Summary of Technical Comments on CalEnviroScreen Made by the Panel of Academic Experts at the Workshop Held in Oakland, California September 7, 2012

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Note: Dr. Mohai is one of seven members of the academic expert panel that commented on the draft CalEnviroScreen report at the September 7 workshop. Other panelists are listed here: http://oehha.ca.gov/ej/pdf/090712academicpanel.pdf

Selection and Scoring of Indicators

The screening tool is composed of five components, three reflecting pollution burdens (Exposures, Environmental Effects, Public Health Effects) and two reflecting population characteristics (Sensitive Populations, Socioeconomic factors). There are 19 indicators contained within these five components. Exposure Indicators include: 1) Ozone, 2) PM2.5, 3) Pesticide Use, 4) Toxic Releases from Facilities, 5) Traffic Density. Public Health Effects Indicators include: 1) Asthma, 2) Cancer, 3) Heart Disease, 4) Low Birth Weight. Environmental Effects Indicators include: 1) Cleanup Sites, 2) Impaired Water Bodies, 3) Leaking Underground Storage Tanks, and Cleanups, 4) Solid Waste Sites and Facilities and Hazardous Waste Facilities. Sensitive Populations Indicators include: 1) Percent of Population under 5, 2) Percent of Population over 65. Socioeconomic Factors include: 1) Educational Attainment, 2) Income, 3) Poverty, 4) Race/Ethnicity.

Although there was general agreement among the panel of academic experts about the suitability of these indicators, with perhaps the exception of the percent over age 65 indicator (see below), most of the discussion of the panel focused on how improvements could be made to the list of indicators used for the screening tool. The list of suggestions included: considering additional indicators or deleting some; indicators be tested for independence; alternative metrics for reproductive outcomes, heart disease, cancer and asthma as well as ozone and PM 2.5; and moving certain indicators to other components, or reorganizing the indicators entirely into two components, one reflecting potential environmental exposures and the other reflecting population vulnerability.

One of the panel members recommended that indicators that do not exist at the zip code level should be excluded from the screening tool. Specifically, county-level values for public health indicators such cancer and heart disease mortality should not be used to impute values for the zip codes because the actual zip code values within the county may have a great deal of variation within them. To assume they are the same for all zip codes in the county when they are not may lead to misleading results.

Exposure and Environmental Effects Indicators

Most of the discussion regarding the Exposure and Environmental Effects indicators focused on including additional data, availability of data at the desired level of spatial resolution, the choice of metric to represent the indicator and whether the indicator was a reasonable proxy for exposure. One of the data sets that was recommended by some of the panelists was the U.S. EPA's National Air Toxics Assessment (NATA). NATA provides air pollution burden estimates from all sources (major industrial, minor industrial, on-road mobile, non-road mobile, and background). Estimates are available for every census tract in the U.S. These estimates can be reconfigured to zip code boundaries by using geographic information systems (GIS) areal apportionment methods. Air pollution burden estimates from single chemicals or for aggregated chemicals (expressed in terms of respiratory, cancer, and neurological risk) can be obtained.

One significant advantage pointed out by one of the experts is that NATA contains estimates of diesel emissions. This expert also pointed out that a number of chemicals modeled by NATA for California correlate well with air quality monitor measurements and recommended that NATA estimates be used to determine concentrations of these chemicals for the California zip codes. However, another expert described an entirely different experience with the quality of NATA estimates. In addition this panelist suggested that traffic density served as a surrogate for all traffic-related emissions, including diesel exhaust emissions.

Another expert who had worked with NATA data for Michigan also found that a number of chemical concentrations estimated by NATA correlate well with data from air quality monitor measurements and similarly recommended using NATA estimates for these chemicals in the screening tool. Another expert pointed out the states provide the pollution data that EPA uses to model NATA and those inputs are similar to what the California screening tool is using. Although one panelist did not support the use of NATA, the U.S. EPA views NATA as one of the key environmental indicators in its own environmental screening tools. These include EJSEAT, EJ Screen, and CenRANK.

