REVIEW OF THE SCAQMD SOCIOECONOMIC ASSESSMENTS

Documentation

Task 1-4 (FINAL)

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List of Abbreviations

ABAG	Association of Bay Area Governments
AERMOD	American Meteorological Society/U.S. Environmental Protection Agency Regulatory Model
AQMP	Air Quality Management Plan
BAAQMD	Bay Area Air Quality Management District
BACT	Best available control technology
BEA	Bureau of Economic Analysis
BenMAP	Environmental Benefits Mapping and Analysis Program
BPT	Benefits per ton
C-R	Concentration-response
CAAA	Clean Air Act Assessment
CARB	California Air Resources Board
CGE	Computable general equilibrium
CMAQ	Community Multi-scale Air Quality Model
COI	Cost-of-illness
DCF	Discounted cash flow
EJ	Environmental justice
GAMS	General algebraic modeling systems
I-O	Input-output
ICP	International Cooperative Program
ISA	Integrated Science Assessments
LCF	Levelized cash flow
LEV-III	Low Emission Vehicle Program
MAGIC	Model of Acidification of Groundwater in Catchments
MATES	Multiple Air Toxics Exposure Study
MATS	Mercury and Air Toxics Standards
MIT	Massachusetts Institute of Technology

MRAD	Minor restricted activity days
MWTP	Marginal willingness to pay
NAAQS	National Ambient Air Quality Standards
NACAA	National Association of Clean Air Agencies
NAICS	North American Industry Classification System
NAPAP	National Acid Precipitation Assessment Program
NESCAUM	Northeast States for Coordinated Air Use Management
NO_x	Nitrogen oxides
O&M	Operations and maintenance
OMB	Office of Management and Budget
PM	Particulate matter
$PM_{2.5}$	Fine particulate matter
RACT	Reasonably available control technology
RECLAIM	Regional Clean Air Incentives Market
REMI	Regional Economic Models, Inc.
RIA	Regulatory Impact Analysis
RIMS II	Regional Input-Output Modeling System
RTP	SCAG 2012 Regional Transportation Plan
SAM	Social accounting matrix
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SDCAPCD	San Diego County Air Pollution Control District
SIP	State Implementation Plan
SJVAPCD	San Joaquin Valley Air Pollution Control District
SMAQMD	Sacramento Metropolitan Air Quality Management District
SO_2	Sulfur dioxide
TCEQ	Texas Commission on Environmental Quality
TCM	Transportation control measure

TSP	Total suspended particulates
USEPA	U.S. Environmental Protection Agency
USEPA SAB	U.S. Environmental Protection Agency Science Advisory Board
VCAPCD	Ventura County Air Pollution Control District
VHT	Vehicle hours traveled
VMT	Vehicle miles traveled
VOC	Volatile organic compound
VSL	Value of a statistical life
WESTAR	Western States Air Resources Council
WTP	Willingness to pay

Executive Summary

Abt Associates has conducted an evaluation of the South Coast Air Quality Management District's (SCAQMD, or the District) practices for conducting socioeconomic assessments for Air Quality Management Plans (AQMP) and individual rules. The key purpose is to evaluate whether these practices represent state-of-the-art methods for these assessments, whether the scope of the analysis undertaken is adequate, and whether the documentation assures a transparent and balanced presentation to reflect interests from different parties.

To fulfill this goal, we have reviewed recent socioeconomic assessments performed by the SCAQMD and sixteen other public agencies in U.S., surveyed analysts at comparable agencies, and interviewed a broad range of stakeholders. The evaluation approach and process is summarized below and detailed in Section 2 of this report.

- Identification and selection of qualified public agencies
- Procurement of representative recent socioeconomic assessments from the SCAQMD and selected public agencies
- Approach to reviewing the rule assessments from the SCAQMD and other public agencies
- Selection of stakeholders to ensure a balanced representation from various sectors
- Design of the Interview instrument
- Interview process and development of a response summary

Our evaluation finds that the SCAQMD's socioeconomic assessments are more comprehensive in both breadth and depth in comparison to those conducted by the majority of other agencies considered in this evaluation effort. For example, many other agencies do not conduct a benefits analysis, whereas the SCAQMD includes analyses of health, visibility, material, and congestion relief benefits. Most other agencies do not examine environmental justice (EJ) implications of their rules, while the District evaluates changes in $PM_{2.5}$ exposure in EJ communities and reports disaggregated benefits, costs and economic impacts for counties and sub-regions within the South Coast Basin. We also find that agencies' resources available to conduct analyses may be linked to the detail level of the assessments. The USEPA's staff and related resource greatly exceed that available to other agencies included in this review.

In general, we find that the SCAQMD uses a sound methodology in its health benefits, compliance cost, and economic impacts analyses.

- The cost analysis includes the major costs of relevant control measures, including the capital, operations, and maintenance costs (O&M), as well as administrative costs. The cost effectiveness calculation method (discounted cash flow method [DCF]) is reasonable, although many other agencies use a levelized cash flow (LCF) method. To allow comparison with other agencies' analyses, we recommend that the District include results based on LCF method in addition to the DCF results in its future analysis.
- The District staff uses EPA's Environmental Benefits Mapping and Analysis Program (BenMAP) tool to estimate health benefits. BenMAP has been peer-reviewed and is a state-of-the-art model for estimating health impacts of air pollution. The District staff has

conducted customized BenMAP analysis with region-specific inputs (e.g., mortality concentration-response function and mortality valuation).

- For economic impact analysis, the District staff uses a well-established and peer reviewed tool — the Regional Economic Models Inc. (REMI) Policy Insight model—which has been customized for the four-county District.

As a science-based agency, the District recognizes the need for periodic review of its practices. Effective reviews do not simply provide a "rubber stamp" approval of existing practices. As such, our evaluation identifies some scope for reconsideration of and improvements in current practices in the SCAQMD's socioeconomic assessments.

One such area concerns the documentation of implementation details for practices and assumptions used in the analyses. Greater efforts at this type of documentation would enhance the transparency of its assessments. Some examples include:

- The baseline and policy/project scenarios are not clearly defined. This can result in confusion in the attribution of benefits and costs to the AQMP or individual rules.
- Methods and data used in cost analyses are not explained sufficiently. Our evaluation was greatly facilitated by Excel spreadsheets provided by the District staff, but much of the information from these spreadsheets was not discussed in the assessment documents.
- The documentation is incomplete for the benefits transfer approaches used to adapt existing research to the needs for each specific policy assessment. In addition, descriptions of data inputs and assumptions are sometimes limited or missing (e.g., baseline health incidence data, studies used for estimating morbidity effects, income elasticity, etc.)
- The brief descriptions of REMI modeling in the analyses omit the details necessary to judge the assumptions and application of the model for specific analyses. Our evaluation was aided by the materials provided by the District staff and REMI Inc.

Another area where District staff should re-consider existing practices is in the treatment of uncertainty in the key components of the analyses. It is especially important to consider how uncertainties surrounding the most influential components and variables in analyses could affect results, and in turn, influence decision making. Current assessments contain brief qualitative discussion. In some cases District staff considered the areas where uncertainties could be important to analytic results; however, little insight is provided on the potential direction or magnitude of uncertainty. For example, point estimates are reported throughout the assessment without quantifying any uncertainties. For cost analysis, there does not appear to be specific consideration of uncertainty (e.g., assumptions used in estimating the capital and O&M costs, the discount rate, or the emission reductions achieved by the controls). The benefits analysis does not include confidence interval estimates (from BenMAP for example) or sensitivity analyses of key assumptions and data inputs (e.g., choices of C-R function, valuation, discount rate, income elasticity, etc.). Uncertainty in the results of the economic impact analyses is commonly investigated using a scenario-based approach in which multiple scenarios are considered and their results are compared. Such scenario analyses have been omitted from most of the SCAQMD's socioeconomic assessments.

