on Radiation Protection and Measurements (NCRP). Dr. Kronenberg is very active in national and international professional societies and institutions. She is currently a Senior Editor for the journal Radiation Research and is also a member of the editorial board of the Journal of Radiation Research (Japan). She was an invited speaker at a symposium on radiation carcinogenesis at the Radiation Effects Research Foundation (RERF) in Hiroshima, Japan. She was co-organizer of the American Statistical Association Conference on Radiation and Health (2006), in addition to many other venues. Dr. Kronenberg serves as a member of the External Advisory Board for the National Space Biomedical Research Institute, and as a member of an international review panel for the GSI Helmholtzentrum in Germany. Her research has been supported by Federal funding sources. Dr. Kronenberg received her A.B. in Biology at Brown University, and her Sc.D. in Cancer Biology from the Harvard School of Public Health.

Landis, Wayne

Western Washington University

Dr. Wayne Landis is Professor and Director, Institute of Environmental Toxicology Huxley College of the Environment, Western Washington University. He holds a B.A. in Biology from Wake Forest University, (1974), an M.A. in Biology from Indiana University (1978), and a Ph.D. in Zoology from Indiana University (1979). Dr. Landis' areas of expertise and research activities include: environmental toxicology, the effects of toxicants on populations, and ecological risk assessment at large spatial and temporal scales. His research contributions also include: co-development of the Community Conditioning Hypothesis, the use of multivariate analysis in microcosm data analysis, creation of the Action at a Distance Hypothesis for landscape toxicology, the application of complex systems theory to risk assessment, and development of the Relative Risk Model for multiple stressor and regional-scale risk assessment and specialized methods for calculating risk due to invasive species and emergent diseases. Dr. Landis has authored over 150 peer-reviewed publications and government technical reports, participated in over 400 scientific presentations, edited four books, and wrote the textbook, Introduction to Environmental Toxicology, now in its sixth edition. He has consulted for industry; nongovernmental organizations as well as federal (U.S. and Canada), state, provincial, and local governments. Dr. Landis' research has been supported by grants and contracts from federal agencies (U.S. Air Force, Environmental Protection Agency, U.S. Forest Service,), industry (DuPont, BP and Teckcominco Ltd.), with additional grant support from state, provincial and local governments, industry, NGOs and foundations. Dr. Landis has served on the American Society of Testing and Materials (ASTM) Committee on Publications overseeing a variety of environmentally related symposia proceedings. He currently serves on the editorial boards of the journals Risk Analysis and is an editor for Integrated Environmental Assessment and Management, and retired as the ecological risk area editor for Risk Analysis. Dr. Landis is a member of the Society of Environmental Toxicology and Chemistry (SETAC) and served on the SETAC Board of Directors from 2000-2003. In 2007 he was named a Fellow of the Society for Risk Analysis and in 2016 a Fellow for the Society for Environmental Toxicology and Chemistry. He was selected for his second term on the Science Panel of the Puget Sound Partnership, a state of Washington agency charged with the restoration of Puget Sound. More recently he served on the NASEM panel that resulted in a keystone document on the future of synthetic biology and specifically the use of gene drives "Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with

Public Values."

Lange, Sabine

Texas Commission on Environmental Quality

Dr. Sabine Lange is the section manager for the Toxicology Division at the Texas Commission on Environmental Quality (TCEQ). Dr. Lange's responsibilities include overseeing health effects risk assessments of air permit applications, ambient air monitoring projects, and hazardous waste sites; overseeing the development of chemical toxicity factors; and conducting and overseeing systematic reviews and independent analyses of risk assessments. Dr. Lange serves as a technical resource for the State and citizens of Texas for human health and environmental risk assessment, especially related to air and water quality. Dr. Lange's research interests include the toxicology of criteria air pollutants, and risk assessment methods used for derivation of toxicity factors. In these areas she has published articles, given invited talks, presented posters, and served as a workshop panel member. On behalf of the TCEQ, she has intensively reviewed the documents released by the US EPA on the National Ambient Air Quality Standards (NAAQS) for ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and lead. Dr. Lange and colleagues have provided comments to the US EPA on the assessment documents supporting these standards, particularly as they relate to principles of toxicology, risk assessment, and the State's perspective on these rules. She has also served as a peer reviewer for EPA on chemical hazard assessments for regulations under the Toxic Substances Control Act. Dr. Lange's work since joining TCEQ has been entirely funded by the State of Texas. Dr. Lange received a Bachelor's degree from the University of Western Ontario in Canada, and completed a Ph.D. and post-doctoral training in biochemistry and molecular carcinogenesis at the University of Texas at Houston and MD Anderson Cancer Center. Dr. Lange is a Diplomate of the American Board of Toxicology.

Lawler, Desmond F.

University of Texas

Dr. Desmond F. Lawler is the Nasser I. Al-Rashid Chair in Civil Engineering, and Distinguished Teaching Professor in the Environmental and Water Resources Engineering Program within the Department of Civil, Architectural and Environmental Engineering at the University of Texas at Austin. He holds a B.S. in Civil Engineering from the University of Notre Dame (1968) and M.S. and Ph.D. degrees in Environmental Engineering from the University of North Carolina at Chapel Hill (1975 and 1980). Dr. Lawler has been at the University of Texas since 1980 and is now the W.A. Cunningham Professor of Engineering and a member of the University's Distinguished Teaching Academy. He was recognized in 1999 by the American Water Works Association with the A.P. Black Award for sustained contributions to drinking water research. His paper on flocculation with M.Y. Han was recognized with the 2005 Association of Environmental Engineering and Science Professors (AEESP) Outstanding Publication Award as one that that has withstood the test of time and influenced environmental engineering practice. Dr. Lawler has served on the Board of Directors of the Association of Environmental Engineering Professors, has been on several committees within AWWA, and is now on the Board of Trustees of the Water Science and Research Division of AWWA. Along with Dr. Mark Benjamin of the University of Washington, he is currently writing a graduate textbook on Physical/Chemical Treatment Processes for Water and Wastewater to be published by McGraw-Hill.

Lenczewski, Melissa

Northern Illinois University

Dr. Melissa Lenczewski is an associate professor in the department of Geology and Environmental Geosciences at Northern Illinois University (NIU). She is also the Director of NIU's Institute for the Study of the Environment, Sustainability, and Energy (the Institute). The Institute integrates

perspectives and methods from the natural sciences, social sciences, humanities, technology, and engineering for interdisciplinary research that addresses environmental and sustainability issues. Dr. Lenczewski holds degrees in Microbiology (B.S., University of Arizona), Soil and Environmental Sciences (M.S., University of Arizona) and Geological Sciences (Ph.D., University of Tennessee). She has served in numerous leadership capacities within the National Groundwater Association including as a director on the Scientist and Engineers Section Board of Directors, Government Affairs Committee, and Education and Awareness Subcommittee. Her main research focuses on contaminant hydrogeology by bringing together geochemistry, microbiology and physical flow hydrogeology. In Illinois, her research centers on a hyperalkaline site (~pH 12) in the Calumet region where she is examining geochemistry and microbiology of this unique extreme environment. She heads a research team that includes geochemists, geophysicist, public health, and geographers to examine the impact of tourism on the karst aquifer in Mexico. Lastly, she is working in Southeast Asia, especially Myanmar and Cambodia, on capacity building in higher education by training local faculty and graduate students in hydrogeology while researching local aquifers and determining major water quality issues. During the last two years Dr. Lenezewski's research has been funded by the National Science Foundation and National Ground Water Association Foundation.

Li, An

University of Illinois at Chicago

I am an environmental chemist, with research interests on how human activities influence the natural environment and how the changes in turn affect human health. My team focuses particularly on the transport and fate of persistent, bioaccumulative, and potentially toxic (PBT) organic chemicals in water. The major projects for which I served as PI since 2001 include three on PBTs in the Great Lakes sediment (funded by USEPA), one on the fate of brominated flame retardants (funded by NSF), and a few on cross-placenta transfer of PBTs (funded by NIEHS and as a part of the National Children's Study). We have discovered unexpected organic pollutants while analyzing legacy toxins; we developed novel analytical methods for trace halogenated PBTs; we are also very interested in quantitative structure-activity relationships. In recent years, I become more interested in "larger pictures" on how our scientific data are helping government make decisions, affecting the view of the general public, and impacting the society. I am the first Dr. Samuel and Catherine Epstein Term Professor at our UIC School of Public Health. I have published about 90 peer-reviewed journal articles with about one third in the Environmental Science and Technology (ES&T), in addition to 2 books and a number of book chapters as well as about 170 invited talks and conference publications. I served in review panels of NIH, NSF, EPA, and other funding agencies, and am a reviewer for >140 manuscripts from 38 journals. In research supervision, I have worked with >10 postdocs and visiting scholars, 23 PhD and 17 MS research assistants, and dozens of undergraduates.

Lohmann, Rainer

University of Rhode Island

Dr. Rainer Lohmann is Professor of Oceanography at the University of Rhode Island (URI)'s Graduate School of Oceanography. He obtained a Ph.D. in Environmental Science from Lancaster University (UK), and a BSc in Chemical Engineering from EHICS (Strasbourg, France). His educational background combines work in chemical / environmental engineering (postdoctoral work at the Massachusetts Institute of Technology, MIT) with marine, atmospheric and environmental chemistry. His group conducts research on the sources, transport, and bioaccumulation of anthropogenic pollutants. Dr. Lohmann has performed work at sites contaminated with legacy hydrophobic organic contaminants using novel passive samplers to assess transport, bioavailability and food-web magnification of these chemicals. He is Director of the new NIEHS-funded Superfund Research Center at URI focused on the sources, transport, exposure and effects of per- and polyfluorinated chemicals (PFASs). Dr. Lohmann has published over 100 articles in the leading

journals in the field (notably the American Chemical Society's Environmental Science and Technology), and has given over 100 invited presentations. He serves as Editor for the Society of Environmental Toxicology and Chemistry (SETAC)'s journal Environmental Toxicology and Chemistry, and is member of several editorial advisory boards, including Environmental Science and Technology, Environmental Science and Technology Letters, and Environmental Pollution. He serves on EPA's Board of Scientific Counselor's sub-committee on sustainable and healthy communities. Dr. Lohmann received the Roy F. Weston Environmental Chemistry Award by SETAC, the INNOLEC Visiting Lectureship by Masyruk University, Brno (Czech Republic) and fellowships by the Alexander-von-Humboldt foundation, the Research Center for Ocean Margins at the University of Bremen and the German Academic Exchange Service. He has received funding from the National Institute of Environmental Health Sciences (NIEHS), the Strategic Environmental Research and Development Program (SERDP), state and private foundations.

Lowery, Darrin L.

Chesapeake Watershed Archaeological Research Foundation

Dr. Darrin L. Lowery is the director of Chesapeake Watershed Archaeological Research. He has been the director of this group since 2001. He has held a research professor position and currently serves as an adjunct professor within the Department of Geology at the University of Delaware. From 2009 to 2014, he maintained a research fellowship position at the Smithsonian Institution. He has managed over fifty research projects since 1992 and served as the principal investigator or co-investigator for these projects. His responsibilities include overseeing field investigations, managing field crew, synthesizing the research results, and preparing final summary reports. He has a strong technology background and research interests in long-term human-environmental interactions, geology, geoarchaeology, biogeochemistry, hydrology and water resources, soil morphology and pedology, environmental isotope analyses, coastal erosion and sediment dynamics, paleoclimatology, and marine-estuarine ecosystems. Dr. Lowery has served as an expert witness concerning coastal resources as well as global positioning issues. He has been the principal author and/or co-author on forty-six peer-reviewed articles or book chapters, as well as fifty-six monographs. He earned both a B.A. in Anthropology and a Ph.D. in Geology from the University of Delaware. He also earned an M.A. in Archaeology from Temple University. His research for the past two years was funded by the Commonwealth of Virginia and the State of Maryland.

Lu, Kun

University of North Carolina

Dr. Lu is an associate professor in the Department of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina at Chapel Hill. The overarching goal of Dr. Lu's research is to better understand health effects of environmental exposure and individual response. He has strong technical background and expertise in analytical chemistry, microbiome, exposome, omics profiling, and biomarker development. Dr. Lu's lab works on numerous important environmental chemicals ranging from formaldehyde, heavy metals to pesticides, as well as others with significant public health concerns. One of his research thrusts is to develop DNA/protein adduct biomarkers and sensitive mass spectrometry assays to understand the carcinogenicity of chemicals and their risk assessment. Dr. Lu also studies how gut microbiome interacts with environmental exposure, how microbiome affects disease susceptibility, and how host factors crosstalk with microbiome to influence its response. Another focus of Dr. Lu's research is to map exposome for human disease to characterize exposures over the lifespan via high-resolution mass spectrometry, understand the health impact of the exposome, and to design strategies to reduce exposure-associated adverse effects. He has published numerous peer-reviewed articles and served on a number of external scientific review panels/committees. Dr. Lu received the Best Publication Award from the Society of Toxicology in 2011 for his work in the risk assessment of formaldehyde using

DNA adducts as chemical-specific biomarkers. He was also awarded with the Outstanding New Environmental Scientist Award in 2015 from the National Institute of Environmental Health Sciences. He earned BE, MS and PhD in chemistry and material sciences from Beijing University of Chemical Technology and University of North Carolina at Chapel Hill, followed by a postdoctoral training at Massachusetts Institute of Technology. His research for the past two years was funded by the National Institutes of Health.

Lupo, Anthony

University of Missouri

Dr. Anthony R. Lupo is Professor of Atmospheric Science in the School of Natural Resources, which is housed in the College of Agriculture, Food and Natural Resources at the University of Missouri. He received an AS in Math and Science from Cayuga County Community College, a BS in meteorology from the State University of New York at Oswego, an MS and PhD in Atmospheric Science at Purdue University, and post-doctoral training in synoptic and large-scale meteorology at The State University of New York at Albany. Since 1997, he has received funding through the National Science Foundation, the United States Department of Agriculture, United States Department of Energy, Civilian Research and Development Foundation Global, and the State of Missouri. His research topics have included atmospheric dynamics, synoptic meteorology, long-range forecasting, tropical meteorology, and climate variability and change, especially as related to agriculture. Dr. Lupo has authored 110 peer-review papers and book chapters. He teaches graduate level courses in atmospheric dynamics, chaos theory, tropical meteorology, the general circulation, and climate science. He has advised 46 graduate students, been a member of 47 graduate committees in atmospheric science, mathematics, education, and political science, and hosted five post-doc or visiting scientists. Dr. Lupo has served on review boards for many journals, government and private research funding agencies, and academic boards. He has been a contributing author and expert reviewer for the Intergovernmental Panel on Climate Change. He is a member of many professional societies and served on committees, such as the American Meteorological Society Board of Certified Consulting Meteorologists (2017), and as associate director of Research and Doctoral Constituency for Sigma Xi (2016-2018). He has received two Fulbright Teaching and Research awards, as well as a research specialist award, and is currently on the Fulbright Specialist roster.

Mace, Robert E.

Texas State University

Dr. Robert E. Mace is a Deputy Executive Administrator for the Texas Water Development Board, managing the Water Science and Conservation office at the agency, a group of 66 scientists, engineers, and technicians focused on better understanding Texas' water resources. His technical background is in hydrogeology with an emphasis on numerical modeling, aquifer characterization, and geostatistics; however, he also has experience in groundwater contaminant transport, groundwater management, surface water, water conservation, water loss, desalination, water reuse, aquifer storage and recovery, water planning, drought response, and rainwater harvesting. He is recognized as an effective communicator of science to policymakers and is sought out to explain complicated water issues to non-technical audiences. Dr. Mace's work has been recognized by the U.S. Department of Interior (Partners in Conservation Award as part of an ensemble effort), National Ground Water Association (Technology Award), Texas State University (Distinguished Texas Hydrogeologist), Austin Geological Society (Distinguished Service Award), Barton Springs/Edwards Aquifer Conservation District (Conservation Award in Research), and Haskell Simon (Rosetta Stone Award). He is the chair of the Multi-State Salinity Coalition, a founding member and current board member and associate editor of the Texas Water Journal, a fellow of the Center for Public Policy Dispute Resolution, a board member of the Scientists and Engineers Board of the National Ground Water Association, a member of the Advisory Committee on Water Information, a member of the Water

Conservation Advisory Council, a member of the Groundwater Contemporary Issues Council (California), a member of the Edwards Aquifer Habitat Conservation Plan Science Committee, the chair of the Texas STATEMAP Project Advisory Panel, and a former president of the Austin Geological Society. He is also a registered professional geoscientist with the Texas Board of Professional Geoscientists. Dr. Mace received his B.S. degree in Geophysics and an M.S. in Hydrology from the New Mexico Institute of Mining and Technology and a Ph.D. in Hydrogeology from The University of Texas at Austin. He and his research group are primarily funded by direct appropriations from the state of Texas but also receives or has received financial support from the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, and University Corporation for Atmospheric Research. His group also works cooperatively with the U.S. Geological Survey.

Marty, Sue

The Dow Chemical Company

Dr. Sue Marty received her Bachelor of Science (B.S.) in biology and a Master of Public Health (MPH) in toxicology from The University of Michigan (Ann Arbor, MI). After a year at the Eberhard-Karls Universität in Tübingen, Germany, she returned to the University of Michigan to complete a Doctor of Philosophy (Ph.D.) degree in toxicology. Her dissertation was in the area of reproductive toxicology, looking at the effects of toxicants on labor onset and progression. Subsequently, she was a postdoctoral fellow at Michigan State University, studying the neurotoxic effects of methylmercury on calcium homeostasis in primary cerebellar neurons. In 1997, she joined The Dow Chemical Company in Midland, Michigan, where she served as a Lead Scientist in the Reproductive and Developmental Toxicology group. After six years, Dr. Marty became a business consultant for Dow's glycol ethers business. In 2006, she decided to return to the laboratory and became a Senior Toxicology Leader in Dow's Neuroendocrine Toxicology group. In 2014, she accepted her current role on the Chemicals and Health Leadership Team at The Dow Chemical Company; this group develops internal programs to address issues related to chemicals and health, including research projects for Dow's toxicology laboratory. Dr. Marty is a diplomate of the American Board of Toxicology (D.A.B.T.) and a member of the editorial board for Birth Defects Research Part B: Developmental and Reproductive Toxicology. She is past president of both the Michigan Regional Chapter of the Society of Toxicology (2007-2008) and the Midwest Teratology Association (2005-2006). She has served on the Continuing Education Committee (2005-2008), Program Committee (2007-2008) and Science Committee (2009) for the Teratology Society, and councilor for the Neurotoxicology Specialty Section of the Society of Toxicology (2009-2011). Dr. Marty has served on expert panels for the National Toxicology Program (NTP) Center for Evaluation of Risks to Human Reproduction (CERHR; 2004-2006). Currently, Dr. Marty serves on several industry panels, including the Endocrine Policy Forum. She serves on several international expert committees, including the Organisation for Economic Cooperation and Development (OECD) Expert Group for Reproductive Toxicology, the OECD Working Group of the National Coordinators of the Test Guidelines Programme (WNT), and the United Nations Environment Programme (UNEP) Endocrine Advisory Group. She also serves on an advisory board for the Humane Society of the United States. Dr. Marty has published over 50 scientific papers in peer-reviewed journals. Her research interests are primarily focused on: 1) endocrine disruption with a focus on the specificity and sensitivity of endocrine endpoints in toxicity studies; 2) effects of toxicant exposure during critical life stages of development; and 3) evaluation of ToxCast and ExpoCast data to evaluate potential toxicity. She is working with the Royal Society of Chemistry (UK) on a project to evaluate low dose/non-monotonic dose responses with endocrine-active compounds. Over the past two years, Dr. Marty's research funding has come from The Dow Chemical Company.

McConnell, Charles

William Marsh Rice University

I serve as the Executive Director of the Energy and Environment Initiative (EEi) at Rice University in Houston, TX. EEi is a program that leverages the multi-discipline expertise at Rice to promote collaborative research in the areas of energy and environment science, engineering, economics, policy, and humanities. Our mission is to impact the marketplace with relevant and impactful transformative technology and research that will result in marketplace impact. Our efforts also extend externally to government, public partnerships, and industry to ensure collaboration and focus on market driven challenges to ensure excellence in energy access and reliability, affordability and economic competitiveness, and environmentally responsible solutions for the future. I have over 30 years of industry experience, have served as Assistant Secretary of Energy at the US Department of Energy, and have 5 years most recently at Rice University. During this period of time I have testified numerous times in both House and Senate committees (House Science and Technology being one of them) on a number of scientific energy related topics.

McKean, Deborah

Independent Consultant

Dr. Deborah McKean is a toxicologist specializing in human health risk assessment, risk-based decision-making, risk communication and training. She received her M.S. degree from the Department of Pharmacology and Toxicology at the University of Arizona and her Ph.D. from the Department of Pathology and Laboratory Medicine at the University of Cincinnati Medical Center. In addition to her experience in emergency response and remediation activities, she has been involved in the development of national policy, risk assessment guidance and chemical-specific, health-based criteria for the U.S. Environmental Protection Agency (EPA). She was an assistant professor at the University of Cincinnati where she taught Anatomy and Physiology, Pharmacology, Pathophysiology and Environmental Science. Dr. McKean served as a Division Director within U.S. EPA's National Homeland Security Research Center before becoming the Chief of Technical Assistance for EPA's Denver Regional office. Dr. McKean has also provided expert witness testimony for litigations involving hazardous waste issues and has been certified as an Environmental Unit Leader within EPA's Incident Command System for emergency response. Dr. McKean was also a member of EPA's Regional and National Incident Management Teams and is certified as an adult trainer and instructor. She recently retired from federal government service and is currently self-employed.

Meredith, Justin

Tennessee Department of Environment and Conservation

Mr. Justin Meredith is the Technical Assistance Manager at the Tennessee Department of Environment and Conservation (TDEC) Nashville, Tennessee. Mr. Meredith manages the Technical Assistance section, which performs a wide variety of scientific reviews and technical services for the entire Division and for external customers. These positions have state-wide responsibility. This section is made up of seven technical staff, representing: 1.) Divisional Risk Assessment team; 2.) Dry Cleaner's Environmental Response program; 3.) Community assistance to local governments and development districts applying for or have been awarded EPA Brownfields grants; 4.) Research on contaminated sites and what companies or individuals may have caused the contamination; and 5.) Hydrogeological expertise. In addition to managing the technical section Mr. Meredith is the petroleum contamination remediation expert, a human health and ecological risk assessor, and project manager. Mr. Meredith presents at conferences and has trained several hundred individuals including internal staff as well as external consultants on several aspects involved in the remediation process. Prior to TDEC-DoR, Mr. Meredith worked for TDEC-Underground Storage Tanks program and prior to that worked in the private sector, as a field geologist. Mr. Meredith is a trainer for the Interstate Technology & Regulatory Council's training course on light non-aqueous phase liquid remediation technology overview. Mr. Meredith has received no research funding. Mr. Meredith has been active in ITRC since 2014 and is serving as Tennessee's ITRC Point of Contact

https://www.itrcweb.org/About/State. Mr. Meredith earned a B.S. in Environmental Geosciences from Valdosta State University in Valdosta, Georgia.

Meselhe, Ehab

Tulane University

Ehab Meselhe, Ph.D., P.E., has more than 20 years of experience researching coastal wetland hydrology, sediment transport, and computer modeling of coastal wetland, estuarine, and riverine systems. His multi-layered background includes work as an educator, researcher, and practitioner with extensive experience working with academic institutions, government agencies, and the private sector. He has been heavily involved in large-scale coastal ecosystem restoration programs in south Louisiana and the Florida Everglades. As the Institute's former Director of Natural Systems, Dr. Meselhe served as Louisiana's technical lead for the Mississippi River Hydrodynamic and Delta Management Study and helped build the numerical models that provided a foundation for Louisiana's 2017 Coastal Master Plan. Dr. Meselhe is heavily involved in the numerical modeling being used by Louisiana to help refine the design of sediment diversions at Mid-Barataria and Mid-Breton along the Mississippi River. Prior to joining The Water Institute of the Gulf, Dr. Meselhe directed the Institute of Coastal Ecology and Engineering at the University of Louisiana-Lafayette, where he also served as distinguished professor for the Department of Civil Engineering. During his tenure at UL Lafayette, he established and sustained an externally funded research program from federal and state agencies. He is a registered Professional Engineer in the sates of Iowa, Louisiana, Texas, and Arkansas. He also served as an Associate Editor of the Journal of Hydrology (Elsevier), and the Journal of Hydraulic Research (International Association of Hydraulic Research).

Moo-Young, H. Keith

Washington State University, Tri-Cities

Dr. H. Keith Moo-Young is Chancellor of the Washington State University, Tri-Cities, Richland, Washington. Prior to assuming this position in April 2013, he served as Dean of the College of Engineering, Computer Science and Technology at California State University-Los Angeles. He holds an M.S. and Ph.D. in Civil-Environmental Engineering from the Rensselaer Polytechnic Institute, and a Masters of Technology Management from the University Pennsylvania, a B.S. degree in Civil Engineering from Morgan State University and is a licensed professional engineer (Environmental Engineering) in Pennsylvania. Dr. Moo-Young was formerly the Interim Dean and Associate Dean for Research and Graduate Studies at Villanova University, and has served as a Professor at Lehigh University and Villanova University. Dr. Moo-Young is a Board Certified Environmental Engineer by the American Association for Environmental Engineers and a Fellow of the American Society of Civil Engineers. The emphasis of his research is on hazardous and solid waste management and technologies, such as the remediation of inorganic contaminants in acid mine drainage and groundwater, manufactured gas plant and coal tar, recycling and reuse of industrial co-product materials, and corrective strategies for contaminated sediments. Dr. Moo-Young's current research is funded by the National Science Foundation to acquire an Ultra-Centrifuge for geoenvironmental research and education, renovate core facilities, fund the GK-12 Fellowship Program, and support the CREST Center for Sustainable Energy; Naval Surface Warfare Center (NSWC) to support its education partnership agreement with the College of Engineering, Computer Science and Technology at California State University, Los Angeles; the California Air and Resource Board to support the Hydrogen Refueling Station; the Department of Defense, to support the Great Minds in Science, Technology, Engineering and Math (STEM) careers program; Department of Education to increase engineering transfers students from East Las Angeles College and Los Angeles Trade Technical College; various corporations to support the 'Senior Design' project; and National Oceanic and Atmospheric Administration to support the University Research Center. Dr. Moo-Young has served as a member of the Water Environmental Research Foundation Exploratory Team on Solids Reduction,

National Science Foundation Committee of Visitors for Civil and Mechanical Systems Division from 2001-2003, the Department of Energy's Workshop on Monitoring of Metals and Radionuclide Contaminated Sites in 2004 and Workshop on Containment Technologies in 2002. He also served as the session leader on Sediment Stability for the Department of Defense's SERDP-ESTCP Workshop on Contaminated Sediment in 2004. Dr. Moo-Young co-chaired the First International Conference on Environmental Research, Technology, and Policy on Africa in Accra, Ghana in 2007 and was the Honorary Chair for the ISEG 2012 The XII International Symposium on Environment, Energy and Global Sustainable Development. He has received numerous national awards including service as an American Association for the Advancement of Science Policy Fellow at the U.S. Environmental Protection Agency from 2001-2002 and Black Engineer of the Year in 2001. Dr. Moo-Young has published over 200 refereed papers and invited talks in peer-reviewed journals, books and conference proceedings, workshops and invited lectures. He is also the co-inventor of one patent.

Mora-Zacarias, Miguel

Texas A&M University

Dr. Mora is currently a Professor and Associate Department Head for Undergraduate Programs in the Department of Wildlife and Fisheries Sciences, Texas A&M University (TAMU). He also has a joint appointment in the Department of Veterinary Pathobiology, College of Veterinary Medicine, and is a member of the Intercollegiate Faculty of Toxicology. Dr. Mora earned a BS in Biochemical Engineering at the National Polytechnic Institute, Mexico City, an MS and Ph.D. in Ecology from the University of California, Davis, and a post-doc in ecotoxicology from Michigan State University. Over the last 30 years, Dr. Mora's research has focused on evaluating the impacts of persistent organic pollutants, metals, and other contaminants on animal populations, with emphasis on aquatic birds, migratory birds, and endangered species. He has over 80 publications in the peer-reviewed literature in addition to many government reports and other publications. Dr. Mora is a Fellow of the American Ornithologists' Union, and he received the "Distinguished Scientist Award" from the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) in 2013. In 2016, he also received the Dean's Outstanding Achievement Award for Excellence in Diversity from the College of Agriculture and Life Sciences, TAMU. Dr. Mora has served on the Board of the Society of Environmental Toxicology and Chemistry (SETAC) for 3 years, and on the SETAC World Council for five years. He also served on the SACNAS Board for six years. Dr. Mora is an Associate Editor for Ecotoxicology (since 2008) and has served on the Editorial Board of Environmental Toxicology and Chemistry (9 years), Chemosphere (15 years), and Environmental Pollution (6 years). He has served on numerous review panels (NSF, EPA, Universities) and reviews articles for various other journals on a regular basis. For the last two years, Dr. Mora's research has been funded by State and Federal agencies (USGS).

Morgan, Christine

Texas A&M University

Cristine Morgan is a Professor of Soil Science with emphasis in soil hydrology and pedometrics at Texas A&M University in College Station, TX. Her research program focuses on the role of soil science in addressing global challenges of water security, food security, environmental quality, and human health. Her technical expertise in is water movement through soil and across landscapes, novel sensing systems to quantify soil in situ, and measuring and modeling soil properties across landscapes. Dr. Morgan provides leadership in a global effort to secure soil for current and future generations. Her soil security efforts include involvement in a coalition of non-profit organizations, federal agencies, and businesses to address soil health, as well as implementation of research strategies to link soil science with economics and sociology to affect changes in soil management in agriculture. She leads interdisciplinary teams of physicists and plant scientists to develop novel techniques that measures roots, in undisturbed soils. Outcomes of her research program provide innovative measures of

spatially and temporally variable soil properties and improvement on our ability to quantify soil ecosystem services affected by soil properties and soil management at the farm and watershed scale. Dr. Morgan's research program and students have been nationally and internationally recognized for their work advancing knowledge in soil science. Her program has recently been funded by Texas Commission on Environmental Quality, US Departments of Agriculture and Energy, and Agricultural Industry. Dr. Morgan serves on the board of directors for the Soil Science Society of America, is co-editor in chief of the global soil science journal, Geoderma, and participates in committees for the International Union of Soil Scientists. Dr. Morgan earned her M.S. and Ph.D. in Soil Science from the University of Wisconsin-Madison. Her Bachelor's degree is in Plant and Environmental Soil Sciences from Texas A&M University.

Morgan, Kevin

Aventis Pharmaceuticals Inc

Kevin Morgan holds the DVM and Ph.D. degrees and is a Board Certified Veterinary Pathologist. Dr. Morgan has published extensively on the pathology of the nasal turbinates and in particular the effect of irritants on the structure. One of the most prominent of agents studied is formaldehyde. Additionally, he has worked with acetaldehyde and vinyl acetate.

Neagu, Carmen

ABB Inc

Mrs. Carmen Neagu is Technical Specialist for FTIR technology for all industries and their subsectors. She held several key positions from 1997 while working for Exxon, Albemarle and Akzo Nobel in research and development, process, analytics and consulting. Her extensive experience in the Science field corroborated with her technical expertise, led to 12 patents in the Polymers field, new tires compounds formulations, new composite materials as well as new organic peroxides reformulations used in medical field, specialty chemicals and life sciences. She has been employed by ABB Inc since 2014 where the primary focus was to offer her expertise to thousands of companies, suggesting technologies and their implementation, FDA regulations implementations. Her responsibilities include coordination and implementation of testing and technology implementation to reduce health effects, improve air quality, testing and detection technology implementation for toxic materials, and she is part of advisory boards of dozen of private companies monitoring air quality and environment protection. She has a strong technical background and research interest in hazard identification, inhalation dosimetry, permits. Mrs. Carmen Neagu serves as a technical resource for hundreds of commercial companies, management and staff on issues concerning air and water quality, pesticides, bacteria removal and products contamination. She has an extensive knowledge on state and federal permitting, remediation, and risk assessment issues, and served as the environmental safety officer at Akzo Nobel, for the safety department. Carmen has published numerous articles in the peer-reviewed literature, serves or has served on numerous external scientific committees, and presented scientific papers and materials on newest science discoveries at various conferences held by American Chemical Society. She earned both a B.S. in Chemical Engineering and a MS in Organic Compounds Synthesis from the Polytechnic University of Bucharest, Romania.

Nespoli, Lisa Marie

Covestro LLC

Ms. Lisa Marie Nespoli manages Product Safety and Stewardship at Covestro. She has been employed by Covestro since 2010 and manages a group of various science, health and safety experts. She holds a B.S. in Biology from Allegheny College and a M.S. in Biology and M.S. in Environmental Science and Management from Duquesne University. Her Bachelor's thesis was in the area of reproductive toxicology, looking for thyroid and behavioral effects of chemical toxicants on future generations and her Master's thesis was in the area of environmental reproductive toxicity and endocrine disruption.

Lisa Marie's primary professional interests are in chemical product safety and stewardship, sustainability and green chemistry, and human health risk assessment. In her corporate role at Covestro, she leads several global teams to provide guidance and expertise on the company's product safety, stewardship, and sustainability initiatives, methods for product prioritization and risk characterization, and informs Covestro's businesses and leadership teams. She was also responsible for developing and implementing global product stewardship core processes and risk characterization procedures for the company. Lisa Marie is known as an expert in product stewardship and sustainability, and has been asked to speak on these topics at numerous venues, including summits on Safer Sustainable Products. Lisa Marie serves in leadership roles on a number of professional and trade associations, such as the American Chemistry Council (ACC), Adhesive and Sealant Council (ASC), the American Coatings Association (ACA), Product Stewardship Society (PSS), and previously Society of Environmental Toxicology and Chemistry (SETAC). Prior to joining Covestro, Lisa Marie provided Environmental Consulting expertise for the Federal Aviation Administration with BAE Systems, where she held various health, safety and environmental positions. Ms. Nespoli receives no outside research funding.

Nuckols, John

Colorado State University

Dr. John R. Nuckols is an Emeritus Professor in Environmental Health Sciences (Colorado State University), and Principal of JRN-Environmental Health Sciences (N. Bethesda, MD). He holds BS (Texas A&I U), MS (Northwestern U) and PhD (U Kentucky) degrees with Civil, Environmental Health, and Agricultural Engineering emphasis, respectively. His largely self-supported professional career (1975- present) is strongly rooted in "science for the public interest", focused on understanding fate and transport of environmental contaminants, and integration of this knowledge into design of intervention strategies for environmental and public health protection. Notable achievements since 1974 include a USEPA Academic Fellowship Award, the Kentucky Conservation Society Conservationist of the Year Award, lead on technical arguments for the first designation in the USA of a land parcel (a municipal watershed) as unsuitable for surface coal mining, Founder/Director of one of the first academic programs in the world devoted to integration of geospatial sciences in health risk analysis (Environmental Health Advanced Systems Laboratory, CSU), two National Institutes of Health Intergovernmental Personnel Agreement awards based on EHASL's contributions to improving exposure assessment in environmental epidemiology, Co-nominee - Centers for Disease Control Charles C. Shepard Science Award, and most recently finalist for the prestigious 2017 American Association for the Advancement of Science Revelle Fellowship. Throughout his career Dr. Nuckols has served on numerous local, state and federal panels or work groups, including Kentucky Task Forces on State Primacy for Coal Mining Regulations and on Oil Shale Mining, the Kentucky Water Quality Advisory Committee, the Lexington Fayette County Kentucky Emergency Response Local Planning Committee, the Colorado Task Force on Non-point Source Pollution, the Larimer County Colorado Farm Bureau Board of Directors, Advisory committees for Environmental Health Tracking Network Programs in CA, NJ, NM, NY, WA, and WI, the National Cancer Institute Long Island Breast Cancer Study Project Advisory Committee, the National Academy of Science Committee on Contaminated Drinking Water at Camp Lejeune, NC, and as NAS reviewer on Exposure Science in the 21st Century report, the European Science Foundation working group on setting the future for water and health research, and currently as representative of the Colorado Water Institute on the US committee of the UNESCO International Hydrology Program. Dr. Nuckols has received no USEPA research funding since 2002.

Oerther, Daniel

Missouri University of Science and Technology

Dr. Daniel Oerther is a professor of environmental health engineering at Missouri S&T and an

Agricultural Policy Advisor to the U.S. Secretary of State representing the U.S. at the Second International Conference on Nutrition (ICN2), the Committee on World Food Security (CFS), the Blue Growth Network, and the Our Ocean Conference. Previously, he was professor and head of Civil and Environmental Engineering at Cincinnati. Dan's education includes a doctorate in environmental engineering (UIUC) and postgraduate training in environmental health (Cincinnati), public health (Hopkins Bloomberg), and public administration (IU Bloomington). Dr. Oerther is a Professional Engineer (PE), Board Certified Environmental Engineer (BCEE), Certified Environmental Health Specialist (CEHS), and Diplomate of the American Academy of Sanitarians (D.AAS). He is a Fellow of the Royal Society for Public Health (F.RSPH), the Chartered Institute of Environmental Health (F.CIEH), and the Society of Environmental Engineers (F.SEE), and he is a lifetime honorary Fellow of the American Academy of Nursing (F.AAN) and the Academy of Nursing Education (ANEF). Dan's professional practice, academic research, interdisciplinary teaching, and entrepreneurial outreach apply environmental biotechnology and community based participatory research (CBPR) to advance the UN Sustainable Development Goals (SDGs) at the interface of food, energy, and water systems (FEWS). Dr. Oerther is currently a trustee and the treasurer of the American Academy of Environmental Engineers and Scientists (AAEES), a board member of Sigma Theta Tau the International Honor Society of Nursing, an associate editor of both the "Journal of Environmental Engineering, ASCE" and "Water Environment Research, " a Program Evaluator (PEv) for the Accreditation Board of Engineering and Technology (ABET), and previously a director and Chief Information Officer (CIO) of the Association of Environmental Engineering and Science Professors (AEESP). Dan has been recognized by the National Academies with the Jefferson Science Fellowship, the Keck Futures Initiative, and the Frontiers in Engineering Education Symposium; by AAEES with the Frederick G. Pohland Medal (integrating research, teaching, practice), the Superior Achievement Award (best project in 2016), and the Stanley E. Kappe Award (advancing public awareness to the betterment of the total environment); by AEESP with the Steven K. Dentel Award for Global Outreach and the Excellence in Environmental Engineering and Science Education Award (training practitioners); and by the U.S. Department of State with a Meritorious Honor Award from the Secretary's Office for Global Food Security, as a Fulbright Scholar to India in 2005, and as the inaugural Fulbright-ALCOA Distinguished Chair in Environmental Science and Engineering to Brazil in 2012. Dr. Oerther's current funding originates from the U.S. Department of State.

Oris, James

Miami University

Dr. James Oris is a Professor in the Department of Zoology and is the Associate Dean for Research and Scholarship at Miami University in Oxford, Ohio. He received a B.A. in Biology from Wittenberg University (1979) and a Ph.D. in Environmental Toxicology and Fisheries and Wildlife from Michigan State University (1985). Dr. Oris's areas of research interest center on the ecological toxicology of chemicals in aquatic systems. His primary interest is the study of the fate and effects of polycyclic aromatic hydrocarbons and mercury in freshwater systems. Sediment toxicity, photo-induced toxicity, long-term reproductive toxicity, routes of uptake, and environmental factors that may alter fate and effects have been areas of study. These studies have ranged from the use of molecular biomarkers to landscape-scale ecological assessments. Dr. Oris is also interested in standard toxicity test development and methodology, including the statistical modeling and analysis of toxicity dose-response relationships. He has published over 90 peer-reviewed scientific research articles and over 170 abstracts for presentations at scientific meetings. Dr. Oris has served on editorial or review boards of 8 journals, 6 books and 9 granting agencies. He served as the President (2004-2005) of the Society of Environmental Toxicology and Chemistry (SETAC) North America.

Orlov, Alexander

State University of New York, Stony Brook

Dr. Alexander Orlov is an Associate Professor of Materials Science and Engineering at State University of New York, Stony Brook, USA. He is also a faculty member of the Consortium for Interdisciplinary Environmental Research, Chemistry Department and the Institute for Advanced Computational Science. In addition Dr. Orlov is the European Research Council (EU) and National Science Foundation (US) funded Visiting Professor of Chemistry at the University of Cambridge. Furthermore, he is President and Founder of the Sustainable Nanotechnology Corporation. Dr. Orlov has already a substantial experience on providing advice to policy makers on environmental, consumer protection and agricultural matters. From 2007 till 2014 he was appointed by two UK Secretary of States for Environment, Food and Rural Affairs to advice the Government on such issues as hazardous substances, sustainability, environmental health/engineering and environmental impact of nanotechnology. More specifically he provided guidance on risk assessment of more than dozen chemicals and nanomaterials, where he evaluated submissions to the UK government and the European Chemicals Agency (ECHA). In particular, he was co-author of reports on DecaBDE toxicity, cumulative toxic effects of phthalates, behavior of pharmaceuticals in the environment and risk assessment of nanosilver/nanoseria to name a few. Several of his current NSF funded projects are focused on development of new technologies for air purification using waste materials, water and air remediation utilizing novel catalytic materials and risk analysis for nanomaterials release in the environment. Dr. Orlov has 5 degrees from various European and the US institutions, including: Doctoral and Master's degrees in Physical and Environmental Chemistry from the University of Cambridge (UK) and Master's degree in Environmental Engineering from the University of Michigan (US). He also holds Diploma in Economics from the London School of Economics. Among his current activities Dr. Orlov is contributing to work of the United Nations Environmental Program (Lead Author for the GEO report and reviewer of various UN reports) and the US-EU working group on Risk Assessment of Nanomaterials under auspices of the US White House and European Commission cooperative program on nanotechnology research. He serves as expert for over 20 Governmental agencies throughout the world, which includes grant reviewing for the NSF (13 Programs), DOE, DOD and the EU Commission. He also chairs the American Institute of Chemical Engineering Committee on Research and New Technologies, and participates in the Executive Committee of the American Chemical Society Environmental Division. Dr. Orlov was awarded the US National Science Foundation CAREER Award and the UK National Endowment for Science Technology and Arts CRUCIBLE award. He was also selected to the Fellowship of the UK Royal Society of Chemistry, the US National Academy of Engineering (NAE) Frontiers of Engineering (US), the EU-US (NAE) Frontiers of Engineering and was made Kavli Fellow in 2014 by the Kavli Foundation and the US National Academy of Sciences. In 2016 Dr. Orlov has been named Sigma Xi Distinguished Lecturer and was recognized by the State University of New York with Chancellor's Award of Excellence in Scholarship and Creative Activities. In addition to research awards, Dr. Orlov has received several teaching awards, including the 2015 NAE Frontiers of Engineering Education selection and the 2017 American Chemical Society Award for Incorporating Sustainability into Chemistry Education.

Osenberg, Craig

University of Georgia

Craig W. Osenberg (PhD, Michigan State University; BA, UC Santa Barbara) is a Professor of Ecology in the Odum School of Ecology at the University of Georgia. Previously, he was on faculty at UC Berkeley and the University of Florida, where he also served as Chair of the Biology Department. His ecological research tackles basic and applied problems across a diversity of habitats (terrestrial, freshwater, estuarine, and marine) and organisms (fish, amphibians, plants, invertebrates), and is

organized around several interrelated themes: (1) size- and spatially-structured population dynamics; (2) the development and application of statistical tools to quantify impacts of human activities (e.g., gas and oil development and marine reserves) on ecosystems; and (3) the development and application of meta-analysis and quantitative synthesis. During the past two years, his research has been supported by the National Science Foundation, US Department of Energy, US Fish and Wildlife Service, and the Marsden Fund of New Zealand. He and the students working in his lab have published ~170 papers, and he co-edited the influential book, Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats. Professor Osenberg was elected a Fellow of the Ecological Society of America (ESA) in 2015. He also was Chair of the Aquatic Section of ESA, Editor-in-Chief of Oecologia, served on the editorial boards of Ecology, Ecological Monographs and Frontiers in Marine Science, and was on the Science Advisory Board of NCEAS. He has served as a consultant to a diversity of groups applying science to important environments issues, including human impacts in marine systems, the design and assessment of marine protected areas in Costa Rica, French Polynesia, and the Mediterranean, and restoration of the Everglades and the Gulf of Mexico.

Otim, Ochan

Environmental Monitoring Division, City of Los Angeles

Dr. Ochan Otim is a Senior Chemist in the Environmental Monitoring Division of the City of Los Angeles, and teaches chemistry at University of California, Los Angeles. He holds a B.Sc. in Chemistry from Makerere University (Uganda), and M.Sc. degree in Chemistry from University of Regina (Canada) and a Ph.D. degree from Wichita State University. Dr. Otim's primary interest is in developing methods for quantifying, and assessing health risk associated with organic and metal contaminants in environmental samples. In his roles with the City of Los Angeles, Dr. Otim has lead the development of numerous methods to assess the levels of organic contaminants in ocean sediments, fish tissues, wastewater, biosolids, stormwater and receiving water (which includes ocean, creeks, rivers and lakes) for which he was recognized by the City. He has also represented the City of Los Angeles on the Contaminant Impact Assessment committee, a policy body of the Southern California Bight Regional Monitoring Program involving over 60 educational, local, state, and federal agencies. Dr. Otim serves on the Environmental Engineering Body of Knowledge committee of the American Academy of Environmental Engineers and Scientists, and on the membership committee of the Society of Environmental Toxicology and Chemistry (NA). He is a Board Certified Environmental Scientist. At UCLA, was awarded the 2017 Distinguished Instructor award for refocusing classroom experience toward contemporary issued in applied chemistry. Prior to joining the City of Los Angeles, Dr. Otim taught chemistry and biology at California State University (Fullerton) and was a Developmental Biology Research Fellow at the California Institute of Technology. Dr. Otim receives no outside research funding.

Otte, Marinus

North Dakota State University

Otte is currently a Professor at NDSU, Fargo, ND, and has studied wetlands for about 30 years, around the world. He carried out his PhD on coastal wetlands in The Netherlands, studied saltmarshes in South Carolina, then worked on many different systems in Ireland, and more recently in the US (ND, MN), China, and Montenegro. He is a lifetime member of the Society of Wetland Scientists, and since 2012 is the Editor-in-Chief of the authoritative scientific journal 'Wetlands'. He served as a Head of Department at NDSU, represented Ireland at EU level scientific panels (COST) and is currently on the K-12 Science Standards Committee for the ND Department of Public Instruction. Since arriving in ND in 2006, most of his research funding has come either directly or indirectly (via the ND Dept. of Health, Water Division) from EPA.

Parkerton, Thomas F.

ExxonMobil Biomedical Science

Dr. Thomas Parkerton joined ExxonMobil Biomedical Sciences, Inc. (EMBSI) as an Ecotoxicologist in 1992. He holds a B.S. in Environmental Science with an emphasis in Environmental Chemistry from Rutgers University and M.S. degrees in Aquatic Biology/Toxicology and Environmental Engineering from North Texas State University and Manhattan College, respectively. He received a Ph.D. in Environmental Science/Exposure Assessment from Rutgers University. Dr. Parkerton's area of expertise is in the development and application of computer models to predict the physio-chemical fate, bioaccumulation, trophic transfer and toxicological effects of chemicals entering the environment. Prior to joining EMBSI, Dr. Parkerton had gained experience in the development of scientifically defensible effluent, water and sediment quality criteria to protect aquatic life, wildlife and human health. Dr. Parkerton has coordinated numerous laboratory-based research programs to support environmental hazard classification and risk assessment of Exxon Mobil products. Other responsibilities have included performing multi-media exposure and environmental risk assessments in support of existing or new regulations. Dr. Parkerton relocated to Brussels in 1998 and served as the European ecotoxicology advisor for four years. In this role, Dr. Parkerton provided technical assistance to Exxon Mobil business units, industry associations and European regulatory agencies on environmental science issues relevant to both products and facility operations. In 2004, Dr. Parkerton became head of the EMBSI environmental sciences section that is headquartered in Annandale, New Jersey. In this position, Dr. Parkerton managed a group of approximately 20 consultants and laboratory staff. Over the next few years, Dr. Parkerton also led industry efforts to develop innovative methods, data and models to comply with the European REACH regulation. In 2011, Dr. Parkerton relocated to Houston Texas to assume a new position as senior environmental technical advisor. In this role, Dr. Parkerton is coordinating EMBSI technical support to its Houston-based clients and is providing expertise in helping EM address a variety of environmental issues. Dr. Parkerton has received no external grants from either government agencies, private companies, or foundations.

Pastore, Christopher

Thomas Jefferson University

Dr. Christopher Pastore is Professor of Transdisciplinary Studies at Thomas Jefferson University. He holds a PhD in Materials Science and Engineering, MS in Mathematics and BA in Mathematics. Chris has published over 100 refereed papers and 8 books in addition to numerous conference presentations. He is a Fulbright Specialist, and also serves as Honorary Research Professor at Durban University of Technology. His work has focused on the role and design of materials, including textiles and composites, for a wide range of industrial applications. He has been researching sustainability of materials for the past twenty years. This work has been funded by government and industry. Dr. Pastore's work in Sustainability has been recognized through a number of awards including Citation for Distinction from the National Institute of Building Sciences for the MS Sustainable Design, Best Practices in Communication (for EcoMan and The Skeptic podcast) from the Council for the Advancement and Support of Education, Excellence in Education Award, (for MS in Sustainable Design) from the United States Green Building Council, Excellence in Sustainability Education from the Delaware Valley Green Building Council, Philadelphia Sustainability Award from the Pennsylvania Environmental Council, and Leadership in Sustainable Building from the Pennsylvania Resources Council.

Patisaul, Heather

North Carolina State University

Dr. Heather Patisaul is Professor of Biological Sciences in the Center for Human Health and the Environment at North Carolina State University. She received her B.S. in Zoology in 1995 from the

University of Florida and her Ph.D. from Emory University in 2001 in Population Biology, Ecology and Evolution but specializes in developmental neuroscience. Her research explores the mechanisms by which exposure to endocrine disruptors, during critical windows of development, impacts sex specific neuroendocrine physiology and behavior. Compounds of interest include Bisphenol A (BPA), phytoestrogens, and fire retardants. An NIEHS ONES Award recipient, Dr. Patisaul has a broad background in neuroanatomy, neuroendocrinology, developmental neuroscience and animal behavior. A key aspect of her research is exploring sex differences in susceptibility and neurodevelopment. She also participated in the CLARITY-BPA consortium in conjunction with scientists at the National Toxicology Program and the National Center of Toxicological Research, and was the first to publish and complete all aims. Dr. Patisaul has participated in over 20 national and international expert panels and workshops on health effects associated with neurotoxicants and endocrine disruptors, including the 2012 Workshop on Low Dose Effects of Endocrine Active Chemicals co-organized by the US National Institute for Environmental Health Sciences (NIEHS) and the Joint Research Centre's Institute for Health and Consumer Protection, and two National Academy of Sciences panels. She chaired the 2016 Gordon Research Conference on Environmental Endocrine Disruptors and served on the program committee for the 2017 Copenhagen Workshop on endocrine disruptors. She is an active member of the Society for Neuroscience, the Society for Behavioral Neuroscience, the Society of Toxicology and the Endocrine Society where she leads working groups on endocrine disruptors, adverse outcome pathway development, and BPA. She is also a member of the Endocrine Society's Advocacy and Public Outreach Core Committee. Dr. Patisaul has a diverse group of active collaborators spanning academia, industry and governmental agencies (including EPA and NIEHS). She has published over 70 papers, and given over 65 invited talks, including five keynotes. She also co-authored the 2017 book Endocrine Disruptors, Brain and Behavior. Dr. Patisaul's work has been supported by the National Institutes of Health and the Department of Defense.

Paustenbach, Dennis J.

Chemrisk, Inc

Dr. Dennis Paustenbach is a board-certified toxicologist and industrial hygienist with nearly 35 years of experience in risk assessment, environmental engineering, ecotoxicology, and occupational health. He is also a degreed chemical engineer who practiced for the better part of 5 years in the chemical industry. Currently he is the President of Cardno ChemRisk, a division of Cardno. This division specializes in human and ecological risk assessment, as well as, risk analysis of chemical and radionuclides in consumer products, contaminated sites, pharmaceuticals and medical devices. Dr. Paustenbach specializes in the areas of industrial and environmental toxicology, occupational health, historical state-of-knowledge regarding environmental issues, and ecological and human risk assessment and has also directed the scientific aspects of toxic tort cases. In addition, he has also provided expert witness testimony in public meetings and as many as 400 depositions and two dozen trials concerning the health effects of chemicals in sediments, air, soil, consumer products, groundwater, and the workplace. He has been an adjunct professor at five universities. He has been an invited technical reviewer for prominent journals and of proposed regulations. Dr. Paustenbach has published approximately 300 peer-reviewed articles and written more than 50 book chapters in the fields of industrial hygiene, human and aquatic toxicology, engineering, and risk assessment. His two textbooks on risk assessment are among the most popular that have ever been published and they have been adopted by a number of universities in various countries.

Peltier, Richard

University of Massachusetts

Dr. Richard Peltier is an Associate Professor in the Department of Environmental Health Sciences at the University of Massachusetts Amherst. He is an expert in air quality assessment and human exposure science and has substantial focus in chemical speciation of aerosol components, source

apportionment, and attribution of specific sources to specific health outcomes. He has extensive experience in conducting research projects in remote locations where traditional research approaches are particularly difficult. As an empiricist, his laboratory is centered on high quality data analysis, uncertainty in sparse datasets, and reducing exposure misclassification, and has resulted in nearly 50 publications to date. Effective science communication to engage the public is also of significant interest, and he is involved in production of effective dissemination tools of scientific findings through mass media. Dr. Peltier completed a BS in Biology of the University of Massachusetts, a MPH in Environmental Health Science at Columbia University, and a PhD in Atmospheric Chemistry from the Georgia Institute of Technology. He conducted postgraduate training at the Institute of Environmental Medicine at New York University's Langone School of Medicine. A former Rosenblith awardee from the Health Effects Institute, Dr. Peltier has prior or current funding from US EPA, the Institute for Advanced Sustainability Studies (Germany), World Resources Institute Ross Center for Sustainable Cities, Worldwide Universities Network, Climate and Health Research Network, and the Commonwealth of Massachusetts Department of Energy Resources. Dr. Peltier is a recipient of a US-UK Fulbright award, and is the Deputy Editor in Chief of the Journal of Exposure Science and Environmental Epidemiology.

Portier, Kenneth

Independent Consultant

Dr. Kenneth M. Portier is a retired biostatistician with a limited private consulting practice. Previously, Dr. Portier was Vice President of the Statistics & Evaluation Center at the American Cancer Society (ACS) home office in Atlanta, GA, and an Affiliate Professor of Biostatistics in the School of Public Health, Emory University. A native of south Louisiana, Dr. Portier holds a BS in Mathematics from Nicholls State University in Thibodaux, Louisiana (1973), and an MS in Statistics (1975) and PhD in Biostatistics (1979) from the University of North Carolina, Chapel Hill. Dr. Portier was with ACS from January, 2006 to June, 2017, providing statistical and administrative support in ACS's Intramural Research Department. From January, 1979 to December, 2005, Dr. Portier was on the statistics faculty of the University of Florida and a statistical consultant to researchers in agriculture, natural resources and the environment. He has coauthored over 175 publications in many of the premier journals in agriculture, natural resources and environmental sciences and collaborated on 36 funded research grants from numerous agencies and private companies, with core research support from multiple federal agencies (NSF, USDA, NOAA, EPA, DOI). Dr. Portier is an affiliate researcher with UF's Center for Environmental and Human Toxicology. He has participated in over 60 US-EPA Scientific Advisory Panel (FIFRA-SAP) meetings since 1999 and five EPA Science Advisory Board science review panels. In addition, Dr. Portier has served on expert and advisory panels for the US National Institutes of Health (NCI, NIEHS, NTP, FDA), and the World Health Organization (WHO/FAO).

Prather, Michael

UC Irvine

Dr. Michael Prather is Distinguished Professor of Earth System Science at the University of California, Irvine (UCI). He joined UCI in 1992 after working at the National aeronautics and Space Administration (NASA) as program manager for atmospheric chemistry modeling and aviation effects. His education and work experiences are broad and technical. Prather holds degrees in mathematics (Yale), physics (Oxford) and finally astrophysics (Yale). While working at Harvard University and Goddard Institute for Space Studies in New York, he developed 3D atmospheric chemistry models as well as the simple box model of global chemistry used by the Environmental Protection Agency. His research remains focused on the simulation of the physical, chemical, and biological processes that determine atmospheric composition including ozone and greenhouse gases. It is far-reaching, about 200 peer-reviewed publications, with tens of thousands of citations. Prather was

editor-in-chief of Geophysical Research Letters overseeing its transition to digital publishing. In addition to his NASA career, he worked in the State Department for a year on leave from UCI as a Jefferson Science Fellow. He has been asked to organize expert meetings on greenhouse gases and air quality by governmental agencies, including Office of Technology Assessment (now defunct), State Department, and Framework Convention on Climate Change. In the role of scientific expert and lead author, Prather has participated in the many international assessments of ozone depletion and climate change over the past three decades. In this role he worked extensively with the governments in plenary to explain and characterize the quality of the science behind the assessment. Prather's current endeavor is as proposer/deputy of the NASA Atmospheric Tomography Mission, which just completed a four-season sweep of the remote ocean basins, identifying the human influence. Prather's research is now funded by NASA and the Department of Energy.

Ramos, Kenneth

University of Arizona

Dr. Kenneth Ramos is Associate Vice President for Precision Health Sciences and Professor of Medicine at the University of Arizona Health Sciences Center. He also serves as Director of the Center for Genetics and Genomic Medicine. He is a leading expert in the study of gene-environment interactions and personalized and genomic medicine. A major focus in his laboratory is the elucidation of molecular mechanisms of reactivation of mammalian retroelements and their role in reprogramming the human genome. Dr. Ramos completed a B.S. in Pharmaceutical Sciences and Chemistry (Magna Cum Laude) at the University of Puerto Rico, a Ph.D. in Biochemical Pharmacology at the University of Texas at Austin, and an M.D. degree with postgraduate training in Internal Medicine at the University of Louisville Health Sciences Center. He previously held faculty positions at the University of the Sciences in Philadelphia, Texas Tech University Health Sciences Center, Texas A&M University and the University of Louisville School of Medicine. He is currently affiliated with the Arizona Respiratory Center, Arizona Cancer Center and BIO5 Institute. Dr. Ramos is a recipient of the Society of Toxicology Achievement Award, Astra Zeneca Traveling Lectureship Award and Distinguished Service Award from the American Heart Association. He was named Associate of the National Academy of Sciences and Fellow of the Academy of Toxicological Sciences. His recent sources of grants include the National Institute of Environmental Health Sciences, the National Cancer Institute, Astra Zeneca, and the Kentucky Lung Cancer Research Program. He has published over 250 peer-reviewed publications and served on numerous national and international committees in the areas of environmental health sciences, genomics, molecular medicine and toxicology.

Randtke, Stephen J.

University of Kansas

Dr. Stephen Randtke is a Professor in the Civil, Environmental, and Architectural Engineering Department, University of Kansas, Lawrence, KS. He holds a B.S. degree in Civil Engineering from Loyola Marymount University and M.S. and Ph.D. degrees in Civil & Environmental Engineering from Stanford University. He is a licensed professional engineer and a diplomate in the American Academy of Environmental Engineers. Professor Randtke has broad interests and experience in the field of environmental engineering and science. Areas of emphasis in his teaching and research activities include control of chemical contaminants in water supplies through source control and conventional and advanced treatment technologies; sources and transformations of organic chemical contaminants in water supplies, including disinfection byproducts, pesticides and their metabolites, taste- and odor-causing compounds, and algal toxins; lake and reservoir management as it pertains to water supply and water quality; water recycling and reuse for potable and non-potable purposes; and management of water associated with oil and gas production (produced water). His sources of research funding during the past two years were the National Science Foundation, the U.S. Environmental

Protection Agency (EPA), the Water Research Foundation, the Kansas Water Office, Black & Veatch, and assorted drinking water utilities. He is a member of the American Water Works Association (AWWA), the American Association for the Advancement of Science, the Association of Environmental Engineering and Science Professors, the North American Lake Management Society, the Water Environment Federation, and the International Water Association. Dr. Randtke has served as a member of the Research Advisory Council of the AWWA Research Foundation (1986-1988), President of the Association of Environmental Engineering and Science Professors (1994-95), Chair of the Research Division of the American Water Works Association (1995-1998), Technical Editor for the 5th edition of Water Treatment Plant Design (2012; prepared under the auspices of AWWA and the American Society of Civil Engineers), Chair of the Kansas Section of AWWA (2013-2014), as a member of the Drinking Water Committee of EPA's Science Advisory Board (2009-2016). He previously served on the SAB's Hydraulic Fracturing Study Plan Review Panel (2010-2011), Drinking Water Committee Augmented for the Review of the Effectiveness of Partial Lead Service Line Replacements (2011), Hydraulic Fracturing Research Advisory Panel (2013-2017). He frequently provides expert advice to utilities, consultants, public officials, and others seeking practical solutions to a broad array of environmental problems.

Rangan, Cyrus

Los Angeles County Department of Public Health

Cyrus Rangan MD, FAAP, FACMT, graduated from the Medical College of Pennsylvania in 1995 (now Drexel University School of Medicine). He completed his residency in Pediatrics at Children's Hospital Los Angeles in 1998, and a fellowship in Medical Toxicology at University of California San Diego in 2000, with dual board-certification in Pediatrics and Medical Toxicology. He is a fellow of both the American Academy of Pediatrics and the American College of Medical Toxicology. Dr. Rangan is Director of Toxicology and Environmental Assessment Branch at the Los Angeles County Department of Public Health. He investigates community reports of environmentally related illnesses or disease clusters, and provides expert consultation and education to medical providers, hospitals, agencies, and other impacted professionals about medical issues regarding toxic exposures, hazardous materials, epidemiology, and environmental health. Dr. Rangan is also an Assistant Medical Director with the California Poison Control System, and serves as the Director of the Los Angeles Area Medical Toxicology Education Program, providing lectures and media support for hospitals, physician groups, nurses, EMT/paramedics/first responders, social workers, healthcare groups, health agencies, and schools. Dr. Rangan is also an attending physician and Medical Toxicologist at Children's Hospital Los Angeles, providing bedside consultations and clinical education to medical students, residents, and medical staff. He is the author of dozens of peer-reviewed journal articles, textbook chapters, web-based publications, and educational videos. Dr. Rangan also provides consultation to scriptwriters and news & media on Medical Toxicology topics.

Ready, Richard

Montana State University

Dr. Richard Ready is Professor of Economics at Montana State University. Previously, he was a faculty member at Pennsylvania State University, the Norwegian University of Life Science, and the University of Kentucky. Dr. Ready received an M.A. and a Ph.D. in Agricultural and Resource Economics from the University of Wisconsin and a B.S. in Fishery Science from Cornell University. Dr. Ready's research focuses on the economic valuation of ecosystem services with particular emphasis on how ecosystem services are affected by land use change, climate change, and invasive species. Dr. Ready's research integrates models of ecological, geophysical, and demographic processes into economic valuation models to evaluate future changes in ecosystem services and their values, and how those values would be affected by policy actions. He has served on editorial boards of Land Economics and American Journal of Agricultural Economics. Dr. Ready's research has been

supported by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture, the U.S. Forest Service, and the U.S. Army Corps of Engineers.

Rhomberg, Lorenz

Gradient

Lorenz R. Rhomberg, Ph.D. Fellow ATS, is a Principal at Gradient, an environmental consulting firm based in Cambridge, Massachusetts, where he specializes in critical review of toxicological information, weight-of-evidence evaluation, human health risk assessment, quantitative risk analysis, and science policy issues for environmental and consumer chemical exposures. He is a member of several scientific societies, including the Society for Risk Analysis, for which he served as a Councilor (2002-2004), and as President of the New England Chapter (1997-1998), as well as the Society of Toxicology, serving as a Councilor of the Risk Assessment Specialty Section (2003-2005), Councilor for the Regulatory and Safety Evaluation Specialty Section (2012-2014), and on the Scientific Program Committee (2016 to present). He served on the Chemical Assessment Advisory Committee (2013-2108), a standing committee of the U.S. Environmental Protection Agency (EPA) Science Advisory Board. Before joining Gradient in 1999, he was on the faculty of the Harvard School of Public Health. From 1984-1994 he was a risk assessor at the U.S. EPA in Washington, specializing in quantitative risk assessment. Dr. Rhomberg earned his Ph.D. in population biology from the State University of New York at Stony Brook and an Honours B.Sc. in biology from Queen's University in Ontario. He was named 2009 Outstanding Risk Practitioner of the Year by the Society for Risk Analysis, and was awarded the Arnold Lehman Award by the Society of Toxicology in 2017. He is a Fellow of the Academy of Toxicological Sciences. He has served on seven committees convened by the National Academy of Sciences, two as chair, and on several advisory panels convened by the U.S. EPA.

Richardson, Mary Jo

Texas A&M University

Dr. Mary Jo Richardson is a Regents' Professor of Oceanography and Geology and Geophysics, (2006-present) at Texas A&M University. She researches the dynamics and biogeochemistry of particle formation, sinking, resuspension, transport and deposition in the ocean from the continental shelf to the deep sea and from surface waters to the seafloor. She seeks to quantify particulate organic carbon (POC) in the ocean through the development of algorithms from satellite ocean color that are sea-truthed with in-situ POC and transmissometer data to unravel global ocean processes of carbon recycling. She is dedicated to increasing the participation and advancement of women in academic science and engineering careers as well as increasing diversity in Geoscience disciplines and improving Geoscience education opportunities through enhanced undergraduate and graduate experiences. Dr. Richardson obtained her Ph.D. from the MIT/WHOI Joint Program in Oceanography in 1980 and has served in professorial and academic administrative roles at Texas A&M University. She has lived in Greece (4 months) while on faculty development leave in 2009 and led a geoscience-based study abroad program at Texas A&M University's Santa Chiara Center in Castiglion Fiorentino, Italy during fall 2011. Dr. Richardson is an award-winning teacher receiving the Texas A&M University's Association of Former Students Teaching Award in 1991 and 2016. She has served on advisory committees for the National Science Foundation and on the Board of Trustees for the University Corporation for Atmospheric Research.

Rodewald, Amanda D.

Cornell University

Amanda D. Rodewald is the endowed Garvin Professor and Senior Director of Conservation Science at the Cornell Lab of Ornithology and the Department of Natural Resources at Cornell University. Prior to joining the Cornell faculty in 2013, she spent 13 years as a professor in the School of

Environment and Natural Resources at The Ohio State University. Dr. Rodewald received a B.S. in Wildlife Biology from University of Montana (1992), an M.S. in Zoology from University of Arkansas (1995), and a Ph.D. in Ecology from Pennsylvania State University (2000). She is a fellow of the American Association for the Advancement of Science, American Ornithological Society, Peter Wall Institute for Advanced Studies, Public Voices, and the CIC Academic Leadership Program. Her leadership roles have included serving on the Science Advisory Board of US EPA, the Scientific Review Committee of the National Socio-environmental Synthesis Center (SESYNC), nominating committee of the American Association for the Advancement of Science, council of the American Ornithologists Union, editorial boards of scientific journals, and the Faculty Advisory Board for the Atkinson Center for a Sustainable Future. Dr. Rodewald has built an interdisciplinary, international research program in ecological and sustainability sciences that addresses global challenges linked to changing climate, land cover, and human activities in temperate and tropical working landscapes that need to serve both social and ecological needs. Since 2000, she has generated nearly $8 million in research funding, including competitive awards from National Science Foundation. She has published 125 scientific papers, 9 book chapters, as well as many popular outreach articles for broad audiences, and she consistently extends and applies her research through programs for managers, decision-makers, community members, and private sector partners. Dr. Rodewald also contributes to the national and state-level environmental decision-making process in her ad-hoc advisory and panel roles with National Science Foundation, USDA Forest Service, U.S. Fish and Wildlife Service, Ohio Department of Natural Resources, and North American Bird Conservation Initiatives.

Rohrs, Allison

Saint Francis University Institute for Energy

Allison Rohrs serves as the Executive Director at the Saint Francis University Institute for Energy in Loretto, Pennsylvania. As Director, Ms. Rohrs manages multiple energy related projects that include: providing renewable energy assessments and energy audits to agricultural producers and small businesses; wind energy data collection and wind farm development assistance; local and state energy policy research; developing curriculum and teaching under the energy technology and policy minor program at SFU; and providing community outreach and education on a variety of environmental and energy topics. Ms. Rohrs holds a Master's degree in Energy and Mineral Engineering from Penn State and a Bachelor's degree from the University of Colorado in Environmental Science. Ms. Rohrs' graduate research was partially funded by the Wind Energy Foundation and focused on the construction aspects and economic analysis of wind farm decommissioning which was inspired by her work in the field as a wind turbine technician. She has been recognized by the Women of Wind Energy as a Rudd Mayer Fellow for outstanding personal commitment and potential to advance the field of renewable energy. Ms. Rohrs spent the early years of her career working for the U.S. Fish and Wildlife Service as well as working in Grand Teton National Park. Her experience in the Natural Resources field led to a passion to preserve the planet and ultimately a career in Energy.

Rosen, Barry

Wayne State University

Dr. Barry P. Rosen is Professor and Chairman of the Department of Biochemistry and Molecular he was Professor in the Department of Biological Chemistry at the University of Maryland School of He received his B.S. degree (1965) from Trinity College, Hartford, CT, M.S. (1968) and Ph.D. (1969) from the University of Connecticut. He was an NIH fellow at Cornell Dr. Rosen's honors include Basil O'Connor Awardee, March of Dimes, 1974-1976; Maryland Distinguished Young Scientist Award, 1979; Josiah Macy, Jr. Faculty Scholar, 1980-1981; Honorary Professor, 1991, Academia Sinica, Institute of Zoology, Beijing, China; Distinguished Faculty Fellow, Wayne State University, 1997; Outstanding Graduate Mentor Award, Wayne State University; 1999; Dr. Rosen is a member of the editorial boards of the Journal of Biological Chemistry, Biometals, Drug Resistance Updates. He

was formerly on the editorial board of the Journal of Bacteriology and Microbiological Reviews. member of grant advisory committees for NIH, NSF, American Heart Association, Canadian Foundation for Innovation, and the Veterans Administration. He has organized numerous international meetings, including chairing a 2004 Gordon Research Conference. 230 papers, reviews and chapters. Dr. Rosen is a sought-after speaker and, over the last two decades has given more than 200 presentations at universities, national and international symposia Dr. Rosen's research accomplishments span four decades. His laboratory focuses on the mechanisms of gene regulation, transport and detoxification of toxic metals, including arsenic, antimony, copper, cadmium and lead. He has elucidated the pathways for arsenic detoxification in prokaryotes and eukaryotes, including the first identification of the pathway of arsenic uptake in human cells such as those in the blood-brain barrier. He identified the transporter that takes up the arsenical drug Trisenox that is used to treat leukemia. He has genetically engineered both plants and microorganisms for arsenic bioremediation of soil and water (patent pending). He has cloned, expressed and characterized many enzymes and proteins of arsenic metabolism, including arsenic reductases, methylases and transcription factors, and has determined the three-dimensional structure of several.

Rosenberg, Andrew A.

Union of Concerned Scientists

Andrew A. Rosenberg is director of the Center for Science and Democracy at the Union of Concerned Scientists. He has more than 25 years of experience in government service and academic and non-profit leadership. He is the author of scores of peer-reviewed studies and reports on ecology and natural resource management and has published on the intersection between science and policy making. He has extensive expertise in environmental science, statistical modeling, the development and implementation of scientific integrity policies and transparency in government. Dr. Rosenberg previously served as Chief Scientist at Conservation International, Dean of Life Sciences and Agriculture at the University of New Hampshire and Deputy Director of NOAA's National Marine Fisheries Service. Dr. Rosenberg appointed to serve on the US Commission on Ocean Policy by President G.W. Bush. He served on the Ocean Studies Board of the National Academy of Sciences, the US Navy Ocean Research Advisory Committee and the National Academy's America's Climate Choices study. Dr Rosenberg also served on the advisory committee for the US National Climate Assessment and was the convening lead author of the oceans chapter. He was also a lead author for the UN World Ocean Assessment. Dr. Rosenberg received his Ph.D. in biology from Dalhousie University in Halifax, Canada, and an M.S. in Oceanography from Oregon State University. In his current position Dr. Rosenberg is employed by a 501c3 charitable organization entirely funded from members and private philanthropy.

Rosol, Thomas

Ohio State University

Thomas Rosol, DVM, PhD, MBA is a professor of veterinary and toxicologic pathology, Chair of Biomedical Sciences at the Ohio University Heritage College of Osteopathic Medicine and diplomate of the American College of Veterinary Pathologists. He has served as dean of the College of Veterinary Medicine and senior associate and interim vice president for research at Ohio State University and on advisory boards or panels to the National Institutes of Health (NIEHS, NTP, NCI, NCRR), USDA (NAREEE), EPA, FDA, and American Veterinary Medical Association, and has provided testimony to the European Chemical Agency (ECHA). Rosol serves as a consultant for industry in preclinical safety and toxicology in the areas of endocrine, bone, and reproductive pathology and animal models of cancer, and serves on the expert panel for the Flavor and Extract Manufacturer's Association GRAS reviews. Rosol is an expert in safety assessment, risk analysis, and human relevance for the toxicity of environmental chemicals, pesticides and herbicides, foods and food additives, and pharmaceuticals. Rosol chaired the international nomenclature committee for

endocrine lesions in rats and mice (2014-2018) and the monograph now serves as the basis for standardized nomenclature for regulatory documents in the United States, Europe, and Japan. The Rosol laboratory investigates the pathogenesis of animal models of human cancer and metabolic diseases, mechanisms and treatment of metastasis, and endocrine and bone diseases, and has been funded by the NIH (NCI, NIBIB, NIAMS) for over 30 years including two research career awards. Rosol has over 300 publications (H-index of 52; 19 papers with 100-400 citations; and 10, 000 total citations) and served as the mentor for 50 PhD students and postdoctoral trainees. The laboratory specializes in molecular, toxicologic, and genomic investigations using animal models, in vivo imaging (microCT, PET, MRI, and bioluminescence), in vitro tissue and cell cultures, and computerized machine learning for automated pathological image analysis. Rosol is an elected fellow of the American Association for the Advancement of Science and was recognized by Ohio State University as a Distinguished Scholar (one of the university's highest honors). Rosol was awarded the Annual Distinguished Mentor Award from the Society of Toxicologic Pathologists (2015) and the ACVP Distinguished Member Award (2016).

Runge, Steven

University of Central Arkansas

Dr. Steven Runge is a 1986 graduate of the University of Wisconsin-Green Bay where he majored in Biology, Chemistry and Human Adaptability. He followed his undergraduate training with graduate work at The Ohio State University where he earned a Ph.D. in Biochemistry in 1991. Dr. Runge joined the University of Central Arkansas (UCA) as an Assistant Professor in the Department of Biology in 1991, earning the rank of Associate Professor in 1995 and the rank of Professor in 2004. Dr. Runge began serving as an administrator in 2003 when he was appointed as Interim Chair of the Department of Biology. One year later he was appointed as the Chair and served in this capacity until 2009 when he was appointed as Interim Dean of the College of Natural Sciences and Mathematics (CNSM). He assumed the position of Dean of the College in July 2010. In February 2012, Dr. Runge was appointed Interim Provost and Vice-President for Academic Affairs at UCA and became Provost and Vice President for Academic Affairs in February 2013. As of July 1, 2014, he was named Executive Vice President and Provost and served in that capacity until July 31, 2017. He is currently serving as a Professor in the Department of Biology. Dr. Runge has developed and taught courses in molecular and cellular biology ranging from the freshman level through graduate offerings and, until 2014, he maintained an active research program studying cell death mechanisms in cultured breast cancer cells. Dr. Runge has also published peer-reviewed articles on his educational innovations. Dr. Runge is heavily involved in a wide variety of academic and non-academic activities at UCA and in Arkansas. He has served as Chair of the Arkansas STEM Coalition; he served as the UCA representative on the Arkansas INBRE (IDEA Network for Biomedical Research Excellence) Steering Committee and is currently a member of the Board of Directors for Arkansas Preschool Plus, Inc. Dr. Runge also served ten years on the Board of Directors for Mayflower Public Schools. He has two adult daughters, Monica and Sabrina. Monica is a graduate of UCA (Biology) and the School of Veterinary Medicine at Louisiana State University. She is a practicing veterinarian in Arizona. Sabrina is also a graduate of UCA (Creative Writing and MBA) and is currently completing the coursework in the Arkansas Coding Academy.

Ruscher, Paul

Florida State University

Dr. Paul Ruscher holds the Doctorate in Atmospheric Science from Oregon State University. As a member of the faculty at Florida State University since 1988, he has had extensive experience in teaching, research, and professional service across the atmospheric sciences. In particular, his research on mesoscale coastal processes has included work on air quality modeling and assessment of air pollution events, including ozone precursors and high exceedance episodes, statistical analysis,

mercury transport issues (atmosphere), and also the teaching of air pollution meteorology (undergraduate) and atmospheric chemistry (graduate, interdisciplinary). In addition, he has held numerous consulting positions or state advisory positions with Florida state agencies and private and non-profit entities, related to air quality and air pollution events. These are enumerated on my vita under consulting.

Sabo-Attwood, Tara

University of Florida

Tara Sabo-Attwood, PhD is an Associate Professor and Chair of the Department of Environmental and Global Heath, College of Public Health and Health Professions and Center of Environmental and Human Toxicology at the University of Florida (UF). She has broad expertise in environmental molecular toxicology with an emphasis on water and airborne contaminants. She earned a B.S. in genetics and Ph.D. in Biomedical Sciences, Pharmacology and Toxicology as a National Institute of Health (NIH) Fellow from UF and was awarded a NIH Postdoctoral Fellowship at the University of Vermont in Pulmonary Pathology. Dr. Sabo-Attwood's research centers on elucidating how pollutants, both historical and emerging (asbestos, endocrine disruptors, nanomaterials) perturb molecular pathways that contribute to adverse health outcomes. Her work encompasses aquatic and mammalian models and spans controlled laboratory approaches and field projects. Her current work focusses on the innate immune system as a target of inhaled or dietary chemical exposure with an emphasis on susceptibility of organisms to pathogenic infections. Based on her contributions she was named a Kavli Fellow in Nanotechnology by the National Academy of Sciences (NAS). Her work is currently funded by the NIH, National Science Foundation (NSF), and the US Department of Agriculture (USDA). In addition to her research contributions, Dr Sabo-Attwood teaches courses in environmental health, one health, toxicology and has trained numerous masters and doctoral students. She serves in several leadership positions including Director of Graduate Programs, Department Chair and elected Councilor for the Nanotoxicology Specialty Section Board for the Society of Toxicology (SOT). She participates on international and national advisory committees including the International Academy of Sciences, routinely participates on Environmental Protection Agency (EPA), NIH, and NSF review panels, is an associate editor for Nano Impact Journal and a long standing member of Society of Toxicology and Chemistry (SETAC) and SOT

Sagers, Cynthia

Arizona State University

Cynthia Sagers has served as the Vice President for Research at Oregon State University since August 31, 2015. As Vice President, Sagers provides leadership to OSU's vast research enterprise, which last year brought in $441 million in research grants and contracts in areas including agriculture, forestry, marine sciences, public health, and engineering. Sagers also works with academic leaders and the University community to expand OSU's entrepreneurial and economic development activities with industry and other public and private partners. An ecologist by training, Dr. Sagers earned two bachelor's degrees from the University of Iowa and a Ph.D. from the University of Utah. She launched her academic career in 1994, joining the faculty of the University of Arkansas, where she developed expertise in crop systems and the evolution of aggressive plant pests. She earned a Research Associateship from the National Research Council in 2005 to work with the U.S. Environmental Protection Agency's National Health and Environmental Effects Laboratory in Corvallis, Oregon. When she returned to Arkansas, she served as state commissioner for the governor's Global Warming Commission, and in 2010, she was named program officer for the National Science Foundation's Office of International Science and Engineering, and later the Directorate for Environmental Biology. In 2012, Dr. Sagers was named Associate Vice Provost for Research and Economic Development at the University of Arkansas. In just two years, she helped the university increase research awards by 30 percent. Joining OSU in 2015, she has marshalled steady growth of the research enterprise, including

three successive years of record research awards. She currently serves on a number of advisory boards for research and economic development entities in the region, including Business Oregon, CleanTech Alliance, Oregon Nanoscience and Microtechnologies Institute and Oregon Built Environment and Sustainable Technologies Center, Inc. In September 2018, Sagers will join Arizona State University where she will assume the role of Vice President for Research.

Saiers, James

Yale University

Professor Saiers studies water quality and supply. He runs experiments, collects observations, and develops models to illuminate how human activities affect the chemical composition of drinking water resources and alter freshwater flows within aquifers, wetlands, and river basins. His recent research projects address water quality impacts of fossil fuel development, carbon and nutrient transport through watersheds, radionuclide migration in groundwater, and climate change effects on water resources in Africa. This research is executed collaboratively with students, postdoctoral associates, and faculty from Yale and other Universities. Professor Saiers' teaching addresses various applied and theoretical aspects of surface water and groundwater hydrology.

Sakaji, Richard

Independent Consultant

Although recently retired as Water Quality Manager for the East Bay Municipal Utility District, Dr. Richard Sakaji recently joined the State Water Resources Control Board, Division of Drinking Water to work on a variety of drinking water quality and public health issues. In his former positions, his activities ranged from reviewing and providing guidance on testing or study protocols in the subject areas of treatment technology and invasive species to serving on technical committees that aid in the establishment of drinking water regulations and public policy. To this end he has reviewed technical protocols for U.S. EPA's Environmental Technology Verification program and for the National Sanitation Foundation for their technical merit. His educational background includes marine biological sciences (A.B., University of California, Berkeley), environmental engineering (M.S. and Ph.D., University of California, Berkeley). Throughout his career, he has brought a public health perspective to various advisory committees and workgroups, such as those serving the National Academy of Sciences, the National Water Research Institute, the Water Research Foundation (formerly the American Water Works Association Research Foundation, and the U.S. EPA. He has also represented the California Department of Public Health as a representative on the Santa Ana River Water Quality and Health Study. He has worked with the National Water Research Institute/AWWA Research Foundation in the development of their ultraviolet disinfection guidelines.

Salvito, Daniel

RIFM

Dr. Daniel Salvito is the Research Institute for Fragrance Materials' (RIFM) Science Fellow for Environmental Sciences and Computational Chemistry. Dr. Salvito started his career with RIFM in 1999 and has led their efforts in establishing a program to study the environmental fate and effects of organic compounds in the environment. Prior to his joining RIFM, he worked extensively for Public Service Electric and Gas on water quality and permitting issues. He has a strong technical background in the fate and effects of organic chemicals in the environment, development and application of tools for environmental risk and hazard assessment, bioaccumulation science, approaches for risk assessing multicomponent substances, methodological development for the use of chemical similarity in toxicology and ecotoxicology, and the use of animal alternatives in ecotoxicology. He has extensive knowledge of national and international regulatory programs on chemicals management and water quality. Dr. Salvito has served on several external scientific committees including the New Jersey Department of Environmental Protection Drinking Water Quality Institute, the Scientific Committee

of the European Center for Ecotoxicology and Toxicology of Organic Chemicals, the Health and Environmental Sciences Institutes' Environmental Risk Assessment of Multi-constituent Substances Project Committee, and ECHA's REACH Implementation Project on Chemical Categories. He currently serves as an editor for Environmental Toxicology and Chemistry. He has published numerous research papers in the peer-reviewed literature and has presented at national and international conferences. Dr. Salvito received his Ph.D. from Rutgers University in Environmental Sciences, his M.S. in Chemistry from SUNY at Stony Brook, and his B.S. in Chemistry from Adelphi University. His research has been funded solely by RIFM.

Santelmann, Mary

Oregon State University

Dr. Mary Santelmann is currently the Director of the Water Resources Graduate Program and Research Faculty at the Department of Geosciences Oregon State University. Academically, she holds three degrees: PhD in Ecology University of Minnesota, Minneapolis, MN, M.S. in Biology University of Michigan, Ann Arbor, MI and B.S. in Botany University of Minnesota, Minneapolis, MN (Honors College). In addition to her affiliation at the Water Resources Graduate Program, she is a member of International Association for Landscape Ecology, American Water Resources Association, Society of Wetland Scientists, British Ecological Society, Ecological Society of America and The Nature Conservancy. Her current research includes Ecosystem response to human land use and management practices; Environmental and anthropogenic influences on species composition and species richness in agricultural, urban and wetland ecosystems and Ecology and biogeochemistry of wetlands and riparian systems.

Savitz, David

Brown University

Dr. David Savitz is Professor of Epidemiology, with joint appointments in Obstetrics and Gynecology and Pediatrics at Brown University, where he previously served as Vice President for Research. He has held faculty appointments at the University of Colorado School of Medicine, the University of North Carolina School of Public Health where he served as the Carey C. Boshamer Distinguished Professor and Chair of the Department of Epidemiology, and as the Charles W. Bluhdorn Professor of Community and Preventive Medicine at Mount Sinai School of Medicine. Dr. Savitz received his undergraduate training in Psychology at Brandeis University and a Masters degree in Preventive Medicine at Ohio State University, and his PhD in Epidemiology from the University of Pittsburgh Graduate School of Public Health. He was elected to membership in the Institute of Medicine in 2007. He has served on 11 National Academy of Medicine Committees and was Chair of 4 of those, all of which concerned environmental health issues. Dr. Savitz's research is focused on reproductive and environmental epidemiology. He has conducted studies of the causes of adverse pregnancy outcome, including miscarriage and preterm birth, as well as pregnancy complications, birth defects, and child health problems. His environmental interests include a wide range of chemical and physical exposures, including perfluorinated chemicals, pesticides, drinking water treatment by-products, and non-ionizing radiation. In addition to his substantive expertise in environmental epidemiology, Dr. Savitz has strong methodologic expertise and has authored a book on the application of epidemiologic research, Interpreting Epidemiologic Evidence: Connecting Research to Applications. Dr. Savitz serves as Chair of the Research Committee of the Health Effects Institute and as Co-Chair of the Scientific Advisory Board of ISGlobal, the Barcelona Institute for Global Health. During the past two years, his research support has come from the National Institutes of Health.

Schneider, David

Memorial University

Dr. David C. Schneider is a Professor at the Department of Ocean Sciences, Memorial University of Newfoundland, St. John's, Canada. His area of expertise is biological oceanography and the impact of human activities on the coastal marine environment. His research activity in benthic habitats include rates of recolonization after physical disturbance, impact of predators on benthic assemblages, and the development of environmental monitoring programs in relation to oil extraction and to at sea-disposal of dredge spoils. His research activities in pelagic habitats include physical oceanographic determinants of the distribution and dynamics of fish and marine birds. Of particular note is a history of collaboration with sociologists to understand the course of interactive restructuring of marine ecosystems, a sequential process of initial impact, environmental change, and subsequent interactive effects in response to environmental change. He has published over 120 refereed articles and book chapters in biological oceanography, coastal processes, spatial scaling as it influences measurement in marine systems, contaminants in the aquatic environments (oil, methyl mercury, mining dust). He has 25 years cumulative experience on advisory panels: Science Advisory Council for the EPA multiscale ecosystem project, the Scientific Review Committee to monitor and assess the impact of low-level jet training, the Science Advisory Board for the Caribou Research Program (Newfoundland Dept. of Environment), the Validation Monitoring Panel (fisheries impacts) at the University of Washington, and the Science Advisory Board to address nutrient loading in south Florida waters (EPA). He 12 cumulative years experience providing statistical advice as a consultant to: Mobil Consortium (Hibernia), Newfoundland Transhipment Facility, US National Park Service, Environment Canada, Baffinland Iron Mines. Of particular note is development of a gradient monitoring design for point source contaminants at the Hibernia site, a design that became standard for oil development projects in eastern Canada.

Sherman, Michael

North Carolina Farm Bureau Federation

M. Paul Sherman is the Associate State Legislative Director with the North Carolina Farm Bureau Federation (NCFB). In this position, he represents NCFB's 500, 000+ member families on engineering, air quality, energy, renewable energy, global climate change, transportation, and other regulatory issues. In this capacity, Paul has advocated for North Carolina's farmer and rural citizen energy interests through participation on many stakeholder groups, boards, and commissions such as: North Carolina's Strategic Plan for Biofuels Leadership, NC Legislative Commission on Global Climate Change, NC Legislative Subcommittee on Offshore Energy Exploration, NC Agricultural Open Burning Stakeholder Group, and NC Idle Reduction Stakeholder Group. Paul has served or continues to serve on the boards of the NC Irrigation Society and the NC State University Biological and Agricultural Engineering department advisory board. He was the agricultural representative during the development and ongoing implementation of the NC Renewable Energy and Energy Efficiency Portfolio Standard. Paul was the project administrator for the NC Farm Energy Efficiency Project where he facilitated farm energy audits and farm scale renewable energy projects including wind, solar, swine methane, and hydro putting farmers in control of their own energy use and production. Paul attended North Carolina State University where he earned a Bachelor of Science degree in Biological and Agricultural Engineering. He is certified as a Professional Engineer in North Carolina. His previous work experience includes livestock confinement design, construction engineering, animal waste management, and environmental permitting. Prior to joining Farm Bureau, Paul worked for the North Carolina Department of Environment and Natural Resources where he directed the animal waste permitting program and served on the technical advisory panel researching alternative swine waste treatment options (Smithfield Agreement). No research funding was received for these activities.

Shipp Hilts, Asante

New York State Department of Health

Dr. Asante Shipp Hilts is the Senior Project Coordinator for the CDC funded Climate Ready States and Cities Initiative within the Office of Public Health Practice at the New York State Department of Health (NYSDOH), where she coordinates research to evaluate the impacts of Hurricane Sandy and other Climate and Health initiatives. Dr. Shipp Hilts has presented her Sandy research and led a dissemination workshop at the 2015 Hurricane Sandy Conference: Translating Research into Practice. Her Sandy research has been published in the Disaster Medicine and Public Health Preparedness Journal, Environmental Law in New York, the Journal of Emergency Management and the Assistant Secretary for Preparedness and Response Hurricane Sandy Recovery Science Newsletter. Dr. Shipp Hilts is a member of the National Institute of Health Best Practices Working Group for the development of special considerations for Institutional Review Board (IRB) review of disaster and emergency related public health research. She is also on the CDC Disaster Epidemiology Curriculum Development Committee. Dr. Shipp Hilts previously served as the Director of a County Health Department in NYS that was devastated by both Hurricane Irene and Tropical Storm Lee. Asante has worked in public health evaluation and research in New York at the community, local and state level and was appointed to the NYSDOH IRB. Dr. Shipp Hilts is an Assistant Professor in the Epidemiology and Biostatistics department at the University at Albany, State University of New York, where she earned her BS in Biology, MPH in Epidemiology, and Doctor of Public Health degrees.

Simon, Ted

University of Georgia

Dr. Ted W. Simon operates a solo consulting practice in Winston, GA near Atlanta. He holds a B.A. in Biology from Middlebury College and a Ph.D. in Neuroscience from Georgia State University. Dr. Simon worked at EPA's Region 4 offices from 1993 until 2006. There he served as the senior toxicologist in the Waste Management Division. At EPA, he was a lead author of Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment. He also received bronze medals for his work on the Base Realignment and Closure effort and for a method for assessing the efficacy of institutional controls for risk mitigation at military facilities. After leaving EPA, he has provided consultation to clients in both the public and private sectors including the Ontario Ministry of the Environment, Health Canada, trade associations including the American Chemistry Council and the European Chemical Industry Council, and others. He has served as a peer reviewer for the journals Regulatory Toxicology and Pharmacology, Environmental Health Perspectives, Critical Reviews in Toxicology and a number of other journals. He has been a member of the Society of Toxicology since 1993. Dr. Simon is the author of over 40 scientific publications including a graduate level textbook, Environmental Risk Assessment: A Toxicological Approach publishing in 2014 by Taylor and Francis. His scientific interests include: 1) the use of dose response analysis to inform mode of action; 2) Bayesian methods for characterizing uncertainty in risk assessment; and 3) endocrine-active substances. Over the past four years, he has received consulting fees from corporations in the US and England, attorneys in the US, and government entities such as the Los Angeles County Sanitation Division and the Fairfax County Virginia Police Department. He is not currently a recipient of research grants from the Environmental Protection Agency, other federal agencies, or the private sector.

Skoglund, Robert

Covestro LLC

Dr. Robert Skoglund is the Head of Product Safety and Regulatory Affairs for Covestro LLC, a world-leading manufacturer of high-tech polymer materials. In addition, he holds an adjunct faculty appointment in the Department of Environmental Health Sciences of the Richard M. Fairbanks School of Public Health at Indiana University and adjunct faculty and graduate school appointments in the

Division of Environmental Health Sciences of the School of Public Health at the University of Minnesota. Dr. Skoglund received his MS in toxicology and PhD in environmental chemistry from the University of Minnesota and is working on an MBA in sustainable business at Maryhurst University. In addition, he is certified in toxicology by the American Board of Toxicology and industrial hygiene by the American Board of Industrial Hygiene. With over 30 years of experience in regulatory and applied toxicology, environmental chemistry, and industrial hygiene, areas of proficiency include product EHS and stewardship, hazard and risk assessments, fit for purpose and alternative analyses, chemical management regulations, and sustainability, but he has not engaged in any externally funded research in the last two years. Dr. Skoglund teaches in graduate level courses, sits on MS and PhD committees, and has authored a number of peer-reviewed abstracts, papers, and book chapters. He presently serves on the EPA Science Advisory Board's chemical assessment advisory committee and on an advisory board for the NIEHS hazardous waste worker training program. Dr. Skoglund is active in various professional and trade organizations with a focus on the training of public and environmental health practitioners, the funding of student research, and advocacy for science-based regulations.