Two of the experts also suggested using the U.S. EPA's Risk Screening Environmental Indicators Geographic Microdata (RSEI-GM) to obtain data about potential air pollution exposures from industrial sources for zip code areas. RSEI-GM is based on modeled air pollution dispersion estimates derived from industrial emissions reported to the Toxic Release Inventory (TRI). The U.S. EPA has produced air pollution burden estimates for each square kilometer of the U.S. These estimates can be aggregated to the zip code level using GIS areal apportionment methods.

Some panelists were of the opinion that the use of the RSEI-GM data would help improve the estimates of industrial air pollution burdens in zip code areas currently proposed. The current method proposed for the screening tool involves multiplying total hazard-weighted pounds of chemicals released on-site to air or water from all facilities within the ZIP code, or within one kilometer of the ZIP code. This method implicitly assumes that releases do not travel very far. What about impacts from facilities farther than 1.0 km away? RSEI-GM could be used to determine total toxic concentrations for the zip code area from all industrial sources, regardless of the distance of the source to the zip code.

Some of the experts expressed concern about the limited number and dispersion of air quality monitors in the state and whether these where adequate for imputing values for ozone and PM2.5 to zip code centroids that could be as far as 50 kilometers from the monitors. These experts felt that supplemental data from NATA and RSEI-GM would therefore be especially helpful.

Another recommendation made by one of the panelists was to take into account proximity to ports, railroads and airports in the screening tool because such proximity is an indicator of sources of air pollution and also an indicator of noise exposure and other hazards.

Another point of discussion was related to the pesticides indicator. Some experts argued that the indicator should reflect exposure not the use, but agreed that such data is not readily available and would take time to generate as well as the limitations to generate for the whole state. Furthermore, one expert felt that exposure *potential* is an important indicator of potential risk. He disagreed with those who assert that one must also have toxicological data before one can claim potential risk. One expert suggested that folding in information on proximity to sensitive receptors such as schools and pregnant women could also be considered in this context – while school locations could be easily identified and proximity would be applicable to all hazards, it was not clearly articulated how exposure of pregnant women could be characterized for pesticides with the large geographical scale of pesticide use data.

Public Health Effects Indicators

There was some discussion about whether the Public Health Effects indicators and component reflect vulnerability or reflect "effects" of environmental exposures. Many of the experts believed it might be better to combine the Public Health Effects indicators with the Sensitive Population and Socioeconomic Factors indicators to create a "Vulnerability" component. One panel member expressed the belief that "birth outcomes are a perfect indicator of vulnerability".

Some expressed concerned that emergency hospital visits may underestimate asthma incidents but others supported its inclusion in the screening tool as an indicator of population vulnerability rather than environmental health effects. Some were of the opinion that asthma ER visits were mostly an indicator for lack access to health care rather than the prevalence of asthma in the population. An alternative indicator of diagnosed asthma in an area, growth retardation in infants, and incidence of lead-poisoning in the zip code areas were also suggested. It was also suggested to consider ER visits for cardiovascular-related illness instead of heart disease mortality.

Sensitive Population Indicators

As mentioned above, one of the experts raised concerns about including simultaneously the percentage under age 5 and the percentage over age 65 in the screening tool, as these are contradictory indicators, i.e., as one is higher in a zip code area, the other is lower. Including both may have a tendency to cancel each other out. Furthermore, this expert found in an earlier analysis pertaining to the U.S. EPA's EJSEAT screening tool that percent over age 65 tends to be negatively correlated with pollution and poverty indicators, i.e., as the percentage of those above age 65 in an area becomes higher, pollution and poverty rates become lower. He explained that this may be because neighborhoods with low levels of pollution and well-off socioeconomically may have higher life expectancies. He recommended excluding contradictory indicators that tend to cancel each other out or otherwise reduce the visibility and ranking of neighborhoods that are environmentally and socioeconomically vulnerable.