We also identified some issues associated with the application of REMI. The REMI model allows users to specify changes to the coefficients in the migration equation as levels or as the equivalent of

a proportionate change in real relative compensation. We believe the magnitude of these adjustments must be properly normalized to link the change in air quality to both the baseline level of air quality and the baseline levels of all the other amenities and dis-amenities that contribute to the estimates for the relative attractiveness of one area compared to others. This modification would not require a change in REMI's structure but would require detailed analysis of the input information developed for REMI. There is recent literature that emphasizes the importance of considering a wide array of amenities in understanding the changes in relative real wages, housing costs, and the migration decisions that are being represented in REMI. Plantinga et al. (2013) and Kuminoff et al. (2013) are notable examples.

Interviews with stakeholders revealed some common themes as well as mixed opinions. Consistent with our evaluation, the respondents found that the methods and tools used in the SCAQMD's socioeconomic assessments are generally appropriate. Many respondents also endorsed the scope of the District's analyses, noting that these addressed a comprehensive array of components. The majority of respondents also found the presentation of results clear and understandable, even for lay public.

Stakeholders expressed a common concern regarding the accuracy of data inputs and assumptions used in the analyses (e.g., assumptions about cost data and equipment life) and the lack of uncertainty analysis in data inputs and results. A second concern is that the REMI is an inappropriate tool for addressing industries dominated by small businesses. Third, there is a concern about the inclusion of the impacts of the Southern California Association of Governments (SCAG) transportation control measures (TCM) when estimating economic costs and benefits. Another common concern is about the credibility of assessments conducted by the District; many stakeholders felt that the rule assessment could be biased if the SCAQMD makes rules and also conducts socioeconomic assessments. Finally, a large majority of stakeholders noted that the District does not make sufficient outreach effort, especially for small businesses.

Based on our review and stakeholder interviews, we make specific recommendations for the District to consider as part of its efforts to continue enhancing the credibility and reliability of its socioeconomic assessments for AQMP and rules. These recommendations are detailed in Section 6 of this report. We provide a summary of key recommendations here.

- The District should redouble its efforts to enhance documentation of the definitions of the baseline and policy scenarios. This effort should extend to assure the consistent implementation of assumptions throughout the entire analysis. If SCAG's TCMs are considered in the baseline as described in the 2012 Assessment, then the District should remove elements of these initiatives from its socioeconomic assessment of the AQMP: the congestion relief benefits from the benefits analysis, the TCM control costs from the cost analysis, and other economic impacts due to congestion relief benefits and costs. These are not logically a part of the assessment of these rules but rather they contribute to the baseline conditions.
- The District should institute a systematic process to review recent literature in specific areas relevant to its socioeconomic assessment and determine when it is prudent to update the practices that are a central part of the assessment methodology. We recommend that the

District's Scientific Advisory Group lead such an effort and periodically suggest relevant literature to the District staff.

- Incorporating treatment of uncertainty is challenging. Nonetheless, the District should consider ways in which uncertainty can be reported without undermining the value and transparency of analyses. A starting point would be to consider reporting a range of benefits and cost estimates defined by credible assumptions. This can be done through a series of sensitivity and scenario analyses for key data inputs and assumptions. When quantification of uncertainty is not feasible, analyses should include detailed qualitative discussion about uncertainty sources, the expected magnitude, and impact of uncertainty (i.e., negative or positive effect on results).
- We recommend expanding the EJ analysis for future socioeconomic assessments. The District should consider conducting more screening of targeted EJ analyses to identify vulnerable populations and locations potentially subject to disproportionate risk or exposure (i.e., "hotspots"). Moreover the SCAQMD should examine whether the regulations worsen or improve the current status through a distributional analysis. The methods/tools for a distributional analysis fall into four categories: visual displays (e.g., GIS maps, Lorenz curves, concentration curves), subgroup-specific summary statistics (e.g., mean or median exposure/health effects), regression techniques, and inequality indices (e.g., Gini coefficient and Atkinson index). Each method/tool has advantages and limitations. We suggest that the District carefully review these methods/tools and choose appropriate ones. Inequality indices seem to be a promising tool to use in a regulatory context. It can be used to rank the impacts of different regulatory options on vulnerable subgroups.
- We support the continued use of the REMI model, but there are instances where REMI provides a somewhat limited picture of the regulatory burden. We suggest that the SCAQMD use partial-equilibrium models of affected industries as well as additional small business analysis for sectors likely to be most affected by regulation. Moreover, we suggest that the District improve the adjustment made to the location-specific fixed-effects coefficients of the migration equation in REMI model. The magnitude of these adjustments should be properly normalized to reflect the baseline levels of all amenities and dis-amenities that contribute to the estimates for the relative attractiveness of one area compared to others. Finally, we encourage the SCAQMD to keep abreast of the USEPA's development of methods for applying benefits in economy-wide models.
- We recommend that the District redesign the reporting/documentation system to consider different types of audiences. The new reporting system could include three types of documentation: (1) a methodology guidebook mainly for the District staff and other interested parties; (2) a summary report for lay public, and (3) a detailed report for audiences with a technical background.
- The transparency of the analyses should be enhanced. We believe that improving transparency offers the best way to deal with concerns about analysis credibility raised by stakeholders. The new documentation system suggested above is useful for improving the transparency of analysis approaches used in the SCAQMD's socioeconomic assessments. In addition, we suggest (1) the standing scientific advisory group should be more involved

during the District's socioeconomic assessment process (e.g., guide the systematic literature review, evaluate the use of REMI versus alternative methods, monitor new cost analysis approach); (2) conducting more outreach to educate the public and collect data inputs, comments, and suggestions; and (3) making the peer review process more transparent.

1. Background and Introduction

According to the California Health & Safety Code §40440.8(a), the South Coast Air Quality Management District (the SCAQMD or the District) must prepare a socioeconomic impact report when proposing to adopt, amend, or repeal a rule that will significantly affect air quality or emissions reductions. The Health & Safety Code requires the inclusion of the following information in the socioeconomic impact report:

(a) The type of industries affected by the rule;

(b) The impact of the rule on employment and the economy of the South Coast Basin;

(c) The range of probable costs, including the cost to industry, of the rule;

(d) The availability and cost-effectiveness of alternatives to the rule;

(e) The emission reduction potential of the rule; and

(f) The necessity of adopting, amending, or repealing the rule in order to attain state and federal ambient air quality standards.

The District Governing Board passed a resolution that called for economic analysis of emission reduction rules proposed for adoption or amendment. Required analysis elements include identification of affected industries, cost effectiveness of control, and public health benefits. None of these requirements apply to the preparation of the Air Quality Management Plan (AQMP) assessment. However, the SCAQMD regularly performs a socioeconomic analysis of the AQMP in order to further inform public discussions and the decision making process.