Smith, Eric

Virginia Tech

Dr. Eric Smith is a professor in the Virginia Tech Department of Statistics. An acknowledged expert in the application of statistical methods to environmental and ecological applications, he is the author or coauthor of more than 120 peer reviewed papers, 45 book chapters, and two books, Dr. Smith is a Fellow of the American Statistical Association, an Elected member of the International Statistics Institute, and he has received the Distinguished Achievement Award from the American Statistical Association's Section on Environmental Statistics. Dr. Smith has served on eleven workshops, panels and committees, including: * Panel Member for EPA's Science Advisory Board review of Lake Erie Phosphorus Levels (2015-16) * Member NRC Panel on Effective Approaches for Monitoring and Assessing Gulf of Mexico Restoration Activities (2015-16) * Panel member for the Scientific Advisory Board reviewing EPA's technical support document: National-Scale Mercury Risk Assessment Supporting the 25 Appropriate and Necessary Finding for Coal and Oil-Fired Electric Generating Units (2011). * Deepwater Horizon SEAMAP Surveys Planning Committee Workshop (2010).

Stevenson, David

Caesar Rodney Institute

David T. Stevenson is an economist (Bachelor of Science in Agricultural Economics from Rutgers University), served on the Environmental Protection Agency Presidential Transition Team, and has worked in the field of energy and environmental policy as an analyst for the last seven years at the Caesar Rodney Institute, a state policy think tank. Stevenson led six major business development projects at the DuPont Company and has founded six businesses as an independent entrepreneur providing a strong perspective for balancing economic development and environmental regulation. He has been involved in numerous Public Service Commission dockets as an intervener and consultant, providing guidance on Solar Renewable Energy Credit auctions, electric grid resilience and reliability, electricity and natural gas pricing and service expansion, and electric supply strategies. He has analyzed Delaware's compliance with National Ambient Air Quality Standard's on six criteria pollutants and ozone down to the individual Air Quality Monitoring Station level. He has extensive experience with cost versus benefit analysis, including for proposed Environmental Protection Agency regulations. Stevenson has a strong background in conservation starting with taking the very first environmental science course offered at Rutgers University, creating the first crankcase oil recycling program and greenways land use plan as Conservation Commission Chairman in Southbury, CT. He was part of a team involved in creating today's solar industry in the United States and India, and also

in approving Material Safety Data Sheets as a lab supervisor for the DuPont Company. As a board member of the Delaware Home Builders Association Stevenson co-founded Delaware's Green Building Council along with building the first "gold" level green home in Delaware using the beta program of the National Association of Home Builders Green Building Program. The transition team briefing experience provided a foundational understanding of the Environmental Protection Agency priorities, organization, budget, and mandated deadlines for 2017/18. He has received no research grants in the last two years.

Stuart, Amy

University of South Florida

Amy L. Stuart, Ph.D. is a Professor at the University of South Florida (USF) in the Department of Environmental and Occupational Health, College of Public Health. She holds a joint appointment in the Department of Civil and Environmental Engineering, and courtesy appointments in the Center for Urban Transportation Research, and the Patel College of Global Sustainability. She is also the founder and director of the Graduate Certificate Program in Environmental Health at USF. Dr. Stuart earned a BS in chemical engineering, a MS in civil engineering, and a PhD in civil and environmental engineering from Stanford University. She completed postdoctoral training at the Center for International Security and Cooperation at Stanford. Dr. Stuart leads multi-disciplinary research and teaching initiatives related to air pollution, public health, and environmental sustainability. Her research has contributed to understanding the impacts of urban design and transportation on air pollution exposures and their social distribution, the fate of volatile chemicals during cloud freezing, mercury contamination and exposures, and associations between air pollution and birth defects, resulting in over 100 scholarly publications. During the last two years, Dr. Stuart's work has been funded by the National Institute of Environmental Health Sciences and by the United States Department of Transportation. She is also a previous recipient of a National Science Foundation Career award. Dr. Stuart is professionally involved in the Association of Environmental Engineering and Science Professors, currently serving on the Lectures Committee. She is a member of the Air and Waste Management Association, including previous service as the Chair of the Student Awards Committee of the Higher Education Council, and is a member of the International Society of Exposure Sciences. She regularly serves as a reviewer of manuscripts for several scientific journals and of proposals for grant sponsors on air pollution topics.

Stubblefield, William

Oregon State University

Dr. William Stubblefield is a senior research professor in the Department of Molecular and Environmental Toxicology at Oregon State University. Dr. Stubblefield has more than 25 years of experience in environmental toxicology, human and environmental risk assessment, derivation of water, sediment and soil criteria, and aquatic and wildlife toxicology studies. He has authored more than 50 peer-reviewed publications and technical presentations in the areas of aquatic and wildlife toxicology and risk assessment. He has conducted a variety of research programs aimed at the evaluation of the toxicity of metals and hydrocarbons in the environment. Dr. Stubblefield's research has examined acclimation induced changes in the responses of aquatic organisms to copper, zinc, and cadmium; evaluated the acute and chronic toxicity of manganese, cobalt, aluminum, methyl tert-butyl ether, petroleum hydrocarbon mixtures, and a variety of other compounds; quantified the effects of water quality characteristics, e.g., hardness, alkalinity, dissolved organic carbon, on the toxicity of several metals (e.g., nickel, lead, and silver). His current research examines methods/models that can be used to predict the toxicity of metals and hydrocarbons to aquatic organisms. Current sources of research funding include the Cobalt Development Institute, the European Aluminum Association, Iron Platform, and British Petroleum. Dr. Stubblefield is an active member of the Society of Environmental Toxicology and Chemistry (SETAC), where he served as President of the Society, member of the

Society's Board of Directors, chairman of the SETAC's Metals Advisory Group, and member of the Editorial Board for Environmental Toxicology and Chemistry. He has been an invited participant at a number of national and international scientific and regulatory conferences, served on U.S. EPA and National Institute of Environmental Health Sciences (NIEHS) peer-review panels, and frequently acts as a technical reviewer for a number of scientific publications. Dr. Stubblefield has a Ph.D. in Zoology and Physiology (emphasis in Environmental Toxicology) from the University of Wyoming, a M.S. degree in Toxicology/Toxicodynamics from the University of Kentucky, and a B.S. in Biology from Eastern Kentucky University.

Suski, Jamie

EA Engineering, Science, Technology, Inc., PBC

Dr. Suski is a senior scientist within the Department of Water and Natural Resources at EA Engineering, Science and Technology, Inc., PBC. She has been in this position 1.5 years and has successfully secured one million dollars in project funding. The projects support both industry and federal government clients. Industry projects are focused on the efficacy and safety of antiseptic agents for consumer and healthcare users and federal client projects include laboratory and desktop research on the effects of contaminates to wildlife receptors including species listed as threatened and endangered (T&E). Specifically, Dr. Suski (Principle Investigator) was recently awarded funding to investigated potential risk to T&E species that occupy habitat on military sites contaminated with per- and polyfluoroalkyl substances (PFAS) and is a co-PI on research evaluating physiological, ecological and environmental determinants of PFAS uptake in fish. Dr. Suski received her Master of Science degree from University of Maryland in environmental toxicology and her Doctoral degree from Texas Tech University in Ecology with a focus on Eco-physiology. She did her post-doctoral studies with Dr. Christopher Swan at University of Maryland Baltimore County focusing on aquatic community responses to pesticides. She currently serves as an active member on the Interstate Technology Regulatory Council (ITRC), PFAS team as an expert in the field of ecotoxicology. Her role involves writing technical regulatory documents and fact sheets for the ITRC. She also serves on the board of the regional chapter of the Society of Environmental Toxicology and Chemistry (SETAC). She is a professional reviewer for a number of peer-reviewed journals including, Environmental Toxicology and Chemistry, Science of the Total Environment and Journal of Environmental Management.

Tan, Shirlee

King County Dept Public Health

Shirlee Tan, PhD has been working in the field of science policy for over 17 years, with a focus on the effects of chemicals on human health. Her career has primarily focused on chemical regulation and science policy at the national, international, and now local levels. Her early career began at the US Environmental Protection Agency (EPA) where she served as an Environmental fellow for the American Association for the Advancement of Science and has since worked for the Smithsonian Institution, the EPA, the Organization for Economic Cooperation and Development (OECD) in Paris, France, as an independent consultant to the OECD and the Endocrine Society, and now as the lead toxicologist for Public Health Seattle and King County.

Tharakan, John

Howard University

Dr. John Tharakan is Professor of Engineering in the Department of Chemical Engineering at Howard University, College of Engineering and Architecture. He has served as Chair, Director of Graduate Studies and is founding Faculty Adviser, Engineers Without Borders, HU Chapter. He received his BS (chemical engineering) at Indian Institute of Technology, Madras, MS and PhD in Engineering Science (Biochemical Engineering) from the University of California, San Diego, with post-doctoral training at American Red Cross, Plasma Derivatives Laboratory and then appointed Research

Scientist, prior to joining Howard. His research expertise is in environmental engineering and biotechnology, appropriate technology development, engineering education, sustainable development and ethics in science and engineering, with funding from US EPA, DOD and NSF. He was Fulbright Senior Scholar, India ('06-'07), researching biological methods of waste treatment in South India. With Engineers Without Borders, he has worked on clean water, sanitation and renewable energy technology implementation in Senegal, Kenya and El Salvador. Dr. Tharakan is Co-Chair of an on-going series of biennial International Conferences on Appropriate Technology held across Africa facilitating knowledge and technology transfer for social justice, and has served as Editor for published conference proceedings. He was Fulbright-Nehru Senior Scholar ('15-'16) at Cochin University of Science and Technology, India, researching social impact assessment of innovative technology implementation. Dr. Tharakan has authored over 50 peer-reviewed papers and book chapters. He teaches undergraduate and graduate engineering courses in chemical, environmental and bioprocess engineering, hazardous waste treatment, and appropriate technology. Dr. Tharakan served two terms on the Executive Committee of the Board of Scientific Counselors and on the BOSC-EC Subcommittee on Safe and Healthy Communities. Dr. Tharakan has served on the editorial and review boards of scientific journals, government agencies and academia, and has chaired sessions at national and international scientific and engineering conferences. His research over the past two years has been funded by Department of State Fulbright program, and his EWB service by various Foundations.

Theis, Thomas

University of Illinois at Chicago

Thomas L. Theis is Professor of Civil and Materials Engineering and Director of the Institute for Environmental Science and Policy (IESP) at the University of Illinois at Chicago. IESP focuses on the development of new cross-disciplinary research initiatives in the environmental area. He was previously at Clarkson University, where he was the Bayard D. Clarkson Professor and Director of the Center for Environmental Management. He is past editor of the Journal of Environmental Engineering, and served on the chartered Science Advisory Board of the USEPA from 2000-2009. His areas of expertise include the mathematical modeling and systems analysis of environmental processes, industrial pollution prevention, industrial ecology, material flow analysis and life cycle assessment, the environmental chemistry of trace organic and inorganic substances, interfacial reactions, subsurface contaminant transport, and hazardous waste management.

Thomas, Evan

University of Colorado at Boulder

Dr. Evan Thomas is the Director of the Mortenson Center in Engineering for Developing Communities, and holds the Mortenson Endowed Chair in Global Engineering at the University of Colorado at Boulder. He is an Associate Professor in the Civil, Environmental and Architectural Engineering Department. He has a technical background in water and air quality and treatment across a range of applications from developing communities to operational spacecraft. He has founded several companies based on these activities, including SweetSense Inc. which is presently supported by USAID and the National Science Foundation to develop and apply satellite connected remotely monitored sensors for drinking water services and quality in developing countries. His team is presently monitoring a million people's water supply across east Africa on a daily basis. Dr. Thomas was previously an Associate Professor at Portland State University. As Chief Operating Officer of DelAgua Health from 2012-2016, where he was responsible for conceptualizing, designing and operating a $25 million dollar public health intervention in Rwanda in partnership with the Government of Rwanda. The program reached 350, 000 households with cookstoves and 102, 000 households with water filters, across over 7, 500 villages and 1.6 million people. Dr. Thomas was previously a civil servant at the NASA-Johnson Space Center in Houston, Texas from 2004-2010, working on microgravity fluid management technologies and water recovery systems. He has a PhD in

Aerospace Engineering Sciences from the University of Colorado at Boulder, is a registered Professional Engineer, and has a Masters in Public Health from the Oregon Health and Science University. His research has been funded by the National Science Foundation, the World Bank, the United States Agency for International Development, the United Nations Foundation, the United States Centers for Disease Control and Prevention, the United Kingdom Department for International Development, the Gates Foundation, and others.

Thurston, George

New York University

Dr. George Thurston is a Professor at the New York University School of Medicine's Department of Environmental Medicine, where he is Director of the Program in Human Exposure Assessment and Health Effects. He received his Bachelor of Science in Engineering from Brown University (with Honors), and his Masters and Doctorate in Environmental Health Sciences from the Harvard University School of Public Health. He has been a faculty member at the New York University School of Medicine since 1984. He has previously served on the EPA's CASAC Committee on NOx and SOx from 2007 to 2010, and is presently the Chair of the American Thoracic Society's Environmental Health Policy Committee. Professor Thurston's research has focused on the human health effects of air pollution exposures. His research in recent years has been funded by the NIH through both R01 and R21 grant mechanisms, as well as under the NYU-NIEHS Center of Excellence grant. He has also received research support from the NYU/Abu Dhabi Institute for Public Health Research. Recent awards for his scientific research include: the 2012 "Haagen Smit Prize" given by the scientific journal Atmospheric Environment, and; "The Top Science Paper of 2012" by the journal Environmental Science & Technology for a Global Burden of Disease report on global particulate matter air pollution exposures around the world. In May, 2018, Dr. Thurston also received the American Thoracic Society's "Public Service Award".

Tormey, Daniel

Catalyst Environmental Solutions Corporation

Dr. Daniel Tormey is an expert in energy, water resources, and land management, and conducts environmental reviews for both government and industry. He works with the environmental aspects of all types of energy development, including oil and gas, including hydraulic fracturing, produced water management, pipelines, LNG terminals, refineries and retail facilities; and all types of electrical generation and transmission. He studies sediment transport, hydrology, water supply, water quality, and groundwater-surface water interaction. He has led over two hundred studies requiring fate and transport analysis of chemicals in the environment. He has managed studies of the environmental effects of some of the most controversial land management projects in the US including the largest dam removal, deregulation of the electrical generation industry in California, the first offshore LNG terminal, and the environmental effects of coal mine and power plant closures, including socioeconomic effects. He has studied climate change and climate change adaptation since 1994. He was on the Steering Committee of the 2015 study of the effects of Hydraulic Fracturing in California being led by the California Council on Science and Technology (CCST), led the only focused study of environmental effects of hydraulic fracturing in the country (at a Los Angeles oil field), and submitted technical reports to the EPA SAB in their consideration of the environmental effects of hydraulic fracturing. He was named by the US National Academy of Sciences to the Science Advisory Board for Giant Sequoia National Monument; is a Distinguished Lecturer for the Society of Petroleum Engineers; recipient of the 2018 SPE award for Environment, Safety, and Corporate Social responsibility; is on the review committee on behalf of IUCN for the UNESCO World Heritage Site List and member of the IUCN Geoscientist Specialist Group; is volcanologist for Cruz del Sur, an emergency response and contingency planning organization in Chile; was an Executive in Residence at California Polytechnic University San Luis Obispo; and is a Professional Geologist in California.

He has worked throughout the USA, Australia, Indonesia, China, Italy, Chile, Ecuador, Colombia, Venezuela, Brazil, Senegal, South Africa, Armenia and the Republic of Georgia. He has an active research program in volcanology, glaciovolcanic effects, volcano-seismic interaction, and biophysical risk analysis and communication. He has a Ph.D. in Geology and Geochemistry from MIT, and a B.S. in Civil Engineering and Geology from Stanford.

Trasande, Leonardo

New York University School of Medicine

Dr. Leonardo Trasande is a faculty member in pediatrics and environmental medicine at the NYU School of Medicine, and in health policy at the NYU Wagner School of Public Service. Dr. Trasande's research focuses on identifying the role of environmental and other factors in chronic childhood disease, and documenting the economic costs for policy makers of failing to prevent them proactively. Dr. Trasande is perhaps best known for a 2011 study in Health Affairs which found that children's exposures to chemicals in the environment cost $76.6 billion in 2008. His analysis of the economic costs of mercury pollution played a critical role in preventing the Clear Skies Act (which would have relaxed regulations on emissions from coal-fired power plants) from becoming law. He has also published a series of studies which document increases in hospitalizations associated with childhood obesity and increases in medical expenditures associated with being obese or overweight in childhood. These studies have been cited in the Presidential Task Force Report in Childhood Obesity, and another landmark study identified that a $2 billion annual investment in prevention would be cost-effective even if it produced small reductions in the number of children who were obese and overweight. He serves on the Executive Committee of the Council for Environmental Health of the American Academy of Pediatrics, on the CDC's World Trade Center Health Program Scientific and Technical Advisory Committee, and on a United Nations Environment Programme Steering Committee which is developing a Global Outlook on Chemicals Policy. He recently served on the Board of Scientific Counselors for the National Center for Environmental Health at the Centers for Disease Control and Prevention. Dr. Trasande earned a Master's degree in Public Policy from Harvard's Kennedy School of Government, and an M.D. from Harvard Medical School. He completed a pediatrics residency at Boston Children's Hospital, a Dyson Foundation Legislative Fellowship in the office of Senator Hillary Rodham Clinton, and a fellowship in environmental pediatrics at the Mount Sinai School of Medicine. He has testified before the Senate's Environment and Public Works committee and Democratic Policy Committee. His work has been featured on the CNN documentary Planet in Peril and in National Geographic, and frequently appears on national media, including NBC's Today Show, ABC's Evening News and National Public Radio. He currently receives funding is from the National Institute for Occupational Safety and Health NIOSH for clinical care for children exposed to the World Trade Center disaster; National Institute of Environmental Health Sciences (NIEHS) & Fogarty for a study of prenatal methylmercury exposure; and NIEHS, Fogarty & NIOSH for building studies of air pollution and children's health in China.

Trindade, Sergio

SE2T International, Ltd.

Dr. Sergio C. Trindade is a New York based global consultant on sustainable business. He started his career designing, building and operating a sorbitol plant. Later, at the MIT Chemical Engineering Graduate Practice School, in Oak Ridge National Laboratories, TN, and at American Cyanamid chemical plants, NJ, he got exposed to American research and industry. His MIT PhD dissertation focused on magnetic demineralization of coal. Next, he joined Arthur D. Little, Inc. in Cambridge, MA, and later headed ADL's Brazilian office. Next, he founded the first private technology center in Brazil at PROMON, working on renewable energy, sustainable chemicals and telecommunications. He then began international consulting on energy and environment. He became the Assistant Secretary-General of the United Nations and Director of the Centre for Science and Technology for

Development - CSTD, in New York. There he created and tested the concept of stakeholders' dialogues to achieve consensus on policy priorities. He supervised studies on environmentally sounder technologies. Later, as a consultant he designed and implemented in Japan the UNEP International Environmental Technology Centre, on environmental issues of large cities and fresh water lakes and reservoirs. He did extensive consulting work for private companies and international organizations such as UNEP, the World Bank, IEA, OECD, Inter-American Development Bank. For International Fuel Technology, MO, he helped develop and market, diesel/biodiesel fuel enhancement additives. He is/was member: chair of the International Symposia on Alcohol Fuels, where the S.C. Trindade Award was established to reward the best paper at each Symposium; vice-chair, Studies Committee, World Energy Council; Advisory Board, UNEP International Environmental Technology Centre in Japan; Supervisory Board, US Congress Office of Technology Assessment study on weapons of mass destruction and means of delivery; Intergovernmental Panel on Climate Change - IPCC on technology issues, honored with the 2007 Nobel Peace Prize; vice-chair and chair of the Audit Committee, Board of Trustees, World Agroforestry Centre, Nairobi. Published numerous peer-reviewed articles and book chapters. He has been often a keynote speaker in public meetings, lately on climate change and sustainability in the Arctic, and has conducted many media interviews. He earned a PhD, ChE, MSc from MIT in chemical engineering with minors in technology management, energy economics and international business, and from the University of Brazil a BSc in chemical engineering.

Turner, Jay

Washington University

Dr. Jay Turner is an Associate Professor of Energy, Environmental and Chemical Engineering, and Vice Dean for Education in the School of Engineering & Applied Science at Washington University in St. Louis. Dr. Turner holds B.S. and M.S. degrees from UCLA (1987) and a D.Sc. from Washington University (1993), all in Chemical Engineering. Following his M.S. studies, he spent two years at the University of Duisburg, Germany, where he was a DAAD Fellow. Following his D.Sc. studies, Dr. Turner spent eight months on assignment with the Federal Highway Administration, U.S. Department of Transportation, as an Air Quality Specialist. He subsequently joined the Washington University faculty in 1994 as an Assistant Professor of Engineering & Policy. Dr. Turner's research primarily focuses on air quality characterization and control with emphasis on field measurements and data analysis to support a variety of applications in the atmospheric science, regulation and policy, and health studies arenas. He was the Principal Investigator of the St. Louis – Midwest Fine Particulate Matter Supersite. He manages a field site in East St. Louis that has hosted several Federal Equivalent Method testing campaigns and was recently one of two U.S. Environmental Protection Agency (EPA) coarse particulate matter pilot speciation study sites. Current and recent research projects include estimating lead emissions from piston engine aircraft, source apportionment of ambient particulate matter in Hong Kong, assessing intraurban variability of air toxics metals, long-term fence line monitoring for gaseous air toxics and particulate matter species at an industrial facility, and air quality measurements to support health studies. Recent consulting activities include monitoring guidance and/or data analyses for agencies in four states in support of State Implementation Plan development. He is currently Washington University lead investigator on a contract from the Airport Cooperative Research Program (ACRP) to Sierra Research, Inc. to develop approaches to mitigate lead concentration hot spots at general aviation airports, and Co-PI on an NIH grant to examine relationships between air pollution and neurodegenerative disease. His consulting work is currently funded by The Organisation for Economic Co-operation and Development (OECD) to assess the state of air quality monitoring in 51 countries and develop a framework for estimating air quality indicators, and by the Hong Kong Environmental Protection Department through Hong Kong University of Science and Technology to develop a conceptual model for particulate matter air quality over the Pearl River Delta. Dr. Turner has served on several state and local air quality-related advisory committees and the Science and Technical Support Workgroup of the Federal Advisory Committee Act (FACA)

Subcommittee for Ozone, Particulate Matter, and Regional Haze Implementation Programs. He currently serves on EPA's chartered Science Advisory Board (SAB), the Ambient Monitoring and Methods Subcommittee (AMMS) of EPA's Clean Air Scientific Advisory Committee (CASAC), and the Independent Technical Advisory Committee of the Texas Air Quality Research Program. He recently served on the Science and Technology Achievement Awards (STAA) Committee of the EPA Science Advisory Board and on the Health Effects Institute project panel for the National Particle Components Toxicity Initiative. Dr. Turner was general chair for the 2007 Annual Conference of the American Association for Aerosol Research (AAAR) and is the immediate past president of AAAR. He is a Visiting Scientist at the Harvard T.H. Chan School of Public Health for the period January-July 2016. He previously served on the Science and Technology Achievement Awards (STAA) Committee of the EPA Science Advisory Board (term 2012-2015).

Tyner, Robin

US Navy Retired

Captain Robin Tyner, Retired, recently transitioned from an active duty Navy career. She qualified/served as Department of Defense (DoD) Science and Technology (S&T) Manager Level III (highest), Surface Warfare Officer, Naval Aviation Observer, In-flight Meteorologist, Hurricane/Typhoon Forecaster, Ship Router, and Information Warfare Officer. She is trained/experienced in nuclear/WMD hazard prediction. She holds a BS in Physics/Oceanography (U.S. Naval Academy), dual-MS in Meteorology and Physical Oceanography (Navy Post-Graduate School), and MBA (Southern New Hampshire University). She completed the Navy Corporate Business Course (University of Virginia, Darden), and begins the Harvard Kennedy School's Executive Climate Change and Energy program September 2018. She is a member of the American Geophysical Union and American Association for the Advancement of Science. She was a voting member on the DoD Space Experiments Review Board (2014-2017), which approves and prioritizes military science experiments for rides on DoD satellites. Through 2017 she served as Deputy Department Head, Office of Naval Research, managing a $305 million S&T portfolio including: oceanography, meteorology, hurricanes, Arctic/cryosphere, coastal prediction, acoustics, remote sensing, signal processing, unmanned vehicles, etc. Congress provided her department additional funding in 2016 for anti-submarine warfare research. She oversaw dozens of PhD Program Officers, engineers, military officers, technical and support contractors - evaluating proposals and awarding competitive grants/contracts to academia, government/private labs, industry, and small businesses. Her Arctic experience includes: her Arctic oceanography thesis, establishment of Navy Arctic, Energy and Climate policy, oversight of multi-year research efforts and field experiments - and experiments at ICEX 2016 (Arctic Ocean ice camp), and selection as one of five DoD attendees at the 2015 Secretary of State-hosted GLACIER conference. She serves on the Exeter, NH Planning Board and Energy Committee, the Oceans 2022 Steering Committee (joint symposium hosted by the Marine Technology Society and Institute of Electrical and Electronic Engineers), and as Senior Fellow, DEPLOY/US.

Ulsh, Brant

M. H. Chew & Associates

Dr. Brant Ulsh is a Certified Health Physicist, and has over thirty years of academic training, and governmental, academic, and private industry work experience in radiation fields including health physics, radiation biology, radiation ecology, and nuclear engineering. Dr. Ulsh's diverse work experience includes regulatory compliance at nuclear power plants and Department of Energy sites, environmental monitoring, and radiation dose reconstruction. He is currently a Principal Health Physicist with M. H. Chew & Associates in Cincinnati, and he serves as the Editor-In-Chief for the Health Physics journal. From 2003-2012, Dr. Ulsh served as a Senior Research Health Scientist with the National Institute for Occupational Safety and Health in the largest radiation worker compensation program in the world. In that position, he had extensive interaction with the Presidentially-appointed

Advisory Board on Radiation Worker Health. Dr. Ulsh's research interests and expertise focus on the biological and environmental effects of low doses of radiation on humans and the environment. He has performed only unfunded research in these areas over the past two years. He earned a Bachelor of Science degree in Nuclear Engineering and a Master of Science degree in Health Physics, both from the University of Cincinnati, and a Ph.D. in Radiological Health Sciences from Colorado State University. Dr. Ulsh completed a postdoctoral appointment at the McMaster University Institute of Applied Radiation Sciences in Canada, with a research focus on low-dose radiation biology. He has authored one book chapter, 19 peer-reviewed publications, 23 scientific presentations, 10 scientific poster presentations, and 6 scientific abstracts. He serves as an affiliate faculty member of Colorado State University, and the Northern Ontario School of Medicine. Dr. Ulsh has held numerous leadership positions in both the Cincinnati Radiation Society, and the Health Physics Society, and he served as a member of the International Radiation Protection Association Radiation Protection Strategy and Practice Committee.

Uppu, Rao

Southern University and A&M College

Dr. Rao M. Uppu is the James and Ruth Smith Endowed Professor of Environmental Toxicology and Chemistry in the College of Sciences and Engineering at Southern University-Baton Rouge (SUBR). He is a highly accomplished scientist recognized internationally for his work in environmental chemistry and molecular toxicology. His major scientific contributions include analytical methods for determining biological reactive intermediates (alloxan, epoxides, and alpha, beta-unsaturated carbonyls) and semi-persistent organic pollutants (bisphenols), apoptotic and/or necrotic cell signaling by 'ozone-specific' oxysterols, free radical nitration and nitrosation in nitric oxide-producing biological systems, modeling of oxidative and free radical reactions of ozone at the air-lung interface, and molecular docking and dynamic studies of environmental estrogen binding to estrogen receptors. In addition to publishing in peer-reviewed journals and books, Uppu has trained numerous MS and PhD students, postdoctoral fellows, and junior faculty and received several accolades including election as Fellow of the Royal Society of Chemistry (FRSC), Fellow of the Academy of Toxicological Sciences (FATS), Fellow of the American Association for the Advancement of Science (FAAAS), Board Certified Environmental Scientist (BCES), Diplomate of the American Board of Toxicology (DABT), Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS), and membership in the CyHABs Research Consortium (Ames, IA). Uppu was a recipient of honors for student mentoring from both within and outside the Southern University System including the Telugu Association of North America Excellence in Science Award and the Becoming Everything You Are (BEYA) STEM Innovators Award. After obtaining his PhD degree in biochemistry from Osmania University (Hyderabad, India), Uppu undertook postdoctoral assignments at the Eppley Institute for Research in Cancer (Omaha, NE) and the Biodynamics Institute at Louisiana State University (Baton Rouge, LA) and worked under the tutelage of Drs. Ercole Cavalieri, Eleanor Rogan, and William Pryor. Uppu's research for the past two years was supported by the U.S. Department of Education, the National Science Foundation, and the USDA National Institute of Food and Agriculture.

Vandenberg, Laura

University of Massachusetts – Amherst

Dr. Vandenberg's research explores how early life exposures to chemicals and chemical mixtures can predispose individuals to diseases that manifest later in life. Classical toxicology often focuses on how fetal chemical exposures can produce birth defects, an important part of chemical safety. Her work instead addresses how low doses of chemicals during critical windows of development can alter gene expression, cell differentiation, and tissue organization in subtle ways that can lead to adult diseases such as cancer, obesity, and infertility. She is specifically interested in the class of chemicals termed

'endocrine disruptors' and have worked extensively with chemicals used as plasticizers and flame retardants. Her work also focuses on how traditional toxicology assays have failed to identify a number of ubiquitous endocrine disruptors, and how current risk assessment practices can be improved in the study and regulation of this class of chemicals.

Vepachedu, Venkata

Pennsylvania Department of Health, COPA

Dr. Venkata Vepachedu, Ph. D. is presently working as Chief/Supervisory Microbiologist leading the Molecular Microbiology/Advanced Molecular Detection (AMD) unit in the division of clinical microbiology at Bureau of Laboratories, Pennsylvania Department of Health, Exton, PA. Dr. Venkata obtained his Ph.D. in biochemistry. His dissertation includes extensive studies on Chromium toxicity and active site directed metal complex synthesis (Chromium and Copper-Uric Acid complexes) & characterization. The lab is accredited for its highly quoted research in studying the mechanisms of metal toxicities and metal reclamation from industrial sewage. Dr. Venkata gained extensive research experience in the area of molecular microbiology as applied to health and environment. Dr. Venkata is an established scientist, successfully completed novel research projects focusing on global warming, environmental health and food-borne outbreaks as evidenced by research publications. He possesses, expertise in the design and running of environmental and public health research & surveillance projects in collaboration with national institutes such as CDC, EPA and FDA. Dr. Venkata gained hands on experience running experiments using advanced instruments in biological research, including, Whole Genome Sequencing, MALDI-TOF. Bioinformatics analysis and program design. He regularly performs compilation of results obtained from different projects to assess a food-borne outbreak investigations/environmental concern and draw conclusions to take decisive action. Dr. Venkata is involved in the review/discussion of various environmental issues in Pennsylvania while working at department of environmental protection. His views, project design and presentations are highly appreciated as he tailors the presentation to the audience. Dr. Venkata is involved and gained knowledge in all aspects of projects i.e. design, writing proposals, performing experiments, result analysis and presentations. He worked with both laboratorians, environmental field staff and epidemiologists. Dr. Venkata worked on field sample collection & analysis and human sample analysis. He completed research projects working with various biological systems namely, Archaea, bacteria, fungi, insects, fish, mice, rats, and human systems (found in curriculum vitae). This made him a suitable candidate to review projects related to different environmental and health issues for field and lab studies.

Viana, Louis R.

LRV NY LLC

Mr. Louis Viana has been practicing the profession of Environmental Engineering for the last 23 years. During his professional tenure he has operated and designed multiple Wastewater Treatment Plants (Anaerobic & Aerobic) and Potable Water Treatment systems, advised Fortune 100 companies in compliance with NPDES permit, Clean Water Act, Clean Air Act, RCRA, CERCLA, SARA, dealt with Asbestos and Lead abatements, cleaning of soil with Hydrocarbons, designed sampling protocols for contaminated sites, Environmental Impact Statements, Phase I & II among others. This knowledge and pass experience allowed him to develop LRV NY, LLC an Environmental Engineering Firm which has been providing services to assist fortune 100 companies to operate in a responsible and sustainable manner while complying with all applicable environmental laws and regulations. Mr. Viana is currently a Ph.D. candidate at Columbia University School of Engineering at the Department of Environmental Engineering and Earth Sciences. His research is being done on Surface Phenomena Changes on Archaea Cell Membrane to Enhance Metabolic Reaction of Glucose and Increase Biogas Production. The results of the research will propel the Anaerobic Digester treatment of high COD loads by helping the industries to reduce COD discharge to the ocean and therefore protect the

environment and its habitat. Mr. Viana is currently a member of the Industrial Advisory Board of the Columbia University, the Florida University Center for Particles and Surfactant System (CpASS), and the American Association for the Advance of Science (AAAS).

Wauchope, Robert D

USDA-ARS

Don Wauchope has chemistry degrees from UNC-Chapel Hill (BS) and NC State University at Raleigh (MS, PhD). After an NIH Postdoctorate at Oregon State University's Department of Agricultural Chemistry he joined the newly-formed USDA – Agricultural Research Service (ARS) Southern Weed Science Laboratory at Stoneville, MS in 1972. Don published research on the analysis and environmental chemistry of arsenical agricultural chemicals, and water quality impacts of pesticides. He was part of the original CREAMS nonpoint agricultural pollution simulation model development team. Don moved to the ARS Southeast Watershed Research Laboratory and later the ARS Nematodes Weeds and Crops Research Laboratory, both at Tifton, Georgia in 1984, retiring in 2008. He developed the pesticide module of the ARS-RZWQM pollution model and the USDA-ARS Pesticide Properties Database, and has had a national and international leadership in minor use pesticide registration, exposure risk assessment and pesticide physical chemistry. He has published 135 journal papers and book chapters, 2 books, and made over 150 presentations. Two of his papers have been cited over 1000 times. Don is a Fellow of the Weed Science Society of America and is a Fellow and past Chair of the Agrochemical Division of the American Chemical Society. He was North American Editor of the Journal "Pest Management Science" and a leader and collaborator on many technology transfer activities of the International Union of Pure and Applied Chemistry (IUPAC), organizing publication projects, meetings and workshops in 16 countries. He has served on several ad hoc EPA and European Union Food Safety Authority technical advisory committees. Except for some cooperative studies with University collaborators, Don's entire research career was funded by USDA in-house and grant funds.

Werth, Charles

University of Texas at Austin

Dr. Charles J. Werth is a Professor and the Bettie Margaret Smith Chair in Environmental Health Engineering in the Department of Civil, Architecture and Environmental Engineering at the University of Texas at Austin. Dr. Werth's areas of expertise include the fate and transport of pollutants in the environment, the development of catalytic technologies for drinking water treatment, and the mitigation of environmental impacts associated with energy production and generation. In his research, he develops and/or uses noninvasive imaging, environmental microfluidics, nanotechnology, spectroscopic analysis, numerical modeling, and life cycle assessment. He has been consulted by law firms litigating cleanup of hazardous waste sites, oil and gas companies treating produced water, and industry developing innovative groundwater cleanup technologies. Dr. Werth has published 110 peer-reviewed journal articles, with research support during the last two years from the Department of Energy (DOE), National Science Foundation, National Aeronautics and Space Administration, United States Geological Survey, Dow Chemical, and Texas Hazardous Waste Research Center. Dr. Werth previously served on the Association of Environmental Engineering and Science Professors (AEESP) board, the AEESP Foundation board, the User Executive Committee for DOE's Environmental Molecular Science Laboratory (EMSL), the External Advisory Board for a DOE Energy Frontier Research Center, and the USEPA Science Advisory Board (2014-2017). The quality of his work has been recognized by appointment as a Wiley Research Fellow at the DOE's EMSL, appointment as Editor-and-Chief of Journal of Contaminant Hydrology, two Best Paper Awards from the journal Environmental Science and Technology, a Humbolt Research Fellow Award, a National Science Foundation CAREER Award, and an Award for Innovation in Undergraduate Instruction. Dr. Werth received a B.S. in Mechanical Engineering from Texas A&M University, an M.S. and Ph.D. in

Environmental Engineering from Stanford University, and a Ph.D. minor in Chemistry from Stanford University.

Wiesner, Mark

Duke University

Dr. Mark R. Wiesner holds the James L. Meriam Chair in Civil and Environmental Engineering at Duke University where he has appointments in the Pratt School of Engineering and the Nicholas School of Environment. He serves as Director of the National Science Foundation's Center for the Environmental Implications of NanoTechnology (CEINT). Dr. Wiesner's research in the area of environmental nanotechnology, examines the application of nanotechnologies for environmental quality control and initiated a consideration of the possible environmental implications of nanomaterials. He co-edited/authored the book "Environmental Nanotechnologies" and serves as Associate Editor of the journals Nanotoxicology and Environmental Engineering Science. Professor Wiesner also pioneered research in area of applications of low-pressure membranes to water treatment. He co-edited and -authored the book "Water Treatment Membrane Process," served as the founding Chair of the American Water Works Association's Membrane Research Committee, and serves on the editorial board of the journal Desalination. Professor Wiesner is a Fellow of both the American Association for the Advancement of Science and the American Society of Civil Engineers. Before joining the Duke University faculty in 2006, Professor Wiesner was a member of the Rice University faculty for 18 years where he held appointments in the Departments of Civil and Environmental Engineering and Chemical Engineering and served as Associate Dean of Engineering, and Director of the Environmental and Energy Systems Institute. Prior to working in academia, Dr. Wiesner was a Research Engineer with the French company the Lyonnaise des Eaux, in Le Pecq, France, and a Principal Engineer with the Environmental Engineering Consulting firm of Malcolm Pirnie, Inc., White Plains, NY. Wiesner received the1995 Rudolf Hering medal from the American Society of Civil Engineers and the 2004 Frontiers in Research Award from the Association of Environmental Engineering and Science Professors. In 2004 Dr. Wiesner was also named a "de Fermat Laureate" and was awarded an International Chair of Excellence at the Chemical Engineering Lab of the French Polytechnic Institute and National Institute for Applied Sciences in Toulouse, France. Wiesner was the 2011 recipient of the Clarke Water Prize for his work in improving water quality through advancements in membrane and nanotechnology research. He is a past President of the Association of Environmental Engineering and Science Professors (AEESP).

Williams, David

Oregon State University

Dr. Williams is Helen P. Rumbel Professor for Cancer Prevention at Oregon State University (OSU) in the Department of Environmental and Molecular Toxicology and Linus Pauling Institute. He obtained his BS from Reed College, MS and PHD from OSU and post-doctoral training at the Medical College of Wisconsin. Dr. Williams is widely recognized as a leading researcher in environmental toxicology and has been funded continuously for 32 years as Principal Investigator by the National Institutes of Health (NIH), primarily the National Institute of Environmental Health Sciences (NIEHS). These grants were both individual research projects as well as multi-individual, multi-disciplinary and multi-institutional. He served as Director of the OSU Superfund Research Program, funded by NIEHS, for 6 years and currently directors a research project. Dr. Williams is also currently funded (2017-2022) by NIEHS to, for the first time ever, determine the pharmacokinetics of an important environmental carcinogen, benzo[a]pyrene, in humans. His recent and current service on external advisory committees include the National Water Research Institute's Santa Ana River Monitoring Review Panel (2005-present); NIEHS U19 (long-term health effects of the Deepwater Horizon spill) programs at the University of Texas, Galveston and University of Florida (2010-2015); standing member of 3 NIH study sections (Alcohol/Toxicology1, 1998-2003, Chair 2001-2003;

Xenobiotic and Nutrient Disposition and Action, 2009-2013, Systemic Injury by Environmental Exposure (SIEE), 2014-2017); NIEHS Superfund Research Programs (P42) at Michigan State University (2014-present) and Baylor University (2015-2016); National Cancer Institute's PREVENT program, 2013-present; ad hoc service on a number of other NIH and EPA panels, most recently Cancer Disease and Prevention (June, 2018) and SIEE (June, 2018). Dr. Williams is an active member of the Society of Toxicology, serving on a number of elected and appointed committees, the International Society for the Study of Xenobiotics and the American Association for Cancer Research.

Williams, Lance

University of Texas at Tyler

Dr. Lance Williams is Chair and Professor of Biology at The University of Texas at Tyler and the Center for Environment, Biodiversity, and Conservation. He has been at UT Tyler since 2007, and before that he was an Assistant Professor at The Ohio State University. Dr. Williams has extensive experience in river ecology and conservation and has been PI or co-PI on nearly 6 million dollars in extramural grants. In the past 20 years, he has served as the major professor for over 20 graduate theses on conservation topics in Eastern U.S. rivers. His most recent grants have focused on endangered mussel and crayfish species in East Texas rivers, and also water quality monitoring of military bases in Texas and Louisiana. He currently has grants from the Texas National Guard, the U.S. Army, the Texas Comptroller's Office, and the Texas Commission on Environmental Quality. Dr. Williams has served on numerous advisory committees and is currently the Managing Editor for the journal Southwestern Naturalist. He earned a B.S. in Zoology from the University of Oklahoma, an M.S. in Zoology from Oklahoma State University, and a Ph.D. in Biological Sciences from Mississippi State University.

Williams, Richard A.

MarginalRegulation

Dr. Richard A Williams is a consultant with his firm, MarginalRegulation.com. He has received compensation from the formaldehyde council at the American Chemistry Council in 2017. He is retired from the U.S. Food and Drug Administration with 27 years experience. At FDA, he was responsible for economic analysis, consumer studies and epidemiology for the Center for Food Safety and Nutrition. Subsequently, he was a Vice President for Policy at the Mercatus Center at George Mason University for nine years. He is currently a Senior Affiliated Scholar with the Mercatus Center and with Utah State's Center for Growth and Opportunity. He is also on the Board of Trustees for the International Life Sciences Institute. He has served on a National Academy of Sciences panel, served as President of the Virginia Chapter of the Society for Risk Analysis and has served as an advisor to the Harvard Center for Risk Analysis. He has extensive knowledge of risk analysis including risk/risk, health/health and benefit-cost analysis. Dr. Williams has created and taught classes on risk analysis for USDA and FDA. He has been invited to testify before the House and Senate multiple times on regulatory issues and has appeared on radio and television, including CNBC, National Public Radio, Reuters, Bloomberg, the New York Times and the Wall Street Journal. He has been invited to speak in multiple countries. He frequently writes op-eds that have a national audience on risk, economic and regulatory issues. He is currently working on the effects using linear, no-threshold dose-response curves as a default for chemicals and radiation. He has given keynote speeches within the last several years to the Governance of Emerging Technologies at ASU and the International Life Sciences Institute on emerging technologies. Dr. Williams received his Ph.D. in economics from Virginia Tech and his BS in business administration from Old Dominion University.

Yang, Raymond

Colorado State University

Dr. Raymond S. H. Yang is Professor Emeritus of Toxicology and Cancer Biology, and the former

leader of the Quantitative and Computational Toxicology Group, at the College of Veterinary Medicine and Biomedical Sciences, Colorado State University (CSU). Between October 2007 and July 2009, Dr. Yang had also been a Visiting Scientist at the National Center for Environmental Assessment, U.S. EPA, Cincinnati, to work on 2, 3, 7, 8-Tetrachlorodibenzo-p-dioxin (TCDD) and chemical mixture toxicology and risk assessment, among other projects. Dr. Yang's research focuses on physiologically based pharmacokinetic/pharmacodynamic (PBPK/PD) modeling, and other biologically-based computer modeling with a special emphasis on the toxicology of chemical mixtures. Dr. Yang has had extensive research and administrative experience in academia, chemical industry, and the federal government. At CSU in the last 20 years, Dr. Yang had served in the capacity as a Department Head, a Center Director, and the Director for a National Institute for Environmental Health Sciences (NIEHS) Quantitative Toxicology Training Program. Since June 2010, Dr. Yang has retired from the CSU but during his tenure at CSU in the past 20 years or so his research funding was principally from the NIEHS, Centers for Disease Control, and Department of Defense for toxicological interactions of chemicals including biologically based computer modeling. Dr. Yang publishes extensively in biomedical journals and is the editor/co-editor of two books; Toxicology of Chemical Mixtures: Cases Studies, Mechanisms, and Novel Approaches (1994), and Physiologically Based Pharmacokinetics: Science and Applications (2005). Dr. Yang is a Fellow of Academy of Toxicological Sciences and served on many prestigious national and international committees and panels. Presently, Dr. Yang is working part-time as an international consultant; part of this service includes Dr. Yang's continuing teaching of his "PBPK Modeling Workshop for Beginners" at CSU and elsewhere in the US, Europe, and Asia.

Zhao, Feng

NOAA

Feng Zhao earned M.S. and Ph.D. in Geography from The University of South Carolina, and Boston University in 2005 and 2010, respectively. After an extended post-doc at the University of California at Berkeley, Dr. Zhao held a Research Assistant Professor position at University of Maryland at College Park in 2012. Since 2017, he has served as a research scientist at Center for Satellite Application and Research (STAR), National Atmospheric and Oceanic Administration (NOAA). Dr. Zhao's research interests are broad, but a recurrent theme is the use of remote sensing to study the dynamics of terrestrial ecosystem and processes, including Vegetation Index (VI) and Green Vegetation Fraction (GVF) product development from NOAA satellite series, forest disturbance history mapping from Landsat and forest structural retrieval using LiDAR system.

Zwiernik, Matthew

Michigan State University

Dr. Matthew Zwiernik is a Professor of Ecotoxicology in the Department of Animal Science at Michigan State University (MSU). He is, a member of the MSU Institute for Integrative Toxicology and is the Director of the MSU Wildlife Toxicology Laboratory (MSU-WTL). Dr. Zwiernik received a B.S. in Biochemistry and a Ph.D. in Environmental Toxicology from the Michigan State University Department of Biochemistry and College of veterinary medicine respectively. Dr. Zwiernik has been a faculty member at MSU since 1999 and in that time has conducted multiple long-term litigation quality studies, assessing the impacts of human activities on wide array of wildlife populations in differing ecosystems. Dr. Zwiernik is an expert in assessing the effects of complex contaminant mixtures on riverine ecosystems. His team has pioneered work pertaining to wildlife species sensitivity to contaminate mixtures, and wildlife exposure and effects assessments. The MSU-WTL approach of combining laboratory based site-specific contaminant exposure protocols with direct field measures of exposure and individual and population health has informed and streamlined the ecological risk assessment process for numerous superfund sites. Dr. Zwiernik specializes in quantifying population dynamics in response to fluctuations in resources and stressors, utilizing a data

driven multiple lines of evidence, hypothetic-deductive approach, including adverse outcome pathway assessment. Dr. Zwiernik is particularly interested in improving the certainty of the quantification of the ecological risk associated with wildlife exposure to complex contaminant (stressor) mixtures by improving approaches for the identification of contaminant interactions, site-specific chemodynamics, the identification of germaine measurement parameters to derive risk estimates that inform sustainable remedial decisions. Dr. Zwiernik's funding is derived from a wide range of sources including industry, local community advisory groups, and state and federal government organizations including EPA, DOD and others. Dr. Zwiernik is a member of the Society of Environmental Toxicology and Chemistry. He has been an expert consultant to the International Joint Commission on Issues of Emerging Contaminants in the Great Lakes. Additional information on projects and qualifications including greater than 85 peer-reviewed publications, 22 invited papers, 3 keynote addresses, and greater than 150 scientific presentations and reports, as well as three book chapters pertaining to wildlife impact assessment can be obtained at www.riverwildlife.msu.edu.

Invitation for Public Comment on the List of Candidates for the EPA Chartered Science Advisory Board
October 16, 2018

The U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Staff Office announced in a Federal Register Notice on July 9, 2018 (83 FR 31752-31753) that it was inviting nominations of experts to be considered for the Administrator's appointment to the Chartered SAB. The SAB is a scientific/technical advisory committee. The objective of the SAB is to provide independent advice and peer review on the scientific and technical aspects of environmental issues to the EPA Administrator. While the SAB reports to the EPA Administrator, congressional committees specified in ERDDAA may ask the EPA Administrator to have the SAB provide scientific advice on a particular issue.

The SAB will review scientific issues, provide independent scientific and technical advice on EPA's major programs, and perform special assignments as requested by Agency officials. The SAB Staff Office sought nominations of experts who have demonstrated experience in the following disciplines: analytical chemistry; benefit-cost analysis; causal inference; complex systems; ecological sciences and ecological assessment; economics; engineering; geochemistry; health sciences; hydrology; hydrogeology; medicine; microbiology; modeling; pediatrics; public health; risk assessment; social, behavioral and decision sciences; statistics; toxicology, and uncertainty analysis.

The SAB Staff Office is especially interested in scientists with expertise described above who have knowledge and experience in: air quality; agricultural sciences; atmospheric sciences; benefit-cost analysis; complex systems; drinking water; energy and the environment; epidemiological risk analyses; water quality; water quantity and reuse; ecosystem services; community environmental health; sustainability; chemical safety; green chemistry; homeland security; uncertainty analysis; and waste management.

The SAB Staff Office identified 175 candidates based on their expertise and willingness to serve. We hereby invite public comments on the attached List of Candidates for consideration by the SAB Staff Office. Comments should be submitted to Mr. Thomas Carpenter, Designated Federal Officer no later than November 7, 2018 at carpenter.thomas@epa.gov. E-mail is the preferred mode of receipt. Please be advised that public comments are subject to release under the Freedom of Information Act.

Candidate Biosketches - FY2019 Chartered SAB Annual Membership

Aguirre, A. Alonso

George Mason University

Dr. A. Alonso Aguirre is Chair and Associate Professor at the Department of Environmental Science and Policy at George Mason University in Fairfax, Virginia. He leads a collaborative research program that takes an ecological approach to understanding wildlife diseases and their links to conservation and human health. His research has been instrumental in revealing the impact of emerging diseases of marine wildlife populations. A wildlife biologist and veterinarian by training, he co-founded the emerging discipline of conservation medicine. He edited both seminal books on the topic and co-founded the journal EcoHealth and the International Association of Ecology and Health. He has published over 160 peer-reviewed papers, books and chapters, advised governments of countries in the Americas, Southeast Asia and Western Europe, and briefed the Mexican and U.S. Congress. He currently serves as co-editor the EcoHealth journal, and associate editor of Journal of Wildlife Diseases and the European Journal of Wildlife Management. His research has been funded by the National Science Foundation, United States Agency for International Development, U.S. Department of Agriculture, National Marine Fisheries Service, and other federal agencies and non-profit organizations. The National Academy of Sciences recently appointed Dr. Aguirre to the Board on Life Sciences in recognition of his contributions to the field of wildlife biology, and he has received numerous awards. Previously, he served as the Executive Director of the Smithsonian-Mason School of Conservation in Front Royal, Virginia and as Senior Vice President at EcoHealth Alliance in New York. He has also held appointments at the Consortium for Conservation Medicine, the Center for Environmental Research and Conservation at Columbia University, and the Center for Conservation Medicine at Tufts University Cummings School of Veterinary Medicine.

Ahrens, Kurt

School District of Philadelphia

Dr. Kurt F. Ahrens is an educator and leader of science curriculum development at The U School, an experimental high school in the Innovation Network of the Philadelphia School District. Dr. Ahrens earned a BA with three majors (Integrated Science Program, Neurobiology, and Physics) at Northwestern University and a PhD in Molecular and Cell Biology at UC-Berkeley, where his research focused on reverse engineering mammalian brain circuitry by combining experimental and computational modeling methods. Dr. Ahrens' postdoctoral research in the Physics department at UC-San Diego expanded his research repertoire to include animal behavior, advanced signal processing and statistical analysis methods, and laser-scanning microscopy. After developing in vivo imaging methods for measuring neural activity in genetically modified animals at the Center for Molecular and Behavioral Neuroscience at Rutgers University, Dr. Ahrens established the Systems Neuroscience Laboratory at the Allen Institute for Brain Science, where his research team combined these techniques with electrophysiology and computational analysis methods to begin labeling, monitoring, and deciphering the interactions of countless brain cells in the living organism. He has published his research in peer reviewed journals and has served as a peer reviewer for the Organization for Computational Neuroscience's annual international conference since 2004. Dr. Ahrens shifted to the education profession in 2012, first teaching biology and research methods at Arcadia University, and currently physics, biology and mathematics. Dr. Ahrens was an active member of the citizen committee that crafted a Sustainability Plan for Cheltenham Township, one of the first in Pennsylvania, and he currently serves as the Chairman of the Environmental Advisory Council, where he and his colleagues provide evidence-based advice on water quality, energy infrastructure and usage, local and sustainable food production, and waste management to the municipal government, local businesses and institutions, and residents. He has no research funding.

Aldy, Joseph

Harvard University

Joseph E. Aldy is an Associate Professor of Public Policy and Faculty Chair of the Mossavar-Rahmani Center for Business and Government Regulatory Policy Program at the Harvard Kennedy School, a University Fellow at Resources for the Future, a Faculty Research Fellow at the National Bureau of Economic Research, and a Senior Adviser at the Center for Strategic and International Studies. He has been a Non-Resident Fellow at the Center on Global Energy Policy at Columbia University, a Visiting Scholar at the Kleinman Center for Energy Policy at the University of Pennsylvania, and a Lone Mountain Fellow at the Property & Environment Research Center. In 2009-2010, he served as the Special Assistant to the President for Energy and Environment at the White House. Aldy previously served as a Fellow at Resources for the Future, Co-Director of the Harvard Project on Climate Agreements, Co-Director of the International Energy Workshop, Treasurer of the Association of Environmental and Resource Economists, and worked on the staff of the President's Council of Economic Advisers as a Senior Economist, Senior Adviser, and Staff Economist. He earned his doctorate in economics from Harvard University, an MEM degree in resource economics and policy from the Nicholas School of the Environment at Duke University, and a bachelor degree in an independently-designed environmental science program from Duke University. Aldy's research focuses on climate change policy, energy policy, and regulatory policy. This includes publications in economics, science, and law journals on valuing mortality risk reduction, the use of market-based instruments to mitigate greenhouse gas emissions, the competitiveness impacts of climate change policy, the design of international environmental agreements, energy efficiency subsidies, renewable power subsidies, and other topics. He is a Member of the Advisory Committee for the Energy and Environment Program at the Alfred P. Sloan Foundation, a Member of the Advisory Board to The Environmental Forum, a Member of the Editorial Advisory Committee of Nature Energy, and a Member of the Advisory Board of the Economics of Energy and Environmental Policy. He is also a Member of the Board of Trustees to the Robert and Patricia Switzer Foundation. He was a Member of the Peer Review Advisory Committee to the Indiana University Corporate Average Fuel Economy Study (led by John Graham). The Administrative Conference of the United States commissioned a report by Aldy on the retrospective review of federal regulations, which included recommendations for agency practice adopted by the ACUS plenary. Government agencies have formally solicited an external peer review by Aldy on a variety of topics, including mortality risk valuation (EPA, Homeland Security, and Transportation), integrated assessment models (Energy and U.S. Global Change Research Program), guidelines for regulatory impact analysis (Health and Human Services), the benefits and costs of regulations (OMB), energy innovation and low-carbon energy policies (National Research Council and Council of Economic Advisers), and academic research projects (National Science Foundation). Over the past two years, Aldy has received funding from the Harvard Kennedy School, the Alfred P. Sloan Foundation, the National Bureau of Economic Research, and Resources for the Future.

Allen, Irving

Virginia Tech

Dr. Irving Allen is a faculty member at Virginia Tech in the Department of Biomedical Sciences and Pathobiology at the Virginia Maryland College of Veterinary Medicine. He is an active scientist with over 20 years of experience conducting research using animal models and human subjects, exploring the intersection between inflammatory diseases, cancer, and the environment. Dr. Allen holds a B.S., M.S., and PhD in Genetics and Molecular Biology, with postdoctoral training in Immunology. Early in his career, he conducted research associated with the role of environmental factors in modulating marine dinoflagellate populations and subsequently worked at Duke University studying complex genetic disorders with environmental influences (including asthma and several neurological

disorders). As his career and training advanced, Dr. Allen's research focus shifted towards exploring the role of the immune system in respiratory and gastrointestinal diseases. Over the last decade, Dr. Allen's research has expanded into studies associated with the biological effects of therapeutic and environmental nanoparticle exposure in the lung and gut. Together, he has contributed to over 60 publications in peer-reviewed journals in his various fields of research, and has broad scientific expertise in multiple areas of relevance to the EPA. Complementing his scientific expertise, he also holds a MBA, with a concentration in Bioscience Management. This allows him to view science from both the research and business perspective. He has a unique working knowledge of cost-benefit analysis and financial modeling associated with conducting basic and applied research. Dr. Allen is a current member and has served in leadership positions in several scientific societies. To date, Dr. Allen's research program has been predominately funded through the National Institutes of Health, Foundation Grants, and Private Industry Support. He has not received previous EPA financial support or served on EPA advisory committees.

Anderson, Henry

Wisconsin Division of Public Health

Dr. Henry A. Anderson, M.D. holds adjunct professorships at the University of Wisconsin-Madison, School of Medicine and Public Health, Department of Population Health Sciences, and the University of Wisconsin Institute for Environmental Studies, Center for Human Studies. In July 2016 he retired from his positions as Wisconsin State Environmental and Occupational Disease Epidemiologist, and Chief Medical Officer in the Wisconsin Division of Public Health, Department of Health Services which he held since 1980. His 35 years of research and programmatic expertise and experience includes public health; preventive, environmental, and occupational medicine; occupational and environmental human health and exposure epidemiology; human health risk assessment; regulatory risk assessment and risk communication. Active research interests include: disease and exposure surveillance systems, cancer and chronic disease epidemiology, reproductive and endocrine health hazards, drinking water contaminants, pesticides and dietary risk assessment including sport fish consumption advisory communication. Dr. Anderson served on the U.S. EPA Science Advisory Board (SAB) Chemical Assessment Advisory Committee from 2013 – 9/2018 and previously served on the EPA National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances. He was chair of the Environmental Health Committee of the U.S. EPA Science Advisory Board, served on the U.S. EPA SAB Executive Committee and is past Chair of the Board of Scientific Councilors for the National Institute of Occupational Safety and Health. He has served on five National Academies of Science Committees including "Toxicity Testing for Assessment of Environmental Agents." He serves on the Presidential Advisory Board on Radiation Worker Compensation. He is associate editor of the American Journal of Industrial Medicine. Dr. Anderson received his M.D. degree in 1972 from the University of Wisconsin-Madison. He was certified in 1977 by the American Board of Preventive Medicine with a sub-specialty in occupational and environmental medicine and in 1983 became a fellow of the American College of Epidemiology. Dr. Anderson was a state government employee until 7/2016 and his research has been supported by the State of Wisconsin and grants from U.S. government agencies, primarily U.S. Department of Health and Human Services/Centers for Disease Control and Prevention and the U.S. Environmental Protection Agency. All EPA and other federal government research support ended with his retirement in 7/2016. Dr. Anderson currently serves on the Presidential Advisory Board on Radiation Worker Compensation (2001-2006 and 2009-current), National Academies of Science Roundtable on Environmental Health Sciences, Research, and Medicine (2011-current) and 2013-2018 on the United States Environmental Protection Agency Science Advisory Board, Chemical Assessment Advisory Committee on which he reviewed Ammonia (2014-2015), Ethylene Oxide (2014-2015), and draft Chloroform, nitrate/nitrite, Ethylbenzene IAPs (2016-2017). Beginning in 1997 he served on various U.S. EPA Science Advisory Board committees including the Executive Committee (1997-2003) and

was chair of the Integrated Human Exposures Subcommittee (1997-2001) and then chair of the Environmental Health Committee (2001-2003). He served on the U.S. EPA's National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances (2006-2012), the U.S. EPA Children's' Health Protection Advisory Council (2004–2009) and the U.S. EPA Endocrine Disruptor Screening and Testing Committee (1997–1999). He was also chair of the Board of Scientific Councilors for the National Institute of Occupational Safety and Health (2004-2006). He served on the Armed Forces Epidemiology Board (1996-2000).

Auvermann, Brent

Texas A&M University

Dr. Brent Auvermann is Professor of Biological and Agricultural Engineering (BAEN) and Extension Specialist with Texas A&M AgriLife. His position with Texas A&M AgriLife consists of a joint appointment, with 65% Extension and 35% research. He also holds an Adjunct Professor appointment at West Texas A&M University. Dr. Auvermann holds a B.S. (1986) and M.S. (1990) in Agricultural Engineering from Texas A&M University, and a Ph.D. in Chemical and Bioresource Engineering from Colorado State University (1996). His research program centers on environmental aspects of concentrated livestock production, with 15 years of work in air pollution. Dr. Auvermann has obtained competitive and special grants in air-quality topics totaling multi-million dollars over the past ten years. His primary research focus has been particulate matter but has also collaborated in research on ammonia, hydrogen sulfide, dispersion modeling, and wet and dry deposition. Dr. Auvermann supervises and chairs graduate thesis/dissertation committees for M.S. and Ph.D. candidates at both Texas A&M University and West Texas A&M University. His office is located in Amarillo, TX, near the heart of the United States' cattle-feeding industry. Since 2007, Dr. Auvermann has operated the "Canonceta" deposition-monitoring sites for the National Atmospheric Deposition Program (NADP site ID: TX43) and the Clean Air Status and Trends Network (CASTNET site ID: PAL190). He has also worked closely with the concentrated dairy industry in Texas, New Mexico, and Arizona with respect to emissions measurement and mitigation techniques.

Barton, Hugh A.

Independent Consultant

Dr. Hugh A. Barton is an independent consultant for applications of systems pharmacology and toxicology to drug discovery and safety evaluation or environmental risk assessment. He provides expert advice on physiologically based pharmacokinetic (PBPK) and pharmacodynamic (PD) models and their implementation for decision-making. Dr. Barton was Associate Research Fellow with Biomedicine Design, Pfizer, Inc. for ten years. His focus in drug discovery was applying translational modeling and simulation to oncology, cardiovascular disease, and neurodegenerative diseases to assess PK, PD, and safety. His pharmacokinetic modeling to support safety evaluation for excipients lead to FDA approval of generic Pfizer docetaxel in 2014. He has more than 25 years of experience in biological modeling with Pfizer, US Environmental Protection Agency and consulting/contract companies, developing computational models for use in biologically based dose-response analyses. Dr. Barton worked in environmental consulting for several years doing site specific risk assessments for hazardous waste sites, air permitting, and other environmental regulatory requirements. He has been adjunct professor at Boston University School of Public Health and in Toxicology at The University of North Carolina at Chapel Hill. He received a B.S. in Life Sciences from the Massachusetts Institute of Technology, Cambridge, MA in 1982 and a Ph.D. in Toxicology from the Department of Applied Biological Sciences at MIT in 1988. Dr. Barton has been President of the Risk Assessment and Biological Modeling Specialty Sections of the Society of Toxicology. He has served as an invited peer-reviewer for organizations including Health Canada, NIEHS, US EPA, NAS/NRC and TERA. He is a member of the US EPA Science Advisory Board's Chemical Assessment Advisory Committee, the Simulations Plus, Inc. Science Advisory Board, and the NRC Committee on

Organohalogen Flame Retardants, and a committee reviewing pesticide PBPK models for Versar under contract to US EPA. He previously served on the NRC Committee on Inorganic Arsenic and WHO IPCS PBPK Modeling working group. He is a reviewer for numerous scientific journals and serves on two editorial boards. Dr. Barton has published more than 50 articles in the scientific literature on physiologically based pharmacokinetic and pharmacodynamic modeling and has received awards from Pfizer, EPA and others for that work and its applications in pharmaceutical safety and risk assessment. Dr. Barton's research currently has no research funding.

Bashkin, James

University of Missouri-St. Louis

Dr. Bashkin is Professor of Chemistry and Biochemistry at the University of Missouri-St. Louis. He was educated at the Universities of Arizona and California-Irvine and received his doctorate from Oxford (UK), followed by postdoctoral studies at Harvard. Half of Dr. Bashkin's career has been spent in the chemical and pharmaceutical industries and half in academia. He was Associate Editor of Green Chemistry for the Royal Society of Chemistry, served on the Editorial Advisory Board of Chemical Reviews for years for the American Chemical Society, and was just appointed to the Editorial Board of the Asian Journal of Green Chemistry. Dr. Bashkin co-invented a process that significantly decreased industrial pollution in the rubber chemical industry, for which he shared Monsanto's highest scientific award and the Presidential Green Chemistry Challenge Award. This chemistry is now practiced worldwide and has changed the economy of the business for the better since it is less polluting and less expensive. He has also served on the EPA-American Chemical Society (ACS) selection committee for the Presidential Green Chemistry Awards, Chaired the International Gordon Research Conference on Green Chemistry, and served on awards and grant committees for the ACS, NSF, and NIH. He has published over 70 papers and hold 16 US patents.

Beck, Barbara

Gradient Corp.

Dr. Beck is a principal at Gradient, an environmental risk sciences consulting firm. She is an expert in toxicology and human health risk assessment for environmental chemicals, especially metals and air pollutants. Her broad experience in risk assessment includes toxicological evaluations of many different chemicals in environmental settings, consumer products, and pharmaceuticals. These projects often lead her to work with other scientists from varying backgrounds, including engineers and chemists, to develop an integrated approach to understanding chemical hazards. Dr. Beck has conducted laboratory studies to refine the understanding of chemical exposure and toxicity, and she has applied study findings in a risk assessment context. She has published over 100 book chapters and journal articles, including the development of health-based criteria for several chemicals and probabilistic exposure models. Several of her publications have received awards from organizations such as the Society of Toxicology's Risk Assessment Specialty Section and the US EPA. She has communicated her work to different audiences, including regulatory agencies, the US Congress, and the public. Dr. Beck's participation in advisory committees and expert panels, such as the National Research Council, the International Life Sciences Institute, and the Watertown, Massachusetts Board of Health, has spanned over thirty years. She is a recipient of the Lifetime Achievement Award from the University of Massachusetts, Amherst, School of Public Health and Health Sciences. She is a fellow and past-president of the Academy of Toxicological Sciences, a Diplomate of the American Board of Toxicology, and a European-Registered Toxicologist. Before joining Gradient, she was Chief of Air Toxics Staff and Regional Expert in Toxicology for US EPA Region I. Prior to that, she was a Fellow in the Interdisciplinary Programs in Health at the Harvard School of Public Health (now the Harvard T.H. Chan School of Public Health). She received her Ph.D. in molecular biology and microbiology from Tufts University and her B.A. in biology from Bryn Mawr College (cum laude).

Becker, Jennifer

Michigan Technological University

Dr. Jennifer G. Becker is an Associate Professor of Environmental Engineering at Michigan Technological University. She holds a B.S. in Environmental Engineering from Michigan Technological University, an M.S. in Civil Engineering from the University of Illinois at Urbana-Champaign, and a Ph.D. in Civil Engineering from Northwestern University. Dr. Becker's research focuses on engineered biological processes for the sustainable treatment of groundwater, wastewater, and residuals. Specifically, she is interested in the bioremediation and environmental fate of hazardous contaminants in the subsurface, the sustainable treatment and management of residuals from municipal wastewater treatment and industrial processes, microbial processes for bioenergy production, and the treatment of emerging pollutants in municipal wastewater. Dr. Becker also has expertise and extensive outreach experience related to animal agricultural practices, their impact on the environment, and the management of their residuals. Core support for Dr. Becker's research has primarily been provided by the federal government via grants from the National Science Foundation (NSF). She is the Past-President of the Association of Environmental Engineering and Science Professors (AEESP) and served on its Board of Directors from 2010 to 2014. Dr. Becker's research has been recognized with the Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the U.S. government on outstanding scientists and engineers beginning their independent careers, as well as a NSF Early Career Development Program (CAREER) Award, the Robert A. Canham Award from the Water Environment Federation, the AEESP/Montgomery Watson Harza Master's Thesis Award (both as the advisor and student), the Junior Faculty Award from the College of Agriculture and Natural Resources, University of Maryland, College Park and several other awards.

Begley, C. Glenn

BioCurate PTY. LTD

Dr. C. Glenn Begley is the Chief Executive Officer of BioCurate Pty. Ltd., a joint venture between Monash University and the University of Melbourne. He also serves as a Scientific/Clinical Advisor for several biotech and pharmaceutical companies. Dr. Begley has over 20 years of clinical experience in medical oncology and hematology. His personal research focused on regulation of hematopoietic cells and translational clinical trials. Recently, he has focused attention on the need to improve the quality of scientific research. His pivotal publications highlighted the need for robust, reproducible research. This has catalyzed an ongoing, broad-based discussion within the scientific community and the lay press. He has numerous invitations to present his work including at the President's Science Council, National Academies Meetings, National Institute of Standards and Technology, and biotech/pharmaceutical companies. He has published over 200 papers that are highly cited (total citations 21, 536; h-index 73; i10 index 180; source Google Scholar, May 2018). He graduated in from the University of Melbourne with M.B., B.S. degrees (MD-equivalent) in 1978, and trained primarily in Melbourne, Australia, at the Walter and Eliza Hall Institute of Medical Research and at the Royal Melbourne Hospital. He is Board Certified in Australia as a Medical Oncologist and Hematologist (F.R.A.C.P.), is a Fellow of the Royal College of Pathologists, United Kingdom, and received an honorary Fellowship from the College of Pathologists, Australia. He has a Ph.D. in cellular and molecular biology from the University of Melbourne. He has received numerous honors and awards, including being elected as the first Foreign Fellow to the American Society of Clinical Investigation in 2000, and to the prestigious Association of American Physicians in 2008. In 2014 he was an inaugural inductee into the "Hall of Fame" at his alma mater, the Royal Melbourne Hospital, and elected to the Australian Academy of Health and Medical Sciences.

Belzer, Richard

Independent consultant

Dr. Richard Belzer has been an independent consultant in regulation, risk, economics and information quality. Previously he was a visiting professor of public policy at Washington University in St. Louis and staff economist in the Office of Information and Regulatory Affairs in the Office of Management and Budget. He received his Ph.D. in public policy from Harvard University (1989), Master's in Public Policy (MPP) from the John F. Kennedy School of Government (now Harvard Kennedy School) (1982), and MS and BS degrees in agricultural economics from the University of California at Davis (1979, 1980). Current original research areas include the measurement and estimation of Type I and Type II errors in the identification, placement, and discipline of children with disabilities; the analysis of benefits and costs from banning glider vehicles from the heavy-duty truck market; the development of statutorily appropriate measures of economic feasibility under the Safe Drinking Water Act; the analysis of variability in pulmonary function testing; the development of objective economic indicators to identify adverse human health effects; the improved use of human health risk assessments as inputs to benefit-cost analysis; the analysis of environmental justice ranking schemes; the analysis of patent law and examination practices; the estimation of potential cost reductions to state Medicaid programs from the substitution of electronic for tobacco cigarettes; and the economic value of subjective quality information in U.S. wine markets. Recent consulting projects have included a benefit-cost analysis of rescinding the ban on gliders from the heavy-duty truck market; reviews of California's proposed drinking water standards for hexavalent chromium and 1, 2, 3-trichloropropane; and the critique of predicted human health impacts and monetized risks attributable to air emissions from new facilities designed to achieve federal regulatory standards. Dr. Belzer is a regular contributor to scholarly professions through journal peer review and service to professional societies. He was elected Treasurer of the Society for Risk Analysis (1998, 2000) and elected Secretary-Treasurer of the Society for Benefit-Cost Analysis (2008, 2010). He earned multiple awards for exemplary performance at OMB, given the SRA's Distinguished Service Award (2003), and named a Fellow of the Cecil and Ida Green Center for the Study of Science and Society (1995). He has not received any grants from EPA, any other government agency, or any private entity. He has conducted independent research on behalf of clients or through self-funding; some projects are jointly funded. His clients since 2015 include: Fitzgerald Glider Kits LLC, the American Chemistry Council, the California Manufacturing Technology Association, the R Street Institute, and Exxon Mobil Biomedical Sciences, Inc.

Bennear, Lori

Duke University

Lori Bennear is the Juli Plant Grainger Associate Professor Energy Economics and Policy at the Nicholas School of the Environment at Duke University and the Associate Director for Educational Programs at the Duke University Energy Initiative. She received her Ph.D. in Public Policy from Harvard University (2004) and also earned an MA in Economics from Yale University (1996) and an AB in Economics and Environmental Studies from Occidental College (1995). Her research focuses on evaluating the effectiveness of flexible environmental policies including information disclosure regulations, management-based regulations, liability regimes, and demand-side management programs. She has applied these evaluations across a range of environmental domains including energy, toxics, and drinking water. Her co-edited book Policy Shock: Recalibrating Risk and Regulation after Oil Spills, Nuclear Accidents and Financial Crises was published by Cambridge University Press in September 2017. She is currently working on developing best practices for adaptive regulation of emerging technologies in the energy domain, with a focus on autonomous vehicles and offshore wind.

Bergendahl, John

Worcester Polytechnic Institute

Dr. John Bergendahl is currently the Director of the Environmental Engineering Program at Worcester Polytechnic Institute, and a tenured Associate Professor in the Department of Civil and Environmental Engineering with a collaborative appointment in Chemical Engineering. John has six years' experience as a practicing engineer in industry, and holds a B.S. in mechanical engineering, an M.S. in environmental engineering, and a Ph.D. in chemical engineering from the University of Connecticut. He conducted postdoctoral research in the Environmental and Water Resources Engineering Program at the University of Texas in Austin. His current research interests are in water quality, water reuse, sustainability, and water-energy relationships; specifically, His research seeks to increase our knowledge of physical and chemical processes for enabling sustainable design of engineered systems including water treatment and wastewater treatment systems, and identification/solution of emerging global water quality threats. John's recent research funding as PI or co-PI has come from the Center for Advanced Research in Drying (NSF and industry funded), Sandia National Laboratories, Triton Systems Inc, and Stantec, Inc. He authored and co-authored 27 peer-reviewed journal articles, participated in 61 professional presentations, authored one textbook and one book chapter, and advised over 8 Ph.D. dissertations, 19 M.S. theses, and 56 Senior engineering projects (some sponsored). He has served on numerous EPA and TRB review panels, and is on the editorial board for Soil and Sediment Contamination, An International Journal. He is also an inducted member of Chi Epsilon and Phi Kappa Phi. Dr. Bergendahl is a registered professional engineer in the State of Connecticut, and has consulted for industry.

Botkin, Daniel

University of California, Santa Barbara

Dr. Daniel B. Botkin is Professor Emeritus, University of California, Santa Barbara, where he was chairman of the Environmental Studies Program. He has also served on the faculty of Yale University's School of Forestry and Environmental Studies; George Mason University (Professor). He has worked on a wide variety of Environmental Science, from helping NASA use its LANDSAT satellite for the first time to study forests; was one of the leaders in establishing the National Science Foundation Long-Term Ecological Research Program. He has directed studies of toxic waste facilities; reserves for many endangered species, from African Elephants to salmon in the U.S. Pacific Northwest; the 1.3 million birds that used Mono Lake, California, threatened by water diversion. Other research: the effects of high levels of radiation on a New York State forest; and long-term studies of the historic data about bowhead whales and other marine mammals. He developed the first successful ecosystem computer model of forests, in use widely around the world. For 50 years, he has worked on the possibility of human-caused climate change. He has received numerous awards, most recently Who's Who Lifetime Achievement Award. He has authored 15 books, including an award-winning Environmental Science textbook. He has testified before both houses of Congress and various state houses. He earned a B.A. from the University of Rochester; a Master's Degree from the University of Wisconsin; and a Ph.D. from Rutgers University (biology/environmental science).

Brown, Derick G.

Lehigh University

Dr. Derick G. Brown is a Professor and Associate Chair of the Department of Civil and Environmental Engineering at Lehigh University. His research is in the experimentation and modeling of complex environmental systems, with a strong focus on environmental biotechnology and the relationships between microbial and physiochemical processes. Example research includes contaminant biodegradation, bacterial interactions with surfaces, and enhanced biological energy production and nutrient recovery from municipal and industrial waste streams. Dr. Brown also has expertise on the fate, transport, risk assessment and management of environmental contaminants,

including pathogenic organisms and complex chemical mixtures. Dr. Brown received a B.S. from Boston University in Aerospace Engineering; an M.S. from University of California, Irvine in Mechanical engineering; and an M.A. and a Ph.D. in Environmental Engineering from Princeton University. He spent eight years in industry working for McDonnell Douglas Space Systems Company (now Boeing) in their Advanced Technology Development division and he has been a faculty member in the Department of Civil and Environmental Engineering at Lehigh University since 2001. Dr. Brown serves or has served on numerous external scientific committees, including the the USEPA Science Advisory Board's Environmental Engineering Committee. He is a Registered Professional Engineer in California and Pennsylvania and is an American Academy of Environmental Engineers and Scientists Board-Certified Environmental Engineer. Dr. Brown's research funding over the past two years includes the National Science Foundation, the Pennsylvania Infrastructure Technology Alliance, the Qatar National Research Fund, and Evoqua Water Technologies. His research has been published in numerous peer-reviewed articles in leading environmental engineering and science journals and Dr. Brown has presented his research at national and international conferences and at invited seminars, panels and workshops.

Bus, James

Exponent, Inc.

Dr. James S. Bus is a Senior Managing Scientist in the Health Sciences Group of Exponent, a leading global consulting firm (May 2013-present). Prior to joining Exponent, Dr. Bus retired from The Dow Chemical Company as Director of External Technology and Fellow in the Toxicology and Environmental Research and Consulting unit (1989-2013). Prior to Dow, he held positions as Associate Director of Toxicology and Director of Drug Metabolism at The Upjohn Company (1986-1989), Senior Scientist at the Chemical Industry Institute of Toxicology (CIIT, 1977-1986), and Assistant Professor of Toxicology, University of Cincinnati (1975-1977). Dr. Bus has served in advisory roles to a variety of institutions including ILSI, ILSI-HESI, The Hamner Institutes (formerly CIIT), American Chemistry Council Long-Research Initiative, and on advisory boards of the EPA (BOSC and Chartered SAB), FDA (NCTR), the National Toxicology Program, and the National Academy of Sciences (BEST). He has served as President of the Society of Toxicology, The American Board of Toxicology, and the Academy of Toxicological Sciences, and in various editorial roles for Toxicology and Applied Pharmacology, Environmental Health Perspectives, and Regulatory Toxicology and Pharmacology. Dr. Bus has received the Society of Toxicology Achievement (1987) and Founders (2010) awards, the Toxicology Forum George H. Scott Award (2013), Rutgers University Robert A. Scala Award (1999), the Michigan State University K.E. Moore Outstanding Alumnus Award), and the International Society of Regulatory Toxicology and Pharmacology International Achievement Award (2015). He received his B.S. in Medicinal Chemistry from the University of Michigan (1971) and PhD in pharmacology from Michigan State University (1975), and currently is an Adjunct Professor in the Dept. Pharmacology and Toxicology at that institution. He has authored/co-authored over 130 publications, books, and scientific reviews. His primary research interests include modes of toxic action of industrial chemicals and pesticides, including the importance of non-linear toxicokinetics as a key consideration for improving the human relevance of in vitro and in vivo toxicity test findings.

Caneba, Gerard

Michigan Tech University

Prof. Gerard T. Caneba is a professor of chemical engineering at Michigan Technological University. He started as a faculty member at Michigan Tech in 1985, and served as director of the Center for Environmentally Benign Functional Materials (CEBFM) in 2007-2015. He finished his bachelor's degree -in 1979 from the University of the Philippines in Quezon City. He was a recipient of a United Nations fellowship for the M.S. degree he obtained from the University of California at Berkeley, CA

in 1982. He finished his Ph.D. in 1985, and became a faculty member at Michigan Tech the same year. He is a small business owner, which is starting to scale-up a process that was developed initially through a P3 (People, Prosperity, and Planet) Phase I project in 2012. He worked with the Michigan Tech-based Center for Clean Industrial and Treatment Technologies (CenCITT) in the 1990s, which culminated in his generation of a report on environmental aspects of polymer products. He was a faculty fellow at Argonne National Laboratory in 2001, and National Aeronautical and Space Administration (NASA)-Johnson Space Center in 2003-2004. He was an active member of the University Senate in 2008-2013 as a Senator-at-Large; he chaired for 5 years its Administrative Policy Committee, which ran the annual evaluation survey of the university president and vice-presidents. He discovered the free-radical retrograde-precipitation polymerization (FRRPP) process, which has been documented in journal articles and two monographs authored or co-authored by him to generate environmentally responsible polymer materials. Most recently (2017-2018), he authored a book that used chemical engineering concepts to propose a new 12-step mechanism of natural climate change, which emanates from deep in the oceans; he analyzed this deterministic mechanism quantitatively with his own set of model calculations backed by experimental data. He has no research funding in the past two years.

Cantrell, Louis

Profitable Weather, LLC

Dr. Louis E. Cantrell Jr. is an American Meteorological Society (AMS) Certified Consulting Meteorologist (CCM) currently serving on the AMS CCM Board. He is presently an advisory consultant to Technology Planning and Integration for Observation office at NOAA/NESDIS Silver Spring, MD. He advises the NOAA Observing System Council and NOAA Research Councils on investments in NOAA's nearly $2.5B annual observing systems portfolio.

Chandra, Dhyan

Roswell Park Comprehensive Cancer Center

Dr. Dhyan Chandra is an Associate Professor of Oncology in the Department of Pharmacology and Therapeutics at Roswell Park Comprehensive Cancer Center, Buffalo, New York. The focus of research in his laboratory is to understand the underlying mechanisms of drug toxicity in cancer and normal cells. The main objectives of his laboratory are to: understand mitochondria-mediated cell death signaling in cancerous and normal cells; and define the role of heat shock proteins in cell survival and death. He has acquired extensive expertise and experience in mitochondrial biology and cell death. These types of research activities will be important in understanding cellular responses to environmental toxicants including toxic metals and radiation, which have been associated with various human diseases including cancer. He has been serving as an expert reviewer for scientific journals and national / international grants funding agencies. He is a member of editorial board of various science journals, and has delivered lectures at scientific conferences and at academic institutions. He earned his PhD degree in the field of radiation and cancer biology from the Jawaharlal Nehru University, New Delhi, India. During his postdoctoral training at the University of Texas MD Anderson Cancer Center, he studied the mitochondrial regulation of cell death in cancer. His research for the last 2 years has been funded by National Institutes of Health.

Chen, Celia

Dartmouth College

Dr. Celia Chen is a Research Professor in the Department of Biological Sciences at Dartmouth College and the Director of the Dartmouth Toxic Metal Superfund Research Program. For the last 23 years, she has studied the fate and effects of metal contaminants in freshwater and estuarine ecosystems particularly the bioaccumulation and trophic transfer of mercury. She has also investigated the effects of multiple stressors on aquatic organisms, including the impacts of changes related to

climate on aquatic food webs. Dr. Chen received a B.A. in Biology at Dartmouth College, M.S. in Biological Oceanography at the University of Rhode Island, and a Ph.D. in Ecology from Dartmouth College. In the Dartmouth Toxic Metals Program, she is also the Core Leader of the Research Translation Core working to communicate scientific information to improve human health and the environment. She has chaired regional and international workshops and meetings on mercury in the environment. She represents Dartmouth College on the United Nations Environment Programme Fate and Transport Partnership and participated in the conferences of the Minamata Convention. She is currently a Review Editor for the journal, Ecohealth, and has been a guest editor of special issues in Environmental Research, Environmental Health Perspectives, Estuaries and Coasts, Ecohealth, Science of the Total Environment, and Ambio. She has published over 70 peer-reviewed papers. She served on the U.S. EPA Science Advisory Board Mercury Panel, the Ecological Processes and Effects Committee, and the Lake Erie Phosphorus Objectives Review Panel. She also has served on the Boards of the North Atlantic Chapter of the Society of Environmental Toxicology and Chemistry, Gelfond Fund at Stony Brook University, and the Scientific Advisory Committee of the Lake Sunapee Protection Association. Her research has recently been supported by the NIEHS, the CDC, the USDA, the USEPA, and the Sea Grant Program of NOAA.

Chitikela, S. Rao

RC-WEE Solutions LLC

Dr. S. Rao Chitikela is a consulting engineer practicing in the water, energy, and environmental compliance specialty areas related to the industrial-manufacturing and municipal water operations. He has significant work experience with both government and private entities, and maintains effective interaction with the academia; currently, he is working with his own firm RC-WEE Solutions LLC. He is a registered professional engineer (P.E.) in the States of OH, IN, MI, PA, DE, NJ, NY, and P.Eng., in Alberta-Canada; also, a Board Certified Environmental Engineer (BCEE) in the Water Supply & Wastewater, and Air Pollution Control specialties. Rao's expertise includes: water and wastewater treatment; air pollution monitoring and control; water infrastructure updating; environmental permitting and auditing; and, energy auditing. His research work included: fate of chemicals in the environment; ammonia emissions of poultry operations; drinking water quality; wastewater and greenhouse gases; air pollutant monitoring, control, and compliance verification; municipal and industrial-manufacturing facilities' environmental permitting and compliance; and, the application of water infrastructure updating via performance infrastructure contracting. He conducted several stakeholder meetings on environmental permitting and negotiations (including enforcement). He was a committee member on 'Chronic Violator Regulation Development' in the State of Delaware (2002). He is an active member of Environmental Permitting, Groundwater Quality, Renewable Energy Technologies, and Sustainability Committees, and Municipal Water Infrastructure Council of the Environmental and Water Resources Institute (EWRI); also, a contact on Government Relations of the American Society of Civil Engineers (ASCE). He is a peer reviewer and, published technical papers and presented on the key topics above. Rao earned his bachelor's, master's, and Ph.D., in Civil Engineering from the Andhra University (India), Nagpur University (India), and University of Delaware (USA), respectively. He did not receive any research grants or funds in the last two (2) years.

Chorghade, Mukund

THINQ Pharma

Dr. Mukund S. Chorghade is President and Chief Scientific Officer, THINQ Pharma / MVRC Research/ Chicago Discovery Solutions. He holds Adjunct Research Professor / Visiting Fellow / Scientist appointments at Harvard, MIT, Princeton, Cambridge, Caltech, Rutgers, Strathclyde and others. He provides synthetic chemistry and chemical development expertise to academic laboratories, agrochemical, pharmaceutical and biopharmaceutical companies. His research interests are in

Traditional Medicine derived New Chemical Entities and his discovery of "chemosynthetic livers" that find utility in drug metabolism, valorization of biomass and environmental remediation. The livers are proprietary oxidative catalysts to conduct and predict metabolic profiling of chemical entities. (in vitro and ex vivo): Metabolites can be synthesized and screened in multi-gram quantities. Dr. Chorghade earned B. Sc. M. Sc. degrees from the University of Poona, and a Ph. D. at Georgetown University. He completed postdoctoral appointments at the University of Virginia and Harvard, visiting scientist appointments at University of British Columbia, College de France / Universite' Louis Pasteur, Cambridge and Caltech and directed research groups at Dow Chemicals, Abbott Laboratories, CytoMed and Genzyme. He received three "Scientist of the Year Awards" and is on the Scientific Advisory Board of several corporations / foundations. He is a Fellow of the American Chemical Society, American Association for the Advancement of Science, American Institute of Chemists and The Royal Society of Chemistry, the Maharashtra, Andhra Pradesh and Telengana Academy of Sciences and has been a featured speaker in national and international symposia that have received favorable press coverage. He was ACS Section Chair (Brazoria 1990) and Northeastern (2007). He is Chair-Elect of the Princeton Section (2018). He is an active participant in ACS' Career Services / Professional Development / Entrepreneurship and the Small Chemicals Businesses Division. He is the Chair of the RSC Committee on Process Chemistry and Technology (2018-9).

Chorover, Jon

University of Arizona

Dr. Jon Chorover is Professor and Head, Department of Soil, Water and Environmental Science at the University of Arizona (UA). He received his B.S. (Environmental Science) from University of Michigan, and M.S. (Forest Science) and Ph.D. (Soil and Water Chemistry) from UC Berkeley, worked as an NSF postdoctoral fellow in Analytical Chemistry at University of Geneva, and was on the faculty of Penn State University before joining the faculty of University of Arizona. His research group explores the biogeochemistry of soil, sediment and water through laboratory and field-based experiments probed with advanced analytical chemistry techniques. Of particular interest is resolving how mineral-organic interactions influence the weathering of soils, the stabilization of organic carbon, and the speciation, mobility and bioaccessibility of pollutants. His research is funded by the National Science Foundation, the National Institute of Environmental Health Sciences, and the Department of Energy. He directs a core analytical chemistry facility, the Arizona Laboratory for Emerging Contaminants and serves as principal investigator of the Santa Catalina Mountains – Jemez River Basin Critical Zone Observatory (http://criticalzone.org/catalina-jemez/), funded by the National Science Foundation.

Christy, John R.

University of Alabama in Huntsville

Dr. John R. Christy is the Director of the Earth System Science Center, Distinguished Professor of Atmospheric Science and Alabama's State Climatologist at the University of Alabama in Huntsville where he has been employed for over 30 years. His responsibilities include managing a science center with over 80 employees working on several research projects ranging from developing and launching space-based instruments to studying impacts of significant weather events in developing countries to high-resolution studies of air pollution (air-chemistry and meteorology) in the Southeast. His own research concerns developing, constructing and refining global and regional climate data records which may be used to test claims of climate variability and change and to understand the climate's sensitivity to various forcing factors, resulting in almost 100 peer-reviewed publications. As State Climatologist he interacts with the government, industry and the public regarding climate resources in Alabama that may be utilized in environmentally and economically sustainable ways. A Fellow of the American Meteorological Society (AMS), Dr. Christy was selected for (a) the AMS Special Award as

co-author of the first satellite-based global bulk-atmosphere temperature record and (b) NASA's Medal for Exceptional Scientific Achievement. He has served on panels of the National Research Council and National Academy of Sciences as well as the Earth Science Subcommittee of the NASA Advisory Council. He has been called to testify before 20 Congressional Hearings and approved as an expert witness in U.S. Federal Court on climate issues. He earned both the M.S. and PhD. Degrees in Atmospheric Sciences from the University of Illinois. Present research is funded by the State of Alabama, NASA and the Department of Energy.

Clasen, Thomas

Emory University

Thomas Clasen, an epidemiologist, is Professor of Environmental Health and Rose Salamone Gangarosa Chair of Sanitation and Safe Water at the Rollins School of Public Health, Emory University where he teaches courses on the critical appraisal of water, sanitation and hygiene research and on US environmental health law and policy. He has led more than $40 million in research on household-level environmental health interventions in low-income countries. His work has been published in leading journals, including The Lancet Global Health, The BMJ, PLOS Med, Environmental Health Perspectives, WHO Bulletin, Epidemiology, and the International Journal of Epidemiology. His research includes randomized controlled field trials to assess the health impact of water, sanitation and household air pollution interventions, systematic reviews of water quality and sanitation interventions to prevent diarrhoeal disease and enteric infection, assessments of water and sanitation interventions in emergency and outbreak response, and cost and cost-effectiveness analyses of water and sanitation interventions in developing countries. His current research includes a multi-country trial to assess the health impact of LPG stoves; a large-scale trial of a program provide water filters and improved cook stoves to lower income populations in Rwanda; a matched-cohort study to evaluate a rural water and sanitation programmes in Orissa, India; and an evaluation of a slum redevelopment intervention in Fiji and Indonesia. Prof. Clasen is the chief advisor to the World Health Organization in developing the first set of Guidelines for Sanitation and Health. Prof. Clasen holds an MSc (Control of Infectious Diseases) and PhD from the University of London; he also holds a JD (Law) from Georgetown University.

Clewell, Harvey

Ramboll Environment and Health

Dr. Harvey J. Clewell is a research scientist with over forty-five years of experience in environmental quality and toxicology research, chemical risk assessment and hazardous materials management. He is currently a Principal Consultant with Ramboll. He received a Master's Degree in Chemistry from Washington University, St. Louis, and a PhD in Toxicology from the University of Utrecht, the Netherlands. He is a Diplomate of the American Board of Toxicology and a Fellow of the Academy of Toxicological Sciences, and holds the position of Visiting Scientist at the University of Utrecht in the Netherlands. He has authored more than 200 peer-reviewed scientific publications and a number of book chapters. He has gained an international reputation for his work on the incorporation of mechanistic data and mode of action information into chemical risk assessments, having played a role in the first uses of physiologically based pharmacokinetic (PBPK) modeling in cancer and non-cancer assessments by EPA, ATSDR, OSHA, and FDA. Dr. Clewell has served on external peer review panels for a number of EPA guidelines, including those for cancer risk assessment, risk characterization, benchmark dose modeling, and dermal absorption, and has participated in chemical-specific reviews conducted by the EPA Scientific Advisory Board and the FIFRA Scientific Advisory Panel. He also served as a member of the ECVAM Scientific Advisory Panel from 2012 to 2016. Over the years he has performed research for a wide variety of clients, including the EPA, FDA, NIEHS, ATSDR, Health Canada, TCEQ, ACC, CEFIC, Pfizer, DuPont, Dow Corning, EPRI, NIPERA, Syngenta and Cosmetics Europe. In 2007 the Society of Toxicology recognized Dr. Clewell with the

Arnold J. Lehman Award for major contributions to chemical safety and risk assessment.