Other experts in the room felt that the percent under age 5 should be retained as children are especially vulnerable biologically and socially to environmental stressors. Furthermore, percent under age 5 is positively correlated with pollution and poverty indicators, in contrast to percent over age 65. Some supported retaining percent over age 65 as the elderly are nevertheless biologically vulnerable regardless of where they are concentrated geographically. It was also pointed out that CalEnviroScreen being a geographically defined area based analysis, alternate approaches must be considered to ensure that the two age variables do not confound each other.

Socioeconomic Effects Indicators

One of the experts recommended dropping income as an indicator in the screening tool, as this is correlated with poverty (and is already included). Instead it was recommended including property ownership in the screening tools as it is an indicator of social capital (or lack thereof) in the community.

Some of the experts also felt that linguistic isolation should be included among the indicators. A question, however, is whether this could overweight the Hispanic and Asian populations and in turn reduce the relative ranking of zip codes with higher proportions of African Americans.

Another suggestion made was to include as an indicator the percentage of households that use more than 50% of their income on housing. The percentage of households with access to air conditioning and life-expectancy at birth were also suggested as indicators.

The Model

For each indicator, zip codes are sorted into percentiles based on the zip code's value for the indicator, typically from the lowest to highest. The percentile values are then averaged across the indicators within the component. These averaged percentiles are then mapped or scaled to a range designated for the component. For the Exposure component, the averaged percentiles are scaled to a range of 1-10. For the Public Health Effects Component, the averaged percentiles are scaled to a range of 1-5. For the Environmental Effects Component, the averaged percentiles are also scaled to a range of 1-5. The resulting component scores are summed across these three components.

For the Sensitive Populations components, the averaged percentiles are scaled to a range of 1-3. For the Socioeconomic Factors component, the averaged percentiles are also scaled to a range of 1-3. The resulting component scores are then summed.

A Cumulative Impact score is computed by multiplying combined pollution burden component scores with the combined population characteristics component scores.

Weighting the Indicators and Components

Averaging the percentiles of the indicators within a component makes an implicit assumption that each indicator in the component has the same level of importance as every other indicator within the component. Several of the panelists agreed that this implicit weighting should be made explicit.

Also important to consider is that the number of indicators within a component also affects the relative importance given to individual indicators. Mathematically, the more indicators a component has, the less weight each of the indicators has compared to those in components with fewer indicators. For example, there are only two indicators for the Sensitive Populations component but four indicators for the Socioeconomic Factors component. Since in both cases percentiles of the respective indicators are averaged, the weight for each of the two indicators in the Sensitive Populations component is mathematically double the weight for each of the indicators in the Socioeconomic Factors component. Specifically, in the first component each indicator is multiplied by ½ while in the second component each indicator is multiplied by ¼. Is it correct to assume, therefore, that the percent over age 65 (in the Sensitive Populations component) is twice as important as percent living below the poverty line (in the Socioeconomic Factors component), as these weights imply?

Concern was also expressed by a number of the experts about the approach of scaling the averaged percentiles of the indicators in a component into more limited ranges. For example, the averaged Exposure component percentiles are scaled onto a range from 1 to 10, the averaged Health Effects component and averaged Environmental Effects component percentiles are scaled onto a range from 1 to 5, and the averaged Sensitive Populations component and averaged Socioeconomic Factors component percentiles are scaled onto values of 1 to 3. It is not clear why the different components should be assigned different ranges. A consequence of using small ranges, such as 1-3 and 1-5, is that the resulting score could have very low resolution and may fail to flag the zip code areas where the focus would be needed.

It was pointed out that such scaling artificially reduces the variation in the data. That is, the percentiles (which range from 1 to 100) are compressed into smaller number of categories (e.g., 1 to 10, 1 to 5, or 1 to 3), which in effect throws away useful information. One of the experts pointed out that, in a review and analysis of another screening tool being developed by the U.S. EPA, when sorting units into percentile categories based on the units' absolute values, the range of values in the top most category typically has a great deal of variation. Values at one end of the interval may be considerably smaller than values at the other end. Thus, it may be useful to preserve the range of values in the top interval rather than collapsing the range into a single number. For example, the state may only have resources to devote to the top 1% impacted zip codes vs. the top 10%. However, once the range in the top interval has been collapsed, it may not be possible to flag the top 1%.