Throughout the rulemaking and socioeconomic assessment process, the District holds public workshops and hearings to collect stakeholders' comments. In addition, a Scientific, Technical & Modeling Peer Review Advisory Group (STMPRAG)[1] oversees the tools and methods that SCAQMD uses in the socioeconomic analyses and brings insight to the District regarding the value of various analyses and identification of areas where expanded analysis would benefit public interest and enhance the rule development process. The Group is designed to provide critical review of SCAQMD analyses, recommend new approaches, and identify areas where expanded analysis would benefit public interest and enhance the rule development process.

The Massachusetts Institute of Technology (MIT) conducted a one-year evaluation of the District's socioeconomic impact analysis program in 1992. The MIT reviewers focused their evaluation on the strengths and weaknesses of the economic modeling (i.e., REMI) used in the SCAQMD's socioeconomic assessments. They also conducted a large scale survey of government agencies, interviews with the staff in some agencies, stakeholder interviews, and an extensive literature review on regional economic impact models. MIT recommended a number of institutional structure/process changes and economic modeling enhancements for future analyses. Details of the MIT evaluation can be found in Polenske et al. (1992). In the past 20+ years, the District staff worked with various

[1] http://www.aqmd.gov/home/about/groups-committees/stmpr-advisory-group [Accessed on June 19, 2014]

advisory groups (e.g., STMPRAG, Small Business Assistance Advisory Group), consultants and stakeholders to implement many of these recommendations and refine its socioeconomic assessments.

In this audit, Abt Associates has been contracted by the SCAQMD to conduct an independent review of its socioeconomic assessments, as well as similar analyses from other public agencies or organizations. The primary focus of our evaluation includes compliance costs analyses, benefits analyses, and economic impacts analyses of regulations/plans/proposed rules. As part of the review process, we have surveyed public agencies/organizations identified to understand their regulatory economic analysis process. We have also conducted stakeholder interviews to collect their opinions on the SCAQMD's socioeconomic assessments. Based on our review and stakeholders' feedback, we make recommendations for the SCAQMD's future socioeconomic analyses.

This report documents our review and interview process, detailed comments on the analysis components, a summary of interview responses, and recommendations. The report is organized as follows:

- The current section provides background and introductory information;
- Section 2 describes the review and interview approach;
- Section 3 presents our evaluation of the SCAQMD's socioeconomic assessments;
- Section 4 reviews other public agencies/organizations analyses and compares them to the SCAQMD's analyses;
- Section 5 summarizes interview results;
- Section 6 presents our recommendations to the SCAQMD.

2. Evaluation Approach and Process

This section documents the Abt Associates Team's approach to performing the review of the SCAQMD and other agencies' socioeconomic assessments of rules/proposed rules/plans, as well as the process and method to conducting stakeholder interviews.

2.1 Review of the SCAQMD's Assessments

The review process began by identifying recent representative regulatory socioeconomic assessments conducted by the SCAQMD. Using SCAQMD's postings on the socioeconomic assessments[2] and communication with the SCAQMD Program Supervisor of the Socioeconomic Section, we obtained the socioeconomic impact assessments for the following rules and AQMP:

- Socioeconomic Assessment of the Air Quality Management Plan (2012 and 2007) as well as the AQMP documents;
- Proposed Rule 1304.1─Electrical Generating Facility Fee for Use of Offset Exemption (September 2013);
- Proposed Amended Regulation ─ Regional Clean Air Incentives Market (RECLAIM) (November 2010);
- Proposed Amended Rule1146.1─Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (August 2008);
- Proposed Rule 1143─Consumer Paint Thinners and Multi-purpose Solvents (February 2009);
- Proposed Rule 2449─Control of Oxides of Nitrogen Emissions from Off-road Diesel Vehicles (May 2008); and
- Proposed Amended Rule 1146.2─Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters (April 2006).

Next, we grouped the documents by the type(s) of analysis included, such as benefits, costs, job impacts, environmental justice, etc. For example, the 2012 AQMP Socioeconomic Assessment included analyses for all of the above analysis types; therefore it was placed in each group. Each group was assigned a technical reviewer (determined at the proposal stage) with appropriate expertise to review the components of the analyses in that group. For example, one benefits analysis expert reviewed all of the sections on benefits assessments in all of the reports in the "Benefits analyses" group. Each reviewer and his/her assistants evaluated the strengths and weaknesses of the analyses assigned to her/him and provided comments for the analysis components in a matrix format. Reviewers focused on several fundamental criteria: (1) transparency of the analyses; (2) appropriateness of the tools and methods used; (3) the breadth and depth of the assessments; (4) completeness of the analyses; (5) consistency with the Office of Management and Budget's (OMB)

[2] For example, http://www.aqmd.gov/home/library/meeting-agendas-minutes [Accessed on June 19, 2014]; http://www.aqmd.gov/home/regulations/rules [Accessed on June 19, 2014]; and http://www.aqmd.gov/home/library/clean-air-plans/air-quality-mgt-plan/socioeconomic-analysis [Accessed on June 19, 2014]

evidence and innovation agenda;[3] and (6) the effectiveness of presentation and communication of the analyses and results.

Upon finishing the review, each technical reviewer prepared a memo and a comparison matrix, which were then synthetized into this report.

2.2 Identification of Other Public Agencies and Review of Their Assessments

We used an iterative approach for both the identification and review of socioeconomic assessments from other public agencies/organizations in the United States, consisting of the following steps: (1) compile a comprehensive list of federal, state, regional, and local air quality control agencies, (2) select agencies/organizations most relevant to our review, (3) contact the agencies/organizations with short surveys to collect information about the their economic impact analyses process, (4) obtain the necessary rule assessment documents, and (4) assign subject matter experts to review the assessments.

2.2.1 Identify Potential Public Agencies

Subject to resource availability, our goal was to identify 10 public agencies/organizations whose rule assessments are comparable with the SCAQMD's socioeconomic assessments, i.e., those that include assessment of control costs, benefits, and/or economic impacts. We used the National Association of Clean Air Agencies (NACAA) website[4] as a starting point to identify a comprehensive list of air quality control agencies. The NACAA website provides agency names and contact information for state and local air quality control agencies across the United States.

We then supplemented this list with federal and regional air quality organizations based on our knowledge and experience in supporting air regulation assessments in the past (e.g., Western States Air Resources Council (WESTAR) and U.S. Environmental Protection Agency (USEPA).

We also consulted the Regional Economic Models, Inc. (REMI) website (http://www.remi.com/clients [Accessed on June 19, 2014]), to identify any additional environmental agencies/organizations that have used REMI in their rule assessments (e.g., the Northeast States for Coordinated Air Use Management (NESCAUM), Minnesota Pollution Control Agency, and Missouri Department of Natural Resources).

The SCAQMD staff reviewed the initial list, and provided additional information and suggestions for inclusion. In total, the comprehensive list included 171 organizations. We then narrowed the list to the most relevant agencies, as described in the next section.

2.2.2 Screen and Finalize the List of Public Agencies for Review

To narrow the list, we focused on agencies in states that are in nonattainment with PM or ozone National Ambient Air Quality Standards (NAAQS), as they would tend to focus more on proposing rules to meet the standards than agencies in states that are already in attainment. In addition, we included environmental agencies/organizations that use REMI for economic impact assessments similar to those performed by the SCAQMD. Our revised list consisted of 48 agencies.