Cobb, Kim

Georgia Inst. of Technology

Dr. Cobb is the Georgia Power Chair and Professor in the School of Earth and Atmospheric Sciences (http://shadow.eas.gatech.edu/~kcobb/) and the Director of the Global Change Program (https://globalchange.gatech.edu) at Georgia Institute of Technology. She is also the ADVANCE Professor for diversity, equity, and inclusion in the College of Science at Georgia Tech. She is the founding Director of the Carbon Reduction Challenge (http://carbonreduction.gatech.edu), which partners students with organizations to reduce greenhouse gas emissions while saving money. She received her B.A. from Yale University in Biology and Geology in 1996, and her Ph.D. in Oceanography from the Scripps Institute of Oceanography in 2002. She spent two years as a Postdoctoral Fellow at Caltech before joining the faculty at Georgia Tech in 2004. She is Editor for Geophysical Research Letters, the flagship journal of the American Geophysical Union, serves on the international CLIVAR Pacific Panel, is Co-Chair of the US CLIVAR Working Group on Water Isotopes, and is a Lead Author for the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Dr. Cobb's research uses corals and cave stalagmites to probe the mechanisms of past, present, and future climate change, with a focus on ocean temperature extremes related to the El Niño-Southern Oscillation. She has sailed on multiple oceanographic cruises to the deep tropics and led caving expeditions in the remote rainforests in Borneo for her geochemical and climate research. In her lab at Georgia Tech, Dr. Cobb and her associates measure the geochemistry of rock samples and water samples from across the world, focusing on trace metal and isotope geochemistry, including radiometric dating techniques. More recently, her research has expanded to include the study of climate change impacts on coral reef ecosystems, as well as "smart" sea level sensor networks for coastal emergency planning and response – projects which have her leading and/or participating in large interdisciplinary research teams. Dr. Cobb received a NSF CAREER Award and a Presidential Early Career Award for Scientists and Engineers in recognition of her research accomplishments, and has received federal funding from NSF and NOAA in support of her research program.

Cohen, Steven

Columbia University

Dr. Cohen is the former Executive Director of Columbia University's Earth Institute, and now serves as a senior advisor for the Institute. He is a former policy analyst and consultant to the U.S. Environmental Protection Agency. Dr. Cohen has served on numerous boards and committees, including the Board of the Pew Faculty Fellowship in International Affairs, the Executive Committee and Committee on Accreditation and Peer Review of the National Association of Schools of Public Affairs and Administration, and the U.S. Environmental Protection Agency's Advisory Council on Environmental Policy and Technology. He currently serves on the Board of Directors of Homes for the Homeless, Board of Directors of the Willdan Group, Inc., Advisory Board of the University of Minnesota's Institute on the Environment, Steering Committee for the Porter School of Environmental Studies at Tel Aviv University. Dr. Cohen also serves on the Judging Committee for the Yidan Prize Foundation and is the Chair of the Lotos Club's Science and Technology Committee. Dr. Cohen is the author of The Sustainable City (2017), Understanding Environmental Policy (2006, 2014), Sustainability Management (2011), The Effective Public Manager (1988, now co-authored in its fifth edition), and the co-author of Sustainability Policy: Hastening the Transition to a Cleaner Economy (2015), The Responsible Contact Manager (2008), Strategic Planning in Environmental Regulation (2005), Tools for Innovators: Creative Strategies for Managing Public Sector Organizations (1998), and Total Quality Management in Government (1993). He has written numerous articles on public management, sustainability management, and environmental policy. Dr. Cohen also writes a weekly blog for the Earth Institute's State of the Planet website.

Cooper, Cal

Apache Corporation

Dr. Cal Cooper is Director of Special Projects and Emerging Technologies at Apache Corporation in Houston, TX. He earned his Ph.D. in Geology and Geophysics from Rice University and did his undergraduate in Geophysical Sciences at the University of Chicago. He has been an industry leader across broad areas of applied sciences. At Apache Corporation since 2009 he has led teams to enable the recycling and use of produced water instead of using fresh water resources for hydraulic fracturing. He has championed the use of inherently safer chemicals and funded innovative ways to produce highly reactive and useful chemicals on-site in processes that maximize safety and minimize risk to humans and eliminate any residual risk to freshwater resources. He has also researched the availability of groundwater resources, especially brackish water in west Texas. His active research includes advanced water treatment systems, innovative carbon based gas separation devices, developing tools for environmental remediation of salts and how to limit seismicity associated with underground injection. He evaluates methane detection and emissions quantification techniques. Dr. Cooper was among the first industry scientists to participate in EPA workshops on Hydraulic Fracturing. He also testified about proposed EPA studies of hydraulic fracturing to the U.S. House Committee on Space, Science and Technology. He played a pivotal role in the realization of FracFocus, the hydraulic fracturing chemical disclosure register, and acted as an advisor to the Groundwater Protection Council. Prior to joining Apache, Dr. Cooper was ConocoPhillips Corporate Science Fellow as well as Chief Geoscientist and Center Manager of Geosciences in the corporate technology organization. He served as the Vice Chairman of the Carbon Capture Project, and on the boards of several thematically related international projects. He has also served on advisory boards for scores of US university programs. Dr. Cooper has not received any funding from non-employer sources since Ph.D. completion.

Cruz-Rivera, Edwin

University of the Virgin Islands

Dr. Edwin Cruz-Rivera is an Associate Professor in the Department of Biological Sciences at the University of the Virgin Islands. He holds a B.S. in Industrial Microbiology from the University of Puerto Rico in Mayagüez and a Ph.D. in Marine Science from the University of North Carolina at Chapel Hill. He has over 20 years of experience in the fields of ecology and marine biology, and has published his research in some of the most prestigious journals in the field. Dr. Cruz-Rivera has been faculty in the USA, the Middle East and Asia before joining the University of the Virgin Islands in 2014. He has taught a variety of courses in ecology, marine biology, zoology, environmental sciences, marine biotechnology, research ethics and general science at both undergraduate and graduate levels. His research interests are in marine ecological and evolutionary processes at various levels of organization, ranging from individuals to ecosystems. His research spans chemical ecology, plant-herbivore/consumer-prey interactions, nutritional ecology, parasite ecology and taxonomy, and invasive species. He has worked in broadly diverse ecosystems, including the North Atlantic, the Chesapeake Bay, the Mediterranean Sea, the tropical Pacific, South Australia, the Red Sea, the Caribbean, brackish lakes in Egypt, and the South African intertidal. Before his academic career, he also served as Executive Director of a public-private partnership aimed at improving drinking water quality in Puerto Rico.

Cushing, Robert

Carollo Engineers, Inc

Dr. Robert Cushing is a Senior Vice President with Carollo Engineers, Inc. In his 21 years with the company, he has been at the forefront of applied research projects for water treatment and improved water quality, as well as studies, plans, designs, cost estimation, and construction of water and sewer infrastructure. Throughout his career, Dr. Cushing has coupled fundamental scientific concepts with

sound engineering practices to provide creative, innovative, and enduring solutions to water and wastewater challenges. Dr. Cushing has practiced nationally, providing service to a broad cross-section of some of the nation's largest and most visible utilities, including New York City and Washington, D.C. Yet he has also provided solutions to smaller agencies with critical and unique water quality challenges, such as the Ouray National Fish Hatchery in Utah. His background and expertise in water and wastewater quality and treatment as well as facility design, construction, and cost estimation, will bring unique and valuable perspectives and insights to the agency and SAB. Dr. Cushing holds a BS in Petroleum Engineering and MS and PhD degrees in Civil Engineering all from the University of Texas at Austin. He is a Registered Professional Engineer and is a Board Certified Environmental Engineer by the American Academy of Environmental Engineers. He has published numerous articles in the peer-reviewed literature and has served on numerous scientific and engineering committees. Dr. Cushing has received no research funding over the past two years.

Davidson, Eric

University of Maryland Center for Environmental Science

Eric A. Davidson is Director and Professor at the Appalachian Laboratory of the University of Maryland Center for Environmental Science. Previously, he was Senior Scientist, President, and Executive Director at the Woods Hole Research Center, Massachusetts. Davidson received a Ph.D. in forestry from North Carolina State University and held post-doctoral positions in soil microbiology and biogeochemistry at University of California-Berkeley and NASA Ames Research Center. He currently serves as President of the 60, 000-member American Geophysical Union and previously was President of its Biogeochemistry section. He is a Fellow of the American Association for the Advancement of Science. He served as the Coordinator of the North American Center for the International Nitrogen Initiative and was the leader of an NSF Research Coordination Network on Reactive Nitrogen in the Environment. The Institute for Scientific Information Clarivate Analytics lists him as a Highly Cited Researcher. Davidson studies the exchange of plant nutrients from land to streams and groundwater, soil carbon dynamics, and the exchange of greenhouse gases between soil and atmosphere. He has worked in forests, cattle pastures, and agricultural fields of Brazil, Central America, Canada, and the USA. Current USDA-funded research focuses on potential "pollution swapping" at an operational farm on the Delmarva Peninsula, where drainage control structures are a best management practice designed to reduce nitrate leaching to ditches, rivers, and the Chesapeake Bay, but could also increase emissions of the greenhouse gases, nitrous oxide and methane. Other recent funding sources include the National Science Foundation, National Park Service, and Maryland Sea Grant. Davidson collaborates on international synthesis projects regarding global budgets of nitrogen and nitrous oxide. Finally, he is co-leading a National Socio-Environmental Synthesis Center project to develop quantitative biophysical and socio-economic indicators of progress toward the Sustainable Development Goal 2 on alleviating hunger and promoting sustainable agriculture.

Davis, Alexander

Carnegie Mellon University

Dr. Alex Davis has worked as an Assistant Professor in the Department of Engineering and Public Policy at Carnegie Mellon University beginning in 2015 after working as a post-doctoral researcher and research scientist from 2012-2015. He has served as chair, co-chair, or committee member for the dissertations of 14 PhD students. His expertise is in individual human decision-making at the technological frontier, where members of the public must understand complex and often uncertain technical issues, then express their preferences for alternative courses of action that involve tradeoffs between cost, risk, and benefit. To do this, Dr. Davis draws on his background in Behavioral Decision Research, an interdisciplinary field that uses psychological and economic perspectives to understand decision-making. His research aims to aid decision-making using technology, risk communication, and interventions. He teaches a Ph.D-level course in data analysis, including the causal evaluation of

policy impacts on socio-economic outcomes, and a course Stochastic Discrete Choice Models focusing on characterizing individual preference based on foundational psychophysical and economic theory dating back to the early 1900's up to the modern era. Dr. Davis has published peer-reviewed articles in Nature Climate Change, the Proceedings of the National Academy of Sciences, Environmental Research Letters, Energy Policy, and the Journal of Experimental Psychology, among others. He earned a B.S. in Psychology with minors in Biology and Mathematics from Northern Arizona University, and an M.S. and Ph.D. from Carnegie Mellon University in Behavioral Decision Research. Dr. Davis' research has been funded by the Richard King Mellon Foundation, the Manufacturing Futures Initiative, the Hillman Foundation, the Center for Machine Learning and Health, the Electric Power Research Institute, and the Swedish Foundation for the Humanities and Social Sciences. He has served as an ad-hoc reviewer and panelist for the National Science Foundation and numerous peer-reviewed journals.

Dayaratna, Kevin

The Heritage Foundation

Kevin D. Dayaratna is Senior Statistician and Research Programmer in The Heritage Foundation's Center for Data Analysis (CDA). An applied statistician, Dayaratna has researched and published on the use of high-powered statistical models in public policy, medical outcomes, business, economics, and even professional sports. Dr. Dayaratna is part of the CDA team that maintains scores of databases and statistical models to support policy research; provides confidential reviews of legislation for members of Congress and the White House; and supplies data and analysis for news organizations. At CDA, Dayaratna instituted the Heritage Energy Model, derived from the Energy Information Administration's National Energy Modeling System, to help policymakers understand the long-term economic effects of energy policy proposals. He has also published extensively on integrated assessment modeling regarding the social cost of carbon, methane, and nitrous oxide. In addition to energy modeling, Dr. Dayaratna also works on statistical modeling pertaining to important climate, tax, labor, health care, welfare, and entitlement policy questions. Regarding energy and climate modeling, Dr. Dayaratna's research has been referenced by both the Obama and Trump administrations. In 2013, Dr. Dayaratna found a mistake in the Obama administration's social cost of carbon modeling, and shortly thereafter, this modeling had been opened up to public comment. In terms of the social cost of carbon and its use in policymaking, Dr. Dayaratna has published both at Heritage and in the peer-reviewed literature, given numerous talks, and has testified twice in front of Congress. Additionally, Dr. Dayaratna's work on energy policy modeling has been recently referenced by the Trump administration. Dayaratna did his undergraduate work at the University of California, Berkeley, majoring in applied mathematics. He also holds a Ph.D. in mathematical statistics as well as two masters' degrees from the University of Maryland, one in business and management and the other in mathematical statistics. Dr. Dayaratna's research has been done as part of his employment at The Heritage Foundation. The Heritage Foundation is a nonprofit 501(c)(3) organization which relies on the financial support of the general public, including individuals, foundations, and corporations. He has also done some independent contract work supported by Lam Research on big data computation.

Dhanasekaran, Danny

University of Oklahoma

Dr. Danny N. Dhanasekaran is the Deputy Director of Basic Cancer research at the Stephenson Cancer Center of the University of Oklahoma. He is also an Endowed Chair and Professor of Cell Biology at the University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma. He has been employed by the University since 2009 and has managed the cancer center's basic research activities and the infrastructure development for cancer research. Dr. Dhanasekaran serves as the Director of NIH-sponsored Center for Biomedical Research Excellence, a federal initiative to increase research infrastructure in Oklahoma. His tenure also includes his professorship at the Temple University

School of Medicine, Philadelphia from 1992 to 2009. Dr. Dhanasekaran has graduated with a M.S. in Molecular Biology and Ph.D. in Biochemistry. His research for the past twenty years has been funded by various Federal agencies including National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), Air Force Research Laboratory (AFRL), Department of Defense (DoD), and Defense Advanced Research Projects Agency (DARPA). He has a strong technical background and research interest in carcinogen identification, chemical and biological effects of carcinogens, their exposure toxicity, and kinetics. He has worked with several federal agencies such as Department of Defense, NASA, and DARPA in monitoring environmental toxicants and detecting water contaminants. Dr. Dhanasekaran has published more than 100 articles in the peer-reviewed literature, serves on numerous external scientific committees, and has provided invited presentations at National and International meetings. He is on the editorial board of several cancer research journals. He has extensive knowledge on federal regulatory and risk assessment issues related to cancer promoting carcinogens and toxicants. He has been granted two patents, one of which is on the detection of chemical toxicants. Dr. Dhanasekaran has been serving as a scientific and technical reviewer for several national and international research agencies. He also serves as an advisor for NIH intramural funding. In addition to participating in scientific meeting and conferences, he has conducted several media interviews.

Dinov, Ivo

University of Michigan

Professor Ivo Dinov is an expert in mathematical modeling, statistical analysis, computational processing, scientific visualization of large datasets (Big Data), and predictive health analytics. He directs the SOCR Resource, the MNORC Integrative Biostatistics and Informatics Core, and the Udall PD Biostatistics and Data Management Core. He co-directs the Center for Complexity and Self-management of Chronic Disease (CSCD Center) and the multi-institutional Probability Distributome Project. Dr. Dinov is an Associate Director for Education and Training, of the Michigan Institute for Data Science (MIDAS). He is a member of the American Statistical Association (ASA), the International Association for Statistical Education (IASE), the American Medical Informatics Association (AMIA), the American Association for the Advancement of Science (AAAS), as well as an Elected Member of the Institutional Statistical Institute (ISI). Dr. Dinov has published over 150 scientific articles in peer-reviewed journals and is the author of the textbook "Data Science and Predictive Analytics". He earned degrees in mathematics and statistics from Sofia University, Michigan Technological University, and Florida State University, and completed a postdoctoral training in computational neuroscience at the University of California, Los Angeles. His recent research is supported in part by the National Science Foundation, the National Institutes of Health, and the Elsie Andresen Fiske Research Fund.

DuPree, Gabriel

University of Florida

Mr. Gabriel Dupree received his Bachelor of Science in Natural Resource Conservation from the University of Florida, where he also completed post-baccalaureate graduate studies in Environmental Policy and Management in Ecological Engineering and was elected to the Student Government Senate. Mr. DuPree has over 13 years of experience in both the public and private sectors working on high profile environmental projects of local, regional, national, and global significance. Geographically, his career experience encompasses the high desert of the West Coast, the Piedmont and Atlantic Coastal Plain of the North and Southeast, prairies and agricultural areas of the Midwest, and subtropical dry forest of Puerto Rico. He worked on the world's largest solar and wind power projects, while also leading numerous environmental compliance field investigations in the nuclear, oil, and natural gas sectors. Mr. DuPree worked at the nation's largest Superfund sites to remediate hazardous waste contamination and at a wide range of military installations across the country,

demonstrating some of the most innovative and cost-effective geophysical and geospatial technologies. Highly skilled in environmental policy analysis, biological monitoring, endangered species assessments, environmental health, and water resources management, Mr. DuPree currently serves as a mayoral appointee on the City of Jacksonville's Environmental Protection Board, where he exercises regulatory authority, oversees the review of environmental permits and enforcement actions, promulgates regulations, and acts as a technical resource for management and staff of the city's Environmental Quality Division. While he is not currently accepting research funding, Mr. DuPree does consider funding requests from citizens that appear before the board. Previously, he served as Vice Chair of the Alachua County Commission's Environmental Protection Advisory Committee advising the County Commission on air quality, water resources and responsible management of public lands. In his spare time, Mr. DuPree enjoys giving back to his community through volunteering, philanthropy, and mentoring.

Embertson, Nichole M.

Whatcom Conservation District

Dr. Nichole Embertson is a Nutrient Management and Air Quality Specialist with the Whatcom Conservation District, adjunct at Washington State University, and Director of the Washington Discovery Farms program. She is also Chair of the Washington State Center for Technical Development working to improve the professional capacity of Conservation District employees. She received her B.S. from Cal Poly, San Luis Obispo, M.S. from University of California at Davis, and Ph.D. from Colorado State University in Animal Science with specialties in Environmental Management of Livestock Systems and Air Quality. Dr. Embertson currently provides technical assistance on nutrient and environmental issues to farmers, agencies and industry professionals alike. She also conducts applied research focused on finding integrated solutions to nutrient management and resource conservation challenges, as well as development of decision support tools such as her innovative manure application risk management system including a real-time manure advisory and on-line nutrient management planning resources for producers. Her goal through Discovery Farms Washington is to help producers discover new and better land management practices for protection of environmental resources. Her projects have been funded by the Washington State Department of Agriculture, Washington State Department of Health, Washington State Conservation Commission, Natural Resource Conservation Service (NRCS), and Environmental Protection Agency (EPA). Her vision, communication style and unique experience makes her very effective in developing useful materials for producers, as well as providing science based input into policy and programing. Dr. Embertson shares her knowledge and expertise through participation on national science panels for USDA-NRCS and the EPA, and in a leadership role for the Livestock and Poultry Environmental Learning Center. She has been awarded both the Northwest and Washington State Conservation District Employee of the year award, NRCS Partnership Award, and Washington State Dairy Federation President's Appreciation Award for her outstanding work and partnership efforts.

Enstrom, James E.

Scientific Integrity Institute

Dr. James E. Enstrom is a retired Research Professor/Researcher from the School of Public Health and Jonsson Comprehensive Cancer Center at the University of California, Los Angeles. He is President of the Scientific Integrity Institute in Los Angeles. He received his BS in physics from Harvey Mudd College, an MS and PhD in elementary particle physics from Stanford University, and a MPH and postdoctoral certificate in epidemiology from UCLA. Dr. Enstrom has authored, primarily as first or sole author, about 50 peer-reviewed articles and book chapters on physics, epidemiology, and scientific integrity. He has received research funding from many sources, including NIH, ACS, UC, private foundations, industry sources, and personal donations. He has received no funding recently, but is still conducting original epidemiologic research by using personal assets in innovative and cost-

effective ways. He has taught graduate classes on environmental health science. He has given numerous lectures on epidemiology and ethics. He has published important articles relating good health practices to reduced mortality and recently has shown that fine particulate matter (PM2.5) is not related to total mortality in the ACS Cancer Prevention Study cohorts (CPS I and CPS II). He is the only independent scientist to obtain and analyze original CPS cohort data. His research shows that the EPA PM2.5 NAAQS is scientifically unjustified and must undergo complete and objective reassessment. His Scientific Integrity Institute website contains thousands of documents on air pollution epidemiology, lifestyle epidemiology, scientific integrity, and critiques of regulations, many of which contain his own research and analysis. He understands air pollution health effects research from the perspectives of both physics and epidemiology and maintains the highest level of integrity. He is a Life Member of the American Physical Society, a Founding Fellow of the American College of Epidemiology, and a current member of the ACE Ethics Committee. In 2015 he received the Heroes of Conscience Award from the American Freedom Alliance in Los Angeles.

Felter, Susan P.

Procter & Gamble

Dr. Susan Felter is a Research Fellow in Procter & Gamble's Central Product Safety organization. She holds a B.S. in Biology from the Massachusetts Institute of Technology and a Ph.D. in Toxicology from the University of Cincinnati. Dr. Felter's primary professional interest is in methods for human health risk assessment. In her Corporate role at P&G, she leads several global teams responsible for the company's methods for human health risk assessment, providing guidance across all geographies and business sectors. She serves on a number of U.S. and European trade association task forces. Prior to joining P&G, Dr. Felter worked for TERA (Toxicology Excellence for Risk Assessment), a nonprofit science organization in Cincinnati, and the U.S. Environmental Protection Agency (Office of Research and Development) where she received the U.S. EPA Bronze Medal for her work in developing the scientific basis to support drinking water regulations for human health. Dr. Felter previously served on the Science Advisory Board of the Food and Drug Administration's National Center for Toxicological Research. She also currently serves on the Science Advisory Board for the Toxicology Forum. She has served as a peer reviewer for the World Health Organization and the National Toxicology Program. Dr. Felter has been a member of the Society of Toxicology since 1996, and has served in elected positions as Secretary-Treasurer of the Risk Assessment Specialty Section, as well as Councilor of the Ohio Chapter of the Society for Risk Analysis. Dr. Felter receives no outside research funding.

Ferry, John

University of South Carolina

Dr. John Ferry has extensive experience in environmental chemistry, including reactive oxygen species, photolysis, advanced oxidation, degradation/transformation of chemicals in the environment, cyanobacterial (algal) toxins, and analytical measurement of environmental contaminants. He has taught environmental chemistry for many years at the University of South Carolina and is one of the most knowledgeable people I have ever met in environmental chemistry. He understands atmospheric chemistry and water chemistry and is very knowledgeable regarding chemical properties. John has served on a STAR Grant review panel several years ago, and is interested in serving on the SAB. He would make an excellent member of the regular SAB or the Chemical Assessment Advisory Committee.

Fike, David

Washington University

Prof. Fike is the InCEES Professor of Biogeochemistry in the Department of Earth & Planetary Sciences at Washington University in St. Louis, where he additionally heads the Environmental

Studies Program and is the Associate Director of the International Center for Energy, Environment, and Sustainability (InCEES). He obtained B.S. degrees from University of Illinois at Urbana-Champaign in engineering physics, astronomy, and geology, respectively. He obtained a Master's of Philosophy in polar studies from Churchill College, Cambridge University in 2002 and a Ph.D. in geochemistry in 2007 from the Massachusetts Institute of Technology. Subsequently, he was as an O.K. Earl postdoctoral fellow at the California Institute of Technology in 2007–2008, before joining the faculty at Washington University in 2009. His current research interests focus on isotope biogeochemistry, particularly understanding the biological, sedimentological, and diagenetic processes that generate and alter isotopic signatures in mineral and organic phases. Metabolic activity imparts diagnostic stable isotopic signatures into biomass and geochemical phases in the environment and preserved in the geologic record. Broadly speaking, his research uses the stable isotopic signatures of carbon and sulfur species to reconstruct the presence and activity of specific metabolic pathways and processes in natural environments. Specifically, he uses these measurements to probe (micro)biological activity and its dependence on the ambient geochemical environment to address: 1) what controls the rates and types of metabolic activity in the environment; 2) how this activity impacts the ambient geochemical environment; 3) how the resulting chemical signatures get preserved over geologic time; and 4) how to extract information from ancient sediments to best reconstruct paleoenvironmental conditions. Prof. Fike's specific approach involves combining diverse measurements collected across a range of spatial and temporal scales to maximize our understanding of organism-environment interactions in natural systems.

Fournier, Aime

MIT

Dr. Fournier obtained a Physics PhD from Yale and has researched for over 15 years, applying physics, statistics, signal processing, high-performance computing and other disciplines to study complex phenomena in geophysics. These study topics include: global climate and numerical methodology (NCAR Climate Division); turbulence (Institute for Mathematics Applied to Geosciences); and uncertainty quantification (UQ) in weather forecasting (NCAR Meteorology Division). As a Senior Research Geophysicist at Schlumberger, he worked with a team of engineers, geologists, geophysicists and managers on various oil & gas exploration contracts. He learned to listen to clients' concerns and effectively connect those concerns with research & development e.g., how to communicate about UQ, and translate UQ into decision guidance. He has served on advisory committees for the National Research Council, NCAR, the National Science Foundation, Schlumberger, the UK Met Office and Yale, been an Associate Editor for the journal Geophysics and a manuscript referee for numerous journals. Since 2015 he holds 2 positions: Research Associate Professor at University of Colorado Denver Department of Mathematical and Statistical Sciences, teaching upper level courses, advising PhD students and researching UQ in wildfire, weather and atmospheric chemistry models (funded by the US Forest Service); and Principal Investigator at MIT Earth Resources Laboratory, leading a small project on carbon sequestration and monitoring, and 2 large projects, on offshore drilling risk assessment, and on deep neural-network learning. All MIT projects are funded by oil & gas industrial sponsors.

Francis, Larijai

City of Corpus Christi

Lj Francis is the City Project Manager for Water Resources at the City of Corpus Christi. In this current role he is responsible for developing and managing projects to address water issues including projected water demands, water supply availability, water use assessments, watershed management plans, and drought contingency serving as the technical expert on water resources projects. He is the City's representative and board member for both the Groundwater Management Area (GMA) 15 and 16, and is the City Liaison/Administrator at Corpus Christi Aquifer Storage and Recovery

Conservation District (CCASRCD). Lj also participates in several stakeholder groups that engage on Water Supply Management and Protection in the Coastal Bend Region. Lj graduated from the University of South Florida's Civil and Environmental Engineering program – accelerated Masters with a concentration in Water Resources Engineering in 2014, currently expecting his PhD in Environmental Engineering at Texas A&M University and Co-Principal Investigator at National Oceanic and Atmospheric Administration.

Frazer, Thomas

University of Florida

Thomas K. Frazer is a Professor and the Director of the School of Natural Resources and Environment at the University of Florida. Dr. Frazer holds a Bachelor's Degree in Fisheries Biology from Humboldt State University and a Master's Degree in Fisheries and Aquatic Sciences from the University of Florida. He earned his Ph.D. in Biological Sciences from the University of California, Santa Barbara. His research addresses contemporary and emerging environmental issues, and is, by nature, interdisciplinary. His work involves collaborators from disparate disciplines, and it includes sampling and experiments conducted across a wide range of spatial and temporal scales. During his tenure at the University of Florida, Dr. Frazer has received substantial research funding to address topics pertaining to water quantity and quality, nutrient dynamics, biogeochemical processes, fish population dynamics, food web interactions, and ecological restoration of degraded ecosystems. Funding sources (past two years only) include the National Science Foundation and St. Johns River Water Management District. He has conducted field research in both freshwater and marine systems around the globe, and he is familiar with a broad suite of environmental and natural resource issues (e.g., eutrophication of fresh, estuarine, and coastal waters; invasive species; and the ecological impacts of contemporary environmental change, including coral bleaching, ocean acidification, and sea level rise). Dr. Frazer has authored and/or co-authored more than 175 peer-reviewed publications, technical reports, and book chapters. He serves as Chief Specialty Editor for the Coral Reef Research section of Frontiers in Marine Science, and he regularly serves as a referee for leading international journals and granting organizations. Dr. Frazer currently holds an at-large seat on the Gulf of Mexico Fisheries Management Council. He is a member of APLU's Board on Oceans, Atmosphere and Climate, and a past member of the US EPA's Oil Spill Research Strategy Review Panel.

Fry, Juliane

Reed College

Dr. Juliane L. Fry is associate professor and department chair of Chemistry at Reed College, as well as a founding faculty member of the College's interdisciplinary Environmental Studies program. Dr. Fry obtained a BS in chemistry from the University of Rochester, a PhD in atmospheric chemistry from the California Institute of Technology, and completed post-doctoral training in atmospheric chemistry at the University of California – Berkeley. She holds a Master's degree in environmental, natural resources and energy law from Lewis and Clark Law School. Dr. Fry teaches general, analytical, and environmental chemistry, and an interdisciplinary course on climate change. Dr. Fry's scientific research program is focused on interactions between anthropogenic air pollution and climate change, in particular via the role of nitrogen oxides in chemical mechanisms of particulate matter production; her interdisciplinary scholarship focuses on regulation of secondary pollutants and the role of science in climate litigation. She has been funded by the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), and the Camille and Henry Dreyfus Foundation, and has authored over 40 peer-reviewed papers and over 80 oral and poster presentations. Dr. Fry is a member of the American Chemical Society and American Geophysical Union, has served on the American Meteorological Society Committee on Atmospheric Chemistry and the Urban Ecology Research Consortium Steering Committee, convened panels for the Association for Environmental Studies and Sciences, and served as a proposal reviewer and panelist for NOAA, the

National Science Foundation, and the Pacific Northwest National Laboratory Environmental and Molecular Sciences Lab. Dr. Fry received an Advanced Study Program Faculty Fellowship from the National Center for Atmospheric Research in 2011, an EPA Early Career Award in 2013, a Fulbright U.S. Scholar Award to the Netherlands in 2016, and the Henry Dreyfus Teacher-Scholar Award in 2017.

Furtado, Manohar

Apton Biosystems Inc.

Currently working to develop a super resolution based sequencing system that will decrease NGS costs by 100-fold. System is also enabled for single molecule multi-omic applications. Areas of domain expertise include research and product development in Oncology, Infectious diseases, and Genetics. Areas of market driven product expertise with food safety, environmental testing, bioproduction safety, animal health, human health, Human identification / CSI, diagnostics and safety. PhD in protein chemistry, post-doc training in molecular virology, PI and on the faculty at Northwestern University. Vice President, Molecular Medicine & Applied Markets at ABI and Life Technology.

Gala, William

Chevron Energy Technology Company

Dr. Gala has worked for Chevron for almost 30 years providing technical support and expert advice to Chevron facilities world-wide on matters related to ecological risk assessment, contaminated sediments, and oil spill response. Dr. Gala was recognized as a Chevron Fellow in 2017 in the field of ecological risk assessment. Dr. Gala has provided technical support for numerous ecological risk assessments and site investigations for Chevron facilities, including agricultural chemical plants, marine and pipeline terminals, production facilities and refineries. Dr. Gala's experience at Chevron has afforded him the opportunity to work on a wide variety of contaminated media (e.g., soil, ground water, surface water, sediments), COPCs (e.g., PAHs, metals, chlorinated pesticides, petroleum products and crude oil) and ecological receptors (aquatic life, benthic community, terrestrial and aquatic wildlife). Dr. Gala received his Ph.D. in Environmental Toxicology and Fisheries and Wildlife from Michigan State University. He was previously involved is collaborative research projects with USGS and Stanford University in areas of passive sampling and in situ treatment of sediment contamination. Recent research efforts have focused on bioavailability of metals in sediments working in collaboration with U Texas and Texas Tech University. He has not received external research funding in the last two years – recent effort is solely funded by internal (Chevron) dollars and was previously appointed to Gulf of Mexico Fisheries Management Council Artificial Substrate Panel and currently serve of the Advisory Board for the California Oiled Wildlife Care Network. He is a long-standing member of the Society of Environmental Toxicology and was involved in several annual meetings organizing committees

Gibbs, Shawn

University of Nebraska Medical Center

Shawn Gibbs is an Associate Professor with the University of Nebraska Medical Center's Department of Environmental, Agricultural & Occupational Health in the College of Public Health. He also serves as the College of Public Health's Director of Masters Programs where he oversees all MS, MPH, and certificate programs. Shawn received a B.S. (1997) in Biology from The Ohio State University, and both a M.S. (2000) and Ph.D. (2002) from the University of Cincinnati in Environmental Science, Water Quality Processes Science. Shawn was a US Fulbright Scholar to Egypt in 2006. He became a Certified Industrial Hygienist (CIH) in 2009. His previous work experience includes three years as a contract Biologist/Toxicologist for the USEPA working on environmental water quality programs. For five years, he was an Assistant Professor at the University of Texas Houston School of Public Health

where his research included water quality and quantity issues along the US-Mexico border, including issues associated with confined animal feeding operations. His research area is environmental exposure assessment, focusing on environmental microbiology. Primary research interests are on environmental bioaerosols (bacterial, antibiotic resistant bacteria, fungal, viral) from both the indoor and ambient environments, and water exposures. This includes source evaluation, source tracking, and methods to reduce exposure. This includes source evaluation, source tracking, and methods to reduce exposure. Shawn is the author of over three dozen peer reviewed articles. He has served as a reviewer for over a dozen peer reviewed journals and has served as grant reviewer for multiple organizations including the USEPA and Fulbright Commission. Shawn has been an author in over three dozen peer review publications. His currently funded projects include the areas of infection control and Water Reuse.

Goldman, Gretchen

Union of Concerned Scientists

Dr. Gretchen T. Goldman has expertise in air pollution exposure science, environmental engineering systems, meteorology, and environmental policy. She received a Ph.D. and M.S. in environmental engineering from the Georgia Institute of Technology and a B.S. in atmospheric science from Cornell University. Her research focused on statistical modeling of urban air pollution for use in epidemiologic studies of acute human health effects. Specifically, Dr. Goldman used geostatistical models to characterize measurement error from air pollution monitoring sites in order to assess the impact of this error on health risk assessments in time-series health studies. Following a postdoctoral research position at Georgia Tech, Dr. Goldman is now the Research Director of the Center for Science and Democracy at the Union of Concerned Scientists. Her work here focuses on a range of issues within science policy studies. She researches how decision making is informed by scientific research and the influences that affect science policy development and implementation. Her areas of study have included the National Ambient Air Quality Standards (NAAQS), scientific integrity at federal agencies, climate change policy, and hydraulic fracturing, among other topics. Dr. Goldman currently serves as the Chair of the Air and Climate Public Advisory Committee (ACPAC) for the Metropolitan Washington Council of Governments (MWCOG), the metropolitan planning organization for the Washington, D.C. region. Dr. Goldman continues to stay active in the academic community, through conferences, publications, and presentations.

Goltz, Mark

Independent Consultant

Dr. Mark N. Goltz is Distinguished Professor Emeritus of Environmental Engineering and Management at the Air Force Institute of Technology. He holds a B.S. in Electrical Engineering from Cornell University, an M.S. in Sanitary Engineering from the University of California, Berkeley, and a Ph.D. in Environmental Engineering and Science, Stanford University. Since 1982 Dr. Goltz has been studying the fate, transport, and remediation of contaminants in groundwater. His research interests include groundwater contamination remediation technologies, fate and transport of organic contaminants in the subsurface, stimulating commercialization of environmental remediation technologies, mathematical modeling of contaminant transport by groundwater, in situ bioremediation of chlorinated organic compounds in the subsurface, scaling-up from the laboratory to the field, physical and chemical water and wastewater treatment technologies, and environmental modeling. His work has included conducting and modeling field demonstrations of innovative contaminated groundwater treatment technologies, as well as investigation of methods to effectively transfer these technologies to commercial use. He recently has conducted research on the application of nanomaterials to remediate contaminated groundwater. Dr. Goltz developed a graduate program in environmental engineering for U.S Air Force officers, and taught in the program for over 20 years. He has consulted on numerous Air Force water pollution problems, and has a unique perspective, due to

his background in both academia and the military. Dr. Goltz is currently conducting a research project funded by the Defense Department's Environmental Security Technology Certification Program. Dr. Goltz is a Registered Professional Engineer in the State of Minnesota and is a Board Certified Environmental Engineer in the American Academy of Environmental Engineers and Scientists. He was a member of the Science Advisory Committee for EPA's Midwest/Great Lakes Hazardous Substance Research Center and currently serves as an environmental engineering program evaluator for the Accreditation Board for Engineering and Technology.

Gordon, Terry

New York University School of Medicine

Dr. Terry Gordon holds the rank of Professor of Environmental Medicine at the New York University (NYU) School of Medicine. He holds a B.S. in Physiology, an M.S. in Toxicology from the University of Michigan, and a Ph.D. in Toxicology from MIT, and was appointed to the faculty of the Department of Environmental Medicine in 1989. He has served as an ad hoc member of grant review panels and/or site visit teams for NIEHS, NIAID, National Coalition for Cancer Research, DOD, Bureau of Mines, NASA, Health Canada, NIOSH/CDC, and the EPA. Dr. Gordon is past Chair of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) committee, a volunteer organization that publishes occupational exposure levels that are used as workplace safety guidelines throughout the world. Dr. Gordon's broad research interest is in inhalation toxicology. The major focus of his research lab is the identification and understanding of the role of genetic host factors in the pathogenesis of the adverse pulmonary effects produced by inhaled environmental and occupational agents. Because inter-individual responses to inhaled particles and gases vary so greatly in both human subjects and test animals, Dr. Gordon has hypothesized that genetic susceptibility factors play a major role in environmental and occupational lung disease. In collaboration with a number of investigators in the department, his laboratory uses classic murine genetics models, computational genomics, and DNA microarrays to identify genes involved in the acute response as well as in the development of tolerance to repeated exposure to inhaled toxicants. Dr. Gordon also plays a major role in the particulate matter (PM) research program at NYU, and was among the first researchers to use concentrator technology to study the adverse cardiopulmonary effects of ambient PM. Dr. Gordon is an active member of the Society of Toxicology (SOT), and has served on the Program, Placement, Membership, and Awards Committees and as President of its Inhalation Specialty Section. He has served as a consultant/author to the EPA on issues of pulmonary toxicology related to the development of various documents, and served on EPA's Clean Air Scientific Advisory Committee (CASAC) Oxides of Nitrogen (NOx) and Sulfur Oxides (SOx) Primary National Ambient Air Quality Standards (NAAQS) Review Panels and is a current member of the PM ad hoc CASAC. Dr. Gordon's current research, supported by NHLBI and NIEHS grants, examines the adverse health effects of environmental and occupational air pollutants, including secondhand smoke from e-cigarettes and hookahs. He is also the Director of NYU's NIEHS-supported Training Grant in Environmental Toxicology.

Graham, Wendy

University of Florida

Dr. Wendy D. Graham is the Carl S. Swisher Eminent Scholar in Water Resources in the Department of Agricultural and Biological Engineering and Director of the Water Institute at the University of Florida, Gainesville. She has a B.S. in environmental engineering from the University of Florida, and a Ph.D. in Civil and Environmental Engineering from the Massachusetts Institute of Technology. Her current research focuses on integrated hydrologic modeling; groundwater resources evaluation and remediation; evaluation of impacts of agricultural production on surface and groundwater quality; evaluation of impacts of climate variability and climate change on hydrologic systems; and stochastic modeling and data assimilation. She has served as principal investigator or co-Principal Investigator

on over $25 million in grants and contracts, has supervised 30 doctoral and master's thesis committees, and has served on more than 60 additional graduate student committees. Dr. Graham served as the Hydrologic Sciences Program Director for the National Science Foundation in 2015-2016, and is currently a member of the National Academy of Sciences Water Science and Technology Board. She served as Chair of the University of Florida Agricultural and Biological Engineering Department from 2003-2006. In her current role as Director of the University of Florida Water Institute she coordinates campus-wide interdisciplinary research, education and outreach programs designed to develop and share new knowledge, and to develop and encourage the implementation of new technology and policy solutions needed to ensure a sustainable water future. In the last two years Dr. Graham has received research funding from: the St Johns River Water Management District, Florida Senate Committee on Environmental Preservation and Conservation, Florida Department of Agriculture and Consumer Services, National Science Foundation, U.S. Department of Agricultural National Institute of Food and Agriculture, Tampa Bay Water, and the North Carolina State University-Department of the Interior Southeast Climate Science Center.

Greenfield, Jeffrey

Florida International University

Dr. Greenfield is an Adjunct Professor in the Civil & Environmental Engineering Dept. at Florida International University (FIU). He is a registered Professional Engineer in several states, a Board Certified Environmental Engineer and a Diplomate Water Resources Engineer. He has been teaching Sr. Environmental Engineering Design, Fluid Mechanics, and Engineering Ethics. In the fall, he will be teaching a combined undergraduate/graduate course on Bioremediation Engineering and will also serve as interim faculty advisor for FIU's Engineers Without Borders (EWB). His fulltime job is a Project Manager in the Engineering Division with Broward County Water & Wastewater Services. He currently is managing a $53M wastewater reclaimed project and several potable water projects which include 1M, 1.5M, and 5 MG ground storage tanks, high service pump stations, standby generators, and new disinfection systems. His professional engineering society leadership positions include former vice chair of the NSPE Licensure & Qualifications Committee, formerly vice chair of the NSPE Committee on Policy & Advocacy, corresponding member of the American Society of Civil Engineers (ASCE) Committee on Licensure, member of the ASCE Committee on Ethical Practice (CEP), member of the NCEEES Environmental Engineering PE Exam Committee for more than 18 years, chair of the American Academy of Environmental Engineers and Scientists Water and Wastewater Subcommittee, past president and state director of the Broward Branch of the Florida Engineering Society, and member and former chair of the Florida Atlantic University Department Advisor Committee for the Department of Civil, Environmental, & Geomatics Engineering. Dr. Greenfield is also a long-time member of the Florida Engineering Society (FES) Committee on Environmental Quality. He has received local and state awards for his engineering society volunteering efforts as well as an adjunct teaching award. He has demonstrated leadership skills for many of the engineering societies of which he has been active including NSPE, FES, AAEES, and ABET.

Griffin, Michael

Carnegie Mellon University

Dr. Griffin is Research Professor Emeritus of Engineering and Public Policy at Carnegie Mellon University (CMU). He has had a long and distinguished career working on a variety of issues in the oil and chemical industries and conducting academic research in the areas of sustainability, life cycle assessment, and ecological and environmental impact assessment. At CMU along with his faculty appointment, he was the Executive Director of the Center for Climate, Energy and Decision Making, Co-Director and Executive Director of the Green Design Institute and had a joint faculty appointment in the Tepper School of Business. Prior to joining the university, he held multiple positions at British

Petroleum, where he directed a microbiology technical service and research group that provided water treatment and corrosion mitigation solutions for the business and developed microbial-based methods to produce biodegradable chemicals and polymers. He later joined Sybron Chemicals as Director of Research where his group provided support for production and bioremediation efforts. He was the Director of Research at the National Environmental Technology Application Corporation and developed methods for evaluating oil spill response tools and products and technical evaluations of various environmental technologies for business and government. Dr. Griffin has published over 70 articles and book chapters of which 50 are in peer-reviewed journals. His current research, with collaboration of colleagues and students at CMU, centers on the analysis of the environmental impacts of energy infrastructure needed to address climate impacts, modeling N2O production in hypoxic events, determining potential impacts of adopting renewable alternative fuels, and addressing uncertainty in life cycle assessment. His has a BS and MS in Biology from the University of Dayton and a PhD in Microbiology from the University of Rhode Island. Research funding for the last 2 years was provided NSF and the CMU-Portugal Program.

Grimalt, Joan

Institute of Environmental Assessment and Water Research (IDAEA)

Dr. Joan O. Grimalt is the director of the geochemistry and pollution group of the Institute of Environmental Assessment and Water Research (IDAEA) from the Spanish Council for Scientific Research (CSIC) in Barcelona. For more than 30 years he has studied organic molecules in the environment to obtain information on the evolution of ecosystems and the impact of organic pollutants in air, water, sediments, soils, organisms and humans in urban and rural areas, rivers, mountains, lakes and marine environments. He has been director of IDAEA for ten years. He has been assessing on environmental pollution management in Catalonia, Spain, France, the United Nations (Geneva), Kuwait and US Research Projects. One outcome of these activities involved the removal of about 750, 000 tons of industrial residues dumped into the Ebro River. He has also been assessing on climate change effects for the Spanish Ministry of Environment and the Spanish Parliament. His expertise in these diverse environmental topics may be useful for the EPA Scientific Advisory Board. He has a lot of experience in communication of environmental topics in tv, radio, and direct talks with the general audience. He earned a BS in chemical engineering from the Sarria Chemical Institute (Barcelona) and a PhD in environmental chemistry from the Autonomous University of Barcelona. He performed postdoctoral research stages in the Oregon State University and the University of Bristol. He has published 680 scientific papers quoted more than 20, 500 times in the scientific literature. H index = 73. He has supervised 47 PhD thesis and 70 master theses to completion. His research for the past two years was funded by the European Union, the Arctic Monitoring and Assessment Program, the Barcelona Health Agency and the Spanish Ministry of Research and Education. He has not received grant funding from EPA. He is not US citizen.

Grimm, Nancy

Arizona State University

Dr. Nancy B. Grimm is Virginia M. Ullman Professor of Ecology and Senior Sustainability Scientist at Arizona State University, where she earned her Ph.D. in 1985. She has held visiting or adjunct appointments at the Center for Advanced Studies in Blanes, Spain, Kellogg Biological Station, National Center for Ecological Analysis and Synthesis, and the University of New Mexico. She was President and is a fellow of the Ecological Society of America (ESA), is a fellow of the American Association for the Advancement of Science and the American Geophysical Union (AGU), and was lead author for the Third National Climate Assessment (NCA). She has served as an NSF program director, a staff scientist for the NCA, and as editor or associate editor for numerous journals; currently, she is an editor of AGU's Earth's Future. International and national advisory board service includes Margalef Prize Selection Committee, the National Research Council's (NRC) Standing

Committee to Advise the US Global Change Research Program, the NRC Standing Committee on Hydrological Sciences, and the Advisory Committee for the Australian CRC for Water Sensitive Cities, among many others. Grimm studies the interaction of climate variation and change, human activities, and ecosystems. Her long-term research focuses on how disturbances (such as flooding or drying) affect the structure and processes of desert streams, how chemical elements move through and cycle within both desert streams and cities, and how storm water infrastructure affects water and material movement across an urban landscape. She was the founding director of the Central Arizona-Phoenix LTER program, an interdisciplinary study by ecologists, engineers, physical and social scientists, and she currently co-directs the Urban Resilience to Extremes Sustainability Research Network. In the latter capacity, she works to help cities develop future visions and strategies to increase resilience in the face of extreme events. Grimm has authored or co-authored over 200 scientific publications and delivered over 100 invited or keynote presentations. Her Google Scholar h-index is 72, with her 2008 Science paper, Global Change and the Ecology of Cities, cited over 3000 times.

Groover, Richard

Reynolds Community College

Dr. Richard Groover has a doctorate in Environmental Science & Public Policy from George Mason University. He is the author of The Environmental Almanac of Virginia, 2nd edition. He is a fellow of the Virginia Academy of Science. He is the treasurer of the Association for Environmental Studies and Science. He is on the Board of Trustees of the Science Museum of Virginia. He was a member of the Governor of Virginia's Climate Commission (2014-2015). He has authored numerous journal articles on ecology and related topics. He is actively researching in the area of aquatic ecology and animal behavior.

Guckenheimer, John

Cornell University

John Guckenheimer retired as Bullis Professor of Mathematics at Cornell University in 2017, where he also served terms as Director of the Center for Applied Mathematics, as Associate Dean of Computing and Information Sciences and Director of Research Programs for the Theory Center. His research investigates nonlinear dynamical systems. This subject unifies phenomena in disparate disciplines by discovering common mathematical foundations. It provides methods used in the study of complex systems. Within mathematics, Guckenheimer has made substantial advances in describing bifurcations – dynamical changes that occur as system parameters are varied – especially within systems that have multiple time scales. As applications, Guckenheimer has investigated recently the unpredictability of El Niño in the tropical Pacific and inferred a controller for human running from motion capture data. Earlier, he used tools from the theory to analyze nonlinear dynamics within the nervous system. He co-chaired a National Research Council committee that produced the 2016 report "Analytic Research Foundations for the Next-Generation Electric Grid." Guckenheimer served as President of the Society for Industrial and Applied Mathematics during 1997-98, was founding chair of its Activity Group in the Life Sciences, and was awarded its Jürgen Moser prize. He was also awarded the American Mathematical Society Steele Prize for mathematical exposition with Philip Holmes for authoring the 1983 book "Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields," that has become a basic reference for the field. Prior to moving to Cornell in 1985, he was a professor at the University of California, Santa Cruz, where he led a California wide effort to create organized research units for nonlinear science. He received a BA from Harvard College and a PhD from the University of California at Berkeley.

Haas, Charles

Drexel University

Dr. Charles N. Haas is the L.D. Betz Professor of Environmental Engineering and head of the Department of Civil, Architectural and Environmental Engineering, at Drexel University, where he has been since 1991. He received his B.S. (Biology) and M.S. (Environmental Engineering) from the Illinois Institute of Technology and his Ph.D. in Environmental Engineering from the University of Illinois at Urbana-Champaign. He has served on the faculties of Rensselaer Polytechnic Institute and the Illinois Institute of Technology prior to joining Drexel. He co-directed the U.S. EPA/Department of Homeland Security University Cooperative Center of Excellence – Center for Advancing Microbial Risk Assessment (CAMRA). He is a fellow of the International Water Association, American Academy for the Advancement of Science, the Society for Risk Analysis, the American Society of Civil Engineers the American Academy of Microbiology and the Association of Environmental Engineering and Science Professors. He is a Board Certified Environmental Engineering Member by eminence of the American Academy of Environmental Engineers. He has received the Dr. John Leal Award and the AP Black Research Award of the American Water Works Association, the distinguished achievement award from the Society of Risk Analysis. and the Clarke Water Prize. Over his career, Professor Haas has specialized in the assessment of risk from and control of human exposure to pathogenic microorganisms, and in particular the treatment of water and wastewater to minimize microbial risk to human health. He has over 225 papers, has recent and current funding from National Science Foundation, U.S. EPA, the Water Environment Research Foundation, and industry. Professor Haas has served on numerous panels of the National Research Council. He is a past member of the Water Science and Technology Board of the National Academies, and the U.S. EPA Board of Scientific Counselors. His primary work focuses on assessment of risk from and control of microorganisms in water, wastes and other environments.

Halloran, Kent

Ohio State University

Mr. Kent Halloran has worked for over 30 years in the field of storm water, potable water, wastewater engineering design and construction. He has also worked as a design and construction engineer in the areas of airport drainage, food processing waste treatment and other industries. He is currently serving as the Ohio State University's water compliance engineer and as an adjunct faculty professor in the Civil, Environmental, and Geodetic Engineering Department. In the past, he has served as the deputy program manager for the City of Fort Wayne's Combined Sewer Capacity Improvement Program and as Interim Program Manager for the City's lift station and storm water programs. He also served as the town engineer for several communities and has promoted the concepts of sustainability throughout his career. He is also pioneering the use of natural systems, such as constructed wetlands, and the conversion of retention basins using native wetland plants to improve storm water retention, increase pollutant removal, and provide pollinator and wetland habitat. He earned a Bachelor of Science in Civil Engineering from The Ohio State University and a Masters of Engineering in Environmental Systems Engineering from Clemson University. He is currently a licensed Professional Engineer in the States of Ohio and Idaho and a Board Certified Environmental Engineer through the American Academy of Environmental Engineers and Scientists. He has also served as a volunteer and Board member for the Friends of the Lower Olentangy Watershed.

Happer, William

Princeton University

Dr. William Happer, Professor Emeritus in the Department of Physics at Princeton University, is a specialist in modern optics, optical and radiofrequency spectroscopy of atoms and molecules, radiation propagation in the atmosphere, and spin-polarized atoms and nuclei. He is also noted for

work in climate-related physics. Dr. Happer received a B.S. degree in Physics from the University of North Carolina in 1960 and the PhD degree in Physics from Princeton University in 1964. He began his academic career in 1964 at Columbia University as a member of the research and teaching staff of the Physics Department. While serving as a Professor of Physics he also served as Co-Director of the Columbia Radiation Laboratory from 1971 to 1976, and Director from 1976 to 1979. In 1980 he joined the faculty at Princeton University. On August 5, 1991 he was appointed Director of Energy Research in the Department of Energy by President George Bush. While serving in that capacity under Secretary of Energy James Watkins, he oversaw a basic research budget of some $3 billion, which included much of the federal funding for high energy and nuclear physics, materials science, magnetic confinement fusion, environmental and climate science, the human genome project, and other areas. He remained at the DOE until May 31, 1993 to help the Clinton Administration during the transition period. He was reappointed Professor of Physics at Princeton University on June 1, 1993, and named Eugene Higgens Professor of Physics and Chair of the University Research Board from 1995 to 2005. From 2003 until his retirement in 2014, he held the Cyrus Fogg Brackett Chair of Physics. From 1987 to 1990 he served as Chairman of the Steering Committee of JASON, a group of scientists and engineers who advise agencies of the Federal Government on matters of defense, intelligence, energy policy and other technical problems. He was a trustee of the MITRE Corporation from 1993 to 2011, he is the Chair of the Board of the Richard Lounsbery Foundation, and he is the President of the CO2 Coalition. From 2002 to 2006 he chaired of the National Research Council's Standing Committee on Improvised Explosive Devices that supported the Joint Improvised Explosive Devices Defeat Organization of the Department of Defense. He was a co-founder in 1994 of Magnetic Imaging Technologies Incorporated (MITI), a small company specializing in the use of laser polarized noble gases for magnetic resonance imaging. He invented the sodium guidestar that is used in astronomical adaptive optics to correct for the degrading effects of atmospheric turbulence. He has published over 200 peer-reviewed scientific papers. He is a Fellow of the American Physical Society, the American Association for the Advancement of Science, and a member of the American Academy of Arts and Sciences, the National Academy of Sciences and the American Philosophical Society. He was awarded an Alfred P. Sloan Fellowship in 1966, an Alexander von Humboldt Award in 1976, the 1997 Broida Prize and the 1999 Davisson-Germer Prize of the American Physical Society, and the Thomas Alva Edison Patent Award in 2000.

Hargiss, Christina

North Dakota State University

Dr. Christina Hargiss is an Assistant Professor at North Dakota (ND) State University in the Natural Resources Management Program. She holds degrees in Natural Resource Management and Science Education. Dr. Hargiss has been conducting research on wetlands and water quality for the past 20 years. During that time her research interests have expanded to also include water use, impacts of energy development on natural resources, environmental education, and urban ecology. Additionally, she is an established expert on environmental law and policy, and the connections between agriculture and natural resources. Recent projects investigated by Dr. Hargiss include assessing change in reference condition wetlands over time, impacts of road dust from energy development on natural resources, potential use of oil-well produced brine as a dust abatement technique, and impacts of brine on clay road binders. Water quality research has focused on source tracking *E. coli* spatially and temporally in stormwater, water quality changes across a gradient of development, evaluating stormwater retention basins water quality during storm events, and assessing harmful algal bacteria. Water use research includes assessing commercial and industrial water use temporally and spatially to determine changes and per capita coefficients across different size municipalities. Funding sources for these projects include the US Geological Survey, US Fish and Wildlife Service, ND State Water Commission, City of Fargo, EPA, ND Department of Health, and ND Soybean Council. Dr. Hargiss currently serves as the President-Elect of the Society of Wetland Scientists North Central Chapter, the

Vice-President of the Board of Directors of River Keepers, a regional non-profit, and on the advisory committee for the ND Envirothon. She is also a member of the National Science Teachers Association, North American Association of Environmental Educators, the Wildlife Society, and regularly reviews manuscripts for several journals including Wetlands, Ecological Indicators, Environmental Monitoring and Assessment, and Aquatic Biology.

Hayes, Stanley

Ramboll Environ

Mr. Stan Hayes has more than 40 years of experience in air-related environmental engineering and science for NAAQS- and air toxics-related purposes, with emphasis on air modeling analysis and health risk assessment. He has an MS degree in Aeronautics & Astronautics and a BS degree in Mechanical Engineering, both from Stanford University. Mr. Hayes is the primary author of more than 70 scientific papers and presentations, and several hundred technical reports on air-related subjects. He is a member of the EPA Science Advisory Board Risk and Technology Review (RTR) Methods Panel. He is a Fellow of the Air & Waste Management Association, for whom he has chaired or co-chaired national and international specialty conferences. He is chair of the Advisory Council of the Bay Area Air Quality Management District, which provides science-based counsel to the Board of Directors, the Executive Officer, and other senior staff. He has provided expert testimony before federal, state and local regulatory agencies and in court. For 25 years, until 2015, Mr. Hayes was a Principal with Ramboll (previously ENVIRON). He is now emeritus, with no regular salary, EPA or other grants, benefits, or firm ownership interest. Over his career, Mr. Hayes has conducted research consulting on NAAQS- and air toxics-related topics for a broad range of private- and public-sector clients, including trade associations (e.g., API and others), individual companies, law firms, and regulatory agencies (e.g., EPA and others). Relevant to the work of CASAC, he has conducted NAAQS-related air quality modeling studies, health risk assessments, exposure analyses, control strategy analyses, nonattainment area plan evaluations, air monitoring data analyses, and regulatory and policy reviews.

Helble, Joseph

Dartmouth College

Joseph J. Helble is Professor and Dean of the Thayer School of Engineering at Dartmouth College. Prior to joining Dartmouth as Dean in 2005, he served as a faculty member and Chair of the Department of Chemical Engineering at the University of Connecticut (UConn), and was also a member of the UConn Environmental Engineering faculty. His research is primarily in the area of air pollution, with specific activities and interests in combustion-derived particulate matter formation and control, mercury, trace metal and air toxics air pollutants, air quality modeling, ambient particulate matter structure, carbon dioxide capture, and particle coalescence. He also initiated a program to produce biodiesel fuel from waste vegetable oil on the UConn campus. Dr. Helble is the author of 100 publications, primarily in the air pollution field, and is a member of the editorial board of the journals Fuel Processing Technology and Environmental Engineering Science. From 2004-2005, Dr. Helble was the holder of the Revelle Fellowship in Global Stewardship from the American Association for the Advancement of Science (AAAS). As the Revelle Fellow, he spent a year working on environmental and technology policy issues in the office of U.S. Senator J. Lieberman. Prior to joining the UConn faculty in 1995, Dr. Helble spent 8 years at Physical Sciences Inc., a small business specializing in environmental and energy technology research and development. He also spent a fellowship period at U.S. EPA headquarters in Washington D.C as a science and policy fellow of AAAS, and received the Barnard Award from AAAS for his work on dioxin as an EPA Fellow in 1993. Dr. Helble is active in the American Association of Aerosol Science, the American Chemical Society, where he is currently Program Chair of the Fuel Chemistry Division for the 2007 national ACS meetings, the American Society for Engineering Education (ASEE), and the science policy

fellowship program of AAAS. He has served on EPA Science Advisory Board panels on air toxics and the first draft report on the environment, and on numerous NSF advisory and review panels in environmental engineering and in combustion. He recently served on the NSF Committee of Visitors (COV) reviewing the combustion program within the NSF Engineering Directorate. Dr. Helble is an elected member of the Connecticut Academy of Science and Engineering. He is a 1982 summa cum laude B.S. graduate of Lehigh University in chemical engineering, and a 1987 chemical engineering Ph.D. graduate of the Massachusetts Institute of Technology.

Henshaw, Jessie

HDS systems design science

Jessie Lydia Henshaw is a research natural systems scientist in New York consulting on patterns of general emerging systems ecology; or more simply, cultures that "blow up" or "take off." Her work began with college physics labs asking why every run of experiments somewhat misbehaves, leading later to her general study of the individuality in emerging systems. At St Lawrence she concentrated on physics and math, Russian studies and arts then took math courses at Stoney Brook and Columbia before turning to architecture at the University of Pennsylvania. There she minored in landscape and presented theses on sustainable town design and microclimates, winning a class medal for structures. After school, she made a portable lab for studying the microclimates of homes, noticing as a general pattern the initial growth period of convection currents was when their systems for releasing energy developed. Work on theory and methods followed mostly at night over 25 years as a New York architect. Her public service work includes comment on hazardous waste storage site placement, restoring a 1890s Opera House as a rural arts center, leading a federal survey of shelters for government in the event of conflict. Her proposals include models for naturally responsive market systems as UN Sustainable Development Goals, suggesting a practical scientific method for giving all decision makers information on their share of the global the impacts of their decisions, a bit ahead of its time but still current. She served two years on a UNEP-FI/WRI technical advisory group, consulting on CO2 risk guidance for the financial industry. Her writings address: whole system accounting; why it is healthy cultures have healthy economies; the organizational limits of economies; the strong coupling of GDP, energy, and CO2; growing societal strains of growing disruptive change; and related subjects.

Hoel, David G.

Medical University of South Carolina

Dr. David G. Hoel is a Distinguished University Professor in the College of Medicine at the Medical University of South Carolina in Charleston. He received an A.B. in both mathematics and statistics from University of California at Berkeley, a Ph.D. in mathematical statistics from University of North Carolina in Chapel Hill and was a post-doctoral fellow in preventive medicine at Stanford University. Prior to joining the Medical University of South Carolina he was Division Director for Risk Assessment at National Institute of Health's (NIH) Institute National Institute of Environmental Health Sciences (NIEHS) in N.C. Dr. Hoel is a Fellow of the American Association for the Advancement of Science (AAAS), a member of the National Academy of Medicine and a National Associate of the National Academies. His awards include the Spiegleman Gold Medal in Public Health and the Ramazzini Award in Environmental and Occupational Health. He has served on 30 National Academy committees and also numerous governmental committees including the Environmental Health Committee and Radiation Advisory Committee of EPA's Science Advisory Board. Specifically, on radiation he was a member of the BEIR V committee of the National Academy of Sciences and the World Health Organization's International Agency for Research on Cancer (IARC)'s cancer monograph committee 100D on radiation and also he was a contributing member of the United Nation's UNSCEAR 2008 report on radiation health effects. Dr. Hoel's research has focused on risk assessment methods with particular interest in low-dose radiation exposures and

cancer. This work has resulted in stays for several years in Hiroshima as a Director at the Radiation Effects Research Foundation (RERF) and recently a RERF Scientific Counselor. Dr. Hoel does not currently have any research grants although previously he has had grant support from both the Department of Energy and from the National Aeronautics and Space Administration (NASA).

Hoffman, Mark

Children's Mercy Hospital, University of Missouri Kansas City

Dr. Mark Hoffman serves as the Chief Research Information officer for Children's Mercy Hospital and as a faculty member of the University of Missouri - Kansas City School of Medicine in the Departments of Pediatrics and Biomedical and Health Informatics. He earned his Ph.D. in Bacteriology from the University of Wisconsin with a minor in Biotechnology and completed an industry internship with a bioinformatics company, DNASTAR. During his 16 years in the electronic health records industry (Cerner) he led initiatives in public health infectious disease surveillance, molecular diagnostics, clinical decision support and the development and application of major (65 million patients) de-identified clinical data warehouse populated by Electronic Health Record (EHR) data. His interdisciplinary background in software engineering and the biological sciences helped him function effectively as the Vice President for Genomics and Research, a group of more than 120 individuals. Dr. Hoffman is an inventor on 17 issued U.S. patents and 3 issued international patents. In his current role at Children's Mercy, Dr. Hoffman is responsible for the development of the software platforms and high-performance computing resources used by the Children's Mercy Genome Center. He works closely with the Children's Mercy Center for Environmental Health and in his personal research is using the de-identified EHR database to investigate health services and epidemiological aspects of lead exposure on a national level. He has delivered a TEDx presentation, "The Envirome: Where Precision Medicine Meets Public Health". Dr. Hoffman has served on multiple federal advisory groups, including the HHS Secretary's Advisory Committee on Genetics, Health and Society task force on the oversight of Genetic Testing (2007) and the CDC sponsored Evaluating Genomic Applications in Practice and Prevention (EGAPP) stakeholders group. Dr. Hoffman is the PI on a CDC funded project to use clinical data warehouses in support of laboratory quality improvement. He has served on the Board of Directors for the Center for Practical Bioethics and other non-profit organizations. His diverse experience in microbiology, data science, engineering, environmental and public health, health sciences, pediatrics and genomics would enable him to contribute to the variety of topics evaluated by the EPA Scientific Advisory Board. His business experience has prepared him to seek consensus and practical solutions to complex problems.

Hood, Darryl

The Ohio State University

Dr. Darryl B. Hood is a nationally recognized expert in the area of Neurotoxicology, particularly with respect to the effects of environmental toxicants on the developing fetus and subsequent effects on learning, memory and behavior. He graduated from Johnson C. Smith University with a B.S. (cum laude) in Biology and Chemistry. He matriculated at Quillen College of Medicine of East Tennessee State University earning a Ph.D. in Biochemistry. Dr. Hood completed postdoctoral training in Biophysics and Molecular Toxicology as a National Science Foundation E.E. Just fellow in the Center in Molecular Toxicology at Vanderbilt University School of Medicine in Nashville, TN. Following his 4-year postdoctoral fellowship, he accepted a faculty position at Meharry Medical College. He recently joined the faculty of the College of Public Health at OSU from Meharry Medical College where he interrogated hypotheses on the mechanisms governing neurotoxicity of environmental chemicals for nearly two decades. Seminal work conducted in his laboratory demonstrated for the first time, the functional impact of in utero exposure to benzo(a)pyrene on later-life behavioral phenotypes mediated by maturing glutamatergic cortical circuits. From his work, the field has learned that postnatal brain development requires input from the environment in order to induce the release of

glutamate and thereby promote critical aspects of synaptic maturation. Dr. Hood is a member of the Environmental Protection Agency's National Environmental Justice Advisory Committee (NEJAC) working group which recently recommended that a reassessment of ambient levels of polycyclic aromatic hydrocarbon emissions from smokestacks be conducted. Once implemented, public policy changes such as this will serve to decrease the adverse health effects associated with environmental exposures in susceptible populations.

Hu, Zhiqiang

University of Missouri

Zhiqiang (Zack) Hu is Professor and Chair of the Department of Civil and Environmental Engineering at the University of Missouri-Columbia. He received his M.S. and Ph.D. degrees at the University of Connecticut and completed his postdoctoral training at Cornell University. He is a registered professional engineer in environmental engineering. Dr. Hu's areas of expertise and research activities include wastewater treatment and biological nutrient removal, environmental nanotechnology and biotechnology, wetlands, algae treatment and water reuse, biofilm formation and control, pathogen detection and removal, emerging renewable energy issues, anaerobic digestion, anaerobic membrane bioreactors, bioreactor landfills, microbial electrolysis systems and bioelectrochemistry, and integrated biochemical and physicochemical treatment. Dr. Hu serve as an EPA Food Quality Protection Act (FQPA) Science Review Board Member, an ad hoc member of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel, US EPA, from 2009 to 2015. He is currently a member of the Advisory Committee, Nano-Micro Conference 2018. He also serves as an academic editor of PLOS ONE, an Associate Editor of Water Environment Research and an ASCE Journal of Hazardous, Toxic, and Radioactive Waste.

Hufford, Walter R.

Talisman Energy USA Inc. - REPSOL

Mr. Walter R. Hufford is the Director of U.S. Government & Regulatory Affairs for Talisman Energy USA Inc., a part of the Repsol Group. He holds a B.S. in Earth Sciences - Geology from Middle Tennessee State University, an M.S. in Geology from Texas A&M University, and a Masters in Management – Business Administration from Pennsylvania State University. Mr. Hufford has 32 years of experience in the energy industry, working with environmental issues associated with both legacy and current operations. He provides internal technical and regulatory support in his company's North America exploration and production operations, and serves on committees with trade organizations at the regional and national level. He has been integral to internal company activities relating to drilling and completions. Mr. Hufford participates on industry and state regulatory committees that address new legislation and rulemaking including oil and gas provisions. Mr. Hufford serves as a corporate advisor regarding hydraulic fracturing, gas migration and stray gas matters. Additionally, Mr. Hufford is a member of the graduate faculty at Texas A&M University as a Professor of Practice teaching graduate level seminar courses. He sits on the board of directors for STRONGER (State Review of Oil, Natural Gas, Environmental Regulations) and has served as a board member with the Pennsylvania Environmental Council and the Pennsylvania Resource Council. His prior experience includes management of multimillion dollar environmental liabilities including nuclear fabrication and disposal sites; chemical plants; petrochemical facilities; manufacturing locations; and refinery projects with complex environmental and liability issues. He has successfully closed hundreds of environmentally-impacted sites regulated at the federal and state level throughout the United States. He served in a leadership role during the 2010 Macondo Deep Water Horizon gulf response, coordinating and advising as a company liaison with the U.S. Coast Guard, EPA, Departments of Homeland Security & Interior, U.S. Fish and Wildlife Service, as well as multiple state regulatory agencies. He also served as a spokesperson for BP's community outreach effort, conducting town hall meetings for residents and elected officials along the Gulf Coast. Mr. Hufford

was selected to present at the EPA 2011 workshops dealing with hydraulic fracturing. Mr. Hufford has received no external research grants from either government agencies, private companies, or foundations during his tenure with Talisman or BP.

Humphreys, James

ABB

I am the North American Product Specialist for the ABB Lewisburg W. Virginia Factory. Currently manufacture Process Gas Chromatographs, Reid Vapor Pressure Analyzers, And MultiWave Photometers IR and UV. I specialize in ensuring customers are compliant with EPA regulations as well as state in local regulations based on technologies available.

Hurtt, George

University of Maryland, College Park

Professor Hurtt received his Ph.D from Princeton University in 1997. From 1998-2010, Dr. Hurtt worked at the University of New Hampshire in the Institute for the Study of Earth Oceans and Space and Department of Natural Resources, finally becoming Chair of the Natural Resources and Earth System Science Ph.D. Program, UNH's largest doctoral program, and Director the Complex Systems Research Center, UNH's main center focused on Earth System Science. In 2010, Dr. Hurtt joined the University of Maryland Department of Geography as Professor & Research Director, and in 2011 he was named Associate Director of the Joint Global Change Research Institute, and Associate Director of Research Innovations at the National Socio-Environmental Synthesis Center (SESYNC). Dr. Hurtt is involved in multiple collaborative research projects including the North American Carbon Program, NASA's Vegetation Structure Working Group, NASA's Carbon Monitoring System, and DOE's Integrated Earth System Modeling project. He previously led the international effort on global land-use harmonization for CMIP5 in preparation for the IPCC 5th assessment, and a NASA interdisciplinary science investigation focused on the role of natural disturbances on the Earth's coupled carbon-climate-human system. He is currently co-chair of the Land Use Model Intercomparison Project (LUMIP) for CMIP6, Science Team Leader for the NASA Carbon Monitoring System, Science Team Member for the NASA-GEDI mission, Associate Editor of Global Biogeochemical Cycles, Guest Editor for Environmental Research Letters, and Contributing Faculty Member to the Global Change Ecology section of Faculty of 1000. He is Chair of the University Research Council, Member of the University Environment Work Group, and leads the UMD/NASA-GSFC Joint Global Carbon Cycle Center.

Jacobsen, Grant

University of Oregon

Dr. Grant Jacobsen is an associate professor at the University of Oregon and the Director of the Master of Public Administration Program. He received an M.A. and Ph.D. in Economics from the University of California-Santa Barbara, where he was a fellow in the National Science Foundation's Economics and Environmental Science IGERT program. His research focuses on the use of applied empirical techniques to evaluate and inform the design of environmental policies. His work has addressed topics related to renewable energy, energy efficiency, air pollution, extraction of natural gas and oil, carbon offsets, climate change awareness, and voluntary environmental protection. He has published articles in leading academic journals, including the Economic Journal, the Review of Economics and Statistics, and the Journal of Public Economics. He is a member of the editorial council of the Journal of Environmental Economics and Management. He has served as a program reviewer for the U.S. Department of Energy and as an adviser to the Eugene Water & Electric Board. Dr. Jacobsen's research has been supported by the W.E. Upjohn Institute for Employment Research.

Juturu, Vijaya

OmniActive Health Technologies Inc.

Dr. Juturu has a doctoral degree in Clinical Nutrition (Cardiovascular Nutrition) from S.V. University in India (1996) and completed her postdoctoral research in Cardiovascular Nutrition at Penn State University (1997-2000). Dr. Juturu is currently working as Director of Clinical Affairs at OmniActive Health Technologies Inc. Her research focuses on the effects of bioactive nutrients on established and emerging risk factors for cardiometabolic syndrome, vision health and inflammation. Her research integrates clinical and basic research including nutrigenomics to evaluate underlying molecular mechanisms of action in disease and health. She conducts preclinical (basic) efficacy, toxicology studies for safety and controlled clinical studies designed to evaluate the role of bioactive nutrients on risk factors in health and disease. These studies have evaluated established and emerging risk factors in health and disease. Dr. Juturu is also as a consultant for consumer research companies and she is an adjunct faculty. She was a consultant and worked for Ocean Spray Cranberries as cardiovascular scientist, Senior Scientist and then as Director of Scientific Affairs at Nutrition 21, Inc., Avon Products, Inc, Unilever cosmetics, United Soybean Board/QUALISOY and the Natural Standard of Integrative Medicine and Cochrane Research Group. Dr. Juturu was the recipient of the Dr. Tinsley R. Harrison Award in 2008 from The Society of Clinical Investigation (SSCI) and the American Journal of Medical Sciences; Dr. Mark Bieber Distinguished Industry Scientist Award in 2008 from the American College of Nutrition; the Young Scientist Award given by the Indian Society of Atherosclerosis Research in 1995; and the Indian Medical Scientist Award in Nutritional Sciences, given by the Indian Council of Medical Research in 1997. She received the Diabetes Education Stipend Award in 2005 and the Diabetes Care Education and Professional Excellence Award in 2007 from the Nutrition in Complementary Care Dietetic Practice Groups of the American Dietetic Association (ADA). She received best communicator award ribbon twice from the Association of Research in Vision and Ophthalmology (ARVO). In addition, she received research and presentation awards from other organizations. Dr. Juturu is the author of several publications including book chapters, patents, and submissions of qualified health claims. She is an invited author, invited speaker, reviewer, council/committee member, and editorial board member for several reputed journals. She was nominated to Board of Editors for three years 2019-2022, Academy of Nutrition and Dietetics. She was nominated as Research and Development Chair for the Medical Nutrition Practice Group of ADA, nominated to HOD/PID research and development, and is working as an Evidence Analysis Library analyst/committee member for Academy of Nutrition and Dietetics, and is involved in a women's working group committee of the American Diabetes Association. Dr. Juturu is a member of numerous professional organizations including the Academy of Nutrition and Dietetics, American Heart Association, American Diabetes Association, ARVO, American Society for Nutritional Sciences, American College of Nutrition, and the American Oil Chemists Society. She is a Fellow of the Academy of Nutrition and Dietetics (FAND) and the American College of Nutrition (FACN.).

Keating, Christopher

Austin Community College

Dr. Christopher F. Keating has an M.S. and the Ph.D. in physics from the University of Texas at Dallas and is currently an adjunct professor of physics at Austin Community College. He has previously served as a professor of physics at the U.S. Coast Guard Academy and the U.S. Naval Academy. His area of research is in planetary geophysics, providing him with an in-depth understanding of a broad range of topics affecting planetary environments. He is a member of the American Geophysical Union (AGU). His work has been published in several peer-reviewed scientific publications and presented at scientific conferences. He has recently been working with ranchers and farmers in the central-Texas area in an effort to be better informed of the issues and problems they face on a daily basis. He has long been engaged in public outreach, speaking at public events,

conducting media interviews, and has authored non-fiction books on science topics for the general public. He personally funds all of his research activities himself and does not receive any financial considerations from any government or industrial organization for his scientific work. In addition to his academic career, Dr. Keating served in the U.S. Navy and Naval Reserve, retiring from the latter in 2012 after 35 years of combined service. His military duties included supervising production teams and service as an in-depth analyst, producing reports that were briefed to all levels of the government. He served on numerous boards, committees, and flag staffs providing scientific and technical expertise for a variety of projects.

Kersting, Annie

Lawrence Livermore National Laboratory

Dr. Annie Kersting is Director of University Relations and Science Education at the Laurence Livermore National Laboratory (LLNL). She holds a B.S. in Geology and Geophysics from the University of California, Berkeley, and an M.S. and Ph.D. in Geology and Geophysics from the University of Michigan. Dr. Kersting previously served as the Director of the Glenn T. Seaborg Institute in the Physical and Life Sciences Directorate, where she focused together with her deputies, Ian Hutcheon and Dawn Shaughessy, on collaborative research between LLNL and the academic community in nuclear forensics, super heavy element discovery and environmental radiochemistry. Dr. Kersting's research interests include the fields of radiochemistry, isotope geochemistry, and environmental chemistry. Her current research focuses on the geochemical mechanisms that control actinide transport in the soil and groundwater, and on identifying the dominant bio-geo-chemical processes and the underlying mechanisms that control actinide (U, Pu, Np, Am) transport. In particular, she is interested in understanding how nanoparticles facilitate transport of contaminants in both the saturated and unsaturated environment. Dr. Kersting was a Board member of the Nuclear and Radiation Studies Board, National Research Council 2010-2012, and a Committee member on the National Academy Sciences National Research Council, Nuclear and Radiation Studies Board Committee from 2006-2007. She served on the Environmental Management Sciences Program Review Panel of the U.S. Department of Energy's Office of Science in 2006, and served as a scientific advisor on the Actinide Migration Committee for Rocky Flats from 2000-2003. Her current research funding comes from the Department of Energy's Office of Science, Biological & Environmental Research. As University of Relations Director, she reports to the Director of Science & Technology in the Director's office.

Khubchandani, Jagdish

Ball State University

Dr. Jagdish Khubchandani is a Professor of Community Health at Ball State University. He also serves as an ad-hoc Biostatistician for the College of Health and has previously served as a fellow of Center for International Development and Global Health Institute at Ball State University. He received his Doctorate in Clinical Medicine from India, Masters in Public Health from Western Kentucky University, and PhD in Health Education and Epidemiology from University of Toledo. Currently, he teaches in the areas of environmental health, global health, social epidemiology, and public health education in community and clinical settings. Within the past decade, he has mentored over 100 students pursuing undergraduate and graduate degrees in the field of public health, nursing, or medicine. In the past 5 years, he has coauthored more than 75 research articles in prestigious journals such as the Lancet, Journal of American Medical Association, and the New England Journal of Medicine on a broad range of issues including morbidity and mortality associated with environmental health problems. Within the past 2 years, Dr. Khubchandani has received research funding from Merck Neuroscience Laboratories and Ball State University Foundation. Previously, he has also mentored racial/ethnic minority students on NSF and NIDDK funded projects. More recently, his research has received widespread attention from prominent media outlets such as Fox News, CNN,

CNBC, MSN, Bloomberg News, Chicago Tribune, WSJ, and Huffington Post. Dr. Khubchandani also serves as an Associate Editor or Editorial Board Member for six journals in the field of public health and biomedical sciences. In 2017, he was also elected Director of the World Association of Medical Editors. Dr. Khubchandani has received many prestigious honors such as the Indiana Governor's Service Learning Award (2012), Hurley Goodall Distinguished Faculty Award (2012), Hero of Health Education (2012) and Open Society Award (2017) from Society for Public Health Education, Outstanding Junior Faculty Award (2014) and Outstanding Diversity Researcher (2017) from Ball State University.

Kieft, Jeffrey

University of Colorado

Dr. Jeffrey Kieft is a tenured Professor and Vice Chair of the Dept. of Biochemistry and Molecular Genetics at the University of Colorado School of Medicine, and Director of the University of Colorado School of Medicine Structural Biology and Biophysics Core Facilities. Dr. Kieft earned his B.S. in Chemistry at West Point, served as a U.S. Army officer, earned a Ph.D. in Chemistry from the University of California Berkeley, then conducted several years of post-doctoral research at Yale University. From 2001-2002, Dr. Kieft was the Roger Revelle/AAAS Fellow in Global Stewardship in the White House Office of Science and Technology Policy (OSTP). There, his portfolio included global climate change, ocean issues, gulf coast hypoxia/eutrophication, green chemistry, container and shipping security, vetting new security technologies, and anthrax spore mitigation. Within OSTP, Dr. Kieft was responsible for preparing congressional testimony, researching and drafting "white papers," chairing or serving on various interagency working groups, traveling to represent the White House in diverse forums, reviewing and analyzing scientific reports, and preparing scientific summaries to aid decision makers. Dr. Kieft then joined the faculty of University of Colorado School of Medicine. His research program focuses on virology, RNA biochemistry, biophysics, and structural biology. In 2009-2016, he received an Early Career Scientist Award from the Howard Hughes Medical Institute (HHMI), given to the top 50 promising biomedical researchers in the nation. He is a Fellow of the American Society of Microbiology, recognizing him as one of the premier scientists in that field. In addition, Dr. Kieft maintains interest in a broad range of scientific topics and in science policy beyond his own research. He is not currently serving on any national advisory committees. His current and recent research funding is from the National Institutes of Health. Professor and Vice Chair

Kinney, Patrick

Boston University School of Public Health

Dr. Kinney has a broad background in environmental health sciences, with specific training and expertise in air pollution exposure assessment, epidemiology, and climate change. He completed his doctoral studies in Environmental Science and Physiology at the Harvard School of Public Health in 1986. As a junior faculty member at New York University, he developed and led epidemiologic research on lung function and inflammatory biomarker changes in relation to chronic exposures to ozone and other air pollutants. Moving to Columbia in 1994, he expanded his research to include community-based studies of traffic pollutant exposures and health outcomes in underprivileged neighborhoods in New York City, leading and contributing to several large-scale studies over the following 22 years. He has contributed to the periodic reviews of the National Ambient Air Quality Standards for ozone and particulate matter, and served on the EPA Clean Air Scientific Advisory Committee for reviews of the Nitrogen Dioxide and Sulfur Dioxide standards. He developed and directed the Climate and Health Program at Columbia, which trains students and postdocs in research on the health dimensions of climate variability and change. He also directed research on indoor and outdoor air quality and health in Africa, including a randomized stove trial in Ghana funded by NIEHS. Current funding sources include the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration. In January 2017, Dr. Kinney was named the

inaugural Beverly A Brown Professor of Urban Health at Boston University.

Klein, Levente

IBM T. J. Watson Research Center

Dr. Levente Klein is a Research Staff Member in the Internet of Things and Industry Solution at the IBM T.J. Watson Research Center, Yorktown Heights, NY. His work at IBM span multiple research topics from material science, nano-optics and wireless sensing solutions with strong focus to apply research technologies to industrial problems. Levente obtain a PHD in Physics from University and Utah and since joining IBM Research in 2006, he developed technologies to enable energy efficient cooling in data centers, monitoring fugitive methane gas in oil and gas industry, and application of wireless sensing solution in agriculture and healthcare. Current research interests focus on environmental monitoring of greenhouse gases, application of wireless sensing in outdoor environment and physics based modeling and analytics. His work was recognized by 3 IBM's Outstanding Technical Achievement award and multiple IBM Research Division Award.

Koziel, Jacek

Iowa State University

Professor Jacek Koziel is a nationally and internationally recognized expert with multidisciplinary knowledge and experience in the following disciplines: air quality, community odor, atmospheric sciences, livestock agriculture, environmental science, analytical chemistry, complex systems on the nexus of food, energy and water; toxicology; benefit-cost analysis; sustainability; chemical safety; green chemistry; and waste management. His work (over 120 articles) was cited more than 2, 500 times (h index = 30, Web of Science). He earned awards for peer-review of more than 175 manuscripts in 65 journals. He has been serving on editorial boards for three journals including Atmosphere, International Journal of Environmental Research and Public Health, and AgriEngineering. Dr. Koziel's work has been featured in Nature, Scientific American, National Geographic, Smithsonian, The Economist, and on the History Channel. He has served as peer-reviewer and panelist for international science funding programs. He earned Ph.D. in Civil Engineering, M.S. degrees in Mechanical Engineering and Environmental Quality Engineering. He is serving at Fulbright Association (Iowa Chapter) and is a member of the American Association for the Advancement of Science, Sigma Xi, American Society of Agricultural and Biological Engineers, and the International Society of Animal Hygiene.

Krantz, William

University of Colorado at Boulder

I received a B.A. (1961) in chemistry from Saint Joseph's College, B.S. (1962) in chemical engineering from the University of Illinois, and a Ph.D. (1968) in chemical engineering from the University of California. I am a licensed Professional Engineer. I have held faculty positions at the University of Colorado, University of Notre Dame, University of Cincinnati, National University of Singapore and Nanyang Technological University (Singapore). I also have worked at Chevron Research and Development (CalTex) and the 3M Company. I presently am serving as a consultant to the Singapore Membrane Technology Center in the area of water desalination and wastewater treatment. I am the author or co-author of 265 technical papers and two recent books, and am co-inventor on 19 patents. I have worked in a broad spectrum of areas spanning several disciplines including chemical, mechanical, civil and environmental engineering, geophysics, and chemistry. I have consulted for several companies as well as the National Institute of Standards and Technology, National Science Foundation, U.S. Air Force, and U.S. Department of Energy.

Kronenberg, Amy

Lawrence Berkeley National Laboratory

Dr. Amy Kronenberg is a Staff Biophysicist at the Lawrence Berkeley National Laboratory. Her research interests include radiation biology, cancer biology, charged particle radiation biophysics and mutagenesis. She has conducted extensive research on molecular mechanisms of mutagenesis and aspects of genomic instability. She is a Council Member of the National Council on Radiation Protection and Measurements (NCRP). Dr. Kronenberg is very active in national and international professional societies and institutions. She is currently a Senior Editor for the journal Radiation Research and is also a member of the editorial board of the Journal of Radiation Research (Japan). She was an invited speaker at a symposium on radiation carcinogenesis at the Radiation Effects Research Foundation (RERF) in Hiroshima, Japan. She was co-organizer of the American Statistical Association Conference on Radiation and Health (2006), in addition to many other venues. Dr. Kronenberg serves as a member of the External Advisory Board for the National Space Biomedical Research Institute, and as a member of an international review panel for the GSI Helmholtzentrum in Germany. Her research has been supported by Federal funding sources. Dr. Kronenberg received her A.B. in Biology at Brown University, and her Sc.D. in Cancer Biology from the Harvard School of Public Health.

Landis, Wayne

Western Washington University

Dr. Wayne Landis is Professor and Director, Institute of Environmental Toxicology Huxley College of the Environment, Western Washington University. He holds a B.A. in Biology from Wake Forest University, (1974), an M.A. in Biology from Indiana University (1978), and a Ph.D. in Zoology from Indiana University (1979). Dr. Landis' areas of expertise and research activities include: environmental toxicology, the effects of toxicants on populations, and ecological risk assessment at large spatial and temporal scales. His research contributions also include: co-development of the Community Conditioning Hypothesis, the use of multivariate analysis in microcosm data analysis, creation of the Action at a Distance Hypothesis for landscape toxicology, the application of complex systems theory to risk assessment, and development of the Relative Risk Model for multiple stressor and regional-scale risk assessment and specialized methods for calculating risk due to invasive species and emergent diseases. Dr. Landis has authored over 150 peer-reviewed publications and government technical reports, participated in over 400 scientific presentations, edited four books, and wrote the textbook, Introduction to Environmental Toxicology, now in its sixth edition. He has consulted for industry; nongovernmental organizations as well as federal (U.S. and Canada), state, provincial, and local governments. Dr. Landis' research has been supported by grants and contracts from federal agencies (U.S. Air Force, Environmental Protection Agency, U.S. Forest Service,), industry (DuPont, BP and Teckcominco Ltd.), with additional grant support from state, provincial and local governments, industry, NGOs and foundations. Dr. Landis has served on the American Society of Testing and Materials (ASTM) Committee on Publications overseeing a variety of environmentally related symposia proceedings. He currently serves on the editorial boards of the journals Risk Analysis and is an editor for Integrated Environmental Assessment and Management, and retired as the ecological risk area editor for Risk Analysis. Dr. Landis is a member of the Society of Environmental Toxicology and Chemistry (SETAC) and served on the SETAC Board of Directors from 2000-2003. In 2007 he was named a Fellow of the Society for Risk Analysis and in 2016 a Fellow for the Society for Environmental Toxicology and Chemistry. He was selected for his second term on the Science Panel of the Puget Sound Partnership, a state of Washington agency charged with the restoration of Puget Sound. More recently he served on the NASEM panel that resulted in a keystone document on the future of synthetic biology and specifically the use of gene drives "Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with

Public Values."

Lange, Sabine

Texas Commission on Environmental Quality

Dr. Sabine Lange is the section manager for the Toxicology Division at the Texas Commission on Environmental Quality (TCEQ). Dr. Lange's responsibilities include overseeing health effects risk assessments of air permit applications, ambient air monitoring projects, and hazardous waste sites; overseeing the development of chemical toxicity factors; and conducting and overseeing systematic reviews and independent analyses of risk assessments. Dr. Lange serves as a technical resource for the State and citizens of Texas for human health and environmental risk assessment, especially related to air and water quality. Dr. Lange's research interests include the toxicology of criteria air pollutants, and risk assessment methods used for derivation of toxicity factors. In these areas she has published articles, given invited talks, presented posters, and served as a workshop panel member. On behalf of the TCEQ, she has intensively reviewed the documents released by the US EPA on the National Ambient Air Quality Standards (NAAQS) for ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and lead. Dr. Lange and colleagues have provided comments to the US EPA on the assessment documents supporting these standards, particularly as they relate to principles of toxicology, risk assessment, and the State's perspective on these rules. She has also served as a peer reviewer for EPA on chemical hazard assessments for regulations under the Toxic Substances Control Act. Dr. Lange's work since joining TCEQ has been entirely funded by the State of Texas. Dr. Lange received a Bachelor's degree from the University of Western Ontario in Canada, and completed a Ph.D. and post-doctoral training in biochemistry and molecular carcinogenesis at the University of Texas at Houston and MD Anderson Cancer Center. Dr. Lange is a Diplomate of the American Board of Toxicology.

Lawler, Desmond F.

University of Texas

Dr. Desmond F. Lawler is the Nasser I. Al-Rashid Chair in Civil Engineering, and Distinguished Teaching Professor in the Environmental and Water Resources Engineering Program within the Department of Civil, Architectural and Environmental Engineering at the University of Texas at Austin. He holds a B.S. in Civil Engineering from the University of Notre Dame (1968) and M.S. and Ph.D. degrees in Environmental Engineering from the University of North Carolina at Chapel Hill (1975 and 1980). Dr. Lawler has been at the University of Texas since 1980 and is now the W.A. Cunningham Professor of Engineering and a member of the University's Distinguished Teaching Academy. He was recognized in 1999 by the American Water Works Association with the A.P. Black Award for sustained contributions to drinking water research. His paper on flocculation with M.Y. Han was recognized with the 2005 Association of Environmental Engineering and Science Professors (AEESP) Outstanding Publication Award as one that that has withstood the test of time and influenced environmental engineering practice. Dr. Lawler has served on the Board of Directors of the Association of Environmental Engineering Professors, has been on several committees within AWWA, and is now on the Board of Trustees of the Water Science and Research Division of AWWA. Along with Dr. Mark Benjamin of the University of Washington, he is currently writing a graduate textbook on Physical/Chemical Treatment Processes for Water and Wastewater to be published by McGraw-Hill.

Lenczewski, Melissa

Northern Illinois University

Dr. Melissa Lenczewski is an associate professor in the department of Geology and Environmental Geosciences at Northern Illinois University (NIU). She is also the Director of NIU's Institute for the Study of the Environment, Sustainability, and Energy (the Institute). The Institute integrates

perspectives and methods from the natural sciences, social sciences, humanities, technology, and engineering for interdisciplinary research that addresses environmental and sustainability issues. Dr. Lenczewski holds degrees in Microbiology (B.S., University of Arizona), Soil and Environmental Sciences (M.S., University of Arizona) and Geological Sciences (Ph.D., University of Tennessee). She has served in numerous leadership capacities within the National Groundwater Association including as a director on the Scientist and Engineers Section Board of Directors, Government Affairs Committee, and Education and Awareness Subcommittee. Her main research focuses on contaminant hydrogeology by bringing together geochemistry, microbiology and physical flow hydrogeology. In Illinois, her research centers on a hyperalkaline site (~pH 12) in the Calumet region where she is examining geochemistry and microbiology of this unique extreme environment. She heads a research team that includes geochemists, geophysicist, public health, and geographers to examine the impact of tourism on the karst aquifer in Mexico. Lastly, she is working in Southeast Asia, especially Myanmar and Cambodia, on capacity building in higher education by training local faculty and graduate students in hydrogeology while researching local aquifers and determining major water quality issues. During the last two years Dr. Lenezewski's research has been funded by the National Science Foundation and National Ground Water Association Foundation.

Li, An

University of Illinois at Chicago

I am an environmental chemist, with research interests on how human activities influence the natural environment and how the changes in turn affect human health. My team focuses particularly on the transport and fate of persistent, bioaccumulative, and potentially toxic (PBT) organic chemicals in water. The major projects for which I served as PI since 2001 include three on PBTs in the Great Lakes sediment (funded by USEPA), one on the fate of brominated flame retardants (funded by NSF), and a few on cross-placenta transfer of PBTs (funded by NIEHS and as a part of the National Children's Study). We have discovered unexpected organic pollutants while analyzing legacy toxins; we developed novel analytical methods for trace halogenated PBTs; we are also very interested in quantitative structure-activity relationships. In recent years, I become more interested in "larger pictures" on how our scientific data are helping government make decisions, affecting the view of the general public, and impacting the society. I am the first Dr. Samuel and Catherine Epstein Term Professor at our UIC School of Public Health. I have published about 90 peer-reviewed journal articles with about one third in the Environmental Science and Technology (ES&T), in addition to 2 books and a number of book chapters as well as about 170 invited talks and conference publications. I served in review panels of NIH, NSF, EPA, and other funding agencies, and am a reviewer for >140 manuscripts from 38 journals. In research supervision, I have worked with >10 postdocs and visiting scholars, 23 PhD and 17 MS research assistants, and dozens of undergraduates.