It was also mentioned that no explanation is given as to why different ranges are used for the various components. Scaling the five components onto different ranges results in different weights for the five components in the final scoring and ranking of the zip code areas. For example, the Exposure component percentiles are mapped onto a range from 1 to 10. Thus, the highest value that the Exposure component can attain is 10. However, the Health Effect and Environmental Effects component percentiles are mapped onto a range from 1 to 5. Thus, the highest value that the Health Effect and Environmental Effects components can attain is only 5. When these values are summed, a value of 10 will have more weight than a 5 in the final score. One of the experts pointed out that such weighting may sometimes be desirable, but the choice of the weights needs to be justified.

A suggestion was also made to reconfigure the tool: a matrix structure where each community would be assigned a burden and vulnerability rating of low, medium, or high based on appropriate indicators. Communities rating high in both categories (burden and vulnerability) would be good candidates for most of the EJ-related purposes contemplated by Cal/EPA.

A concern was also expressed about a problem associated with the relative ranking approach. The concern was that it discounts the burdens borne by communities with extremely high impacts and that it might introduce distinctions between communities that are well below thresholds or established safe levels. In addition, it may overstate negative conditions in a zip code(s) regardless of the level of improvement that has occurred or may now be at levels considered to be safe. For example, some zip codes may still be flagged in the top 10% in terms of air pollution, even though air pollution levels may have been reduced significantly and air quality may now be relatively good.

It was also suggested to dispense with the scaling of the component scores, and simply use the averaged percentiles of the indicators within the component as the component score. This would preserve a higher level of resolution for the component score, reduce unwanted outcomes resulting from complicated weighting schemes, and overall simplify the model.

Another suggestion was to rank each of the state's1800 zip code areas based on the values of each the 19 indicators currently used in the screening tool, and then to take the average of the19 rankings to produce a final overall ranking of the zip codes. This would preserve the highest level of resolution, as zip codes would in effect be sorted into categories of 1 to 1800, rather than only into categories of 1 to 100 (i.e., into percentiles). Another advantage of this approach is the simplicity of the model and the accompanying mathematical calculations. In addition, a rank correlation analysis would identify potentially duplicative indicators.

Accounting for population density in all zip codes or another scale that would be finally used was also suggested. (Author's comment: While this would fit the typical public health protection paradigm of getting maximum benefits for the buck, it could undermine the fundamental issue of fairness or equity in benefit distribution across all geographical areas, a primary concern in addressing environmental justice).

Summing vs. Multiplying Component Scores

There was some discussion about whether it is desirable to sum the component scores for Sensitive Populations and Socioeconomic Factors separately from the sum of the Exposure, Health Effects, and Environmental Effects scores, and then to multiply the two sums to derive the final Cumulative Impact score for the zip codes. Some experts observed that the multiplication step is the standard approach taken in risk assessment. Others suggested simply summing all the five component scores directly. They pointed out that, for purposes of the screening tool, summing without the multiplication step may be adequate and even more desirable. One panelist suggested that the purpose of the multiplicative approach was to enhance the environmental burden based on the vulnerability of the population, but that the ranges of the multipliers might be too high for the environmental burden indicators. In either case, it would be worthwhile conducting a sensitivity analysis to see how much the results converge or diverge by taking the two different approaches.

Alternate Groupings of the Indicators

It was not clear to some of the experts why the Public Health Effects component was summed with the Exposures and Environmental Effects components, as the Public Health Effects variables can also be seen as indicators of vulnerability, such as the age and socioeconomic variables. One of the experts suggested collapsing the 19 indicators that are currently grouped into the five components into only two components, one to reflect potential environmental exposures and the other to represent vulnerability. He suggested including the Public Health Effects variables in the vulnerability component. Reducing the number of components simplifies the environmental screening rankings both conceptually and mathematically. There appeared to be general support among the experts for this idea.