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[3] http://www.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-17.pdf [Accessed on June 19, 2014]

[4] http://www.4cleanair.org/agencies [Accessed on June 19, 2014]

Next, we directly contacted each of the agencies/organizations on our revised list by email and phone with a set of screening questions. Appendix A presents this revised list and a summary of our questions and process. The replies to the screening questions helped us to determine (1) whether the agencies/organizations conducted regulatory impact analysis, (2) whether they used any modeling tools, such as Environmental Benefits Mapping and Analysis Program (BenMAP) or REMI, for their assessments, and (3) how to obtain representative examples of their assessments. At the end of this process, 16 agencies/organizations were selected for the final list.

2.2.3 Conduct a Short Survey and Obtain Relevant Documentation

For the 16 agencies/organizations in the final list, we conducted a short survey about their socioeconomic analysis process (e.g., resource allocation, assessment timeline, public participation, and decision making process) through email inquiry or conference call (if they were willing to talk on the telephone). Appendix B shows the short-survey questions we developed. Appendix C summarizes the survey results.[5]

We obtained the relevant analysis documents from these 16 agencies/organizations. Where appropriate, we consulted their websites and followed up with their staff with additional questions.

2.2.4 Review Socioeconomic Assessment Documents

After we obtained the socioeconomic assessment documents from the above step, we followed the same evaluation approach described in Section 2.1 to review the SCAQMD's analyses. Appendix D provides an overview of the rule documents we have reviewed. We summarized the review results using the comparison matrices from the SCAQMD review (see Appendix E for the comparison matrices). The evaluation results are reported in Section 4.

2.3 Stakeholder Interviews

We took the following five steps to conduct stakeholder interviews: (1) identify stakeholders who are regulated and affected by the SCAQMD's AQMP, (2) invite stakeholders to participate and schedule the interview, (3) design interview questions, (4) conduct face-to-face and telephone interviews, and (5) compile and summarize the interview results.

2.3.1 Identify and Invite Stakeholders

To identify affected stakeholders, we started with the list of stakeholders represented in the AQMP Advisory Group Membership Rosters;[6] the Scientific, Technical & Modeling Peer Review Advisory Group Membership Roster;[7] and participants of monthly AQMP meetings in 2012.[8] These lists provided member names as well as their associated industry organizations. Appendix F shows the organizations that participate in the interviews. The key criterion for the identification process is to ensure fair representation from various sectors, including:

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[5] Note that not all finalized agencies responded to the survey questions.

[6] The Roster lists are available at: http://www.aqmd.gov/docs/default-source/GB-Committees/aqmpadvisoryroster.pdf?sfvrsn=4 [Accessed on June 19, 2014] and http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2015-air-quality-management-plan/2015aqmp-advisoryroster.pdf [Accessed on June 19, 2014]

[7] http://www.aqmd.gov/home/about/groups-committees/stmpr-advisory-group [Accessed on June 19, 2014]

[8] The participants of AQMP meetings can be found from the meeting minute documents on SCAQMD's website.

- Manufacturing facilities,
- Large and small business (including business associations),
- Transportation/goods movement,
- Local governments,
- Public health advocates,
- Environmental communities/organizations, and
- Environmental justice organizations.

We discussed the corresponding candidate stakeholders in each target sector, with the SCAQMD staff for finalizing the list of stakeholders. According to the resource availability, the target number of interviews was 20. Considering the possibility that some candidates might not be able to attend, we prepared two sets of candidates: a primary list consisted of 20 candidates and a waiting list of 13 individuals.

Next, we sent invitation letters out via email.[9] The stakeholders were given the option to choose between a face-to-face interview and a telephone interview. We used an Excel spreadsheet to document the process, including detailed contact and tracking information for each stakeholder contacted (e.g., date contacted, follow-up date, date responded, scheduled time). In case a candidate from the primary list could not participate or failed to respond, we looked for a replacement from the same sector in the back-up list. After the invitees agreed to participate, we sent them the interview questions and a packet of SCAQMD's rule assessments. We asked that they familiarize themselves with these documents before the interview. We sent out a reminder about the appointment a few days before the scheduled date. Five interviews were conducted face-to-face, with the remainder conducted by telephone.

2.3.2 Design Interview Questions

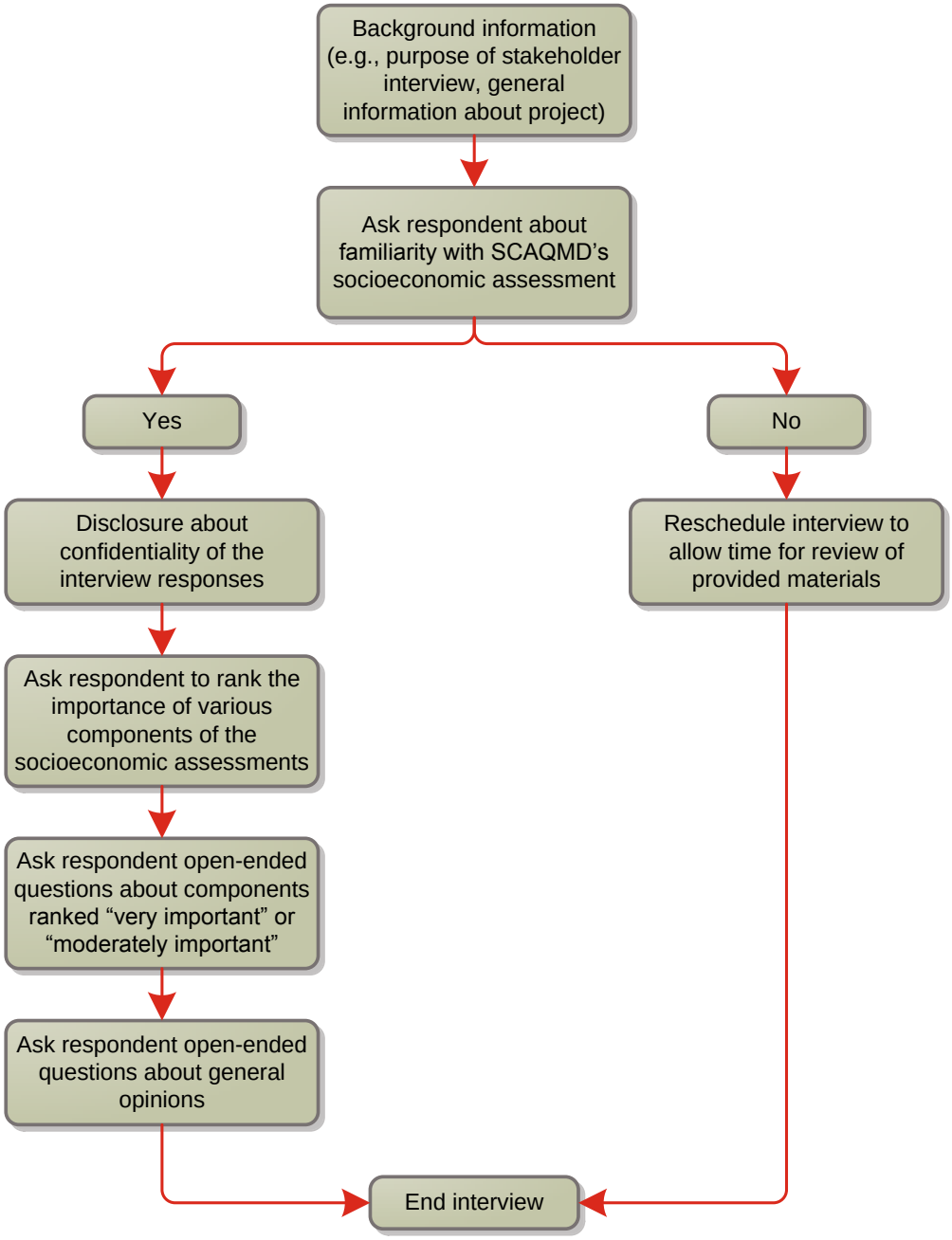
While identifying and inviting the interviewees, we worked on designing interview questions. To develop an effective interview instrument, we first conducted meetings with SCAQMD staff to better understand the interview goals and background information (e.g., previous concerns expressed by stakeholders). We also looked through the SCAQMD's monthly AQMP meeting minutes, which document stakeholders' comments on air pollution regulations and their impacts.