Lohmann, Rainer

University of Rhode Island

Dr. Rainer Lohmann is Professor of Oceanography at the University of Rhode Island (URI)'s Graduate School of Oceanography. He obtained a Ph.D. in Environmental Science from Lancaster University (UK), and a BSc in Chemical Engineering from EHICS (Strasbourg, France). His educational background combines work in chemical / environmental engineering (postdoctoral work at the Massachusetts Institute of Technology, MIT) with marine, atmospheric and environmental chemistry. His group conducts research on the sources, transport, and bioaccumulation of anthropogenic pollutants. Dr. Lohmann has performed work at sites contaminated with legacy hydrophobic organic contaminants using novel passive samplers to assess transport, bioavailability and food-web magnification of these chemicals. He is Director of the new NIEHS-funded Superfund Research Center at URI focused on the sources, transport, exposure and effects of per- and polyfluorinated chemicals (PFASs). Dr. Lohmann has published over 100 articles in the leading

journals in the field (notably the American Chemical Society's Environmental Science and Technology), and has given over 100 invited presentations. He serves as Editor for the Society of Environmental Toxicology and Chemistry (SETAC)'s journal Environmental Toxicology and Chemistry, and is member of several editorial advisory boards, including Environmental Science and Technology, Environmental Science and Technology Letters, and Environmental Pollution. He serves on EPA's Board of Scientific Counselor's sub-committee on sustainable and healthy communities. Dr. Lohmann received the Roy F. Weston Environmental Chemistry Award by SETAC, the INNOLEC Visiting Lectureship by Masyruk University, Brno (Czech Republic) and fellowships by the Alexander-von-Humboldt foundation, the Research Center for Ocean Margins at the University of Bremen and the German Academic Exchange Service. He has received funding from the National Institute of Environmental Health Sciences (NIEHS), the Strategic Environmental Research and Development Program (SERDP), state and private foundations.

Lowery, Darrin L.

Chesapeake Watershed Archaeological Research Foundation

Dr. Darrin L. Lowery is the director of Chesapeake Watershed Archaeological Research. He has been the director of this group since 2001. He has held a research professor position and currently serves as an adjunct professor within the Department of Geology at the University of Delaware. From 2009 to 2014, he maintained a research fellowship position at the Smithsonian Institution. He has managed over fifty research projects since 1992 and served as the principal investigator or co-investigator for these projects. His responsibilities include overseeing field investigations, managing field crew, synthesizing the research results, and preparing final summary reports. He has a strong technology background and research interests in long-term human-environmental interactions, geology, geoarchaeology, biogeochemistry, hydrology and water resources, soil morphology and pedology, environmental isotope analyses, coastal erosion and sediment dynamics, paleoclimatology, and marine-estuarine ecosystems. Dr. Lowery has served as an expert witness concerning coastal resources as well as global positioning issues. He has been the principal author and/or co-author on forty-six peer-reviewed articles or book chapters, as well as fifty-six monographs. He earned both a B.A. in Anthropology and a Ph.D. in Geology from the University of Delaware. He also earned an M.A. in Archaeology from Temple University. His research for the past two years was funded by the Commonwealth of Virginia and the State of Maryland.

Lu, Kun

University of North Carolina

Dr. Lu is an associate professor in the Department of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina at Chapel Hill. The overarching goal of Dr. Lu's research is to better understand health effects of environmental exposure and individual response. He has strong technical background and expertise in analytical chemistry, microbiome, exposome, omics profiling, and biomarker development. Dr. Lu's lab works on numerous important environmental chemicals ranging from formaldehyde, heavy metals to pesticides, as well as others with significant public health concerns. One of his research thrusts is to develop DNA/protein adduct biomarkers and sensitive mass spectrometry assays to understand the carcinogenicity of chemicals and their risk assessment. Dr. Lu also studies how gut microbiome interacts with environmental exposure, how microbiome affects disease susceptibility, and how host factors crosstalk with microbiome to influence its response. Another focus of Dr. Lu's research is to map exposome for human disease to characterize exposures over the lifespan via high-resolution mass spectrometry, understand the health impact of the exposome, and to design strategies to reduce exposure-associated adverse effects. He has published numerous peer-reviewed articles and served on a number of external scientific review panels/committees. Dr. Lu received the Best Publication Award from the Society of Toxicology in 2011 for his work in the risk assessment of formaldehyde using

DNA adducts as chemical-specific biomarkers. He was also awarded with the Outstanding New Environmental Scientist Award in 2015 from the National Institute of Environmental Health Sciences. He earned BE, MS and PhD in chemistry and material sciences from Beijing University of Chemical Technology and University of North Carolina at Chapel Hill, followed by a postdoctoral training at Massachusetts Institute of Technology. His research for the past two years was funded by the National Institutes of Health.

Lupo, Anthony

University of Missouri

Dr. Anthony R. Lupo is Professor of Atmospheric Science in the School of Natural Resources, which is housed in the College of Agriculture, Food and Natural Resources at the University of Missouri. He received an AS in Math and Science from Cayuga County Community College, a BS in meteorology from the State University of New York at Oswego, an MS and PhD in Atmospheric Science at Purdue University, and post-doctoral training in synoptic and large-scale meteorology at The State University of New York at Albany. Since 1997, he has received funding through the National Science Foundation, the United States Department of Agriculture, United States Department of Energy, Civilian Research and Development Foundation Global, and the State of Missouri. His research topics have included atmospheric dynamics, synoptic meteorology, long-range forecasting, tropical meteorology, and climate variability and change, especially as related to agriculture. Dr. Lupo has authored 110 peer-review papers and book chapters. He teaches graduate level courses in atmospheric dynamics, chaos theory, tropical meteorology, the general circulation, and climate science. He has advised 46 graduate students, been a member of 47 graduate committees in atmospheric science, mathematics, education, and political science, and hosted five post-doc or visiting scientists. Dr. Lupo has served on review boards for many journals, government and private research funding agencies, and academic boards. He has been a contributing author and expert reviewer for the Intergovernmental Panel on Climate Change. He is a member of many professional societies and served on committees, such as the American Meteorological Society Board of Certified Consulting Meteorologists (2017), and as associate director of Research and Doctoral Constituency for Sigma Xi (2016-2018). He has received two Fulbright Teaching and Research awards, as well as a research specialist award, and is currently on the Fulbright Specialist roster.

Mace, Robert E.

Texas State University

Dr. Robert E. Mace is a Deputy Executive Administrator for the Texas Water Development Board, managing the Water Science and Conservation office at the agency, a group of 66 scientists, engineers, and technicians focused on better understanding Texas' water resources. His technical background is in hydrogeology with an emphasis on numerical modeling, aquifer characterization, and geostatistics; however, he also has experience in groundwater contaminant transport, groundwater management, surface water, water conservation, water loss, desalination, water reuse, aquifer storage and recovery, water planning, drought response, and rainwater harvesting. He is recognized as an effective communicator of science to policymakers and is sought out to explain complicated water issues to non-technical audiences. Dr. Mace's work has been recognized by the U.S. Department of Interior (Partners in Conservation Award as part of an ensemble effort), National Ground Water Association (Technology Award), Texas State University (Distinguished Texas Hydrogeologist), Austin Geological Society (Distinguished Service Award), Barton Springs/Edwards Aquifer Conservation District (Conservation Award in Research), and Haskell Simon (Rosetta Stone Award). He is the chair of the Multi-State Salinity Coalition, a founding member and current board member and associate editor of the Texas Water Journal, a fellow of the Center for Public Policy Dispute Resolution, a board member of the Scientists and Engineers Board of the National Ground Water Association, a member of the Advisory Committee on Water Information, a member of the Water

Conservation Advisory Council, a member of the Groundwater Contemporary Issues Council (California), a member of the Edwards Aquifer Habitat Conservation Plan Science Committee, the chair of the Texas STATEMAP Project Advisory Panel, and a former president of the Austin Geological Society. He is also a registered professional geoscientist with the Texas Board of Professional Geoscientists. Dr. Mace received his B.S. degree in Geophysics and an M.S. in Hydrology from the New Mexico Institute of Mining and Technology and a Ph.D. in Hydrogeology from The University of Texas at Austin. He and his research group are primarily funded by direct appropriations from the state of Texas but also receives or has received financial support from the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, and University Corporation for Atmospheric Research. His group also works cooperatively with the U.S. Geological Survey.

Marty, Sue

The Dow Chemical Company

Dr. Sue Marty received her Bachelor of Science (B.S.) in biology and a Master of Public Health (MPH) in toxicology from The University of Michigan (Ann Arbor, MI). After a year at the Eberhard-Karls Universität in Tübingen, Germany, she returned to the University of Michigan to complete a Doctor of Philosophy (Ph.D.) degree in toxicology. Her dissertation was in the area of reproductive toxicology, looking at the effects of toxicants on labor onset and progression. Subsequently, she was a postdoctoral fellow at Michigan State University, studying the neurotoxic effects of methylmercury on calcium homeostasis in primary cerebellar neurons. In 1997, she joined The Dow Chemical Company in Midland, Michigan, where she served as a Lead Scientist in the Reproductive and Developmental Toxicology group. After six years, Dr. Marty became a business consultant for Dow's glycol ethers business. In 2006, she decided to return to the laboratory and became a Senior Toxicology Leader in Dow's Neuroendocrine Toxicology group. In 2014, she accepted her current role on the Chemicals and Health Leadership Team at The Dow Chemical Company; this group develops internal programs to address issues related to chemicals and health, including research projects for Dow's toxicology laboratory. Dr. Marty is a diplomate of the American Board of Toxicology (D.A.B.T.) and a member of the editorial board for Birth Defects Research Part B: Developmental and Reproductive Toxicology. She is past president of both the Michigan Regional Chapter of the Society of Toxicology (2007-2008) and the Midwest Teratology Association (2005-2006). She has served on the Continuing Education Committee (2005-2008), Program Committee (2007-2008) and Science Committee (2009) for the Teratology Society, and councilor for the Neurotoxicology Specialty Section of the Society of Toxicology (2009-2011). Dr. Marty has served on expert panels for the National Toxicology Program (NTP) Center for Evaluation of Risks to Human Reproduction (CERHR; 2004-2006). Currently, Dr. Marty serves on several industry panels, including the Endocrine Policy Forum. She serves on several international expert committees, including the Organisation for Economic Cooperation and Development (OECD) Expert Group for Reproductive Toxicology, the OECD Working Group of the National Coordinators of the Test Guidelines Programme (WNT), and the United Nations Environment Programme (UNEP) Endocrine Advisory Group. She also serves on an advisory board for the Humane Society of the United States. Dr. Marty has published over 50 scientific papers in peer-reviewed journals. Her research interests are primarily focused on: 1) endocrine disruption with a focus on the specificity and sensitivity of endocrine endpoints in toxicity studies; 2) effects of toxicant exposure during critical life stages of development; and 3) evaluation of ToxCast and ExpoCast data to evaluate potential toxicity. She is working with the Royal Society of Chemistry (UK) on a project to evaluate low dose/non-monotonic dose responses with endocrine-active compounds. Over the past two years, Dr. Marty's research funding has come from The Dow Chemical Company.

McConnell, Charles

William Marsh Rice University

I serve as the Executive Director of the Energy and Environment Initiative (EEi) at Rice University in Houston, TX. EEi is a program that leverages the multi-discipline expertise at Rice to promote collaborative research in the areas of energy and environment science, engineering, economics, policy, and humanities. Our mission is to impact the marketplace with relevant and impactful transformative technology and research that will result in marketplace impact. Our efforts also extend externally to government, public partnerships, and industry to ensure collaboration and focus on market driven challenges to ensure excellence in energy access and reliability, affordability and economic competitiveness, and environmentally responsible solutions for the future. I have over 30 years of industry experience, have served as Assistant Secretary of Energy at the US Department of Energy, and have 5 years most recently at Rice University. During this period of time I have testified numerous times in both House and Senate committees (House Science and Technology being one of them) on a number of scientific energy related topics.

McKean, Deborah

Independent Consultant

Dr. Deborah McKean is a toxicologist specializing in human health risk assessment, risk-based decision-making, risk communication and training. She received her M.S. degree from the Department of Pharmacology and Toxicology at the University of Arizona and her Ph.D. from the Department of Pathology and Laboratory Medicine at the University of Cincinnati Medical Center. In addition to her experience in emergency response and remediation activities, she has been involved in the development of national policy, risk assessment guidance and chemical-specific, health-based criteria for the U.S. Environmental Protection Agency (EPA). She was an assistant professor at the University of Cincinnati where she taught Anatomy and Physiology, Pharmacology, Pathophysiology and Environmental Science. Dr. McKean served as a Division Director within U.S. EPA's National Homeland Security Research Center before becoming the Chief of Technical Assistance for EPA's Denver Regional office. Dr. McKean has also provided expert witness testimony for litigations involving hazardous waste issues and has been certified as an Environmental Unit Leader within EPA's Incident Command System for emergency response. Dr. McKean was also a member of EPA's Regional and National Incident Management Teams and is certified as an adult trainer and instructor. She recently retired from federal government service and is currently self-employed.

Meredith, Justin

Tennessee Department of Environment and Conservation

Mr. Justin Meredith is the Technical Assistance Manager at the Tennessee Department of Environment and Conservation (TDEC) Nashville, Tennessee. Mr. Meredith manages the Technical Assistance section, which performs a wide variety of scientific reviews and technical services for the entire Division and for external customers. These positions have state-wide responsibility. This section is made up of seven technical staff, representing: 1.) Divisional Risk Assessment team; 2.) Dry Cleaner's Environmental Response program; 3.) Community assistance to local governments and development districts applying for or have been awarded EPA Brownfields grants; 4.) Research on contaminated sites and what companies or individuals may have caused the contamination; and 5.) Hydrogeological expertise. In addition to managing the technical section Mr. Meredith is the petroleum contamination remediation expert, a human health and ecological risk assessor, and project manager. Mr. Meredith presents at conferences and has trained several hundred individuals including internal staff as well as external consultants on several aspects involved in the remediation process. Prior to TDEC-DoR, Mr. Meredith worked for TDEC-Underground Storage Tanks program and prior to that worked in the private sector, as a field geologist. Mr. Meredith is a trainer for the Interstate Technology & Regulatory Council's training course on light non-aqueous phase liquid remediation technology overview. Mr. Meredith has received no research funding. Mr. Meredith has been active in ITRC since 2014 and is serving as Tennessee's ITRC Point of Contact

https://www.itrcweb.org/About/State. Mr. Meredith earned a B.S. in Environmental Geosciences from Valdosta State University in Valdosta, Georgia.

Meselhe, Ehab

Tulane University

Ehab Meselhe, Ph.D., P.E., has more than 20 years of experience researching coastal wetland hydrology, sediment transport, and computer modeling of coastal wetland, estuarine, and riverine systems. His multi-layered background includes work as an educator, researcher, and practitioner with extensive experience working with academic institutions, government agencies, and the private sector. He has been heavily involved in large-scale coastal ecosystem restoration programs in south Louisiana and the Florida Everglades. As the Institute's former Director of Natural Systems, Dr. Meselhe served as Louisiana's technical lead for the Mississippi River Hydrodynamic and Delta Management Study and helped build the numerical models that provided a foundation for Louisiana's 2017 Coastal Master Plan. Dr. Meselhe is heavily involved in the numerical modeling being used by Louisiana to help refine the design of sediment diversions at Mid-Barataria and Mid-Breton along the Mississippi River. Prior to joining The Water Institute of the Gulf, Dr. Meselhe directed the Institute of Coastal Ecology and Engineering at the University of Louisiana-Lafayette, where he also served as distinguished professor for the Department of Civil Engineering. During his tenure at UL Lafayette, he established and sustained an externally funded research program from federal and state agencies. He is a registered Professional Engineer in the sates of Iowa, Louisiana, Texas, and Arkansas. He also served as an Associate Editor of the Journal of Hydrology (Elsevier), and the Journal of Hydraulic Research (International Association of Hydraulic Research).

Moo-Young, H. Keith

Washington State University, Tri-Cities

Dr. H. Keith Moo-Young is Chancellor of the Washington State University, Tri-Cities, Richland, Washington. Prior to assuming this position in April 2013, he served as Dean of the College of Engineering, Computer Science and Technology at California State University-Los Angeles. He holds an M.S. and Ph.D. in Civil-Environmental Engineering from the Rensselaer Polytechnic Institute, and a Masters of Technology Management from the University Pennsylvania, a B.S. degree in Civil Engineering from Morgan State University and is a licensed professional engineer (Environmental Engineering) in Pennsylvania. Dr. Moo-Young was formerly the Interim Dean and Associate Dean for Research and Graduate Studies at Villanova University, and has served as a Professor at Lehigh University and Villanova University. Dr. Moo-Young is a Board Certified Environmental Engineer by the American Association for Environmental Engineers and a Fellow of the American Society of Civil Engineers. The emphasis of his research is on hazardous and solid waste management and technologies, such as the remediation of inorganic contaminants in acid mine drainage and groundwater, manufactured gas plant and coal tar, recycling and reuse of industrial co-product materials, and corrective strategies for contaminated sediments. Dr. Moo-Young's current research is funded by the National Science Foundation to acquire an Ultra-Centrifuge for geoenvironmental research and education, renovate core facilities, fund the GK-12 Fellowship Program, and support the CREST Center for Sustainable Energy; Naval Surface Warfare Center (NSWC) to support its education partnership agreement with the College of Engineering, Computer Science and Technology at California State University, Los Angeles; the California Air and Resource Board to support the Hydrogen Refueling Station; the Department of Defense, to support the Great Minds in Science, Technology, Engineering and Math (STEM) careers program; Department of Education to increase engineering transfers students from East Las Angeles College and Los Angeles Trade Technical College; various corporations to support the 'Senior Design' project; and National Oceanic and Atmospheric Administration to support the University Research Center. Dr. Moo-Young has served as a member of the Water Environmental Research Foundation Exploratory Team on Solids Reduction,

National Science Foundation Committee of Visitors for Civil and Mechanical Systems Division from 2001-2003, the Department of Energy's Workshop on Monitoring of Metals and Radionuclide Contaminated Sites in 2004 and Workshop on Containment Technologies in 2002. He also served as the session leader on Sediment Stability for the Department of Defense's SERDP-ESTCP Workshop on Contaminated Sediment in 2004. Dr. Moo-Young co-chaired the First International Conference on Environmental Research, Technology, and Policy on Africa in Accra, Ghana in 2007 and was the Honorary Chair for the ISEG 2012 The XII International Symposium on Environment, Energy and Global Sustainable Development. He has received numerous national awards including service as an American Association for the Advancement of Science Policy Fellow at the U.S. Environmental Protection Agency from 2001-2002 and Black Engineer of the Year in 2001. Dr. Moo-Young has published over 200 refereed papers and invited talks in peer-reviewed journals, books and conference proceedings, workshops and invited lectures. He is also the co-inventor of one patent.

Mora-Zacarias, Miguel

Texas A&M University

Dr. Mora is currently a Professor and Associate Department Head for Undergraduate Programs in the Department of Wildlife and Fisheries Sciences, Texas A&M University (TAMU). He also has a joint appointment in the Department of Veterinary Pathobiology, College of Veterinary Medicine, and is a member of the Intercollegiate Faculty of Toxicology. Dr. Mora earned a BS in Biochemical Engineering at the National Polytechnic Institute, Mexico City, an MS and Ph.D. in Ecology from the University of California, Davis, and a post-doc in ecotoxicology from Michigan State University. Over the last 30 years, Dr. Mora's research has focused on evaluating the impacts of persistent organic pollutants, metals, and other contaminants on animal populations, with emphasis on aquatic birds, migratory birds, and endangered species. He has over 80 publications in the peer-reviewed literature in addition to many government reports and other publications. Dr. Mora is a Fellow of the American Ornithologists' Union, and he received the "Distinguished Scientist Award" from the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) in 2013. In 2016, he also received the Dean's Outstanding Achievement Award for Excellence in Diversity from the College of Agriculture and Life Sciences, TAMU. Dr. Mora has served on the Board of the Society of Environmental Toxicology and Chemistry (SETAC) for 3 years, and on the SETAC World Council for five years. He also served on the SACNAS Board for six years. Dr. Mora is an Associate Editor for Ecotoxicology (since 2008) and has served on the Editorial Board of Environmental Toxicology and Chemistry (9 years), Chemosphere (15 years), and Environmental Pollution (6 years). He has served on numerous review panels (NSF, EPA, Universities) and reviews articles for various other journals on a regular basis. For the last two years, Dr. Mora's research has been funded by State and Federal agencies (USGS).

Morgan, Christine

Texas A&M University

Cristine Morgan is a Professor of Soil Science with emphasis in soil hydrology and pedometrics at Texas A&M University in College Station, TX. Her research program focuses on the role of soil science in addressing global challenges of water security, food security, environmental quality, and human health. Her technical expertise in is water movement through soil and across landscapes, novel sensing systems to quantify soil in situ, and measuring and modeling soil properties across landscapes. Dr. Morgan provides leadership in a global effort to secure soil for current and future generations. Her soil security efforts include involvement in a coalition of non-profit organizations, federal agencies, and businesses to address soil health, as well as implementation of research strategies to link soil science with economics and sociology to affect changes in soil management in agriculture. She leads interdisciplinary teams of physicists and plant scientists to develop novel techniques that measures roots, in undisturbed soils. Outcomes of her research program provide innovative measures of

spatially and temporally variable soil properties and improvement on our ability to quantify soil ecosystem services affected by soil properties and soil management at the farm and watershed scale. Dr. Morgan's research program and students have been nationally and internationally recognized for their work advancing knowledge in soil science. Her program has recently been funded by Texas Commission on Environmental Quality, US Departments of Agriculture and Energy, and Agricultural Industry. Dr. Morgan serves on the board of directors for the Soil Science Society of America, is co-editor in chief of the global soil science journal, Geoderma, and participates in committees for the International Union of Soil Scientists. Dr. Morgan earned her M.S. and Ph.D. in Soil Science from the University of Wisconsin-Madison. Her Bachelor's degree is in Plant and Environmental Soil Sciences from Texas A&M University.

Morgan, Kevin

Aventis Pharmaceuticals Inc

Kevin Morgan holds the DVM and Ph.D. degrees and is a Board Certified Veterinary Pathologist. Dr. Morgan has published extensively on the pathology of the nasal turbinates and in particular the effect of irritants on the structure. One of the most prominent of agents studied is formaldehyde. Additionally, he has worked with acetaldehyde and vinyl acetate.

Neagu, Carmen

ABB Inc

Mrs. Carmen Neagu is Technical Specialist for FTIR technology for all industries and their subsectors. She held several key positions from 1997 while working for Exxon, Albemarle and Akzo Nobel in research and development, process, analytics and consulting. Her extensive experience in the Science field corroborated with her technical expertise, led to 12 patents in the Polymers field, new tires compounds formulations, new composite materials as well as new organic peroxides reformulations used in medical field, specialty chemicals and life sciences. She has been employed by ABB Inc since 2014 where the primary focus was to offer her expertise to thousands of companies, suggesting technologies and their implementation, FDA regulations implementations. Her responsibilities include coordination and implementation of testing and technology implementation to reduce health effects, improve air quality, testing and detection technology implementation for toxic materials, and she is part of advisory boards of dozen of private companies monitoring air quality and environment protection. She has a strong technical background and research interest in hazard identification, inhalation dosimetry, permits. Mrs. Carmen Neagu serves as a technical resource for hundreds of commercial companies, management and staff on issues concerning air and water quality, pesticides, bacteria removal and products contamination. She has an extensive knowledge on state and federal permitting, remediation, and risk assessment issues, and served as the environmental safety officer at Akzo Nobel, for the safety department. Carmen has published numerous articles in the peer-reviewed literature, serves or has served on numerous external scientific committees, and presented scientific papers and materials on newest science discoveries at various conferences held by American Chemical Society. She earned both a B.S. in Chemical Engineering and a MS in Organic Compounds Synthesis from the Polytechnic University of Bucharest, Romania.

Nespoli, Lisa Marie

Covestro LLC

Ms. Lisa Marie Nespoli manages Product Safety and Stewardship at Covestro. She has been employed by Covestro since 2010 and manages a group of various science, health and safety experts. She holds a B.S. in Biology from Allegheny College and a M.S. in Biology and M.S. in Environmental Science and Management from Duquesne University. Her Bachelor's thesis was in the area of reproductive toxicology, looking for thyroid and behavioral effects of chemical toxicants on future generations and her Master's thesis was in the area of environmental reproductive toxicity and endocrine disruption.

Lisa Marie's primary professional interests are in chemical product safety and stewardship, sustainability and green chemistry, and human health risk assessment. In her corporate role at Covestro, she leads several global teams to provide guidance and expertise on the company's product safety, stewardship, and sustainability initiatives, methods for product prioritization and risk characterization, and informs Covestro's businesses and leadership teams. She was also responsible for developing and implementing global product stewardship core processes and risk characterization procedures for the company. Lisa Marie is known as an expert in product stewardship and sustainability, and has been asked to speak on these topics at numerous venues, including summits on Safer Sustainable Products. Lisa Marie serves in leadership roles on a number of professional and trade associations, such as the American Chemistry Council (ACC), Adhesive and Sealant Council (ASC), the American Coatings Association (ACA), Product Stewardship Society (PSS), and previously Society of Environmental Toxicology and Chemistry (SETAC). Prior to joining Covestro, Lisa Marie provided Environmental Consulting expertise for the Federal Aviation Administration with BAE Systems, where she held various health, safety and environmental positions. Ms. Nespoli receives no outside research funding.

Nuckols, John

Colorado State University

Dr. John R. Nuckols is an Emeritus Professor in Environmental Health Sciences (Colorado State University), and Principal of JRN-Environmental Health Sciences (N. Bethesda, MD). He holds BS (Texas A&I U), MS (Northwestern U) and PhD (U Kentucky) degrees with Civil, Environmental Health, and Agricultural Engineering emphasis, respectively. His largely self-supported professional career (1975- present) is strongly rooted in "science for the public interest", focused on understanding fate and transport of environmental contaminants, and integration of this knowledge into design of intervention strategies for environmental and public health protection. Notable achievements since 1974 include a USEPA Academic Fellowship Award, the Kentucky Conservation Society Conservationist of the Year Award, lead on technical arguments for the first designation in the USA of a land parcel (a municipal watershed) as unsuitable for surface coal mining, Founder/Director of one of the first academic programs in the world devoted to integration of geospatial sciences in health risk analysis (Environmental Health Advanced Systems Laboratory, CSU), two National Institutes of Health Intergovernmental Personnel Agreement awards based on EHASL's contributions to improving exposure assessment in environmental epidemiology, Co-nominee - Centers for Disease Control Charles C. Shepard Science Award, and most recently finalist for the prestigious 2017 American Association for the Advancement of Science Revelle Fellowship. Throughout his career Dr. Nuckols has served on numerous local, state and federal panels or work groups, including Kentucky Task Forces on State Primacy for Coal Mining Regulations and on Oil Shale Mining, the Kentucky Water Quality Advisory Committee, the Lexington Fayette County Kentucky Emergency Response Local Planning Committee, the Colorado Task Force on Non-point Source Pollution, the Larimer County Colorado Farm Bureau Board of Directors, Advisory committees for Environmental Health Tracking Network Programs in CA, NJ, NM, NY, WA, and WI, the National Cancer Institute Long Island Breast Cancer Study Project Advisory Committee, the National Academy of Science Committee on Contaminated Drinking Water at Camp Lejeune, NC, and as NAS reviewer on Exposure Science in the 21st Century report, the European Science Foundation working group on setting the future for water and health research, and currently as representative of the Colorado Water Institute on the US committee of the UNESCO International Hydrology Program. Dr. Nuckols has received no USEPA research funding since 2002.

Oerther, Daniel

Missouri University of Science and Technology

Dr. Daniel Oerther is a professor of environmental health engineering at Missouri S&T and an

Agricultural Policy Advisor to the U.S. Secretary of State representing the U.S. at the Second International Conference on Nutrition (ICN2), the Committee on World Food Security (CFS), the Blue Growth Network, and the Our Ocean Conference. Previously, he was professor and head of Civil and Environmental Engineering at Cincinnati. Dan's education includes a doctorate in environmental engineering (UIUC) and postgraduate training in environmental health (Cincinnati), public health (Hopkins Bloomberg), and public administration (IU Bloomington). Dr. Oerther is a Professional Engineer (PE), Board Certified Environmental Engineer (BCEE), Certified Environmental Health Specialist (CEHS), and Diplomate of the American Academy of Sanitarians (D.AAS). He is a Fellow of the Royal Society for Public Health (F.RSPH), the Chartered Institute of Environmental Health (F.CIEH), and the Society of Environmental Engineers (F.SEE), and he is a lifetime honorary Fellow of the American Academy of Nursing (F.AAN) and the Academy of Nursing Education (ANEF). Dan's professional practice, academic research, interdisciplinary teaching, and entrepreneurial outreach apply environmental biotechnology and community based participatory research (CBPR) to advance the UN Sustainable Development Goals (SDGs) at the interface of food, energy, and water systems (FEWS). Dr. Oerther is currently a trustee and the treasurer of the American Academy of Environmental Engineers and Scientists (AAEES), a board member of Sigma Theta Tau the International Honor Society of Nursing, an associate editor of both the "Journal of Environmental Engineering, ASCE" and "Water Environment Research, " a Program Evaluator (PEv) for the Accreditation Board of Engineering and Technology (ABET), and previously a director and Chief Information Officer (CIO) of the Association of Environmental Engineering and Science Professors (AEESP). Dan has been recognized by the National Academies with the Jefferson Science Fellowship, the Keck Futures Initiative, and the Frontiers in Engineering Education Symposium; by AAEES with the Frederick G. Pohland Medal (integrating research, teaching, practice), the Superior Achievement Award (best project in 2016), and the Stanley E. Kappe Award (advancing public awareness to the betterment of the total environment); by AEESP with the Steven K. Dentel Award for Global Outreach and the Excellence in Environmental Engineering and Science Education Award (training practitioners); and by the U.S. Department of State with a Meritorious Honor Award from the Secretary's Office for Global Food Security, as a Fulbright Scholar to India in 2005, and as the inaugural Fulbright-ALCOA Distinguished Chair in Environmental Science and Engineering to Brazil in 2012. Dr. Oerther's current funding originates from the U.S. Department of State.

Oris, James

Miami University

Dr. James Oris is a Professor in the Department of Zoology and is the Associate Dean for Research and Scholarship at Miami University in Oxford, Ohio. He received a B.A. in Biology from Wittenberg University (1979) and a Ph.D. in Environmental Toxicology and Fisheries and Wildlife from Michigan State University (1985). Dr. Oris's areas of research interest center on the ecological toxicology of chemicals in aquatic systems. His primary interest is the study of the fate and effects of polycyclic aromatic hydrocarbons and mercury in freshwater systems. Sediment toxicity, photo-induced toxicity, long-term reproductive toxicity, routes of uptake, and environmental factors that may alter fate and effects have been areas of study. These studies have ranged from the use of molecular biomarkers to landscape-scale ecological assessments. Dr. Oris is also interested in standard toxicity test development and methodology, including the statistical modeling and analysis of toxicity dose-response relationships. He has published over 90 peer-reviewed scientific research articles and over 170 abstracts for presentations at scientific meetings. Dr. Oris has served on editorial or review boards of 8 journals, 6 books and 9 granting agencies. He served as the President (2004-2005) of the Society of Environmental Toxicology and Chemistry (SETAC) North America.

Orlov, Alexander

State University of New York, Stony Brook

Dr. Alexander Orlov is an Associate Professor of Materials Science and Engineering at State University of New York, Stony Brook, USA. He is also a faculty member of the Consortium for Interdisciplinary Environmental Research, Chemistry Department and the Institute for Advanced Computational Science. In addition Dr. Orlov is the European Research Council (EU) and National Science Foundation (US) funded Visiting Professor of Chemistry at the University of Cambridge. Furthermore, he is President and Founder of the Sustainable Nanotechnology Corporation. Dr. Orlov has already a substantial experience on providing advice to policy makers on environmental, consumer protection and agricultural matters. From 2007 till 2014 he was appointed by two UK Secretary of States for Environment, Food and Rural Affairs to advice the Government on such issues as hazardous substances, sustainability, environmental health/engineering and environmental impact of nanotechnology. More specifically he provided guidance on risk assessment of more than dozen chemicals and nanomaterials, where he evaluated submissions to the UK government and the European Chemicals Agency (ECHA). In particular, he was co-author of reports on DecaBDE toxicity, cumulative toxic effects of phthalates, behavior of pharmaceuticals in the environment and risk assessment of nanosilver/nanoseria to name a few. Several of his current NSF funded projects are focused on development of new technologies for air purification using waste materials, water and air remediation utilizing novel catalytic materials and risk analysis for nanomaterials release in the environment. Dr. Orlov has 5 degrees from various European and the US institutions, including: Doctoral and Master's degrees in Physical and Environmental Chemistry from the University of Cambridge (UK) and Master's degree in Environmental Engineering from the University of Michigan (US). He also holds Diploma in Economics from the London School of Economics. Among his current activities Dr. Orlov is contributing to work of the United Nations Environmental Program (Lead Author for the GEO report and reviewer of various UN reports) and the US-EU working group on Risk Assessment of Nanomaterials under auspices of the US White House and European Commission cooperative program on nanotechnology research. He serves as expert for over 20 Governmental agencies throughout the world, which includes grant reviewing for the NSF (13 Programs), DOE, DOD and the EU Commission. He also chairs the American Institute of Chemical Engineering Committee on Research and New Technologies, and participates in the Executive Committee of the American Chemical Society Environmental Division. Dr. Orlov was awarded the US National Science Foundation CAREER Award and the UK National Endowment for Science Technology and Arts CRUCIBLE award. He was also selected to the Fellowship of the UK Royal Society of Chemistry, the US National Academy of Engineering (NAE) Frontiers of Engineering (US), the EU-US (NAE) Frontiers of Engineering and was made Kavli Fellow in 2014 by the Kavli Foundation and the US National Academy of Sciences. In 2016 Dr. Orlov has been named Sigma Xi Distinguished Lecturer and was recognized by the State University of New York with Chancellor's Award of Excellence in Scholarship and Creative Activities. In addition to research awards, Dr. Orlov has received several teaching awards, including the 2015 NAE Frontiers of Engineering Education selection and the 2017 American Chemical Society Award for Incorporating Sustainability into Chemistry Education.

Osenberg, Craig

University of Georgia

Craig W. Osenberg (PhD, Michigan State University; BA, UC Santa Barbara) is a Professor of Ecology in the Odum School of Ecology at the University of Georgia. Previously, he was on faculty at UC Berkeley and the University of Florida, where he also served as Chair of the Biology Department. His ecological research tackles basic and applied problems across a diversity of habitats (terrestrial, freshwater, estuarine, and marine) and organisms (fish, amphibians, plants, invertebrates), and is

organized around several interrelated themes: (1) size- and spatially-structured population dynamics; (2) the development and application of statistical tools to quantify impacts of human activities (e.g., gas and oil development and marine reserves) on ecosystems; and (3) the development and application of meta-analysis and quantitative synthesis. During the past two years, his research has been supported by the National Science Foundation, US Department of Energy, US Fish and Wildlife Service, and the Marsden Fund of New Zealand. He and the students working in his lab have published ~170 papers, and he co-edited the influential book, Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats. Professor Osenberg was elected a Fellow of the Ecological Society of America (ESA) in 2015. He also was Chair of the Aquatic Section of ESA, Editor-in-Chief of Oecologia, served on the editorial boards of Ecology, Ecological Monographs and Frontiers in Marine Science, and was on the Science Advisory Board of NCEAS. He has served as a consultant to a diversity of groups applying science to important environments issues, including human impacts in marine systems, the design and assessment of marine protected areas in Costa Rica, French Polynesia, and the Mediterranean, and restoration of the Everglades and the Gulf of Mexico.

Otim, Ochan

Environmental Monitoring Division, City of Los Angeles

Dr. Ochan Otim is a Senior Chemist in the Environmental Monitoring Division of the City of Los Angeles, and teaches chemistry at University of California, Los Angeles. He holds a B.Sc. in Chemistry from Makerere University (Uganda), and M.Sc. degree in Chemistry from University of Regina (Canada) and a Ph.D. degree from Wichita State University. Dr. Otim's primary interest is in developing methods for quantifying, and assessing health risk associated with organic and metal contaminants in environmental samples. In his roles with the City of Los Angeles, Dr. Otim has lead the development of numerous methods to assess the levels of organic contaminants in ocean sediments, fish tissues, wastewater, biosolids, stormwater and receiving water (which includes ocean, creeks, rivers and lakes) for which he was recognized by the City. He has also represented the City of Los Angeles on the Contaminant Impact Assessment committee, a policy body of the Southern California Bight Regional Monitoring Program involving over 60 educational, local, state, and federal agencies. Dr. Otim serves on the Environmental Engineering Body of Knowledge committee of the American Academy of Environmental Engineers and Scientists, and on the membership committee of the Society of Environmental Toxicology and Chemistry (NA). He is a Board Certified Environmental Scientist. At UCLA, was awarded the 2017 Distinguished Instructor award for refocusing classroom experience toward contemporary issued in applied chemistry. Prior to joining the City of Los Angeles, Dr. Otim taught chemistry and biology at California State University (Fullerton) and was a Developmental Biology Research Fellow at the California Institute of Technology. Dr. Otim receives no outside research funding.

Otte, Marinus

North Dakota State University

Otte is currently a Professor at NDSU, Fargo, ND, and has studied wetlands for about 30 years, around the world. He carried out his PhD on coastal wetlands in The Netherlands, studied saltmarshes in South Carolina, then worked on many different systems in Ireland, and more recently in the US (ND, MN), China, and Montenegro. He is a lifetime member of the Society of Wetland Scientists, and since 2012 is the Editor-in-Chief of the authoritative scientific journal 'Wetlands'. He served as a Head of Department at NDSU, represented Ireland at EU level scientific panels (COST) and is currently on the K-12 Science Standards Committee for the ND Department of Public Instruction. Since arriving in ND in 2006, most of his research funding has come either directly or indirectly (via the ND Dept. of Health, Water Division) from EPA.

Parkerton, Thomas F.

ExxonMobil Biomedical Science

Dr. Thomas Parkerton joined ExxonMobil Biomedical Sciences, Inc. (EMBSI) as an Ecotoxicologist in 1992. He holds a B.S. in Environmental Science with an emphasis in Environmental Chemistry from Rutgers University and M.S. degrees in Aquatic Biology/Toxicology and Environmental Engineering from North Texas State University and Manhattan College, respectively. He received a Ph.D. in Environmental Science/Exposure Assessment from Rutgers University. Dr. Parkerton's area of expertise is in the development and application of computer models to predict the physio-chemical fate, bioaccumulation, trophic transfer and toxicological effects of chemicals entering the environment. Prior to joining EMBSI, Dr. Parkerton had gained experience in the development of scientifically defensible effluent, water and sediment quality criteria to protect aquatic life, wildlife and human health. Dr. Parkerton has coordinated numerous laboratory-based research programs to support environmental hazard classification and risk assessment of Exxon Mobil products. Other responsibilities have included performing multi-media exposure and environmental risk assessments in support of existing or new regulations. Dr. Parkerton relocated to Brussels in 1998 and served as the European ecotoxicology advisor for four years. In this role, Dr. Parkerton provided technical assistance to Exxon Mobil business units, industry associations and European regulatory agencies on environmental science issues relevant to both products and facility operations. In 2004, Dr. Parkerton became head of the EMBSI environmental sciences section that is headquartered in Annandale, New Jersey. In this position, Dr. Parkerton managed a group of approximately 20 consultants and laboratory staff. Over the next few years, Dr. Parkerton also led industry efforts to develop innovative methods, data and models to comply with the European REACH regulation. In 2011, Dr. Parkerton relocated to Houston Texas to assume a new position as senior environmental technical advisor. In this role, Dr. Parkerton is coordinating EMBSI technical support to its Houston-based clients and is providing expertise in helping EM address a variety of environmental issues. Dr. Parkerton has received no external grants from either government agencies, private companies, or foundations.

Pastore, Christopher

Thomas Jefferson University

Dr. Christopher Pastore is Professor of Transdisciplinary Studies at Thomas Jefferson University. He holds a PhD in Materials Science and Engineering, MS in Mathematics and BA in Mathematics. Chris has published over 100 refereed papers and 8 books in addition to numerous conference presentations. He is a Fulbright Specialist, and also serves as Honorary Research Professor at Durban University of Technology. His work has focused on the role and design of materials, including textiles and composites, for a wide range of industrial applications. He has been researching sustainability of materials for the past twenty years. This work has been funded by government and industry. Dr. Pastore's work in Sustainability has been recognized through a number of awards including Citation for Distinction from the National Institute of Building Sciences for the MS Sustainable Design, Best Practices in Communication (for EcoMan and The Skeptic podcast) from the Council for the Advancement and Support of Education, Excellence in Education Award, (for MS in Sustainable Design) from the United States Green Building Council, Excellence in Sustainability Education from the Delaware Valley Green Building Council, Philadelphia Sustainability Award from the Pennsylvania Environmental Council, and Leadership in Sustainable Building from the Pennsylvania Resources Council.

Patisaul, Heather

North Carolina State University

Dr. Heather Patisaul is Professor of Biological Sciences in the Center for Human Health and the Environment at North Carolina State University. She received her B.S. in Zoology in 1995 from the

University of Florida and her Ph.D. from Emory University in 2001 in Population Biology, Ecology and Evolution but specializes in developmental neuroscience. Her research explores the mechanisms by which exposure to endocrine disruptors, during critical windows of development, impacts sex specific neuroendocrine physiology and behavior. Compounds of interest include Bisphenol A (BPA), phytoestrogens, and fire retardants. An NIEHS ONES Award recipient, Dr. Patisaul has a broad background in neuroanatomy, neuroendocrinology, developmental neuroscience and animal behavior. A key aspect of her research is exploring sex differences in susceptibility and neurodevelopment. She also participated in the CLARITY-BPA consortium in conjunction with scientists at the National Toxicology Program and the National Center of Toxicological Research, and was the first to publish and complete all aims. Dr. Patisaul has participated in over 20 national and international expert panels and workshops on health effects associated with neurotoxicants and endocrine disruptors, including the 2012 Workshop on Low Dose Effects of Endocrine Active Chemicals co-organized by the US National Institute for Environmental Health Sciences (NIEHS) and the Joint Research Centre's Institute for Health and Consumer Protection, and two National Academy of Sciences panels. She chaired the 2016 Gordon Research Conference on Environmental Endocrine Disruptors and served on the program committee for the 2017 Copenhagen Workshop on endocrine disruptors. She is an active member of the Society for Neuroscience, the Society for Behavioral Neuroscience, the Society of Toxicology and the Endocrine Society where she leads working groups on endocrine disruptors, adverse outcome pathway development, and BPA. She is also a member of the Endocrine Society's Advocacy and Public Outreach Core Committee. Dr. Patisaul has a diverse group of active collaborators spanning academia, industry and governmental agencies (including EPA and NIEHS). She has published over 70 papers, and given over 65 invited talks, including five keynotes. She also co-authored the 2017 book Endocrine Disruptors, Brain and Behavior. Dr. Patisaul's work has been supported by the National Institutes of Health and the Department of Defense.

Paustenbach, Dennis J.

Chemrisk, Inc

Dr. Dennis Paustenbach is a board-certified toxicologist and industrial hygienist with nearly 35 years of experience in risk assessment, environmental engineering, ecotoxicology, and occupational health. He is also a degreed chemical engineer who practiced for the better part of 5 years in the chemical industry. Currently he is the President of Cardno ChemRisk, a division of Cardno. This division specializes in human and ecological risk assessment, as well as, risk analysis of chemical and radionuclides in consumer products, contaminated sites, pharmaceuticals and medical devices. Dr. Paustenbach specializes in the areas of industrial and environmental toxicology, occupational health, historical state-of-knowledge regarding environmental issues, and ecological and human risk assessment and has also directed the scientific aspects of toxic tort cases. In addition, he has also provided expert witness testimony in public meetings and as many as 400 depositions and two dozen trials concerning the health effects of chemicals in sediments, air, soil, consumer products, groundwater, and the workplace. He has been an adjunct professor at five universities. He has been an invited technical reviewer for prominent journals and of proposed regulations. Dr. Paustenbach has published approximately 300 peer-reviewed articles and written more than 50 book chapters in the fields of industrial hygiene, human and aquatic toxicology, engineering, and risk assessment. His two textbooks on risk assessment are among the most popular that have ever been published and they have been adopted by a number of universities in various countries.

Peltier, Richard

University of Massachusetts

Dr. Richard Peltier is an Associate Professor in the Department of Environmental Health Sciences at the University of Massachusetts Amherst. He is an expert in air quality assessment and human exposure science and has substantial focus in chemical speciation of aerosol components, source

apportionment, and attribution of specific sources to specific health outcomes. He has extensive experience in conducting research projects in remote locations where traditional research approaches are particularly difficult. As an empiricist, his laboratory is centered on high quality data analysis, uncertainty in sparse datasets, and reducing exposure misclassification, and has resulted in nearly 50 publications to date. Effective science communication to engage the public is also of significant interest, and he is involved in production of effective dissemination tools of scientific findings through mass media. Dr. Peltier completed a BS in Biology of the University of Massachusetts, a MPH in Environmental Health Science at Columbia University, and a PhD in Atmospheric Chemistry from the Georgia Institute of Technology. He conducted postgraduate training at the Institute of Environmental Medicine at New York University's Langone School of Medicine. A former Rosenblith awardee from the Health Effects Institute, Dr. Peltier has prior or current funding from US EPA, the Institute for Advanced Sustainability Studies (Germany), World Resources Institute Ross Center for Sustainable Cities, Worldwide Universities Network, Climate and Health Research Network, and the Commonwealth of Massachusetts Department of Energy Resources. Dr. Peltier is a recipient of a US-UK Fulbright award, and is the Deputy Editor in Chief of the Journal of Exposure Science and Environmental Epidemiology.

Portier, Kenneth

Independent Consultant

Dr. Kenneth M. Portier is a retired biostatistician with a limited private consulting practice. Previously, Dr. Portier was Vice President of the Statistics & Evaluation Center at the American Cancer Society (ACS) home office in Atlanta, GA, and an Affiliate Professor of Biostatistics in the School of Public Health, Emory University. A native of south Louisiana, Dr. Portier holds a BS in Mathematics from Nicholls State University in Thibodaux, Louisiana (1973), and an MS in Statistics (1975) and PhD in Biostatistics (1979) from the University of North Carolina, Chapel Hill. Dr. Portier was with ACS from January, 2006 to June, 2017, providing statistical and administrative support in ACS's Intramural Research Department. From January, 1979 to December, 2005, Dr. Portier was on the statistics faculty of the University of Florida and a statistical consultant to researchers in agriculture, natural resources and the environment. He has coauthored over 175 publications in many of the premier journals in agriculture, natural resources and environmental sciences and collaborated on 36 funded research grants from numerous agencies and private companies, with core research support from multiple federal agencies (NSF, USDA, NOAA, EPA, DOI). Dr. Portier is an affiliate researcher with UF's Center for Environmental and Human Toxicology. He has participated in over 60 US-EPA Scientific Advisory Panel (FIFRA-SAP) meetings since 1999 and five EPA Science Advisory Board science review panels. In addition, Dr. Portier has served on expert and advisory panels for the US National Institutes of Health (NCI, NIEHS, NTP, FDA), and the World Health Organization (WHO/FAO).

Prather, Michael

UC Irvine

Dr. Michael Prather is Distinguished Professor of Earth System Science at the University of California, Irvine (UCI). He joined UCI in 1992 after working at the National aeronautics and Space Administration (NASA) as program manager for atmospheric chemistry modeling and aviation effects. His education and work experiences are broad and technical. Prather holds degrees in mathematics (Yale), physics (Oxford) and finally astrophysics (Yale). While working at Harvard University and Goddard Institute for Space Studies in New York, he developed 3D atmospheric chemistry models as well as the simple box model of global chemistry used by the Environmental Protection Agency. His research remains focused on the simulation of the physical, chemical, and biological processes that determine atmospheric composition including ozone and greenhouse gases. It is far-reaching, about 200 peer-reviewed publications, with tens of thousands of citations. Prather was

editor-in-chief of Geophysical Research Letters overseeing its transition to digital publishing. In addition to his NASA career, he worked in the State Department for a year on leave from UCI as a Jefferson Science Fellow. He has been asked to organize expert meetings on greenhouse gases and air quality by governmental agencies, including Office of Technology Assessment (now defunct), State Department, and Framework Convention on Climate Change. In the role of scientific expert and lead author, Prather has participated in the many international assessments of ozone depletion and climate change over the past three decades. In this role he worked extensively with the governments in plenary to explain and characterize the quality of the science behind the assessment. Prather's current endeavor is as proposer/deputy of the NASA Atmospheric Tomography Mission, which just completed a four-season sweep of the remote ocean basins, identifying the human influence. Prather's research is now funded by NASA and the Department of Energy.

Ramos, Kenneth

University of Arizona

Dr. Kenneth Ramos is Associate Vice President for Precision Health Sciences and Professor of Medicine at the University of Arizona Health Sciences Center. He also serves as Director of the Center for Genetics and Genomic Medicine. He is a leading expert in the study of gene-environment interactions and personalized and genomic medicine. A major focus in his laboratory is the elucidation of molecular mechanisms of reactivation of mammalian retroelements and their role in reprogramming the human genome. Dr. Ramos completed a B.S. in Pharmaceutical Sciences and Chemistry (Magna Cum Laude) at the University of Puerto Rico, a Ph.D. in Biochemical Pharmacology at the University of Texas at Austin, and an M.D. degree with postgraduate training in Internal Medicine at the University of Louisville Health Sciences Center. He previously held faculty positions at the University of the Sciences in Philadelphia, Texas Tech University Health Sciences Center, Texas A&M University and the University of Louisville School of Medicine. He is currently affiliated with the Arizona Respiratory Center, Arizona Cancer Center and BIO5 Institute. Dr. Ramos is a recipient of the Society of Toxicology Achievement Award, Astra Zeneca Traveling Lectureship Award and Distinguished Service Award from the American Heart Association. He was named Associate of the National Academy of Sciences and Fellow of the Academy of Toxicological Sciences. His recent sources of grants include the National Institute of Environmental Health Sciences, the National Cancer Institute, Astra Zeneca, and the Kentucky Lung Cancer Research Program. He has published over 250 peer-reviewed publications and served on numerous national and international committees in the areas of environmental health sciences, genomics, molecular medicine and toxicology.

Randtke, Stephen J.

University of Kansas

Dr. Stephen Randtke is a Professor in the Civil, Environmental, and Architectural Engineering Department, University of Kansas, Lawrence, KS. He holds a B.S. degree in Civil Engineering from Loyola Marymount University and M.S. and Ph.D. degrees in Civil & Environmental Engineering from Stanford University. He is a licensed professional engineer and a diplomate in the American Academy of Environmental Engineers. Professor Randtke has broad interests and experience in the field of environmental engineering and science. Areas of emphasis in his teaching and research activities include control of chemical contaminants in water supplies through source control and conventional and advanced treatment technologies; sources and transformations of organic chemical contaminants in water supplies, including disinfection byproducts, pesticides and their metabolites, taste- and odor-causing compounds, and algal toxins; lake and reservoir management as it pertains to water supply and water quality; water recycling and reuse for potable and non-potable purposes; and management of water associated with oil and gas production (produced water). His sources of research funding during the past two years were the National Science Foundation, the U.S. Environmental

Protection Agency (EPA), the Water Research Foundation, the Kansas Water Office, Black & Veatch, and assorted drinking water utilities. He is a member of the American Water Works Association (AWWA), the American Association for the Advancement of Science, the Association of Environmental Engineering and Science Professors, the North American Lake Management Society, the Water Environment Federation, and the International Water Association. Dr. Randtke has served as a member of the Research Advisory Council of the AWWA Research Foundation (1986-1988), President of the Association of Environmental Engineering and Science Professors (1994-95), Chair of the Research Division of the American Water Works Association (1995-1998), Technical Editor for the 5th edition of Water Treatment Plant Design (2012; prepared under the auspices of AWWA and the American Society of Civil Engineers), Chair of the Kansas Section of AWWA (2013-2014), as a member of the Drinking Water Committee of EPA's Science Advisory Board (2009-2016). He previously served on the SAB's Hydraulic Fracturing Study Plan Review Panel (2010-2011), Drinking Water Committee Augmented for the Review of the Effectiveness of Partial Lead Service Line Replacements (2011), Hydraulic Fracturing Research Advisory Panel (2013-2017). He frequently provides expert advice to utilities, consultants, public officials, and others seeking practical solutions to a broad array of environmental problems.

Rangan, Cyrus

Los Angeles County Department of Public Health

Cyrus Rangan MD, FAAP, FACMT, graduated from the Medical College of Pennsylvania in 1995 (now Drexel University School of Medicine). He completed his residency in Pediatrics at Children's Hospital Los Angeles in 1998, and a fellowship in Medical Toxicology at University of California San Diego in 2000, with dual board-certification in Pediatrics and Medical Toxicology. He is a fellow of both the American Academy of Pediatrics and the American College of Medical Toxicology. Dr. Rangan is Director of Toxicology and Environmental Assessment Branch at the Los Angeles County Department of Public Health. He investigates community reports of environmentally related illnesses or disease clusters, and provides expert consultation and education to medical providers, hospitals, agencies, and other impacted professionals about medical issues regarding toxic exposures, hazardous materials, epidemiology, and environmental health. Dr. Rangan is also an Assistant Medical Director with the California Poison Control System, and serves as the Director of the Los Angeles Area Medical Toxicology Education Program, providing lectures and media support for hospitals, physician groups, nurses, EMT/paramedics/first responders, social workers, healthcare groups, health agencies, and schools. Dr. Rangan is also an attending physician and Medical Toxicologist at Children's Hospital Los Angeles, providing bedside consultations and clinical education to medical students, residents, and medical staff. He is the author of dozens of peer-reviewed journal articles, textbook chapters, web-based publications, and educational videos. Dr. Rangan also provides consultation to scriptwriters and news & media on Medical Toxicology topics.

Ready, Richard

Montana State University

Dr. Richard Ready is Professor of Economics at Montana State University. Previously, he was a faculty member at Pennsylvania State University, the Norwegian University of Life Science, and the University of Kentucky. Dr. Ready received an M.A. and a Ph.D. in Agricultural and Resource Economics from the University of Wisconsin and a B.S. in Fishery Science from Cornell University. Dr. Ready's research focuses on the economic valuation of ecosystem services with particular emphasis on how ecosystem services are affected by land use change, climate change, and invasive species. Dr. Ready's research integrates models of ecological, geophysical, and demographic processes into economic valuation models to evaluate future changes in ecosystem services and their values, and how those values would be affected by policy actions. He has served on editorial boards of Land Economics and American Journal of Agricultural Economics. Dr. Ready's research has been

supported by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture, the U.S. Forest Service, and the U.S. Army Corps of Engineers.

Rhomberg, Lorenz

Gradient

Lorenz R. Rhomberg, Ph.D. Fellow ATS, is a Principal at Gradient, an environmental consulting firm based in Cambridge, Massachusetts, where he specializes in critical review of toxicological information, weight-of-evidence evaluation, human health risk assessment, quantitative risk analysis, and science policy issues for environmental and consumer chemical exposures. He is a member of several scientific societies, including the Society for Risk Analysis, for which he served as a Councilor (2002-2004), and as President of the New England Chapter (1997-1998), as well as the Society of Toxicology, serving as a Councilor of the Risk Assessment Specialty Section (2003-2005), Councilor for the Regulatory and Safety Evaluation Specialty Section (2012-2014), and on the Scientific Program Committee (2016 to present). He served on the Chemical Assessment Advisory Committee (2013-2108), a standing committee of the U.S. Environmental Protection Agency (EPA) Science Advisory Board. Before joining Gradient in 1999, he was on the faculty of the Harvard School of Public Health. From 1984-1994 he was a risk assessor at the U.S. EPA in Washington, specializing in quantitative risk assessment. Dr. Rhomberg earned his Ph.D. in population biology from the State University of New York at Stony Brook and an Honours B.Sc. in biology from Queen's University in Ontario. He was named 2009 Outstanding Risk Practitioner of the Year by the Society for Risk Analysis, and was awarded the Arnold Lehman Award by the Society of Toxicology in 2017. He is a Fellow of the Academy of Toxicological Sciences. He has served on seven committees convened by the National Academy of Sciences, two as chair, and on several advisory panels convened by the U.S. EPA.

Richardson, Mary Jo

Texas A&M University

Dr. Mary Jo Richardson is a Regents' Professor of Oceanography and Geology and Geophysics, (2006-present) at Texas A&M University. She researches the dynamics and biogeochemistry of particle formation, sinking, resuspension, transport and deposition in the ocean from the continental shelf to the deep sea and from surface waters to the seafloor. She seeks to quantify particulate organic carbon (POC) in the ocean through the development of algorithms from satellite ocean color that are sea-truthed with in-situ POC and transmissometer data to unravel global ocean processes of carbon recycling. She is dedicated to increasing the participation and advancement of women in academic science and engineering careers as well as increasing diversity in Geoscience disciplines and improving Geoscience education opportunities through enhanced undergraduate and graduate experiences. Dr. Richardson obtained her Ph.D. from the MIT/WHOI Joint Program in Oceanography in 1980 and has served in professorial and academic administrative roles at Texas A&M University. She has lived in Greece (4 months) while on faculty development leave in 2009 and led a geoscience-based study abroad program at Texas A&M University's Santa Chiara Center in Castiglion Fiorentino, Italy during fall 2011. Dr. Richardson is an award-winning teacher receiving the Texas A&M University's Association of Former Students Teaching Award in 1991 and 2016. She has served on advisory committees for the National Science Foundation and on the Board of Trustees for the University Corporation for Atmospheric Research.

Rodewald, Amanda D.

Cornell University

Amanda D. Rodewald is the endowed Garvin Professor and Senior Director of Conservation Science at the Cornell Lab of Ornithology and the Department of Natural Resources at Cornell University. Prior to joining the Cornell faculty in 2013, she spent 13 years as a professor in the School of

Environment and Natural Resources at The Ohio State University. Dr. Rodewald received a B.S. in Wildlife Biology from University of Montana (1992), an M.S. in Zoology from University of Arkansas (1995), and a Ph.D. in Ecology from Pennsylvania State University (2000). She is a fellow of the American Association for the Advancement of Science, American Ornithological Society, Peter Wall Institute for Advanced Studies, Public Voices, and the CIC Academic Leadership Program. Her leadership roles have included serving on the Science Advisory Board of US EPA, the Scientific Review Committee of the National Socio-environmental Synthesis Center (SESYNC), nominating committee of the American Association for the Advancement of Science, council of the American Ornithologists Union, editorial boards of scientific journals, and the Faculty Advisory Board for the Atkinson Center for a Sustainable Future. Dr. Rodewald has built an interdisciplinary, international research program in ecological and sustainability sciences that addresses global challenges linked to changing climate, land cover, and human activities in temperate and tropical working landscapes that need to serve both social and ecological needs. Since 2000, she has generated nearly $8 million in research funding, including competitive awards from National Science Foundation. She has published 125 scientific papers, 9 book chapters, as well as many popular outreach articles for broad audiences, and she consistently extends and applies her research through programs for managers, decision-makers, community members, and private sector partners. Dr. Rodewald also contributes to the national and state-level environmental decision-making process in her ad-hoc advisory and panel roles with National Science Foundation, USDA Forest Service, U.S. Fish and Wildlife Service, Ohio Department of Natural Resources, and North American Bird Conservation Initiatives.

Rohrs, Allison

Saint Francis University Institute for Energy

Allison Rohrs serves as the Executive Director at the Saint Francis University Institute for Energy in Loretto, Pennsylvania. As Director, Ms. Rohrs manages multiple energy related projects that include: providing renewable energy assessments and energy audits to agricultural producers and small businesses; wind energy data collection and wind farm development assistance; local and state energy policy research; developing curriculum and teaching under the energy technology and policy minor program at SFU; and providing community outreach and education on a variety of environmental and energy topics. Ms. Rohrs holds a Master's degree in Energy and Mineral Engineering from Penn State and a Bachelor's degree from the University of Colorado in Environmental Science. Ms. Rohrs' graduate research was partially funded by the Wind Energy Foundation and focused on the construction aspects and economic analysis of wind farm decommissioning which was inspired by her work in the field as a wind turbine technician. She has been recognized by the Women of Wind Energy as a Rudd Mayer Fellow for outstanding personal commitment and potential to advance the field of renewable energy. Ms. Rohrs spent the early years of her career working for the U.S. Fish and Wildlife Service as well as working in Grand Teton National Park. Her experience in the Natural Resources field led to a passion to preserve the planet and ultimately a career in Energy.

Rosen, Barry

Wayne State University

Dr. Barry P. Rosen is Professor and Chairman of the Department of Biochemistry and Molecular he was Professor in the Department of Biological Chemistry at the University of Maryland School of He received his B.S. degree (1965) from Trinity College, Hartford, CT, M.S. (1968) and Ph.D. (1969) from the University of Connecticut. He was an NIH fellow at Cornell Dr. Rosen's honors include Basil O'Connor Awardee, March of Dimes, 1974-1976; Maryland Distinguished Young Scientist Award, 1979; Josiah Macy, Jr. Faculty Scholar, 1980-1981; Honorary Professor, 1991, Academia Sinica, Institute of Zoology, Beijing, China; Distinguished Faculty Fellow, Wayne State University, 1997; Outstanding Graduate Mentor Award, Wayne State University; 1999; Dr. Rosen is a member of the editorial boards of the Journal of Biological Chemistry, Biometals, Drug Resistance Updates. He

was formerly on the editorial board of the Journal of Bacteriology and Microbiological Reviews. member of grant advisory committees for NIH, NSF, American Heart Association, Canadian Foundation for Innovation, and the Veterans Administration. He has organized numerous international meetings, including chairing a 2004 Gordon Research Conference. 230 papers, reviews and chapters. Dr. Rosen is a sought-after speaker and, over the last two decades has given more than 200 presentations at universities, national and international symposia Dr. Rosen's research accomplishments span four decades. His laboratory focuses on the mechanisms of gene regulation, transport and detoxification of toxic metals, including arsenic, antimony, copper, cadmium and lead. He has elucidated the pathways for arsenic detoxification in prokaryotes and eukaryotes, including the first identification of the pathway of arsenic uptake in human cells such as those in the blood-brain barrier. He identified the transporter that takes up the arsenical drug Trisenox that is used to treat leukemia. He has genetically engineered both plants and microorganisms for arsenic bioremediation of soil and water (patent pending). He has cloned, expressed and characterized many enzymes and proteins of arsenic metabolism, including arsenic reductases, methylases and transcription factors, and has determined the three-dimensional structure of several.

Rosenberg, Andrew A.

Union of Concerned Scientists

Andrew A. Rosenberg is director of the Center for Science and Democracy at the Union of Concerned Scientists. He has more than 25 years of experience in government service and academic and non-profit leadership. He is the author of scores of peer-reviewed studies and reports on ecology and natural resource management and has published on the intersection between science and policy making. He has extensive expertise in environmental science, statistical modeling, the development and implementation of scientific integrity policies and transparency in government. Dr. Rosenberg previously served as Chief Scientist at Conservation International, Dean of Life Sciences and Agriculture at the University of New Hampshire and Deputy Director of NOAA's National Marine Fisheries Service. Dr. Rosenberg appointed to serve on the US Commission on Ocean Policy by President G.W. Bush. He served on the Ocean Studies Board of the National Academy of Sciences, the US Navy Ocean Research Advisory Committee and the National Academy's America's Climate Choices study. Dr Rosenberg also served on the advisory committee for the US National Climate Assessment and was the convening lead author of the oceans chapter. He was also a lead author for the UN World Ocean Assessment. Dr. Rosenberg received his Ph.D. in biology from Dalhousie University in Halifax, Canada, and an M.S. in Oceanography from Oregon State University. In his current position Dr. Rosenberg is employed by a 501c3 charitable organization entirely funded from members and private philanthropy.

Rosol, Thomas

Ohio State University

Thomas Rosol, DVM, PhD, MBA is a professor of veterinary and toxicologic pathology, Chair of Biomedical Sciences at the Ohio University Heritage College of Osteopathic Medicine and diplomate of the American College of Veterinary Pathologists. He has served as dean of the College of Veterinary Medicine and senior associate and interim vice president for research at Ohio State University and on advisory boards or panels to the National Institutes of Health (NIEHS, NTP, NCI, NCRR), USDA (NAREEE), EPA, FDA, and American Veterinary Medical Association, and has provided testimony to the European Chemical Agency (ECHA). Rosol serves as a consultant for industry in preclinical safety and toxicology in the areas of endocrine, bone, and reproductive pathology and animal models of cancer, and serves on the expert panel for the Flavor and Extract Manufacturer's Association GRAS reviews. Rosol is an expert in safety assessment, risk analysis, and human relevance for the toxicity of environmental chemicals, pesticides and herbicides, foods and food additives, and pharmaceuticals. Rosol chaired the international nomenclature committee for

endocrine lesions in rats and mice (2014-2018) and the monograph now serves as the basis for standardized nomenclature for regulatory documents in the United States, Europe, and Japan. The Rosol laboratory investigates the pathogenesis of animal models of human cancer and metabolic diseases, mechanisms and treatment of metastasis, and endocrine and bone diseases, and has been funded by the NIH (NCI, NIBIB, NIAMS) for over 30 years including two research career awards. Rosol has over 300 publications (H-index of 52; 19 papers with 100-400 citations; and 10, 000 total citations) and served as the mentor for 50 PhD students and postdoctoral trainees. The laboratory specializes in molecular, toxicologic, and genomic investigations using animal models, in vivo imaging (microCT, PET, MRI, and bioluminescence), in vitro tissue and cell cultures, and computerized machine learning for automated pathological image analysis. Rosol is an elected fellow of the American Association for the Advancement of Science and was recognized by Ohio State University as a Distinguished Scholar (one of the university's highest honors). Rosol was awarded the Annual Distinguished Mentor Award from the Society of Toxicologic Pathologists (2015) and the ACVP Distinguished Member Award (2016).

Runge, Steven

University of Central Arkansas

Dr. Steven Runge is a 1986 graduate of the University of Wisconsin-Green Bay where he majored in Biology, Chemistry and Human Adaptability. He followed his undergraduate training with graduate work at The Ohio State University where he earned a Ph.D. in Biochemistry in 1991. Dr. Runge joined the University of Central Arkansas (UCA) as an Assistant Professor in the Department of Biology in 1991, earning the rank of Associate Professor in 1995 and the rank of Professor in 2004. Dr. Runge began serving as an administrator in 2003 when he was appointed as Interim Chair of the Department of Biology. One year later he was appointed as the Chair and served in this capacity until 2009 when he was appointed as Interim Dean of the College of Natural Sciences and Mathematics (CNSM). He assumed the position of Dean of the College in July 2010. In February 2012, Dr. Runge was appointed Interim Provost and Vice-President for Academic Affairs at UCA and became Provost and Vice President for Academic Affairs in February 2013. As of July 1, 2014, he was named Executive Vice President and Provost and served in that capacity until July 31, 2017. He is currently serving as a Professor in the Department of Biology. Dr. Runge has developed and taught courses in molecular and cellular biology ranging from the freshman level through graduate offerings and, until 2014, he maintained an active research program studying cell death mechanisms in cultured breast cancer cells. Dr. Runge has also published peer-reviewed articles on his educational innovations. Dr. Runge is heavily involved in a wide variety of academic and non-academic activities at UCA and in Arkansas. He has served as Chair of the Arkansas STEM Coalition; he served as the UCA representative on the Arkansas INBRE (IDEA Network for Biomedical Research Excellence) Steering Committee and is currently a member of the Board of Directors for Arkansas Preschool Plus, Inc. Dr. Runge also served ten years on the Board of Directors for Mayflower Public Schools. He has two adult daughters, Monica and Sabrina. Monica is a graduate of UCA (Biology) and the School of Veterinary Medicine at Louisiana State University. She is a practicing veterinarian in Arizona. Sabrina is also a graduate of UCA (Creative Writing and MBA) and is currently completing the coursework in the Arkansas Coding Academy.

Ruscher, Paul

Florida State University

Dr. Paul Ruscher holds the Doctorate in Atmospheric Science from Oregon State University. As a member of the faculty at Florida State University since 1988, he has had extensive experience in teaching, research, and professional service across the atmospheric sciences. In particular, his research on mesoscale coastal processes has included work on air quality modeling and assessment of air pollution events, including ozone precursors and high exceedance episodes, statistical analysis,

mercury transport issues (atmosphere), and also the teaching of air pollution meteorology (undergraduate) and atmospheric chemistry (graduate, interdisciplinary). In addition, he has held numerous consulting positions or state advisory positions with Florida state agencies and private and non-profit entities, related to air quality and air pollution events. These are enumerated on my vita under consulting.

Sabo-Attwood, Tara

University of Florida

Tara Sabo-Attwood, PhD is an Associate Professor and Chair of the Department of Environmental and Global Heath, College of Public Health and Health Professions and Center of Environmental and Human Toxicology at the University of Florida (UF). She has broad expertise in environmental molecular toxicology with an emphasis on water and airborne contaminants. She earned a B.S. in genetics and Ph.D. in Biomedical Sciences, Pharmacology and Toxicology as a National Institute of Health (NIH) Fellow from UF and was awarded a NIH Postdoctoral Fellowship at the University of Vermont in Pulmonary Pathology. Dr. Sabo-Attwood's research centers on elucidating how pollutants, both historical and emerging (asbestos, endocrine disruptors, nanomaterials) perturb molecular pathways that contribute to adverse health outcomes. Her work encompasses aquatic and mammalian models and spans controlled laboratory approaches and field projects. Her current work focusses on the innate immune system as a target of inhaled or dietary chemical exposure with an emphasis on susceptibility of organisms to pathogenic infections. Based on her contributions she was named a Kavli Fellow in Nanotechnology by the National Academy of Sciences (NAS). Her work is currently funded by the NIH, National Science Foundation (NSF), and the US Department of Agriculture (USDA). In addition to her research contributions, Dr Sabo-Attwood teaches courses in environmental health, one health, toxicology and has trained numerous masters and doctoral students. She serves in several leadership positions including Director of Graduate Programs, Department Chair and elected Councilor for the Nanotoxicology Specialty Section Board for the Society of Toxicology (SOT). She participates on international and national advisory committees including the International Academy of Sciences, routinely participates on Environmental Protection Agency (EPA), NIH, and NSF review panels, is an associate editor for Nano Impact Journal and a long standing member of Society of Toxicology and Chemistry (SETAC) and SOT

Sagers, Cynthia

Arizona State University

Cynthia Sagers has served as the Vice President for Research at Oregon State University since August 31, 2015. As Vice President, Sagers provides leadership to OSU's vast research enterprise, which last year brought in $441 million in research grants and contracts in areas including agriculture, forestry, marine sciences, public health, and engineering. Sagers also works with academic leaders and the University community to expand OSU's entrepreneurial and economic development activities with industry and other public and private partners. An ecologist by training, Dr. Sagers earned two bachelor's degrees from the University of Iowa and a Ph.D. from the University of Utah. She launched her academic career in 1994, joining the faculty of the University of Arkansas, where she developed expertise in crop systems and the evolution of aggressive plant pests. She earned a Research Associateship from the National Research Council in 2005 to work with the U.S. Environmental Protection Agency's National Health and Environmental Effects Laboratory in Corvallis, Oregon. When she returned to Arkansas, she served as state commissioner for the governor's Global Warming Commission, and in 2010, she was named program officer for the National Science Foundation's Office of International Science and Engineering, and later the Directorate for Environmental Biology. In 2012, Dr. Sagers was named Associate Vice Provost for Research and Economic Development at the University of Arkansas. In just two years, she helped the university increase research awards by 30 percent. Joining OSU in 2015, she has marshalled steady growth of the research enterprise, including

three successive years of record research awards. She currently serves on a number of advisory boards for research and economic development entities in the region, including Business Oregon, CleanTech Alliance, Oregon Nanoscience and Microtechnologies Institute and Oregon Built Environment and Sustainable Technologies Center, Inc. In September 2018, Sagers will join Arizona State University where she will assume the role of Vice President for Research.

Saiers, James

Yale University

Professor Saiers studies water quality and supply. He runs experiments, collects observations, and develops models to illuminate how human activities affect the chemical composition of drinking water resources and alter freshwater flows within aquifers, wetlands, and river basins. His recent research projects address water quality impacts of fossil fuel development, carbon and nutrient transport through watersheds, radionuclide migration in groundwater, and climate change effects on water resources in Africa. This research is executed collaboratively with students, postdoctoral associates, and faculty from Yale and other Universities. Professor Saiers' teaching addresses various applied and theoretical aspects of surface water and groundwater hydrology.

Sakaji, Richard

Independent Consultant

Although recently retired as Water Quality Manager for the East Bay Municipal Utility District, Dr. Richard Sakaji recently joined the State Water Resources Control Board, Division of Drinking Water to work on a variety of drinking water quality and public health issues. In his former positions, his activities ranged from reviewing and providing guidance on testing or study protocols in the subject areas of treatment technology and invasive species to serving on technical committees that aid in the establishment of drinking water regulations and public policy. To this end he has reviewed technical protocols for U.S. EPA's Environmental Technology Verification program and for the National Sanitation Foundation for their technical merit. His educational background includes marine biological sciences (A.B., University of California, Berkeley), environmental engineering (M.S. and Ph.D., University of California, Berkeley). Throughout his career, he has brought a public health perspective to various advisory committees and workgroups, such as those serving the National Academy of Sciences, the National Water Research Institute, the Water Research Foundation (formerly the American Water Works Association Research Foundation, and the U.S. EPA. He has also represented the California Department of Public Health as a representative on the Santa Ana River Water Quality and Health Study. He has worked with the National Water Research Institute/AWWA Research Foundation in the development of their ultraviolet disinfection guidelines.

Salvito, Daniel

RIFM

Dr. Daniel Salvito is the Research Institute for Fragrance Materials' (RIFM) Science Fellow for Environmental Sciences and Computational Chemistry. Dr. Salvito started his career with RIFM in 1999 and has led their efforts in establishing a program to study the environmental fate and effects of organic compounds in the environment. Prior to his joining RIFM, he worked extensively for Public Service Electric and Gas on water quality and permitting issues. He has a strong technical background in the fate and effects of organic chemicals in the environment, development and application of tools for environmental risk and hazard assessment, bioaccumulation science, approaches for risk assessing multicomponent substances, methodological development for the use of chemical similarity in toxicology and ecotoxicology, and the use of animal alternatives in ecotoxicology. He has extensive knowledge of national and international regulatory programs on chemicals management and water quality. Dr. Salvito has served on several external scientific committees including the New Jersey Department of Environmental Protection Drinking Water Quality Institute, the Scientific Committee

of the European Center for Ecotoxicology and Toxicology of Organic Chemicals, the Health and Environmental Sciences Institutes' Environmental Risk Assessment of Multi-constituent Substances Project Committee, and ECHA's REACH Implementation Project on Chemical Categories. He currently serves as an editor for Environmental Toxicology and Chemistry. He has published numerous research papers in the peer-reviewed literature and has presented at national and international conferences. Dr. Salvito received his Ph.D. from Rutgers University in Environmental Sciences, his M.S. in Chemistry from SUNY at Stony Brook, and his B.S. in Chemistry from Adelphi University. His research has been funded solely by RIFM.

Santelmann, Mary

Oregon State University

Dr. Mary Santelmann is currently the Director of the Water Resources Graduate Program and Research Faculty at the Department of Geosciences Oregon State University. Academically, she holds three degrees: PhD in Ecology University of Minnesota, Minneapolis, MN, M.S. in Biology University of Michigan, Ann Arbor, MI and B.S. in Botany University of Minnesota, Minneapolis, MN (Honors College). In addition to her affiliation at the Water Resources Graduate Program, she is a member of International Association for Landscape Ecology, American Water Resources Association, Society of Wetland Scientists, British Ecological Society, Ecological Society of America and The Nature Conservancy. Her current research includes Ecosystem response to human land use and management practices; Environmental and anthropogenic influences on species composition and species richness in agricultural, urban and wetland ecosystems and Ecology and biogeochemistry of wetlands and riparian systems.

Savitz, David

Brown University

Dr. David Savitz is Professor of Epidemiology, with joint appointments in Obstetrics and Gynecology and Pediatrics at Brown University, where he previously served as Vice President for Research. He has held faculty appointments at the University of Colorado School of Medicine, the University of North Carolina School of Public Health where he served as the Carey C. Boshamer Distinguished Professor and Chair of the Department of Epidemiology, and as the Charles W. Bluhdorn Professor of Community and Preventive Medicine at Mount Sinai School of Medicine. Dr. Savitz received his undergraduate training in Psychology at Brandeis University and a Masters degree in Preventive Medicine at Ohio State University, and his PhD in Epidemiology from the University of Pittsburgh Graduate School of Public Health. He was elected to membership in the Institute of Medicine in 2007. He has served on 11 National Academy of Medicine Committees and was Chair of 4 of those, all of which concerned environmental health issues. Dr. Savitz's research is focused on reproductive and environmental epidemiology. He has conducted studies of the causes of adverse pregnancy outcome, including miscarriage and preterm birth, as well as pregnancy complications, birth defects, and child health problems. His environmental interests include a wide range of chemical and physical exposures, including perfluorinated chemicals, pesticides, drinking water treatment by-products, and non-ionizing radiation. In addition to his substantive expertise in environmental epidemiology, Dr. Savitz has strong methodologic expertise and has authored a book on the application of epidemiologic research, Interpreting Epidemiologic Evidence: Connecting Research to Applications. Dr. Savitz serves as Chair of the Research Committee of the Health Effects Institute and as Co-Chair of the Scientific Advisory Board of ISGlobal, the Barcelona Institute for Global Health. During the past two years, his research support has come from the National Institutes of Health.

Schneider, David

Memorial University

Dr. David C. Schneider is a Professor at the Department of Ocean Sciences, Memorial University of Newfoundland, St. John's, Canada. His area of expertise is biological oceanography and the impact of human activities on the coastal marine environment. His research activity in benthic habitats include rates of recolonization after physical disturbance, impact of predators on benthic assemblages, and the development of environmental monitoring programs in relation to oil extraction and to at sea-disposal of dredge spoils. His research activities in pelagic habitats include physical oceanographic determinants of the distribution and dynamics of fish and marine birds. Of particular note is a history of collaboration with sociologists to understand the course of interactive restructuring of marine ecosystems, a sequential process of initial impact, environmental change, and subsequent interactive effects in response to environmental change. He has published over 120 refereed articles and book chapters in biological oceanography, coastal processes, spatial scaling as it influences measurement in marine systems, contaminants in the aquatic environments (oil, methyl mercury, mining dust). He has 25 years cumulative experience on advisory panels: Science Advisory Council for the EPA multiscale ecosystem project, the Scientific Review Committee to monitor and assess the impact of low-level jet training, the Science Advisory Board for the Caribou Research Program (Newfoundland Dept. of Environment), the Validation Monitoring Panel (fisheries impacts) at the University of Washington, and the Science Advisory Board to address nutrient loading in south Florida waters (EPA). He 12 cumulative years experience providing statistical advice as a consultant to: Mobil Consortium (Hibernia), Newfoundland Transhipment Facility, US National Park Service, Environment Canada, Baffinland Iron Mines. Of particular note is development of a gradient monitoring design for point source contaminants at the Hibernia site, a design that became standard for oil development projects in eastern Canada.

Sherman, Michael

North Carolina Farm Bureau Federation

M. Paul Sherman is the Associate State Legislative Director with the North Carolina Farm Bureau Federation (NCFB). In this position, he represents NCFB's 500, 000+ member families on engineering, air quality, energy, renewable energy, global climate change, transportation, and other regulatory issues. In this capacity, Paul has advocated for North Carolina's farmer and rural citizen energy interests through participation on many stakeholder groups, boards, and commissions such as: North Carolina's Strategic Plan for Biofuels Leadership, NC Legislative Commission on Global Climate Change, NC Legislative Subcommittee on Offshore Energy Exploration, NC Agricultural Open Burning Stakeholder Group, and NC Idle Reduction Stakeholder Group. Paul has served or continues to serve on the boards of the NC Irrigation Society and the NC State University Biological and Agricultural Engineering department advisory board. He was the agricultural representative during the development and ongoing implementation of the NC Renewable Energy and Energy Efficiency Portfolio Standard. Paul was the project administrator for the NC Farm Energy Efficiency Project where he facilitated farm energy audits and farm scale renewable energy projects including wind, solar, swine methane, and hydro putting farmers in control of their own energy use and production. Paul attended North Carolina State University where he earned a Bachelor of Science degree in Biological and Agricultural Engineering. He is certified as a Professional Engineer in North Carolina. His previous work experience includes livestock confinement design, construction engineering, animal waste management, and environmental permitting. Prior to joining Farm Bureau, Paul worked for the North Carolina Department of Environment and Natural Resources where he directed the animal waste permitting program and served on the technical advisory panel researching alternative swine waste treatment options (Smithfield Agreement). No research funding was received for these activities.

Shipp Hilts, Asante

New York State Department of Health

Dr. Asante Shipp Hilts is the Senior Project Coordinator for the CDC funded Climate Ready States and Cities Initiative within the Office of Public Health Practice at the New York State Department of Health (NYSDOH), where she coordinates research to evaluate the impacts of Hurricane Sandy and other Climate and Health initiatives. Dr. Shipp Hilts has presented her Sandy research and led a dissemination workshop at the 2015 Hurricane Sandy Conference: Translating Research into Practice. Her Sandy research has been published in the Disaster Medicine and Public Health Preparedness Journal, Environmental Law in New York, the Journal of Emergency Management and the Assistant Secretary for Preparedness and Response Hurricane Sandy Recovery Science Newsletter. Dr. Shipp Hilts is a member of the National Institute of Health Best Practices Working Group for the development of special considerations for Institutional Review Board (IRB) review of disaster and emergency related public health research. She is also on the CDC Disaster Epidemiology Curriculum Development Committee. Dr. Shipp Hilts previously served as the Director of a County Health Department in NYS that was devastated by both Hurricane Irene and Tropical Storm Lee. Asante has worked in public health evaluation and research in New York at the community, local and state level and was appointed to the NYSDOH IRB. Dr. Shipp Hilts is an Assistant Professor in the Epidemiology and Biostatistics department at the University at Albany, State University of New York, where she earned her BS in Biology, MPH in Epidemiology, and Doctor of Public Health degrees.

Simon, Ted

University of Georgia

Dr. Ted W. Simon operates a solo consulting practice in Winston, GA near Atlanta. He holds a B.A. in Biology from Middlebury College and a Ph.D. in Neuroscience from Georgia State University. Dr. Simon worked at EPA's Region 4 offices from 1993 until 2006. There he served as the senior toxicologist in the Waste Management Division. At EPA, he was a lead author of Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment. He also received bronze medals for his work on the Base Realignment and Closure effort and for a method for assessing the efficacy of institutional controls for risk mitigation at military facilities. After leaving EPA, he has provided consultation to clients in both the public and private sectors including the Ontario Ministry of the Environment, Health Canada, trade associations including the American Chemistry Council and the European Chemical Industry Council, and others. He has served as a peer reviewer for the journals Regulatory Toxicology and Pharmacology, Environmental Health Perspectives, Critical Reviews in Toxicology and a number of other journals. He has been a member of the Society of Toxicology since 1993. Dr. Simon is the author of over 40 scientific publications including a graduate level textbook, Environmental Risk Assessment: A Toxicological Approach publishing in 2014 by Taylor and Francis. His scientific interests include: 1) the use of dose response analysis to inform mode of action; 2) Bayesian methods for characterizing uncertainty in risk assessment; and 3) endocrine-active substances. Over the past four years, he has received consulting fees from corporations in the US and England, attorneys in the US, and government entities such as the Los Angeles County Sanitation Division and the Fairfax County Virginia Police Department. He is not currently a recipient of research grants from the Environmental Protection Agency, other federal agencies, or the private sector.

Skoglund, Robert

Covestro LLC

Dr. Robert Skoglund is the Head of Product Safety and Regulatory Affairs for Covestro LLC, a world-leading manufacturer of high-tech polymer materials. In addition, he holds an adjunct faculty appointment in the Department of Environmental Health Sciences of the Richard M. Fairbanks School of Public Health at Indiana University and adjunct faculty and graduate school appointments in the

Division of Environmental Health Sciences of the School of Public Health at the University of Minnesota. Dr. Skoglund received his MS in toxicology and PhD in environmental chemistry from the University of Minnesota and is working on an MBA in sustainable business at Maryhurst University. In addition, he is certified in toxicology by the American Board of Toxicology and industrial hygiene by the American Board of Industrial Hygiene. With over 30 years of experience in regulatory and applied toxicology, environmental chemistry, and industrial hygiene, areas of proficiency include product EHS and stewardship, hazard and risk assessments, fit for purpose and alternative analyses, chemical management regulations, and sustainability, but he has not engaged in any externally funded research in the last two years. Dr. Skoglund teaches in graduate level courses, sits on MS and PhD committees, and has authored a number of peer-reviewed abstracts, papers, and book chapters. He presently serves on the EPA Science Advisory Board's chemical assessment advisory committee and on an advisory board for the NIEHS hazardous waste worker training program. Dr. Skoglund is active in various professional and trade organizations with a focus on the training of public and environmental health practitioners, the funding of student research, and advocacy for science-based regulations.

Smith, Eric

Virginia Tech

Dr. Eric Smith is a professor in the Virginia Tech Department of Statistics. An acknowledged expert in the application of statistical methods to environmental and ecological applications, he is the author or coauthor of more than 120 peer reviewed papers, 45 book chapters, and two books, Dr. Smith is a Fellow of the American Statistical Association, an Elected member of the International Statistics Institute, and he has received the Distinguished Achievement Award from the American Statistical Association's Section on Environmental Statistics. Dr. Smith has served on eleven workshops, panels and committees, including: * Panel Member for EPA's Science Advisory Board review of Lake Erie Phosphorus Levels (2015-16) * Member NRC Panel on Effective Approaches for Monitoring and Assessing Gulf of Mexico Restoration Activities (2015-16) * Panel member for the Scientific Advisory Board reviewing EPA's technical support document: National-Scale Mercury Risk Assessment Supporting the 25 Appropriate and Necessary Finding for Coal and Oil-Fired Electric Generating Units (2011). * Deepwater Horizon SEAMAP Surveys Planning Committee Workshop (2010).

Stevenson, David

Caesar Rodney Institute

David T. Stevenson is an economist (Bachelor of Science in Agricultural Economics from Rutgers University), served on the Environmental Protection Agency Presidential Transition Team, and has worked in the field of energy and environmental policy as an analyst for the last seven years at the Caesar Rodney Institute, a state policy think tank. Stevenson led six major business development projects at the DuPont Company and has founded six businesses as an independent entrepreneur providing a strong perspective for balancing economic development and environmental regulation. He has been involved in numerous Public Service Commission dockets as an intervener and consultant, providing guidance on Solar Renewable Energy Credit auctions, electric grid resilience and reliability, electricity and natural gas pricing and service expansion, and electric supply strategies. He has analyzed Delaware's compliance with National Ambient Air Quality Standard's on six criteria pollutants and ozone down to the individual Air Quality Monitoring Station level. He has extensive experience with cost versus benefit analysis, including for proposed Environmental Protection Agency regulations. Stevenson has a strong background in conservation starting with taking the very first environmental science course offered at Rutgers University, creating the first crankcase oil recycling program and greenways land use plan as Conservation Commission Chairman in Southbury, CT. He was part of a team involved in creating today's solar industry in the United States and India, and also

in approving Material Safety Data Sheets as a lab supervisor for the DuPont Company. As a board member of the Delaware Home Builders Association Stevenson co-founded Delaware's Green Building Council along with building the first "gold" level green home in Delaware using the beta program of the National Association of Home Builders Green Building Program. The transition team briefing experience provided a foundational understanding of the Environmental Protection Agency priorities, organization, budget, and mandated deadlines for 2017/18. He has received no research grants in the last two years.

Stuart, Amy

University of South Florida

Amy L. Stuart, Ph.D. is a Professor at the University of South Florida (USF) in the Department of Environmental and Occupational Health, College of Public Health. She holds a joint appointment in the Department of Civil and Environmental Engineering, and courtesy appointments in the Center for Urban Transportation Research, and the Patel College of Global Sustainability. She is also the founder and director of the Graduate Certificate Program in Environmental Health at USF. Dr. Stuart earned a BS in chemical engineering, a MS in civil engineering, and a PhD in civil and environmental engineering from Stanford University. She completed postdoctoral training at the Center for International Security and Cooperation at Stanford. Dr. Stuart leads multi-disciplinary research and teaching initiatives related to air pollution, public health, and environmental sustainability. Her research has contributed to understanding the impacts of urban design and transportation on air pollution exposures and their social distribution, the fate of volatile chemicals during cloud freezing, mercury contamination and exposures, and associations between air pollution and birth defects, resulting in over 100 scholarly publications. During the last two years, Dr. Stuart's work has been funded by the National Institute of Environmental Health Sciences and by the United States Department of Transportation. She is also a previous recipient of a National Science Foundation Career award. Dr. Stuart is professionally involved in the Association of Environmental Engineering and Science Professors, currently serving on the Lectures Committee. She is a member of the Air and Waste Management Association, including previous service as the Chair of the Student Awards Committee of the Higher Education Council, and is a member of the International Society of Exposure Sciences. She regularly serves as a reviewer of manuscripts for several scientific journals and of proposals for grant sponsors on air pollution topics.

Stubblefield, William

Oregon State University

Dr. William Stubblefield is a senior research professor in the Department of Molecular and Environmental Toxicology at Oregon State University. Dr. Stubblefield has more than 25 years of experience in environmental toxicology, human and environmental risk assessment, derivation of water, sediment and soil criteria, and aquatic and wildlife toxicology studies. He has authored more than 50 peer-reviewed publications and technical presentations in the areas of aquatic and wildlife toxicology and risk assessment. He has conducted a variety of research programs aimed at the evaluation of the toxicity of metals and hydrocarbons in the environment. Dr. Stubblefield's research has examined acclimation induced changes in the responses of aquatic organisms to copper, zinc, and cadmium; evaluated the acute and chronic toxicity of manganese, cobalt, aluminum, methyl tert-butyl ether, petroleum hydrocarbon mixtures, and a variety of other compounds; quantified the effects of water quality characteristics, e.g., hardness, alkalinity, dissolved organic carbon, on the toxicity of several metals (e.g., nickel, lead, and silver). His current research examines methods/models that can be used to predict the toxicity of metals and hydrocarbons to aquatic organisms. Current sources of research funding include the Cobalt Development Institute, the European Aluminum Association, Iron Platform, and British Petroleum. Dr. Stubblefield is an active member of the Society of Environmental Toxicology and Chemistry (SETAC), where he served as President of the Society, member of the

Society's Board of Directors, chairman of the SETAC's Metals Advisory Group, and member of the Editorial Board for Environmental Toxicology and Chemistry. He has been an invited participant at a number of national and international scientific and regulatory conferences, served on U.S. EPA and National Institute of Environmental Health Sciences (NIEHS) peer-review panels, and frequently acts as a technical reviewer for a number of scientific publications. Dr. Stubblefield has a Ph.D. in Zoology and Physiology (emphasis in Environmental Toxicology) from the University of Wyoming, a M.S. degree in Toxicology/Toxicodynamics from the University of Kentucky, and a B.S. in Biology from Eastern Kentucky University.

Suski, Jamie

EA Engineering, Science, Technology, Inc., PBC

Dr. Suski is a senior scientist within the Department of Water and Natural Resources at EA Engineering, Science and Technology, Inc., PBC. She has been in this position 1.5 years and has successfully secured one million dollars in project funding. The projects support both industry and federal government clients. Industry projects are focused on the efficacy and safety of antiseptic agents for consumer and healthcare users and federal client projects include laboratory and desktop research on the effects of contaminates to wildlife receptors including species listed as threatened and endangered (T&E). Specifically, Dr. Suski (Principle Investigator) was recently awarded funding to investigated potential risk to T&E species that occupy habitat on military sites contaminated with per- and polyfluoroalkyl substances (PFAS) and is a co-PI on research evaluating physiological, ecological and environmental determinants of PFAS uptake in fish. Dr. Suski received her Master of Science degree from University of Maryland in environmental toxicology and her Doctoral degree from Texas Tech University in Ecology with a focus on Eco-physiology. She did her post-doctoral studies with Dr. Christopher Swan at University of Maryland Baltimore County focusing on aquatic community responses to pesticides. She currently serves as an active member on the Interstate Technology Regulatory Council (ITRC), PFAS team as an expert in the field of ecotoxicology. Her role involves writing technical regulatory documents and fact sheets for the ITRC. She also serves on the board of the regional chapter of the Society of Environmental Toxicology and Chemistry (SETAC). She is a professional reviewer for a number of peer-reviewed journals including, Environmental Toxicology and Chemistry, Science of the Total Environment and Journal of Environmental Management.

Tan, Shirlee

King County Dept Public Health

Shirlee Tan, PhD has been working in the field of science policy for over 17 years, with a focus on the effects of chemicals on human health. Her career has primarily focused on chemical regulation and science policy at the national, international, and now local levels. Her early career began at the US Environmental Protection Agency (EPA) where she served as an Environmental fellow for the American Association for the Advancement of Science and has since worked for the Smithsonian Institution, the EPA, the Organization for Economic Cooperation and Development (OECD) in Paris, France, as an independent consultant to the OECD and the Endocrine Society, and now as the lead toxicologist for Public Health Seattle and King County.

