November 26, 2019

RE: RELEASE OF FISCAL YEAR 2020-21 PROPOSED RESEARCH PROJECTS

Dear Public Stakeholders:

The California Air Resources Board (CARB or Board) has identified its fiscal year 2020-21 priority research projects. The proposed projects support CARB's regulatory priorities related to health, environmental justice, air pollution, and climate change. A research budget of $4 million is anticipated to fund five new projects and five white papers. There is one time funding of $1 million for the development of a performance evaluation tool of low-carbon transportation incentive strategies for heavy-duty trucks and off-road equipment.

The selection of these projects was guided by the research initiatives outlined in *The Triennial Strategic Research Plan for Fiscal Years 2018-2021* (Plan), along with extensive coordination with other agencies, research institutions, stakeholders, and experts in these fields of research. Additional input was received at a research roundtable that was hosted by CARB staff at the CalEPA headquarters on October 9, 2019, which provided an opportunity for the public to provide input on emerging research topics that the Board should consider for funding.

These projects will be proposed to the Board on December 13, 2019. If the Board approves these projects, staff will proceed to work with researchers to develop the research projects into complete proposals. The proposals will be reviewed by interested stakeholders and CARB's Research Screening Committee before they are fully executed. Results are anticipated in three to five years after a project commences.

For additional information on the research program, please visit our website (https://ww2.arb.ca.gov/our-work/topics/research). For more information on the Fiscal Year 2020-2021 Proposed Research Projects, please contact Dr. Sarah Pittiglio at (916) 324-0627 or sarah.pittiglio@arb.ca.gov.

Sincerely,

Elizabeth Scheehle
Chief, Research Division

Enclosure
cc: Jorn Herner, Research Division
Sarah Pittiglio, Research Division

FISCAL YEAR 2020-21 PROPOSED RESEARCH PROJECTS

Project	Cost
1 - Measurements of volatile organic compounds in the South Coast Air Basin: Chemical characterization, fluxes, and impacts on ozone and PM formation (CalNexT)	$950,000
2 - Real-world observations of vehicle emissions for light- and heavy-duty program development and verification	$900,000
3 - VMT reduction success and opportunities to overcome remaining barriers	$500,000
4 - Total exposures to air pollutants and noise in disadvantaged communities	$800,000
5 - Coupling comprehensive program metrics with a better understanding of decision drivers to facilitate lower-polluting consumer choices	$650,000
6 - Low-Carbon transportation incentive strategies using performance evaluation tools for heavy-duty trucks and off-road equipment	$1,000,000
White Paper	
7 - Integrated framework to characterize community-level air quality	$50,000
8 – Opportunities for the application of big data analytics and data fusion techniques to inform CARB programs	$50,000
9 - Leverage biomonitoring data to mitigate toxic exposure	$50,000
10 - Framework for quantifying statewide carbon fluxes between atmosphere and biosphere to inform carbon neutrality policy	$25,000
11 - Economic benefits of affordable infill housing	$25,000
Total Budget	$5,000,000

PROJECT DESCRIPTIONS

1) **Measurements of volatile organic compounds in the South Coast Air Basin: Chemical characterization, fluxes, and impacts on ozone and PM formation (CalNexT)**

Volatile organic compounds (VOCs) are precursors for the formation of both secondary organic aerosols (SOA) and ozone (O3), which cause adverse health effects, especially among sensitive populations. Due to continuous changes in VOC sources, it is important to characterize and update the atmospheric VOC composition and emissions from major sources in California - biogenic, mobile, volatile consumer products, and cooking. CalNexT is a major air quality study planned for Summer 2020 to Summer 2021 in the South Coast Air Basin (SoCAB). This is an updating of the previous, highly successful, collaborative field study with the National Oceanic and Atmospheric Administration (NOAA) and the California Energy Commission (CEC) in 2010