Next, we designed an outline of the interview instrument where we decided to use primarily open-ended questions. The outline included the logic flow for developing specific questions (see Exhibit 1).

We then developed the set of interview questions based on the outline and the information collected in the first step. We tested the questions in two pilot stakeholder interviews and then held follow-up meetings with each pilot stakeholder to discuss the interview questions. Based on the feedback from the pilot interviews and comments from the SCAQMD, we modified the interview questions slightly. Appendix G. includes the finalized interview instrument we used in both the face-to-face and phone interviews.

[9] To encourage stakeholders' participation, the SCAQMD sent a note to them before we sent out the invitation letters.

Exhibit 1. Interview Instrument Design Flow Chart



2.3.3 Conduct Stakeholder Interviews and Summarize Responses

As stated above, we conducted five face-to-face interviews, all scheduled on the same day in the SCAQMD's office in Diamond Bar, without SCAQMD staff presence. All the remaining interviews were conducted on conference calls. Each interview included two Abt staff (interviewer and note-taker) and one interviewee, except three occasions where there were two interviewees from the same organization. The interviewer asked the interview questions while the note-taker took detailed notes

while recording the interview (with the participant's permission[10]). We asked the interview questions selectively based on the interviewee's component importance rankings (see the stakeholder interview instrument in Appendix G.). During the interview, Abt staff maintained a neutral stance on all questions and responses. When necessary, we provided additional background information.

Following each interview, the stakeholder's responses were summarized in a Word document. These summaries were then classified in an Excel spreadsheet, organized by interview questions. Using this spreadsheet, we determined common themes and summarized the interview results in Section 5.

[10] All participants agreed to be recorded (see Appendix G. for the recording statement we made to the interviewees).

3. Review of Socioeconomic Assessments of the SCAQMD

Abt Associates has reviewed the SCAQMD's socioeconomic assessments for its AQMPs (2012 and 2007) and six rules (see the list of rules in Section 2.1). This section presents the results of that review.

3.1 Review of Benefits Assessment

Among the SCAQMD's socioeconomic assessments for the AQMPs and the six rules, benefits assessments are included in the AQMP assessments but not individual rule assessments. Therefore our review of benefits assessment focuses on the AQMP Socioeconomic Assessments (particularly the most recent assessment; hereafter, *the 2012 Assessment*).[11] Below we summarize our evaluation results for the analysis components in the SCAQMD's benefits assessment. Appendix E presents our comments on weaknesses and strengths in a matrix format.

It should be noted that the 2012 Assessment focuses on $PM_{2.5}$ and the 2007 Assessment includes ozone and $PM_{2.5}$; many of our comments and recommendations are general and not limited to a particular pollutant.

3.1.1 Health Benefits

Health Effects Quantification

The SCAQMD's health benefits analyses for the 2012 AQMP appropriately include a comprehensive set of health outcomes that are causally associated with fine particulate matter ($PM_{2.5}$), i.e., premature mortality, respiratory and cardiovascular disease (CVD) hospitalization, emergency department (ED) visits, asthma attacks, minor restricted activity days (MRAD), acute respiratory symptoms, and non-fatal heart attacks. Local concentration-response (C-R) functions are used when available. For example, the 2012 Assessment uses a mortality C-R function estimated for Los Angeles (LA) Metro Area from Krewski et al. (2009). Further, the SCAQMD uses USEPA's BenMAP tool to quantify the health effects. BenMAP is the state of the art model for estimating health impacts of air pollution and is widely used by regulatory agencies in US. In addition, the 2012 Assessment explicitly discusses thresholds effects and makes it clear that thresholds are not applied.

There are many assumptions associated with the implementation of health benefits analyses. The weaknesses in the 2012 assessment are mainly due to the lack of details on implementation, resulting in an appearance of lack of clarity. Specifically, the 2012 Assessment (1) does not discuss whether Southern California Association of Governments' (SCAG) Transportation control measures (TCMs) are included in the baseline air quality modeling, that is, whether TCM benefits are incorporated as co-benefits of AQMP;[12,13] (2) does not discuss why/how those health endpoints and C-R functions are chosen or whether/how function transfer is used; (3) does not discuss whether/how BenMAP pooling

[11] We reviewed both the 2012 and 2007 AQMP Socioeconomic Assessments, which used similar approaches. We therefore focus on 2012 AQMP Assessment in this review report, but cite the 2007 document when necessary.

[12] This comment also applies to the estimation of visibility and material benefits because those also rely on the outputs from air quality modeling.

[13] Follow-up correspondent with the SCAQMD staff confirms that the baseline air quality modeling does include the TCMs. Thus the benefits associated with air quality improvement due to implementation of TCMs were not counted as part of AQMP benefits. More discussion on this is included in the subsequent sections.

is conducted to incorporate multiple functions from different studies;[14] (4) only reports the mean relative risk value (1.17) without confidence interval information; (5) does not include health effects related to other pollutants such as ozone;[15] and (6) does not describe baseline incidence data, which is an input to the health impact functions.

Although BenMAP contains many required databases and can automate the analysis, users need to provide their own inputs in customized analyses and make decisions throughout the process (e.g., selecting C-R functions, valuation functions, and pooling options). Therefore it is necessary for the SCAQMD to document inputs and decisions to make the analyses transparent and allow other researchers/analysts to replicate the BenMAP runs.

Regarding the population projections, Woods & Poole projections are built in BenMAP, while the projected population data from REMI are used in the economic impact analyses. The 2012 Assessment does not provide discussions about how the differences in these assumptions for different projections are reconciled for consistency.

Health Effects Valuation

This subsection focuses on mortality valuation because it is the single most important component of the benefit measures and therefore deserves careful scrutiny. We evaluate the mortality valuation conducted by the SCAQMD in two aspects: the choice of willingness-to-pay (WTP) study and the benefits transfer approach.

The 2012 Assessment uses Kochi et al. (2006) to monetize mortality. This study conducts a meta-analysis and uses an empirical Bayes pooling method to combine and compare estimates of the value of a statistical life (VSL). The data come from 40 selected studies published between 1974 and 2002, containing 197 VSL estimates. The estimated composite distribution of empirical-Bayes-adjusted-VSL has a mean of $5.4 million and a standard deviation of $2.4 million.

In recent years, meta-analyses of the VSL literature have played a prominent role in agencies' selection of the VSL (Doucouliagos et al., 2014). Compared with the meta-analysis USEPA used in the mortality valuation, Kochi et al. (2006) has included a larger number of published WTP studies and more recent studies that employed better valuation methods than earlier studies. In addition, the authors include both revealed and stated preference studies that value mortality risk reduction from a wider array of health hazards, i.e., more than work injuries that comprise the majority of studies used in USEPA's meta-analysis. We therefore conclude that the SCAQMD's choice of valuation study is appropriate; however the 2012 Assessment does not provide explicit justification or discussion of the study choice.[16] Comparison with other meta-analysis studies or sensitivity analysis of the study choice is not included either.