Tharakan, John

Howard University

Dr. John Tharakan is Professor of Engineering in the Department of Chemical Engineering at Howard University, College of Engineering and Architecture. He has served as Chair, Director of Graduate Studies and is founding Faculty Adviser, Engineers Without Borders, HU Chapter. He received his BS (chemical engineering) at Indian Institute of Technology, Madras, MS and PhD in Engineering Science (Biochemical Engineering) from the University of California, San Diego, with post-doctoral training at American Red Cross, Plasma Derivatives Laboratory and then appointed Research

Scientist, prior to joining Howard. His research expertise is in environmental engineering and biotechnology, appropriate technology development, engineering education, sustainable development and ethics in science and engineering, with funding from US EPA, DOD and NSF. He was Fulbright Senior Scholar, India ('06-'07), researching biological methods of waste treatment in South India. With Engineers Without Borders, he has worked on clean water, sanitation and renewable energy technology implementation in Senegal, Kenya and El Salvador. Dr. Tharakan is Co-Chair of an on-going series of biennial International Conferences on Appropriate Technology held across Africa facilitating knowledge and technology transfer for social justice, and has served as Editor for published conference proceedings. He was Fulbright-Nehru Senior Scholar ('15-'16) at Cochin University of Science and Technology, India, researching social impact assessment of innovative technology implementation. Dr. Tharakan has authored over 50 peer-reviewed papers and book chapters. He teaches undergraduate and graduate engineering courses in chemical, environmental and bioprocess engineering, hazardous waste treatment, and appropriate technology. Dr. Tharakan served two terms on the Executive Committee of the Board of Scientific Counselors and on the BOSC-EC Subcommittee on Safe and Healthy Communities. Dr. Tharakan has served on the editorial and review boards of scientific journals, government agencies and academia, and has chaired sessions at national and international scientific and engineering conferences. His research over the past two years has been funded by Department of State Fulbright program, and his EWB service by various Foundations.

Theis, Thomas

University of Illinois at Chicago

Thomas L. Theis is Professor of Civil and Materials Engineering and Director of the Institute for Environmental Science and Policy (IESP) at the University of Illinois at Chicago. IESP focuses on the development of new cross-disciplinary research initiatives in the environmental area. He was previously at Clarkson University, where he was the Bayard D. Clarkson Professor and Director of the Center for Environmental Management. He is past editor of the Journal of Environmental Engineering, and served on the chartered Science Advisory Board of the USEPA from 2000-2009. His areas of expertise include the mathematical modeling and systems analysis of environmental processes, industrial pollution prevention, industrial ecology, material flow analysis and life cycle assessment, the environmental chemistry of trace organic and inorganic substances, interfacial reactions, subsurface contaminant transport, and hazardous waste management.

Thomas, Evan

University of Colorado at Boulder

Dr. Evan Thomas is the Director of the Mortenson Center in Engineering for Developing Communities, and holds the Mortenson Endowed Chair in Global Engineering at the University of Colorado at Boulder. He is an Associate Professor in the Civil, Environmental and Architectural Engineering Department. He has a technical background in water and air quality and treatment across a range of applications from developing communities to operational spacecraft. He has founded several companies based on these activities, including SweetSense Inc. which is presently supported by USAID and the National Science Foundation to develop and apply satellite connected remotely monitored sensors for drinking water services and quality in developing countries. His team is presently monitoring a million people's water supply across east Africa on a daily basis. Dr. Thomas was previously an Associate Professor at Portland State University. As Chief Operating Officer of DelAgua Health from 2012-2016, where he was responsible for conceptualizing, designing and operating a $25 million dollar public health intervention in Rwanda in partnership with the Government of Rwanda. The program reached 350, 000 households with cookstoves and 102, 000 households with water filters, across over 7, 500 villages and 1.6 million people. Dr. Thomas was previously a civil servant at the NASA-Johnson Space Center in Houston, Texas from 2004-2010, working on microgravity fluid management technologies and water recovery systems. He has a PhD in

Aerospace Engineering Sciences from the University of Colorado at Boulder, is a registered Professional Engineer, and has a Masters in Public Health from the Oregon Health and Science University. His research has been funded by the National Science Foundation, the World Bank, the United States Agency for International Development, the United Nations Foundation, the United States Centers for Disease Control and Prevention, the United Kingdom Department for International Development, the Gates Foundation, and others.

Thurston, George

New York University

Dr. George Thurston is a Professor at the New York University School of Medicine's Department of Environmental Medicine, where he is Director of the Program in Human Exposure Assessment and Health Effects. He received his Bachelor of Science in Engineering from Brown University (with Honors), and his Masters and Doctorate in Environmental Health Sciences from the Harvard University School of Public Health. He has been a faculty member at the New York University School of Medicine since 1984. He has previously served on the EPA's CASAC Committee on NOx and SOx from 2007 to 2010, and is presently the Chair of the American Thoracic Society's Environmental Health Policy Committee. Professor Thurston's research has focused on the human health effects of air pollution exposures. His research in recent years has been funded by the NIH through both R01 and R21 grant mechanisms, as well as under the NYU-NIEHS Center of Excellence grant. He has also received research support from the NYU/Abu Dhabi Institute for Public Health Research. Recent awards for his scientific research include: the 2012 "Haagen Smit Prize" given by the scientific journal Atmospheric Environment, and; "The Top Science Paper of 2012" by the journal Environmental Science & Technology for a Global Burden of Disease report on global particulate matter air pollution exposures around the world. In May, 2018, Dr. Thurston also received the American Thoracic Society's "Public Service Award".

Tormey, Daniel

Catalyst Environmental Solutions Corporation

Dr. Daniel Tormey is an expert in energy, water resources, and land management, and conducts environmental reviews for both government and industry. He works with the environmental aspects of all types of energy development, including oil and gas, including hydraulic fracturing, produced water management, pipelines, LNG terminals, refineries and retail facilities; and all types of electrical generation and transmission. He studies sediment transport, hydrology, water supply, water quality, and groundwater-surface water interaction. He has led over two hundred studies requiring fate and transport analysis of chemicals in the environment. He has managed studies of the environmental effects of some of the most controversial land management projects in the US including the largest dam removal, deregulation of the electrical generation industry in California, the first offshore LNG terminal, and the environmental effects of coal mine and power plant closures, including socioeconomic effects. He has studied climate change and climate change adaptation since 1994. He was on the Steering Committee of the 2015 study of the effects of Hydraulic Fracturing in California being led by the California Council on Science and Technology (CCST), led the only focused study of environmental effects of hydraulic fracturing in the country (at a Los Angeles oil field), and submitted technical reports to the EPA SAB in their consideration of the environmental effects of hydraulic fracturing. He was named by the US National Academy of Sciences to the Science Advisory Board for Giant Sequoia National Monument; is a Distinguished Lecturer for the Society of Petroleum Engineers; recipient of the 2018 SPE award for Environment, Safety, and Corporate Social responsibility; is on the review committee on behalf of IUCN for the UNESCO World Heritage Site List and member of the IUCN Geoscientist Specialist Group; is volcanologist for Cruz del Sur, an emergency response and contingency planning organization in Chile; was an Executive in Residence at California Polytechnic University San Luis Obispo; and is a Professional Geologist in California.

He has worked throughout the USA, Australia, Indonesia, China, Italy, Chile, Ecuador, Colombia, Venezuela, Brazil, Senegal, South Africa, Armenia and the Republic of Georgia. He has an active research program in volcanology, glaciovolcanic effects, volcano-seismic interaction, and biophysical risk analysis and communication. He has a Ph.D. in Geology and Geochemistry from MIT, and a B.S. in Civil Engineering and Geology from Stanford.

Trasande, Leonardo

New York University School of Medicine

Dr. Leonardo Trasande is a faculty member in pediatrics and environmental medicine at the NYU School of Medicine, and in health policy at the NYU Wagner School of Public Service. Dr. Trasande's research focuses on identifying the role of environmental and other factors in chronic childhood disease, and documenting the economic costs for policy makers of failing to prevent them proactively. Dr. Trasande is perhaps best known for a 2011 study in Health Affairs which found that children's exposures to chemicals in the environment cost $76.6 billion in 2008. His analysis of the economic costs of mercury pollution played a critical role in preventing the Clear Skies Act (which would have relaxed regulations on emissions from coal-fired power plants) from becoming law. He has also published a series of studies which document increases in hospitalizations associated with childhood obesity and increases in medical expenditures associated with being obese or overweight in childhood. These studies have been cited in the Presidential Task Force Report in Childhood Obesity, and another landmark study identified that a $2 billion annual investment in prevention would be cost-effective even if it produced small reductions in the number of children who were obese and overweight. He serves on the Executive Committee of the Council for Environmental Health of the American Academy of Pediatrics, on the CDC's World Trade Center Health Program Scientific and Technical Advisory Committee, and on a United Nations Environment Programme Steering Committee which is developing a Global Outlook on Chemicals Policy. He recently served on the Board of Scientific Counselors for the National Center for Environmental Health at the Centers for Disease Control and Prevention. Dr. Trasande earned a Master's degree in Public Policy from Harvard's Kennedy School of Government, and an M.D. from Harvard Medical School. He completed a pediatrics residency at Boston Children's Hospital, a Dyson Foundation Legislative Fellowship in the office of Senator Hillary Rodham Clinton, and a fellowship in environmental pediatrics at the Mount Sinai School of Medicine. He has testified before the Senate's Environment and Public Works committee and Democratic Policy Committee. His work has been featured on the CNN documentary Planet in Peril and in National Geographic, and frequently appears on national media, including NBC's Today Show, ABC's Evening News and National Public Radio. He currently receives funding is from the National Institute for Occupational Safety and Health NIOSH for clinical care for children exposed to the World Trade Center disaster; National Institute of Environmental Health Sciences (NIEHS) & Fogarty for a study of prenatal methylmercury exposure; and NIEHS, Fogarty & NIOSH for building studies of air pollution and children's health in China.

Trindade, Sergio

SE2T International, Ltd.

Dr. Sergio C. Trindade is a New York based global consultant on sustainable business. He started his career designing, building and operating a sorbitol plant. Later, at the MIT Chemical Engineering Graduate Practice School, in Oak Ridge National Laboratories, TN, and at American Cyanamid chemical plants, NJ, he got exposed to American research and industry. His MIT PhD dissertation focused on magnetic demineralization of coal. Next, he joined Arthur D. Little, Inc. in Cambridge, MA, and later headed ADL's Brazilian office. Next, he founded the first private technology center in Brazil at PROMON, working on renewable energy, sustainable chemicals and telecommunications. He then began international consulting on energy and environment. He became the Assistant Secretary-General of the United Nations and Director of the Centre for Science and Technology for

Development - CSTD, in New York. There he created and tested the concept of stakeholders' dialogues to achieve consensus on policy priorities. He supervised studies on environmentally sounder technologies. Later, as a consultant he designed and implemented in Japan the UNEP International Environmental Technology Centre, on environmental issues of large cities and fresh water lakes and reservoirs. He did extensive consulting work for private companies and international organizations such as UNEP, the World Bank, IEA, OECD, Inter-American Development Bank. For International Fuel Technology, MO, he helped develop and market, diesel/biodiesel fuel enhancement additives. He is/was member: chair of the International Symposia on Alcohol Fuels, where the S.C. Trindade Award was established to reward the best paper at each Symposium; vice-chair, Studies Committee, World Energy Council; Advisory Board, UNEP International Environmental Technology Centre in Japan; Supervisory Board, US Congress Office of Technology Assessment study on weapons of mass destruction and means of delivery; Intergovernmental Panel on Climate Change - IPCC on technology issues, honored with the 2007 Nobel Peace Prize; vice-chair and chair of the Audit Committee, Board of Trustees, World Agroforestry Centre, Nairobi. Published numerous peer-reviewed articles and book chapters. He has been often a keynote speaker in public meetings, lately on climate change and sustainability in the Arctic, and has conducted many media interviews. He earned a PhD, ChE, MSc from MIT in chemical engineering with minors in technology management, energy economics and international business, and from the University of Brazil a BSc in chemical engineering.

Turner, Jay

Washington University

Dr. Jay Turner is an Associate Professor of Energy, Environmental and Chemical Engineering, and Vice Dean for Education in the School of Engineering & Applied Science at Washington University in St. Louis. Dr. Turner holds B.S. and M.S. degrees from UCLA (1987) and a D.Sc. from Washington University (1993), all in Chemical Engineering. Following his M.S. studies, he spent two years at the University of Duisburg, Germany, where he was a DAAD Fellow. Following his D.Sc. studies, Dr. Turner spent eight months on assignment with the Federal Highway Administration, U.S. Department of Transportation, as an Air Quality Specialist. He subsequently joined the Washington University faculty in 1994 as an Assistant Professor of Engineering & Policy. Dr. Turner's research primarily focuses on air quality characterization and control with emphasis on field measurements and data analysis to support a variety of applications in the atmospheric science, regulation and policy, and health studies arenas. He was the Principal Investigator of the St. Louis – Midwest Fine Particulate Matter Supersite. He manages a field site in East St. Louis that has hosted several Federal Equivalent Method testing campaigns and was recently one of two U.S. Environmental Protection Agency (EPA) coarse particulate matter pilot speciation study sites. Current and recent research projects include estimating lead emissions from piston engine aircraft, source apportionment of ambient particulate matter in Hong Kong, assessing intraurban variability of air toxics metals, long-term fence line monitoring for gaseous air toxics and particulate matter species at an industrial facility, and air quality measurements to support health studies. Recent consulting activities include monitoring guidance and/or data analyses for agencies in four states in support of State Implementation Plan development. He is currently Washington University lead investigator on a contract from the Airport Cooperative Research Program (ACRP) to Sierra Research, Inc. to develop approaches to mitigate lead concentration hot spots at general aviation airports, and Co-PI on an NIH grant to examine relationships between air pollution and neurodegenerative disease. His consulting work is currently funded by The Organisation for Economic Co-operation and Development (OECD) to assess the state of air quality monitoring in 51 countries and develop a framework for estimating air quality indicators, and by the Hong Kong Environmental Protection Department through Hong Kong University of Science and Technology to develop a conceptual model for particulate matter air quality over the Pearl River Delta. Dr. Turner has served on several state and local air quality-related advisory committees and the Science and Technical Support Workgroup of the Federal Advisory Committee Act (FACA)

Subcommittee for Ozone, Particulate Matter, and Regional Haze Implementation Programs. He currently serves on EPA's chartered Science Advisory Board (SAB), the Ambient Monitoring and Methods Subcommittee (AMMS) of EPA's Clean Air Scientific Advisory Committee (CASAC), and the Independent Technical Advisory Committee of the Texas Air Quality Research Program. He recently served on the Science and Technology Achievement Awards (STAA) Committee of the EPA Science Advisory Board and on the Health Effects Institute project panel for the National Particle Components Toxicity Initiative. Dr. Turner was general chair for the 2007 Annual Conference of the American Association for Aerosol Research (AAAR) and is the immediate past president of AAAR. He is a Visiting Scientist at the Harvard T.H. Chan School of Public Health for the period January-July 2016. He previously served on the Science and Technology Achievement Awards (STAA) Committee of the EPA Science Advisory Board (term 2012-2015).

Tyner, Robin

US Navy Retired

Captain Robin Tyner, Retired, recently transitioned from an active duty Navy career. She qualified/served as Department of Defense (DoD) Science and Technology (S&T) Manager Level III (highest), Surface Warfare Officer, Naval Aviation Observer, In-flight Meteorologist, Hurricane/Typhoon Forecaster, Ship Router, and Information Warfare Officer. She is trained/experienced in nuclear/WMD hazard prediction. She holds a BS in Physics/Oceanography (U.S. Naval Academy), dual-MS in Meteorology and Physical Oceanography (Navy Post-Graduate School), and MBA (Southern New Hampshire University). She completed the Navy Corporate Business Course (University of Virginia, Darden), and begins the Harvard Kennedy School's Executive Climate Change and Energy program September 2018. She is a member of the American Geophysical Union and American Association for the Advancement of Science. She was a voting member on the DoD Space Experiments Review Board (2014-2017), which approves and prioritizes military science experiments for rides on DoD satellites. Through 2017 she served as Deputy Department Head, Office of Naval Research, managing a $305 million S&T portfolio including: oceanography, meteorology, hurricanes, Arctic/cryosphere, coastal prediction, acoustics, remote sensing, signal processing, unmanned vehicles, etc. Congress provided her department additional funding in 2016 for anti-submarine warfare research. She oversaw dozens of PhD Program Officers, engineers, military officers, technical and support contractors - evaluating proposals and awarding competitive grants/contracts to academia, government/private labs, industry, and small businesses. Her Arctic experience includes: her Arctic oceanography thesis, establishment of Navy Arctic, Energy and Climate policy, oversight of multi-year research efforts and field experiments - and experiments at ICEX 2016 (Arctic Ocean ice camp), and selection as one of five DoD attendees at the 2015 Secretary of State-hosted GLACIER conference. She serves on the Exeter, NH Planning Board and Energy Committee, the Oceans 2022 Steering Committee (joint symposium hosted by the Marine Technology Society and Institute of Electrical and Electronic Engineers), and as Senior Fellow, DEPLOY/US.

Ulsh, Brant

M. H. Chew & Associates

Dr. Brant Ulsh is a Certified Health Physicist, and has over thirty years of academic training, and governmental, academic, and private industry work experience in radiation fields including health physics, radiation biology, radiation ecology, and nuclear engineering. Dr. Ulsh's diverse work experience includes regulatory compliance at nuclear power plants and Department of Energy sites, environmental monitoring, and radiation dose reconstruction. He is currently a Principal Health Physicist with M. H. Chew & Associates in Cincinnati, and he serves as the Editor-In-Chief for the Health Physics journal. From 2003-2012, Dr. Ulsh served as a Senior Research Health Scientist with the National Institute for Occupational Safety and Health in the largest radiation worker compensation program in the world. In that position, he had extensive interaction with the Presidentially-appointed

Advisory Board on Radiation Worker Health. Dr. Ulsh's research interests and expertise focus on the biological and environmental effects of low doses of radiation on humans and the environment. He has performed only unfunded research in these areas over the past two years. He earned a Bachelor of Science degree in Nuclear Engineering and a Master of Science degree in Health Physics, both from the University of Cincinnati, and a Ph.D. in Radiological Health Sciences from Colorado State University. Dr. Ulsh completed a postdoctoral appointment at the McMaster University Institute of Applied Radiation Sciences in Canada, with a research focus on low-dose radiation biology. He has authored one book chapter, 19 peer-reviewed publications, 23 scientific presentations, 10 scientific poster presentations, and 6 scientific abstracts. He serves as an affiliate faculty member of Colorado State University, and the Northern Ontario School of Medicine. Dr. Ulsh has held numerous leadership positions in both the Cincinnati Radiation Society, and the Health Physics Society, and he served as a member of the International Radiation Protection Association Radiation Protection Strategy and Practice Committee.

Uppu, Rao

Southern University and A&M College

Dr. Rao M. Uppu is the James and Ruth Smith Endowed Professor of Environmental Toxicology and Chemistry in the College of Sciences and Engineering at Southern University-Baton Rouge (SUBR). He is a highly accomplished scientist recognized internationally for his work in environmental chemistry and molecular toxicology. His major scientific contributions include analytical methods for determining biological reactive intermediates (alloxan, epoxides, and alpha, beta-unsaturated carbonyls) and semi-persistent organic pollutants (bisphenols), apoptotic and/or necrotic cell signaling by 'ozone-specific' oxysterols, free radical nitration and nitrosation in nitric oxide-producing biological systems, modeling of oxidative and free radical reactions of ozone at the air-lung interface, and molecular docking and dynamic studies of environmental estrogen binding to estrogen receptors. In addition to publishing in peer-reviewed journals and books, Uppu has trained numerous MS and PhD students, postdoctoral fellows, and junior faculty and received several accolades including election as Fellow of the Royal Society of Chemistry (FRSC), Fellow of the Academy of Toxicological Sciences (FATS), Fellow of the American Association for the Advancement of Science (FAAAS), Board Certified Environmental Scientist (BCES), Diplomate of the American Board of Toxicology (DABT), Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS), and membership in the CyHABs Research Consortium (Ames, IA). Uppu was a recipient of honors for student mentoring from both within and outside the Southern University System including the Telugu Association of North America Excellence in Science Award and the Becoming Everything You Are (BEYA) STEM Innovators Award. After obtaining his PhD degree in biochemistry from Osmania University (Hyderabad, India), Uppu undertook postdoctoral assignments at the Eppley Institute for Research in Cancer (Omaha, NE) and the Biodynamics Institute at Louisiana State University (Baton Rouge, LA) and worked under the tutelage of Drs. Ercole Cavalieri, Eleanor Rogan, and William Pryor. Uppu's research for the past two years was supported by the U.S. Department of Education, the National Science Foundation, and the USDA National Institute of Food and Agriculture.

Vandenberg, Laura

University of Massachusetts – Amherst

Dr. Vandenberg's research explores how early life exposures to chemicals and chemical mixtures can predispose individuals to diseases that manifest later in life. Classical toxicology often focuses on how fetal chemical exposures can produce birth defects, an important part of chemical safety. Her work instead addresses how low doses of chemicals during critical windows of development can alter gene expression, cell differentiation, and tissue organization in subtle ways that can lead to adult diseases such as cancer, obesity, and infertility. She is specifically interested in the class of chemicals termed

'endocrine disruptors' and have worked extensively with chemicals used as plasticizers and flame retardants. Her work also focuses on how traditional toxicology assays have failed to identify a number of ubiquitous endocrine disruptors, and how current risk assessment practices can be improved in the study and regulation of this class of chemicals.

Vepachedu, Venkata

Pennsylvania Department of Health, COPA

Dr. Venkata Vepachedu, Ph. D. is presently working as Chief/Supervisory Microbiologist leading the Molecular Microbiology/Advanced Molecular Detection (AMD) unit in the division of clinical microbiology at Bureau of Laboratories, Pennsylvania Department of Health, Exton, PA. Dr. Venkata obtained his Ph.D. in biochemistry. His dissertation includes extensive studies on Chromium toxicity and active site directed metal complex synthesis (Chromium and Copper-Uric Acid complexes) & characterization. The lab is accredited for its highly quoted research in studying the mechanisms of metal toxicities and metal reclamation from industrial sewage. Dr. Venkata gained extensive research experience in the area of molecular microbiology as applied to health and environment. Dr. Venkata is an established scientist, successfully completed novel research projects focusing on global warming, environmental health and food-borne outbreaks as evidenced by research publications. He possesses, expertise in the design and running of environmental and public health research & surveillance projects in collaboration with national institutes such as CDC, EPA and FDA. Dr. Venkata gained hands on experience running experiments using advanced instruments in biological research, including, Whole Genome Sequencing, MALDI-TOF. Bioinformatics analysis and program design. He regularly performs compilation of results obtained from different projects to assess a food-borne outbreak investigations/environmental concern and draw conclusions to take decisive action. Dr. Venkata is involved in the review/discussion of various environmental issues in Pennsylvania while working at department of environmental protection. His views, project design and presentations are highly appreciated as he tailors the presentation to the audience. Dr. Venkata is involved and gained knowledge in all aspects of projects i.e. design, writing proposals, performing experiments, result analysis and presentations. He worked with both laboratorians, environmental field staff and epidemiologists. Dr. Venkata worked on field sample collection & analysis and human sample analysis. He completed research projects working with various biological systems namely, Archaea, bacteria, fungi, insects, fish, mice, rats, and human systems (found in curriculum vitae). This made him a suitable candidate to review projects related to different environmental and health issues for field and lab studies.

Viana, Louis R.

LRV NY LLC

Mr. Louis Viana has been practicing the profession of Environmental Engineering for the last 23 years. During his professional tenure he has operated and designed multiple Wastewater Treatment Plants (Anaerobic & Aerobic) and Potable Water Treatment systems, advised Fortune 100 companies in compliance with NPDES permit, Clean Water Act, Clean Air Act, RCRA, CERCLA, SARA, dealt with Asbestos and Lead abatements, cleaning of soil with Hydrocarbons, designed sampling protocols for contaminated sites, Environmental Impact Statements, Phase I & II among others. This knowledge and pass experience allowed him to develop LRV NY, LLC an Environmental Engineering Firm which has been providing services to assist fortune 100 companies to operate in a responsible and sustainable manner while complying with all applicable environmental laws and regulations. Mr. Viana is currently a Ph.D. candidate at Columbia University School of Engineering at the Department of Environmental Engineering and Earth Sciences. His research is being done on Surface Phenomena Changes on Archaea Cell Membrane to Enhance Metabolic Reaction of Glucose and Increase Biogas Production. The results of the research will propel the Anaerobic Digester treatment of high COD loads by helping the industries to reduce COD discharge to the ocean and therefore protect the

environment and its habitat. Mr. Viana is currently a member of the Industrial Advisory Board of the Columbia University, the Florida University Center for Particles and Surfactant System (CpASS), and the American Association for the Advance of Science (AAAS).

Wauchope, Robert D

USDA-ARS

Don Wauchope has chemistry degrees from UNC-Chapel Hill (BS) and NC State University at Raleigh (MS, PhD). After an NIH Postdoctorate at Oregon State University's Department of Agricultural Chemistry he joined the newly-formed USDA – Agricultural Research Service (ARS) Southern Weed Science Laboratory at Stoneville, MS in 1972. Don published research on the analysis and environmental chemistry of arsenical agricultural chemicals, and water quality impacts of pesticides. He was part of the original CREAMS nonpoint agricultural pollution simulation model development team. Don moved to the ARS Southeast Watershed Research Laboratory and later the ARS Nematodes Weeds and Crops Research Laboratory, both at Tifton, Georgia in 1984, retiring in 2008. He developed the pesticide module of the ARS-RZWQM pollution model and the USDA-ARS Pesticide Properties Database, and has had a national and international leadership in minor use pesticide registration, exposure risk assessment and pesticide physical chemistry. He has published 135 journal papers and book chapters, 2 books, and made over 150 presentations. Two of his papers have been cited over 1000 times. Don is a Fellow of the Weed Science Society of America and is a Fellow and past Chair of the Agrochemical Division of the American Chemical Society. He was North American Editor of the Journal "Pest Management Science" and a leader and collaborator on many technology transfer activities of the International Union of Pure and Applied Chemistry (IUPAC), organizing publication projects, meetings and workshops in 16 countries. He has served on several ad hoc EPA and European Union Food Safety Authority technical advisory committees. Except for some cooperative studies with University collaborators, Don's entire research career was funded by USDA in-house and grant funds.

Werth, Charles

University of Texas at Austin

Dr. Charles J. Werth is a Professor and the Bettie Margaret Smith Chair in Environmental Health Engineering in the Department of Civil, Architecture and Environmental Engineering at the University of Texas at Austin. Dr. Werth's areas of expertise include the fate and transport of pollutants in the environment, the development of catalytic technologies for drinking water treatment, and the mitigation of environmental impacts associated with energy production and generation. In his research, he develops and/or uses noninvasive imaging, environmental microfluidics, nanotechnology, spectroscopic analysis, numerical modeling, and life cycle assessment. He has been consulted by law firms litigating cleanup of hazardous waste sites, oil and gas companies treating produced water, and industry developing innovative groundwater cleanup technologies. Dr. Werth has published 110 peer-reviewed journal articles, with research support during the last two years from the Department of Energy (DOE), National Science Foundation, National Aeronautics and Space Administration, United States Geological Survey, Dow Chemical, and Texas Hazardous Waste Research Center. Dr. Werth previously served on the Association of Environmental Engineering and Science Professors (AEESP) board, the AEESP Foundation board, the User Executive Committee for DOE's Environmental Molecular Science Laboratory (EMSL), the External Advisory Board for a DOE Energy Frontier Research Center, and the USEPA Science Advisory Board (2014-2017). The quality of his work has been recognized by appointment as a Wiley Research Fellow at the DOE's EMSL, appointment as Editor-and-Chief of Journal of Contaminant Hydrology, two Best Paper Awards from the journal Environmental Science and Technology, a Humbolt Research Fellow Award, a National Science Foundation CAREER Award, and an Award for Innovation in Undergraduate Instruction. Dr. Werth received a B.S. in Mechanical Engineering from Texas A&M University, an M.S. and Ph.D. in

Environmental Engineering from Stanford University, and a Ph.D. minor in Chemistry from Stanford University.

Wiesner, Mark

Duke University

Dr. Mark R. Wiesner holds the James L. Meriam Chair in Civil and Environmental Engineering at Duke University where he has appointments in the Pratt School of Engineering and the Nicholas School of Environment. He serves as Director of the National Science Foundation's Center for the Environmental Implications of NanoTechnology (CEINT). Dr. Wiesner's research in the area of environmental nanotechnology, examines the application of nanotechnologies for environmental quality control and initiated a consideration of the possible environmental implications of nanomaterials. He co-edited/authored the book "Environmental Nanotechnologies" and serves as Associate Editor of the journals Nanotoxicology and Environmental Engineering Science. Professor Wiesner also pioneered research in area of applications of low-pressure membranes to water treatment. He co-edited and -authored the book "Water Treatment Membrane Process," served as the founding Chair of the American Water Works Association's Membrane Research Committee, and serves on the editorial board of the journal Desalination. Professor Wiesner is a Fellow of both the American Association for the Advancement of Science and the American Society of Civil Engineers. Before joining the Duke University faculty in 2006, Professor Wiesner was a member of the Rice University faculty for 18 years where he held appointments in the Departments of Civil and Environmental Engineering and Chemical Engineering and served as Associate Dean of Engineering, and Director of the Environmental and Energy Systems Institute. Prior to working in academia, Dr. Wiesner was a Research Engineer with the French company the Lyonnaise des Eaux, in Le Pecq, France, and a Principal Engineer with the Environmental Engineering Consulting firm of Malcolm Pirnie, Inc., White Plains, NY. Wiesner received the1995 Rudolf Hering medal from the American Society of Civil Engineers and the 2004 Frontiers in Research Award from the Association of Environmental Engineering and Science Professors. In 2004 Dr. Wiesner was also named a "de Fermat Laureate" and was awarded an International Chair of Excellence at the Chemical Engineering Lab of the French Polytechnic Institute and National Institute for Applied Sciences in Toulouse, France. Wiesner was the 2011 recipient of the Clarke Water Prize for his work in improving water quality through advancements in membrane and nanotechnology research. He is a past President of the Association of Environmental Engineering and Science Professors (AEESP).

Williams, David

Oregon State University

Dr. Williams is Helen P. Rumbel Professor for Cancer Prevention at Oregon State University (OSU) in the Department of Environmental and Molecular Toxicology and Linus Pauling Institute. He obtained his BS from Reed College, MS and PHD from OSU and post-doctoral training at the Medical College of Wisconsin. Dr. Williams is widely recognized as a leading researcher in environmental toxicology and has been funded continuously for 32 years as Principal Investigator by the National Institutes of Health (NIH), primarily the National Institute of Environmental Health Sciences (NIEHS). These grants were both individual research projects as well as multi-individual, multi-disciplinary and multi-institutional. He served as Director of the OSU Superfund Research Program, funded by NIEHS, for 6 years and currently directors a research project. Dr. Williams is also currently funded (2017-2022) by NIEHS to, for the first time ever, determine the pharmacokinetics of an important environmental carcinogen, benzo[a]pyrene, in humans. His recent and current service on external advisory committees include the National Water Research Institute's Santa Ana River Monitoring Review Panel (2005-present); NIEHS U19 (long-term health effects of the Deepwater Horizon spill) programs at the University of Texas, Galveston and University of Florida (2010-2015); standing member of 3 NIH study sections (Alcohol/Toxicology1, 1998-2003, Chair 2001-2003;

Xenobiotic and Nutrient Disposition and Action, 2009-2013, Systemic Injury by Environmental Exposure (SIEE), 2014-2017); NIEHS Superfund Research Programs (P42) at Michigan State University (2014-present) and Baylor University (2015-2016); National Cancer Institute's PREVENT program, 2013-present; ad hoc service on a number of other NIH and EPA panels, most recently Cancer Disease and Prevention (June, 2018) and SIEE (June, 2018). Dr. Williams is an active member of the Society of Toxicology, serving on a number of elected and appointed committees, the International Society for the Study of Xenobiotics and the American Association for Cancer Research.

Williams, Lance

University of Texas at Tyler

Dr. Lance Williams is Chair and Professor of Biology at The University of Texas at Tyler and the Center for Environment, Biodiversity, and Conservation. He has been at UT Tyler since 2007, and before that he was an Assistant Professor at The Ohio State University. Dr. Williams has extensive experience in river ecology and conservation and has been PI or co-PI on nearly 6 million dollars in extramural grants. In the past 20 years, he has served as the major professor for over 20 graduate theses on conservation topics in Eastern U.S. rivers. His most recent grants have focused on endangered mussel and crayfish species in East Texas rivers, and also water quality monitoring of military bases in Texas and Louisiana. He currently has grants from the Texas National Guard, the U.S. Army, the Texas Comptroller's Office, and the Texas Commission on Environmental Quality. Dr. Williams has served on numerous advisory committees and is currently the Managing Editor for the journal Southwestern Naturalist. He earned a B.S. in Zoology from the University of Oklahoma, an M.S. in Zoology from Oklahoma State University, and a Ph.D. in Biological Sciences from Mississippi State University.

Williams, Richard A.

MarginalRegulation

Dr. Richard A Williams is a consultant with his firm, MarginalRegulation.com. He has received compensation from the formaldehyde council at the American Chemistry Council in 2017. He is retired from the U.S. Food and Drug Administration with 27 years experience. At FDA, he was responsible for economic analysis, consumer studies and epidemiology for the Center for Food Safety and Nutrition. Subsequently, he was a Vice President for Policy at the Mercatus Center at George Mason University for nine years. He is currently a Senior Affiliated Scholar with the Mercatus Center and with Utah State's Center for Growth and Opportunity. He is also on the Board of Trustees for the International Life Sciences Institute. He has served on a National Academy of Sciences panel, served as President of the Virginia Chapter of the Society for Risk Analysis and has served as an advisor to the Harvard Center for Risk Analysis. He has extensive knowledge of risk analysis including risk/risk, health/health and benefit-cost analysis. Dr. Williams has created and taught classes on risk analysis for USDA and FDA. He has been invited to testify before the House and Senate multiple times on regulatory issues and has appeared on radio and television, including CNBC, National Public Radio, Reuters, Bloomberg, the New York Times and the Wall Street Journal. He has been invited to speak in multiple countries. He frequently writes op-eds that have a national audience on risk, economic and regulatory issues. He is currently working on the effects using linear, no-threshold dose-response curves as a default for chemicals and radiation. He has given keynote speeches within the last several years to the Governance of Emerging Technologies at ASU and the International Life Sciences Institute on emerging technologies. Dr. Williams received his Ph.D. in economics from Virginia Tech and his BS in business administration from Old Dominion University.

Yang, Raymond

Colorado State University

Dr. Raymond S. H. Yang is Professor Emeritus of Toxicology and Cancer Biology, and the former

leader of the Quantitative and Computational Toxicology Group, at the College of Veterinary Medicine and Biomedical Sciences, Colorado State University (CSU). Between October 2007 and July 2009, Dr. Yang had also been a Visiting Scientist at the National Center for Environmental Assessment, U.S. EPA, Cincinnati, to work on 2, 3, 7, 8-Tetrachlorodibenzo-p-dioxin (TCDD) and chemical mixture toxicology and risk assessment, among other projects. Dr. Yang's research focuses on physiologically based pharmacokinetic/pharmacodynamic (PBPK/PD) modeling, and other biologically-based computer modeling with a special emphasis on the toxicology of chemical mixtures. Dr. Yang has had extensive research and administrative experience in academia, chemical industry, and the federal government. At CSU in the last 20 years, Dr. Yang had served in the capacity as a Department Head, a Center Director, and the Director for a National Institute for Environmental Health Sciences (NIEHS) Quantitative Toxicology Training Program. Since June 2010, Dr. Yang has retired from the CSU but during his tenure at CSU in the past 20 years or so his research funding was principally from the NIEHS, Centers for Disease Control, and Department of Defense for toxicological interactions of chemicals including biologically based computer modeling. Dr. Yang publishes extensively in biomedical journals and is the editor/co-editor of two books; Toxicology of Chemical Mixtures: Cases Studies, Mechanisms, and Novel Approaches (1994), and Physiologically Based Pharmacokinetics: Science and Applications (2005). Dr. Yang is a Fellow of Academy of Toxicological Sciences and served on many prestigious national and international committees and panels. Presently, Dr. Yang is working part-time as an international consultant; part of this service includes Dr. Yang's continuing teaching of his "PBPK Modeling Workshop for Beginners" at CSU and elsewhere in the US, Europe, and Asia.

Zhao, Feng

NOAA

Feng Zhao earned M.S. and Ph.D. in Geography from The University of South Carolina, and Boston University in 2005 and 2010, respectively. After an extended post-doc at the University of California at Berkeley, Dr. Zhao held a Research Assistant Professor position at University of Maryland at College Park in 2012. Since 2017, he has served as a research scientist at Center for Satellite Application and Research (STAR), National Atmospheric and Oceanic Administration (NOAA). Dr. Zhao's research interests are broad, but a recurrent theme is the use of remote sensing to study the dynamics of terrestrial ecosystem and processes, including Vegetation Index (VI) and Green Vegetation Fraction (GVF) product development from NOAA satellite series, forest disturbance history mapping from Landsat and forest structural retrieval using LiDAR system.

Zwiernik, Matthew

Michigan State University

Dr. Matthew Zwiernik is a Professor of Ecotoxicology in the Department of Animal Science at Michigan State University (MSU). He is, a member of the MSU Institute for Integrative Toxicology and is the Director of the MSU Wildlife Toxicology Laboratory (MSU-WTL). Dr. Zwiernik received a B.S. in Biochemistry and a Ph.D. in Environmental Toxicology from the Michigan State University Department of Biochemistry and College of veterinary medicine respectively. Dr. Zwiernik has been a faculty member at MSU since 1999 and in that time has conducted multiple long-term litigation quality studies, assessing the impacts of human activities on wide array of wildlife populations in differing ecosystems. Dr. Zwiernik is an expert in assessing the effects of complex contaminant mixtures on riverine ecosystems. His team has pioneered work pertaining to wildlife species sensitivity to contaminate mixtures, and wildlife exposure and effects assessments. The MSU-WTL approach of combining laboratory based site-specific contaminant exposure protocols with direct field measures of exposure and individual and population health has informed and streamlined the ecological risk assessment process for numerous superfund sites. Dr. Zwiernik specializes in quantifying population dynamics in response to fluctuations in resources and stressors, utilizing a data

driven multiple lines of evidence, hypothetic-deductive approach, including adverse outcome pathway assessment. Dr. Zwiernik is particularly interested in improving the certainty of the quantification of the ecological risk associated with wildlife exposure to complex contaminant (stressor) mixtures by improving approaches for the identification of contaminant interactions, site-specific chemodynamics, the identification of germaine measurement parameters to derive risk estimates that inform sustainable remedial decisions. Dr. Zwiernik's funding is derived from a wide range of sources including industry, local community advisory groups, and state and federal government organizations including EPA, DOD and others. Dr. Zwiernik is a member of the Society of Environmental Toxicology and Chemistry. He has been an expert consultant to the International Joint Commission on Issues of Emerging Contaminants in the Great Lakes. Additional information on projects and qualifications including greater than 85 peer-reviewed publications, 22 invited papers, 3 keynote addresses, and greater than 150 scientific presentations and reports, as well as three book chapters pertaining to wildlife impact assessment can be obtained at www.riverwildlife.msu.edu.

Message

From: US EPA Domino Webhosting Authority [domino.webmasters@epamail.epa.gov]
on behalf of SAB Staff [SAB_Staff@epamail.epa.gov]
Sent: 11/26/2018 7:22:25 PM
To: Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]
Subject: Ted Steichen, affiliation American Petroleum Institute, has been sent the call-in information for your 11/29/2018 meeting

Ted Steichen, steichent@api.org, affiliation American Petroleum Institute, has been sent the call-in information for your 11/29/2018 Chartered Clean Air Scientific Advisory Committee (CASAC) Public Teleconference on Ozone.

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 10/15/2018 5:36:05 PM
To: AO SAB EVERYONE [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ee10fa204de24c1793c3c33a462e0d39-AO SAB EVERYONE]
Subject: Greenwire - Wheeler hands 'YUGE win' to foes of science panels

AIR POLLUTION

Wheeler hands 'YUGE win' to foes of science panels

Sean Reilly, E&E News reporter

Published: Monday, October 15, 2018

Two years ago, Steve Milloy was at the forefront in promoting a lawsuit aimed at forcing EPA to dissolve and reconstitute a scientific panel that would review the agency's standards for soot and other tiny airborne particles.

The suit failed, but Milloy, who served on President Trump's EPA transition team, is now celebrating a victory by administrative fiat that arguably went even further than his lawsuit on the review panel for particulate matter.

"EPA disbands PM panel ... another YUGE win!" he wrote in an email Saturday linking to a post on his blog, JunkScience.com.

In the decision announced last week, acting EPA Administrator Andrew Wheeler abolished the roughly 24-member review panel and didn't replace it. Instead, he concentrated responsibility for helping in the review with the Clean Air Scientific Advisory Committee, a seven-member body now dominated by his appointees.

In an email this morning, EPA spokesman John Konkus again stressed that the decision was consistent with the Clean Air Act and the committee's charter. Neither mentions using the review panels — which are, in effect, subcommittees — to provide added expertise in determining whether the standards for particulate matter and other common air pollutants are adequate to protect public health.

But the seven-member committee — often known by its acronym, CASAC — has tapped such panels for at least 30 years, a report posted on EPA's website indicates.

"This is not a fix, in my mind; it's a radical change," Jon Samet, a former CASAC chairman who is now dean of the Colorado School of Public Health, said in an interview Friday.

Wheeler's decision comes, moreover, as recent research suggests that EPA's current limits on fine particulates aren't stringent enough to protect the public.

Such particulates, technically known as PM2.5 but often simply called soot, are linked to an array of heart and lung problems. In a study published last year, for example, Harvard University researchers linked increasing exposure — even at thresholds below EPA's current annual limit — to higher hospitalization rates among older Americans.

That yearly threshold of 12 micrograms per cubic meter of air was set in late 2012. Not long after, a coalition of business groups — including the National Association of Manufacturers, U.S. Chamber of Commerce and Utility Air Regulatory Group — challenged that decision with the U.S. Court of Appeals for the District of Columbia Circuit. They contended, in part, that the new threshold was unreasonable.

The coalition's lawyers included current EPA air chief Bill Wehrum, then an attorney in private practice.

In a unanimous 2014 opinion, a three-judge panel rejected the coalition's arguments and ruled entirely in EPA's favor. The opinion's author was then-Circuit Judge Brett Kavanaugh, recently elevated by Trump to the Supreme Court.

The latest review of the particulate matter standards got underway in 2015. Wehrum referred to the EPA press office in an email this morning when asked whether he had any role in the decision to disband the review panel. Spokesman Konkus said Wehrum was "not involved" in that process.

Spokesmen for the manufacturers association and the U.S. Chamber also said their organizations didn't seek the panel's dissolution. A spokesman for the Edison Electric Institute, whose membership overlaps significantly with that of the Utility Air Regulatory Group, didn't reply to similar queries Friday and today.

'I couldn't be more pleased'

Milloy has long contended that concerns about the health effects of fine particulates are based on bogus science.

In 2016, the Energy and Environmental Legal Institute, an industry-allied organization where Milloy is listed as a senior policy fellow, sued to compel EPA to reconstitute the particulate matter review panel on the grounds that most of its members had received agency grants at some point and were thus allegedly biased in favor of stricter regulation.

The institute dropped the lawsuit after EPA attorneys questioned the group's legal standing to sue.

But in a *Wall Street Journal* op-ed last year, Milloy wrote that "President Trump and his EPA administrator have ample statutory authority to rectify the problem."

"I couldn't be more pleased" with Wheeler's decision, Milloy said in a phone interview today. "This is something that I've been pushing for since the transition team."

Wheeler last week also called off plans to create a similar panel to assist in a newly launched review of the ground-level ozone standard. EPA had sought nominations for that panel in late July, almost a month after Wheeler took over as acting administrator.

Wheeler was traveling today and not available for an interview, according to Konkus.

Asked why Wheeler sought candidates for the ozone panel in light of his current stance, Konkus said he decided to give the seven-member CASAC the job of leading the reviews, based on a number of factors. Those included a May memorandum laying out a new process for conducting the assessments of pollutant standards, as well as "the plain language" of the Clean Air Act, the Federal Advisory Committee Act and CASAC's charter, he said.

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 9/17/2018 11:30:14 PM
To: Sean Reilly [sreilly@eenews.net]
Subject: RE: CASAC candidates -- as discussed
Attachments: CASAC FY 2019 List of Candidates-web.pdf

Here is the CASAC FY19 List of Candidates that we posted for public comment back in June.

-Aaron

Aaron Yeow, M.P.H.
Designated Federal Officer
U.S. Environmental Protection Agency
Science Advisory Board
202-564-2050 (P)
202-565-2098 (F)

Mailing Address:
USEPA, 1200 Pennsylvania Avenue, NW, (1400R), Washington, DC 20460

Physical Location/Deliveries:
1300 Pennsylvania Avenue, NW, Suite 31150, Washington, DC 20004

From: Sean Reilly [mailto:sreilly@eenews.net]
Sent: Monday, September 17, 2018 7:19 PM
To: Yeow, Aaron <Yeow.Aaron@epa.gov>
Subject: CASAC candidates -- as discussed

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EnergyWire, ClimateWire, E&E Daily, Greenwire, E&ENews PM

Invitation for Public Comment on the List of Candidates
For the Environmental Protection Agency's
Clean Air Scientific Advisory Committee

June 11, 2018

The U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Staff Office announced in a Federal Register Notice on March 21, 2018, (83 FR 12383-12384) that it was inviting nominations of experts to be considered for the Administrator's appointment to the Clean Air Scientific Advisory Committee (CASAC). The CASAC provides independent advice, information and recommendations to the EPA Administrator on the scientific and technical aspects of air quality criteria and National Ambient Air Quality Standards (NAAQS). The SAB Staff Office sought nominations of experts to serve on the CASAC with expertise in: Air quality, biostatistics, ecology, environmental economics, environmental engineering, epidemiology, exposure assessment, medicine, risk assessment, and toxicology.

The SAB Staff Office received nominations for the attached 36 candidates based on their expertise and willingness to serve. We hereby invite public comments on the attached List of Candidates under consideration for appointment to the CASAC. Comments should be submitted to Mr. Aaron Yeow, Designated Federal Officer, at yeow.aaron@epa.gov no later than **July 2, 2018**. E-mail is the preferred mode of receipt. Please be advised that public comments are subject to release under the Freedom of Information Act.

FY19 Chartered CASAC Annual Membership

Berrocal,Veronica

University of Michigan

Dr. Veronica J. Berrocal is Associate Professor of Biostatistics at the University of Michigan. Her expertise and research interests are in spatial and environmental statistics and biostatistics, with a particular interest on development and application of statistical methods for environmental exposure risk assessment, particularly air pollution, weather and climate modeling, and their impact on health. Dr. Berrocal has also investigated assessment of the National Ambient Air Quality Standard for ozone using spatial statistical models and data from monitoring sites and an air quality model. Dr. Berrocal is the current core co-leader of the Integrated Health Sciences Core of the University of Michigan NIEHS-funded P30 center MLEEaD – Michigan Lifetime Environmental Exposure and Disease. She has also been and is co-Investigator on various NIH-funded and NSF-funded research projects investigating the effect of the physical and built environment on health, the impact of climate change on health, as well as studies on rheumatic diseases, brain cancer, and reproductive health among others. She has served as ad-hoc member of the EPA Federal Insecticide, Fungicide and Rodenticide Act Scientific Advisory Panel in December 2014, May 2015, and November 2017, and has served as member of an External Peer Review panel for EPA on the "Environmental Relative Moldiness Index (ERMI)" (October 2016) and on "Significant Impact Levels (SILs) for ozone and fine particle pollution" (September 2016). She is a member of the American Statistical Association (ASA), the International Society for Bayesian Analysis (ISBA), the International Biometrics Society (IBS), and the Association for Women in Mathematics. She has been the Chair of the Section on "Statistics and the Environment" of the American Statistical Association in 2017, and she is currently the Program Chair Elect for the Section of "Statistics in Epidemiology" of the American Statistical Association. Prior to joining the University of Michigan as faculty in 2010 as Assistant Professor, Dr. Berrocal earned a Ph.D. in Statistics at the University of Washington in 2007, was a postdoctoral research associate at the NSF-funded Statistical and Applied Mathematical Sciences Institute (SAMSI) in academic year 2009-2010, a postdoctoral fellow at Duke University, in the Department of Statistical Science and in the Children Environmental Health Initiative (CEHI) center in academic year 2008-2009, and a National Research Council postdoctoral research associate at the U.S. Environmental Protection Agency in the National Exposure Research Laboratory (NERL) in academic year 2007-2008. As a postdoc at EPA-NERL, Dr. Berrocal has developed spatial statistical models to combine data from monitoring sites and outputs from an air quality model (the Community Multiscale Air Quality – CMAQ) to generate improved estimates of air pollution concentration at fine spatial scale. These models, called downscaler and data fusion models, have been presented in several scientific journals, are highly cited and have been used in various epidemiological studies to assess the health impact of ambient and personal exposure to air pollution.

Burke,Thomas

Johns Hopkins Bloomberg School of Public Health

Thomas A. Burke is a Professor at The Johns Hopkins Bloomberg School of Public Health, Department of Health Policy and Management, with joint appointments in the Department of Environmental Health Sciences and the School of Medicine Department of Oncology. He is also the the Director of the Johns Hopkins Risk Sciences and Public Policy Institute. Dr. Burke is Chair of the National Academy of Sciences Committee on Improving Risk Analysis and in 2006 he was named a Fellow of the Society for Risk Anaysis. His research interests include environmental epidemiology and surveillance, evaluation of population exposures to environmental pollutants, assessment and communication of environmental risks, and application of epidemiology and health risk assessment to public policy. He was Principal Investigator for the Pew Environmental Health Commission which established the framework for a national approach to environmental public health tracking. He has been awarded the Johns Hopkins Golden Apple Award for excellence in teaching three times.Before joining the University faculty, Dr. Burke was Deputy Commissioner of Health for the State of New Jersey and Director of Science and Research for the New Jersey Department of Environmental Protection. In New Jersey, he directed initiatives that influenced the development of national programs, such as Superfund, the Safe Drinking Water Act, and the Toxics Release Inventory. Dr. Burke has served as a member of the National Academy of Sciences Board on Environmental Studies and Toxicology and chaired the NAS Committee on Human Biomonitoring for Environmental Toxicants and Committee on Toxicants and Pathogens in Biosolids Applied to Land. He also served on the NAS Committee on the Toxicological Effects of Methylmercury. In 2003 he was named a lifetime National Associate of the National Academies. He was Inaugural Chair of the Advisory Committee to the Director of the CDC National Center for Environmental Health and a member of the Executive Committee of the EPA Board of Scientific Counselors. Dr. Burke received his B.S. from St. Peter's College, his M.P.H. from the University of Texas and his Ph.D. in epidemiology from the University of Pennsylvania.

Chance,Kelly

Smithsonian Institution

Kelly Chance is a Senior Physicist at the Smithsonian Astrophysical Observatory. He taught Spectroscopy and Radiative Transfer of Planetary Atmospheres as a Lecturer on Earth and Planetary Sciences at Harvard University (now Oxford University Press, ISBN 978-0-19-966210-4). He has been measuring Earth's atmosphere from balloons, aircraft, the ground and, especially, from satellites since receiving his Ph.D. in Chemical Physics from Harvard in 1978. His research specialties are measurements of the Earth's atmosphere; atmospheric composition and radiative transfer; chemical astrophysics; and molecular spectroscopy, structure and dynamics. His atmospheric measurements encompass the stratospheric ozone layer, climate-altering greenhouse gases, and atmospheric pollution. His proposal for Tropospheric Emissions: Monitoring of Pollution (TEMPO) was selected in 2012 as the first NASA Earth Venture Instrument. TEMPO will be the first space-based instrument to monitor major air pollutants across the North American continent from Mexico City to the Canadian oil sands, and from the Atlantic to the Pacific, hourly at high spatial resolution. TEMPO will be launched in about 2020-2021, sharing a ride on a commercial satellite to a geostationary orbit. TEMPO measurements of ozone, nitrogen dioxide, sulfur dioxide, formaldehyde, glyoxal, water vapor, aerosols, cloud parameters, and harmful ultraviolet radiation will enable researchers to improve emission inventories, monitor population exposure, and evaluate effective emission-control strategies. It also will provide near-real-time air quality products that will be made publicly available.

Chow,Judith

Desert Research Institute

Dr. Judith Chow holds the Nazir and Mary Ansari Chair in Science and Entrepreneurialism and is a Research Professor in the Division of Atmospheric Sciences of the Desert Research Institute (DRI) of the Nevada System of Higher Education in Reno, Nevada. Dr. Chow has led DRI's Environmental Analysis Facility since its inception in 1985. She earned her B.S. degree in Biology from Fu-Jen Catholic University in Taiwan (1974), her M.S. degree in Environmental Health Science (1983) from Harvard University, and her Sc.D. degree in Environmental Science and Physiology (1985) from Harvard University. For more than 35 years, she has conducted air quality studies and performed data analysis to improve understanding of effects of air quality on human health, visibility, historical treasures, ecosystems, and climate. Dr. Chow is currently the principal investigator for: 1) conducting organic and black carbon measurements with the U.S. Environmental Protection Agency's (EPA) Chemical Speciation Network (CSN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) network; 2) tracking changes in air quality with control measures at the ports of Los Angeles and Long Beach; 3) investigating the chemical nature and composition of atmospheric brown carbon aerosol; and 4) evaluating nitrogen partitioning and evolution of particulate organic nitrogen in peat fire emissions. She has been principal investigator or a major collaborator in more than 50 large air quality studies (and many smaller ones) across the United States and in other countries. Dr. Chow prepared and revised sections of the EPA's PM Criteria Document pertaining to chemical analysis and source emissions and contributed to EPA guidance documents on network design, continuous particulate monitoring, and particulate matter chemical speciation. Dr. Chow's research has been sponsored by grants and contracts from the federal government (e.g., EPA, Department of Energy, Department of Interior, Department of Defense), local, state, and international air quality management authorities, industry, and the National Science Foundation. As past chair and a member of the Air & Waste Management Association's (A&WMA) Critical Review Committee, Dr. Chow has coordinated and evaluated Critical Reviews and Discussions on environmental science and technology topics. She was chair of the Publications Committee for the Journal of the Air & Waste Management Association and serves on Editorial Boards and/or as Associate Editor for several international journals including: the Journal of Air Quality, Atmosphere, & Health, Aerosol and Air Quality Research, Atmospheric Pollution Research, and Particuology. Dr. Chow was a member of the National Research Council's (NRC) committees on Research Priorities for Airborne Particulate Matter (1998–2003) and Energy and Air Pollution Futures in the U.S. and China (2004-2008); she also served on the NRC Board on Environmental Studies and Toxicology (2002–2005). She was a member of advisory panels for the National Environmental Respiratory Center (New Mexico) and South Coast (California) Air Quality Management District. Dr. Chow has been a member of EPA's Clean Air Scientific Advisory Committee (CASAC) since 2015 and CASAC's Air Monitoring and Methods Subcommittee (AMMS, formerly the Ambient Air Monitoring and Methods Subcommittee) since 2004. She is the principal author or co-author of more than 350 peer-reviewed articles and more than 90 peer-reviewed book chapters and has been recognized by ISIHighlyCited.com in ecology and environment with more than 14,500 citations of her work. Dr. Chow has received the California Air Resources Board's 2011 Haagen-Smit Clean Air Award for her contributions to air quality science and technology, the Air & Waste Management Association's 2016 Arthur C. Stern Award for Distinguished Paper and 2002 Frank A. Chambers Excellence in Air Pollution Control Award, and the 2001 Nevada System of Higher Education's Regents' Researcher Award.

Cocker III,David R.

University of California at Riverside

David R. Cocker III is a professor of Chemical and Environmental Engineering at the University of California, Riverside. He currently manages the Atmospheric Processes Laboratory at the Bourns College of Engineering, Center for Environmental Research and Technology in addition to being a UCR Honors Faculty Fellow. He received both his M.S. (1998) and Ph.D. (2001) in Environmental Engineering Science from the California Institute of Technology and double B.S. degrees in Environmental Engineering and Chemistry from the University of California, Riverside. His research expertise includes atmospheric chemistry leading to secondary organic aerosol and ozone formation, in-use characterization of a variety combustion emission sources, and the health impacts of atmospheric pollutants. Funding over the last two years has included the South Coast Air Quality Management District, California Air Resources Board, U.S. EPA (student design competitions), Coordinated Research Council, National Science Foundation, Naval Surface Warfare Center, USDA, and Honda. He has served as a technical advisor to the Western Regional Air Pollution Committee, has been an advocate for STEM education within the Riverside Unified School District, is an active member of the American Association for Aerosol Research, and is affiliated with the BREATHE center through the UCR School of Medicine.

Cohan,Daniel

Rice University

Dr. Cohan is an Associate Professor of Civil and Environmental Engineering at Rice University. His research specializes in atmospheric modeling to inform environmental decision-making and quantify the responsiveness of air pollution to emissions. Dr. Cohan received a B.A. in Applied Mathematics from Harvard University, a Ph.D. in Atmospheric Chemistry from Georgia Tech, and served as a Fulbright Scholar to Australia. He is a recipient of an NSF CAREER award and was a member of the NASA Air Quality Applied Sciences Team. Prior involvement with EPA includes serving as PI of a STAR research grant and developing advanced features for the CMAQ air quality model.

Crawford,James

NASA

Dr. James H. Crawford is a Senior Research Scientist at NASA, serving as the agency lead for tropospheric chemistry. In this capacity he provides leadership for national and international airborne field studies that collect detailed measurements of atmospheric composition to identify human and natural impacts related to gaseous and particulate pollution. These observations are critical to understanding the emissions, chemistry, and dynamics that underlie air pollution events. An important focus of Dr. Crawford's work has been to improve the interpretation and application of satellite observations for air quality through integration with surface monitoring, aircraft observations, and air quality models. In conducting these studies, Dr. Crawford has collaborated with federal and state air quality agencies in California, Colorado, Maryland, and Texas, always drawing on local advice and experience to ensure that flights are executed to advance current understanding of the unique issues faced by each locality. He currently serves on the Advisory Panel of the Texas Air Quality Research Program. He has authored over 130 peer-reviewed publications on the chemistry of the lower atmosphere including photochemical production of ozone and particulate matter, carbon monoxide and atmospheric transport, and near-surface vertical gradients in reactive nitrogen oxides, formaldehyde, and ozone production. Dr. Crawford has also coordinated special issue publications of air quality findings in EM magazine, targeted to air quality decision makers, and he has served as the atmospheric chemistry editor for the Journal of Geophysical Research-Atmospheres since 2013. A current member of the International Global Atmospheric Chemistry (IGAC) project Steering Committee, Dr. Crawford will assume the IGAC co-Chair role in 2019. Dr. Crawford was selected for a Presidential Early Career Award for Scientists and Engineers in 2001. He has also received NASA's highest honors, the Outstanding Leadership Medal, and NASA's Exceptional Achievement Medal for sustained scientific contributions to NASA's Tropospheric Chemistry Program. His current research interests include the photochemistry of tropospheric ozone and free radicals, the global budget of reactive nitrogen, the influence of clouds on trace gas transport and chemistry, and the use of satellites to study long-range pollution transport and air quality. Since 2010, Dr. Crawford has led a series of air quality focused field studies across the United States (DISCOVER-AQ) and in South Korea (KORUS-AQ) to understand local and transboundary influences on air quality and to prepare for geostationary satellite observations of air quality planned by Korea and the U.S. in the early 2020s. Dr Crawford received his Ph.D. in Atmospheric Chemistry from Georgia Institute of Technology, and his B.S. in Mathematics from the United States Military Academy.

DeFelice,Tom

In Progress

Dr. DeFelice is currently a consultant to NOAA and NASA federal service sector small businesses, while taking management courses to maintain his PMP certification. He has submitted a US Utility Patent pending application, involving the use of UAS w/autonomous, adaptive control, and on-board environmental sensors. Dr. DeFelice has a PhD in Atmospheric Science from N.C. State University, MS Atmospheric Physics from DRI/UNR, and a BS in Math and Atmospheric Science from SUNY at Albany. He has performed air quality, meteorology, atmospheric chemistry (aqueous & gas phases) measurements on an EPA project that funded his PhD work. Dr. DeFelice taught wet and gas phase atmospheric chemistry, cloud physics, remote sensing of aerosols, plus meteorological instrumentation and measurement at the University Senior/Grad student level. His university level teaching included mentoring a Graduate student who's research involved Air Pollution Control Technology development. Dr. DeFelice has authored 40+ relevant peer-reviewed publications, and a college text-meteorological instrumentation & measurement. He has been an editorial board member of Atmospheric Research since 2000, and Atmospheric and Solar-Terrestrial Physics. Dr. DeFelice's expertise and research activities are focused on atmospheric science, cloud and aerosol physics and chemistry, meteorological measurements and the effect of aerosols on atmospheric and other processes(biosphere, geosphere, hydrosphere), and the effect of cloud systems on the environment. He has over 20 years of experience relevant to air quality, mainly focused on investigating aerosol characteristics and cloud system-aerosol interactions. Dr. DeFelice led an unbudgeted full cycle validation infrastructure project created per Data Qual. Act 2000, which today still serves as a focal point for research studies and public outreach at EDC. He supported air quality studies of APHC focusing on meteorology and aerosol (chemical & physical) measurements, their analysis and their effect on soldier. Dr. DeFelice has served on advisory committees not supported by the SAB staff office and professional societies, for example, 2+ years on an International Commission for the Ministry of Agriculture, Mendoza, Ar. He also served as a member of the ARL biosafety committee for 3 yrs. Dr. DeFelice has served on the American Society of Civil Engineers, Environmental Water Resources Institute Atmospheric Water Management Standards Committee since 1994 which included serving as its chair and secretary.

Enstrom,James E.

Scientific Integrity Institute

Dr. James E. Enstrom is a retired Research Professor/Researcher from the School of Public Health and Jonsson Comprehensive Cancer Center at the University of California, Los Angeles. He is President of the Scientific Integrity Institute in Los Angeles. He received his BS in physics from Harvey Mudd College, an MS and PhD in elementary particle physics from Stanford University, and a MPH and postdoctoral certificate in epidemiology from UCLA. Dr. Enstrom has authored, primarily as first or sole author, about 50 peer-reviewed articles and book chapters on physics, epidemiology, and scientific integrity. He has received research funding from many sources, including NIH, ACS, UC, private foundations, industry sources, and personal donations. He has received no funding recently, but is still conducting original epidemiologic research by using personal assets in innovative and cost-effective ways. He has taught graduate classes on environmental health science. He has given numerous lectures on epidemiology and ethics. He has published important articles relating good health practices to reduced mortality and recently has shown that fine particulate matter (PM2.5) is not related to total mortality in the ACS Cancer Prevention Study cohorts (CPS I and CPS II). He is the only independent scientist to obtain and analyze original CPS cohort data. His research shows that the EPA PM2.5 NAAQS is scientifically unjustified and must undergo complete and objective reassessment. His Scientific Integrity Institute website contains thousands of documents on air pollution epidemiology, lifestyle epidemiology, scientific integrity, and critiques of regulations, many of which contain his own research and analysis. He understands air pollution health effects research from the perspectives of both physics and epidemiology and maintains the highest level of integrity. He is a Life Member of the American Physical Society, a Founding Fellow of the American College of Epidemiology, and a current member of the ACE Ethics Committee. In 2015 he received the Heroes of Conscience Award from the American Freedom Alliance in Los Angeles.

Fernandez,Ivan J.

University of Maine

Dr. Ivan J. Fernandez is a Professor and forest soil scientist at the University of Maine, Orono. He is a Distinguished Maine Professor and faculty member in the School of Forest Resources, the Climate Change Institute, and the School of Food and Agriculture. His expertise is in biogeochemical cycling in forested ecosystems, terrestrial-aquatic linkages, and biogeochemical responses to a changing chemical and physical climate. He is a member of numerous professional organizations such as the Society of American Foresters, Soil and Water Conservation Society, and a fellow and member of the Soil Science Society of America. He serves as a member of the National Council of Soil Science Examiners and the Maine Board of Certification for Professional Geologists and Soil Scientists. He is recognized for establishing or helping to establish several long-term ecosystem studies in Maine that include the Howland Research Forest, research watersheds in Acadia National Park, and the long-term whole ecosystem research program at the Bear Brook Watershed in Maine. He also serves as the External Science Advisor to the Hubbard Brook Ecosystem Study in New Hampshire and is the point of contact for the U.S. Department of Agriculture (USDA) Northeast Climate Hub at the University of Maine. His current research interests are in atmospheric deposition and climate change effects on forested ecosystems and watershed processes, bioenergy implications for forest management, and climate change adaptation. He was co-leader of the 2009 climate change assessment for Maine and the subsequent report Maine's Climate Future. Dr. Fernandez has funding from the U.S. Department of Agriculture, the National Oceanic and Atmospheric Administration, the Northeastern States Research Cooperative and the National Science Foundation to study acidification and recovery, climate, and nitrogen effects on long-term forest biogeochemistry.

Fine,Philip

South Coast Air Quality Management District

Philip Fine, Ph.D. is currently the Deputy Executive Officer for Planning, Rule Development & Area Sources at the South Coast Air Quality Management District (SCAQMD) in Diamond Bar, CA. He is responsible for oversight, administration, and direction of all activities of the Division, including all rulemaking functions, Air Quality Management Plan and SIP development, particulate matter and ozone control strategies, climate and energy policy, air quality modeling, meteorology and forecasting, air quality data evaluation, emissions reporting, and air toxics risk assessment. He also recently served as the Assistant Deputy Executive Officer for the Science & Technology Advancement Division in charge of all field and laboratory activities related to the AQMD ambient network of over 36 air monitoring stations, source testing, compliance testing, quality assurance, and all special air monitoring research projects. Dr. Fine has been a member of several CASAC panels, and currently serves as a member of the California Air Resources Board legislatively mandated Research Screening Committee. Prior to joining the SCAQMD, he was a Research Assistant Professor at the University of Southern California, Los Angeles where he taught courses and conducted extensive research on particulate pollution, its health effects, atmospheric science, and measurement methods resulting in over 50 peer-reviewed scientific publications. Dr. Fine received his Ph.D. from California Institute of Technology in Environmental Engineering Science, and his bachelor's degree in Mechanical Engineering and Materials Science & Engineering from the University of California, Berkeley.

Frampton,Mark

University of Rochester

Dr. Mark W. Frampton is Professor Emeritus in Medicine in the Pulmonary & Critical Care division, at the University of Rochester Medical Center (URMC), Rochester, NY. Dr. Frampton holds an M.D. from New York University. During pulmonary specialty training at URMC in the late 1980s, Dr. Frampton became interested in the adverse health effects of air pollution, at a time when epidemiology studies were beginning to provide strong links between ambient particulate air pollution and mortality. Working with Dr. Mark Utell and utilizing the human clinical studies facility at URMC, he expanded the focus of human clinical air pollution studies beyond pulmonary function effects to include effects on airway inflammation, host defense against viral infection, and cardiovascular effects. Dr. Frampton's laboratory was the first to conduct human clinical studies of ultrafine particles (smaller than 100 nm), first using laboratory generated elemental carbon particles, and subsequently with concentrated ambient ultrafine particles, using the Harvard ultrafine concentrator system. Over the years his laboratory has studied healthy subjects as well as those considered to have increased susceptibility, including older subjects and people with mild asthma, chronic obstructive pulmonary disease, type 2 diabetes, and even genetic susceptibility. Dr. Frampton's laboratory is one of three centers completing a study of the cardiovascular effects of ozone exposure in healthy older subjects, funded by the Health Effects Institute. These studies have helped to understand the physiological changes and pathways to adverse effects that occur in response to pollutant exposure, and have helped to inform the EPA's promulgation of rational ambient air quality standards. Funding for these studies has come from the National Institutes of Health, the U.S. EPA, the Health Effects Institute, the New York State Energy Research and Development Authority, CONCAWE, ExxonMobil, the American Petroleum Institute, and others. Dr. Frampton has served on numerous scientific review panels with the National Institutes of Health and other scientific funding organizations. He has been active in the Environmental and Occupational Health Assembly of the American Thoracic Society, serving as its Chair in 2001-2003. At the request of the ATS President at the time, Dr. Frampton chaired a Task Force on Bioterrorism, and helped to form a new Section on Bioterrorism, serving as its first Chair in 2003-2005. He recently served as a member of the ATS committee preparing a revision of the important and oft-cited document, "What Constitutes a Health Effect of Air Pollution?", which has now been published. Dr. Frampton has served as a consultant and reviewer for the Health Effects Institute, a health research organization jointly funded by EPA and the automobile industry. He is currently a member of the Science Review Committee for the Health Effects Institute. He participated in an HEI review panel on the health effects of traffic-related air pollution, and chaired an HEI Review Panel on ultrafine particles, which produced a recent HEI Perspectives, "Understanding the Health Effects of Ambient Ultrafine Particles". Dr. Frampton has served as a consultant to the EPA in developing and reviewing Integrated Scientific Assessments (formerly Criteria Documents) for nitrogen dioxide, ozone, and particulate matter. In addition, he has served on several EPA grant and fellowship review panels and scientific workshops, and has been invited to speak at EPA functions. He currently serves on the CASAC PM Review Panel.

Fritz,Patricia

New York State Department of Health

Patricia Mason Fritz, is a Research Scientist III with the Bureau of Toxic Substance Assessment in the Center for Environmental Health. She has worked for the New York State Department of Health, Center for Environmental Health in the Bureau of Toxic Substance Assessment since 1994. Prior to joining the Health Department, Pat was a Senior Research Scientist with Sterling Winthrop Research Institute, where she conducted laboratory research in the neurobehavioral effects of compounds of pharmacological interest. Pat holds Bachelor of Science degrees from Syracuse University and SUNY College of Environmental Science and Forestry, and a Masters' degree in Environmental Engineering from Rensselaer Polytechnic Institute. Ms. Fritz has represented the Health Department on multi-disciplinary review and advisory panels related to environmental health, prepared and provided technical support for testimony in administrative hearings, and served on grant and contract review panels in the areas of energy, environment, and health. She is a current member of ASHRAE, the American academy of Allergy, Asthma and Immunology (AAAAI), where she serves on the Environmental Exposure and Respiratory Health and Aerobiology Committees, the American Association for Aerosol Research (AAAR), where she serves on the Early Career Committee, and the Pan- American Aerobiology Association(PAAA). Ms. Fritz' work at NYSDOH encompasses exposure assessment and toxicological risk assessment of chemical and biological contaminants in air water and soil, criteria and hazardous air pollutants, aerosols, aerobiology, asthma, air quality, nanotechnology, mercury, and impacts from conventional and alternative energy sources. She has worked on the development and analysis of results from surveys conducted in New York State focused on asthma prevalence and exacerbation, collaborated on a study investigating pediatric exposure to mercury, and has conducted multiple investigations related to indoor and outdoor air quality in residential, school and occupational settings in NYS. In addition to her research efforts, she responds to public inquiries about health effects from chemical and biological pollution, develops and provides training on health effects of air pollutants, provides technical support to Department technical documents and initiatives, and has participated in multi-agency evaluations of environmental sampling data collected following industrial accidents, natural disasters and following the World Trade Center attacks. She is currently in the third year of a New York State Energy Research and Development Authority funded research project characterizing particulate emissions from advanced biomass-fueled appliances.

Gordon,Terry

New York University School of Medicine

Dr. Terry Gordon holds the rank of Professor of Environmental Medicine at the New York University (NYU) School of Medicine. He holds a B.S. in Physiology (1974), an M.S. in Toxicology (1976) from the University of Michigan, and a Ph.D. in Toxicology from MIT (1981), and was appointed to the faculty of the Department of Environmental Medicine in 1989. He has served as an ad hoc member of grant review panels and/or site visit teams for NIEHS, NIAID, National Coalition for Cancer Research, DOD, Bureau of Mines, NASA, Health Canada, NIOSH/CDC, and the EPA. Dr. Gordon is past Chair of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) committee, a volunteer organization that publishes occupational exposure levels that are used as workplace safety guidelines throughout the world. Dr. Gordon's broad research interest is in inhalation toxicology. The major focus of his research lab is the identification and understanding of the role of genetic host factors in the pathogenesis of the adverse pulmonary effects produced by inhaled environmental and occupational agents. Because inter-individual responses to inhaled particles and gases vary so greatly in both human subjects and test animals, Dr. Gordon has hypothesized that genetic susceptibility factors play a major role in environmental and occupational lung disease. In collaboration with a number of investigators in the department, his laboratory uses classic murine genetics models, computational genomics, and DNA microarrays to identify genes involved in the acute response as well as in the development of tolerance to repeated exposure to inhaled toxicants. Dr. Gordon also plays a major role in the particulate matter (PM) research program at NYU, and was among the first researchers to use concentrator technology to study the adverse cardiopulmonary effects of ambient PM. Dr. Gordon is an active member of the Society of Toxicology (SOT), and has served on the Program, Placement, Membership, and Awards Committees and as President of its Inhalation Specialty Section. He has served as a consultant/author to the EPA on issues of pulmonary toxicology related to the development of various documents, and served on EPA's Clean Air Scientific Advisory Committee (CASAC) Oxides of Nitrogen (NOx) and Sulfur Oxides (SOx) Primary National Ambient Air Quality Standards (NAAQS) Review Panels and is a current member of the PM ad hoc CASAC.

Hailer,Katie

Montana Tech

Dr. Katie Hailer started her education in chemistry at West Virginia University, graduating in 2001 with a B.A. in Chemistry, summa cum laude. She then went to the University of Montana for her doctoral graduate studies in bioinorganic chemistry. Under the direction of Dr. Kent Sugden, Dr. Hailer spent her time in graduate school working to elucidate the mechanism of hexavalent chromium carcinogenesis. After graduating in 2006, she accepted a one-year postdoctoral position at the Mayo Clinic in Rochester, MN. There she worked with Dr. Scott Kaufmann again focusing on mechanisms of carcinogenicity in an oncology lab. Dr. Hailer then transitioned into a faculty position, first at Winona State University from 2007-2010, and then moving to Montana Tech in 2010. Dr. Hailer currently holds the rank of tenured, Associate Professor and Department Head of Chemistry at Montana Tech. Dr. Hailer is best described as a bioinorganic chemist. Her research has always focused on metal interactions in living systems. Montana Tech is in Butte, MT which also happens to be one of the largest Superfund sites in the United States. Using the historical environmental contamination and current open-pit mining activities as inspiration, Dr. Hailer now focuses her research on measuring and identifying metals in the people that live and work in Butte, MT. Her research has been most recently funded by the National Institutes of Health INBRE grant.

Hayes,Stanley

Ramboll Environ

Mr. Stan Hayes has more than 40 years of experience in air-related environmental engineering and science for NAAQS- and air toxics-related purposes, with emphasis on air modeling analysis and health risk assessment. He has an MS degree in Aeronautics & Astronautics and a BS degree in Mechanical Engineering, both from Stanford University. Mr. Hayes is the primary author of more than 70 scientific papers and presentations, and several hundred technical reports on air-related subjects. He is a member of the EPA Science Advisory Board Risk and Technology Review (RTR) Methods Panel. He is a Fellow of the Air & Waste Management Association, for whom he has chaired or co-chaired national and international specialty conferences. He is chair of the Advisory Council of the Bay Area Air Quality Management District, which provides science-based counsel to the Board of Directors, the Executive Officer, and other senior staff. He has provided expert testimony before federal, state and local regulatory agencies and in court. For 25 years, until 2015, Mr. Hayes was a Principal with Ramboll (previously ENVIRON). He is now emeritus, with no regular salary, EPA or other grants, benefits, or firm ownership interest. Over his career, Mr. Hayes has conducted research consulting on NAAQS- and air toxics-related topics for a broad range of private- and public-sector clients, including trade associations (e.g., API and others), individual companies, law firms, and regulatory agencies (e.g., EPA and others). Relevant to the work of CASAC, he has conducted NAAQS-related air quality modeling studies, health risk assessments, exposure analyses, control strategy analyses, nonattainment area plan evaluations, air monitoring data analyses, and regulatory and policy reviews.

Hayworth,Nan

Independent Consultant

The Honorable Nan Hayworth, M.D. is a consultant and a Special Business Development Advisor for Pilot Growth Equity. She is the only female physician ever to serve as a Member of Congress, representing the 19th District of New York in 2011 and 2012. As a freshman Member of the House Majority, Congresswoman Hayworth was assigned to the House Financial Services Committee and the Majority Whip Team; she also had the honor of being chosen by Speaker Boehner to serve on two House-Senate Conference Committees. She has been recognized by many organizations, including the Sierra Club, League of Conservation Voters, Defenders of Wildlife, and Wilderness Society, for her efforts to protect the environment. A board-certified ophthalmologist, Dr. Hayworth practiced for nearly 20 years in Mount Kisco, New York, before becoming a vice president and medical director at Cline Davis & Mann, a healthcare communications agency, prior to running for Congress. She chairs the board of directors of ConservAmerica, a Republican organization dedicated to environmental protection, and she served as a primary media surrogate for EPA Administrator Scott Pruitt when he was a candidate for this position. Congresswoman Hayworth speaks on television and radio in behalf of Independent Women's Forum, the Trump campaign, and the Republican National Committee. She graduated summa cum laude from Princeton University in 1981 with a degree in Biology, subsequently graduating at the top of her class from Cornell University Medical College (now Weill Cornell Medicine) in 1985. Dr. Hayworth has not been a recipient of any research grants from the public or private sectors over the past two years.

Huang,Guanyu

Spelman College

Dr. Guanyu Huang is an assistant professor of Environmental and Health Sciences program at Spelman College. He received his B. Eng. (2008) in remote sensing science and technology from Wuhan University in China, and his M.S. (2010) and Ph. D. (2015) in Atmospheric Science from University of Alabama in Huntsville. He became a postdoctoral fellow at Harvard-Smithsonian Center for Astrophysics in 2015 and then joined Spelman college as a tenure-track assistant professor in 2017. Dr. Huang is an expert of air quality, especially in ozone and its precursors. His research interests include trace gas remote sensing, air quality modeling and observations in multiple scales, and the application of machine learning in environmental science and remote sensing. He has authored and co-authored multiple journal papers and conference papers. He teaches courses in air quality, atmospheric science and environmental science in Spelman College.

Kinney,Patrick

Boston University School of Public Health

Dr. Kinney has a broad background in environmental health sciences, with specific training and expertise in air pollution exposure assessment, epidemiology, and climate change. He completed his doctoral studies in Environmental Science and Physiology at the Harvard School of Public Health in 1986. As a junior faculty member at New York University, he developed and led epidemiologic research on lung function and inflammatory biomarker changes in relation to chronic exposures to ozone and other air pollutants. Moving to Columbia in 1994, he expanded his research to include community-based studies of traffic pollutant exposures and health outcomes in underprivileged neighborhoods in New York City, leading and contributing to several large-scale studies over the following 22 years. He has contributed to the periodic reviews of the National Ambient Air Quality Standards for ozone and particulate matter, and served on the EPA Clean Air Scientific Advisory Committee for reviews of the Nitrogen Dioxide and Sulfur Dioxide standards. He developed and directed the Climate and Health Program at Columbia, which trains students and postdocs in research on the health dimensions of climate variability and change. He also directed research on indoor and outdoor air quality and health in Africa, including a randomized stove trial in Ghana funded by NIEHS. Current funding sources include the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration. In January 2017, Dr. Kinney was named the inaugural Beverly A Brown Professor of Urban Health at Boston University.

Kleinman,Michael T.

University of California, Irvine

Dr. Michael T. Kleinman is an Adjunct Professor of Toxicology in the Department of Medicine's Occupational and Environmental Medicine Division at the University of California, Irvine (UCI), with a joint appointment in the Program in Public Health. He was previously employed by the U.S. Atomic Energy Commission (AEC) as an environmental scientist and he directed the Aerosol Exposure and Analytical Laboratory at Rancho Los Amigos Hospital in Downey, CA. He has more than 40 years of experience researching the health effects of environmental contaminants. He holds a M.S. in Chemistry (Biochemistry) from the Polytechnic Institute of Brooklyn and a Ph.D. in Environmental Health Sciences from New York University. He is the Co-Director of the Air Pollution Health Effects Laboratory at UCI. He has published more than 115 peer-reviewed journal articles on effects of environmental contaminants on cardiopulmonary and immunological systems and on global and regional distribution of environmental contaminants including heavy metals and radioactive contaminants from nuclear weapons testing. He has directed more than 50 controlled exposure studies of human volunteers and laboratory animals to ozone and other photochemical oxidants, carbon monoxide, ambient particulate matter (PM) and laboratory-generated aerosols containing chemically or biologically reactive metals such as lead, cadmium, iron and manganese. He has served on two National Academy committees to examine issues in protecting deployed U.S. Forces from the effects of chemical and biological weapons. Dr. Kleinman's current research focuses on neurological and cardiopulmonary effects of inhaled particles, including nanomaterials and ultrafine, fine and coarse ambient particles in humans and laboratory animals. His recent health effects studies have the role of inhaled combustion-generated particles on the promotion of airway allergies and acceleration of development of cardiovascular disease and how these effects are mediated by organic and elemental carbon components of PM. Dr. Kleinman's current research grants and contracts include a grant to examine the effects of inhaled particles on brain stem cells related to tumor development from the California Brain and Lung Tumor Foundation, a contract from the California Environmental Protection Agency to study the role of semi-volatile components of fine and ultrafine PM on cardiac function and atherosclerosis, and a contract to examine the effects of long term inhalation exposure to concentrated fine particles on brain inflammation. Dr. Kleinman has previously served on the U.S. EPA Clean Air Scientific Advisory Committee (CASAC) Ozone, PM and NO2 panels and was appointed to Chair the Scientific Review Panel for Toxic Substances for the state of California. Dr. Kleinman's current research focuses on neurological and cardiopulmonary effects of inhaled particles, including nanomaterials and ultrafine, fine and coarse ambient particles in humans and laboratory animals. His recent health effects studies have the role of inhaled combustion-generated particles on the promotion of airway allergies and acceleration of development of cardiovascular disease and how these effects are mediated by organic and elemental carbon components of PM. Dr. Kleinman is a co-Investigator on grants from NIH and NSF as well as contracts from the California Brain and Lung Tumor Foundation and from the California Environmental Protection Agency to study the role of semi-volatile components of fine and ultrafine PM on cardiac function, atherosclerosis, and effects of subchronic and chronic inhalation exposures to concentrated fine particles on brain inflammation.

Lange,Sabine

Texas Commission on Environmental Quality

Dr. Sabine Lange is the section manager for the Toxicology Division at the Texas Commission on Environmental Quality (TCEQ). Dr. Lange's responsibilities include overseeing health effects risk assessments of air permit applications, ambient air monitoring projects, and hazardous waste sites; overseeing the development of chemical toxicity factors; and conducting and overseeing systematic reviews and independent analyses of risk assessments. Dr. Lange serves as a technical resource for the State and citizens of Texas for human health and environmental risk assessment, especially related to air and water quality. Dr. Lange's research interests include the toxicology of criteria air pollutants, particularly ozone dosimetry and exposure-response. In this area she has published articles, given invited talks, presented posters, and served as a workshop panel member. On behalf of the TCEQ, she has intensively reviewed the documents released by the US EPA on the National Ambient Air Quality Standards (NAAQS) for ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and lead. Dr. Lange and colleagues have provided comments to the US EPA on the assessment documents supporting these standards, particularly as they relate to principles of toxicology, risk assessment, and the State's perspective on these rules. Dr. Lange's work since joining TCEQ has been entirely funded by the State of Texas.Dr. Lange received a Bachelor's degree from the University of Western Ontario in Canada, and completed a Ph.D. and post-doctoral training in biochemistry and molecular carcinogenesis at the University of Texas at Houston and MD Anderson Cancer Center. Dr. Lange is a Diplomate of the American Board of Toxicology.

Lefohn,Allen

A.S.L. & Associates, LLC

Dr. Allen S. Lefohn is currently President and Founder of A.S.L. & Associates, LLC in Helena, Montana. From 1981 until 2017, he served as President and Founder of A.S.L. & Associates, a Montana corporation. He received his Bachelor's degree from UCLA in 1966 and a Ph.D. in physical chemistry from the University of California at Berkeley in 1969. His advisor was Professor George C. Pimentel. For the period 1989 – 1999, he served as an Executive Editor of the internationally recognized journal Atmospheric Environment and is an Emeritus Editor of the Journal. Dr. Lefohn has published approximately 125 peer-reviewed publications, edited four books, presented numerous oral papers, and participated in panel presentations. During a career spanning over 50 years, his research has focused on (1) understanding the importance of background ozone in relation to ambient concentrations, (2) developing exposure-response relationships and indices that describe the effects of ozone on vegetation and human health, (3) investigating biological mechanisms that define the nonlinearity (i.e., weighting of the higher concentrations more than the mid- and low-level values) response to ozone for both human health and vegetation, and (4) integrating results from the EPA's air quality database for (a) characterizing co-occurrence patterns of criteria air pollutants under ambient conditions (e.g., ozone, sulfur dioxide, and nitrogen dioxide), (b) characterizing ozone trend patterns, and (c) designing research experiments that utilize realistic ambient exposures for assessing human health and vegetation effects. For 19 years, Dr. Lefohn has worked with the American Lung Association in characterizing ambient ozone and particulate matter data for the organization's annual State of the Air report. His research results have also been applied by the EPA. Between 2007 and 2015, EPA staff, CASAC, and the EPA Administrator considered the application of an exposure metric, the W126 exposure index, as the federal standard to protect vegetation. Dr. Lefohn created the exposure metric in 1985 with the help of the first-generation Apple Macintosh computer and described the metric in the peer-review literature in 1987 and 1988. In October 2015, the EPA Administrator announced that the 8-h ozone standard would be used as a surrogate for the protection of vegetation; the EPA continues to use the W126 metric as an indicator of the potential risk of ambient ozone exposures to vegetation. Dr. Lefohn is familiar with the EPA's rulemaking process. He was the lead consultant scientist for the EPA in authoring the air quality characterization chapter and the vegetation exposure-response section for the Ozone Criteria Document in 1996 and contributed to the Ozone Criteria Documents in 1985 and 2006. Dr. Lefohn presented testimony in March 2015 to the House Committee on Science, Space, and Technology about background ozone. In 2015, Dr. Lefohn was a co-guest editor for the Atmospheric Environment special issue: Observations and source attribution of ozone in rural regions of the Western United States. Dr. Lefohn is currently on the Steering Committee of the important international research effort, Tropospheric Ozone Assessment Report (TOAR). The project provides the international research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause. Dr. Lefohn is the lead author (with 23 additional co-authors) of the TOAR paper, Global Ozone Metrics for Climate Change, Human Health and Crop/Ecosystem Research, which was published in April 2018 and is available online. Dr. Lefohn is currently an Adjunct Professor of Environmental Engineering at Montana Tech in Butte, Montana. He is a member of the AAAS. For the past two years, Dr. Lefohn's funding sources for his research activities have originated from the American Lung Association and his own company, A.S.L. & Associates.

Lewis,Timothy

U.S. Army Corps of Engineers

Tim Lewis is a supervisory research ecologist with the U.S. Army Corps of Engineer, Engineer Research and Development Center, Environmental Laboratory in Vicksburg, MS. He worked for Lockheed Engineering, primary contractor for the U.S. EPA, serving as Project Leader and Principal Scientist on studies related to the National Surface Water Survey, the Direct Delayed Response Project (soil acidification), and the Environmental Monitoring and Assessment Program (EMAP). He accepted a position with the Bureau of Land Management in 1993 and served as the National Indicator Development Coordinator for the U.S. EPA's EMAP - Forest Health Monitoring program. He edited and authored a CRC Press book entitled Tree Rings as Indicators of Ecosystem Health. He went on to become Effectiveness Monitoring Coordinator for the Northwest Forest Plan. In 1996 Tim became the first Director of the Forest Science Project at Humboldt State University, where he applied his regional aquatic and terrestrial monitoring experience to private and public lands in Northern California. In 2001, Dr. Lewis accepted a position as senior ecologist with the U.S. EPA's National Center for Environmental Assessment, where he was involved in the assessment of ecological risks due to air pollutants. He served as associate editor of the premier journal Ecological Indicators during its startup. In 2007 Tim joined the Environmental Laboratory at the USACE's Engineer Research and Development Center in Vicksburg, MS as Chief for the Aquatic Ecology and Invasive Species Branch. The branch is actively engaged in ecosystem restoration and the assessment of the impact of Corps projects on habitat for threatened and endangered species and prevention and reduction of impacts of invasive plants and animals in the nation's waterways. EducationB.A., West Chester University, West Chester, PA, 1977, Biology M.S., Rutgers University, New Brunswick, NJ, 1980, Plant Pathology Ph.D., Rutgers University, New Brunswick, NJ, 1984, Environmental Science

Masuca,Corey

Jefferson County Department of Health

Corey Masuca, PE, PhD, JD is currently the Principal Air Pollution Control Engineer with the Jefferson County Department of Health. As the leader of the Air Pollution Control Program with the Jefferson County of Health he is responsible for overseeing a staff of approximately 35 persons who responsibilities include regulating industrial sources of emissions, area and point sources of emissions such as dry cleaners/gasoline stations and open burning, respectively. In addition, he oversees the ambient air monitoring program which is responsible for measuring air contaminant concentrations within Jefferson County, Alabama to ensure compliance with healthy clean air standards set by the United States Environmental Protection Agency (USEPA). Since he graduated from Auburn University with a Bachelor of Chemical Engineering degree, he has continued to work in the environmental arena, specifically air quality and air pollution. As a student at Auburn University, he completed a cooperative education program rotation with the Tennessee Valley Authority in Muscle Shoals, Alabama where he completed stack testing of fertilizer plant residuals including stack testing equipment preparation and calibration. After he graduated from Auburn University, he was employed as an Environmental Engineer with the State of Connecticut Department of Environmental Protection where he regulated sources of air pollutant emissions and was responsible for the implementation of a major new air regulatory USEPA program as part of the 1990 Clean Air Act Amendments. Following his tenure with the Connecticut Department of Environmental Protection, he worked as a consulting engineer with the environmental consultant firm, CH2M Hill, in the Atlanta, Georgia area. With CH2M Hill, he prepared air program applications for several industrial air-polluting facilities applying for applications to operate. This involved extensive regulatory review and complex, mathematical calculations to determine compliance and/or regulatory applicability. Next, he returned to Alabama where he worked an Environmental Engineer with the Alabama Department of Environmental Management where he continued his work as an Environmental Engineer where he was responsible for permitting, determining compliance, inspecting, and initiating enforcement actions, where applicable, of industrial sources of air pollution. Finally, he was initially employed as an Air Pollution Control Engineer with the Jefferson County Department of Health where, again, his primary duties entailed permitting, determining compliance, inspection, and initiating enforcement actions of industrial sources of air pollutant emissions. While with the Jefferson County Department of Health, he continued his professional and academic pursuits where he was promoted to the position of a Senior Air Pollution Control Engineer, became a registered/licensed Professional Engineer with the State of Alabama, and obtained a doctoral degree in Environmental Health Engineering from the University of Alabama in Birmingham. His doctoral degree research consisted of completing an epidemiology study of air pollutant concentrations and pre-term birth defects for populations within Atlanta, Georgia. After obtaining his doctoral degree and while still working full-time as a Senior Air Pollution Control Engineer with the Jefferson County Department of Health, he was also employed an adjunct professor both with the University of West Alabama (where he continues to be an advisory board member for the Environmental Sciences section of the Biology Division) and with the University of Phoenix (Birmingham campus). He taught classes in environmental science, environmental ethics, and general environmental air pollution health effects with both the University of Phoenix (Birmingham campus) and the University of West Alabama. In addition, during and subsequent to this time, he acted as a professional consultant providing air pollution data and review/analyses for three (3) epidemiological studies being performed/conducted by the University of Alabama at Birmingham, School of Public Health, Department of Epidemiology, which involved determining the relationship between ambient air pollution and emergency room visits for cardiovascular disease in Jefferson County, Alabama; ambient air pollution and emergency room visits for respiratory disease among adults in Jefferson County, Alabama; and ambient air pollution and respiratory diseases in children in Jefferson County, Alabama. During and subsequent to this time, he was promoted to his current position of Principal Air Pollution Control Engineer with responsibility for all of the various components of the Health Department's Air Pollution Control Program. Following his teaching stints with the University of West Alabama and with the University of Phoenix (Birmingham campus), all the while still being employed with the Health Department, he undertook an initiative to pursue as Juris Doctorate degree from the Miles College School of Law in Birmingham. He completed his requisite law studies and recently graduated from law school (May 2018). He is still employed as the Principal Air Pollution Control Engineer with the Jefferson County Department of Health Air Pollution Control Program and is currently planning to sit for the Alabama State Bar in July 2018, after which he will continue to work at/with the Health Department in a lead scientific and administrative capacity, and, hopefully, legal capacity subsequent to passing the Alabama State Bar.

Moore, Jr.,Charles Thomas (Tom)

Western States Air Resources Council - Western Regional Air Partnership

Mr. Tom Moore works for the 15 state air agency members of the Western States Air Resources (WESTAR) Council. He is the manager of the Western Regional Air Partnership (WRAP) air quality program, a voluntary partnership of states, tribes, federal land managers, local air agencies and the U.S. EPA, whose purpose is to provide technical support to understand current and evolving regional air quality issues in the context of the Clean Air Act (CAA) and the National Environmental Policy Act (NEPA). His regional analysis and planning support work is conducted through management of a series of interrelated contractor-supported regional projects for the WESTAR and WRAP membership, related to western U.S. air quality. These diverse, complex, and highly technical projects cover ambient monitoring data analysis, emissions inventory preparation and analysis, regional photochemical grid modeling and source apportionment results, and satellite air quality data.