(CalNex 2010). While emissions from vehicles have decreased significantly since 2010, volatile organic compound (VOC) emissions from stationary sources (industrial, residential, biogenic) have not decreased as rapidly. These VOCs are precursors for the formation of both secondary organic aerosols (SOA) and ozone (O3), which cause adverse health effects, especially among sensitive populations. Therefore, improving emission inventories of VOCs is essential to make accurate predictions of O3 and fine particulate matter (PM2.5) levels for future mitigation strategies. The purpose of CalNexT is to characterize these changes in VOC emissions and their impact on air quality, and clarify new demands in air quality management. As part of this campaign, CARB will fund two major projects. The first project will carry out high-precision airborne measurements of VOC fluxes in SoCAB. The same method has been used in the past to evaluate and improve CARB's biogenic emission inventory. The second project will conduct detailed chemical speciation measurements of ambient VOCs at a ground site in the SoCAB to evaluate the variety of species and their variability. Both of these projects will leverage many additional measurements that are planned as part of CalNexT. The updated and improved characterization of VOC profiles and fluxes from these projects will help 1) improve the performance of a chemical transport model (CTM) used to develop the State Implementation Plan (SIP), 2) determine the relative contributions of mobile and non-mobile sources to O3 and PM2.5 formation, 3) update the VOC emission inventories, 4) determine the causes of recent increases in O3 and PM2.5 levels across California that negatively impact the State's ability to achieve the National Ambient Air Quality Standards (NAAQS), and 5) identify viable pathways to optimize O3 and PM2.5 reductions in California, which reduce potential exposure to pollutants that are harmful to health.

2) **Real-world observations of vehicle emissions for light- and heavy-duty program development and verification**

Motor vehicles continue to be a major source of oxides of nitrogen (NOX) and other pollutants in California, contributing to air pollution at both community and regional levels. Real-world observations of these emissions are needed to gauge the success of emission reduction efforts and to inform further mitigation strategies. The objectives of this project are to expand real-world vehicular emissions observations to cover more geographical areas in California and to continue existing long-term measurement records of these emissions. The project will use roadside remote sensing devices to measure light-duty vehicle exhaust carbon monoxide, hydrocarbons, and NOX emission rates at 8 to 9 California locations, and use a plume capture system to measure the emissions of those species and particulate matter from heavy-duty vehicles at the Caldecott Tunnel (Oakland, CA) in three annual campaigns. Results will be used to evaluate vehicle emission disparities between disadvantaged and non-disadvantaged communities across the State, quantify the emissions benefit of the final stage of the Truck and Bus Rule, inform CARB's mobile source emissions inventory, evaluate U.S.-Mexico border-crossing vehicles' air pollution impact on border communities, evaluate air pollution impact of low-performing (less stringent than required) Smog Check stations, and support the development of a future heavy-duty vehicle inspection and maintenance program.

3) **VMT reduction success and opportunities to overcome remaining barriers**

The SB 150 Report, which CARB staff released in November 2018, indicated that California is falling short of its vehicle miles traveled (VMT) reduction goals. Although transportation planning efforts across the state have identified strategies intended to reduce VMT, the real world application of these strategies is not yielding the anticipated reductions. This research project will investigate this shortfall by identifying VMT reduction success stories in California and assess their scalability/transferability and associated potential for statewide VMT reduction. This research project will also investigate remaining barriers to achieving VMT reduction goals, such as barriers to infill development, lack of access to transit or active travel, and lack of accessibility to key services and destinations. The project will utilize big travel data to examine changes in VMT, travel

behavior, trip purpose, and mode over time across California. Researchers will analyze big data alongside other datasets such as travel surveys, and assess sociodemographics, population growth, employment, vehicle ownership, overall location efficiency, land use context, etc.. The statewide assessment will be used to map out VMT and trip purpose patterns across the state, identify areas where VMT reduction strategies were successful and barriers where implementation was not successful, and assess the potential for further VMT reduction in different regions and land use contexts across the State.
Results will inform policies to better align transportation funding and land use planning with climate goals, for example by identifying strategies at the local, regional, and state level to ensure that new growth in local governments is aligned with transportation investment to reduce VMT. This information will help to inform the next SB 150 report, the next Scoping Plan, and support CARB's SB 375 program by informing SCS guidelines and evaluation. The work will also provide guidance for the Greenhouse Gas Reduction Fund's funding guidelines and quantification, and CARB comments on other transportation funding program guidelines and review of associated applications (e.g., through SB 1).