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[14] Details of BenMAP pooling can be found in Section K.2 in the BenMAP User Manual Appendix (http://www.epa.gov/airquality/benmap/models/BenMAPAppendicesOct2012.pdf [Accessed on June 19, 2014]).

[15] Note that the 2007 AQMP Assessment included benefits associated with ozone. SCAQMD explained that the 2012 AQMP included several ozone control measures to assist the attainment of 8-hour ozone standard; however, the ozone emission reductions in this plan were not projected to be substantial and so health benefits related to ozone were not estimated nor included in the 2012 AQMP Assessment.

[16] The rationale of recommendation of Kochi et al. (2006) was buried in the DeShazo's memo to the SCAQMD (p. F-9 in Appendix F).

Public agencies generally face a benefits transfer problem: the population in any VSL study may not be representative of the population affected by the regulation (Doucouliagos et al., 2014). While adjusting for population characteristics remains a controversial issue (USEPA, 2010a; Viscusi, 2011), agencies have incorporated income elasticity adjustments into their analyses, especially when the analysis considers benefits over a long enough time period and when incomes are expected to change. Thus these adjustments to the VSL to reflect increasing income over time or in recognition of the higher values of future generations are generally viewed favorably, while the equivalent adjustments for spatial income differences at a given period of time are not (Viscusi, 2010). USEPA Science Advisory Board's (SAB) white paper (USEPA, 2010a) also recommends against cross-sectional differences in income, because of the sensitivity of making such distinctions and the potential for misinterpretation.

The 2012 Assessment adjusts the mean VSL reported from Kochi et al. (2006) to 2005 dollars and 2010 real income. The resulting unit value used for valuing mortality risk reduction ranges from $6.1 to $6.7 million; this range reflects variations in real income across sub-regions in the District. Since the discussion about income adjustment is very brief and limited in the 2012 Assessment, it would not allow us to evaluate whether the income adjustment was appropriately done.[17]

Another important factor to consider in the benefits transfer is discounting. There is evidence from the literature that individuals value risks in the future less than they value commensurate risks they face today (Viscusi and Aldy, 2003), which is why many guidance documents recommend discounting the value of future impacts at a range of discount rates (USEPA, 2010b; Australian Government, 2008; European Commission, 2009; Treasury Board of Canada, 2007; IGCB, 2007). However, there is recent empirical evidence that WTP for mortality risk reductions does not decline over latency periods (Hammitt and Haninger, 2010; Alberini and Scasny, 2010; Lindhjem et al., 2011). Whether to discount and what discount rate to use will continue to be the issue/challenge in the benefits transfer process. The SCAQMD's 2012 Assessment does not provide any information about the specific assumptions underlying the discounting and the sensitivity of the conclusions to alternative assumptions.[18]

Some additional comments on valuation include the following:

- Does not describe studies used for monetizing morbidity endpoints;
- Does not specify dollar year for the unit values provided in Table 3-4;
- Does not discuss income elasticity, income growth, discounting, and inflation factors (see footnote 17).
- Mixed the discussion of valuation with C-R functions/studies, which is confusing to the reader.

[17] Follow-up correspondence with the District Staff clarifies that detailed information about benefits transfer approach is described in a memo Stratus submitted to the District on 8/16/2012. That memo discusses income elasticity, inflation, and income growth over time but it does not discuss the cross-sectional adjustment of income.

[18] Stratus memo to the District did not include information about discounting decisions either.

Environmental Justice Aspect of the Health Benefits Analyses

Chapter 5 (p. 5-3) of the 2012 Assessment presents clean air benefits by sub-region (based on results from REMI). Figure 5-1 shows a $PM_{2.5}$ concentration distribution, which is typically the initial step to identify vulnerable populations in an EJ analysis. In that subsection, it defines an EJ community as "an area that exceeds a 10 percent rate of poverty with a cancer risk greater than 850 in a million or a $PM_{2.5}$ concentration greater than 19.02 $\mu g/m^3$." This definition of an EJ community is not consistent with the definition used by other organizations.

The 2012 Assessment includes a qualitative discussion of health impacts on low-income households (see p. 3-10 of the 2012 Assessment). But this discussion is mixed with the quantitative health benefits results, creating a false impression that the environmental justice (EJ) aspect was derived from the health benefits analyses. Since the quantitative health benefit analyses in the 2012 Assessment does not examine impacts on income groups, the qualitative discussion of EJ implication may fit better in the summary/discussion section or the section on future improvements.

3.1.2 Welfare Benefits Analyses

The SCAQMD has conducted some welfare benefits analyses including visibility, material, and traffic congestion relief benefits analyses. We summarize our review of these analyses in this section.

Visibility Benefits Analyses

The 2012 Assessment uses a local hedonic study (Beron et al., 2001) to reflect the local willingness to pay. The visibility data were obtained from empirical visibility models; these models were able to generate the visibility data at a fine resolution level. The authors did a careful job of constructing the data and conducting the analysis until the second stage analysis, where substantial problems arose. Recent research has identified a number of issues with past practices in hedonic modeling which would apply to most studies conducted during this time period. Most current hedonic literature recognizes that household sorting among different communities and limitations in measurement imply there will be significant issues with omitted variables. These omissions are likely to be linked to spatial locations and potentially correlated with the measures used for spatial amenities and dis-amenities. This implies that without efforts to control for their effects the measure of marginal effects of spatial enmities on housing prices may well be biased (Kuminoff et al., 2010). We do not know as yet the extent to which current refinements in practices would really change results. Moreover, some of the refinements have interacting effects. We review a few of the issues involved to explain our concerns:

- Current practice with hedonic models acknowledges the difficulty in measuring neighborhood and environmental amenities. Since these variables are due to each analyst linking proxy measures they could reflect the effects spatial delineated omitted variables. As a result it is common practice to include spatial fixed effects –census tracts, counties, etc. To the extent the proxy variables display robust effects over a variety of these formulations of fixed effects we gain confidence in the measured effects.
- The interaction arises in the choice of functional form for hedonic models. The conclusions of the early Cropper Deck and McConnell work has been shown to change when hedonic models have these fixed effects to take account of spatially varying omitted variables. Kuminoff et al. (2010) find that the semi-log is no longer the best specification for the hedonic price function when there is the possibility of specification effects with omitted

variables –more flexible specifications with Box Cox transformations and greater nonlinearity were found superior in their simulation analyses.

- There is also greater concern over endogeneity of spatial amenities (or at least correlation with the error and hence the need for instruments) at the first stage of estimation due to sorting. As a practical matter the available applications are not controlled evaluations. Recent research by Klaiber and Smith (2013) considers the magnitude of the likely bias when estimates drawn from simple quasi experimental studies are used as measures of tradeoffs. This research suggests it can depend on circumstances. The most objective assessment is that the verdict is not in yet –but effort should be made to consider alternatives. The implication of this research is that continued use of the Beron et al. (2001) research based on earlier methods may lead to biased estimates of the benefits from visibility improvements.
- Our most significant concern about the Beron et al. (2001) is the design of the second stage model; it is for an "average" household in a census tract by year. Marginal willingness to pay (MWTP) is measured for the average house and then attached to average income and other variables. There is no such household. While this parallels the early representative individual models before micro data were available, modern research has attempted to match mortgage application records with housing sales data so that the economic characteristics are those of the home buyers when there is a match (e.g., Galiani et al., 2012). No doubt these data were not available at the time Beron et al. (2001) was done. In our opinion, benefits transfer should stop with the estimates of MWTP from the first stage and attempt to conduct sensitivity analyses rather than using the second stage model at all. These analyses could include considering how the MWTP is measured –varying the treatment of the year of the estimate, varying the measures used for independent variables. With a semi-log form they could consider the effects of using predicted or current housing prices in computing marginal effect. The design of these robustness assessments should be based on the specifics of the benefit analysis they are undertaking.