Morris,Vernon

Howard University

Dr. Morris is a Professor in the Department of Chemistry, Director of the Atmospheric Sciences Program at Howard University. He serves as the PI and Director of a NOAA cooperative science center for Atmospheric Sciences at Howard University. He also maintains an adjunct appointment in the Environmental Engineering Program. Dr. Morris received BS degrees in chemistry and mathematics from Morehouse College and a PhD in Earth and Atmospheric Sciences from the Georgia Institute of Technology. He has completed advanced study in Sicily (Erice), at the Lawrence Livermore National Laboratories, and as a Presidential Postdoctoral Scholar at the University of California (Davis). Beginning with an NSF CAREER award in 1997, Dr. Morris has raised more than $60M in external research funding, founded the Atmospheric Sciences Program, which is already a national leader in the production of minority PhDs in the field, and helped guide the success of multiple NOAA and NASA-funded research centers. Recent funding includes several grants from NOAA and the National Science Foundation. Dr. Morris has guided the research for more than 150 students at the graduate, undergraduate, and high school levels, published over 75 refereed papers, book chapters, and conference proceedings, ranging from quantum chemistry to the impacts of lightning in tropical Africa, and has made over 100 invited talks and national conference presentations. The research themes that guide his current research are (i) the impact of mineral dust aerosols on global atmospheric chemistry and climate, (ii) the role and influence of tropospheric aerosols on regional environmental health, and (iii) the interplay between weather phenomena (e.g. dust storms, lightning, and precipitation) and atmospheric chemistry, i.e. "chemical meteorology". Dr. Morris has won numerous academic and scientific honors and awards including being recognizedas one of the 50 Most Influential Blacks in Science and Technology in 2011, inducted as a History Maker in Science in 2012, winning the NOBCChE Henry Cecil McBay Outstanding Teacher Award (2012), a Fulbright Specialist Award (2013), elected a Fellow of the American Meteorological Society (2016), and the Charles Anderson Award of the AMS in 2017. Dr. Morris is a member of the AMS, AGU, and the National Society of Black Physicists (NSBP). He has previously served on several national advisory committees including the Department of Energy ARM Science Board (2015 – 2017), the District of Columbia STEM Advisory Council (2011 – 2014), the UNESCO steering committee for the "Application of Remote Sensing for Integrated Management of Ecosystems and Water Resources in Africa", the National Academies of Sciences Board on Atmospheric Sciences and Climate (BASC) (2005 – 2007), and Member of the NASA Earth Systems Sciences and Applications Advisory Council, (ESSAAC) (2003 – 2005).

Morris,William

Efficient Fuel Additives

Dr. Morris completed his Ph.D. and M.S. in chemical engineering at the University of Utah examining the effect of pollutants such as NOX, SOX, and particulate matter on aerosol formation in air and oxy-fired combustion. He also holds a coordinate A.B. in Physics and Environmental Studies with a minor in History from Bowdoin College. He is currently President of Efficient Fuel Additives where he provides fuel additives and technical services to promote energy efficiency, use of alternative fuels, and utilization of agricultural waste biomass resources. He is also contracted by the Wyoming Integrated Test Center (ITC) as Program Director to provide engineering and business development support services for CO2 management technologies related to the ITC. The ITC facility, which was recently completed, is a public/private venture between Basin Electric Power Cooperative, Tri-State G&T, the National Rural Electric Cooperative Association, Black Hills Power, and the state of Wyoming through the Wyoming Infrastructure Authority. The research facility can provide up to 20 MW equivalent of flue gas for post combustion CO2 capture testing as well as 5 small 0.4 MWe test bays which will host the NRG COSIA Carbon XPRIZE CO2 utilization competition.Additionally, in a consultative capacity, he has provided engineering and technical advice for to private and government entities in the U.S. and S. Korea. As an employee of ADA Environmental Solutions, he worked in the areas of mercury emissions control, CO2 capture, NOX control, and is the listed inventor on 3 issued NOX, mercury, and CO2 emissions control patents as well as other patents pending. He was also a contributing author to the oxy-fuel combustion section of the National Coal Council's report, Fossil Forward in 2015 for then Department of Energy Secretary of Energy Ernest Moniz providing an update on CO2 capture technologies. His primary area of expertise is in combustion by-product formation such as NOX and particulate matter as well as emissions controls for mercury and CO2. He has conducted basic research, small pilot research, and commercial scale demonstrations and trials of various mercury, NOX, and emissions control technologies with both private industry and universities. Previous partners have included University of Utah, University of California Berkeley, Texas A&M University, Lehigh University, Southern Company, Aspen Aerogels, The University of Akron, the Electric Power Research Institute, the National Energy Technology Laboratory, the U.S. Department of Energy and other private industry companies. In addition, he has been a peer reviewer for the journals of American Chemical Society as well as Elsevier Publishing.

Packham,Steven

Utah Department of Environmental Quality

Dr. Steven Packham is an inhalation toxicologist with 28 years of regulatory experience with the Utah Division of Air Quality. Foremost among his responsibilities has been public education and communication of the scientific basis and intent of USC Title 42, Chapter 85 (particularly Sections 7409 and 7412): To protect human health with an ample margin of safety "requisite to protect" public health. His actual regulatory experience includes: Preparation of case-specific HAPs residual risks and leaking underground storage tank vapor intrusion risk assessments. Development of State Implementation Plans. State adoption of Federal NESHAP MACT's, and annual reviews of Utah's NATA Urban Air Toxics program. His research has focused on causal biologic mechanisms of dose-dependent health effects from breathing air pollution. He has developed a model to estimate margins of safety for mobile app users based on EPA Air Quality Index (AQI) values for sensitive and normal groups who may wish to engage in fitness improvement training and enjoy physical recreational activities outdoors under fluctuating air quality conditions. Dr. Packham is an Adjunct Associate Professor in the University of Utah College of Health Sciences Department of Family and Preventative Medicine and a member of the Advisory Board of the Rocky Mountain Center for Occupational and Environmental Health in Salt Lake City. Past professional activities include: Editorial Board, Journal of Fire Sciences. Chairman, American Society for Testing and Materials (ASTM) Task Group E5.21.05. Member, Toxicity Advisory Committee National Fire Protection Association. Member, ASTM Committee on Toxic Hazard Assessment of Materials used in Transportation Vehicles. United States of America Member, Technical Advisory Committee, ISO/TC 92/SC 3. Convener: ISO Technical Committee 92, Subcommittee 3, Working Group 1 on Fire Model. United States of America Assigned Expert: ISO/TC 92/SC 3/Working Group on Bio-assays.

Pair,Benson

KBR

Mr. Benson Pair is currently the Chief Technology Engineer- Environmental for KBR, located in the Houston Office. He has held this position for 29 years, since he joined KBR, then the M.W. Kellogg Company, in 1988. Prior to joining KBR, Mr. Pair spent 16 years with Engineering Science, Inc., environmental engineers and consultants, in their Houston Office, serving as Office Manager the last five years. He graduated from Rice University with two degrees in Chemical Engineering, a B.A. and an M.Ch.E, both degrees awarded in 1972. Mr. Pair is a registered Professional Engineer in the State of Texas and a Board Certified Environmental Engineer (BCEE). He is a member of the American Institute of Chemical Engineers (AIChE), the American Academy of Environmental Engineers and Scientists (AAEES) and the Water Environment Federation. Mr. Pair has served as an officer in the Water Environment Association of Texas (WEAT) holding every office in the Southeast Texas Section. He served as Chair of the Environmental Division of the AIChE, and served on the Programming Committee of AIChE. Mr. Pair is currently the AIChE representative on the Board of Trustees of the AAEES. This marks the second time he has been asked to serve in that position. Mr. Pair has nearly 46 years of experience in Environmental Engineering, all of it spent in providing consulting and engineering services to the hydrocarbon processing industry. He has executed projects involving air pollution control, wastewater treatment and solid waste management. Mr. Pair has been responsible for all phases of a project, from site selection studies through start up and commissioning. He has conducted bench scale and pilot scale treatability studies, and designed treatment plants. Mr. Pair has completed projects located in over a dozen States and ten foreign countries, giving him a working knowledge and appreciation of the regulatory requirements of a broad range of local, state and federal agencies, as well as international lending institutions. His career began shortly after the passage of the Clean Air Act in 1970 and the Clean Water Act in 1972. Mr. Pair has followed the development of air pollution control and wastewater treatment technologies for nearly five decades, applying these technologies to achieve regulatory compliance in a cost effective manner.

Paulson,Suzanne

University of California Los Angeles

Dr. Suzanne Paulson is Professor in the Department of Atmospheric & Oceanic Sciences, and Professor in the Institute of the Environment at UCLA, where she serves as the director of the Center for Clean Air. She earned a B.A. in Chemistry from the University of Colorado, an MS in Plant Biology from the University of Illinois, and an MS and PhD in Environmental Engineering Science from the California Institute of Technology. She was an Advanced Study Program Postdoctoral Fellow at the National Center for Atmospheric Research in Boulder, Colorado. Currently she investigates the impact of aerosol particles on human health and in clouds. She is also studies the influence of the built environment (sound walls, vegetation, cityscape design and traffic control) on pollution levels in urban areas at block and sub-block scales, including. She did extensive earlier work on ozone-alkene chemistry and aerosol optical properties, and has also conducted research projects in indoor air, biofuel emissions, and bioaerosol among others. Currently Dr. Paulson serves on the Research Screening Committee for the California Air Resources Board. Until recently she also served as an Airport Commissioner for the City of Santa Monica. She is a member of the American Association for Aerosol Research, the American Association for the Advancement of Science, the American Chemical Society and the American Geophysical Union.

Randolph,Dennis A.

City of Grandview

Mr. Dennis A. Randolph, P.E. is the Public Works Director for Grandview Missouri and Adjunct Instructor at the University of Missouri – Kansas City. He holds B.S. and M.S. degrees in civil engineering from Wayne State University as well as an MPA from Western Michigan University. He previous taught at Western Michigan and Wayne State, and has been a full-time local government engineer for over 40 years. His interests span a broad range emphasizing applied research that brings results to local communities. His current emphasis area is the impact of air, noise, and water pollution on Environmental Justice communities. Currently, he is responsible for leading technical work involved with litigation concerning the administration and permitting under the Clean Air Act. In conjunction with the air quality modelling work he led an effort to study noise along a newly designated interstate road to evaluate the cumulative impacts on the same Environment Justice communities. Mr. Randolph's current research has been supported by funding from the City of Grandview; Mr. Randolph has received no external research funding for this work from either federal of state government agencies, private companies, or foundations. Over the years Randolph has led work in solid waste management, surface and groundwater pollution and management, rural and urban sewage handling and treatment, and brownfield cleanup. He has formed collaborations between university faculty and local communities to investigate a wide-range of problems and to conduct field trials. He conducted a large county-funded project to trace multiple salt plumes through a rural. He was responsible for technical review of a $100 million wastewater treatment plant upgrade and managed several large combined sewer separation projects, and community sewage lagoon upgrades. He is managing a sanitary sewer inflow and infiltration (I&I) study to identify problem areas as well as a study of storm sewer pipe condition using robotic sensors. He obtained voter-approved funding for a $15 million brownfield cleanup of several abandoned industrial sites, and two $200,000 U.S. Environmental Protection Agency cleanup grants to identify and test suburban and rural sites. He has led countywide solid waste recycling efforts, been a flood plain administrator, and led efforts to incorporate stormwater Best Management Practices in construction projects, and been responsible for soil erosion and sedimentation regulation enforcement for several communities. He has led safety studies as a Principal Investigator on Federal Highway funded research and served on several National Cooperative Highway Research Program projects. He has also provided several grants to university departments to provide funding for focused research on local government engineering problems and is currently providing funding for a study of road asset management with the University of Missouri – Columbia, Civil Engineering Department. Mr. Randolph Is a Registered Professional Engineer in four States, a Public Works Leadership Fellow (APWA), and was recently selected as one of 2015's Top Ten Public Works Officials (APWA). He is a member of several American Society of Civil Engineers (ASCE) committees including the Public Agency Peer Review Committee. His other current committee work includes the ASCE Infrastructure Resilience Division SPEED Committee, and the Institute of Sustainable Infrastructure, where the work focuses on the topics of resilience and sustainability of infrastructure. He is a Life Member of the Institute of Transportation Engineers, American Society of Civil Engineers, and Institute of Electrical and Electronics Engineers. He has written nearly ninety articles and publications including a number of peer reviewed articles. He has authored two books and been the executive editor on a third.

Sheppard,Elizabeth A. (Lianne)

University of Washington

Dr. Elizabeth A. (Lianne) Sheppard, PhD is Professor and Assistant Chair in the Department of Environmental and Occupational Health Sciences and Professor of Biostatistics at the University of Washington. She holds a B.A. in psychology and a Sc.M. in biostatistics from Johns Hopkins University, and a Ph.D. in biostatistics from University of Washington. Her research interests focus on modeling and understanding the health effects of environmental and occupational exposures with particular emphasis on statistical methods for environmental and occupational epidemiology. She actively collaborates on a variety of research projects in the environmental and occupational health sciences and has been lead statistician for the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air) study, a 10-year study funded by EPA to determine the effect of long-term air pollution exposure on subclinical progression of cardiovascular disease. Dr. Sheppard directs a NIEHS-funded program for quantitative training in the environmental health sciences. Her recent research funding comes from EPA, NIEHS, NIOSH, and the Health Effects Institute. She is a fellow of the American Statistical Association and a member of the editorial board for Epidemiology. She serves on the Health Effects Institute's Review Committee, and has advised EPA through service on several Clean Air Scientific Advisory Committee special panels and Science Advisory Board ad hoc committees.

Sorooshian,Armin

University of Arizona,Department of Chemical and Environmental Engineering

Armin Sorooshian is an Associate Professor, University Distinguished Scholar, and da Vinci Fellow at the University of Arizona in the Departments of Chemical and Environmental Engineering, Hydrology and Atmospheric Sciences, and Public Health. He received his B.S. (2003) in Chemical Engineering at the University of Arizona, and a M.S. (2005) and Ph.D. (2008) in Chemical Engineering at the California Institute of Technology. Armin specializes in aerosol physics and chemistry, in addition to aerosol-cloud interactions. Armin is involved with projects including instrument development/characterization, surface/ship/airborne field measurements, and the use of data from models of varying complexity and remote sensing measurements. His sources of funding in the past two years include the Office of Naval Research, NASA, and the National Institute of Environmental Health Sciences. He is a member of the following professional societies: American Geophysical Union (AGU), American Institute of Chemical Engineers (AICHE), American Meteorological Society (AMS), and American Association for the Advancement of Science (AAAS).

Stuart,Amy

University of South Florida

Amy L. Stuart, Ph.D. is a Professor at the University of South Florida (USF) in the Department of Environmental and Occupational Health, College of Public Health. She holds a joint appointment in the Department of Civil and Environmental Engineering, and courtesy appointments in the Center for Urban Transportation Research, and the Patel College of Global Sustainability. She is also the founder and director of the Graduate Certificate Program in Environmental Health at USF. Dr. Stuart earned a BS in chemical engineering, a MS in civil engineering, and a PhD in civil and environmental engineering from Stanford University. She completed postdoctoral training at the Center for International Security and Cooperation at Stanford. Dr. Stuart leads multi-disciplinary research and teaching initiatives related to air pollution, public health, and environmental sustainability. Her research has contributed to understanding the impacts of urban design and transportation on air pollution exposures and their social distribution, the fate of volatile chemicals during cloud freezing, mercury contamination and exposures, and associations between air pollution and birth defects, resulting in over 100 scholarly publications. During the last two years, Dr. Stuart's work has been funded by the National Institute of Environmental Health Sciences and by the United States Department of Transportation. She is also a previous recipient of a National Science Foundation Career award. Dr. Stuart is professionally involved in the Association of Environmental Engineering and Science Professors, currently serving on the Lectures Committee. She is a member of the Air and Waste Management Association, including previous service as the Chair of the Student Awards Committee of the Higher Education Council, and is a member of the International Society of Exposure Sciences. She regularly serves as a reviewer of manuscripts for several scientific journals and of proposals for grant sponsors on air pollution topics.

Wagner,James

Michigan State University

Dr. Wagner is an associate professor in cardiopulmonary toxicology in the Department of Pathobiology and Diagnostic Investigation at Michigan State University. He earned a bachelor's degree in biochemistry, a master's degree in business administration in management science, and a PhD in pharmacology and toxicology. His post-doctoral training focused on comparative pathology and air pollutant exposure. Current research efforts are focused on conducting translational studies to understand the mechanisms of airway injury and systemic responses induced by inhalation exposures to pathogens, toxicants, and environmental pollutants. Mechanistic studies are designed to address exposure related changes to respiratory, cardiovascular, immunological, and nervous systems. Dr. Wagner has over 20 years of experience conducting both field- and laboratory-based, animal inhalation exposure studies across the country, and have relied on approaches of digital pathology, cardiovascular telemetry, pulmonary function testing, and genomic analyses in multiple transgenic and strain-sensitive rodents to understand the histopathological, biochemical, and physiologic responses to inhalation exposures. From his 77 research publications, he has been fortunate to collaborate with over 90 different coauthors from 8 units at Michigan State University and over 30 national and international laboratories. Sources of research funding in the past two years have included the National Institutes of Health (NIH), the State of Michigan, and the European Union, although previous funding sources (> 3years ago) have included the Health Effects Institute (HEI), EPA, and the American Chemistry Council (ACC). He recently contributed to the writing and review of EPA's integrated science assessment (ISA) for PM2.5 from 2015-16. Dr. Wagner has provided review and consultation for other national and international agencies, including Health Canada's Human Health Risk Assessment for Gasoline Exhaust, the EPA's ISA for both ozone and for sulfur oxides, the National Research Council's report on Submarine Air Quality, and the Japan Automotive Research Institute's strategic priorities planning. As a member of the TLV-Chemical Substance Committee for the American Conference for Governmental and Industrial Hygienists (ACGIH), he evaluates toxicological and epidemiological data to conduct risk assessment and make exposure recommendations for a variety of airborne workplace chemicals. Dr. Wagner is an active member in the Society of Toxicology where he served leadership positions in Finance, Inhalation and Respiratory Toxicology, and Cardiovascular Toxicology groups. He is a frequent panel member for proposal peer review for NIH (Children's Health Centers, Superfund Program) and CDC (World Trade Center Research Program). Lastly, Dr. Wagner is active on editorial boards of journals with a focus on air pollutant toxicology, including Inhalation Toxicology and Particle and Fibre Toxicology, and he regularly conducts peer review in Toxicological Sciences, Environmental Health Perspectives, Atmospheric Environment, and Science of the Total Environment, among others.

Waldman,Deane

Texas Public Policy Foundation

Dr. Deane Waldman, MD MBA, is a U.S. citizen and currently the Director of the Center for Health Care Policy at the Texas Public Policy Foundation as well as a Director on the Board of the New Mexico Health Insurance Exchange. He is Professor Emeritus of Pediatrics, Pathology, and Decision Science. "Dr. Deane" was educated and trained at Yale (BA, History), Chicago Medical School (MD), Mayo Clinic, Northwestern, Harvard, and Anderson Graduate Schools of Management (MBA). He practiced medicine as a pediatric cardiologist for 37 years, and was the Chief of Cardiology (Pediatric) at University of Chicago. Dr. Deane is an experienced biomedical scientist with more than 120 peer-reviewed medical research citations, over $3 million in research grants received, more than 300 publications in healthcare policy, as well as the author of nine books.Dr. Deane's scientific expertise along with nearly four decades of caring for patients, coupled with his administrative experience and practical business knowledge gives him a unique perspective. Dr. Deane's goal as a member of CASAC would be to assure that EPA standards for Clean Air are based on reliable science and that the Administrator can connect Clean Air standards to the health status of Americans.

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 9/17/2018 11:39:05 AM
To: Brennan, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=78caa4c8d91743c887c1bb5dc8cdb369-Thomas Brennan]; Johnston, Khanna [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=4ee74eeb7ad744e58f6dbf7d2f20243b-Johnston, Khanna]; Carpenter, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c286cf1692fa46dc9636a7c49c0925b8-Carpenter, Thomas]
Subject: API Comments on Ozone NAAQS Call for Information
Attachments: epa2018_1649b.pdf

API's comments on the EPA's call for information on the Ozone NAAQS. Deliberative Process / Ex. 5

Deliberative Process / Ex. 5

Aaron

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August 27, 2018

Via www.regulations.gov

Environmental Protection Agency
1200 Pennsylvania Ave., NW.
Washington, D.C. 20460

Re: **Review of the National Ambient Air Quality Standards for Ozone—Call for Scientific and Policy-Relevant Information; June 26, 2018; 83 Fed. Reg. 29,785; Docket ID: EPA–HQ–ORD–2018–0274**

The American Petroleum Institute (API) offers the following comments on the Environmental Protection Agency's (EPA) Call for Scientific and Policy-Relevant Information: Review of the National Ambient Air Quality Standards (NAAQS) for Ozone.

API is the only national trade association representing all facets of the oil and natural gas industry, which supports 10.3 million U.S. jobs and nearly 8 percent of the U.S. economy. API's more than 620 members include large integrated companies, as well as exploration and production, refining, marketing, pipeline, and marine businesses, and service and supply firms. They provide most of the nation's energy and are backed by a growing grassroots movement of more than 40 million Americans. Regulations and the required emission control requirements to attain the NAAQS can have an impact on all aspects of API member operations.

The members of API are dedicated to continuous efforts to improve the compatibility of their operations with the environment while economically developing energy resources and supplying high quality products and services to consumers. Our members recognize their responsibility to work with the public, the government, and others to develop and to use natural resources in an environmentally sound manner while protecting the health and safety of our employees and the public.

This call for information is the initial step in the NAAQS ozone review, which the Agency has stated will be complete by October 2020.[1] Of course, API supports compliance with the Clean Air Act (CAA) and its schedule requirements and this challenging schedule is in the forefront of this 5-year NAAQS ozone review. Getting this review planned out is urgent and is arguably the first step the Agency should undertake. With this priority in mind, the API comments first address how the Back-to-Basics memorandum could be incorporated into this review.

[1] May 9, 2018 E. Scot Pruitt to Assistant Administrators Back-to-Basics Process for reviewing National Ambient Air Quality Standards, page 2. https://www.epa.gov/sites/production/files/2018-05/documents/image2018-05-09-173219.pdf (accessed August 24, 2018).

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API finds that an emphasis on a robust and comprehensive Integrated Review Plan (IRP) is perhaps the best path forward to meet the Agency's challenging deadline. A focused "one draft process" with clear roles and responsibilities will be key. Please find suggestions on how the Agency can meet the timeframe in the attached comments. The challenge of this schedule cannot overemphasize. The number of issues underway, not least of which is the NAAQS $PM_{2.5}$ review process, risk delaying this central objective to meet NAAQS statutory deadlines.

In this call for information EPA requests materials regarding significant new ozone research and policy-relevant issues for consideration in this review. The API comments contain input on both the research and policy-relevant issues and discuss the importance of properly characterizing background ozone as a policy relevant issue during the NAAQS ozone review.

API appreciates the opportunity to provide these comments and looks forward to remaining an engaged and supportive stakeholder as the Agency moves forward with the NAAQS ozone review. If you have any questions about these comments, please contact me at (202) 682-8568 or steichent@api.org.

Sincerely,

/s/

Ted Steichen

Comments on the

U. S. Environmental Protection Agency's

Review of the National Ambient Air Quality Standards for Ozone

Call for Scientific and Policy-Relevant Information

Docket ID: EPA–HQ–ORD–2018–0274

June 26, 2018

83 Fed. Reg. 29,785

Submitted by the

American Petroleum Institute

August 27, 2018

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I. Introduction

A. Scope of the Call for Information on Ozone NAAQS

EPA called for the submittal of information regarding significant new ozone research and policy-relevant issues for consideration in this review of the primary (health-based) and secondary (welfare-based) ozone standards.

B. Organization of these Comments

This call for information is the initial step in the NAAQS ozone review, which the Agency has stated will be complete by October 2020.[2] Of course, API supports compliance with the Clean Air Act and its schedule requirements and this challenging schedule is in the forefront of this NAAQS ozone review. Getting this review planned out is urgent and is arguably the first step the Agency should undertake. With this priority in mind, the API comments first address how the Back-to-Basic memorandum could be incorporated into this review.

API finds that an emphasis on a robust and comprehensive Integrated Review Plan (IRP) is perhaps the best path forward to meet the Agency's challenging deadline. A focused "one draft process" with clear roles and responsibilities will be key. Please find in Section II suggestions on how the Agency could meet the timeframe established in the Back-to-Basics memorandum.

In this call for information EPA requests materials regarding significant new ozone research and policy-relevant issues for consideration in this review.[3] The API research input is organized in Sections III and IV, and associated Exhibits A and B.

Section III provides an example list of studies that could form a "pivotal list" of studies that the ISA could cover. This list contains examples of recent information, some of which API anticipates EPA's Office of Research and Development (ORD) would likely select as pivotal. Please note the studies listed are not an endorsement of these studies but are listed for illustration. Exhibit A of the comments provide more detail and suggestions for how these studies could be summarized in the ISA.

Section IV and Exhibit B deal with ozone research that API suggests the Agency consider as the "pivotal list" is developed.

API comments discuss the importance of properly characterizing background ozone as a policy-relevant issue during the NAAQS ozone review in Section V and Exhibit C. Comments on adverse impacts on the NAAQS setting process will follow in response to that separate call for information.

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[2] E. Scot Pruitt memorandum to: EPA Assistant Administrators, May 9, 2018, page 2. https://www.epa.gov/sites/production/files/2018-05/documents/image2018-05-09-173219.pdf (accessed August 24, 2018).

[3] 83 Fed. Reg. 29,785 (June 26, 2018).

II. Toward a Final Ozone Rule by October 2020

In thinking about how the challenging deadline can be met API reviewed materials created by the Administration relevant to the NAAQS review process.

A. Recent Memoranda on the NAAQS Review Process

The NAAQS ozone review began with this July 2018 call for information. This upcoming review has been the subject of memoranda from the President and the EPA Administrator.

1. Presidential Memorandum of April 12, 2018 Promoting Domestic Manufacturing and Job Creation—Policies and Procedures Relating to Implementation of Air Quality Standards[4]

A key excerpt from this memo referenced future NAAQS reviews:

> *"Sec. 7. Future NAAQS Reviews. The Administrator shall evaluate whether EPA is complying fully with the requirements of section 109(d)(2)(C) of the CAA (42 U.S.C. 7409(d)(2)(C)) relating to the scope and characterization of advice provided by its Clean Air Act Scientific Advisory Committee, including requirements that the Committee advise the Administrator regarding background concentrations and adverse public health or other effects that may result from implementation of revised air quality standards. In addition, the Administrator shall examine the current NAAQS review process and develop criteria to ensure transparency in the evaluation, assessment, and characterization of scientific evidence in such reviews. The Administrator shall also develop clear guidance for differentiating the role of science and policy considerations in establishing NAAQS."*[5]

2. Administrators Back-to-Basics Process for reviewing National Ambient Air Quality Standards[6]

In this document there is substantial detail on how the Agency should refocus and reimagine the review process. In this memorandum, the Administrator set out the following five principles for EPA to observe in future NAAQS reviews:

- Meet statutory deadlines;
- Address all CAA provisions for NAAQS reviews;
- Streamline and standardize the process for development and review of key policy-relevant information;
- Differentiate science and policy judgments in the NAAQS review process; and
- Issue timely implementation regulations and guidance.

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[4] 83 Fed. Reg. 16,761 (April 12, 2018).
[5] 83 Fed. Reg. 16,764 (April 16, 2018).
[6] E. Scot Pruitt memorandum to: EPA Assistant Administrators, May 9, 2018.

The memorandum discusses each of the five principles and builds on early improvements to the NAAQS review process, memoranda issued December 7, 2006,[7] and May 21, 2009.[8]

Meet Statutory Deadlines is the first principle in the memorandum. The Administrator states "[f]or the next review of the ozone NAAQS, EPA shall seek efficiencies through replacing the kick-off workshop with a more robust request for information, and shall consider combining its integrated science, risk and exposure, and policy assessment into a single review.

As EPA implements this memo API encourages the Agency to look to the first document, the Integrated Review Plan (IRP) to provide the outline for this efficient review. In Part G. of this Section, API provides more detail on how the IRP and the Clean Air Scientific Advisory Committee (CASAC) review of the IRP will allow the Agency to adhere to this first principle.

Address All CAA Provisions for NAAQS Reviews is the second principle, and these provisions are specified in Section 109(d)(2) of the Act on the roles and responsibilities of CASAC. Some of these responsibilities have not been completed in past reviews and the reasons given were that EPA did not provide within the science documents material for review on all the topics mentioned in Section 109(d)(2) and that CASAC panel did not include members to address all these areas[9]. In the recent request for nominations the need for members across all the relevant disciplines was highlighted. API anxiously awaits the list of nominated panelists and intends to comment on whether or not the needed expertise will be provided on the panel. The task remains for EPA to determine how they will address all the topics that require review and if that is best incorporated in the ISA. EPA should address this issue in the IRP as to the plan to develop the needed materials for a CASAC review in the IRP.

Of note, these NAAQS topic specific panels have been constituted by the EPA Science Advisory Board (SAB) Staff Office, as compared to the statutory CASAC membership that is determined by the Administrator. Since the previous process has not provided for panels to address all the provisions, for at least this ozone panel API recommends the Administrator takes an active role to ensure this principle is fully addressed.

Streamline and standardize the process for development and review of key policy-relevant information is the third principle. The IRP should include details on how the Agency intends to meet this requirement.

Differentiate science and policy judgments in the NAAQS review process is the fourth principle. These expectations need to be enumerated and provide to the ozone NAAQS review panel as soon as it is formed. In attending many review meetings in the past API staff sensed that the CASAC panel members did not always have a common understanding of this distinction. Written expectations to the CASAC review panel would greatly improve the chances the ozone review will adhere to this principle.

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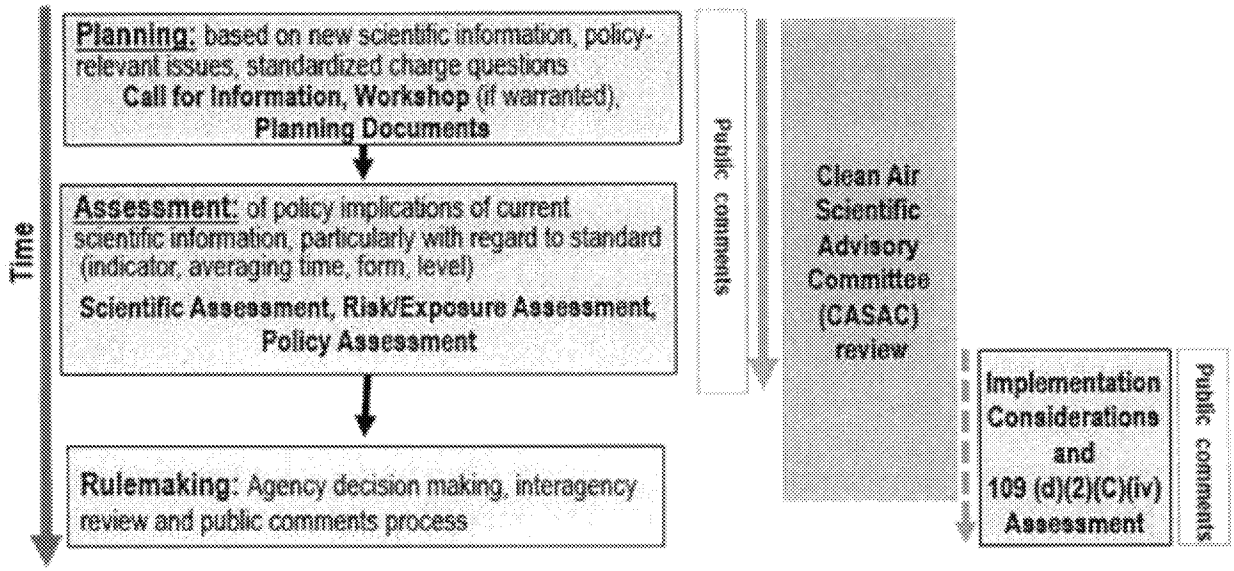
[7] Marcus Peacock: memorandum to George Gray, and Bill Wehrum, December 7, 2006. https://www3.epa.gov/ttn/naaqs/pdfs/memo_process_for_reviewing_naaqs.pdf (accessed August 24, 2018).
[8] Lisa Jackson: memorandum to Elizabeth Craig and Lek Kadeli, May 21, 2009. https://www3.epa.gov/ttn/naaqs/pdfs/NAAQSReviewProcessMemo52109.pdf (accessed August 24, 2018).
[9] Dr. H. Christopher Frey: letter to The Honorable Gina McCarthy, June 26, 2014. https://yosemite.epa.gov/sab/sabproduct.nsf/5EFA320CCAD326E885257D030071531C/$File/EPA-CASAC-14-004+unsigned.pdf (accessed August 24, 2018).

Issue timely implementation regulations and guidance is the fifth principle. This principle is important, but the challenging schedule to complete this NAAQS ozone review by October 2020 elevates the prior four principles over this one.

Within the Back-to-Basics memorandum a schematic of the steps associated with a streamlined and efficient NAAQS review is illustrated as Figure 1:[10]

Figure 1. Schematic of the steps associated with a streamlined and efficient NAAQS review.

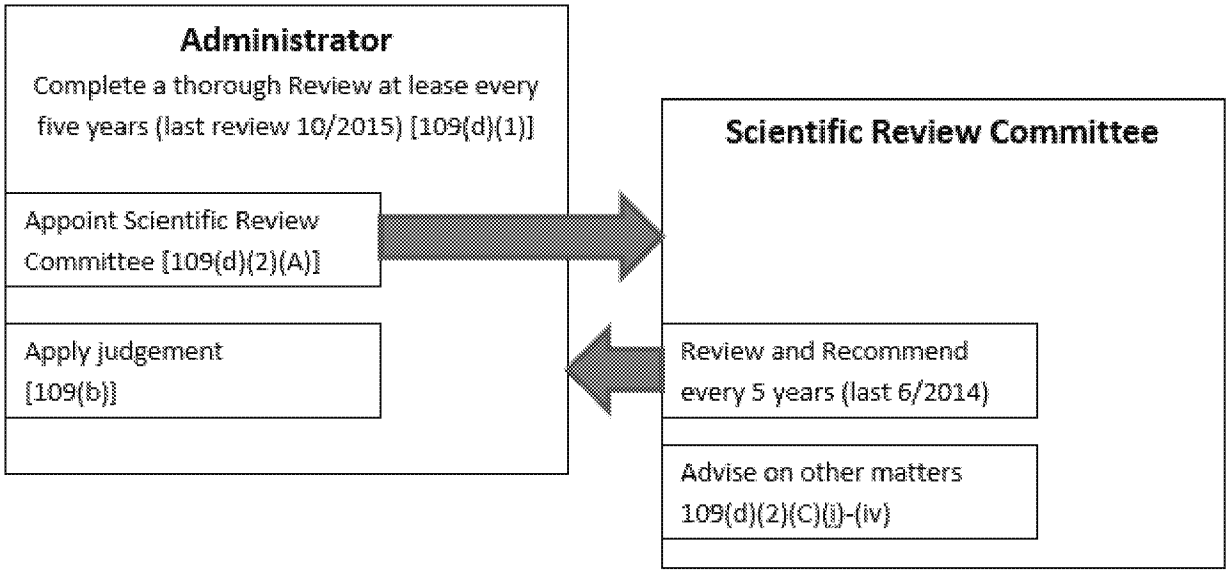


[10] E. Scot Pruitt memorandum to: EPA Assistant Administrators, May 9, 2018, page 10.

To pare this down to the minimum statutory requirements, the following illustration is provided:

Review of National Ambient Air Quality Standards

Statutory Requirements



The Administrator (EPA) prepares documents that the Scientific Review Committee, known as CASAC, review and provide recommendations. For ozone, prior to the 2015 review a Criteria Document was developed and reviewed by CASAC.[11] For the 2015 ozone review an Integrated Review Plan, Risk and Exposure Assessment Scope and Methods Plans (otherwise referred to as the Risk and Exposure Assessment Planning Documents), an Integrated Science Assessment, Risk and Exposure Assessments and a Policy Assessment were completed.

The schematic from the Back-to-Basics references all the documents that were part of the 2015 review. API recommends EPA consider whether all of these documents are necessary to produce and review. The need to do no more than necessary is critical within the timeline the Administrator has established. Please see Part B of this Section for further discussion on what API views as an aggressive timeline and provides a suggested alternative schematic in Part F of this Section.

On page 9 of the memorandum the Administrator states:

> *"EPA should strive to ensure that initial drafts of all documents are sufficiently robust and complete to serve as adequate vehicles for review from both the CASAC and the public, and CASAC should strive to focus on significant comments for these drafts to avoid multiple draft reviews whenever possible. EPA focus on providing CASAC with assessments and chapters succinctly reflect the most salient information, and CASAC focus on providing clear scientific, not editorial, advice, will prevent the inefficiency of what one former CASAC Chair called a "ping-pong" review process with review of multiple drafts. The Agency should seek additional*

[11] U.S. EPA. Air Quality Criteria for Ozone and Related Photochemical Oxidants (Second External Review Draft). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-05/004aB-cB, 2005. https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=137307 (accessed August 24, 2018).

efficiencies in each step in the review process ..., redesigning those steps as needed, and utilizing, in the most efficient manner possible, only those steps that add value in a particular review."

API strongly supports this expectation and suggests that it is best accomplished by a robust IRP that already outlines which new science may be most pivotal to review to accomplish the review. The CASAC and the public, at that point in the process, can provide feedback to the Agency to inform the development of a focused ISA. Please see Part G of this Section for further suggestions on the development of more robust IRP.

B. Aggressive Timeline

Within this call for information EPA provides a deadline to complete this review by October 2020.[12] The task before the EPA is challenging and the need to establish clear expectations and timelines for the Agency staff and CASAC is critical.

To highlight the challenge, in the last Integrated Review Plan the Call for Information (this request) was documented as being made September 2008 with a target final rule in February 2014 in the draft of the IRP,[13] and June 2014 in the final document.[14] The rule was actually finalized in October 2015[15]. The final IRP plan projected was almost 6 years, and it ended up being 7 years. The time between this Call for Information in July 2018 and the date the Administrator intends the review to be complete, October 2020, is little more than two years. Clearly to meet this new timeline will require a sweeping change in the NAAQS review process.

To add to the workload, EPA will likely need to gather additional materials that directly apply to the advice the scientific review committee (CASAC) has not traditionally provided, most especially that required in Section 109(d)(2)(C)(iv).

In considering how to implement a sweeping change, API starts with the statutory requirements and looks how to incorporate all the elements from the latest NAAQS ozone review into the minimum number of documents that require review. For example, assume the documents to be prepared are:

- Integrated Review Plan
- Integrated Science Assessment
- Materials for Section 109(d)(2)(C)(iv) (from existing materials)
- Advanced Notice of Proposed Rulemaking
- Proposed Rule
- Final Rule

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[12] E. Scot Pruitt memorandum to: EPA Assistant Administrators, May 9, 2018, page 2.
[13] U.S. EPA. Integrated Review Plan for the Ozone National Ambient Air Quality Standards Review - External Review Draft. U.S. Environmental Protection Agency, Washington, DC, EPA/452/D-09-001, 2009, page 14. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1005B09.txt (accessed August 24, 2018)
[14] U.S. EPA. Integrated Review Plan for the Ozone National Ambient Air Quality Standards. U.S. Environmental Protection Agency, Washington, DC, EPA/452/R-11-006, 2011, page 2-2. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100AUZO.txt (accessed August 24, 2018)
[15] 80 Fed. Reg. 65,292 (October 26, 2015).

For illustration, please see the following possible timeline to meet the challenging schedule:

Potential NAAQS Ozone Review Milestones

Milestone	Date	Notes
Call for Information	July 2018	30-day comment period
Draft IRP	March 2019	60-day comment period
CASAC Review of IRP	April 2019	
Final IRP (becomes an element of the ISA)	July 2019	
Draft ISA & Materials for 109(d)(2)(C)(iv)	September 2019	30-day comment period
CASAC Review of ISA & Materials for 109(d)(2)(C)(iv)	October 2019	
Final ISA	December 2019	
ANPRM	February 2020	30-day comment period
Proposed Rule	May 2020	60-day comment period
Final Rule	October 2020	

The timeline allows for the development of the much more robust IRP including significant detail on the science to be reviewed and any already identified potential new risks and exposures that might need to be evaluated. Close coordination between the Office of Research and Development and the Office of Air Quality Policy and Standards within the Office of Air and Radiation would likely be the necessary to complete this draft robust IRP.

For the 2015 ozone review CASAC did not hold a meeting to discuss the draft IRP, it was discussed on a consultation conference call; CASAC provided no consensus report for the Administrator.[16] This illustrates that, in the current process, the planning phase (IRP) is not elevated to the same level as the assessment phase.

The key suggestion to EPA is to elevate the planning phase to receive the informed recommendations from the CASAC following a full review of a more robust draft IRP. The review of the ISA could then be focused on how well the IRP was followed. In Part G of this Section is a further discussion on the IRP while Part H provides discussion of the other review steps.

C. Full Requirements of the Review (CAA requirements)

Section 109(d)(2) of the Act requires appointment of an independent scientific review committee that is to periodically review the existing air quality criteria and NAAQS and to recommend any new standards and revisions of existing criteria and standards as may be appropriate. Since the early 1980s, the requirement for an independent scientific review committee has been fulfilled by the Clean Air Scientific Advisory Committee (CASAC).

Section 109(d)(2)(C) of the Act additionally requires the independent scientific review committee to advise the EPA Administrator of areas in which additional knowledge is required to appraise the adequacy and basis of existing, new, or revised NAAQS; describe the research efforts necessary to provide the required information; advise the EPA Administrator on the relative contribution to air

[16] Dr. Jonathan M. Samet: letter to The Honorable Lisa P. Jackson, December 3, 2009 https://yosemite.epa.gov/sab/sabproduct.nsf/8A8B1D042C07DE5185257681007B7D85/$File/EPA-CASAC-10-004-unsigned.pdf (accessed August 24, 2018).

pollution concentrations of natural as well as anthropogenic activity; and, advise the EPA Administrator of any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such NAAQS. To ensure this final statutory requirement is fully met, EPA further published in the Federal Register a call for information that would facilitate the committee's consideration of these issues.

Within this call for information Federal Register Notice the CASAC requirements include:

> *"advise the EPA Administrator on the relative contribution to air pollution concentrations of natural as well as anthropogenic activity; and, advise the EPA Administrator of any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such NAAQS."*

The CASAC panel will need to include experts to address these issues and EPA will need to provide materials for CASAC review to ultimately address the noted requirements. Furthermore, API suggests that EPA prepare materials to highlight to CASAC exactly what is expected to provide this policy relevant information that can inform rule development of any new ozone NAAQS. API also suggests the Administrator identify an office within EPA to be responsible for assembling or preparing the needed documents for CASAC review on these issues.

D. Relationship with Call for Information on Adverse Impacts

The Administrator is already calling for information to evaluate the element of these CASAC review requirements dealing with adverse impacts.[17] API will comment on that call for information but strongly suggests the Agency work this issue now, before those comments are provided, to give the CASAC panel clear expectations on this task.

E. Request for Nominations for CASAC Ozone Panel

In a July 27, 2018 Notice[18] the SAB Staff Office requested public nominations for scientific experts to form a CASAC ad hoc panel to provide advice through the chartered CASAC on the scientific and technical aspects of air quality criteria and the NAAQS for ozone.

The SAB Staff Office sought nominations of nationally and internationally recognized scientists with demonstrated expertise and research in the field of air pollution related to ozone as they select the panel. Experts solicited include:

- Air quality,
- atmospheric science and chemistry,
- causal inference,
- dosimetry,
- toxicology,
- controlled clinical exposure,
- epidemiology,
- biostatistics,

[17] 83 Fed. Reg. 29,784 (June 26, 2018).
[18] 83 Fed Reg 35,635 (July 27, 2018).

- human exposure modeling,
- risk assessment/modeling, uncertainty analysis,
- ecology and effects on welfare and the environment, and
- environmental economics.

The approved policy[19] delegates the decision on this panel to the SAB Staff Office.

The recent request for nominations for the CASAC ozone panel[20] included the need to address the full range of the statutory CASAC duties, including an analysis of background and adverse effects. However, it did not fully highlight the needed experts to handle the full requirements of the review. In other efforts the Agency has begun to address the formation of CASAC,[21] and API recommends the Administrator continue to prioritize making further improvements in canvasing for and selecting the CASAC and the specific NAAQS review panels.

The Administrator could improve the NAAQS ozone review by guiding and supporting CASAC directly, at least as the NAAQS review process is streamlined. The repeated inability for the process to be completed within 5-years, that the full scope of the statutory advice has not been provided in recent reviews, that enhanced coordination will be necessary between ORD and OAQPS within OAR to accomplish a review redesign, and the documented substantial benefits to public health attributed to the NAAQS all argue for the Administrator's direct attention. While the SAB Staff Office has the expertise and supports numerous science panels, CASAC is pivotal to the NAAQS review process. The efficiencies of maintaining this role within the existing SAB framework could be weighed against the attention that is needed by the Administrator to ensure the advice required by the CAA is developed.

At a minimum the Administrator should update the CASAC panel formation approval policy to provide guidance to SAB Staff Office regarding CASAC. API would also suggest the Administrator ensure the CASAC panel members are provided with clear requirements and expectations of their service.

F. Overview of Possible Streamlined Process

The example schematic API provides in these comments is simplified to assist in clarifying the recommendations. These recommendations assume the same level of public interaction with the Agency and the CASAC that has historically been the case. API appreciates EPA's track record on soliciting public comment throughout the NAAQS review process. EPA's schematic provided in the recent Back-to-Basics memorandum demonstrates again its commitment to public engagement.

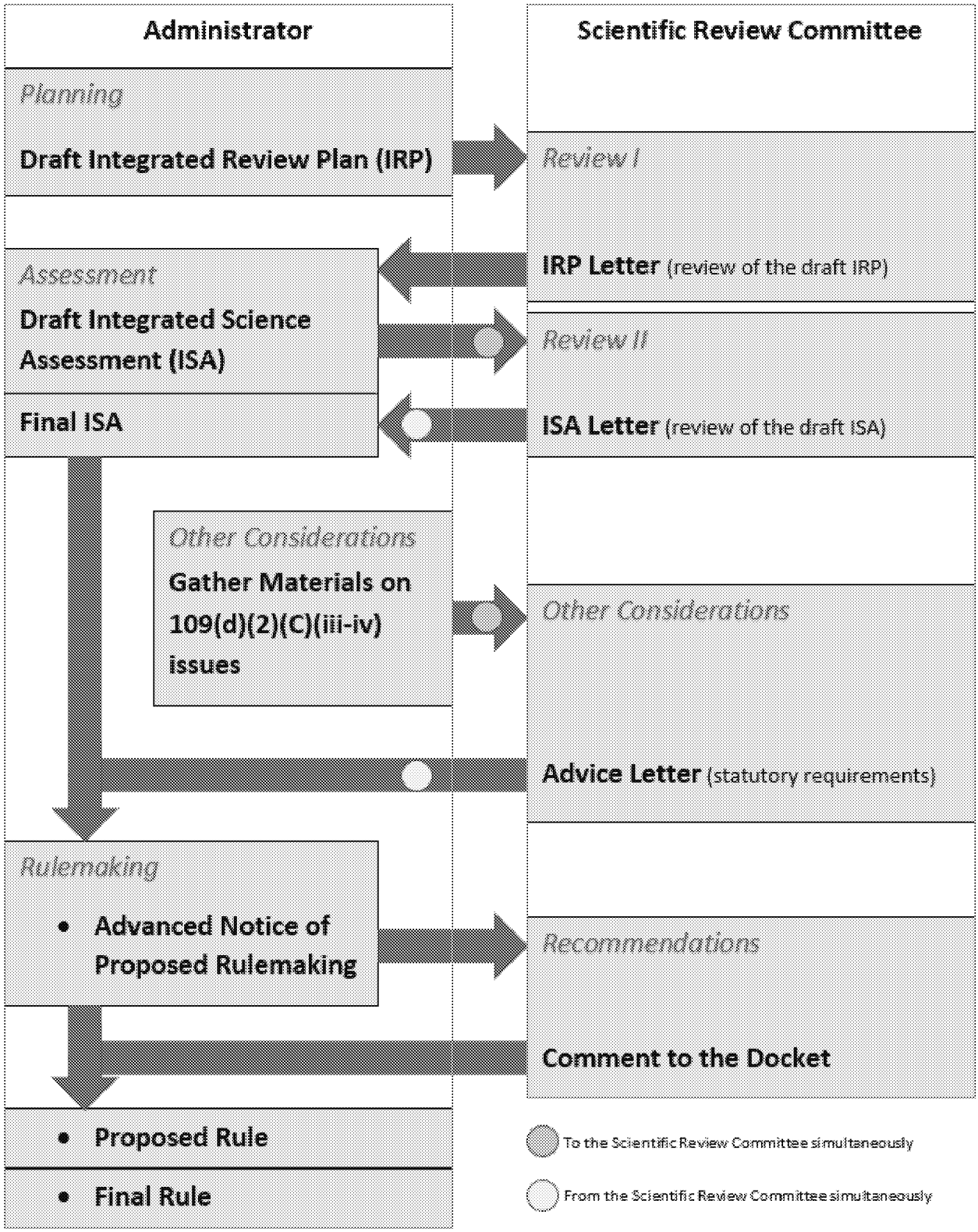
As with the potential scheduled provided in Part B. of this Section, API starts with the statutory requirements and examines how to incorporate all the elements from the latest NAAQS ozone review into

[19] U.S. EPA. Overview of the Panel Formation Process at the Environmental Protection Agency Science Advisory Board. U.S. Environmental Protection Agency, Washington, DC, EPA–SAB–EC– 02–010, 2002. https://yosemite.epa.gov/sab/sabproduct.nsf/WebFiles/OverviewPanelForm/$File/ec02010.pdf (accessed August 24, 2018).
[20] 83 Fed Reg 35,635 (July 27, 2018).
[21] E. Scott Pruitt: letter to EPA Assistant Administrators, October 31, 2017. https://www.epa.gov/sites/production/files/2017-10/documents/final_draft_fac_memo-10.30.2017.pdf (accessed August 24, 2018).

the minimum number of documents that require review. For purposes of this example the documents will be prepared:

- Integrated Review Plan
- Integrated Science Assessment
- Materials for Section 109(d)(2)(C)(iv) (these are anticipated to be existing materials)
- Advanced Notice of Proposed Rulemaking
- Proposed Rule
- Final Rule

Example Review of National Ambient Air Quality Standards



The example would require two reviews by the Science Review Committee, known as CASAC. The first would be on the more robust draft IRP, the second would be for the draft ISA as well as the areas CASAC has not traditionally focused, the 109(d)(2)(C)(iv) issues discussed in Part C. of this Section.

Following those reviews the Administrator (EPA) would incorporate the recommendations from CASAC and the public and publish an Advance Notice of Proposed Rulemaking (ANPRM). Any needed materials that relate to a risk and exposure assessment that are not already incorporated in the final ISA could be included within the ANPRM or provided separately to the Docket and referenced in the ANPRM. CASAC, as a key stakeholder, would be asked to comment on the ANPRM to provide any additional advice to the Administrator prior to the proposed rule.

G. Integrated Review Plan

1. Key Review Document

As previously stated the challenging schedule requires a substantial reevaluation of the work needed on each identified step in the review process. API suggests EPA focus heavily on developing an IRP that is detailed and provides not only the process to complete the review but also identifies by name the pivotal studies the Agency will review, and how the interpretation of those studies might require further analysis of risk and exposure.

For several cycles the ozone NAAQS review process has extensively evaluated new studies to inform the level and form of the standards, though reviews have been refinements built on the existing record. In more recent years EPA staff have developed data systems that track recent research[22] so it is reasonable to assume the EPA staff experts are generally familiar with the state of the science.

To meet the challenging timeline, yet clearly meet the requirements of the CAA, API recommends EPA assemble a list of "pivotal" studies that will be investigated and discussed in the ISA. This list can and should be thoroughly reviewed by CASAC. Many of these experts, which by definition are "nationally and internationally recognized scientists with demonstrated expertise and research in the field of air pollution related to ozone",[23] can review the EPA list and identify more "pivotal" studies that should replace one on the EPA draft list. This determination of the scope of the review seems to be the highest and best use of the time committed by the CASAC ozone panel.

With the list of studies provided in the final IRP, the scope of the ISA is set and then the review can be primarily on whether the Agency had fulfilled the review as planned in the IRP.

In a similar fashion, the IRP could include the known key elements of what are now separate planning documents. Perhaps the experts at EPA can review the final REA from the last review and, in consultation with those developing the "pivotal" studies table provide at least some detail on how to address the possible need and scope of any risk or exposure assessments within the draft IRP. Again, the CASAC panelists, with their extensive knowledge are likely able to review and provide key guidance on the likely planning elements of such potential assessments by reviewing such a chapter within the draft

[22] https://hero.epa.gov/hero

[23] 83 Fed Reg 35,635 (July 27, 2018).

IRP. Inclusion of planning material about these potential assessments in the IRP will allow even more refinement of a potential plan for potential risk and exposure assessments within the draft ISA.

In both cases this robust IRP could rely on "expert elicitation" by both EPA staff and CASAC. This is a departure from prior reviews that can be made given the body of knowledge already evaluated regarding ozone and the rapid improvement in information handling capabilities. The measure of the efficacy of this approach is: does it fulfill the requirements of the statutory CASAC review. Based on the historic inability to complete the review within 5-years and the failure to address all the elements specified within the CAA, this is an example of the fresh thinking EPA should consider.

Traditionally the IRP has contained information from the prior review, summary information on new available materials and some detail on how that information will be evaluated. Each IRP has been tailored to the pollutant, but it remained very much about process and not content. In fairness, the traditional IRP content clearly does meet the definition of a review plan, but the suggestions above would make the review plan much more specific to the pollutant and the research to be reviewed in the current cycle.

More specificity earlier in the process would allow the best use of the expertise of CASAC in finalizing the IRP, as well as provide a clear framework for CASAC to ultimately judge if EPA completed what they indicated within the plan. In this approach the ISA review can be focused on evaluating the quality of the EPA effort in implementing the "plan" without needing to address the "mission creep" that API staff have observed in prior reviews where multiple ISA drafts were prepared and reviewed by CASAC. To highlight where the work has typically been focused, in the 2015 ozone review the IRP was 77 pages,[24] while the ISA was 1,251 pages.[25] In the 2008 ozone review the IRP was 22 pages,[26] while the final ISA was in three volumes with a total page count of 2,118.[27]

2. The IRP Sets the Scope of the Review

The NAAQS review process must be timely and meet the statutory requirements. An improved process should start with a detailed plan with a clear scope. Since any review is not starting from scratch and those developing the materials are already familiar with the current state of science, EPA should strongly consider focusing on developing a detailed scope of the entire NAAQS ozone review and move away from a sequential process of document development, reviews, rework of those documents and then further reviews.

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[24] U.S. EPA. Integrated Review Plan for the Ozone National Ambient Air Quality Standards. U.S. Environmental Protection Agency, Washington, DC, EPA/452/R-11-006, 2011. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100AUZO.txt (accessed August 24, 2018)

[25] U.S. EPA. Integrated Science Assessment (ISA) of Ozone and Related Photochemical Oxidants (Final Report, Feb 2013). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-10/076F, 2013. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492 (accessed August 24, 2018).

[26] U.S. EPA. Plan for Review of the National Ambient Air Quality Standards for Ozone. U.S. Environmental Protection Agency, Washington, DC. https://www3.epa.gov/ttn/naaqs/standards/ozone/data/o3_review_plan_march05.pdf. (accessed August 24, 2018).

[27] U.S. EPA. Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final Report, 2006). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-05/004aF-cF, 2006. https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=149923. (Accessed August 24, 2018).

One of the key roles of the CASAC is to describe the research efforts necessary to provide the required information. This is often done in the final letter to the Administrator on the PA.[28] Ultimately, as this NAAQS ozone review proceeds, if unexpected information comes to light it should be flagged by CASAC to investigate for the next review cycle.

3. CASAC Identified Shortcomings in Recent Integrated Review Plans

To illustrate that the current draft IRP is not necessarily sufficient within the current review process, API notes the CASAC review of EPA's Draft Integrated Review Plan for the Secondary National Ambient Air Quality Standard for Oxides of Nitrogen and Oxides of Sulfur. The then Chair of CASAC highlighted, among other items:

- Lack of Specificity in the Plan: The CASAC is concerned that providing just preliminary ideas in the draft IRP does not constitute a plan that could be put into action.[29]
- Uncertainty: A more in-depth consideration of uncertainty is needed[30]

The IRP has not always been fully reviewed by CASAC. For example, in the last review for ozone the Draft Review was a "consultation" and no consensus report was provided[31]

Using substantial EPA resources to create a more robust and specific IRP could provide the best opportunity to meet the Administrator's schedule. A more robust and specific IRP could also allow for a more substantive CASAC review of this key document. Details about how EPA will address uncertainties and highlighting the degree of transparency in the science reviewed will ultimately give the Administrator key information to evaluate any potential change in the NAAQS.

4. Charge Questions

The IRP should include charge questions that are specific to this review, perhaps directed at individual key studies and setting the expectation that the ISA identify the specific evidence within those study results that argues for a change in a NAAQS. Further charge questions can build on the identified evidence to address if the degree of uncertainty of that substantiation is more or less robust than the prior evidence used to set the existing NAAQS. All charge questions would be subject to both public and CASAC input as part of the draft IRP review defining the task in front of EPA as it develops the ISA.

5. Request for Comment by Public and CASAC

The roles and responsibilities of the Chartered CASAC and the CASAC ozone panel should be established before the first meeting. All stakeholders should be encouraged to comment on the IRP. A clear IRP can then be implemented in the ISA and the rulemaking phase.

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[28] Dr. H. Christopher Frey: letter to The Honorable Gina McCarthy, EPA-CASAC-14-004, June 26, 2014.
[29] Dr. Ana V. Diez Roux: letter to The Honorable Gina McCarthy, EPA-CASAC-16-001, April 1, 2016.
[30] Ibid, page 2
[31] Dr. John M. Samet: letter to The Honorable Lisa P. Jackson, EPA-CASAC-10-004, December 3, 2009.

6. Finalizing the IRP

EPA should incorporate, as they are able, the comments of the Public and CASAC when finalizing the IRP. An IRP specific to the pivotal science will facilitate the completion of an ISA that documents any new key evidence including a discussion of uncertainty and transparency. The finalized IRP could be incorporated in the final ISA as an appendix.

H. Other Review Steps

1. Integrated Science Assessment

Were the IRP developed as suggested, the ISA would have a clear format and would answer the specific charge questions raised by the pivotal studies indicated in the IRP to be addressed in the review. The CASAC review of the ISA would be clear. Did EPA adequately review the pivotal research identified in the IRP and complete the risk and exposure review as laid out in the IRP?

If CASAC does identify a needed improvement in the ISA, EPA could then address that in the final ISA. CASAC would also work on answering the full scope of their statutory requirements, which would be included in an advice letter to the Administrator. This letter could end the formal role of the CASAC panel, however CASAC could be encouraged to comment on the ANPRM

2. Risk and Exposure Assessment

A separate document detailing the risk and exposure assessment is not a statutory requirement. In earlier reviews the Criteria Document did not contain risk and exposure information. That information was subsequently prepared as technical documents for use by the Administrator.[32]

Incorporating risk and exposure assessments within the review process could be addressed by including these issues in both the more robust IRP and the ISA. Any available early (preliminary) results of any needed risk and exposure assessment could be included in the draft ISA. If additional risk and exposure assessments are identified, then the results could be included within the final ISA if complete at that time. If such assessments are conducted, another option would be to include the results in their entirety or by reference and place them into the Docket at the time the ANPRM is issued. CASAC could be encouraged to comment on the ANPRM.

3. Policy Assessment as an Advanced Notice of Proposed Rulemaking

The Policy Assessment (PA) could be issued as an Advanced Notice of Proposed Rulemaking (ANPRM) as outlined in the 2006 Memorandum from the Deputy Administrator Marcus Peacock.[33] The ANPRM should have a relatively short comment period and not be held up by the practice of waiting for a CASAC meeting to be held to review the PA. At the time of the ANPRM the CASAC ozone panel could review the ANPRM and update their recommendations to the Administrator via the Docket.

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[32] One of the documents: A Probabilistic Assessment of Health Risks Associated with Short-Term Exposure to Tropospheric Ozone; R,G,Whitfield, W.F. Biller, M.J. Jusko, and J.M. Keisler, ANL/DOS-3, June 1996. https://www3.epa.gov/ttn/naaqs/standards/ozone/data/riskrep.pdf (accessed August 24, 2018).

[33] Marcus Peacock: memorandum to George Gray, and Bill Wehrum, December 7, 2006. https://www3.epa.gov/ttn/naaqs/pdfs/memo_process_for_reviewing_naaqs.pdf (accessed August 24, 2018).

4. Proposed and Final Rulemaking

The release of the ANPRM could provide the opportunity to then release a proposed rule with a preferred option moving forward. After public comment, the final rule could move on to that preferred or perhaps an alternate option as laid out in the proposed rule.

III. Identify Pivotal Studies and List in the IRP

EPA should identify a limited number of truly pivotal studies that will be further evaluated in the Integrated Review Plan (IRP). The much shorter review period will require a streamlined process and EPA should fully utilize the technical expertise of EPA staff and CASAC members to establish the scope of the Integrated Science Assessment (ISA) within the IRP.

Here is an example of studies that might be included in such a focused list:

1. Long-term (chronic) effects

- **Ambient PM2.5, O_3, and NO_2 Exposures and Associations with Mortality over 16 Years of Follow-Up in the Canadian Census Health and Environment Cohort (CanCHEC);** Crouse DL, Peters PA, Hystad P, Brook JR, van Donkelaar A, Martin RV, Villeneuve PJ, Jerrett M, Goldberg MS, Pope CA 3rd, Brauer M, Brook RD, Robichaud A, Menard R, Burnett RT. *Environ Health Perspect.* 2015 Nov;123(11):1180-6.

- **Long-Term Ozone Exposure and Mortality in a Large Prospective Study;** Turner MC, Jerrett M, Pope CA 3rd, Krewski D, Gapstur SM, Diver WR, Beckerman BS, Marshall JD, Su J, Crouse DL, Burnett RT. *Am J Respir Crit Care Med.* 2016 May15;193(10):1134-42.

- **Associations between long-term PM2.5 and ozone exposure and mortality in the Canadian Census Health and Environment Cohort (CANCHEC), by spatial synoptic classification zone;** Cakmak S, Hebbern C, Pinault L, Lavigne E, Vanos J, Crouse DL, Tjepkema M. *Environ Int.* 2018 Feb;111:200-211.

- **Has reducing fine particulate matter and ozone caused reduced mortality rates in the United States?** Cox LA Jr, Popken DA. *Ann Epidemiol.* 2015 Mar;25(3):162-73.

- **Mortality associations with long-term exposure to outdoor air pollution in a national English cohort;** Carey IM, Atkinson RW, Kent AJ, van Staa T, Cook DG, Anderson HR. *Am J Respir Crit Care Med.* 2013 Jun 1;187(11):1226-33.

- **Long-term exposure to ambient ozone and mortality: a quantitative systematic review and meta-analysis of evidence from cohort studies;** Atkinson RW, Butland BK, Dimitroulopoulou C, Heal MR, Stedman JR, Carslaw N, Jarvis D, Heaviside C, Vardoulakis S, Walton H, Anderson HR. *BMJ Open.* 2016 Feb23;6(2):e00949.

- **Ambient ozone and incident diabetes: A prospective analysis in a large cohort of African American women;** Jerrett M, Brook R, White LF, Burnett RT, Yu J, Su J, Seto E, Marshall J, Palmer JR, Rosenberg L, Coogan PF. *Environ Int.* 2017 May;102:42-47.

2. Short-term (acute) effects

- **Association of Short-term Exposure to Air Pollution with Mortality in Older Adults;** Di Q, Dai L, Wang Y, Zanobetti A, Choirat C, Schwartz JD, Dominici F. *JAMA*. 2017 Dec 26;318(24):2446-2456

- **Characterization of the concentration-response curve for ambient ozone and acute respiratory morbidity in 5 US cities;** Barry V, Klein M, Winquist A, Chang HH, Mulholland JA, Talbott EO, Rager JR, Tolbert PE, Sarnat SE. *J Expo Sci Environ Epidemiol*. 2018 Jun 19

- **Acute effects of ambient ozone on mortality in Europe and North America: results from the APHENA study;** Peng RD, Samoli E, Pham L, Dominici F, Touloumi G, Ramsay T, Burnett RT, Krewski D, Le Tertre A, Cohen A, Atkinson RW, Anderson HR, Katsouyanni K, Samet JM. *Air Qual Atmos Health*. 2013 Jun 1;6(2):445-453

- **Air quality and acute deaths in California, 2000-2012;** Young SS, Smith RL, Lopiano KK. Air quality and acute deaths in California,2000-2012. *Regul Toxicol Pharmacol*. 2017 Aug;88:173-184

3. Respiratory Function

- **Effects of Policy-Driven Air Quality Improvements on Children's Respiratory Health;** Gilliland F, Avol E, McConnell R, Berhane K, Gauderman WJ, Lurmann FW, et al. 2017. The Effects of Policy-Driven Air Quality Improvements on Children's Respiratory Health. Research Report 190. Boston, MA:Health Effects Institute.

4. Toxicological literature

- **The perpetuation of the misconception that rats receive a 3-5 times lower lung tissue dose than humans at the same ozone concentration;** McCant D, Lange S, Haney J, Honeycutt M. *Inhal Toxicol*. 2017 Apr;29(5):187-196. doi: 10.1080/08958378.2017.1323982.

In Exhibit A to these comments is further information briefly discussing the study, conclusions and other relevant information. Also included for each of these studies is a quick strengths / limitations reference. As an example, below is the table for the first item on this list, **Ambient PM2.5, O_3, and NO_2 Exposures and Associations with Mortality over 16 Years of Follow-Up in the Canadian Census Health and Environment Cohort (CanCHEC):**

Strengths	Limitations
Large (2.5M) national 20% sample from long form Census	Lack of smoking data
Cause-specific mortality, not just all-cause	Associative, not causal modeling; standard limitations
2- and 3-p models with PM2.5 & NO2 with stable results	Hard to statistically separate pollutants' effects

IV. Additional Studies to Consider in Developing a Pivotal List

As EPA develops the list of pivotal studies to present to CASAC in the draft IRP, API offers further material in Exhibit B. In this exhibit API has included original research, methods & recommended practices, reviews, critiques, weight of evidence and commentary that can inform on the policy relevant issues associated with reviewing the ozone NAAQS.

V. Policy Relevance of Background Ozone

EPA has both the ability and legal obligation to consider the impacts of background levels of ozone on the achievability of the NAAQS. Although the U.S. Supreme Court's decision in *Whitman v. Am. Trucking Ass'ns*, 531 U.S. 457 (2001) is often cited for the proposition that EPA cannot consider the costs of implementation, EPA still can and must consider other contextual factors. Notably, in order to determine the levels of ozone that are "sufficient, but not more than necessary" to protect the public health and welfare, EPA must conduct an assessment of the extent to which the risks from exposure to the pollutant are unacceptable, which requires EPA to take into account contextual considerations. *Id.* at 473. The contextual risk assessment factors were described by Justice Breyer in *Whitman* as including "the public's ordinary tolerance of the particular health risk," "comparative health consequences," and the "acceptability of small risks to health." *Id.* At 494-95 (Breyer, J., concurring in part and concurring in the judgment). These contextual factors can all be influenced by the overall adverse economic, social, and energy impacts that could result from a revised NAAQS. For example, the public's "tolerance" and "acceptability" or a particular level of risk can be affected by the standard's adverse impacts on the public that could occur through reductions in economic growth and job loss.

Furthermore, the text of the Clean Air Act shows that Congress intended the NAAQS to be achievable by regulation of U.S. sources through State Implementation Plans (SIPs). The requirements in Section 107(a) that SIPs specify the manner in which the NAAQS "will be achieved and maintained" and the requirements in Section 110(a)(2)(C) call for an enforcement and regulation program "as necessary to assure that [NAAQS] are achieved." Furthermore, Sections 172(a)(2),181, 186, 188 and 192 specify deadlines for achieving attainment. Additionally, Section 109(b) itself links the setting of "requisite" NAAQS to their "attainment and maintenance." These attainment requirements help demonstrate that Congress did not intend NAAQS to address pollution that is beyond the control of the States or EPA. It follows that, in revising NAAQS, EPA must consider whether the standards can be achieved through the regulations provided for by the Clean Air Act – which means taking background ozone into account – and cannot set a standard that is unachievable on a nationwide basis through these regulations.

A. EPA's Identification of the Issue

As EPA states in this call for information, the EPA Administrator is to be advised on the relative contribution to air pollution concentrations of natural as well as anthropogenic activity as part of his deliberations in setting a NAAQS.

In the ISA and the PA for the 2015 NAAQS review a summary of studies regarding background ozone and its contribution to total ambient ozone levels were provided.

B. Summarize the Key Background Studies in the IRP

EPA should start the update of background studies to include in the IRP by reviewing a key paper by Jaffe et al., 2018, *Scientific assessment of background ozone over the U.S.: Implications for air quality management*[34]. This paper considered over a 100 background ozone studies as part of an assessment of the spatial and temporal distribution, trends, and sources of background ozone over the continental U.S.

[34] Jaffe, DA, et al. 2018. Scientific assessment of background ozone over the U.S.: Implications for air quality management. Elem Sci Anth, 6:56. https://www.elementascience.org/article/10.1525/elementa.309/

Many of the referenced studies were published subsequent to the 2015 NAAQS review and should be considered as part of the current review.

The Jaffe et al. (2018) assessment found that spring and summer seasonal mean U.S. background ozone (i.e., ozone from other than U.S. anthropogenic sources) was greatest at high elevation locations in the western U.S., with monthly mean maximum daily 8-hour average (MDA8) mole fractions approaching 50 parts per billion (ppb) and annual 4th highest MDA8s exceeding 60 ppb at some locations.

C. Further Input into the Background Study Summary for the IRP

Within these comments are a list of recent studies (Exhibit C) that included information about the contribution of internationally transported ozone to U.S. background ozone. Most of these studies are included as references in the Jaffe paper; the attached list summarizes the studies' key findings.

Background ozone levels can and should be considered in setting of the NAAQS. In the previous ozone PA, EPA acknowledged that "The Administrator, when evaluating the range of possible standards that are supported by the scientific evidence, could consider proximity to background O_3 concentrations as one factor in selecting the appropriate standard."[35]

Studies listed in the previous 2015 NAAQS review, as well as those considered in the Jaffe et al. (2018) assessment show that in certain locations a significant fraction of observed ozone is due to background sources, which includes ozone derived from natural sources and international transport of ozone and its precursors. Previous studies have shown that peak background ozone exceeds 60 ppb, contributes to NAAQS exceedances, and comprises a significant fraction of seasonal mean and integrated ozone across the US. Background events are not infrequent and peak background concentrations are near the current ozone NAAQS.

EPA has historically sought to account for uncontrollable sources of ozone via implementation rules. However, in some cases the available tools and guidance to address background ozone issues may not be fully developed or functional, and states' resources to utilize the tools may be limited. While EPA should continue to improve upon implementation tools to address event-driven background ozone, it should also utilize its authority under the CAA to consider background ozone levels in setting the NAAQS.

[35] Policy Assessment for the Review of the Ozone National Ambient Air Quality Standard, Final Report , August 2014, Pg 1-27

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 10/10/2018 1:50:58 PM
To: AO SAB EVERYONE [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ee10fa204de24c1793c3c33a462e0d39-AO SAB EVERYONE]
Subject: Inside EPA Daily Feed - Wehrum calls for dramatic acceleration of NAAQS reviews

The Daily Feed

Wehrum calls for dramatic acceleration of NAAQS reviews

October 10, 2018

Bill Wehrum, head of EPA's Office of Air & Radiation, is calling for dramatic acceleration of the process the agency uses to review its national ambient air quality standards (NAAQS), aiming for completed reviews in as little as three and a half to four years -- a far shorter timeframe than the agency typically achieves.

"We have to reinvent" what we do when reviewing the agency's six NAAQS, Wehrum told a recent meeting of the Clean Air Act Advisory Committee (CAAAC) in Arlington, VA.

"We need a way of doing NAAQS reviews that not just gets them done, but gets them done comfortably" within statutory deadlines, Wehrum said.

The Clean Air Act requires EPA to review its NAAQS, set for criteria pollutants like ozone and particulate matter (PM), every five years. But EPA has routinely taken far longer to complete reviews.

The Trump EPA has set a goal of completing the next ozone review on time, by Oct. 1, 2020, five years after the Obama administration issued its toughened ozone standard of 70 parts per billion. EPA further wants to complete its already-overdue review of the PM NAAQS, last reviewed in 2012, by December 2020.

Achieving such ambitious schedules will require a fundamental shift in the way EPA reviews NAAQS, likely with less consultation of the Clean Air Scientific Advisory Committee (CASAC) that advises EPA on how to set the NAAQS, and possibly reducing the number of steps in the review process.

Currently, EPA produces an integrated review plan to chart the course of a review, an integrated science assessment to synthesize the latest available science, sometimes a risk and exposure assessment to weigh risks to the population, a policy assessment to present the administrator with policy options, and then proposed and final rules either changing the NAAQS, or leaving them in place.

Former Trump EPA Administrator Scott Pruitt in a May 9 memo outlined his vision of a faster process, possibly with fewer steps, before resigning in July following a series of ethics scandals.

Pruitt also required CASAC to dispense advice on issues it has previously avoided addressing, such as the technical feasibility and implementation costs of NAAQS. Although the committee is mandated by the air law to do so, it has never reviewed such issues, and critics argue that Supreme Court precedent bars EPA from

weighing these issues in setting NAAQS, given that the limits must be set based on data about threats to public health and the environment.

But Ted Steichen, representing the American Petroleum Institute (API), at the Sept. 26 CAAAC meeting expressed his concern that EPA's Office of Research and Development (ORD) is not making the necessary changes.

Citing the traditional process now unfolding in EPA's review of "secondary," or welfare-based NAAQS for nitrogen oxides, sulfur oxides and PM, Steichen said ORD "still doesn't know how else to do it."

He also questioned whether EPA has given specific direction to the agency's independent Science Advisory Board (SAB), which manages CASAC, on how to speed up reviews.

API in its comments to EPA on the ozone NAAQS review has advocated a substantially shorter review process, with fewer drafts of documents and less repeated consultation of CASAC.

Wehrum answered that first Pruitt, and now Acting EPA Administrator Andrew Wheeler, support the ambitious schedule for ozone and PM, and "we work backwards from there."

EPA has in the past consulted CASAC multiple times during reviews, sometimes on several drafts of the same document. "We need to be a bit smarter about when and where we go back to CASAC," Wehrum said.

He compared reviewing NAAQS to "driving a supertanker. You need to be turning the wheel early and often" to get the "bow to come around."

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 11/13/2018 9:01:53 PM
To: AO SAB EVERYONE [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ee10fa204de24c1793c3c33a462e0d39-AO SAB EVERYONE]
Subject: Rolling Stone - The President's Coal Warrior

CASAC and SAB-relevant portions highlighted…

The President's Coal Warrior

Inside EPA head Andrew Wheeler's highly effective campaign to sacrifice public health in favor of the fossil-fuel industry

By
Jeff Goodell

If you could design the ideal character to assure the continuing domination of Big Coal and Big Oil in America and to reaffirm their faith in their God-given right to cook the climate in pursuit of profit, that character would look a lot like acting EPA Administrator Andrew Wheeler. And the odd thing is, if you met "Andy," as his many friends call him, at one of his popular Halloween parties at his brick house in suburban Alexandria, Virginia, you would probably think he was a great guy. He's 53, gray hair, glasses, a stout Midwesterner with a warm and friendly manner. He is unfailingly civil to everyone, no matter if you are right, left, enviro or Oklahoma wildcatter. He is likely to ply you with homemade Cincinnati chili or tell you about his hike up Mount Kilimanjaro or remind you that when he worked in the U.S. Senate some people called him "the Werewolf." You might notice he's wearing socks with little penguins on them, as he often does. And if you make a joke that connects the penguins on his socks with the disappearing ice in Antarctica due to the fossil fuels burned by his pals in the oil and coal industry, he will probably just laugh. "Andy's a hard guy not to love," says Chris Hessler, a lobbyist and former Senate staffer who has known Wheeler for more than a decade.

But make no mistake, Wheeler is one of the most skilled regulatory hitmen the fossil-fuel industry has ever deployed. Compared to former EPA Administrator Scott Pruitt, his clownishly corrupt and incompetent predecessor, Wheeler is a no-nonsense professional, a man with vast experience in the dark corners of the Senate who can crawl through the most fetid lobbyist dungeons and emerge with the name of the right congressional staffer to call to tweak a bill that's heading for the floor. Pruitt, on the other hand, who had come to Washington from the wilds of Oklahoma, was almost comically ineffective at rolling back the laws he made such a show of attacking as he embroiled himself in no fewer than 13 scandals during his 18-month tenure.

Wheeler won't make the same mistakes. "Under Trump, the EPA's mission is to deliver for the Republican Party's fossil-fuel overlords," Rhode Island Sen. Sheldon Whitehouse tells me in an e-mail. "Under Wheeler, I don't think that will change." What will change is his mission plan. "Wheeler is the embodiment of the anti-regulatory 'deep state' in Washington," says Ken Cook, president of the nonprofit advocacy organization Environmental Working Group. "His goal is not just to roll back the environmental progress made under President Obama, but to weaken and deconstruct the entire regulatory system at the EPA. He's playing the long game. And that's exactly what makes him so dangerous."

WHEELER GREW UP in Fairfield, Ohio, just outside Cincinnati. His father, a dentist, died when Andrew was 21 months old, and he and his two sisters were raised mostly by their mother, an elementary-school teacher. He had asthma as a

kid, and still uses an inhaler to this day. He became an Eagle Scout and, ironically, given his future in the war against nature, worked several summers as the nature-conservation director at a nearby Boy Scout camp ("The most fun I've had at a job," he recalled). During the summer, he visited his grandmother in Beckley, West Virginia. "My grandfather was a coal miner during the Depression," Wheeler said in his first official remarks to EPA staffers. "My grandmother raised her children in the coal camps in West Virginia. In fact, I still have some of the company scrip that she used to buy food in the company store." (Wheeler and the EPA did not respond to requests for comment for this story.)

Wheeler did his time in academia: undergrad at Case Western Reserve University, a law degree from Washington University in St. Louis, and an MBA from Virginia's George Mason University. In the early 1990s, he went to work for the EPA in Washington, in a division that promoted the public release of information about toxic chemicals. In 1995, Wheeler jumped into politics, as a staffer for both Ohio Republican Sen. George Voinovich and Oklahoma Sen. James Inhofe, who has long been the most outspoken and notorious climate-change denier in American politics. In 2003, after Inhofe became chair of the powerful Senate Committee on Environment and Public Works, he worked hard to derail any legislation designed to curb carbon pollution, arguing that "manmade global warming is the greatest hoax ever perpetrated on the American people." At the time Inhofe made this statement, Wheeler was his committee's chief counsel.

But even Wheeler's opponents appreciated his political skills. "He could be sharp-elbowed," says Chris Miller, the former senior policy adviser for Vermont Sen. Jim Jeffords. "But he was also straightforward. He could broker deals because you always knew where you stood with him. He was always honest about what he could do and what he couldn't. And he never made it personal. No matter how tough the fight, he was always happy to have drinks with you afterward."

Wheeler left the Senate in 2009 and joined Faegre Baker Daniels, a prominent law firm that was recently accused of helping conceal sexual-abuse allegations against USA Gymnastics team doctor Larry Nassar. For a princely sum, Wheeler helped the firm's many clients navigate the regulatory thickets in D.C. (a financial-disclosure form filed in 2017 shows Wheeler claimed a salary and bonus of $741,074). His most prominent client was Robert Murray, the Ohio coal operator whom *Last Week Tonight* host John Oliver called "geriatric Dr. Evil." Murray is the last of the Old World coal barons, a man who believes that coal is the fuel of prosperity and salvation and that, as he put it recently, "people are going to die in the dark" if coal-power generation declines too far.

Over an eight-year period, Murray paid $2.7 million in lobbying fees to Wheeler's firm. Wheeler's lobbying disclosure reports have been vague, saying only that he worked with Murray on "general energy and environment issues." In an interview with *The New York Times*, Wheeler acknowledged working with Murray to fight Obama's Clean Power Plan, a landmark regulation on coal-plant emissions to be implemented and overseen by the EPA. But Wheeler said that he never lobbied Pruitt's EPA, presumably because he suspected he might be tapped for a position in the Trump administration and didn't want to run afoul of rules that prohibit former lobbyists from working for an agency they had recently lobbied. "I knew it was a possibility, so after the election I stopped lobbying any new EPA issues," Wheeler told the *Times.*

In the early days of Trump's campaign, Wheeler thought Trump was a joke. In an appraisal on Facebook, Wheeler noted that Trump "has demonstrated through debates and interviews that he doesn't understand how government works," that "as a businessman, he hasn't been very successful. He's a successful PR person, but not a businessperson." And most important, "[Trump] is a bully. This alone should disqualify him from the White House."

Wheeler changed his tune a few months later when he heard Trump speak at a closed-door fundraising dinner in Wheeling, West Virginia, that was hosted by none other than Robert Murray. "It was about a 40-minute energy speech that [Trump] gave," Wheeler told *The Washington Post*, offering a master class in political ass-kissing. "He didn't use notes. He didn't use a teleprompter. I really thought it was the most comprehensive energy speech by a presidential candidate I had ever heard."

When Trump won, Murray was a made man. Shortly after Trump took office, Murray, who contributed $300,000 to Trump's inauguration fund, met with Energy Secretary Rick Perry and handed him an "Action Plan . . . to assist in the survival of our country's coal industry." Among the 16 items on the list: Eliminate the Clean Power Plan, pull out of the

Paris Agreement, and overturn regulations on mercury and other air toxins from coal plants — all of which the Trump administration is doing (or trying to).

At the meeting with Murray was his pal Wheeler. And in a move that surprised no one, Wheeler was nominated by the White House in October 2017 to be second-in-command at the EPA, where he was seen as a sober counterweight to Pruitt. In July, when Pruitt finally resigned, Wheeler stepped in.

AS AN ARCHITECT of environmental rollbacks, Pruitt was inept. When he tried to halt rules restricting methane release, it was stayed by the D.C. circuit court. When he tried to delay the Chemical Disaster Rule, the D.C. circuit called the agency's argument a "mockery" of the Clean Air Act and demanded the rule be put into effect without delay. When the EPA tried to stall an ozone-air-pollution standard, environmental groups sued, forcing the EPA to proceed with the new standards.

Wheeler is much shrewder. Shortly after moving into the EPA administrator's wood-paneled office, he reversed Pruitt's decision to grant a loophole for so-called glider trucks, which allowed older, heavy-polluter engines to be installed in new trucks. He has also distanced himself from one of the Trump administration's biggest environmental debacles: the misguided attempt to rewrite fuel-efficiency standards for cars and light trucks. The proposal is based on questionable legal arguments that even die-hard anti-regulatory zealots think won't stand a chance in court. "This is a nutso administration — Wheeler is not going to blow himself up on this rule," says one lobbyist familiar with the negotiations. "He has other stuff to do."

More important, Wheeler understands that it's smarter to pursue a backdoor assault on rules in order to get what the industry wants, which is, to put it bluntly, to offload the costs and risks of pollution from industry to the public. But since the role of the EPA is to protect public health — and people like unpolluted water and clean air — the trick, if you are Wheeler, is to undermine the process of crafting the regulations in the first place.

To do that, Wheeler first needs to undermine science. As the old saying goes, what you don't know can't hurt you. Consider particulate matter, a deadly form of air pollution that can affect your brain, heart and lungs. A 2013 study found that tighter regulation of this form of microscopic air pollution could help prevent 200,000 early deaths each year in the U.S.

So what happens shortly after Wheeler arrives? The EPA announces it is eliminating the 20-person scientific-review panel for particulate matter.

A similar impulse is behind an EPA initiative called "Strengthening Transparency in Regulatory Science." In it, the EPA claims to want to use reproducible science and so will only consider studies in which all the data is publicly available. But it's Orwellian bullshit. Wheeler surely knows that many public-health studies depend on nonpublic data (for privacy reasons). In fact, the initiative appears to target a landmark 1993 public-health study known as the Harvard Six Cities study — it found that Americans who live in more polluted cities die faster, and became the foundation for more stringent air-pollution regulations in recent years.

Wheeler is also gutting the EPA's Science Advisory Board, the agency's main scientific oversight committee. New board members won't be selected until early next year, but among the finalists are sketchy characters like James Enstrom, a researcher who took funds from Big Tobacco and whose work downplays the dangers of air pollution. Another is John Christy, a professor at the University of Alabama who is well-known for his view that the risks of climate change are overblown. A third candidate argues that more carbon dioxide is good for the planet. And of course there are a number of hacks from Big Oil companies. "The purpose of undermining scientific advisory committees is to stop EPA progress on clean water, clean air and climate change," says David Michaels, a professor of environmental and occupational health at George Washington University. "By removing independent scientists, they can be sure there is no dissent."

Wheeler's second method of undermining the regulatory powers of the EPA is through changing the way the costs and benefits of environmental regulations are assessed. You can see echoes of this in the latest rhetoric of climate deniers like Florida Sen. Marco Rubio, who argue that, yes, climate change is real, and humans might be responsible, but it's too

expensive to do anything about it. This is an obvious lie — look at California, where the economy is booming but carbon pollution is in sharp decline. In fact, the economic and human impacts of a rapidly changing climate dwarf any costs associated with cutting carbon pollution. If cost were the real criteria for action, fossil fuels would have been outlawed a decade ago. But that's not what this is about. It's about protecting the empires of Big Coal and Big Oil.

Congress directs that all costs and benefits of regulation must be considered in a reasonable assessment of EPA rules. But the devil is in the details. The best example of this is Wheeler's attempt to change the Mercury and Air Toxins Standards. The rule regulates the emission of highly toxic metals like mercury and arsenic, as well as cancer-causing chemicals like cadmium and selenium, from industrial sources (mostly coal-burning power plants). Big Coal fought a pitched battle for more than a decade to stop this rule, but it lost in 2014, and for good reason: Mercury and the other heavy metals the rule regulates are among the most toxic substances on Earth, and disproportionately impact what are often poor communities living near power plants. In recent years, power companies have spent $18 billion to install mercury scrubbers, and mercury emissions have fallen by 70 percent. It is one of the most dramatic environmental success stories of the past decade.

And yet Wheeler wants to weaken the air-toxins rule. From a public-policy perspective, it's like arguing child-abuse laws should be rolled back. Not even the electric power industry wants the rule softened. In a highly unusual move, the Edison Electric Institute, a powerful industry trade group, and six other utilities signed an open letter urging the agency not to weaken the rule. The rollback "is a mean-spirited and dumb move," says Ann Weeks, legal director at the Clean Air Task Force. "They will lose in court and in public opinion."

So if Wheeler is such a wily operator, why is he pushing it? The simplest explanation is that it was on Murray's list. The slightly less simple explanation is that Bill Wehrum, the coal- and oil-industry lawyer who fought the mercury rule for years in court (and sued the EPA 31 times), now heads the EPA division in charge of it. The most plausible explanation is that Wheeler wants to use the mercury fight to set a precedent that could fundamentally change how environmental rules are calculated.

The EPA's argument to change the rule is based on the idea that ancillary benefits from reducing mercury emissions should not be included, even if they are real. Under Obama, the EPA estimated that it would cost utilities $9.6 billion a year to comply with the new standards, while limiting mercury could translate to $6 million in public-health benefits. But when you install a mercury scrubber on a coal plant, you reduce a lot of other nasty stuff too, and the EPA estimated that the soot and nitrogen-oxide reductions that would accompany cuts to mercury would save between $37 billion and $90 billion in annual health costs and lost workdays by preventing as many as 11,000 premature deaths and 4,700 heart attacks. Thus the cost-benefit analysis justified the regulation. And this was hardly regulatory "overreach" by the Obama administration: The EPA has for decades been including co-benefits in cost-benefit analyses for new regulations.

But Wheeler believes this is wrong. "I just think it's a little fuzzy math when you say, 'Reduce mercury and we have all these other benefits over here,' as the shiny object," he told *The Washington Post*. But the benefits aren't "over here" — they're part and parcel to the process of limiting mercury. It's like running five miles a day — you might do it to lose weight, but you get other rewards too, from better muscle tone to a stronger heart.

This change in analysis is at the center of other proposed rule changes too, including the replacement of the Clean Power Plan. Setting limits on carbon pollution is required by law, but such limits have long been anathema to Big Coal and Big Oil. So instead of trying to kill the Clean Power Plan, which would launch a legal battle they would surely lose, Wheeler and his EPA pals have proposed a replacement of the plan, dubbing it the Affordable Clean Energy Rule. The upshot is that instead of the federal government setting emissions targets for states, states can set them for themselves (that's good for big coal-burning states like Ohio). The goal of the Clean Power Plan was to cut carbon pollution from the power sector to 32 percent below 2005 levels by 2030. The new plan, announced by Wheeler in August, would only reduce emissions between 0.7 and 1.5 percent in the same time frame.

Just like with the mercury rule, the EPA is justifying the much weaker regulation by disregarding the co-benefits of cutting carbon pollution, such as reducing conventional air pollutants, which have enormous public-health impacts. The

EPA's own calculations show its power plan would lead to upward of 1,400 additional premature deaths and 48,000 new cases of exacerbated asthma each year. But those costs, not to mention those lives, aren't factored into the new rules.

"If the EPA is able to get away with recalculating cost-benefit analysis, it will be much harder to undo than if they just changed the criteria for, say, ozone levels from a 70 to a 72," says Melinda Pierce, legislative director at the Sierra Club. "It will do serious damage to the agency's ability to protect public health, and after Wheeler is gone, it will take years to rebuild that capacity."

And that's exactly Wheeler's game plan. The ultimate goal here is what futurist Alex Steffen calls "predatory delay." Wheeler knows every rule he can blunt, every bit of science he can undermine, keeps guys like Robert Murray in business for a few more years before the old coal plants are shut down and replaced by wind or solar, which, in most parts of the country, are already cheaper than coal. What Big Coal and Big Oil want from Wheeler is not victory, but time. That, in the end, is what makes Wheeler so dangerous. Because given how fast our climate is changing, and how urgent it is to leave fossil fuels in the tar pit of history, that's exactly what we don't have.

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 10/23/2018 11:53:11 AM
To: AO SAB EVERYONE [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ee10fa204de24c1793c3c33a462e0d39-AO SAB EVERYONE]
Subject: Daily Kos - Polluters Picked Pruitt's Science Advisory Board Members, Will They Win Over Wheeler Too?

Polluters Picked Pruitt's Science Advisory Board Members, Will They Win Over Wheeler Too?

ClimateDenierRoundup

Monday October 22, 2018 · 10:02 AM EDT

One of the ongoing fights we shouldn't have to be having with the EPA is over particulate matter (PM2.5), and its risk to public health. While some of the PM2.5 denial-driven policies have been backburnered, it remains a pressing issue. A new study adds to the weight of evidence showing the importance of reducing PM2.5, finding that 40,000 lives were saved by regulations in 2010.

News of this study came, of all places, from Watts Up With That, where Anthony Watts suggested that the reduction in deaths thanks to past regulations means that there's less reason to implement new laws.

Um, if policies are reducing deaths, wouldn't that mean more policies would further reduce mortality? And wouldn't that be a good reason for ramping up efforts, as opposed to winding down and letting more people die?

Sadly, this sort of stupid reasoning may be even more welcomed at the EPA if polluters have their way and install even more of their own experts on the EPA's Science Advisory Board.

Back in June, we found out that the "expert" Pruitt selected to chair one of the EPA's science advisory boards was hand-picked by a major Republican donor and the industry-funded Texas Public Policy Association. Then on Thursday, E&E's Sean Reilly reported that Tony Cox, who Pruitt chose as chair of the Clean Air Scientific Advisory Committee, was nominated by Dan Byers, a senior US Chamber of Commerce executive.

Specifically, Byers is the vice president for policy for the chamber's Global Energy Institute, whose position on climate and energy is made clear by an August post headlined "Seven ways EPA's Affordable Clean Energy Rule is a better approach than the Clean Power Plan."

Unfortunately, it's about to get worse. The EPA released the finalists for the next round of Science Advisory Board, and the list of 174 nominees includes all too many names we recognize. As Scott Waldman reported in E&E, it includes such luminaries as tobacco-funded and Heartland-affiliated James Enstrom, as well as consultant Richard Belzer, whose clients include Exxon Mobil and Fitzgerald Glider Kits.

Then there's satellite lover John Christy, a favorite witness of congressional Republicans because of his steadfast commitment to being wrong. Should someone whose work has, for decades, required correction be sought to offer advice? Not if you're looking for correct answers. But if you're looking for politically correct answers…

Christy, then, is a prime choice for those favoring denial over accuracy. As is another nominee, Heritage Foundation's Kevin Dayaratna, who worked hard to cook the books and provide economic justification for Trump's Paris pull-out.

Then there's William Happer, who perhaps takes the cake as most willing to provide preferred answers in exchange for a paycheck. We'll remind you that Happer was caught in a sting in 2015 accepting an offer from a group he believed to represent Middle Eastern oil interests. In exchange for a generous "donation" to his denial non-profit, Happer was willing to author a report extolling the benefits of CO2.

Though that was a Greenpeace sting, we do know that Happer's CO2 Coalition has been funded by all sorts of really nefarious forces, including the Trump-backing Mercer family.

With multiple nominees paid by fossil fuels to take anti-climate positions, as well as John Christy who just so happens to make mistakes for decades to downplay warming in the satellite record, odds are good at least one of these goons makes it on the Science Advisory Board.