4) Total Exposures to Air Pollutants and Noise in Disadvantaged Communities

Accurate estimation of exposures to air pollutants and identification of sources and factors contributing to high exposures in disadvantaged (DAC) communities is essential to achieving the goals of AB 617. Despite overall reductions in ambient levels of air pollution, disparities still remain between pollutant exposures in DAC and non-DAC communities. This project aims to identify what air pollutants residents in DAC communities are most exposed to, activities and sources which contribute to these exposures, and relative risks for possible health effects associated with these exposures. This will be accomplished by quantifying the exposure patterns of DAC residents to particulate and toxic air pollutants such as PM2.5, ultrafine particles, VOCs as well as noise from both outdoor and indoor sources. Survey data will be used to determine if factors such as housing stock and location, and social and environmental factors impact exposures. In addition, the effect of personal behavior such as consumer product and transportation choices and activities like cooking and cleaning will be assessed as well. Results from this study will be used to inform future research and determine if elevated risk to particular air pollutants necessitate more stringent regulations/standards or additional mechanisms for protection of residents in DAC communities.

5) Coupling Comprehensive Program Metrics with a Better Understanding of Decision Drivers to Facilitate Lower-Polluting Consumer Choices

Achieving California's challenging climate and air quality objectives will require large-scale deployment of low-polluting technologies and practices, which in turn will require a deeper understanding of what drives consumer choices. Further, the 2017 Climate Change Scoping Plan Update recognizes that consumer choice and adoption is key to achieving the state's climate targets. Messaging about the benefits of climate change policies in improving health and well-being can lead to increased community and decision-maker support among vulnerable groups for aggressive climate and air quality policies and measures. Thus, there is a critical need to develop comprehensive metrics, beyond the Social Cost of Carbon, to better quantify climate, air quality, and other co-benefits of reducing greenhouse gas emissions. These metrics can be leveraged with a better understanding of consumer choice drivers – along with more strategic communication methods for conveying those metrics – to facilitate lower-polluting consumer choices on a broad scale. The objectives of this three-part project are to: (A) capture more programmatic benefits beyond direct avoided damages (Social Cost of Carbon) – and develop, if feasible, a social cost of criteria and toxic emissions; (B) develop an appropriate framework for conducting additional research to better understand key consumer choice drivers; and (C) identify optimal communications for end users and other target audiences to facilitate better environmental outcomes by leveraging the fuller understanding of benefit metrics and choice drivers in (A)

and (B). The project will involve an appropriate use of literature review, data gathering and generation, modeling and testing, marketing and consumer surveys, and other methodologies to develop: (1) the enhanced benefits metrics, (2) a framework for further research into consumer choice drivers, and (3) more impactful communication campaigns intended to facilitate low-polluting choices in technologies and practices on a large scale. The results of this project will better inform policymakers, rulemakings, legislators, and other stakeholders on comprehensive program benefits and the best ways to inform end users of the benefits of their actions and decisions.

6) **Low-Carbon Transportation Incentive Strategies Using Performance Evaluation Tools for Heavy-Duty Trucks and Off-Road Equipment**

To meet federal health-based air quality standards and California climate change goals, including carbon neutrality by 2045, medium and heavy-duty vehicles (HDVs) and off-road equipment (ORE) operating in California must transition to low-NOx emission technologies coupled with advanced renewable fuels and to zero-emission vehicles where possible. Multiple incentive programs and regulatory measures exist to facilitate the transition to low carbon technology, however, the HDV and ORE sectors are complex and varied in their energy consumption and operational characteristics. Incentives are a useful tool to bring new technologies to greater maturity and market acceptance and although they have a high initial cost to the state, the benefits propagated by these programs are positive and lead to deep and lasting changes to the market landscape, economy and health outcomes. The objective of this project is to identify potential policy and incentive strategies that promote greater adoption of low-carbon transportation (LCT) technologies (zero and near-zero carbon and pollutant emissions) in the heavy-duty and off-road sectors. This project will involve a detailed analysis of data collected through existing incentive and regulatory programs as well as a market analysis of LCT technologies to ascertain the extent to which incentive programs affect the market share of LCT and its positive socioeconomic impacts. Barriers to adoption of LCT by the HDV and ORE sectors will be identified. A market survey will be performed either through paper surveys or through focus group interviews to continue to assess incentive strategies and identify barriers to adoption of new technologies. An incentive program performance evaluation tool will be created from the initial analysis using criteria quantifying market, health and economic impacts. New incentive strategies will be proposed that promote LCT adoption and would likely lead to large impacts on health and the market in future years. Finally, this project will forecast low-carbon transportation technologies' attainment of cost parity or market acceptance relative to conventional technologies without incentive program supports.