Other problems we identified with the visibility analysis include the following:

- The data description and modeling details are generally insufficient for many input variables;
- The details of the methods are not sufficient. For example, it is not clear whether ACS sampling uncertainty was reflected in the modeling and projections and whether there is omitted variable bias;
- Descriptions are vague about the assumption of the lifetime for a house in the calculation of annual values for the asset value of a house; and
- The choice of the four percent interest rate is not discussed.

Material Benefits Analyses

The 2012 Assessment uses the relationship between costs of repainting and total suspended particulates (TSP), estimated in Murray et al. (1985) for commercial buildings, and the relationship between additional cleaning costs and TSP estimated in Cummings et al. (1985) for residential properties.

Our major concern about this analysis is that the material valuation is based on very old studies. As the entire character of the materials and their maintenance may have changed in 30 years, these

studies may not be valid to use in the current circumstances. We discuss recommendations in Section 6.

Traffic Congestion Relief Benefits

The 2012 Assessment includes the traffic congestion relief benefits realized by implementing Transportation Control Measures (TCMs) proposed by the Southern California Association of Governments (SCAG) for the South Coast Region. The congestion relief benefits are included in the socioeconomic report because, according to the 2012 AQMP:

> As required by the Federal Clean Air Act (CAA), a reasonably available control measure (RACM) analysis must be included as part of the overall control strategy in the AQMP/SIP to ensure that all potential control measures are evaluated for implementation and that justification is provided for those measures that are not implemented. Appendix IV-C contains the TCM RACM component for the South Coast $PM_{2.5}$ control strategy. In accordance with EPA procedures, this analysis considers TCMs in the 2012-2035 RTP/SCS, measures identified by the CAA, and relevant measures adopted in other non-attainment areas of the country. (2012 AQMP, Appendix IV-C, p. IV-C-3, http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2012-air-quality-management-plan/final-2012-aqmp-carb-epa-sip-submittal-(december-2012)/2012-aqmp-carb-epa-sip-submittal-appendix-iv(c).pdf [Accessed on June 19, 2014]).

While we do not disagree with the decision the SCAQMD made regarding the attribution to the AQMP of the congestion relief benefits realized from TCM implementation, we note two general points. First, this attribution needs to be stated clearly in the socioeconomic report: specifically that the TCMs included in the SCAG's Regional Transportation Plan (RTP) and committed to by the State Implementation Plan (SIP) are part of the AQMP.[19]

Second, it is worth noting that while the AQMP is an air quality management plan, the largest benefits from the AQMP are not air quality benefits, but rather, as Table 3-3 of the report makes clear, those from traffic congestion relief (72.3% of the average annual quantifiable benefits of the 2012 AQMP). This figure does not represent the value of the air quality improvements resulting from traffic congestion relief, but rather the value of the congestion relief itself. The major contributor to the $7.7 billion dollar congestion relief in the 2012 Assessment is the $5.8 billion average annual reduction in travel time from commuting trips. Given the large magnitude of these benefits and their subsequent impact on the cost-benefit calculation, these benefits demand substantial scrutiny and discussion in the AQMP Assessment.

In a separate issue, the discussion of the baseline and policy scenarios is problematic. The report differentiates the projected congestion relief benefits into 1) SIP-committed TCMs and 2) all TCMs in the SCAG's RTP. [20] Specifically, the benefits for 2014 are exclusively from SIP-committed TCMs,

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[19] The discussion of the role of TCMs in the 2012 Assessment (pp.1-6, 1-8, 3-2, 3-12, 3-13, 3-14, A-7) does not seem to incorporate this point.

[20] While we acknowledge that the 2012 SCAG RTP, from which the TCMs in the AQMP are taken, does not consider reducing air pollution as its only objective, it is clearly incorporated into the plan's central objective to "improve the environment and quality of life" (p. vii,

and those for the 2020 and 2035 projections are from all TCMs in the SCAG RTP, as noted in the last paragraph on p. 3-12. There is an inconsistency in the description of the baseline in the 2012 Assessment. Language in the report states on the one hand that the program's "reductions were calculated as the difference between baseline (without SCAG TCMs) and control (with SCAG TCMs) conditions for the benchmark years 2014, 2020, and 2035" (p. 3-13). Yet, at the same time, the report states earlier that:

> The socioeconomic impacts of the 2012 AQMP are evaluated with respect to a baseline condition, which assumed that the four-county region would continue receiving federal highway funding to make the necessary infrastructure investments for implementation of the 2012 Regional Transportation Plan (RTP) in order to keep the region competitive nationally and globally. However, the funding hinges on achieving the air quality standard that is the primary goal of the 2012 AQMP. For this reason, *the baseline forecast provided by SCAG includes the 2012 RTP*. The socioeconomic analysis herein attempts to address any deviations from the baseline as the 2012 AQMP is fully implemented in terms of benefits of cleaner air, costs of control measures, and spillover impacts of direct benefits and costs. These deviations represent the impact of the 2012 AQMP (pp. 1-5 and 1-6 of the 2012 Assessment)

We interpret this characterization of the baseline to mean the impact of the AQMP is being measured as any additional benefit (cleaner air, spillover impacts) apart from the benefits (e.g., congestion relief, ancillary health benefits) associated with TCM implementation. Under this characterization of the baseline, congestion relief benefits should not be attributed to the 2012 AQMP and should not be included in Table 3-3 of the 2012 Assessment. Since they are included, either the report is using incorrect terminology to describe this as a baseline (where the baseline is actually with no TCMs), or it is incorrectly attributing baseline benefits to the AQMP (where the baseline includes benefits associated with TCMs).

In addition, we observe a large difference in the magnitudes of projected congestion relief benefits between the 2012 and 2007 AQMP socioeconomic assessment. The average annual congestion relief benefits for the 2012 report amount to $7.7 billion (in 2005 dollars), while those for the 2007 report are only $966 million (in 2000 dollar).[21] The most significant component of these benefits is the travel time savings from commute trips, which we reproduce in Exhibit 2 below with an extra panel to account for difference in base units of currency. First, note that comparison of the projected benefits realized in 2014 shows that the 2007 report seems to overestimate the benefits ($937 million 2005 dollars in total) relative to those that are projected with presumably better information in the 2012 report at $358 million. Despite this, the 2020 benefits for the 2012 report are more than twice the size of those for the 2007 report ($1,558 versus $3,962). Finally, the magnitude of the 2035 estimates, while not strictly comparable to those for 2025 in the 2007 report, are extremely large at $13.8 billion.

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http://rtpscs.scag.ca.gov/Documents/2012/final/f2012RTPSCS.pdf [Accessed on June 19, 2014]), where it intends to have "direct and substantial benefits to public health by reducing pollutant emissions" (p. 12).

[21] While the period covered in the 2007 report is 18 years and that in the 2012 report is 21 years, these are annualized benefits, so it seems doubtful that the time span difference (which is only 17% longer) should be the reason for 698% higher benefits.