Fortunately, the public comment period is open until November 7th, so if you'd rather the EPA not take advice from deniers, send an email detailing your concerns to Mr. Thomas Carpenter, Designated Federal Officer at carpenter.thomas@epa.gov.

Sure, it can be boring to bore into the boors on these boards, but if they're allowed on board, we can't be sure the advice these boards give is all above board.

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 10/18/2018 5:33:30 PM
To: AO SAB EVERYONE [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ee10fa204de24c1793c3c33a462e0d39-AO SAB EVERYONE]
Subject: Greenwire - U.S. Chamber's pick got chairmanship of EPA advisory panel

AIR POLLUTION

U.S. Chamber's pick got chairmanship of EPA advisory panel

Sean Reilly, E&E News reporter

Published: Thursday, October 18, 2018

The U.S. Chamber of Commerce, which regularly opposes tougher environmental regulations, last year succeeded in placing one of its candidates on a key EPA air quality committee, newly released records show.

Then-EPA chief Scott Pruitt named Tony Cox, a Denver-based consultant, as chairman of the Clean Air Scientific Advisory Committee last fall after a senior U.S. Chamber executive nominated him for a seat on the panel, the records show.

The seven-member committee, often known by its acronym as CASAC, is charged with providing outside expertise to EPA during legally required reviews of the standards for a half-dozen common pollutants. It's now in the early stages of a closely watched assessment of the limits on airborne particulates.

In an email exchange, Cox said he did not know that the chamber was behind his nomination until E&E News contacted him late yesterday. Cox said he had no information on why the powerful business lobby chose him.

"I hope that it was because of my long-standing commitment to applying objective, transparent, data-driven science and analytics to address important risk analysis questions, along with my insistence on following wherever the data lead," he said.

Putting Cox's name in play was Dan Byers, vice president for policy with the chamber's Global Energy Institute. Byers referred questions yesterday to a spokesman, Matt Letourneau. In a statement, Letourneau said the chamber nominated "preeminent scientists who are experts in their fields with outstanding credentials for EPA's consideration. We had no discussion with these individuals about their views on any particular policy or science issue."

During the Obama administration, the chamber frequently challenged new environmental regulations. In 2013, for example, it went to court in an unsuccessful battle against EPA's decision to tighten particulate standards. It's also a plaintiff in a pending challenge to the agency's 2015 ground-level ozone changes and in a report has denounced limits imposed that same year on hazardous emissions from the brick industry (*E&E Daily*, Feb. 2, 2016).

Cox was among four candidates whom Byers recommended for CASAC, according to the EPA roster released yesterday. Pruitt instead appointed two of the others — air pollution researcher Robert Phalen and S. Stanley Young, an applied statistician from North Carolina — to the Science Advisory Board, another influential panel. Letourneau confirmed that the chamber had nominated the two men for those seats, as well, but said he did not know whether the group had pressed for Cox to be named CASAC chairman.

Phalen is a professor of community and environmental medicine at the University of California, Irvine. Following his appointment to SAB last November, he came under fire for remarks in an earlier interview in which he said, "Modern air is a little too clean for optimum health."

In a letter to Pruitt early this year, Sens. Tom Carper (D-Del.) and Sheldon Whitehouse (D-R.I.) questioned whether both Cox and Young were fit to serve on their respective EPA panels, based on their scientific credentials and their prior work for the oil business and other polluting industries (*Greenwire*, Jan. 9).

Neither Phalen nor Young could immediately be reached for comment this morning. Cox, whose specialty is risk analysis, noted that he has done work for EPA, the World Health Organization and universities, but said he did not recall working for the U.S. Chamber in the course of a 40-year career.

"I have made no commitments to anyone about CASAC," he said, "other than to the administrator and EPA to do my best to assure that we give objective, dispassionate, high-quality scientific advice without regard for politics, policy, or other considerations that go beyond science."

EPA had formally requested nominations for the Clean Air Scientific Advisory Committee in June of last year. The agency released the resulting list of about 130 candidates, as well as those who nominated them, yesterday, almost a year after E&E News requested the roster under the Freedom of Information Act.

The list shows that most of the candidates were university researchers nominated either by other researchers or EPA staff. The only other advocacy groups to make recommendations were the Energy and Environment Legal Institute, an industry-allied organization critical of tighter air pollution regulations, and the American Thoracic Society, which focuses on lung health issues. None of their respective nominees were chosen.

Besides Cox, Pruitt instead selected James Boylan, manager of planning and support for the Georgia Environmental Protection Division's air branch, and Larry Wolk, who was then the executive director of the Colorado Department of Public Health and Environment. Boylan nominated himself, the roster shows, while Wolk was the choice of Richard Yamada, a high-ranking political appointee at the time in EPA's Office of Research and Development.

In all, Yamada offered about 10 nominations. They ranged from Mark Frampton, a retired professor of medicine at the University of Rochester who was named to CASAC last week, to Michael Rohan, an orthopedist in Panama City, Fla.

Carper and Whitehouse had also previously questioned Yamada's role in the selection process. EPA documents showed that he overrode the advice of EPA career staff in pushing for the appointments to Cox and Wolk to the committee, the two lawmakers wrote in a February letter asking the Government Accountability Office to look into whether such involvement was typical (*E&E Daily*, Feb. 15).

Yamada recently left EPA to take a job at the Defense Department. Efforts to reach him were unsuccessful.

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 10/18/2018 12:04:35 PM
To: AO SAB EVERYONE [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=ee10fa204de24c1793c3c33a462e0d39-AO SAB EVERYONE]
Subject: Climatewire - Skeptics named as finalists for Science Advisory Board

EPA

Skeptics named as finalists for Science Advisory Board

Scott Waldman, E&E News reporter

Published: Thursday, October 18, 2018

Finalists for EPA's Science Advisory Board include researchers who reject mainstream climate science and who have fought against environmental regulations for years.

Among them is an economist from the conservative Heritage Foundation whose work was cited by President Trump as a justification for withdrawing from the Paris climate agreement. Another downplays the dangers of air pollution. Several scientists are from energy companies like Exxon Mobil Corp. and Chevron Corp., and the list includes a researcher who argues that more carbon dioxide is good for the planet.

A few are associated with the Heartland Institute, which has advocated for the rejection of climate science to lawmakers, teachers and voters. Among its efforts is the publication of books, like the "Roosters of the Apocalypse," which describes climate change as an "apocalyptic prophecy" (*Climatewire*, April 2, 2012).

The agency released a list of 174 nominees yesterday and will accept public comment until Nov. 7. The Science Advisory Board provides EPA with expert advice on a range of scientific and technical issues. Former Administrator Scott Pruitt sought to reshape the SAB by forcing off academic researchers who received agency grants, while elevating those who were funded by industry.

The latest round of selections, which will be made by acting Administrator Andrew Wheeler, could shift the makeup of the board toward an industry viewpoint as EPA weighs a number of deregulatory actions. It currently has 44 members.

Last week, Wheeler replaced five of seven members on the agency's Clean Air Scientific Advisory Committee. He weighted the panel with industry voices and regulators from states critical of regulations adopted under former President Obama (*Climatewire*, Oct. 11). EPA also disbanded an affiliated panel that had been working on an assessment of the current limits on airborne particulates.

The list of finalists from which Wheeler will select the newest members of the SAB includes academics whose work has been funded by the premier science agencies in the United States, such as the National Science Foundation, NOAA and the National Institutes of Health.

Gretchen Goldman, who has a Ph.D in environmental engineering, is the research director of the Center for Science and Democracy at the Union of Concerned Scientists. Kimberly Cobb, director of the Global Change Program at the Georgia Institute of Technology, is an expert on climate change and coral reefs. Steven Cohen is

the former executive director of Columbia University's Earth Institute. Andrew Rosenberg is the director of the Center for Science and Democracy at the Union of Concerned Scientists.

However, many stand out for fighting against climate science and agency regulations. The work of several has been used to justify rolling back environmental rules.

James Enstrom, who has served as a policy adviser for the Heartland Institute and is a retired professor from UCLA, has received funding from the tobacco industry to produce research that downplays the risks of secondhand smoke. He has said that his work negates the research of air pollution experts who connected fine particle air pollution, or PM2.5, with premature deaths.

A description of his qualifications for the appointment said that Enstrom's research, which has vastly different conclusions from those of the majority of scientists, justifies rolling back EPA regulations on air pollution, known as National Ambient Air Quality Standards (NAAQS).

"His research shows that the EPA PM2.5 NAAQS is scientifically unjustified and must undergo complete and objective reassessment," says the description submitted to EPA.

Richard Belzer is an independent consultant on regulatory economics who has worked for a number of conservative think tanks, including the Competitive Enterprise Institute and R Street Institute. His recent clients include Exxon Mobil, the American Chemistry Council and Fitzgerald Glider Kits, which is pushing EPA to roll back air pollution protections on heavy trucks.

Belzer has encouraged the Trump administration to go after EPA's endangerment finding for greenhouse gases, a scientific determination that provides the legal underpinning for agency regulations on climate-changing emissions.

"The goal here is not to change the policy but to correct the science," Belzer said at a conference hosted by the Heartland Institute last year.

John Christy, another nominee, is Alabama's state climatologist and a professor at the University of Alabama, Huntsville. He's a favorite of congressional Republicans who reject mainstream climate science and says that human-caused global warming has been exaggerated. At a House Science, Space and Technology Committee hearing, he was one of the first to suggest that a "red team" climate debate could contest established findings on global warming. He has also called on EPA to revisit the endangerment finding and has said that it is not scientifically valid.

Anthony Lupo, a professor of atmospheric science at the University of Missouri, Columbia, has argued that global warming is natural, not man-made. He co-founded Climate Exit, or "Clexit," which asserts that rising levels of carbon dioxide benefit the Earth.

Kevin Dayaratna is a senior statistician and research programmer with the Heritage Foundation. He was invited to attend Trump's announcement to withdraw from the Paris Agreement in the Rose Garden in June 2017, and his work was cited by the president as a reason to quit the accord. He says in his work that the agreement could shrink the U.S. gross domestic product by $2.5 trillion within two decades. (Trump stated that it would arrive within a decade.) The report was criticized by some as being misleading, because that amount is less than 1 percent of the aggregate GDP over that period, and the report did not account for the cost of taking no climate change action.

William Happer, an emeritus physics professor at Princeton University, is also on the list. Happer helped Pruitt develop the red-team concept and heads the CO2 Coalition, which received $150,000 in funding from the Mercer family in 2016 to suggest that more carbon dioxide would benefit humans.

Happer was recently appointed to serve on the Trump administration's National Security Council as the senior director for emerging technologies.

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 11/8/2018 2:07:54 PM
To: Ted Steichen [SteichenT@api.org]
Subject: RE: Request for Oral Presentation to CASAC - at the public meeting regarding EPA's Integrated Science Assessment (ISA) for Particulat

Ted,

We have added you to the List of Speakers. Will you be attending in person or on the phone?

You will have 5 minutes to make oral comments and we encourage you to submit written comments prior to the meeting.

-Aaron

Aaron Yeow, M.P.H.
Designated Federal Officer
U.S. Environmental Protection Agency
Science Advisory Board
202-564-2050 (P)
202-565-2098 (F)

Mailing Address:
USEPA, 1200 Pennsylvania Avenue, NW, (1400R), Washington, DC 20460

Physical Location/Deliveries:
1300 Pennsylvania Avenue, NW, Suite 31150, Washington, DC 20004

From: Ted Steichen <SteichenT@api.org>
Sent: Tuesday, November 06, 2018 9:20 AM
To: Yeow, Aaron <Yeow.Aaron@epa.gov>
Cc: Mara E. Zimmerman <ZimmermanM@api.org>; Howard Feldman <Feldman@api.org>
Subject: Request for Oral Presentation to CASAC - at the public meeting regarding EPA's Integrated Science Assessment (ISA) for Particulat

Hi Aaron,

I request a time slot to provide a 5-miunte oral presentation on behalf of the American Petroleum Institute at the public meeting of the Chartered Clean Air Scientific Advisory Committee (CASAC) to peer review EPA's Integrated Science Assessment (ISA) for Particulate Matter (External Review Draft—October 2018). DATES: The Chartered CASAC meeting will be on Wednesday, December 12, 2018, from 9:00 a.m. to 5:30 p.m. (Eastern Time) and on Thursday, December 13, 2018, from 8:30 a.m. to 3:30 p.m. (Eastern Time).

As requested in the Federal Register notice, if possible, a written statement will be provided prior to November 23, 2018.

Thank you for your consideration.

Ted Steichen
Senior Policy Advisor
American Petroleum Institute
202 682 8568
steichent@api.org

Message

From: Ted Steichen [SteichenT@api.org]
Sent: 11/6/2018 2:19:42 PM
To: Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]
CC: Mara E. Zimmerman [ZimmermanM@api.org]; Howard Feldman [Feldman@api.org]
Subject: Request for Oral Presentation to CASAC - at the public meeting regarding EPA's Integrated Science Assessment (ISA) for Particulat
Attachments: 0036_001.pdf; 0037_001.pdf

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Thank you for your consideration.

Ted Steichen
Senior Policy Advisor
American Petroleum Institute
202 682 8568
steichent@api.org

EPA-HQ-2019-001215

EPA's federal advisory committees and panels has a different purpose from public comment provided to EPA program offices. Therefore, the process for submitting comments to a federal advisory committee is different from the process used to submit comments to an EPA program office. Federal advisory committees and panels, including scientific advisory committees, provide independent advice to EPA. Members of the public can submit relevant comments on the topic of this advisory activity, including the charge to the CASAC and the EPA review documents, and/or the group conducting the activity, for the CASAC to consider as it develops advice for EPA. Input from the public to the CASAC will have the most impact if it provides specific scientific or technical information or analysis for CASAC to consider or if it relates to the clarity or accuracy of the technical information. Members of the public wishing to provide comment should follow the instructions below to submit comments.

Oral Statements: In general, individuals or groups requesting an oral presentation at a public meeting will be limited to five minutes. Each person making an oral statement should consider providing written comments as well as their oral statement so that the points presented orally can be expanded upon in writing. Interested parties should contact Mr. Aaron Yeow, DFO, in writing (preferably via email) at the contact information noted above by November 23, 2018, to be placed on the list of public speakers.

Written Statements: Written statements will be accepted throughout the advisory process; however, for timely consideration by CASAC members, statements should be supplied to the DFO (preferably via email) at the contact information noted above by November 23, 2018. It is the SAB Staff Office general policy to post written comments on the web page for the advisory meeting or teleconference. Submitters are requested to provide an unsigned version of each document because the SAB Staff Office does not publish documents with signatures on its websites. Members of the public should be aware that their personal contact information, if included in any written comments, may be posted to the CASAC website. Copyrighted material will not be posted without explicit permission of the copyright holder.

Accessibility: For information on access or services for individuals with disabilities, please contact Mr. Aaron Yeow at (202) 564–2050 or *yeow.aaron@epa.gov*. To request accommodation of a disability, please contact Mr. Yeow preferably at least ten days prior to each meeting to give EPA as much time as possible to process your request.

Dated: October 25, 2018.

Khanna Johnston,

Acting Director, EPA Science Advisory Staff Office.

[FR Doc. 2018–24269 Filed 11–5–18; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[FRL–9986–13–OA]

Notification of a Public Meeting of the Chartered Clean Air Scientific Advisory Committee (CASAC)

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: The EPA Science Advisory Board (SAB) Staff Office announces a public meeting of the Chartered Clean Air Scientific Advisory Committee (CASAC) to peer review EPA's *Integrated Science Assessment (ISA) for Particulate Matter (External Review Draft—October 2018).*

DATES: The Chartered CASAC meeting will be on Wednesday, December 12, 2018, from 9:00 a.m. to 5:30 p.m. (Eastern Time) and on Thursday, December 13, 2018, from 8:30 a.m. to 3:30 p.m. (Eastern Time).

ADDRESSES: The public meeting will be held at the Crystal Gateway Marriott, 1700 Jefferson Davis Highway, Arlington, Virginia 22202.

FOR FURTHER INFORMATION CONTACT: Any member of the public wishing to obtain information concerning the public meeting may contact Mr. Aaron Yeow, Designated Federal Officer (DFO), EPA Science Advisory Board Staff Office (1400R), U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue NW, Washington, DC 20460; by telephone/voice mail at (202) 564–2050 or at *yeow.aaron@epa.gov*. General information about the CASAC, as well as any updates concerning the meeting announced in this notice, may be found on the EPA website at *http://www.epa.gov/casac*.

SUPPLEMENTARY INFORMATION: The CASAC was established pursuant to the Clean Air Act (CAA) Amendments of 1977, codified at 42 U.S.C. 7409(d)(2), to review air quality criteria and NAAQS and recommend any new NAAQS and revisions of existing criteria and NAAQS as may be appropriate. The CASAC shall also provide advice, information, and recommendations to the Administrator on the scientific and technical aspects of issues related to the criteria for air quality standards, research related to air quality, sources of air pollution, and of adverse effects which may result from various strategies to attain and maintain air quality standards. The CASAC is a Federal Advisory Committee chartered under the Federal Advisory Committee Act (FACA), 5 U.S.C., App. 2. Section 109(d)(1) of the CAA requires that the Agency periodically review and revise, as appropriate, the air quality criteria and the NAAQS for the six "criteria" air pollutants, including particulate matter. EPA is currently reviewing the NAAQS for particulate matter (PM).

On October 10, 2018, Acting Administrator Andrew Wheeler announced (*https://www.epa.gov/newsreleases/acting-administrator-wheeler-announces-science-advisors-key-clean-air-act-committee*) that the seven-member Chartered CASAC will serve as the body to review the remaining key scientific assessments for the PM NAAQS review.

Pursuant to FACA and EPA policy, notice is hereby given that the Chartered CASAC will hold a public meeting to peer review EPA's *Integrated Science Assessment (ISA) for Particulate Matter (External Review Draft—October 2018).* The Chartered CASAC will comply with the provisions of FACA and all appropriate SAB Staff Office procedural policies.

Technical Contacts: Any technical questions concerning the *Integrated Science Assessment for Particulate Matter (External Review Draft—October 2018)* should be directed to Mr. Jason Sacks (*sacks.jason@epa.gov*).

Availability of Meeting Materials: Prior to the meeting, the review documents, agenda and other materials will be accessible through the calendar link on the blue navigation bar at *http://www.epa.gov/casac/*.

Procedures for Providing Public Input: Public comment for consideration by EPA's federal advisory committees and panels has a different purpose from public comment provided to EPA program offices. Therefore, the process for submitting comments to a federal advisory committee is different from the process used to submit comments to an EPA program office. Federal advisory committees and panels, including scientific advisory committees, provide independent advice to EPA. Members of the public can submit relevant comments on the topic of this advisory activity, including the charge to the CASAC and the EPA review documents, and/or the group conducting the activity, for the CASAC to consider as it develops advice for EPA. Input from

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the public to the CASAC will have the most impact if it provides specific scientific or technical information or analysis for CASAC to consider or if it relates to the clarity or accuracy of the technical information. Members of the public wishing to provide comment should follow the instructions below to submit comments.

Oral Statements: In general, individuals or groups requesting an oral presentation at a public meeting will be limited to five minutes. Each person making an oral statement should consider providing written comments as well as their oral statement so that the points presented orally can be expanded upon in writing. Interested parties should contact Mr. Aaron Yeow, DFO, in writing (preferably via email) at the contact information noted above by December 5, 2018, to be placed on the list of public speakers.

Written Statements: Written statements will be accepted throughout the advisory process; however, for timely consideration by CASAC members, statements should be supplied to the DFO (preferably via email) at the contact information noted above by December 5, 2018. It is the SAB Staff Office general policy to post written comments on the web page for the advisory meeting or teleconference. Submitters are requested to provide an unsigned version of each document because the SAB Staff Office does not publish documents with signatures on its websites. Members of the public should be aware that their personal contact information, if included in any written comments, may be posted to the CASAC website. Copyrighted material will not be posted without explicit permission of the copyright holder.

Accessibility: For information on access or services for individuals with disabilities, please contact Mr. Aaron Yeow at (202) 564–2050 or *yeow.aaron@epa.gov*. To request accommodation of a disability, please contact Mr. Yeow preferably at least ten days prior to each meeting to give EPA as much time as possible to process your request.

Dated: October 29, 2018.

Khanna Johnston,

Acting Director, EPA Science Advisory Staff Office.

[FR Doc. 2018–24266 Filed 11–5–18; 8:45 am]

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FEDERAL COMMUNICATIONS COMMISSION

[OMB 3060–0270, OMB 3060–0463 and OMB 3060–3060–1215]

Information Collections Being Submitted for Review and Approval to the Office of Management and Budget

AGENCY: Federal Communications Commission.

ACTION: Notice and request for comments.

SUMMARY: As part of its continuing effort to reduce paperwork burdens, and as required by the Paperwork Reduction Act (PRA) of 1995, the Federal Communications Commission (FCC or the Commission) invites the general public and other Federal agencies to take this opportunity to comment on the following information collection. Comments are requested concerning: Whether the proposed collection of information is necessary for the proper performance of the functions of the Commission, including whether the information shall have practical utility; the accuracy of the Commission's burden estimate; ways to enhance the quality, utility, and clarity of the information collected; ways to minimize the burden of the collection of information on the respondents, including the use of automated collection techniques or other forms of information technology; and ways to further reduce the information collection burden on small business concerns with fewer than 25 employees.

The Commission may not conduct or sponsor a collection of information unless it displays a currently valid Office of Management and Budget (OMB) control number. No person shall be subject to any penalty for failing to comply with a collection of information subject to the PRA that does not display a valid OMB control number.

DATES: Written comments should be submitted on or before December 6, 2018. If you anticipate that you will be submitting comments, but find it difficult to do so within the period of time allowed by this notice, you should advise the contacts listed below as soon as possible.

ADDRESSES: Direct all PRA comments to Nicholas A. Fraser, OMB, via email *Nicholas_A._Fraser@omb.eop.gov;* and to Cathy Williams, FCC, via email *PRA@fcc.gov* and to *Cathy.Williams@fcc.gov*. Include in the comments the OMB control number as shown in the **SUPPLEMENTARY INFORMATION** below.

FOR FURTHER INFORMATION CONTACT: For additional information or copies of the information collection, contact Cathy Williams at (202) 418–2918. To view a copy of this information collection request (ICR) submitted to OMB: (1) Go to the web page <*http://www.reginfo.gov/public/do/PRAMain*>, (2) look for the section of the web page called "Currently Under Review," (3) click on the downward-pointing arrow in the "Select Agency" box below the "Currently Under Review" heading, (4) select "Federal Communications Commission" from the list of agencies presented in the "Select Agency" box, (5) click the "Submit" button to the right of the "Select Agency" box, (6) when the list of FCC ICRs currently under review appears, look for the OMB control number of this ICR and then click on the ICR Reference Number. A copy of the FCC submission to OMB will be displayed.

SUPPLEMENTARY INFORMATION: As part of its continuing effort to reduce paperwork burdens, and as required by the Paperwork Reduction Act (PRA) of 1995 (44 U.S.C. 3501–3520), the Federal Communications Commission (FCC or the Commission) invites the general public and other Federal agencies to take this opportunity to comment on the following information collection. Comments are requested concerning: Whether the proposed collection of information is necessary for the proper performance of the functions of the Commission, including whether the information shall have practical utility; the accuracy of the Commission's burden estimate; ways to enhance the quality, utility, and clarity of the information collected; ways to minimize the burden of the collection of information on the respondents, including the use of automated collection techniques or other forms of information technology; and ways to further reduce the information collection burden on small business concerns with fewer than 25 employees.

OMB Control No.: 3060–0270.

Title: Section 90.443, Content of Station Records.

Form No.: N/A.

Type of Review: Extension of a currently approved collection.

Respondents: Business or other for-profit, not-for-profit institutions, and state, local or tribal government.

Number of Respondents: 52,383 respondents; 52,383 responses.

Estimated Time per Response: .25 hours.

Frequency of Response: Recordkeeping requirement.

Obligation to Respond: Required to obtain or retain benefits. Statutory authority for this collection of

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EPA Docket Center homepage at *http://www.epa.gov/dockets/.*

Docket: All documents in the docket are listed in the *www.regulations.gov* index. Although listed in the index, some information is not publicly available, *e.g.,* CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in *www.regulations.gov* or in hard copy at the Board of Scientific Counselors (BOSC) Homeland Security Subcommittee Docket, EPA/DC, William Jefferson Clinton West Building, Room 3334, 1301 Constitution Ave. NW, Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the ORD Docket is (202) 566–1752.

FOR FURTHER INFORMATION CONTACT: The Designated Federal Officer via mail at: Tom Tracy, Mail Code 8104R, Office of Science Policy, Office of Research and Development, U.S. Environmental Protection Agency, 1200 Pennsylvania Ave. NW, Washington, DC 20460; via phone/voice mail at: (202) 564–6518; via fax at: (202) 565–2911; or via email at: *tracy.tom@epa.gov.*

SUPPLEMENTARY INFORMATION:

General Information: The meeting is open to the public. Any member of the public interested in receiving a draft agenda, attending the meeting, or making a presentation at the meeting may contact Tom Tracy, the Designated Federal Officer, via any of the contact methods listed in the **FOR FURTHER INFORMATION CONTACT** section above. Individuals making an oral presentation will be limited to a total of three minutes. For security purposes, all attendees must provide their names to the Designated Federal Officer or register online at *https://epa-bosc-homelandsecurity-subcommittee.eventbrite.com* by December 5, 2018, and must go through a metal detector, sign in with the security desk, and show REAL ID Act-compliant government-issued photo identification to enter the building. Attendees are encouraged to arrive at least 15 minutes prior to the start of the meeting to allow sufficient time for security screening. Proposed agenda items for the meeting include but are not limited to the following: Overview of materials provided to the subcommittee, update on ORD's Homeland Security Research Program and the draft Strategic Research Action Plan, Review of charge questions, and Subcommittee discussion.

Information on Services for Individuals with Disabilities: For information on access or services for individuals with disabilities, please contact Tom Tracy at (202) 564–6518 or *tracy.tom@epa.gov.* To request accommodation of a disability, please contact Tom Tracy, preferably at least ten days prior to the meeting, to give the EPA as much time as possible to process your request.

Dated October 26, 2018.

Fred S. Hauchman,

Director, Office of Science Policy.

[FR Doc. 2018–24268 Filed 11–5–18; 8:45 am]

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ENVIRONMENTAL PROTECTION AGENCY

[FRL–9985–90–OA]

Notification of a Public Teleconference of the Chartered Clean Air Scientific Advisory Committee (CASAC)

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: The Environmental Protection Agency (EPA) Science Advisory Board (SAB) Staff Office announces a public teleconference of the Chartered Clean Air Scientific Advisory Committee (CASAC) provide advice on EPA's *Integrated Review Plan for the Review of the Ozone National Ambient Air Quality Standards (External Review Draft).*

DATES: The Chartered CASAC teleconference will be held on Thursday, November 29, 2018, from 10 a.m. to 2 p.m. (Eastern Time).

LOCATION: The teleconference will be held by telephone only.

FOR FURTHER INFORMATION CONTACT: Any member of the public wishing to obtain information concerning the teleconference may contact Mr. Aaron Yeow, Designated Federal Officer (DFO), EPA Science Advisory Board Staff Office (1400R), U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue NW, Washington, DC 20460; by telephone at (202) 564–2050 or at *yeow.aaron@epa.gov.* General information about the CASAC, as well as any updates concerning the teleconference announced in this notice, may be found on the CASAC web page at *http://www.epa.gov/casac.*

SUPPLEMENTARY INFORMATION: The CASAC was established pursuant to the Clean Air Act (CAA) Amendments of 1977, codified at 42 U.S.C. 7409(d)(2), to review air quality criteria and National Ambient Air Quality Standards (NAAQS) and recommend any new NAAQS and revisions of existing criteria and NAAQS as may be appropriate. The CASAC shall also: Advise the EPA Administrator of areas in which additional knowledge is required to appraise the adequacy and basis of existing, new, or revised NAAQS; describe the research efforts necessary to provide the required information; advise the EPA Administrator on the relative contribution to air pollution concentrations of natural as well as anthropogenic activity; and advise the EPA Administrator of any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such NAAQS. The CASAC is a Federal Advisory Committee chartered under the Federal Advisory Committee Act (FACA), 5 U.S.C., App. 2.

As amended, 5 U.S.C., App. Section 109(d)(1) of the Clean Air Act (CAA) requires that EPA carry out a periodic review and revision, as appropriate, of the air quality criteria and the NAAQS for the six "criteria" air pollutants, including ozone. On October 10, 2018, Acting Administrator Andrew Wheeler announced (*https://www.epa.gov/newsreleases/acting-administrator-wheeler-announces-science-advisors-key-clean-air-act-committee*) that the seven-member Chartered CASAC will serve as the body to review the key scientific assessments for the Ozone NAAQS review.

Pursuant to FACA and EPA policy, notice is hereby given that the Chartered CASAC will hold a public teleconference to provide advice on EPA's *Integrated Review Plan for the Review of the Ozone National Ambient Air Quality Standards (External Review Draft).* The Chartered CASAC will comply with the provisions of FACA and all appropriate SAB Staff Office procedural policies.

Technical Contacts: Any technical questions concerning the *Integrated Review Plan for the Review of the Ozone National Ambient Air Quality Standards (External Review Draft)* should be directed to Dr. Deirdre Murphy (*murphy.deirdre@epa.gov*), EPA Office of Air and Radiation.

Availability of Meeting Materials: Prior to the meeting, the review documents, agenda and other materials will be available on the CASAC web page at *http://www.epa.gov/casac/.*

Procedures for Providing Public Input: Public comment for consideration by

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EPA's federal advisory committees and panels has a different purpose from public comment provided to EPA program offices. Therefore, the process for submitting comments to a federal advisory committee is different from the process used to submit comments to an EPA program office. Federal advisory committees and panels, including scientific advisory committees, provide independent advice to EPA. Members of the public can submit relevant comments on the topic of this advisory activity, including the charge to the CASAC and the EPA review documents, and/or the group conducting the activity, for the CASAC to consider as it develops advice for EPA. Input from the public to the CASAC will have the most impact if it provides specific scientific or technical information or analysis for CASAC to consider or if it relates to the clarity or accuracy of the technical information. Members of the public wishing to provide comment should follow the instructions below to submit comments.

Oral Statements: In general, individuals or groups requesting an oral presentation at a public meeting will be limited to five minutes. Each person making an oral statement should consider providing written comments as well as their oral statement so that the points presented orally can be expanded upon in writing. Interested parties should contact Mr. Aaron Yeow, DFO, in writing (preferably via email) at the contact information noted above by November 23, 2018, to be placed on the list of public speakers.

Written Statements: Written statements will be accepted throughout the advisory process; however, for timely consideration by CASAC members, statements should be supplied to the DFO (preferably via email) at the contact information noted above by November 23, 2018. It is the SAB Staff Office general policy to post written comments on the web page for the advisory meeting or teleconference. Submitters are requested to provide an unsigned version of each document because the SAB Staff Office does not publish documents with signatures on its websites. Members of the public should be aware that their personal contact information, if included in any written comments, may be posted to the CASAC website. Copyrighted material will not be posted without explicit permission of the copyright holder.

Accessibility: For information on access or services for individuals with disabilities, please contact Mr. Aaron Yeow at (202) 564–2050 or *yeow.aaron@epa.gov*. To request accommodation of a disability, please contact Mr. Yeow preferably at least ten days prior to each meeting to give EPA as much time as possible to process your request.

Dated: October 25, 2018.

Khanna Johnston,

Acting Director, EPA Science Advisory Staff Office.

[FR Doc. 2018–24269 Filed 11–5–18; 8:45 am]

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ENVIRONMENTAL PROTECTION AGENCY

[FRL–9986–13–OA]

Notification of a Public Meeting of the Chartered Clean Air Scientific Advisory Committee (CASAC)

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: The EPA Science Advisory Board (SAB) Staff Office announces a public meeting of the Chartered Clean Air Scientific Advisory Committee (CASAC) to peer review EPA's *Integrated Science Assessment (ISA) for Particulate Matter (External Review Draft—October 2018).*

DATES: The Chartered CASAC meeting will be on Wednesday, December 12, 2018, from 9:00 a.m. to 5:30 p.m. (Eastern Time) and on Thursday, December 13, 2018, from 8:30 a.m. to 3:30 p.m. (Eastern Time).

ADDRESSES: The public meeting will be held at the Crystal Gateway Marriott, 1700 Jefferson Davis Highway, Arlington, Virginia 22202.

FOR FURTHER INFORMATION CONTACT: Any member of the public wishing to obtain information concerning the public meeting may contact Mr. Aaron Yeow, Designated Federal Officer (DFO), EPA Science Advisory Board Staff Office (1400R), U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue NW, Washington, DC 20460; by telephone/voice mail at (202) 564–2050 or at *yeow.aaron@epa.gov*. General information about the CASAC, as well as any updates concerning the meeting announced in this notice, may be found on the EPA website at *http://www.epa.gov/casac*.

SUPPLEMENTARY INFORMATION: The CASAC was established pursuant to the Clean Air Act (CAA) Amendments of 1977, codified at 42 U.S.C. 7409(d)(2), to review air quality criteria and NAAQS and recommend any new NAAQS and revisions of existing criteria and NAAQS as may be appropriate. The CASAC shall also provide advice, information, and recommendations to the Administrator on the scientific and technical aspects of issues related to the criteria for air quality standards, research related to air quality, sources of air pollution, and of adverse effects which may result from various strategies to attain and maintain air quality standards. The CASAC is a Federal Advisory Committee chartered under the Federal Advisory Committee Act (FACA), 5 U.S.C., App. 2. Section 109(d)(1) of the CAA requires that the Agency periodically review and revise, as appropriate, the air quality criteria and the NAAQS for the six "criteria" air pollutants, including particulate matter. EPA is currently reviewing the NAAQS for particulate matter (PM).

On October 10, 2018, Acting Administrator Andrew Wheeler announced (*https://www.epa.gov/newsreleases/acting-administrator-wheeler-announces-science-advisors-key-clean-air-act-committee*) that the seven-member Chartered CASAC will serve as the body to review the remaining key scientific assessments for the PM NAAQS review.

Pursuant to FACA and EPA policy, notice is hereby given that the Chartered CASAC will hold a public meeting to peer review EPA's *Integrated Science Assessment (ISA) for Particulate Matter (External Review Draft—October 2018).* The Chartered CASAC will comply with the provisions of FACA and all appropriate SAB Staff Office procedural policies.

Technical Contacts: Any technical questions concerning the *Integrated Science Assessment for Particulate Matter (External Review Draft—October 2018)* should be directed to Mr. Jason Sacks (*sacks.jason@epa.gov*).

Availability of Meeting Materials: Prior to the meeting, the review documents, agenda and other materials will be accessible through the calendar link on the blue navigation bar at *http://www.epa.gov/casac/*.

Procedures for Providing Public Input: Public comment for consideration by EPA's federal advisory committees and panels has a different purpose from public comment provided to EPA program offices. Therefore, the process for submitting comments to a federal advisory committee is different from the process used to submit comments to an EPA program office. Federal advisory committees and panels, including scientific advisory committees, provide independent advice to EPA. Members of the public can submit relevant comments on the topic of this advisory activity, including the charge to the CASAC and the EPA review documents, and/or the group conducting the activity, for the CASAC to consider as it develops advice for EPA. Input from

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Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 9/18/2018 4:37:25 PM
To: tcoxdenver@aol.com
Subject: Biosketches
Attachments: CASAC FY 2019 List of Candidates-web.pdf

Here are the biosketches, as discussed.

-Aaron

Aaron Yeow, M.P.H.
Designated Federal Officer
U.S. Environmental Protection Agency
Science Advisory Board
202-564-2050 (P)
202-565-2098 (F)

Mailing Address:
USEPA, 1200 Pennsylvania Avenue, NW, (1400R), Washington, DC 20460

Physical Location/Deliveries:
1300 Pennsylvania Avenue, NW, Suite 31150, Washington, DC 20004

Invitation for Public Comment on the List of Candidates
For the Environmental Protection Agency's
Clean Air Scientific Advisory Committee

June 11, 2018

The U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Staff Office announced in a Federal Register Notice on March 21, 2018, (83 FR 12383-12384) that it was inviting nominations of experts to be considered for the Administrator's appointment to the Clean Air Scientific Advisory Committee (CASAC). The CASAC provides independent advice, information and recommendations to the EPA Administrator on the scientific and technical aspects of air quality criteria and National Ambient Air Quality Standards (NAAQS). The SAB Staff Office sought nominations of experts to serve on the CASAC with expertise in: Air quality, biostatistics, ecology, environmental economics, environmental engineering, epidemiology, exposure assessment, medicine, risk assessment, and toxicology.

The SAB Staff Office received nominations for the attached 36 candidates based on their expertise and willingness to serve. We hereby invite public comments on the attached List of Candidates under consideration for appointment to the CASAC. Comments should be submitted to Mr. Aaron Yeow, Designated Federal Officer, at yeow.aaron@epa.gov no later than **July 2, 2018**. E-mail is the preferred mode of receipt. Please be advised that public comments are subject to release under the Freedom of Information Act.

FY19 Chartered CASAC Annual Membership

Berrocal,Veronica

University of Michigan

Dr. Veronica J. Berrocal is Associate Professor of Biostatistics at the University of Michigan. Her expertise and research interests are in spatial and environmental statistics and biostatistics, with a particular interest on development and application of statistical methods for environmental exposure risk assessment, particularly air pollution, weather and climate modeling, and their impact on health. Dr. Berrocal has also investigated assessment of the National Ambient Air Quality Standard for ozone using spatial statistical models and data from monitoring sites and an air quality model. Dr. Berrocal is the current core co-leader of the Integrated Health Sciences Core of the University of Michigan NIEHS-funded P30 center MLEEaD – Michigan Lifetime Environmental Exposure and Disease. She has also been and is co-Investigator on various NIH-funded and NSF-funded research projects investigating the effect of the physical and built environment on health, the impact of climate change on health, as well as studies on rheumatic diseases, brain cancer, and reproductive health among others. She has served as ad-hoc member of the EPA Federal Insecticide, Fungicide and Rodenticide Act Scientific Advisory Panel in December 2014, May 2015, and November 2017, and has served as member of an External Peer Review panel for EPA on the "Environmental Relative Moldiness Index (ERMI)" (October 2016) and on "Significant Impact Levels (SILs) for ozone and fine particle pollution" (September 2016). She is a member of the American Statistical Association (ASA), the International Society for Bayesian Analysis (ISBA), the International Biometrics Society (IBS), and the Association for Women in Mathematics. She has been the Chair of the Section on "Statistics and the Environment" of the American Statistical Association in 2017, and she is currently the Program Chair Elect for the Section of "Statistics in Epidemiology" of the American Statistical Association. Prior to joining the University of Michigan as faculty in 2010 as Assistant Professor, Dr. Berrocal earned a Ph.D. in Statistics at the University of Washington in 2007, was a postdoctoral research associate at the NSF-funded Statistical and Applied Mathematical Sciences Institute (SAMSI) in academic year 2009-2010, a postdoctoral fellow at Duke University, in the Department of Statistical Science and in the Children Environmental Health Initiative (CEHI) center in academic year 2008-2009, and a National Research Council postdoctoral research associate at the U.S. Environmental Protection Agency in the National Exposure Research Laboratory (NERL) in academic year 2007-2008. As a postdoc at EPA-NERL, Dr. Berrocal has developed spatial statistical models to combine data from monitoring sites and outputs from an air quality model (the Community Multiscale Air Quality – CMAQ) to generate improved estimates of air pollution concentration at fine spatial scale. These models, called downscaler and data fusion models, have been presented in several scientific journals, are highly cited and have been used in various epidemiological studies to assess the health impact of ambient and personal exposure to air pollution.

Burke,Thomas

Johns Hopkins Bloomberg School of Public Health

Thomas A. Burke is a Professor at The Johns Hopkins Bloomberg School of Public Health, Department of Health Policy and Management, with joint appointments in the Department of Environmental Health Sciences and the School of Medicine Department of Oncology. He is also the the Director of the Johns Hopkins Risk Sciences and Public Policy Institute. Dr. Burke is Chair of the National Academy of Sciences Committee on Improving Risk Analysis and in 2006 he was named a Fellow of the Society for Risk Anaysis. His research interests include environmental epidemiology and surveillance, evaluation of population exposures to environmental pollutants, assessment and communication of environmental risks, and application of epidemiology and health risk assessment to public policy. He was Principal Investigator for the Pew Environmental Health Commission which established the framework for a national approach to environmental public health tracking. He has been awarded the Johns Hopkins Golden Apple Award for excellence in teaching three times.Before joining the University faculty, Dr. Burke was Deputy Commissioner of Health for the State of New Jersey and Director of Science and Research for the New Jersey Department of Environmental Protection. In New Jersey, he directed initiatives that influenced the development of national programs, such as Superfund, the Safe Drinking Water Act, and the Toxics Release Inventory. Dr. Burke has served as a member of the National Academy of Sciences Board on Environmental Studies and Toxicology and chaired the NAS Committee on Human Biomonitoring for Environmental Toxicants and Committee on Toxicants and Pathogens in Biosolids Applied to Land. He also served on the NAS Committee on the Toxicological Effects of Methylmercury. In 2003 he was named a lifetime National Associate of the National Academies. He was Inaugural Chair of the Advisory Committee to the Director of the CDC National Center for Environmental Health and a member of the Executive Committee of the EPA Board of Scientific Counselors. Dr. Burke received his B.S. from St. Peter's College, his M.P.H. from the University of Texas and his Ph.D. in epidemiology from the University of Pennsylvania.

Chance,Kelly

Smithsonian Institution

Kelly Chance is a Senior Physicist at the Smithsonian Astrophysical Observatory. He taught Spectroscopy and Radiative Transfer of Planetary Atmospheres as a Lecturer on Earth and Planetary Sciences at Harvard University (now Oxford University Press, ISBN 978-0-19-966210-4). He has been measuring Earth's atmosphere from balloons, aircraft, the ground and, especially, from satellites since receiving his Ph.D. in Chemical Physics from Harvard in 1978. His research specialties are measurements of the Earth's atmosphere; atmospheric composition and radiative transfer; chemical astrophysics; and molecular spectroscopy, structure and dynamics. His atmospheric measurements encompass the stratospheric ozone layer, climate-altering greenhouse gases, and atmospheric pollution. His proposal for Tropospheric Emissions: Monitoring of Pollution (TEMPO) was selected in 2012 as the first NASA Earth Venture Instrument. TEMPO will be the first space-based instrument to monitor major air pollutants across the North American continent from Mexico City to the Canadian oil sands, and from the Atlantic to the Pacific, hourly at high spatial resolution. TEMPO will be launched in about 2020-2021, sharing a ride on a commercial satellite to a geostationary orbit. TEMPO measurements of ozone, nitrogen dioxide, sulfur dioxide, formaldehyde, glyoxal, water vapor, aerosols, cloud parameters, and harmful ultraviolet radiation will enable researchers to improve emission inventories, monitor population exposure, and evaluate effective emission-control strategies. It also will provide near-real-time air quality products that will be made publicly available.

Chow,Judith

Desert Research Institute

Dr. Judith Chow holds the Nazir and Mary Ansari Chair in Science and Entrepreneurialism and is a Research Professor in the Division of Atmospheric Sciences of the Desert Research Institute (DRI) of the Nevada System of Higher Education in Reno, Nevada. Dr. Chow has led DRI's Environmental Analysis Facility since its inception in 1985. She earned her B.S. degree in Biology from Fu-Jen Catholic University in Taiwan (1974), her M.S. degree in Environmental Health Science (1983) from Harvard University, and her Sc.D. degree in Environmental Science and Physiology (1985) from Harvard University. For more than 35 years, she has conducted air quality studies and performed data analysis to improve understanding of effects of air quality on human health, visibility, historical treasures, ecosystems, and climate. Dr. Chow is currently the principal investigator for: 1) conducting organic and black carbon measurements with the U.S. Environmental Protection Agency's (EPA) Chemical Speciation Network (CSN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) network; 2) tracking changes in air quality with control measures at the ports of Los Angeles and Long Beach; 3) investigating the chemical nature and composition of atmospheric brown carbon aerosol; and 4) evaluating nitrogen partitioning and evolution of particulate organic nitrogen in peat fire emissions. She has been principal investigator or a major collaborator in more than 50 large air quality studies (and many smaller ones) across the United States and in other countries. Dr. Chow prepared and revised sections of the EPA's PM Criteria Document pertaining to chemical analysis and source emissions and contributed to EPA guidance documents on network design, continuous particulate monitoring, and particulate matter chemical speciation. Dr. Chow's research has been sponsored by grants and contracts from the federal government (e.g., EPA, Department of Energy, Department of Interior, Department of Defense), local, state, and international air quality management authorities, industry, and the National Science Foundation. As past chair and a member of the Air & Waste Management Association's (A&WMA) Critical Review Committee, Dr. Chow has coordinated and evaluated Critical Reviews and Discussions on environmental science and technology topics. She was chair of the Publications Committee for the Journal of the Air & Waste Management Association and serves on Editorial Boards and/or as Associate Editor for several international journals including: the Journal of Air Quality, Atmosphere, & Health, Aerosol and Air Quality Research, Atmospheric Pollution Research, and Particuology. Dr. Chow was a member of the National Research Council's (NRC) committees on Research Priorities for Airborne Particulate Matter (1998–2003) and Energy and Air Pollution Futures in the U.S. and China (2004-2008); she also served on the NRC Board on Environmental Studies and Toxicology (2002–2005). She was a member of advisory panels for the National Environmental Respiratory Center (New Mexico) and South Coast (California) Air Quality Management District. Dr. Chow has been a member of EPA's Clean Air Scientific Advisory Committee (CASAC) since 2015 and CASAC's Air Monitoring and Methods Subcommittee (AMMS, formerly the Ambient Air Monitoring and Methods Subcommittee) since 2004. She is the principal author or co-author of more than 350 peer-reviewed articles and more than 90 peer-reviewed book chapters and has been recognized by ISIHighlyCited.com in ecology and environment with more than 14,500 citations of her work. Dr. Chow has received the California Air Resources Board's 2011 Haagen-Smit Clean Air Award for her contributions to air quality science and technology, the Air & Waste Management Association's 2016 Arthur C. Stern Award for Distinguished Paper and 2002 Frank A. Chambers Excellence in Air Pollution Control Award, and the 2001 Nevada System of Higher Education's Regents' Researcher Award.

Cocker III,David R.

University of California at Riverside

David R. Cocker III is a professor of Chemical and Environmental Engineering at the University of California, Riverside. He currently manages the Atmospheric Processes Laboratory at the Bourns College of Engineering, Center for Environmental Research and Technology in addition to being a UCR Honors Faculty Fellow. He received both his M.S. (1998) and Ph.D. (2001) in Environmental Engineering Science from the California Institute of Technology and double B.S. degrees in Environmental Engineering and Chemistry from the University of California, Riverside. His research expertise includes atmospheric chemistry leading to secondary organic aerosol and ozone formation, in-use characterization of a variety combustion emission sources, and the health impacts of atmospheric pollutants. Funding over the last two years has included the South Coast Air Quality Management District, California Air Resources Board, U.S. EPA (student design competitions), Coordinated Research Council, National Science Foundation, Naval Surface Warfare Center, USDA, and Honda. He has served as a technical advisor to the Western Regional Air Pollution Committee, has been an advocate for STEM education within the Riverside Unified School District, is an active member of the American Association for Aerosol Research, and is affiliated with the BREATHE center through the UCR School of Medicine.

Cohan,Daniel

Rice University

Dr. Cohan is an Associate Professor of Civil and Environmental Engineering at Rice University. His research specializes in atmospheric modeling to inform environmental decision-making and quantify the responsiveness of air pollution to emissions. Dr. Cohan received a B.A. in Applied Mathematics from Harvard University, a Ph.D. in Atmospheric Chemistry from Georgia Tech, and served as a Fulbright Scholar to Australia. He is a recipient of an NSF CAREER award and was a member of the NASA Air Quality Applied Sciences Team. Prior involvement with EPA includes serving as PI of a STAR research grant and developing advanced features for the CMAQ air quality model.

Crawford,James

NASA

Dr. James H. Crawford is a Senior Research Scientist at NASA, serving as the agency lead for tropospheric chemistry. In this capacity he provides leadership for national and international airborne field studies that collect detailed measurements of atmospheric composition to identify human and natural impacts related to gaseous and particulate pollution. These observations are critical to understanding the emissions, chemistry, and dynamics that underlie air pollution events. An important focus of Dr. Crawford's work has been to improve the interpretation and application of satellite observations for air quality through integration with surface monitoring, aircraft observations, and air quality models. In conducting these studies, Dr. Crawford has collaborated with federal and state air quality agencies in California, Colorado, Maryland, and Texas, always drawing on local advice and experience to ensure that flights are executed to advance current understanding of the unique issues faced by each locality. He currently serves on the Advisory Panel of the Texas Air Quality Research Program. He has authored over 130 peer-reviewed publications on the chemistry of the lower atmosphere including photochemical production of ozone and particulate matter, carbon monoxide and atmospheric transport, and near-surface vertical gradients in reactive nitrogen oxides, formaldehyde, and ozone production. Dr. Crawford has also coordinated special issue publications of air quality findings in EM magazine, targeted to air quality decision makers, and he has served as the atmospheric chemistry editor for the Journal of Geophysical Research-Atmospheres since 2013. A current member of the International Global Atmospheric Chemistry (IGAC) project Steering Committee, Dr. Crawford will assume the IGAC co-Chair role in 2019. Dr. Crawford was selected for a Presidential Early Career Award for Scientists and Engineers in 2001. He has also received NASA's highest honors, the Outstanding Leadership Medal, and NASA's Exceptional Achievement Medal for sustained scientific contributions to NASA's Tropospheric Chemistry Program. His current research interests include the photochemistry of tropospheric ozone and free radicals, the global budget of reactive nitrogen, the influence of clouds on trace gas transport and chemistry, and the use of satellites to study long-range pollution transport and air quality. Since 2010, Dr. Crawford has led a series of air quality focused field studies across the United States (DISCOVER-AQ) and in South Korea (KORUS-AQ) to understand local and transboundary influences on air quality and to prepare for geostationary satellite observations of air quality planned by Korea and the U.S. in the early 2020s. Dr Crawford received his Ph.D. in Atmospheric Chemistry from Georgia Institute of Technology, and his B.S. in Mathematics from the United States Military Academy.

DeFelice,Tom

In Progress

Dr. DeFelice is currently a consultant to NOAA and NASA federal service sector small businesses, while taking management courses to maintain his PMP certification. He has submitted a US Utility Patent pending application, involving the use of UAS w/autonomous, adaptive control, and on-board environmental sensors. Dr. DeFelice has a PhD in Atmospheric Science from N.C. State University, MS Atmospheric Physics from DRI/UNR, and a BS in Math and Atmospheric Science from SUNY at Albany. He has performed air quality, meteorology, atmospheric chemistry (aqueous & gas phases) measurements on an EPA project that funded his PhD work. Dr. DeFelice taught wet and gas phase atmospheric chemistry, cloud physics, remote sensing of aerosols, plus meteorological instrumentation and measurement at the University Senior/Grad student level. His university level teaching included mentoring a Graduate student who's research involved Air Pollution Control Technology development. Dr. DeFelice has authored 40+ relevant peer-reviewed publications, and a college text-meteorological instrumentation & measurement. He has been an editorial board member of Atmospheric Research since 2000, and Atmospheric and Solar-Terrestrial Physics. Dr. DeFelice's expertise and research activities are focused on atmospheric science, cloud and aerosol physics and chemistry, meteorological measurements and the effect of aerosols on atmospheric and other processes(biosphere, geosphere, hydrosphere), and the effect of cloud systems on the environment. He has over 20 years of experience relevant to air quality, mainly focused on investigating aerosol characteristics and cloud system-aerosol interactions. Dr. DeFelice led an unbudgeted full cycle validation infrastructure project created per Data Qual. Act 2000, which today still serves as a focal point for research studies and public outreach at EDC. He supported air quality studies of APHC focusing on meteorology and aerosol (chemical & physical) measurements, their analysis and their effect on soldier. Dr. DeFelice has served on advisory committees not supported by the SAB staff office and professional societies, for example, 2+ years on an International Commission for the Ministry of Agriculture, Mendoza, Ar. He also served as a member of the ARL biosafety committee for 3 yrs. Dr. DeFelice has served on the American Society of Civil Engineers, Environmental Water Resources Institute Atmospheric Water Management Standards Committee since 1994 which included serving as its chair and secretary.

Enstrom,James E.

Scientific Integrity Institute

Dr. James E. Enstrom is a retired Research Professor/Researcher from the School of Public Health and Jonsson Comprehensive Cancer Center at the University of California, Los Angeles. He is President of the Scientific Integrity Institute in Los Angeles. He received his BS in physics from Harvey Mudd College, an MS and PhD in elementary particle physics from Stanford University, and a MPH and postdoctoral certificate in epidemiology from UCLA. Dr. Enstrom has authored, primarily as first or sole author, about 50 peer-reviewed articles and book chapters on physics, epidemiology, and scientific integrity. He has received research funding from many sources, including NIH, ACS, UC, private foundations, industry sources, and personal donations. He has received no funding recently, but is still conducting original epidemiologic research by using personal assets in innovative and cost-effective ways. He has taught graduate classes on environmental health science. He has given numerous lectures on epidemiology and ethics. He has published important articles relating good health practices to reduced mortality and recently has shown that fine particulate matter (PM2.5) is not related to total mortality in the ACS Cancer Prevention Study cohorts (CPS I and CPS II). He is the only independent scientist to obtain and analyze original CPS cohort data. His research shows that the EPA PM2.5 NAAQS is scientifically unjustified and must undergo complete and objective reassessment. His Scientific Integrity Institute website contains thousands of documents on air pollution epidemiology, lifestyle epidemiology, scientific integrity, and critiques of regulations, many of which contain his own research and analysis. He understands air pollution health effects research from the perspectives of both physics and epidemiology and maintains the highest level of integrity. He is a Life Member of the American Physical Society, a Founding Fellow of the American College of Epidemiology, and a current member of the ACE Ethics Committee. In 2015 he received the Heroes of Conscience Award from the American Freedom Alliance in Los Angeles.

Fernandez,Ivan J.

University of Maine

Dr. Ivan J. Fernandez is a Professor and forest soil scientist at the University of Maine, Orono. He is a Distinguished Maine Professor and faculty member in the School of Forest Resources, the Climate Change Institute, and the School of Food and Agriculture. His expertise is in biogeochemical cycling in forested ecosystems, terrestrial-aquatic linkages, and biogeochemical responses to a changing chemical and physical climate. He is a member of numerous professional organizations such as the Society of American Foresters, Soil and Water Conservation Society, and a fellow and member of the Soil Science Society of America. He serves as a member of the National Council of Soil Science Examiners and the Maine Board of Certification for Professional Geologists and Soil Scientists. He is recognized for establishing or helping to establish several long-term ecosystem studies in Maine that include the Howland Research Forest, research watersheds in Acadia National Park, and the long-term whole ecosystem research program at the Bear Brook Watershed in Maine. He also serves as the External Science Advisor to the Hubbard Brook Ecosystem Study in New Hampshire and is the point of contact for the U.S. Department of Agriculture (USDA) Northeast Climate Hub at the University of Maine. His current research interests are in atmospheric deposition and climate change effects on forested ecosystems and watershed processes, bioenergy implications for forest management, and climate change adaptation. He was co-leader of the 2009 climate change assessment for Maine and the subsequent report Maine's Climate Future. Dr. Fernandez has funding from the U.S. Department of Agriculture, the National Oceanic and Atmospheric Administration, the Northeastern States Research Cooperative and the National Science Foundation to study acidification and recovery, climate, and nitrogen effects on long-term forest biogeochemistry.

Fine,Philip

South Coast Air Quality Management District

Philip Fine, Ph.D. is currently the Deputy Executive Officer for Planning, Rule Development & Area Sources at the South Coast Air Quality Management District (SCAQMD) in Diamond Bar, CA. He is responsible for oversight, administration, and direction of all activities of the Division, including all rulemaking functions, Air Quality Management Plan and SIP development, particulate matter and ozone control strategies, climate and energy policy, air quality modeling, meteorology and forecasting, air quality data evaluation, emissions reporting, and air toxics risk assessment. He also recently served as the Assistant Deputy Executive Officer for the Science & Technology Advancement Division in charge of all field and laboratory activities related to the AQMD ambient network of over 36 air monitoring stations, source testing, compliance testing, quality assurance, and all special air monitoring research projects. Dr. Fine has been a member of several CASAC panels, and currently serves as a member of the California Air Resources Board legislatively mandated Research Screening Committee. Prior to joining the SCAQMD, he was a Research Assistant Professor at the University of Southern California, Los Angeles where he taught courses and conducted extensive research on particulate pollution, its health effects, atmospheric science, and measurement methods resulting in over 50 peer-reviewed scientific publications. Dr. Fine received his Ph.D. from California Institute of Technology in Environmental Engineering Science, and his bachelor's degree in Mechanical Engineering and Materials Science & Engineering from the University of California, Berkeley.

Frampton,Mark

University of Rochester

Dr. Mark W. Frampton is Professor Emeritus in Medicine in the Pulmonary & Critical Care division, at the University of Rochester Medical Center (URMC), Rochester, NY. Dr. Frampton holds an M.D. from New York University. During pulmonary specialty training at URMC in the late 1980s, Dr. Frampton became interested in the adverse health effects of air pollution, at a time when epidemiology studies were beginning to provide strong links between ambient particulate air pollution and mortality. Working with Dr. Mark Utell and utilizing the human clinical studies facility at URMC, he expanded the focus of human clinical air pollution studies beyond pulmonary function effects to include effects on airway inflammation, host defense against viral infection, and cardiovascular effects. Dr. Frampton's laboratory was the first to conduct human clinical studies of ultrafine particles (smaller than 100 nm), first using laboratory generated elemental carbon particles, and subsequently with concentrated ambient ultrafine particles, using the Harvard ultrafine concentrator system. Over the years his laboratory has studied healthy subjects as well as those considered to have increased susceptibility, including older subjects and people with mild asthma, chronic obstructive pulmonary disease, type 2 diabetes, and even genetic susceptibility. Dr. Frampton's laboratory is one of three centers completing a study of the cardiovascular effects of ozone exposure in healthy older subjects, funded by the Health Effects Institute. These studies have helped to understand the physiological changes and pathways to adverse effects that occur in response to pollutant exposure, and have helped to inform the EPA's promulgation of rational ambient air quality standards. Funding for these studies has come from the National Institutes of Health, the U.S. EPA, the Health Effects Institute, the New York State Energy Research and Development Authority, CONCAWE, ExxonMobil, the American Petroleum Institute, and others. Dr. Frampton has served on numerous scientific review panels with the National Institutes of Health and other scientific funding organizations. He has been active in the Environmental and Occupational Health Assembly of the American Thoracic Society, serving as its Chair in 2001-2003. At the request of the ATS President at the time, Dr. Frampton chaired a Task Force on Bioterrorism, and helped to form a new Section on Bioterrorism, serving as its first Chair in 2003-2005. He recently served as a member of the ATS committee preparing a revision of the important and oft-cited document, "What Constitutes a Health Effect of Air Pollution?", which has now been published. Dr. Frampton has served as a consultant and reviewer for the Health Effects Institute, a health research organization jointly funded by EPA and the automobile industry. He is currently a member of the Science Review Committee for the Health Effects Institute. He participated in an HEI review panel on the health effects of traffic-related air pollution, and chaired an HEI Review Panel on ultrafine particles, which produced a recent HEI Perspectives, "Understanding the Health Effects of Ambient Ultrafine Particles". Dr. Frampton has served as a consultant to the EPA in developing and reviewing Integrated Scientific Assessments (formerly Criteria Documents) for nitrogen dioxide, ozone, and particulate matter. In addition, he has served on several EPA grant and fellowship review panels and scientific workshops, and has been invited to speak at EPA functions. He currently serves on the CASAC PM Review Panel.

Fritz,Patricia

New York State Department of Health

Patricia Mason Fritz, is a Research Scientist III with the Bureau of Toxic Substance Assessment in the Center for Environmental Health. She has worked for the New York State Department of Health, Center for Environmental Health in the Bureau of Toxic Substance Assessment since 1994. Prior to joining the Health Department, Pat was a Senior Research Scientist with Sterling Winthrop Research Institute, where she conducted laboratory research in the neurobehavioral effects of compounds of pharmacological interest. Pat holds Bachelor of Science degrees from Syracuse University and SUNY College of Environmental Science and Forestry, and a Masters' degree in Environmental Engineering from Rensselaer Polytechnic Institute. Ms. Fritz has represented the Health Department on multi-disciplinary review and advisory panels related to environmental health, prepared and provided technical support for testimony in administrative hearings, and served on grant and contract review panels in the areas of energy, environment, and health. She is a current member of ASHRAE, the American academy of Allergy, Asthma and Immunology (AAAAI), where she serves on the Environmental Exposure and Respiratory Health and Aerobiology Committees, the American Association for Aerosol Research (AAAR), where she serves on the Early Career Committee, and the Pan- American Aerobiology Association(PAAA). Ms. Fritz' work at NYSDOH encompasses exposure assessment and toxicological risk assessment of chemical and biological contaminants in air water and soil, criteria and hazardous air pollutants, aerosols, aerobiology, asthma, air quality, nanotechnology, mercury, and impacts from conventional and alternative energy sources. She has worked on the development and analysis of results from surveys conducted in New York State focused on asthma prevalence and exacerbation, collaborated on a study investigating pediatric exposure to mercury, and has conducted multiple investigations related to indoor and outdoor air quality in residential, school and occupational settings in NYS. In addition to her research efforts, she responds to public inquiries about health effects from chemical and biological pollution, develops and provides training on health effects of air pollutants, provides technical support to Department technical documents and initiatives, and has participated in multi-agency evaluations of environmental sampling data collected following industrial accidents, natural disasters and following the World Trade Center attacks. She is currently in the third year of a New York State Energy Research and Development Authority funded research project characterizing particulate emissions from advanced biomass-fueled appliances.

Gordon,Terry

New York University School of Medicine

Dr. Terry Gordon holds the rank of Professor of Environmental Medicine at the New York University (NYU) School of Medicine. He holds a B.S. in Physiology (1974), an M.S. in Toxicology (1976) from the University of Michigan, and a Ph.D. in Toxicology from MIT (1981), and was appointed to the faculty of the Department of Environmental Medicine in 1989. He has served as an ad hoc member of grant review panels and/or site visit teams for NIEHS, NIAID, National Coalition for Cancer Research, DOD, Bureau of Mines, NASA, Health Canada, NIOSH/CDC, and the EPA. Dr. Gordon is past Chair of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) committee, a volunteer organization that publishes occupational exposure levels that are used as workplace safety guidelines throughout the world. Dr. Gordon's broad research interest is in inhalation toxicology. The major focus of his research lab is the identification and understanding of the role of genetic host factors in the pathogenesis of the adverse pulmonary effects produced by inhaled environmental and occupational agents. Because inter-individual responses to inhaled particles and gases vary so greatly in both human subjects and test animals, Dr. Gordon has hypothesized that genetic susceptibility factors play a major role in environmental and occupational lung disease. In collaboration with a number of investigators in the department, his laboratory uses classic murine genetics models, computational genomics, and DNA microarrays to identify genes involved in the acute response as well as in the development of tolerance to repeated exposure to inhaled toxicants. Dr. Gordon also plays a major role in the particulate matter (PM) research program at NYU, and was among the first researchers to use concentrator technology to study the adverse cardiopulmonary effects of ambient PM. Dr. Gordon is an active member of the Society of Toxicology (SOT), and has served on the Program, Placement, Membership, and Awards Committees and as President of its Inhalation Specialty Section. He has served as a consultant/author to the EPA on issues of pulmonary toxicology related to the development of various documents, and served on EPA's Clean Air Scientific Advisory Committee (CASAC) Oxides of Nitrogen (NOx) and Sulfur Oxides (SOx) Primary National Ambient Air Quality Standards (NAAQS) Review Panels and is a current member of the PM ad hoc CASAC.

Hailer,Katie

Montana Tech

Dr. Katie Hailer started her education in chemistry at West Virginia University, graduating in 2001 with a B.A. in Chemistry, summa cum laude. She then went to the University of Montana for her doctoral graduate studies in bioinorganic chemistry. Under the direction of Dr. Kent Sugden, Dr. Hailer spent her time in graduate school working to elucidate the mechanism of hexavalent chromium carcinogenesis. After graduating in 2006, she accepted a one-year postdoctoral position at the Mayo Clinic in Rochester, MN. There she worked with Dr. Scott Kaufmann again focusing on mechanisms of carcinogenicity in an oncology lab. Dr. Hailer then transitioned into a faculty position, first at Winona State University from 2007-2010, and then moving to Montana Tech in 2010. Dr. Hailer currently holds the rank of tenured, Associate Professor and Department Head of Chemistry at Montana Tech. Dr. Hailer is best described as a bioinorganic chemist. Her research has always focused on metal interactions in living systems. Montana Tech is in Butte, MT which also happens to be one of the largest Superfund sites in the United States. Using the historical environmental contamination and current open-pit mining activities as inspiration, Dr. Hailer now focuses her research on measuring and identifying metals in the people that live and work in Butte, MT. Her research has been most recently funded by the National Institutes of Health INBRE grant.

Hayes,Stanley

Ramboll Environ

Mr. Stan Hayes has more than 40 years of experience in air-related environmental engineering and science for NAAQS- and air toxics-related purposes, with emphasis on air modeling analysis and health risk assessment. He has an MS degree in Aeronautics & Astronautics and a BS degree in Mechanical Engineering, both from Stanford University. Mr. Hayes is the primary author of more than 70 scientific papers and presentations, and several hundred technical reports on air-related subjects. He is a member of the EPA Science Advisory Board Risk and Technology Review (RTR) Methods Panel. He is a Fellow of the Air & Waste Management Association, for whom he has chaired or co-chaired national and international specialty conferences. He is chair of the Advisory Council of the Bay Area Air Quality Management District, which provides science-based counsel to the Board of Directors, the Executive Officer, and other senior staff. He has provided expert testimony before federal, state and local regulatory agencies and in court. For 25 years, until 2015, Mr. Hayes was a Principal with Ramboll (previously ENVIRON). He is now emeritus, with no regular salary, EPA or other grants, benefits, or firm ownership interest. Over his career, Mr. Hayes has conducted research consulting on NAAQS- and air toxics-related topics for a broad range of private- and public-sector clients, including trade associations (e.g., API and others), individual companies, law firms, and regulatory agencies (e.g., EPA and others). Relevant to the work of CASAC, he has conducted NAAQS-related air quality modeling studies, health risk assessments, exposure analyses, control strategy analyses, nonattainment area plan evaluations, air monitoring data analyses, and regulatory and policy reviews.

Hayworth,Nan

Independent Consultant

The Honorable Nan Hayworth, M.D. is a consultant and a Special Business Development Advisor for Pilot Growth Equity. She is the only female physician ever to serve as a Member of Congress, representing the 19th District of New York in 2011 and 2012. As a freshman Member of the House Majority, Congresswoman Hayworth was assigned to the House Financial Services Committee and the Majority Whip Team; she also had the honor of being chosen by Speaker Boehner to serve on two House-Senate Conference Committees. She has been recognized by many organizations, including the Sierra Club, League of Conservation Voters, Defenders of Wildlife, and Wilderness Society, for her efforts to protect the environment. A board-certified ophthalmologist, Dr. Hayworth practiced for nearly 20 years in Mount Kisco, New York, before becoming a vice president and medical director at Cline Davis & Mann, a healthcare communications agency, prior to running for Congress. She chairs the board of directors of ConservAmerica, a Republican organization dedicated to environmental protection, and she served as a primary media surrogate for EPA Administrator Scott Pruitt when he was a candidate for this position. Congresswoman Hayworth speaks on television and radio in behalf of Independent Women's Forum, the Trump campaign, and the Republican National Committee. She graduated summa cum laude from Princeton University in 1981 with a degree in Biology, subsequently graduating at the top of her class from Cornell University Medical College (now Weill Cornell Medicine) in 1985. Dr. Hayworth has not been a recipient of any research grants from the public or private sectors over the past two years.

Huang,Guanyu

Spelman College

Dr. Guanyu Huang is an assistant professor of Environmental and Health Sciences program at Spelman College. He received his B. Eng. (2008) in remote sensing science and technology from Wuhan University in China, and his M.S. (2010) and Ph. D. (2015) in Atmospheric Science from University of Alabama in Huntsville. He became a postdoctoral fellow at Harvard-Smithsonian Center for Astrophysics in 2015 and then joined Spelman college as a tenure-track assistant professor in 2017. Dr. Huang is an expert of air quality, especially in ozone and its precursors. His research interests include trace gas remote sensing, air quality modeling and observations in multiple scales, and the application of machine learning in environmental science and remote sensing. He has authored and co-authored multiple journal papers and conference papers. He teaches courses in air quality, atmospheric science and environmental science in Spelman College.

Kinney,Patrick

Boston University School of Public Health

Dr. Kinney has a broad background in environmental health sciences, with specific training and expertise in air pollution exposure assessment, epidemiology, and climate change. He completed his doctoral studies in Environmental Science and Physiology at the Harvard School of Public Health in 1986. As a junior faculty member at New York University, he developed and led epidemiologic research on lung function and inflammatory biomarker changes in relation to chronic exposures to ozone and other air pollutants. Moving to Columbia in 1994, he expanded his research to include community-based studies of traffic pollutant exposures and health outcomes in underprivileged neighborhoods in New York City, leading and contributing to several large-scale studies over the following 22 years. He has contributed to the periodic reviews of the National Ambient Air Quality Standards for ozone and particulate matter, and served on the EPA Clean Air Scientific Advisory Committee for reviews of the Nitrogen Dioxide and Sulfur Dioxide standards. He developed and directed the Climate and Health Program at Columbia, which trains students and postdocs in research on the health dimensions of climate variability and change. He also directed research on indoor and outdoor air quality and health in Africa, including a randomized stove trial in Ghana funded by NIEHS. Current funding sources include the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration. In January 2017, Dr. Kinney was named the inaugural Beverly A Brown Professor of Urban Health at Boston University.

Kleinman,Michael T.

University of California, Irvine

Dr. Michael T. Kleinman is an Adjunct Professor of Toxicology in the Department of Medicine's Occupational and Environmental Medicine Division at the University of California, Irvine (UCI), with a joint appointment in the Program in Public Health. He was previously employed by the U.S. Atomic Energy Commission (AEC) as an environmental scientist and he directed the Aerosol Exposure and Analytical Laboratory at Rancho Los Amigos Hospital in Downey, CA. He has more than 40 years of experience researching the health effects of environmental contaminants. He holds a M.S. in Chemistry (Biochemistry) from the Polytechnic Institute of Brooklyn and a Ph.D. in Environmental Health Sciences from New York University. He is the Co-Director of the Air Pollution Health Effects Laboratory at UCI. He has published more than 115 peer-reviewed journal articles on effects of environmental contaminants on cardiopulmonary and immunological systems and on global and regional distribution of environmental contaminants including heavy metals and radioactive contaminants from nuclear weapons testing. He has directed more than 50 controlled exposure studies of human volunteers and laboratory animals to ozone and other photochemical oxidants, carbon monoxide, ambient particulate matter (PM) and laboratory-generated aerosols containing chemically or biologically reactive metals such as lead, cadmium, iron and manganese. He has served on two National Academy committees to examine issues in protecting deployed U.S. Forces from the effects of chemical and biological weapons. Dr. Kleinman's current research focuses on neurological and cardiopulmonary effects of inhaled particles, including nanomaterials and ultrafine, fine and coarse ambient particles in humans and laboratory animals. His recent health effects studies have the role of inhaled combustion-generated particles on the promotion of airway allergies and acceleration of development of cardiovascular disease and how these effects are mediated by organic and elemental carbon components of PM. Dr. Kleinman's current research grants and contracts include a grant to examine the effects of inhaled particles on brain stem cells related to tumor development from the California Brain and Lung Tumor Foundation, a contract from the California Environmental Protection Agency to study the role of semi-volatile components of fine and ultrafine PM on cardiac function and atherosclerosis, and a contract to examine the effects of long term inhalation exposure to concentrated fine particles on brain inflammation. Dr. Kleinman has previously served on the U.S. EPA Clean Air Scientific Advisory Committee (CASAC) Ozone, PM and NO2 panels and was appointed to Chair the Scientific Review Panel for Toxic Substances for the state of California. Dr. Kleinman's current research focuses on neurological and cardiopulmonary effects of inhaled particles, including nanomaterials and ultrafine, fine and coarse ambient particles in humans and laboratory animals. His recent health effects studies have the role of inhaled combustion-generated particles on the promotion of airway allergies and acceleration of development of cardiovascular disease and how these effects are mediated by organic and elemental carbon components of PM. Dr. Kleinman is a co-Investigator on grants from NIH and NSF as well as contracts from the California Brain and Lung Tumor Foundation and from the California Environmental Protection Agency to study the role of semi-volatile components of fine and ultrafine PM on cardiac function, atherosclerosis, and effects of subchronic and chronic inhalation exposures to concentrated fine particles on brain inflammation.

Lange,Sabine

Texas Commission on Environmental Quality

Dr. Sabine Lange is the section manager for the Toxicology Division at the Texas Commission on Environmental Quality (TCEQ). Dr. Lange's responsibilities include overseeing health effects risk assessments of air permit applications, ambient air monitoring projects, and hazardous waste sites; overseeing the development of chemical toxicity factors; and conducting and overseeing systematic reviews and independent analyses of risk assessments. Dr. Lange serves as a technical resource for the State and citizens of Texas for human health and environmental risk assessment, especially related to air and water quality. Dr. Lange's research interests include the toxicology of criteria air pollutants, particularly ozone dosimetry and exposure-response. In this area she has published articles, given invited talks, presented posters, and served as a workshop panel member. On behalf of the TCEQ, she has intensively reviewed the documents released by the US EPA on the National Ambient Air Quality Standards (NAAQS) for ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and lead. Dr. Lange and colleagues have provided comments to the US EPA on the assessment documents supporting these standards, particularly as they relate to principles of toxicology, risk assessment, and the State's perspective on these rules. Dr. Lange's work since joining TCEQ has been entirely funded by the State of Texas.Dr. Lange received a Bachelor's degree from the University of Western Ontario in Canada, and completed a Ph.D. and post-doctoral training in biochemistry and molecular carcinogenesis at the University of Texas at Houston and MD Anderson Cancer Center. Dr. Lange is a Diplomate of the American Board of Toxicology.

Lefohn,Allen

A.S.L. & Associates, LLC

Dr. Allen S. Lefohn is currently President and Founder of A.S.L. & Associates, LLC in Helena, Montana. From 1981 until 2017, he served as President and Founder of A.S.L. & Associates, a Montana corporation. He received his Bachelor's degree from UCLA in 1966 and a Ph.D. in physical chemistry from the University of California at Berkeley in 1969. His advisor was Professor George C. Pimentel. For the period 1989 – 1999, he served as an Executive Editor of the internationally recognized journal Atmospheric Environment and is an Emeritus Editor of the Journal. Dr. Lefohn has published approximately 125 peer-reviewed publications, edited four books, presented numerous oral papers, and participated in panel presentations. During a career spanning over 50 years, his research has focused on (1) understanding the importance of background ozone in relation to ambient concentrations, (2) developing exposure-response relationships and indices that describe the effects of ozone on vegetation and human health, (3) investigating biological mechanisms that define the nonlinearity (i.e., weighting of the higher concentrations more than the mid- and low-level values) response to ozone for both human health and vegetation, and (4) integrating results from the EPA's air quality database for (a) characterizing co-occurrence patterns of criteria air pollutants under ambient conditions (e.g., ozone, sulfur dioxide, and nitrogen dioxide), (b) characterizing ozone trend patterns, and (c) designing research experiments that utilize realistic ambient exposures for assessing human health and vegetation effects. For 19 years, Dr. Lefohn has worked with the American Lung Association in characterizing ambient ozone and particulate matter data for the organization's annual State of the Air report. His research results have also been applied by the EPA. Between 2007 and 2015, EPA staff, CASAC, and the EPA Administrator considered the application of an exposure metric, the W126 exposure index, as the federal standard to protect vegetation. Dr. Lefohn created the exposure metric in 1985 with the help of the first-generation Apple Macintosh computer and described the metric in the peer-review literature in 1987 and 1988. In October 2015, the EPA Administrator announced that the 8-h ozone standard would be used as a surrogate for the protection of vegetation; the EPA continues to use the W126 metric as an indicator of the potential risk of ambient ozone exposures to vegetation. Dr. Lefohn is familiar with the EPA's rulemaking process. He was the lead consultant scientist for the EPA in authoring the air quality characterization chapter and the vegetation exposure-response section for the Ozone Criteria Document in 1996 and contributed to the Ozone Criteria Documents in 1985 and 2006. Dr. Lefohn presented testimony in March 2015 to the House Committee on Science, Space, and Technology about background ozone. In 2015, Dr. Lefohn was a co-guest editor for the Atmospheric Environment special issue: Observations and source attribution of ozone in rural regions of the Western United States. Dr. Lefohn is currently on the Steering Committee of the important international research effort, Tropospheric Ozone Assessment Report (TOAR). The project provides the international research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause. Dr. Lefohn is the lead author (with 23 additional co-authors) of the TOAR paper, Global Ozone Metrics for Climate Change, Human Health and Crop/Ecosystem Research, which was published in April 2018 and is available online. Dr. Lefohn is currently an Adjunct Professor of Environmental Engineering at Montana Tech in Butte, Montana. He is a member of the AAAS. For the past two years, Dr. Lefohn's funding sources for his research activities have originated from the American Lung Association and his own company, A.S.L. & Associates.

Lewis,Timothy

U.S. Army Corps of Engineers

Tim Lewis is a supervisory research ecologist with the U.S. Army Corps of Engineer, Engineer Research and Development Center, Environmental Laboratory in Vicksburg, MS. He worked for Lockheed Engineering, primary contractor for the U.S. EPA, serving as Project Leader and Principal Scientist on studies related to the National Surface Water Survey, the Direct Delayed Response Project (soil acidification), and the Environmental Monitoring and Assessment Program (EMAP). He accepted a position with the Bureau of Land Management in 1993 and served as the National Indicator Development Coordinator for the U.S. EPA's EMAP - Forest Health Monitoring program. He edited and authored a CRC Press book entitled Tree Rings as Indicators of Ecosystem Health. He went on to become Effectiveness Monitoring Coordinator for the Northwest Forest Plan. In 1996 Tim became the first Director of the Forest Science Project at Humboldt State University, where he applied his regional aquatic and terrestrial monitoring experience to private and public lands in Northern California. In 2001, Dr. Lewis accepted a position as senior ecologist with the U.S. EPA's National Center for Environmental Assessment, where he was involved in the assessment of ecological risks due to air pollutants. He served as associate editor of the premier journal Ecological Indicators during its startup. In 2007 Tim joined the Environmental Laboratory at the USACE's Engineer Research and Development Center in Vicksburg, MS as Chief for the Aquatic Ecology and Invasive Species Branch. The branch is actively engaged in ecosystem restoration and the assessment of the impact of Corps projects on habitat for threatened and endangered species and prevention and reduction of impacts of invasive plants and animals in the nation's waterways. EducationB.A., West Chester University, West Chester, PA, 1977, Biology M.S., Rutgers University, New Brunswick, NJ, 1980, Plant Pathology Ph.D., Rutgers University, New Brunswick, NJ, 1984, Environmental Science

Masuca,Corey

Jefferson County Department of Health

Corey Masuca, PE, PhD, JD is currently the Principal Air Pollution Control Engineer with the Jefferson County Department of Health. As the leader of the Air Pollution Control Program with the Jefferson County of Health he is responsible for overseeing a staff of approximately 35 persons who responsibilities include regulating industrial sources of emissions, area and point sources of emissions such as dry cleaners/gasoline stations and open burning, respectively. In addition, he oversees the ambient air monitoring program which is responsible for measuring air contaminant concentrations within Jefferson County, Alabama to ensure compliance with healthy clean air standards set by the United States Environmental Protection Agency (USEPA). Since he graduated from Auburn University with a Bachelor of Chemical Engineering degree, he has continued to work in the environmental arena, specifically air quality and air pollution. As a student at Auburn University, he completed a cooperative education program rotation with the Tennessee Valley Authority in Muscle Shoals, Alabama where he completed stack testing of fertilizer plant residuals including stack testing equipment preparation and calibration. After he graduated from Auburn University, he was employed as an Environmental Engineer with the State of Connecticut Department of Environmental Protection where he regulated sources of air pollutant emissions and was responsible for the implementation of a major new air regulatory USEPA program as part of the 1990 Clean Air Act Amendments. Following his tenure with the Connecticut Department of Environmental Protection, he worked as a consulting engineer with the environmental consultant firm, CH2M Hill, in the Atlanta, Georgia area. With CH2M Hill, he prepared air program applications for several industrial air-polluting facilities applying for applications to operate. This involved extensive regulatory review and complex, mathematical calculations to determine compliance and/or regulatory applicability. Next, he returned to Alabama where he worked an Environmental Engineer with the Alabama Department of Environmental Management where he continued his work as an Environmental Engineer where he was responsible for permitting, determining compliance, inspecting, and initiating enforcement actions, where applicable, of industrial sources of air pollution. Finally, he was initially employed as an Air Pollution Control Engineer with the Jefferson County Department of Health where, again, his primary duties entailed permitting, determining compliance, inspection, and initiating enforcement actions of industrial sources of air pollutant emissions. While with the Jefferson County Department of Health, he continued his professional and academic pursuits where he was promoted to the position of a Senior Air Pollution Control Engineer, became a registered/licensed Professional Engineer with the State of Alabama, and obtained a doctoral degree in Environmental Health Engineering from the University of Alabama in Birmingham. His doctoral degree research consisted of completing an epidemiology study of air pollutant concentrations and pre-term birth defects for populations within Atlanta, Georgia. After obtaining his doctoral degree and while still working full-time as a Senior Air Pollution Control Engineer with the Jefferson County Department of Health, he was also employed an adjunct professor both with the University of West Alabama (where he continues to be an advisory board member for the Environmental Sciences section of the Biology Division) and with the University of Phoenix (Birmingham campus). He taught classes in environmental science, environmental ethics, and general environmental air pollution health effects with both the University of Phoenix (Birmingham campus) and the University of West Alabama. In addition, during and subsequent to this time, he acted as a professional consultant providing air pollution data and review/analyses for three (3) epidemiological studies being performed/conducted by the University of Alabama at Birmingham, School of Public Health, Department of Epidemiology, which involved determining the relationship between ambient air pollution and emergency room visits for cardiovascular disease in Jefferson County, Alabama; ambient air pollution and emergency room visits for respiratory disease among adults in Jefferson County, Alabama; and ambient air pollution and respiratory diseases in children in Jefferson County, Alabama. During and subsequent to this time, he was promoted to his current position of Principal Air Pollution Control Engineer with responsibility for all of the various components of the Health Department's Air Pollution Control Program. Following his teaching stints with the University of West Alabama and with the University of Phoenix (Birmingham campus), all the while still being employed with the Health Department, he undertook an initiative to pursue as Juris Doctorate degree from the Miles College School of Law in Birmingham. He completed his requisite law studies and recently graduated from law school (May 2018). He is still employed as the Principal Air Pollution Control Engineer with the Jefferson County Department of Health Air Pollution Control Program and is currently planning to sit for the Alabama State Bar in July 2018, after which he will continue to work at/with the Health Department in a lead scientific and administrative capacity, and, hopefully, legal capacity subsequent to passing the Alabama State Bar.

Moore, Jr.,Charles Thomas (Tom)

Western States Air Resources Council - Western Regional Air Partnership

Mr. Tom Moore works for the 15 state air agency members of the Western States Air Resources (WESTAR) Council. He is the manager of the Western Regional Air Partnership (WRAP) air quality program, a voluntary partnership of states, tribes, federal land managers, local air agencies and the U.S. EPA, whose purpose is to provide technical support to understand current and evolving regional air quality issues in the context of the Clean Air Act (CAA) and the National Environmental Policy Act (NEPA). His regional analysis and planning support work is conducted through management of a series of interrelated contractor-supported regional projects for the WESTAR and WRAP membership, related to western U.S. air quality. These diverse, complex, and highly technical projects cover ambient monitoring data analysis, emissions inventory preparation and analysis, regional photochemical grid modeling and source apportionment results, and satellite air quality data.

Morris,Vernon

Howard University

Dr. Morris is a Professor in the Department of Chemistry, Director of the Atmospheric Sciences Program at Howard University. He serves as the PI and Director of a NOAA cooperative science center for Atmospheric Sciences at Howard University. He also maintains an adjunct appointment in the Environmental Engineering Program. Dr. Morris received BS degrees in chemistry and mathematics from Morehouse College and a PhD in Earth and Atmospheric Sciences from the Georgia Institute of Technology. He has completed advanced study in Sicily (Erice), at the Lawrence Livermore National Laboratories, and as a Presidential Postdoctoral Scholar at the University of California (Davis). Beginning with an NSF CAREER award in 1997, Dr. Morris has raised more than $60M in external research funding, founded the Atmospheric Sciences Program, which is already a national leader in the production of minority PhDs in the field, and helped guide the success of multiple NOAA and NASA-funded research centers. Recent funding includes several grants from NOAA and the National Science Foundation. Dr. Morris has guided the research for more than 150 students at the graduate, undergraduate, and high school levels, published over 75 refereed papers, book chapters, and conference proceedings, ranging from quantum chemistry to the impacts of lightning in tropical Africa, and has made over 100 invited talks and national conference presentations. The research themes that guide his current research are (i) the impact of mineral dust aerosols on global atmospheric chemistry and climate, (ii) the role and influence of tropospheric aerosols on regional environmental health, and (iii) the interplay between weather phenomena (e.g. dust storms, lightning, and precipitation) and atmospheric chemistry, i.e. "chemical meteorology". Dr. Morris has won numerous academic and scientific honors and awards including being recognizedas one of the 50 Most Influential Blacks in Science and Technology in 2011, inducted as a History Maker in Science in 2012, winning the NOBCChE Henry Cecil McBay Outstanding Teacher Award (2012), a Fulbright Specialist Award (2013), elected a Fellow of the American Meteorological Society (2016), and the Charles Anderson Award of the AMS in 2017. Dr. Morris is a member of the AMS, AGU, and the National Society of Black Physicists (NSBP). He has previously served on several national advisory committees including the Department of Energy ARM Science Board (2015 – 2017), the District of Columbia STEM Advisory Council (2011 – 2014), the UNESCO steering committee for the "Application of Remote Sensing for Integrated Management of Ecosystems and Water Resources in Africa", the National Academies of Sciences Board on Atmospheric Sciences and Climate (BASC) (2005 – 2007), and Member of the NASA Earth Systems Sciences and Applications Advisory Council, (ESSAAC) (2003 – 2005).

Morris,William

Efficient Fuel Additives

Dr. Morris completed his Ph.D. and M.S. in chemical engineering at the University of Utah examining the effect of pollutants such as NOX, SOX, and particulate matter on aerosol formation in air and oxy-fired combustion. He also holds a coordinate A.B. in Physics and Environmental Studies with a minor in History from Bowdoin College. He is currently President of Efficient Fuel Additives where he provides fuel additives and technical services to promote energy efficiency, use of alternative fuels, and utilization of agricultural waste biomass resources. He is also contracted by the Wyoming Integrated Test Center (ITC) as Program Director to provide engineering and business development support services for CO2 management technologies related to the ITC. The ITC facility, which was recently completed, is a public/private venture between Basin Electric Power Cooperative, Tri-State G&T, the National Rural Electric Cooperative Association, Black Hills Power, and the state of Wyoming through the Wyoming Infrastructure Authority. The research facility can provide up to 20 MW equivalent of flue gas for post combustion CO2 capture testing as well as 5 small 0.4 MWe test bays which will host the NRG COSIA Carbon XPRIZE CO2 utilization competition.Additionally, in a consultative capacity, he has provided engineering and technical advice for to private and government entities in the U.S. and S. Korea. As an employee of ADA Environmental Solutions, he worked in the areas of mercury emissions control, CO2 capture, NOX control, and is the listed inventor on 3 issued NOX, mercury, and CO2 emissions control patents as well as other patents pending. He was also a contributing author to the oxy-fuel combustion section of the National Coal Council's report, Fossil Forward in 2015 for then Department of Energy Secretary of Energy Ernest Moniz providing an update on CO2 capture technologies. His primary area of expertise is in combustion by-product formation such as NOX and particulate matter as well as emissions controls for mercury and CO2. He has conducted basic research, small pilot research, and commercial scale demonstrations and trials of various mercury, NOX, and emissions control technologies with both private industry and universities. Previous partners have included University of Utah, University of California Berkeley, Texas A&M University, Lehigh University, Southern Company, Aspen Aerogels, The University of Akron, the Electric Power Research Institute, the National Energy Technology Laboratory, the U.S. Department of Energy and other private industry companies. In addition, he has been a peer reviewer for the journals of American Chemical Society as well as Elsevier Publishing.

Packham,Steven

Utah Department of Environmental Quality

Dr. Steven Packham is an inhalation toxicologist with 28 years of regulatory experience with the Utah Division of Air Quality. Foremost among his responsibilities has been public education and communication of the scientific basis and intent of USC Title 42, Chapter 85 (particularly Sections 7409 and 7412): To protect human health with an ample margin of safety "requisite to protect" public health. His actual regulatory experience includes: Preparation of case-specific HAPs residual risks and leaking underground storage tank vapor intrusion risk assessments. Development of State Implementation Plans. State adoption of Federal NESHAP MACT's, and annual reviews of Utah's NATA Urban Air Toxics program. His research has focused on causal biologic mechanisms of dose-dependent health effects from breathing air pollution. He has developed a model to estimate margins of safety for mobile app users based on EPA Air Quality Index (AQI) values for sensitive and normal groups who may wish to engage in fitness improvement training and enjoy physical recreational activities outdoors under fluctuating air quality conditions. Dr. Packham is an Adjunct Associate Professor in the University of Utah College of Health Sciences Department of Family and Preventative Medicine and a member of the Advisory Board of the Rocky Mountain Center for Occupational and Environmental Health in Salt Lake City. Past professional activities include: Editorial Board, Journal of Fire Sciences. Chairman, American Society for Testing and Materials (ASTM) Task Group E5.21.05. Member, Toxicity Advisory Committee National Fire Protection Association. Member, ASTM Committee on Toxic Hazard Assessment of Materials used in Transportation Vehicles. United States of America Member, Technical Advisory Committee, ISO/TC 92/SC 3. Convener: ISO Technical Committee 92, Subcommittee 3, Working Group 1 on Fire Model. United States of America Assigned Expert: ISO/TC 92/SC 3/Working Group on Bio-assays.

Pair,Benson

KBR

Mr. Benson Pair is currently the Chief Technology Engineer- Environmental for KBR, located in the Houston Office. He has held this position for 29 years, since he joined KBR, then the M.W. Kellogg Company, in 1988. Prior to joining KBR, Mr. Pair spent 16 years with Engineering Science, Inc., environmental engineers and consultants, in their Houston Office, serving as Office Manager the last five years. He graduated from Rice University with two degrees in Chemical Engineering, a B.A. and an M.Ch.E, both degrees awarded in 1972. Mr. Pair is a registered Professional Engineer in the State of Texas and a Board Certified Environmental Engineer (BCEE). He is a member of the American Institute of Chemical Engineers (AIChE), the American Academy of Environmental Engineers and Scientists (AAEES) and the Water Environment Federation. Mr. Pair has served as an officer in the Water Environment Association of Texas (WEAT) holding every office in the Southeast Texas Section. He served as Chair of the Environmental Division of the AIChE, and served on the Programming Committee of AIChE. Mr. Pair is currently the AIChE representative on the Board of Trustees of the AAEES. This marks the second time he has been asked to serve in that position. Mr. Pair has nearly 46 years of experience in Environmental Engineering, all of it spent in providing consulting and engineering services to the hydrocarbon processing industry. He has executed projects involving air pollution control, wastewater treatment and solid waste management. Mr. Pair has been responsible for all phases of a project, from site selection studies through start up and commissioning. He has conducted bench scale and pilot scale treatability studies, and designed treatment plants. Mr. Pair has completed projects located in over a dozen States and ten foreign countries, giving him a working knowledge and appreciation of the regulatory requirements of a broad range of local, state and federal agencies, as well as international lending institutions. His career began shortly after the passage of the Clean Air Act in 1970 and the Clean Water Act in 1972. Mr. Pair has followed the development of air pollution control and wastewater treatment technologies for nearly five decades, applying these technologies to achieve regulatory compliance in a cost effective manner.

Paulson,Suzanne

University of California Los Angeles

Dr. Suzanne Paulson is Professor in the Department of Atmospheric & Oceanic Sciences, and Professor in the Institute of the Environment at UCLA, where she serves as the director of the Center for Clean Air. She earned a B.A. in Chemistry from the University of Colorado, an MS in Plant Biology from the University of Illinois, and an MS and PhD in Environmental Engineering Science from the California Institute of Technology. She was an Advanced Study Program Postdoctoral Fellow at the National Center for Atmospheric Research in Boulder, Colorado. Currently she investigates the impact of aerosol particles on human health and in clouds. She is also studies the influence of the built environment (sound walls, vegetation, cityscape design and traffic control) on pollution levels in urban areas at block and sub-block scales, including. She did extensive earlier work on ozone-alkene chemistry and aerosol optical properties, and has also conducted research projects in indoor air, biofuel emissions, and bioaerosol among others. Currently Dr. Paulson serves on the Research Screening Committee for the California Air Resources Board. Until recently she also served as an Airport Commissioner for the City of Santa Monica. She is a member of the American Association for Aerosol Research, the American Association for the Advancement of Science, the American Chemical Society and the American Geophysical Union.

Randolph,Dennis A.