7) **Integrated Framework to Characterize Community-Level Air Quality**

It is essential to understand community-scale air quality and implement mitigation measures in the most impacted communities. In addition to the regional regulatory air monitoring network, new approaches have become available to study community-level air quality, such as satellite retrieval, remote sensing, sensor network and mobile measurement. The object of this project is to develop an integrated framework to characterize community-level air quality based on multiple approaches. The project will review and summarize existing approaches and findings on community air monitoring from both inside and outside of California, and develop a framework to integrate data from different measurement and analysis approaches to provide a comprehensive understanding of air quality in local communities. Results from this project will guide future scientific research including citizen science to design and perform community air monitoring studies and interpret the results. The project will also identify research gaps and make recommendations for future research on community air quality.

8) **Opportunities for the application of big data analytics and data fusion techniques to inform CARB programs**

California is embarking on new challenges in air quality, climate change mitigation and adaptation, and clean energy futures, while balancing the broader goals of social equity, economic growth, and environmental sustainability. All these objectives will require development and implementation of integrated programs that can successfully achieve diverse goals. As we embark on these new challenges, application and exploration of big data analyses and data fusion techniques may offer new opportunities to inform, improve, and build effective programs. CARB staff is conducting a survey to take stock of existing large data sets at CARB, to investigate how these data systems are currently being used, and how combined use of these disparate datasets may provide additional information for program development, planning, and implementation. This effort will expand on the initial survey by CARB staff to take stock of programs that could benefit from big data analysis and data fusion techniques. This project will build on the current efforts by bringing external big data expertise to help evaluate program connections, identify research gaps, and outline additional datasets and approaches that can be integrated into CARB programs.

9) **Leverage biomonitoring data to mitigate toxic exposure**

The objective of this proposed study is to develop a high-resolution map of blood lead levels to identify potential sources of lead exposures. The results of this study could help identify previously unknown sources of lead emissions. The results could also identify targets for mitigation efforts including education, enforcement, and regulatory action. This research project would be a collaboration with the California Department of Public Health. The project would need blood lead data at a higher resolution than is publically available on the CDPH website. Census tract-level resolution would be sufficient in densely populated areas with small census tracts. Areas with larger census tracts may require more granular data to identify lead emissions hotspots. CARB recognizes the confidential nature of the data. This project would require institutional review board approval to protect the rights and privacy of everyone's medical information. CARB has experience obtaining IRB approval for research projects.

10) **Framework for quantifying statewide carbon fluxes between atmosphere and biosphere to inform carbon neutrality policy**

Limiting global warming to 1.5°C requires urgent action to reduce global annual carbon emissions to net zero, and California has taken steps in that direction by adopting an ambitious climate target of achieving carbon neutrality by 2045. To achieve this goal, CARB needs a comprehensive strategy to minimize the statewide anthropogenic carbon emissions, and also protect and enhance the carbon uptake capabilities of the natural land while increasing the statewide artificial carbon sequestration levels. It will also be important to have a thorough knowledge of current sources and sinks of carbon in the state as a benchmark to make optimized mitigation portfolio choices and climate investments for the future. The objective of this project is to leverage new theory and observations in land, atmosphere, and space-based research to develop a framework for accurate partitioning of statewide carbon fluxes between terrestrial ecosystems and the atmosphere at high spatial and temporal resolution. This project will define a comprehensive process-based upscaling framework using multiplatform measurements and geo-statistical inverse modeling systems to improve the carbon budget analysis of the CARB GHG emission inventory. Such a system will be useful to analyze the statewide carbon budget against the climate goals to evaluate our progress in the future.

11) **Economic Benefits of Affordable Infill Housing**

California's persistent shortage of affordable housing has driven up housing costs, and exacerbated housing-burdened poverty and homelessness. Although California has enacted laws – such as SB 375 -- to encourage development of affordable infill housing, many municipalities have adopted regulations that inhibit its development, and housing production in California is falling short of each region's housing needs determination (established by the Department of Housing and Community Development). The objective of this project is to review the literature on the economic impacts of affordable infill housing and characterize the economic benefits of expanding the supply of affordable infill housing in California communities. The review will cover both market and non-market economic benefits and will assess their potential influence on local and regional stakeholders vis-à-vis affordable infill housing production. The white paper will also recommend policy-development and communication strategies that permit State incentive-fund and SB 375 programs to leverage the identified economic benefits to optimize development of affordable infill housing.