Some experts proposed that an alternate way of grouping the indicators would be to group them based on whether or not something could be done about the conditions they reflect. For example, environmental exposures can be reduced, but many of the socioeconomic variables, such as race and ethnicity, cannot be changed. Thus, sorting indicators into components based on what we can change separately from those we cannot was also suggested

One of the experts argued for grouping the indicators into three components: Environmental Exposures, Socioeconomic Factors, and Health Outcomes.

Regional vs. State-wide Scoring

Some of the experts felt that the scoring of the zip codes should be done regionally rather than state-wide, given the size of and diversity within the state.

Sensitivity Analysis

Some experts suggested using factor analyses to determine how well the various indicators hang together in the five components. Factor analysis could also be used to identify indicators that are not well associated with the current components. They also could be used to determine whether the 19 indicators might be grouped differently from the current five components. Some panelists agreed to the suggestion that rank-order correlation analysis be used to determine the indicators that need to be excluded (being duplicative in nature).

A number of experts suggested performing sensitivity analyses to see how well each of the 19 indicators distinguishes among the zip code areas. One suggestion was to map each of the indicators by zip code to see if they flag the zip codes in ways that make sense. I.e., do they highlight areas known to be high in environmental burdens, high in negative health outcomes, high in poverty rates, etc.? Does the inclusion of some indicators result in obfuscating known problem areas? Do they bring “noise” into the data or are simply redundant?

In addition, sensitivity analysis could be performed to determine how inclusion or exclusion of certain indicators affects the zip code rankings. It also can be used to determine how different weightings of the indicators or components affect the ranking outcomes. The zip code rankings produced by the varying schemes/approaches could be correlated with each other to see how consistently they produce similar rankings. If approaches produce similar results, the correlation coefficients should by high, say between 0.9 and 1.0, and would indicate that the screening tool is robust despite tweaking the indicators lists and weights.

Some panelists discussed how the correlational analysis could also be applied to see how well each of the indicators is correlated with the others. Indicators that are negatively and statistically significantly correlated with the majority of known indicators of environmental injustice, such as poverty, minority status, presence of hazardous sites, etc., should be considered for re-evaluation and possible elimination. It was suggested that extraneous and incompatible indicators be eliminated, as these will only insert noise into the data and camouflage rather than highlight problem areas. Percent over 65 may be one such variable as discussed above. Ideally, the environmental screening method should highlight areas that have high concentrations of environmental hazards and/or high concentrations of vulnerable populations.

To verify the results of the rankings, one of the experts suggested looking at life expectancies in the top rated zip codes.

Other Suggestions

Many of the experts felt that census tracts may be a better geographic unit of analysis to use than zip code areas because they are generally smaller and thus preserve more variability and are geographically more specific. Also, the U.S. EPA plans on using census tracts in their EJ Screening tool, and thus the California and U.S. EPA screening tools will not be entirely compatible. One expert, however, felt that an advantage of zip codes is that everyone knows what zip codes they live and work in, while no one knows what census tracts they live or work in. Thus information from the screening tool may be more easily interpretable and meaningful to community members at the zip code level. Some felt that with the availability of the internet and mapping software such as Google

Earth, it should relatively be easy for people to see where they live and so information at the zip code level may not be critical. A caveat, however, is that people in poor communities that may be the hardest hit by pollution may not have easy access to computers or be familiar with the how to access maps and other information from them.

Most of the panel members seemed to agree that the advantages of using census tracts outweigh the limitations posed by using zip codes. However, one panelist pointed out that using a finer spatial resolution (such as census tracts) could introduce additional interpolation errors for some indicators.

Several panel members pointed out that, with the current percentile sorting and component weighting approaches, improvements in the zip codes over time will be difficult to assess. It would be especially important to measure improvements made in the zip codes flagged as most problematic. A possible solution might be to periodically check the untransformed values of the indicators over time to see if improvements have been made. For example, do air quality monitors reveal decreases in air pollution burdens in the flagged zip codes over time? Do Census data reveal reductions in the poverty rates of the flagged zip code areas over time?