City of Grandview

Mr. Dennis A. Randolph, P.E. is the Public Works Director for Grandview Missouri and Adjunct Instructor at the University of Missouri – Kansas City. He holds B.S. and M.S. degrees in civil engineering from Wayne State University as well as an MPA from Western Michigan University. He previous taught at Western Michigan and Wayne State, and has been a full-time local government engineer for over 40 years. His interests span a broad range emphasizing applied research that brings results to local communities. His current emphasis area is the impact of air, noise, and water pollution on Environmental Justice communities. Currently, he is responsible for leading technical work involved with litigation concerning the administration and permitting under the Clean Air Act. In conjunction with the air quality modelling work he led an effort to study noise along a newly designated interstate road to evaluate the cumulative impacts on the same Environment Justice communities. Mr. Randolph's current research has been supported by funding from the City of Grandview; Mr. Randolph has received no external research funding for this work from either federal of state government agencies, private companies, or foundations. Over the years Randolph has led work in solid waste management, surface and groundwater pollution and management, rural and urban sewage handling and treatment, and brownfield cleanup. He has formed collaborations between university faculty and local communities to investigate a wide-range of problems and to conduct field trials. He conducted a large county-funded project to trace multiple salt plumes through a rural. He was responsible for technical review of a $100 million wastewater treatment plant upgrade and managed several large combined sewer separation projects, and community sewage lagoon upgrades. He is managing a sanitary sewer inflow and infiltration (I&I) study to identify problem areas as well as a study of storm sewer pipe condition using robotic sensors. He obtained voter-approved funding for a $15 million brownfield cleanup of several abandoned industrial sites, and two $200,000 U.S. Environmental Protection Agency cleanup grants to identify and test suburban and rural sites. He has led countywide solid waste recycling efforts, been a flood plain administrator, and led efforts to incorporate stormwater Best Management Practices in construction projects, and been responsible for soil erosion and sedimentation regulation enforcement for several communities. He has led safety studies as a Principal Investigator on Federal Highway funded research and served on several National Cooperative Highway Research Program projects. He has also provided several grants to university departments to provide funding for focused research on local government engineering problems and is currently providing funding for a study of road asset management with the University of Missouri – Columbia, Civil Engineering Department. Mr. Randolph Is a Registered Professional Engineer in four States, a Public Works Leadership Fellow (APWA), and was recently selected as one of 2015's Top Ten Public Works Officials (APWA). He is a member of several American Society of Civil Engineers (ASCE) committees including the Public Agency Peer Review Committee. His other current committee work includes the ASCE Infrastructure Resilience Division SPEED Committee, and the Institute of Sustainable Infrastructure, where the work focuses on the topics of resilience and sustainability of infrastructure. He is a Life Member of the Institute of Transportation Engineers, American Society of Civil Engineers, and Institute of Electrical and Electronics Engineers. He has written nearly ninety articles and publications including a number of peer reviewed articles. He has authored two books and been the executive editor on a third.

Sheppard,Elizabeth A. (Lianne)

University of Washington

Dr. Elizabeth A. (Lianne) Sheppard, PhD is Professor and Assistant Chair in the Department of Environmental and Occupational Health Sciences and Professor of Biostatistics at the University of Washington. She holds a B.A. in psychology and a Sc.M. in biostatistics from Johns Hopkins University, and a Ph.D. in biostatistics from University of Washington. Her research interests focus on modeling and understanding the health effects of environmental and occupational exposures with particular emphasis on statistical methods for environmental and occupational epidemiology. She actively collaborates on a variety of research projects in the environmental and occupational health sciences and has been lead statistician for the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air) study, a 10-year study funded by EPA to determine the effect of long-term air pollution exposure on subclinical progression of cardiovascular disease. Dr. Sheppard directs a NIEHS-funded program for quantitative training in the environmental health sciences. Her recent research funding comes from EPA, NIEHS, NIOSH, and the Health Effects Institute. She is a fellow of the American Statistical Association and a member of the editorial board for Epidemiology. She serves on the Health Effects Institute's Review Committee, and has advised EPA through service on several Clean Air Scientific Advisory Committee special panels and Science Advisory Board ad hoc committees.

Sorooshian,Armin

University of Arizona,Department of Chemical and Environmental Engineering

Armin Sorooshian is an Associate Professor, University Distinguished Scholar, and da Vinci Fellow at the University of Arizona in the Departments of Chemical and Environmental Engineering, Hydrology and Atmospheric Sciences, and Public Health. He received his B.S. (2003) in Chemical Engineering at the University of Arizona, and a M.S. (2005) and Ph.D. (2008) in Chemical Engineering at the California Institute of Technology. Armin specializes in aerosol physics and chemistry, in addition to aerosol-cloud interactions. Armin is involved with projects including instrument development/characterization, surface/ship/airborne field measurements, and the use of data from models of varying complexity and remote sensing measurements. His sources of funding in the past two years include the Office of Naval Research, NASA, and the National Institute of Environmental Health Sciences. He is a member of the following professional societies: American Geophysical Union (AGU), American Institute of Chemical Engineers (AICHE), American Meteorological Society (AMS), and American Association for the Advancement of Science (AAAS).

Stuart,Amy

University of South Florida

Amy L. Stuart, Ph.D. is a Professor at the University of South Florida (USF) in the Department of Environmental and Occupational Health, College of Public Health. She holds a joint appointment in the Department of Civil and Environmental Engineering, and courtesy appointments in the Center for Urban Transportation Research, and the Patel College of Global Sustainability. She is also the founder and director of the Graduate Certificate Program in Environmental Health at USF. Dr. Stuart earned a BS in chemical engineering, a MS in civil engineering, and a PhD in civil and environmental engineering from Stanford University. She completed postdoctoral training at the Center for International Security and Cooperation at Stanford. Dr. Stuart leads multi-disciplinary research and teaching initiatives related to air pollution, public health, and environmental sustainability. Her research has contributed to understanding the impacts of urban design and transportation on air pollution exposures and their social distribution, the fate of volatile chemicals during cloud freezing, mercury contamination and exposures, and associations between air pollution and birth defects, resulting in over 100 scholarly publications. During the last two years, Dr. Stuart's work has been funded by the National Institute of Environmental Health Sciences and by the United States Department of Transportation. She is also a previous recipient of a National Science Foundation Career award. Dr. Stuart is professionally involved in the Association of Environmental Engineering and Science Professors, currently serving on the Lectures Committee. She is a member of the Air and Waste Management Association, including previous service as the Chair of the Student Awards Committee of the Higher Education Council, and is a member of the International Society of Exposure Sciences. She regularly serves as a reviewer of manuscripts for several scientific journals and of proposals for grant sponsors on air pollution topics.

Wagner,James

Michigan State University

Dr. Wagner is an associate professor in cardiopulmonary toxicology in the Department of Pathobiology and Diagnostic Investigation at Michigan State University. He earned a bachelor's degree in biochemistry, a master's degree in business administration in management science, and a PhD in pharmacology and toxicology. His post-doctoral training focused on comparative pathology and air pollutant exposure. Current research efforts are focused on conducting translational studies to understand the mechanisms of airway injury and systemic responses induced by inhalation exposures to pathogens, toxicants, and environmental pollutants. Mechanistic studies are designed to address exposure related changes to respiratory, cardiovascular, immunological, and nervous systems. Dr. Wagner has over 20 years of experience conducting both field- and laboratory-based, animal inhalation exposure studies across the country, and have relied on approaches of digital pathology, cardiovascular telemetry, pulmonary function testing, and genomic analyses in multiple transgenic and strain-sensitive rodents to understand the histopathological, biochemical, and physiologic responses to inhalation exposures. From his 77 research publications, he has been fortunate to collaborate with over 90 different coauthors from 8 units at Michigan State University and over 30 national and international laboratories. Sources of research funding in the past two years have included the National Institutes of Health (NIH), the State of Michigan, and the European Union, although previous funding sources (> 3years ago) have included the Health Effects Institute (HEI), EPA, and the American Chemistry Council (ACC). He recently contributed to the writing and review of EPA's integrated science assessment (ISA) for PM2.5 from 2015-16. Dr. Wagner has provided review and consultation for other national and international agencies, including Health Canada's Human Health Risk Assessment for Gasoline Exhaust, the EPA's ISA for both ozone and for sulfur oxides, the National Research Council's report on Submarine Air Quality, and the Japan Automotive Research Institute's strategic priorities planning. As a member of the TLV-Chemical Substance Committee for the American Conference for Governmental and Industrial Hygienists (ACGIH), he evaluates toxicological and epidemiological data to conduct risk assessment and make exposure recommendations for a variety of airborne workplace chemicals. Dr. Wagner is an active member in the Society of Toxicology where he served leadership positions in Finance, Inhalation and Respiratory Toxicology, and Cardiovascular Toxicology groups. He is a frequent panel member for proposal peer review for NIH (Children's Health Centers, Superfund Program) and CDC (World Trade Center Research Program). Lastly, Dr. Wagner is active on editorial boards of journals with a focus on air pollutant toxicology, including Inhalation Toxicology and Particle and Fibre Toxicology, and he regularly conducts peer review in Toxicological Sciences, Environmental Health Perspectives, Atmospheric Environment, and Science of the Total Environment, among others.

Waldman,Deane

Texas Public Policy Foundation

Dr. Deane Waldman, MD MBA, is a U.S. citizen and currently the Director of the Center for Health Care Policy at the Texas Public Policy Foundation as well as a Director on the Board of the New Mexico Health Insurance Exchange. He is Professor Emeritus of Pediatrics, Pathology, and Decision Science. "Dr. Deane" was educated and trained at Yale (BA, History), Chicago Medical School (MD), Mayo Clinic, Northwestern, Harvard, and Anderson Graduate Schools of Management (MBA). He practiced medicine as a pediatric cardiologist for 37 years, and was the Chief of Cardiology (Pediatric) at University of Chicago. Dr. Deane is an experienced biomedical scientist with more than 120 peer-reviewed medical research citations, over $3 million in research grants received, more than 300 publications in healthcare policy, as well as the author of nine books.Dr. Deane's scientific expertise along with nearly four decades of caring for patients, coupled with his administrative experience and practical business knowledge gives him a unique perspective. Dr. Deane's goal as a member of CASAC would be to assure that EPA standards for Clean Air are based on reliable science and that the Administrator can connect Clean Air standards to the health status of Americans.

Message

From: Tony Cox [tcoxdenver@aol.com]
Sent: 10/19/2018 1:38:45 AM
To: Sean Reilly [sreilly@eenews.net]
CC: Yeow, Aaron [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=613120791828428b8cbfd6178910d97e-Yeow, Arron]
Subject: Re: CASAC

Thank you, Sean!

Best,

-- Tony

On Oct 18, 2018, at 4:42 PM, Sean Reilly <sreilly@eenews.net> wrote:

Hi Tony:

Here is the final version of the story, which was just updated: https://www.eenews.net/greenwire/stories/1060103681/. As in the past, I've pasted the text below in case our subscriber paywall blocks the link from opening. Thank you again for your assistance; please let me know if you have any further thoughts or comments.

Regards,

Sean

AIR POLLUTION

U.S. Chamber's pick landed gavel of key EPA advisory panel

Sean Reilly, E&E News reporter

Published: Thursday, October 18, 2018 <image001.jpg>

Dan Byers of the U.S. Chamber of Commerce pushed nominees for a group that advises EPA on clean air rules. National Coal Council/YouTube

This story was updated at 6:05 p.m. EDT.

The U.S. Chamber of Commerce, which regularly opposes tougher environmental regulations, last year succeeded in placing one of its candidates on a key EPA air quality committee, newly released records show.

Then-EPA chief Scott Pruitt named Tony Cox, a Denver-based consultant, as chairman of the Clean Air Scientific Advisory Committee last fall after a senior U.S. Chamber executive nominated him for a seat on the panel, the records show.

The seven-member committee, often known by its acronym as CASAC, is charged with providing outside expertise to EPA during legally required reviews of the standards for a half-dozen common pollutants. It's now in the early stages of a closely watched assessment of the limits on airborne particulates.

In an email exchange, Cox said he did not know that the chamber was behind his nomination until E&E News contacted him late yesterday. Cox said he had no information on why the powerful business lobby chose him.

"I hope that it was because of my long-standing commitment to applying objective, transparent, data-driven science and analytics to address important risk analysis questions, along with my insistence on following wherever the data lead," he said.

Putting Cox's name in play was Dan Byers, vice president for policy with the chamber's Global Energy Institute. Byers referred questions yesterday to a spokesman, Matt Letourneau. In a statement, Letourneau said the chamber nominated "preeminent scientists who are experts in their fields with outstanding credentials for EPA's consideration. We had no discussion with these individuals about their views on any particular policy or science issue."

During the Obama administration, the chamber frequently challenged new environmental regulations. In 2013, for example, it went to court in an unsuccessful battle against EPA's decision to tighten particulate standards. It's also a plaintiff in a pending challenge to the agency's 2015 ground-level ozone changes and in a report has denounced limits imposed that same year on hazardous emissions from the brick industry (*E&E Daily*, Feb. 2, 2016).

Cox was among four candidates whom Byers recommended for CASAC, according to the EPA roster released yesterday. Pruitt instead appointed two of the others — air pollution researcher Robert Phalen and S. Stanley Young, an applied statistician from North Carolina — to the Science Advisory Board, another influential panel. Letourneau confirmed that the chamber had nominated the two men for those seats, as well, but had not asked for Cox to be named CASAC chairman.

Phalen is a professor of community and environmental medicine at the University of California, Irvine. Following his appointment to SAB last November, he came under fire for remarks in an earlier interview in which he said, "Modern air is a little too clean for optimum health."

In a letter to Pruitt early this year, Sens. Tom Carper (D-Del.) and Sheldon Whitehouse (D-R.I.) questioned whether both Cox and Young were fit to serve on their respective EPA panels, based on their scientific credentials and their prior work for the oil business and other polluting industries (*Greenwire*, Jan. 9).

"The news that the Chamber of Commerce wanted Mr. Cox to sit on the board, amplifies my concerns," Carper, the ranking member on the Senate Environment and Public Works Committee, said in a statement today after this story was initially posted online. "The Chamber lobbies Congress on behalf of some of the same companies Mr. Cox did work for."

Whitehouse, also an EPW Committee member, described the episode as further proof that EPA is now "thoroughly captured by industry," according to a separate statement released by a spokesman.

Phalen did not reply to emailed questions. Young has previously said he is retired and not employed by anyone. In an email today, Young added that he thought he had also nominated himself for both the CASAC and the Science Advisory Board.

"Many of the issues are statistical, and I'm considered an expert on statistics," he said.

Cox, whose specialty is risk analysis, noted that he has done work for EPA, the World Health Organization and universities, but said he did not recall providing services to the U.S. Chamber in the course of a 40-year career.

"I have made no commitments to anyone about CASAC," he said, "other than to the administrator and EPA to do my best to assure that we give objective, dispassionate, high-quality scientific advice without regard for politics, policy, or other considerations that go beyond science."

EPA had formally requested nominations for the Clean Air Scientific Advisory Committee in June of last year. The agency released the resulting list of about 130 candidates, as well as those who nominated them, yesterday, almost a year after E&E News requested the roster under the Freedom of Information Act.

The list shows that most of the candidates were university researchers nominated either by other researchers or EPA staff. The only other advocacy groups to make recommendations were the Energy and Environment Legal Institute, an industry-allied organization critical of tighter air pollution regulations, and the American Thoracic Society, which focuses on lung health issues. None of their respective nominees were chosen.

Besides Cox, Pruitt instead selected James Boylan, manager of planning and support for the Georgia Environmental Protection Division's air branch, and Larry Wolk, who was then the executive director of the Colorado Department of Public Health and Environment. Boylan nominated himself, the roster shows, while Wolk was the choice of Richard Yamada, a high-ranking political appointee at the time in EPA's Office of Research and Development.

The appointments drew unusual scrutiny because they were among the first made by Pruitt under a policy barring active EPA grant recipients from serving on agency advisory committees.

In all, Yamada offered about 10 nominations. They ranged from Mark Frampton, a retired professor of medicine at the University of Rochester who was named to CASAC last week, to Michael Rohan, an orthopedic surgeon in Panama City, Fla.

Carper and Whitehouse have also questioned Yamada's role in the selection process. EPA documents showed that he overrode the advice of EPA career staff in pushing for the appointments to Cox and Wolk to the committee, the two lawmakers wrote in a February letter asking the Government Accountability Office to look into whether such involvement was typical (*E&E Daily*, Feb. 15).

Yamada recently left EPA to take a job at the Defense Department. Efforts to reach him were unsuccessful

From: tcoxdenver@aol.com <tcoxdenver@aol.com>
Sent: Thursday, October 18, 2018 10:54 AM
To: Sean Reilly <sreilly@eenews.net>
Cc: Yeow.Aaron@epa.gov
Subject: Re: CASAC

Thanks, Sean,

-- Tony

-----Original Message-----
From: Sean Reilly <sreilly@eenews.net>
To: tcoxdenver <tcoxdenver@aol.com>
Cc: Yeow.Aaron <Yeow.Aaron@epa.gov>
Sent: Thu, Oct 18, 2018 8:52 am
Subject: RE: CASAC

Received, Tony. I'll forward a copy of the story when it posts this afternoon.

Regards,
Sean

From: tcoxdenver@aol.com <tcoxdenver@aol.com>
Sent: Thursday, October 18, 2018 10:26 AM
To: Sean Reilly <sreilly@eenews.net>
Cc: Yeow.Aaron@epa.gov
Subject: Re: CASAC

Yesterday, when I received your e-mail.

I was contacted by EPA a little over a year ago to ask whether I would willing to serve in this role, but did not know who had nominated me until I learned it from you.

Best,

-- Tony

-----Original Message-----
From: Sean Reilly <sreilly@eenews.net>
To: tcoxdenver <tcoxdenver@aol.com>
Cc: Yeow.Aaron <Yeow.Aaron@epa.gov>
Sent: Thu, Oct 18, 2018 4:48 am
Subject: RE: CASAC

Tony:

Thank you for the correction on the silica issue; I misread a Bloomberg article. One other question: When/how did you become aware that the Chamber had nominated you for a seat on the CASAC?

Regards,
Sean

From: tcoxdenver@aol.com [tcoxdenver@aol.com]
Sent: Wednesday, October 17, 2018 11:14 PM
To: Sean Reilly
Cc: Yeow.Aaron@epa.gov
Subject: Re: CASAC

Sean, I do not believe that I was ever sounded out by anyone in the Chamber. I am not currently doing any work for them. I do not recall ever providing services to them, although I recognize that 40 years of consulting and research is a long time.

You mentioned past work that you said I had done for the Chamber on issues such as OSHA's silica dust regs. My own recollection is that I did that work for the Crystalline Silica Panel of the American Chemistry Council. I am not sure how or whether they are connected to the Chamber, but I have not considered the Chamber a client. (My publications on crystalline silica list clients whose support made my research possible, but I do not believe the Chamber is one of them.)

Best,

-- Tony

-----Original Message-----
From: Sean Reilly <sreilly@eenews.net>
To: tcoxdenver <tcoxdenver@aol.com>
Cc: Yeow.Aaron <Yeow.Aaron@epa.gov>
Sent: Wed, Oct 17, 2018 7:31 pm
Subject: RE: CASAC

Hi Tony:

I appreciate your getting back to me so quickly; this is very helpful. Just to make sure that I've understood correctly, is it accurate that neither Mr. Byers nor anyone else affiliated with the Chamber first sounded you out before nominating you for the CASAC? If so, when did you become aware that you were a candidate?

Also, as I'm not familiar with the application of federal ethics requirements to special government employees and am likely to get this question from an editor, are you currently doing any work for the Chamber? If not, when did you last provide any services to the Chamber, and in what capacity/subject area?

Thank you again,
Sean

From: tcoxdenver@aol.com [tcoxdenver@aol.com]
Sent: Wednesday, October 17, 2018 8:37 PM
To: Sean Reilly
Cc: Yeow.Aaron@epa.gov
Subject: Re: CASAC

Thanks, Sean. I was unaware of these details of the nomination process. I have no information about why Mr. Byers, or any other particular person or group, nominated me. (Although I do not know, I hope that it was because of my long-standing commitment to applying objective, transparent, data-driven science and analytics to address important risk analysis questions, along with my insistence on following wherever the data lead.)

I did not agree with anyone outside EPA to do anything for anyone as a condition of my nomination. I have made no commitments to anyone about CASAC, other than to the Administrator and EPA to do my best to assure that we give objective, dispassionate, high-quality scientific advice without regard for politics, policy, or other considerations that go beyond science.

To those who might question my objectivity, I would note first that the US EPA has an ethics program that I support and follow. Second, I have disclosed all potential conflicts of interest of which I am aware, including previous work for the EPA, USDA, WHO, industry, and universities. I am not beholden to any previous or current clients or organizations, as my only commitments as a consultant have been to discover and describe the truth as well as I can on matters involving various tyoes of risks. My views on

how best to pursue objective scientific truth about risks using data and analytics are extensively documented and published in the open literature.

Please leg me know if you have any other questions.

-- Tony

-----Original Message-----
From: Sean Reilly <sreilly@eenews.net>
To: tcoxdenver <tcoxdenver@aol.com>
Sent: Wed, Oct 17, 2018 6:05 pm
Subject: CASAC

Hi Tony:

I just wanted to let you know that we'll be running a story tomorrow based on newly obtained records that show you were nominated to CASAC last year by Dan Byers of the U.S. Chamber of Commerce.

Given that the Chamber has regularly opposed significant changes to air quality regs, such as the 2012 PM NAAQS, the 2015 Brick MACT, and the 2015 ozone NAAQS, what is your understanding of why Mr. Byers nominated you? Is it related to past work that you have done for the Chamber on issues such as OSHA's silica dust regs? Did you agree to do anything as a condition of the nomination? I will be sure to note your past comments that no decision has been made on potential revisions to the PM NAAQS, but how would you respond to those in the public health and environmental community who might question your objectivity as CASAC Chairman in conducting that review in light of your nomination by the Chamber?

My deadline 11:30 a.m. (ET) tomorrow.

Thanks very much,
Sean

Sean Reilly
Reporter
E&E News
Ph: 202-446-0433
Cell: 202-316-4596
Twitter: @SeanatGreenwire

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 10/11/2018 2:17:29 PM
To: jenstrom@ucla.edu
Subject: EPA Clean Air Scientific Advisory Committee

Dr. Enstrom,

Thank you for your interest in serving on the U.S. Environmental Protection Agency (EPA) Clean Air Scientific Advisory Committee (CASAC). EPA has completed the process of appointing members to this Committee and unfortunately we are not able to include you on the Committee. We received many nominations and appointments were constrained by committee size and balance of disciplinary expertise.

The CASAC can undoubtedly benefit from your expertise. Accordingly, we hope that we may consider you for service on future CASAC activities. Again, we appreciate your time and effort, and hope that you will consider working with the CASAC as new opportunities arise. Should you have any questions, please feel free to contact me by telephone or e-mail.

-Aaron

Aaron Yeow, M.P.H.
Designated Federal Officer
U.S. Environmental Protection Agency
Science Advisory Board
202-564-2050 (P)
202-565-2098 (F)

Mailing Address:
USEPA, 1200 Pennsylvania Avenue, NW, (1400R), Washington, DC 20460

Physical Location/Deliveries:
1300 Pennsylvania Avenue, NW, Suite 31150, Washington, DC 20004

Message

From: Yeow, Aaron [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=613120791828428B8CBFD6178910D97E-YEOW, ARRON]
Sent: 11/20/2018 1:58:32 PM
To: Dunlap, David [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=591eb15a268249dda0c05a7451f765c3-Dunlap, Dav]; Brennan, Thomas [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=78caa4c8d91743c887c1bb5dc8cdb369-Thomas Brennan]
Subject: RE: Revised CASAC Briefing
Attachments: CASAC FY 2019 List of Candidates-web.pdf

Here is the FY19 List of Candidates for CASAC with biosketches.

-Aaron

Aaron Yeow, M.P.H.
Designated Federal Officer
U.S. Environmental Protection Agency
Science Advisory Board
202-564-2050 (P)
202-565-2098 (F)

Mailing Address:
USEPA, 1200 Pennsylvania Avenue, NW, (1400R), Washington, DC 20460

Physical Location/Deliveries:
1300 Pennsylvania Avenue, NW, Suite 31150, Washington, DC 20004

From: Dunlap, David
Sent: Tuesday, November 20, 2018 8:56 AM
To: Brennan, Thomas <Brennan.Thomas@epa.gov>
Cc: Yeow, Aaron <Yeow.Aaron@epa.gov>
Subject: RE: Revised CASAC Briefing

Thank you for this info.

Can you please send the entire "most recent List of Candidates?" Deliberative Process / Ex. 5

Deliberative Process / Ex. 5

DDD

From: Brennan, Thomas
Sent: Tuesday, November 20, 2018 8:44 AM
To: Dunlap, David <dunlap.david@epa.gov>
Cc: Yeow, Aaron <Yeow.Aaron@epa.gov>
Subject: FW: Revised CASAC Briefing

Hi David,

Deliberative Process / Ex. 5

Tom Brennan
Acting Director, Science Advisory Board Staff Office
US Environmental Protection Agency

Desk # 202 564 6953
Mobile # 703 581 9300

From: Yeow, Aaron
Sent: Monday, November 19, 2018 11:21 AM
To: Brennan, Thomas <Brennan.Thomas@epa.gov>
Cc: Johnston, Khanna <Johnston.Khanna@epa.gov>
Subject: Revised CASAC Briefing

Tom,

Deliberative Process / Ex. 5

-Aaron

Aaron Yeow, M.P.H.
Designated Federal Officer
U.S. Environmental Protection Agency
Science Advisory Board
202-564-2050 (P)
202-565-2098 (F)

Mailing Address:
USEPA, 1200 Pennsylvania Avenue, NW, (1400R), Washington, DC 20460

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1300 Pennsylvania Avenue, NW, Suite 31150, Washington, DC 20004

Invitation for Public Comment on the List of Candidates
For the Environmental Protection Agency's
Clean Air Scientific Advisory Committee

June 11, 2018

The U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB) Staff Office announced in a Federal Register Notice on March 21, 2018, (83 FR 12383-12384) that it was inviting nominations of experts to be considered for the Administrator's appointment to the Clean Air Scientific Advisory Committee (CASAC). The CASAC provides independent advice, information and recommendations to the EPA Administrator on the scientific and technical aspects of air quality criteria and National Ambient Air Quality Standards (NAAQS). The SAB Staff Office sought nominations of experts to serve on the CASAC with expertise in: Air quality, biostatistics, ecology, environmental economics, environmental engineering, epidemiology, exposure assessment, medicine, risk assessment, and toxicology.

The SAB Staff Office received nominations for the attached 36 candidates based on their expertise and willingness to serve. We hereby invite public comments on the attached List of Candidates under consideration for appointment to the CASAC. Comments should be submitted to Mr. Aaron Yeow, Designated Federal Officer, at yeow.aaron@epa.gov no later than **July 2, 2018**. E-mail is the preferred mode of receipt. Please be advised that public comments are subject to release under the Freedom of Information Act.

FY19 Chartered CASAC Annual Membership

Berrocal,Veronica

University of Michigan

Dr. Veronica J. Berrocal is Associate Professor of Biostatistics at the University of Michigan. Her expertise and research interests are in spatial and environmental statistics and biostatistics, with a particular interest on development and application of statistical methods for environmental exposure risk assessment, particularly air pollution, weather and climate modeling, and their impact on health. Dr. Berrocal has also investigated assessment of the National Ambient Air Quality Standard for ozone using spatial statistical models and data from monitoring sites and an air quality model. Dr. Berrocal is the current core co-leader of the Integrated Health Sciences Core of the University of Michigan NIEHS-funded P30 center MLEEaD – Michigan Lifetime Environmental Exposure and Disease. She has also been and is co-Investigator on various NIH-funded and NSF-funded research projects investigating the effect of the physical and built environment on health, the impact of climate change on health, as well as studies on rheumatic diseases, brain cancer, and reproductive health among others. She has served as ad-hoc member of the EPA Federal Insecticide, Fungicide and Rodenticide Act Scientific Advisory Panel in December 2014, May 2015, and November 2017, and has served as member of an External Peer Review panel for EPA on the "Environmental Relative Moldiness Index (ERMI)" (October 2016) and on "Significant Impact Levels (SILs) for ozone and fine particle pollution" (September 2016). She is a member of the American Statistical Association (ASA), the International Society for Bayesian Analysis (ISBA), the International Biometrics Society (IBS), and the Association for Women in Mathematics. She has been the Chair of the Section on "Statistics and the Environment" of the American Statistical Association in 2017, and she is currently the Program Chair Elect for the Section of "Statistics in Epidemiology" of the American Statistical Association. Prior to joining the University of Michigan as faculty in 2010 as Assistant Professor, Dr. Berrocal earned a Ph.D. in Statistics at the University of Washington in 2007, was a postdoctoral research associate at the NSF-funded Statistical and Applied Mathematical Sciences Institute (SAMSI) in academic year 2009-2010, a postdoctoral fellow at Duke University, in the Department of Statistical Science and in the Children Environmental Health Initiative (CEHI) center in academic year 2008-2009, and a National Research Council postdoctoral research associate at the U.S. Environmental Protection Agency in the National Exposure Research Laboratory (NERL) in academic year 2007-2008. As a postdoc at EPA-NERL, Dr. Berrocal has developed spatial statistical models to combine data from monitoring sites and outputs from an air quality model (the Community Multiscale Air Quality – CMAQ) to generate improved estimates of air pollution concentration at fine spatial scale. These models, called downscaler and data fusion models, have been presented in several scientific journals, are highly cited and have been used in various epidemiological studies to assess the health impact of ambient and personal exposure to air pollution.

Burke,Thomas

Johns Hopkins Bloomberg School of Public Health

Thomas A. Burke is a Professor at The Johns Hopkins Bloomberg School of Public Health, Department of Health Policy and Management, with joint appointments in the Department of Environmental Health Sciences and the School of Medicine Department of Oncology. He is also the the Director of the Johns Hopkins Risk Sciences and Public Policy Institute. Dr. Burke is Chair of the National Academy of Sciences Committee on Improving Risk Analysis and in 2006 he was named a Fellow of the Society for Risk Anaysis. His research interests include environmental epidemiology and surveillance, evaluation of population exposures to environmental pollutants, assessment and communication of environmental risks, and application of epidemiology and health risk assessment to public policy. He was Principal Investigator for the Pew Environmental Health Commission which established the framework for a national approach to environmental public health tracking. He has been awarded the Johns Hopkins Golden Apple Award for excellence in teaching three times.Before joining the University faculty, Dr. Burke was Deputy Commissioner of Health for the State of New Jersey and Director of Science and Research for the New Jersey Department of Environmental Protection. In New Jersey, he directed initiatives that influenced the development of national programs, such as Superfund, the Safe Drinking Water Act, and the Toxics Release Inventory. Dr. Burke has served as a member of the National Academy of Sciences Board on Environmental Studies and Toxicology and chaired the NAS Committee on Human Biomonitoring for Environmental Toxicants and Committee on Toxicants and Pathogens in Biosolids Applied to Land. He also served on the NAS Committee on the Toxicological Effects of Methylmercury. In 2003 he was named a lifetime National Associate of the National Academies. He was Inaugural Chair of the Advisory Committee to the Director of the CDC National Center for Environmental Health and a member of the Executive Committee of the EPA Board of Scientific Counselors. Dr. Burke received his B.S. from St. Peter's College, his M.P.H. from the University of Texas and his Ph.D. in epidemiology from the University of Pennsylvania.

Chance,Kelly

Smithsonian Institution

Kelly Chance is a Senior Physicist at the Smithsonian Astrophysical Observatory. He taught Spectroscopy and Radiative Transfer of Planetary Atmospheres as a Lecturer on Earth and Planetary Sciences at Harvard University (now Oxford University Press, ISBN 978-0-19-966210-4). He has been measuring Earth's atmosphere from balloons, aircraft, the ground and, especially, from satellites since receiving his Ph.D. in Chemical Physics from Harvard in 1978. His research specialties are measurements of the Earth's atmosphere; atmospheric composition and radiative transfer; chemical astrophysics; and molecular spectroscopy, structure and dynamics. His atmospheric measurements encompass the stratospheric ozone layer, climate-altering greenhouse gases, and atmospheric pollution. His proposal for Tropospheric Emissions: Monitoring of Pollution (TEMPO) was selected in 2012 as the first NASA Earth Venture Instrument. TEMPO will be the first space-based instrument to monitor major air pollutants across the North American continent from Mexico City to the Canadian oil sands, and from the Atlantic to the Pacific, hourly at high spatial resolution. TEMPO will be launched in about 2020-2021, sharing a ride on a commercial satellite to a geostationary orbit. TEMPO measurements of ozone, nitrogen dioxide, sulfur dioxide, formaldehyde, glyoxal, water vapor, aerosols, cloud parameters, and harmful ultraviolet radiation will enable researchers to improve emission inventories, monitor population exposure, and evaluate effective emission-control strategies. It also will provide near-real-time air quality products that will be made publicly available.

Chow,Judith

Desert Research Institute

Dr. Judith Chow holds the Nazir and Mary Ansari Chair in Science and Entrepreneurialism and is a Research Professor in the Division of Atmospheric Sciences of the Desert Research Institute (DRI) of the Nevada System of Higher Education in Reno, Nevada. Dr. Chow has led DRI's Environmental Analysis Facility since its inception in 1985. She earned her B.S. degree in Biology from Fu-Jen Catholic University in Taiwan (1974), her M.S. degree in Environmental Health Science (1983) from Harvard University, and her Sc.D. degree in Environmental Science and Physiology (1985) from Harvard University. For more than 35 years, she has conducted air quality studies and performed data analysis to improve understanding of effects of air quality on human health, visibility, historical treasures, ecosystems, and climate. Dr. Chow is currently the principal investigator for: 1) conducting organic and black carbon measurements with the U.S. Environmental Protection Agency's (EPA) Chemical Speciation Network (CSN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) network; 2) tracking changes in air quality with control measures at the ports of Los Angeles and Long Beach; 3) investigating the chemical nature and composition of atmospheric brown carbon aerosol; and 4) evaluating nitrogen partitioning and evolution of particulate organic nitrogen in peat fire emissions. She has been principal investigator or a major collaborator in more than 50 large air quality studies (and many smaller ones) across the United States and in other countries. Dr. Chow prepared and revised sections of the EPA's PM Criteria Document pertaining to chemical analysis and source emissions and contributed to EPA guidance documents on network design, continuous particulate monitoring, and particulate matter chemical speciation. Dr. Chow's research has been sponsored by grants and contracts from the federal government (e.g., EPA, Department of Energy, Department of Interior, Department of Defense), local, state, and international air quality management authorities, industry, and the National Science Foundation. As past chair and a member of the Air & Waste Management Association's (A&WMA) Critical Review Committee, Dr. Chow has coordinated and evaluated Critical Reviews and Discussions on environmental science and technology topics. She was chair of the Publications Committee for the Journal of the Air & Waste Management Association and serves on Editorial Boards and/or as Associate Editor for several international journals including: the Journal of Air Quality, Atmosphere, & Health, Aerosol and Air Quality Research, Atmospheric Pollution Research, and Particuology. Dr. Chow was a member of the National Research Council's (NRC) committees on Research Priorities for Airborne Particulate Matter (1998–2003) and Energy and Air Pollution Futures in the U.S. and China (2004-2008); she also served on the NRC Board on Environmental Studies and Toxicology (2002–2005). She was a member of advisory panels for the National Environmental Respiratory Center (New Mexico) and South Coast (California) Air Quality Management District. Dr. Chow has been a member of EPA's Clean Air Scientific Advisory Committee (CASAC) since 2015 and CASAC's Air Monitoring and Methods Subcommittee (AMMS, formerly the Ambient Air Monitoring and Methods Subcommittee) since 2004. She is the principal author or co-author of more than 350 peer-reviewed articles and more than 90 peer-reviewed book chapters and has been recognized by ISIHighlyCited.com in ecology and environment with more than 14,500 citations of her work. Dr. Chow has received the California Air Resources Board's 2011 Haagen-Smit Clean Air Award for her contributions to air quality science and technology, the Air & Waste Management Association's 2016 Arthur C. Stern Award for Distinguished Paper and 2002 Frank A. Chambers Excellence in Air Pollution Control Award, and the 2001 Nevada System of Higher Education's Regents' Researcher Award.

Cocker III,David R.

University of California at Riverside

David R. Cocker III is a professor of Chemical and Environmental Engineering at the University of California, Riverside. He currently manages the Atmospheric Processes Laboratory at the Bourns College of Engineering, Center for Environmental Research and Technology in addition to being a UCR Honors Faculty Fellow. He received both his M.S. (1998) and Ph.D. (2001) in Environmental Engineering Science from the California Institute of Technology and double B.S. degrees in Environmental Engineering and Chemistry from the University of California, Riverside. His research expertise includes atmospheric chemistry leading to secondary organic aerosol and ozone formation, in-use characterization of a variety combustion emission sources, and the health impacts of atmospheric pollutants. Funding over the last two years has included the South Coast Air Quality Management District, California Air Resources Board, U.S. EPA (student design competitions), Coordinated Research Council, National Science Foundation, Naval Surface Warfare Center, USDA, and Honda. He has served as a technical advisor to the Western Regional Air Pollution Committee, has been an advocate for STEM education within the Riverside Unified School District, is an active member of the American Association for Aerosol Research, and is affiliated with the BREATHE center through the UCR School of Medicine.

Cohan,Daniel

Rice University

Dr. Cohan is an Associate Professor of Civil and Environmental Engineering at Rice University. His research specializes in atmospheric modeling to inform environmental decision-making and quantify the responsiveness of air pollution to emissions. Dr. Cohan received a B.A. in Applied Mathematics from Harvard University, a Ph.D. in Atmospheric Chemistry from Georgia Tech, and served as a Fulbright Scholar to Australia. He is a recipient of an NSF CAREER award and was a member of the NASA Air Quality Applied Sciences Team. Prior involvement with EPA includes serving as PI of a STAR research grant and developing advanced features for the CMAQ air quality model.

Crawford,James

NASA

Dr. James H. Crawford is a Senior Research Scientist at NASA, serving as the agency lead for tropospheric chemistry. In this capacity he provides leadership for national and international airborne field studies that collect detailed measurements of atmospheric composition to identify human and natural impacts related to gaseous and particulate pollution. These observations are critical to understanding the emissions, chemistry, and dynamics that underlie air pollution events. An important focus of Dr. Crawford's work has been to improve the interpretation and application of satellite observations for air quality through integration with surface monitoring, aircraft observations, and air quality models. In conducting these studies, Dr. Crawford has collaborated with federal and state air quality agencies in California, Colorado, Maryland, and Texas, always drawing on local advice and experience to ensure that flights are executed to advance current understanding of the unique issues faced by each locality. He currently serves on the Advisory Panel of the Texas Air Quality Research Program. He has authored over 130 peer-reviewed publications on the chemistry of the lower atmosphere including photochemical production of ozone and particulate matter, carbon monoxide and atmospheric transport, and near-surface vertical gradients in reactive nitrogen oxides, formaldehyde, and ozone production. Dr. Crawford has also coordinated special issue publications of air quality findings in EM magazine, targeted to air quality decision makers, and he has served as the atmospheric chemistry editor for the Journal of Geophysical Research-Atmospheres since 2013. A current member of the International Global Atmospheric Chemistry (IGAC) project Steering Committee, Dr. Crawford will assume the IGAC co-Chair role in 2019. Dr. Crawford was selected for a Presidential Early Career Award for Scientists and Engineers in 2001. He has also received NASA's highest honors, the Outstanding Leadership Medal, and NASA's Exceptional Achievement Medal for sustained scientific contributions to NASA's Tropospheric Chemistry Program. His current research interests include the photochemistry of tropospheric ozone and free radicals, the global budget of reactive nitrogen, the influence of clouds on trace gas transport and chemistry, and the use of satellites to study long-range pollution transport and air quality. Since 2010, Dr. Crawford has led a series of air quality focused field studies across the United States (DISCOVER-AQ) and in South Korea (KORUS-AQ) to understand local and transboundary influences on air quality and to prepare for geostationary satellite observations of air quality planned by Korea and the U.S. in the early 2020s. Dr Crawford received his Ph.D. in Atmospheric Chemistry from Georgia Institute of Technology, and his B.S. in Mathematics from the United States Military Academy.

DeFelice,Tom

In Progress

Dr. DeFelice is currently a consultant to NOAA and NASA federal service sector small businesses, while taking management courses to maintain his PMP certification. He has submitted a US Utility Patent pending application, involving the use of UAS w/autonomous, adaptive control, and on-board environmental sensors. Dr. DeFelice has a PhD in Atmospheric Science from N.C. State University, MS Atmospheric Physics from DRI/UNR, and a BS in Math and Atmospheric Science from SUNY at Albany. He has performed air quality, meteorology, atmospheric chemistry (aqueous & gas phases) measurements on an EPA project that funded his PhD work. Dr. DeFelice taught wet and gas phase atmospheric chemistry, cloud physics, remote sensing of aerosols, plus meteorological instrumentation and measurement at the University Senior/Grad student level. His university level teaching included mentoring a Graduate student who's research involved Air Pollution Control Technology development. Dr. DeFelice has authored 40+ relevant peer-reviewed publications, and a college text-meteorological instrumentation & measurement. He has been an editorial board member of Atmospheric Research since 2000, and Atmospheric and Solar-Terrestrial Physics. Dr. DeFelice's expertise and research activities are focused on atmospheric science, cloud and aerosol physics and chemistry, meteorological measurements and the effect of aerosols on atmospheric and other processes(biosphere, geosphere, hydrosphere), and the effect of cloud systems on the environment. He has over 20 years of experience relevant to air quality, mainly focused on investigating aerosol characteristics and cloud system-aerosol interactions. Dr. DeFelice led an unbudgeted full cycle validation infrastructure project created per Data Qual. Act 2000, which today still serves as a focal point for research studies and public outreach at EDC. He supported air quality studies of APHC focusing on meteorology and aerosol (chemical & physical) measurements, their analysis and their effect on soldier. Dr. DeFelice has served on advisory committees not supported by the SAB staff office and professional societies, for example, 2+ years on an International Commission for the Ministry of Agriculture, Mendoza, Ar. He also served as a member of the ARL biosafety committee for 3 yrs. Dr. DeFelice has served on the American Society of Civil Engineers, Environmental Water Resources Institute Atmospheric Water Management Standards Committee since 1994 which included serving as its chair and secretary.

Enstrom,James E.

Scientific Integrity Institute

Dr. James E. Enstrom is a retired Research Professor/Researcher from the School of Public Health and Jonsson Comprehensive Cancer Center at the University of California, Los Angeles. He is President of the Scientific Integrity Institute in Los Angeles. He received his BS in physics from Harvey Mudd College, an MS and PhD in elementary particle physics from Stanford University, and a MPH and postdoctoral certificate in epidemiology from UCLA. Dr. Enstrom has authored, primarily as first or sole author, about 50 peer-reviewed articles and book chapters on physics, epidemiology, and scientific integrity. He has received research funding from many sources, including NIH, ACS, UC, private foundations, industry sources, and personal donations. He has received no funding recently, but is still conducting original epidemiologic research by using personal assets in innovative and cost-effective ways. He has taught graduate classes on environmental health science. He has given numerous lectures on epidemiology and ethics. He has published important articles relating good health practices to reduced mortality and recently has shown that fine particulate matter (PM2.5) is not related to total mortality in the ACS Cancer Prevention Study cohorts (CPS I and CPS II). He is the only independent scientist to obtain and analyze original CPS cohort data. His research shows that the EPA PM2.5 NAAQS is scientifically unjustified and must undergo complete and objective reassessment. His Scientific Integrity Institute website contains thousands of documents on air pollution epidemiology, lifestyle epidemiology, scientific integrity, and critiques of regulations, many of which contain his own research and analysis. He understands air pollution health effects research from the perspectives of both physics and epidemiology and maintains the highest level of integrity. He is a Life Member of the American Physical Society, a Founding Fellow of the American College of Epidemiology, and a current member of the ACE Ethics Committee. In 2015 he received the Heroes of Conscience Award from the American Freedom Alliance in Los Angeles.

Fernandez,Ivan J.

University of Maine

Dr. Ivan J. Fernandez is a Professor and forest soil scientist at the University of Maine, Orono. He is a Distinguished Maine Professor and faculty member in the School of Forest Resources, the Climate Change Institute, and the School of Food and Agriculture. His expertise is in biogeochemical cycling in forested ecosystems, terrestrial-aquatic linkages, and biogeochemical responses to a changing chemical and physical climate. He is a member of numerous professional organizations such as the Society of American Foresters, Soil and Water Conservation Society, and a fellow and member of the Soil Science Society of America. He serves as a member of the National Council of Soil Science Examiners and the Maine Board of Certification for Professional Geologists and Soil Scientists. He is recognized for establishing or helping to establish several long-term ecosystem studies in Maine that include the Howland Research Forest, research watersheds in Acadia National Park, and the long-term whole ecosystem research program at the Bear Brook Watershed in Maine. He also serves as the External Science Advisor to the Hubbard Brook Ecosystem Study in New Hampshire and is the point of contact for the U.S. Department of Agriculture (USDA) Northeast Climate Hub at the University of Maine. His current research interests are in atmospheric deposition and climate change effects on forested ecosystems and watershed processes, bioenergy implications for forest management, and climate change adaptation. He was co-leader of the 2009 climate change assessment for Maine and the subsequent report Maine's Climate Future. Dr. Fernandez has funding from the U.S. Department of Agriculture, the National Oceanic and Atmospheric Administration, the Northeastern States Research Cooperative and the National Science Foundation to study acidification and recovery, climate, and nitrogen effects on long-term forest biogeochemistry.

Fine,Philip

South Coast Air Quality Management District

Philip Fine, Ph.D. is currently the Deputy Executive Officer for Planning, Rule Development & Area Sources at the South Coast Air Quality Management District (SCAQMD) in Diamond Bar, CA. He is responsible for oversight, administration, and direction of all activities of the Division, including all rulemaking functions, Air Quality Management Plan and SIP development, particulate matter and ozone control strategies, climate and energy policy, air quality modeling, meteorology and forecasting, air quality data evaluation, emissions reporting, and air toxics risk assessment. He also recently served as the Assistant Deputy Executive Officer for the Science & Technology Advancement Division in charge of all field and laboratory activities related to the AQMD ambient network of over 36 air monitoring stations, source testing, compliance testing, quality assurance, and all special air monitoring research projects. Dr. Fine has been a member of several CASAC panels, and currently serves as a member of the California Air Resources Board legislatively mandated Research Screening Committee. Prior to joining the SCAQMD, he was a Research Assistant Professor at the University of Southern California, Los Angeles where he taught courses and conducted extensive research on particulate pollution, its health effects, atmospheric science, and measurement methods resulting in over 50 peer-reviewed scientific publications. Dr. Fine received his Ph.D. from California Institute of Technology in Environmental Engineering Science, and his bachelor's degree in Mechanical Engineering and Materials Science & Engineering from the University of California, Berkeley.

Frampton,Mark

University of Rochester

Dr. Mark W. Frampton is Professor Emeritus in Medicine in the Pulmonary & Critical Care division, at the University of Rochester Medical Center (URMC), Rochester, NY. Dr. Frampton holds an M.D. from New York University. During pulmonary specialty training at URMC in the late 1980s, Dr. Frampton became interested in the adverse health effects of air pollution, at a time when epidemiology studies were beginning to provide strong links between ambient particulate air pollution and mortality. Working with Dr. Mark Utell and utilizing the human clinical studies facility at URMC, he expanded the focus of human clinical air pollution studies beyond pulmonary function effects to include effects on airway inflammation, host defense against viral infection, and cardiovascular effects. Dr. Frampton's laboratory was the first to conduct human clinical studies of ultrafine particles (smaller than 100 nm), first using laboratory generated elemental carbon particles, and subsequently with concentrated ambient ultrafine particles, using the Harvard ultrafine concentrator system. Over the years his laboratory has studied healthy subjects as well as those considered to have increased susceptibility, including older subjects and people with mild asthma, chronic obstructive pulmonary disease, type 2 diabetes, and even genetic susceptibility. Dr. Frampton's laboratory is one of three centers completing a study of the cardiovascular effects of ozone exposure in healthy older subjects, funded by the Health Effects Institute. These studies have helped to understand the physiological changes and pathways to adverse effects that occur in response to pollutant exposure, and have helped to inform the EPA's promulgation of rational ambient air quality standards. Funding for these studies has come from the National Institutes of Health, the U.S. EPA, the Health Effects Institute, the New York State Energy Research and Development Authority, CONCAWE, ExxonMobil, the American Petroleum Institute, and others. Dr. Frampton has served on numerous scientific review panels with the National Institutes of Health and other scientific funding organizations. He has been active in the Environmental and Occupational Health Assembly of the American Thoracic Society, serving as its Chair in 2001-2003. At the request of the ATS President at the time, Dr. Frampton chaired a Task Force on Bioterrorism, and helped to form a new Section on Bioterrorism, serving as its first Chair in 2003-2005. He recently served as a member of the ATS committee preparing a revision of the important and oft-cited document, "What Constitutes a Health Effect of Air Pollution?", which has now been published. Dr. Frampton has served as a consultant and reviewer for the Health Effects Institute, a health research organization jointly funded by EPA and the automobile industry. He is currently a member of the Science Review Committee for the Health Effects Institute. He participated in an HEI review panel on the health effects of traffic-related air pollution, and chaired an HEI Review Panel on ultrafine particles, which produced a recent HEI Perspectives, "Understanding the Health Effects of Ambient Ultrafine Particles". Dr. Frampton has served as a consultant to the EPA in developing and reviewing Integrated Scientific Assessments (formerly Criteria Documents) for nitrogen dioxide, ozone, and particulate matter. In addition, he has served on several EPA grant and fellowship review panels and scientific workshops, and has been invited to speak at EPA functions. He currently serves on the CASAC PM Review Panel.

Fritz,Patricia

New York State Department of Health

Patricia Mason Fritz, is a Research Scientist III with the Bureau of Toxic Substance Assessment in the Center for Environmental Health. She has worked for the New York State Department of Health, Center for Environmental Health in the Bureau of Toxic Substance Assessment since 1994. Prior to joining the Health Department, Pat was a Senior Research Scientist with Sterling Winthrop Research Institute, where she conducted laboratory research in the neurobehavioral effects of compounds of pharmacological interest. Pat holds Bachelor of Science degrees from Syracuse University and SUNY College of Environmental Science and Forestry, and a Masters' degree in Environmental Engineering from Rensselaer Polytechnic Institute. Ms. Fritz has represented the Health Department on multi-disciplinary review and advisory panels related to environmental health, prepared and provided technical support for testimony in administrative hearings, and served on grant and contract review panels in the areas of energy, environment, and health. She is a current member of ASHRAE, the American academy of Allergy, Asthma and Immunology (AAAAI), where she serves on the Environmental Exposure and Respiratory Health and Aerobiology Committees, the American Association for Aerosol Research (AAAR), where she serves on the Early Career Committee, and the Pan- American Aerobiology Association(PAAA). Ms. Fritz' work at NYSDOH encompasses exposure assessment and toxicological risk assessment of chemical and biological contaminants in air water and soil, criteria and hazardous air pollutants, aerosols, aerobiology, asthma, air quality, nanotechnology, mercury, and impacts from conventional and alternative energy sources. She has worked on the development and analysis of results from surveys conducted in New York State focused on asthma prevalence and exacerbation, collaborated on a study investigating pediatric exposure to mercury, and has conducted multiple investigations related to indoor and outdoor air quality in residential, school and occupational settings in NYS. In addition to her research efforts, she responds to public inquiries about health effects from chemical and biological pollution, develops and provides training on health effects of air pollutants, provides technical support to Department technical documents and initiatives, and has participated in multi-agency evaluations of environmental sampling data collected following industrial accidents, natural disasters and following the World Trade Center attacks. She is currently in the third year of a New York State Energy Research and Development Authority funded research project characterizing particulate emissions from advanced biomass-fueled appliances.

Gordon,Terry

New York University School of Medicine

Dr. Terry Gordon holds the rank of Professor of Environmental Medicine at the New York University (NYU) School of Medicine. He holds a B.S. in Physiology (1974), an M.S. in Toxicology (1976) from the University of Michigan, and a Ph.D. in Toxicology from MIT (1981), and was appointed to the faculty of the Department of Environmental Medicine in 1989. He has served as an ad hoc member of grant review panels and/or site visit teams for NIEHS, NIAID, National Coalition for Cancer Research, DOD, Bureau of Mines, NASA, Health Canada, NIOSH/CDC, and the EPA. Dr. Gordon is past Chair of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) committee, a volunteer organization that publishes occupational exposure levels that are used as workplace safety guidelines throughout the world. Dr. Gordon's broad research interest is in inhalation toxicology. The major focus of his research lab is the identification and understanding of the role of genetic host factors in the pathogenesis of the adverse pulmonary effects produced by inhaled environmental and occupational agents. Because inter-individual responses to inhaled particles and gases vary so greatly in both human subjects and test animals, Dr. Gordon has hypothesized that genetic susceptibility factors play a major role in environmental and occupational lung disease. In collaboration with a number of investigators in the department, his laboratory uses classic murine genetics models, computational genomics, and DNA microarrays to identify genes involved in the acute response as well as in the development of tolerance to repeated exposure to inhaled toxicants. Dr. Gordon also plays a major role in the particulate matter (PM) research program at NYU, and was among the first researchers to use concentrator technology to study the adverse cardiopulmonary effects of ambient PM. Dr. Gordon is an active member of the Society of Toxicology (SOT), and has served on the Program, Placement, Membership, and Awards Committees and as President of its Inhalation Specialty Section. He has served as a consultant/author to the EPA on issues of pulmonary toxicology related to the development of various documents, and served on EPA's Clean Air Scientific Advisory Committee (CASAC) Oxides of Nitrogen (NOx) and Sulfur Oxides (SOx) Primary National Ambient Air Quality Standards (NAAQS) Review Panels and is a current member of the PM ad hoc CASAC.

Hailer,Katie

Montana Tech

Dr. Katie Hailer started her education in chemistry at West Virginia University, graduating in 2001 with a B.A. in Chemistry, summa cum laude. She then went to the University of Montana for her doctoral graduate studies in bioinorganic chemistry. Under the direction of Dr. Kent Sugden, Dr. Hailer spent her time in graduate school working to elucidate the mechanism of hexavalent chromium carcinogenesis. After graduating in 2006, she accepted a one-year postdoctoral position at the Mayo Clinic in Rochester, MN. There she worked with Dr. Scott Kaufmann again focusing on mechanisms of carcinogenicity in an oncology lab. Dr. Hailer then transitioned into a faculty position, first at Winona State University from 2007-2010, and then moving to Montana Tech in 2010. Dr. Hailer currently holds the rank of tenured, Associate Professor and Department Head of Chemistry at Montana Tech. Dr. Hailer is best described as a bioinorganic chemist. Her research has always focused on metal interactions in living systems. Montana Tech is in Butte, MT which also happens to be one of the largest Superfund sites in the United States. Using the historical environmental contamination and current open-pit mining activities as inspiration, Dr. Hailer now focuses her research on measuring and identifying metals in the people that live and work in Butte, MT. Her research has been most recently funded by the National Institutes of Health INBRE grant.

Hayes,Stanley

Ramboll Environ

Mr. Stan Hayes has more than 40 years of experience in air-related environmental engineering and science for NAAQS- and air toxics-related purposes, with emphasis on air modeling analysis and health risk assessment. He has an MS degree in Aeronautics & Astronautics and a BS degree in Mechanical Engineering, both from Stanford University. Mr. Hayes is the primary author of more than 70 scientific papers and presentations, and several hundred technical reports on air-related subjects. He is a member of the EPA Science Advisory Board Risk and Technology Review (RTR) Methods Panel. He is a Fellow of the Air & Waste Management Association, for whom he has chaired or co-chaired national and international specialty conferences. He is chair of the Advisory Council of the Bay Area Air Quality Management District, which provides science-based counsel to the Board of Directors, the Executive Officer, and other senior staff. He has provided expert testimony before federal, state and local regulatory agencies and in court. For 25 years, until 2015, Mr. Hayes was a Principal with Ramboll (previously ENVIRON). He is now emeritus, with no regular salary, EPA or other grants, benefits, or firm ownership interest. Over his career, Mr. Hayes has conducted research consulting on NAAQS- and air toxics-related topics for a broad range of private- and public-sector clients, including trade associations (e.g., API and others), individual companies, law firms, and regulatory agencies (e.g., EPA and others). Relevant to the work of CASAC, he has conducted NAAQS-related air quality modeling studies, health risk assessments, exposure analyses, control strategy analyses, nonattainment area plan evaluations, air monitoring data analyses, and regulatory and policy reviews.

Hayworth,Nan

Independent Consultant

The Honorable Nan Hayworth, M.D. is a consultant and a Special Business Development Advisor for Pilot Growth Equity. She is the only female physician ever to serve as a Member of Congress, representing the 19th District of New York in 2011 and 2012. As a freshman Member of the House Majority, Congresswoman Hayworth was assigned to the House Financial Services Committee and the Majority Whip Team; she also had the honor of being chosen by Speaker Boehner to serve on two House-Senate Conference Committees. She has been recognized by many organizations, including the Sierra Club, League of Conservation Voters, Defenders of Wildlife, and Wilderness Society, for her efforts to protect the environment. A board-certified ophthalmologist, Dr. Hayworth practiced for nearly 20 years in Mount Kisco, New York, before becoming a vice president and medical director at Cline Davis & Mann, a healthcare communications agency, prior to running for Congress. She chairs the board of directors of ConservAmerica, a Republican organization dedicated to environmental protection, and she served as a primary media surrogate for EPA Administrator Scott Pruitt when he was a candidate for this position. Congresswoman Hayworth speaks on television and radio in behalf of Independent Women's Forum, the Trump campaign, and the Republican National Committee. She graduated summa cum laude from Princeton University in 1981 with a degree in Biology, subsequently graduating at the top of her class from Cornell University Medical College (now Weill Cornell Medicine) in 1985. Dr. Hayworth has not been a recipient of any research grants from the public or private sectors over the past two years.

Huang,Guanyu

Spelman College

Dr. Guanyu Huang is an assistant professor of Environmental and Health Sciences program at Spelman College. He received his B. Eng. (2008) in remote sensing science and technology from Wuhan University in China, and his M.S. (2010) and Ph. D. (2015) in Atmospheric Science from University of Alabama in Huntsville. He became a postdoctoral fellow at Harvard-Smithsonian Center for Astrophysics in 2015 and then joined Spelman college as a tenure-track assistant professor in 2017. Dr. Huang is an expert of air quality, especially in ozone and its precursors. His research interests include trace gas remote sensing, air quality modeling and observations in multiple scales, and the application of machine learning in environmental science and remote sensing. He has authored and co-authored multiple journal papers and conference papers. He teaches courses in air quality, atmospheric science and environmental science in Spelman College.

Kinney,Patrick

Boston University School of Public Health

Dr. Kinney has a broad background in environmental health sciences, with specific training and expertise in air pollution exposure assessment, epidemiology, and climate change. He completed his doctoral studies in Environmental Science and Physiology at the Harvard School of Public Health in 1986. As a junior faculty member at New York University, he developed and led epidemiologic research on lung function and inflammatory biomarker changes in relation to chronic exposures to ozone and other air pollutants. Moving to Columbia in 1994, he expanded his research to include community-based studies of traffic pollutant exposures and health outcomes in underprivileged neighborhoods in New York City, leading and contributing to several large-scale studies over the following 22 years. He has contributed to the periodic reviews of the National Ambient Air Quality Standards for ozone and particulate matter, and served on the EPA Clean Air Scientific Advisory Committee for reviews of the Nitrogen Dioxide and Sulfur Dioxide standards. He developed and directed the Climate and Health Program at Columbia, which trains students and postdocs in research on the health dimensions of climate variability and change. He also directed research on indoor and outdoor air quality and health in Africa, including a randomized stove trial in Ghana funded by NIEHS. Current funding sources include the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration. In January 2017, Dr. Kinney was named the inaugural Beverly A Brown Professor of Urban Health at Boston University.

Kleinman,Michael T.

University of California, Irvine

Dr. Michael T. Kleinman is an Adjunct Professor of Toxicology in the Department of Medicine's Occupational and Environmental Medicine Division at the University of California, Irvine (UCI), with a joint appointment in the Program in Public Health. He was previously employed by the U.S. Atomic Energy Commission (AEC) as an environmental scientist and he directed the Aerosol Exposure and Analytical Laboratory at Rancho Los Amigos Hospital in Downey, CA. He has more than 40 years of experience researching the health effects of environmental contaminants. He holds a M.S. in Chemistry (Biochemistry) from the Polytechnic Institute of Brooklyn and a Ph.D. in Environmental Health Sciences from New York University. He is the Co-Director of the Air Pollution Health Effects Laboratory at UCI. He has published more than 115 peer-reviewed journal articles on effects of environmental contaminants on cardiopulmonary and immunological systems and on global and regional distribution of environmental contaminants including heavy metals and radioactive contaminants from nuclear weapons testing. He has directed more than 50 controlled exposure studies of human volunteers and laboratory animals to ozone and other photochemical oxidants, carbon monoxide, ambient particulate matter (PM) and laboratory-generated aerosols containing chemically or biologically reactive metals such as lead, cadmium, iron and manganese. He has served on two National Academy committees to examine issues in protecting deployed U.S. Forces from the effects of chemical and biological weapons. Dr. Kleinman's current research focuses on neurological and cardiopulmonary effects of inhaled particles, including nanomaterials and ultrafine, fine and coarse ambient particles in humans and laboratory animals. His recent health effects studies have the role of inhaled combustion-generated particles on the promotion of airway allergies and acceleration of development of cardiovascular disease and how these effects are mediated by organic and elemental carbon components of PM. Dr. Kleinman's current research grants and contracts include a grant to examine the effects of inhaled particles on brain stem cells related to tumor development from the California Brain and Lung Tumor Foundation, a contract from the California Environmental Protection Agency to study the role of semi-volatile components of fine and ultrafine PM on cardiac function and atherosclerosis, and a contract to examine the effects of long term inhalation exposure to concentrated fine particles on brain inflammation. Dr. Kleinman has previously served on the U.S. EPA Clean Air Scientific Advisory Committee (CASAC) Ozone, PM and NO2 panels and was appointed to Chair the Scientific Review Panel for Toxic Substances for the state of California. Dr. Kleinman's current research focuses on neurological and cardiopulmonary effects of inhaled particles, including nanomaterials and ultrafine, fine and coarse ambient particles in humans and laboratory animals. His recent health effects studies have the role of inhaled combustion-generated particles on the promotion of airway allergies and acceleration of development of cardiovascular disease and how these effects are mediated by organic and elemental carbon components of PM. Dr. Kleinman is a co-Investigator on grants from NIH and NSF as well as contracts from the California Brain and Lung Tumor Foundation and from the California Environmental Protection Agency to study the role of semi-volatile components of fine and ultrafine PM on cardiac function, atherosclerosis, and effects of subchronic and chronic inhalation exposures to concentrated fine particles on brain inflammation.

Lange,Sabine

Texas Commission on Environmental Quality

Dr. Sabine Lange is the section manager for the Toxicology Division at the Texas Commission on Environmental Quality (TCEQ). Dr. Lange's responsibilities include overseeing health effects risk assessments of air permit applications, ambient air monitoring projects, and hazardous waste sites; overseeing the development of chemical toxicity factors; and conducting and overseeing systematic reviews and independent analyses of risk assessments. Dr. Lange serves as a technical resource for the State and citizens of Texas for human health and environmental risk assessment, especially related to air and water quality. Dr. Lange's research interests include the toxicology of criteria air pollutants, particularly ozone dosimetry and exposure-response. In this area she has published articles, given invited talks, presented posters, and served as a workshop panel member. On behalf of the TCEQ, she has intensively reviewed the documents released by the US EPA on the National Ambient Air Quality Standards (NAAQS) for ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and lead. Dr. Lange and colleagues have provided comments to the US EPA on the assessment documents supporting these standards, particularly as they relate to principles of toxicology, risk assessment, and the State's perspective on these rules. Dr. Lange's work since joining TCEQ has been entirely funded by the State of Texas.Dr. Lange received a Bachelor's degree from the University of Western Ontario in Canada, and completed a Ph.D. and post-doctoral training in biochemistry and molecular carcinogenesis at the University of Texas at Houston and MD Anderson Cancer Center. Dr. Lange is a Diplomate of the American Board of Toxicology.

Lefohn,Allen

A.S.L. & Associates, LLC

Dr. Allen S. Lefohn is currently President and Founder of A.S.L. & Associates, LLC in Helena, Montana. From 1981 until 2017, he served as President and Founder of A.S.L. & Associates, a Montana corporation. He received his Bachelor's degree from UCLA in 1966 and a Ph.D. in physical chemistry from the University of California at Berkeley in 1969. His advisor was Professor George C. Pimentel. For the period 1989 – 1999, he served as an Executive Editor of the internationally recognized journal Atmospheric Environment and is an Emeritus Editor of the Journal. Dr. Lefohn has published approximately 125 peer-reviewed publications, edited four books, presented numerous oral papers, and participated in panel presentations. During a career spanning over 50 years, his research has focused on (1) understanding the importance of background ozone in relation to ambient concentrations, (2) developing exposure-response relationships and indices that describe the effects of ozone on vegetation and human health, (3) investigating biological mechanisms that define the nonlinearity (i.e., weighting of the higher concentrations more than the mid- and low-level values) response to ozone for both human health and vegetation, and (4) integrating results from the EPA's air quality database for (a) characterizing co-occurrence patterns of criteria air pollutants under ambient conditions (e.g., ozone, sulfur dioxide, and nitrogen dioxide), (b) characterizing ozone trend patterns, and (c) designing research experiments that utilize realistic ambient exposures for assessing human health and vegetation effects. For 19 years, Dr. Lefohn has worked with the American Lung Association in characterizing ambient ozone and particulate matter data for the organization's annual State of the Air report. His research results have also been applied by the EPA. Between 2007 and 2015, EPA staff, CASAC, and the EPA Administrator considered the application of an exposure metric, the W126 exposure index, as the federal standard to protect vegetation. Dr. Lefohn created the exposure metric in 1985 with the help of the first-generation Apple Macintosh computer and described the metric in the peer-review literature in 1987 and 1988. In October 2015, the EPA Administrator announced that the 8-h ozone standard would be used as a surrogate for the protection of vegetation; the EPA continues to use the W126 metric as an indicator of the potential risk of ambient ozone exposures to vegetation. Dr. Lefohn is familiar with the EPA's rulemaking process. He was the lead consultant scientist for the EPA in authoring the air quality characterization chapter and the vegetation exposure-response section for the Ozone Criteria Document in 1996 and contributed to the Ozone Criteria Documents in 1985 and 2006. Dr. Lefohn presented testimony in March 2015 to the House Committee on Science, Space, and Technology about background ozone. In 2015, Dr. Lefohn was a co-guest editor for the Atmospheric Environment special issue: Observations and source attribution of ozone in rural regions of the Western United States. Dr. Lefohn is currently on the Steering Committee of the important international research effort, Tropospheric Ozone Assessment Report (TOAR). The project provides the international research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause. Dr. Lefohn is the lead author (with 23 additional co-authors) of the TOAR paper, Global Ozone Metrics for Climate Change, Human Health and Crop/Ecosystem Research, which was published in April 2018 and is available online. Dr. Lefohn is currently an Adjunct Professor of Environmental Engineering at Montana Tech in Butte, Montana. He is a member of the AAAS. For the past two years, Dr. Lefohn's funding sources for his research activities have originated from the American Lung Association and his own company, A.S.L. & Associates.

Lewis,Timothy

U.S. Army Corps of Engineers

Tim Lewis is a supervisory research ecologist with the U.S. Army Corps of Engineer, Engineer Research and Development Center, Environmental Laboratory in Vicksburg, MS. He worked for Lockheed Engineering, primary contractor for the U.S. EPA, serving as Project Leader and Principal Scientist on studies related to the National Surface Water Survey, the Direct Delayed Response Project (soil acidification), and the Environmental Monitoring and Assessment Program (EMAP). He accepted a position with the Bureau of Land Management in 1993 and served as the National Indicator Development Coordinator for the U.S. EPA's EMAP - Forest Health Monitoring program. He edited and authored a CRC Press book entitled Tree Rings as Indicators of Ecosystem Health. He went on to become Effectiveness Monitoring Coordinator for the Northwest Forest Plan. In 1996 Tim became the first Director of the Forest Science Project at Humboldt State University, where he applied his regional aquatic and terrestrial monitoring experience to private and public lands in Northern California. In 2001, Dr. Lewis accepted a position as senior ecologist with the U.S. EPA's National Center for Environmental Assessment, where he was involved in the assessment of ecological risks due to air pollutants. He served as associate editor of the premier journal Ecological Indicators during its startup. In 2007 Tim joined the Environmental Laboratory at the USACE's Engineer Research and Development Center in Vicksburg, MS as Chief for the Aquatic Ecology and Invasive Species Branch. The branch is actively engaged in ecosystem restoration and the assessment of the impact of Corps projects on habitat for threatened and endangered species and prevention and reduction of impacts of invasive plants and animals in the nation's waterways. EducationB.A., West Chester University, West Chester, PA, 1977, Biology M.S., Rutgers University, New Brunswick, NJ, 1980, Plant Pathology Ph.D., Rutgers University, New Brunswick, NJ, 1984, Environmental Science

Masuca,Corey

Jefferson County Department of Health

Corey Masuca, PE, PhD, JD is currently the Principal Air Pollution Control Engineer with the Jefferson County Department of Health. As the leader of the Air Pollution Control Program with the Jefferson County of Health he is responsible for overseeing a staff of approximately 35 persons who responsibilities include regulating industrial sources of emissions, area and point sources of emissions such as dry cleaners/gasoline stations and open burning, respectively. In addition, he oversees the ambient air monitoring program which is responsible for measuring air contaminant concentrations within Jefferson County, Alabama to ensure compliance with healthy clean air standards set by the United States Environmental Protection Agency (USEPA). Since he graduated from Auburn University with a Bachelor of Chemical Engineering degree, he has continued to work in the environmental arena, specifically air quality and air pollution. As a student at Auburn University, he completed a cooperative education program rotation with the Tennessee Valley Authority in Muscle Shoals, Alabama where he completed stack testing of fertilizer plant residuals including stack testing equipment preparation and calibration. After he graduated from Auburn University, he was employed as an Environmental Engineer with the State of Connecticut Department of Environmental Protection where he regulated sources of air pollutant emissions and was responsible for the implementation of a major new air regulatory USEPA program as part of the 1990 Clean Air Act Amendments. Following his tenure with the Connecticut Department of Environmental Protection, he worked as a consulting engineer with the environmental consultant firm, CH2M Hill, in the Atlanta, Georgia area. With CH2M Hill, he prepared air program applications for several industrial air-polluting facilities applying for applications to operate. This involved extensive regulatory review and complex, mathematical calculations to determine compliance and/or regulatory applicability. Next, he returned to Alabama where he worked an Environmental Engineer with the Alabama Department of Environmental Management where he continued his work as an Environmental Engineer where he was responsible for permitting, determining compliance, inspecting, and initiating enforcement actions, where applicable, of industrial sources of air pollution. Finally, he was initially employed as an Air Pollution Control Engineer with the Jefferson County Department of Health where, again, his primary duties entailed permitting, determining compliance, inspection, and initiating enforcement actions of industrial sources of air pollutant emissions. While with the Jefferson County Department of Health, he continued his professional and academic pursuits where he was promoted to the position of a Senior Air Pollution Control Engineer, became a registered/licensed Professional Engineer with the State of Alabama, and obtained a doctoral degree in Environmental Health Engineering from the University of Alabama in Birmingham. His doctoral degree research consisted of completing an epidemiology study of air pollutant concentrations and pre-term birth defects for populations within Atlanta, Georgia. After obtaining his doctoral degree and while still working full-time as a Senior Air Pollution Control Engineer with the Jefferson County Department of Health, he was also employed an adjunct professor both with the University of West Alabama (where he continues to be an advisory board member for the Environmental Sciences section of the Biology Division) and with the University of Phoenix (Birmingham campus). He taught classes in environmental science, environmental ethics, and general environmental air pollution health effects with both the University of Phoenix (Birmingham campus) and the University of West Alabama. In addition, during and subsequent to this time, he acted as a professional consultant providing air pollution data and review/analyses for three (3) epidemiological studies being performed/conducted by the University of Alabama at Birmingham, School of Public Health, Department of Epidemiology, which involved determining the relationship between ambient air pollution and emergency room visits for cardiovascular disease in Jefferson County, Alabama; ambient air pollution and emergency room visits for respiratory disease among adults in Jefferson County, Alabama; and ambient air pollution and respiratory diseases in children in Jefferson County, Alabama. During and subsequent to this time, he was promoted to his current position of Principal Air Pollution Control Engineer with responsibility for all of the various components of the Health Department's Air Pollution Control Program. Following his teaching stints with the University of West Alabama and with the University of Phoenix (Birmingham campus), all the while still being employed with the Health Department, he undertook an initiative to pursue as Juris Doctorate degree from the Miles College School of Law in Birmingham. He completed his requisite law studies and recently graduated from law school (May 2018). He is still employed as the Principal Air Pollution Control Engineer with the Jefferson County Department of Health Air Pollution Control Program and is currently planning to sit for the Alabama State Bar in July 2018, after which he will continue to work at/with the Health Department in a lead scientific and administrative capacity, and, hopefully, legal capacity subsequent to passing the Alabama State Bar.

Moore, Jr.,Charles Thomas (Tom)

Western States Air Resources Council - Western Regional Air Partnership

Mr. Tom Moore works for the 15 state air agency members of the Western States Air Resources (WESTAR) Council. He is the manager of the Western Regional Air Partnership (WRAP) air quality program, a voluntary partnership of states, tribes, federal land managers, local air agencies and the U.S. EPA, whose purpose is to provide technical support to understand current and evolving regional air quality issues in the context of the Clean Air Act (CAA) and the National Environmental Policy Act (NEPA). His regional analysis and planning support work is conducted through management of a series of interrelated contractor-supported regional projects for the WESTAR and WRAP membership, related to western U.S. air quality. These diverse, complex, and highly technical projects cover ambient monitoring data analysis, emissions inventory preparation and analysis, regional photochemical grid modeling and source apportionment results, and satellite air quality data.

Morris,Vernon

Howard University

Dr. Morris is a Professor in the Department of Chemistry, Director of the Atmospheric Sciences Program at Howard University. He serves as the PI and Director of a NOAA cooperative science center for Atmospheric Sciences at Howard University. He also maintains an adjunct appointment in the Environmental Engineering Program. Dr. Morris received BS degrees in chemistry and mathematics from Morehouse College and a PhD in Earth and Atmospheric Sciences from the Georgia Institute of Technology. He has completed advanced study in Sicily (Erice), at the Lawrence Livermore National Laboratories, and as a Presidential Postdoctoral Scholar at the University of California (Davis). Beginning with an NSF CAREER award in 1997, Dr. Morris has raised more than $60M in external research funding, founded the Atmospheric Sciences Program, which is already a national leader in the production of minority PhDs in the field, and helped guide the success of multiple NOAA and NASA-funded research centers. Recent funding includes several grants from NOAA and the National Science Foundation. Dr. Morris has guided the research for more than 150 students at the graduate, undergraduate, and high school levels, published over 75 refereed papers, book chapters, and conference proceedings, ranging from quantum chemistry to the impacts of lightning in tropical Africa, and has made over 100 invited talks and national conference presentations. The research themes that guide his current research are (i) the impact of mineral dust aerosols on global atmospheric chemistry and climate, (ii) the role and influence of tropospheric aerosols on regional environmental health, and (iii) the interplay between weather phenomena (e.g. dust storms, lightning, and precipitation) and atmospheric chemistry, i.e. "chemical meteorology". Dr. Morris has won numerous academic and scientific honors and awards including being recognizedas one of the 50 Most Influential Blacks in Science and Technology in 2011, inducted as a History Maker in Science in 2012, winning the NOBCChE Henry Cecil McBay Outstanding Teacher Award (2012), a Fulbright Specialist Award (2013), elected a Fellow of the American Meteorological Society (2016), and the Charles Anderson Award of the AMS in 2017. Dr. Morris is a member of the AMS, AGU, and the National Society of Black Physicists (NSBP). He has previously served on several national advisory committees including the Department of Energy ARM Science Board (2015 – 2017), the District of Columbia STEM Advisory Council (2011 – 2014), the UNESCO steering committee for the "Application of Remote Sensing for Integrated Management of Ecosystems and Water Resources in Africa", the National Academies of Sciences Board on Atmospheric Sciences and Climate (BASC) (2005 – 2007), and Member of the NASA Earth Systems Sciences and Applications Advisory Council, (ESSAAC) (2003 – 2005).

Morris,William

Efficient Fuel Additives

Dr. Morris completed his Ph.D. and M.S. in chemical engineering at the University of Utah examining the effect of pollutants such as NOX, SOX, and particulate matter on aerosol formation in air and oxy-fired combustion. He also holds a coordinate A.B. in Physics and Environmental Studies with a minor in History from Bowdoin College. He is currently President of Efficient Fuel Additives where he provides fuel additives and technical services to promote energy efficiency, use of alternative fuels, and utilization of agricultural waste biomass resources. He is also contracted by the Wyoming Integrated Test Center (ITC) as Program Director to provide engineering and business development support services for CO2 management technologies related to the ITC. The ITC facility, which was recently completed, is a public/private venture between Basin Electric Power Cooperative, Tri-State G&T, the National Rural Electric Cooperative Association, Black Hills Power, and the state of Wyoming through the Wyoming Infrastructure Authority. The research facility can provide up to 20 MW equivalent of flue gas for post combustion CO2 capture testing as well as 5 small 0.4 MWe test bays which will host the NRG COSIA Carbon XPRIZE CO2 utilization competition.Additionally, in a consultative capacity, he has provided engineering and technical advice for to private and government entities in the U.S. and S. Korea. As an employee of ADA Environmental Solutions, he worked in the areas of mercury emissions control, CO2 capture, NOX control, and is the listed inventor on 3 issued NOX, mercury, and CO2 emissions control patents as well as other patents pending. He was also a contributing author to the oxy-fuel combustion section of the National Coal Council's report, Fossil Forward in 2015 for then Department of Energy Secretary of Energy Ernest Moniz providing an update on CO2 capture technologies. His primary area of expertise is in combustion by-product formation such as NOX and particulate matter as well as emissions controls for mercury and CO2. He has conducted basic research, small pilot research, and commercial scale demonstrations and trials of various mercury, NOX, and emissions control technologies with both private industry and universities. Previous partners have included University of Utah, University of California Berkeley, Texas A&M University, Lehigh University, Southern Company, Aspen Aerogels, The University of Akron, the Electric Power Research Institute, the National Energy Technology Laboratory, the U.S. Department of Energy and other private industry companies. In addition, he has been a peer reviewer for the journals of American Chemical Society as well as Elsevier Publishing.

Packham,Steven

Utah Department of Environmental Quality

Dr. Steven Packham is an inhalation toxicologist with 28 years of regulatory experience with the Utah Division of Air Quality. Foremost among his responsibilities has been public education and communication of the scientific basis and intent of USC Title 42, Chapter 85 (particularly Sections 7409 and 7412): To protect human health with an ample margin of safety "requisite to protect" public health. His actual regulatory experience includes: Preparation of case-specific HAPs residual risks and leaking underground storage tank vapor intrusion risk assessments. Development of State Implementation Plans. State adoption of Federal NESHAP MACT's, and annual reviews of Utah's NATA Urban Air Toxics program. His research has focused on causal biologic mechanisms of dose-dependent health effects from breathing air pollution. He has developed a model to estimate margins of safety for mobile app users based on EPA Air Quality Index (AQI) values for sensitive and normal groups who may wish to engage in fitness improvement training and enjoy physical recreational activities outdoors under fluctuating air quality conditions. Dr. Packham is an Adjunct Associate Professor in the University of Utah College of Health Sciences Department of Family and Preventative Medicine and a member of the Advisory Board of the Rocky Mountain Center for Occupational and Environmental Health in Salt Lake City. Past professional activities include: Editorial Board, Journal of Fire Sciences. Chairman, American Society for Testing and Materials (ASTM) Task Group E5.21.05. Member, Toxicity Advisory Committee National Fire Protection Association. Member, ASTM Committee on Toxic Hazard Assessment of Materials used in Transportation Vehicles. United States of America Member, Technical Advisory Committee, ISO/TC 92/SC 3. Convener: ISO Technical Committee 92, Subcommittee 3, Working Group 1 on Fire Model. United States of America Assigned Expert: ISO/TC 92/SC 3/Working Group on Bio-assays.

Pair,Benson

KBR

Mr. Benson Pair is currently the Chief Technology Engineer- Environmental for KBR, located in the Houston Office. He has held this position for 29 years, since he joined KBR, then the M.W. Kellogg Company, in 1988. Prior to joining KBR, Mr. Pair spent 16 years with Engineering Science, Inc., environmental engineers and consultants, in their Houston Office, serving as Office Manager the last five years. He graduated from Rice University with two degrees in Chemical Engineering, a B.A. and an M.Ch.E, both degrees awarded in 1972. Mr. Pair is a registered Professional Engineer in the State of Texas and a Board Certified Environmental Engineer (BCEE). He is a member of the American Institute of Chemical Engineers (AIChE), the American Academy of Environmental Engineers and Scientists (AAEES) and the Water Environment Federation. Mr. Pair has served as an officer in the Water Environment Association of Texas (WEAT) holding every office in the Southeast Texas Section. He served as Chair of the Environmental Division of the AIChE, and served on the Programming Committee of AIChE. Mr. Pair is currently the AIChE representative on the Board of Trustees of the AAEES. This marks the second time he has been asked to serve in that position. Mr. Pair has nearly 46 years of experience in Environmental Engineering, all of it spent in providing consulting and engineering services to the hydrocarbon processing industry. He has executed projects involving air pollution control, wastewater treatment and solid waste management. Mr. Pair has been responsible for all phases of a project, from site selection studies through start up and commissioning. He has conducted bench scale and pilot scale treatability studies, and designed treatment plants. Mr. Pair has completed projects located in over a dozen States and ten foreign countries, giving him a working knowledge and appreciation of the regulatory requirements of a broad range of local, state and federal agencies, as well as international lending institutions. His career began shortly after the passage of the Clean Air Act in 1970 and the Clean Water Act in 1972. Mr. Pair has followed the development of air pollution control and wastewater treatment technologies for nearly five decades, applying these technologies to achieve regulatory compliance in a cost effective manner.

Paulson,Suzanne

University of California Los Angeles

Dr. Suzanne Paulson is Professor in the Department of Atmospheric & Oceanic Sciences, and Professor in the Institute of the Environment at UCLA, where she serves as the director of the Center for Clean Air. She earned a B.A. in Chemistry from the University of Colorado, an MS in Plant Biology from the University of Illinois, and an MS and PhD in Environmental Engineering Science from the California Institute of Technology. She was an Advanced Study Program Postdoctoral Fellow at the National Center for Atmospheric Research in Boulder, Colorado. Currently she investigates the impact of aerosol particles on human health and in clouds. She is also studies the influence of the built environment (sound walls, vegetation, cityscape design and traffic control) on pollution levels in urban areas at block and sub-block scales, including. She did extensive earlier work on ozone-alkene chemistry and aerosol optical properties, and has also conducted research projects in indoor air, biofuel emissions, and bioaerosol among others. Currently Dr. Paulson serves on the Research Screening Committee for the California Air Resources Board. Until recently she also served as an Airport Commissioner for the City of Santa Monica. She is a member of the American Association for Aerosol Research, the American Association for the Advancement of Science, the American Chemical Society and the American Geophysical Union.

Randolph,Dennis A.

City of Grandview

Mr. Dennis A. Randolph, P.E. is the Public Works Director for Grandview Missouri and Adjunct Instructor at the University of Missouri – Kansas City. He holds B.S. and M.S. degrees in civil engineering from Wayne State University as well as an MPA from Western Michigan University. He previous taught at Western Michigan and Wayne State, and has been a full-time local government engineer for over 40 years. His interests span a broad range emphasizing applied research that brings results to local communities. His current emphasis area is the impact of air, noise, and water pollution on Environmental Justice communities. Currently, he is responsible for leading technical work involved with litigation concerning the administration and permitting under the Clean Air Act. In conjunction with the air quality modelling work he led an effort to study noise along a newly designated interstate road to evaluate the cumulative impacts on the same Environment Justice communities. Mr. Randolph's current research has been supported by funding from the City of Grandview; Mr. Randolph has received no external research funding for this work from either federal of state government agencies, private companies, or foundations. Over the years Randolph has led work in solid waste management, surface and groundwater pollution and management, rural and urban sewage handling and treatment, and brownfield cleanup. He has formed collaborations between university faculty and local communities to investigate a wide-range of problems and to conduct field trials. He conducted a large county-funded project to trace multiple salt plumes through a rural. He was responsible for technical review of a $100 million wastewater treatment plant upgrade and managed several large combined sewer separation projects, and community sewage lagoon upgrades. He is managing a sanitary sewer inflow and infiltration (I&I) study to identify problem areas as well as a study of storm sewer pipe condition using robotic sensors. He obtained voter-approved funding for a $15 million brownfield cleanup of several abandoned industrial sites, and two $200,000 U.S. Environmental Protection Agency cleanup grants to identify and test suburban and rural sites. He has led countywide solid waste recycling efforts, been a flood plain administrator, and led efforts to incorporate stormwater Best Management Practices in construction projects, and been responsible for soil erosion and sedimentation regulation enforcement for several communities. He has led safety studies as a Principal Investigator on Federal Highway funded research and served on several National Cooperative Highway Research Program projects. He has also provided several grants to university departments to provide funding for focused research on local government engineering problems and is currently providing funding for a study of road asset management with the University of Missouri – Columbia, Civil Engineering Department. Mr. Randolph Is a Registered Professional Engineer in four States, a Public Works Leadership Fellow (APWA), and was recently selected as one of 2015's Top Ten Public Works Officials (APWA). He is a member of several American Society of Civil Engineers (ASCE) committees including the Public Agency Peer Review Committee. His other current committee work includes the ASCE Infrastructure Resilience Division SPEED Committee, and the Institute of Sustainable Infrastructure, where the work focuses on the topics of resilience and sustainability of infrastructure. He is a Life Member of the Institute of Transportation Engineers, American Society of Civil Engineers, and Institute of Electrical and Electronics Engineers. He has written nearly ninety articles and publications including a number of peer reviewed articles. He has authored two books and been the executive editor on a third.

Sheppard,Elizabeth A. (Lianne)

University of Washington

Dr. Elizabeth A. (Lianne) Sheppard, PhD is Professor and Assistant Chair in the Department of Environmental and Occupational Health Sciences and Professor of Biostatistics at the University of Washington. She holds a B.A. in psychology and a Sc.M. in biostatistics from Johns Hopkins University, and a Ph.D. in biostatistics from University of Washington. Her research interests focus on modeling and understanding the health effects of environmental and occupational exposures with particular emphasis on statistical methods for environmental and occupational epidemiology. She actively collaborates on a variety of research projects in the environmental and occupational health sciences and has been lead statistician for the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air) study, a 10-year study funded by EPA to determine the effect of long-term air pollution exposure on subclinical progression of cardiovascular disease. Dr. Sheppard directs a NIEHS-funded program for quantitative training in the environmental health sciences. Her recent research funding comes from EPA, NIEHS, NIOSH, and the Health Effects Institute. She is a fellow of the American Statistical Association and a member of the editorial board for Epidemiology. She serves on the Health Effects Institute's Review Committee, and has advised EPA through service on several Clean Air Scientific Advisory Committee special panels and Science Advisory Board ad hoc committees.

Sorooshian,Armin

University of Arizona,Department of Chemical and Environmental Engineering

Armin Sorooshian is an Associate Professor, University Distinguished Scholar, and da Vinci Fellow at the University of Arizona in the Departments of Chemical and Environmental Engineering, Hydrology and Atmospheric Sciences, and Public Health. He received his B.S. (2003) in Chemical Engineering at the University of Arizona, and a M.S. (2005) and Ph.D. (2008) in Chemical Engineering at the California Institute of Technology. Armin specializes in aerosol physics and chemistry, in addition to aerosol-cloud interactions. Armin is involved with projects including instrument development/characterization, surface/ship/airborne field measurements, and the use of data from models of varying complexity and remote sensing measurements. His sources of funding in the past two years include the Office of Naval Research, NASA, and the National Institute of Environmental Health Sciences. He is a member of the following professional societies: American Geophysical Union (AGU), American Institute of Chemical Engineers (AICHE), American Meteorological Society (AMS), and American Association for the Advancement of Science (AAAS).

Stuart,Amy

University of South Florida

Amy L. Stuart, Ph.D. is a Professor at the University of South Florida (USF) in the Department of Environmental and Occupational Health, College of Public Health. She holds a joint appointment in the Department of Civil and Environmental Engineering, and courtesy appointments in the Center for Urban Transportation Research, and the Patel College of Global Sustainability. She is also the founder and director of the Graduate Certificate Program in Environmental Health at USF. Dr. Stuart earned a BS in chemical engineering, a MS in civil engineering, and a PhD in civil and environmental engineering from Stanford University. She completed postdoctoral training at the Center for International Security and Cooperation at Stanford. Dr. Stuart leads multi-disciplinary research and teaching initiatives related to air pollution, public health, and environmental sustainability. Her research has contributed to understanding the impacts of urban design and transportation on air pollution exposures and their social distribution, the fate of volatile chemicals during cloud freezing, mercury contamination and exposures, and associations between air pollution and birth defects, resulting in over 100 scholarly publications. During the last two years, Dr. Stuart's work has been funded by the National Institute of Environmental Health Sciences and by the United States Department of Transportation. She is also a previous recipient of a National Science Foundation Career award. Dr. Stuart is professionally involved in the Association of Environmental Engineering and Science Professors, currently serving on the Lectures Committee. She is a member of the Air and Waste Management Association, including previous service as the Chair of the Student Awards Committee of the Higher Education Council, and is a member of the International Society of Exposure Sciences. She regularly serves as a reviewer of manuscripts for several scientific journals and of proposals for grant sponsors on air pollution topics.

Wagner,James

Michigan State University

Dr. Wagner is an associate professor in cardiopulmonary toxicology in the Department of Pathobiology and Diagnostic Investigation at Michigan State University. He earned a bachelor's degree in biochemistry, a master's degree in business administration in management science, and a PhD in pharmacology and toxicology. His post-doctoral training focused on comparative pathology and air pollutant exposure. Current research efforts are focused on conducting translational studies to understand the mechanisms of airway injury and systemic responses induced by inhalation exposures to pathogens, toxicants, and environmental pollutants. Mechanistic studies are designed to address exposure related changes to respiratory, cardiovascular, immunological, and nervous systems. Dr. Wagner has over 20 years of experience conducting both field- and laboratory-based, animal inhalation exposure studies across the country, and have relied on approaches of digital pathology, cardiovascular telemetry, pulmonary function testing, and genomic analyses in multiple transgenic and strain-sensitive rodents to understand the histopathological, biochemical, and physiologic responses to inhalation exposures. From his 77 research publications, he has been fortunate to collaborate with over 90 different coauthors from 8 units at Michigan State University and over 30 national and international laboratories. Sources of research funding in the past two years have included the National Institutes of Health (NIH), the State of Michigan, and the European Union, although previous funding sources (> 3years ago) have included the Health Effects Institute (HEI), EPA, and the American Chemistry Council (ACC). He recently contributed to the writing and review of EPA's integrated science assessment (ISA) for PM2.5 from 2015-16. Dr. Wagner has provided review and consultation for other national and international agencies, including Health Canada's Human Health Risk Assessment for Gasoline Exhaust, the EPA's ISA for both ozone and for sulfur oxides, the National Research Council's report on Submarine Air Quality, and the Japan Automotive Research Institute's strategic priorities planning. As a member of the TLV-Chemical Substance Committee for the American Conference for Governmental and Industrial Hygienists (ACGIH), he evaluates toxicological and epidemiological data to conduct risk assessment and make exposure recommendations for a variety of airborne workplace chemicals. Dr. Wagner is an active member in the Society of Toxicology where he served leadership positions in Finance, Inhalation and Respiratory Toxicology, and Cardiovascular Toxicology groups. He is a frequent panel member for proposal peer review for NIH (Children's Health Centers, Superfund Program) and CDC (World Trade Center Research Program). Lastly, Dr. Wagner is active on editorial boards of journals with a focus on air pollutant toxicology, including Inhalation Toxicology and Particle and Fibre Toxicology, and he regularly conducts peer review in Toxicological Sciences, Environmental Health Perspectives, Atmospheric Environment, and Science of the Total Environment, among others.

Waldman,Deane

Texas Public Policy Foundation

Dr. Deane Waldman, MD MBA, is a U.S. citizen and currently the Director of the Center for Health Care Policy at the Texas Public Policy Foundation as well as a Director on the Board of the New Mexico Health Insurance Exchange. He is Professor Emeritus of Pediatrics, Pathology, and Decision Science. "Dr. Deane" was educated and trained at Yale (BA, History), Chicago Medical School (MD), Mayo Clinic, Northwestern, Harvard, and Anderson Graduate Schools of Management (MBA). He practiced medicine as a pediatric cardiologist for 37 years, and was the Chief of Cardiology (Pediatric) at University of Chicago. Dr. Deane is an experienced biomedical scientist with more than 120 peer-reviewed medical research citations, over $3 million in research grants received, more than 300 publications in healthcare policy, as well as the author of nine books.Dr. Deane's scientific expertise along with nearly four decades of caring for patients, coupled with his administrative experience and practical business knowledge gives him a unique perspective. Dr. Deane's goal as a member of CASAC would be to assure that EPA standards for Clean Air are based on reliable science and that the Administrator can connect Clean Air standards to the health status of Americans.