Exhibit 2. Travel Time Savings from the 2012 and 2007 AQMP Socioeconomic Assessments

TABLE 3-10 (p. 3-15, 2007 Report)

Savings from Reduced Travel Time by Trip Type (millions of 2000 dollars)

Type of Trip	2014	2020	2023	Average Annual (2007-2025)
Business	$323	$537	$532	$358
Commute	$503	$837	$829	$558
Total	$826	$1,374	$1,362	$916
Inflated to 2005 dollars using CPI				
Business	$366	$609	$603	$406
Commute	$570	$949	$940	$633
Total	$937	$1,558	$1,544	$1,039

TABLE 3-9 (p.3-14, 2012 Report)

Savings from Reduced Travel Time by Trip Type (millions of 2005 dollars)

Type of Trip	2014	2020	2035	Average Annual (2014-2035)
Business	$59	$657	$2,291	$1,156
Commute	$299	$3,305	$11,529	$5,817
Total	$358	$3,962	$13,820	$6,973

We note that the report classifies reduced VHT and VMT from traffic congestion relief benefits due to personal trips in the Unquantified Benefits section of the report. While we agree with the report's statement that "savings resulting from reduced travel time for personal trips are difficult to quantify due to the variation of the value of time from one individual to another," (p. 3-15) these benefits are actually quantified in the report at $78 million, and the authors use the exact same method to calculate these benefits as those from commuting and business trips in the Quantified Benefits section. Calling these benefits "Unquantified" is inaccurate; they are, indeed quantified and quantifiable.

Moreover, their exclusion of these benefits on the grounds of their uncertainty only highlights the lack of discussion of the uncertainty associated with their calculation of the benefits for commute and business trips. A more defensible approach would be to include personal trips in the overall benefit calculation, but then present upper and lower bounds (or ranges of estimates given different assumptions) on all estimates of travel time and operating benefits based on reasonable assumptions. An example of the kind of assumptions that could be varied includes that made on p. 3-14 with regard

to the share of trips coming out of the SCAG model that are business versus commuting versus personal.[22]

Similar to other benefits analyses, lack of clarity and details remains as an issue in the benefits analysis for traffic congestion reduction. We have the following specific comments regarding the lack of clarity and details:

- Data sources and calculation methods are not clearly described. For instance, the data source for the projected VHT reduction should be specified in the first sentence on p. 3-14.
- The current appendix on congestion reduction does not provide additional details.

3.1.3 Uncertainty Analysis

All benefits estimates presented in the 2012 Assessment are point estimates without either confidence intervals or a range; sensitivity analyses (for key input variables) were not conducted. The uncertainty associated with the benefits analysis is briefly discussed in the Chapter 8 of the 2012 Assessment, which recognizes the uncertainties associated with data inputs such as population exposure, concentration-response functions, and unquantified effects.

The uncertainty analysis is weak and insufficient in the SCAQMD's benefits assessments. We discuss recommendations regarding uncertainty analysis in Section 6.3.

3.2 Review of Cost Analyses

This section summarizes our review of the cost analysis in the SCAQMD's socioeconomic assessments, including the methodology used to estimate the control costs and cost effectiveness for the various control measures included in the 2012 SCAQMD's AQMP and accompanying Socioeconomic Assessment, as well as for six recent rules proposed by the SCAQMD. In general, the SCAQMD uses a sound methodology in its cost analysis, but the estimates could be improved with some additional procedures, as described below. Exhibit E-2 in Appendix E summarizes the strengths and weaknesses of the cost analyses of the six rules and the 2012 AQMP in a matrix format.

One observation is that neither the cost analysis methodology nor the underlying assumptions were adequately explained in the public documents. Our review of the cost analysis methodology was greatly aided by an internal spreadsheet provided to us by the SCAQMD, which had more explicit information about the exact methods and assumptions used in the cost analysis, including the capital and operations and maintenance (O&M) costs, discount rate, capital recovery factor, and project length.

It is assumed that the cost analysis for the other rules followed broadly similar principles.[23] As such, the remainder of this section focuses specifically on the 2012 AQMP, and it discusses the strengths

[22] Specifically, we refer to the assumptions: "For the purpose of this analysis, it was assumed that 81 percent of VHT reductions were for business and commute trips and percent were for other trips (SCAG, 2012a). Only VHT reductions for business and commute trips were included in the benefit assessment. Of the 81 percent reductions in business and commute trips, it was further assumed that 8 percent was for business and 73 percent was for commute trips (SCAG, 2012a)" (p.3-14).

[23] Abt Associates verified with Sue Lieu of SCAQMD that it is a reasonable assumption.

and weaknesses of the methodology used by the SCAQMD to estimate the cost and cost effectiveness of air quality controls included in the AQMP.

3.2.1 Capital and Operating Costs

The cost analysis appropriately includes the major costs of the relevant control measures, including the capital and O&M costs, as well as administrative costs, such as permitting and monitoring costs. The costs are all discounted, and the capital costs are annualized, using a real four percent annual interest rate.

As discussed above, there is little explanation of the cost analysis methodology in socioeconomic reports for the AQMP or the other rules, and similarly, there is little discussion of how these costs estimates were obtained or why the four percent discount rate was used. In discussions with SCAQMD staff, it was indicated that the SCAQMD has used a four percent real discount rate in its analyses since 1987 for consistency.

The discount rate is an important parameter in cost analyses that should be chosen carefully, and the rationale for the selection of the discount rate should be discussed in the analysis. For example, discount rates can be different for costs incurred by the public sector and costs that arise in the private sector from regulatory mandates. This could be addressed with a sensitivity analysis, as discussed below, but in general, the Socioeconomic Assessment of the AQMP could benefit from more discussion about the sources of the cost estimates and other parameter assumptions.

In some cases, the staff reports for the rules include much more information about the methodology used in the cost analysis than is included in the socioeconomic analyses of the rules. For example, the staff reports for the SOx RECLAIM rule and Rule 1146 (NOx Emissions from Industrial, Commercial, and Institutional Boilers) give more in-depth information about how the cost estimates were derived. In particular, the SOx RECLAIM staff report details how multiple sources were used to estimate a range of control costs used in the analysis. This level of information is not included in the corresponding socioeconomic analyses.

3.2.2 Uncertainty and Sensitivity Analysis

In our review of the cost analysis methodology, there does not appear to be any consideration of uncertainty in the assumptions used, such as the capital and O&M costs, the discount rate, or the emission reductions achieved by the controls. For example, Table IV-A-1 in Appendix IV-A of the AQMP[24] shows that the estimated emission reductions for the contingency control measure CMB-01 are 2-3 tons per day. The difference between two and three tons per day over the useful life of the equipment is several thousand tons, and this can significantly affect the cost-effectiveness calculation. However, the control measure spreadsheet that the SCAQMD provided calculated the cost effectiveness based only on emission reductions of three tons per day.

In discussions with the SCAQMD staff, it was indicated that where possible, the District uses conservative cost estimates at the higher end of the known range. For example, for the purpose of worst case cost scenario, the SCAQMD includes a 50 percent contingency factor into the cost

[24] South Coast Air Quality Management District. 2013. Air Quality Management Plan, Appendix IV-A. http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2012-air-quality-management-plan/final-2012-aqmp-carb-epa-sip-submittal-(december-2012)/2012-aqmp-carb-epa-sip-submittal-appendix-iv(a).pdf [Accessed on June 19, 2014]

estimations which is based on a verified approach. While this is an acceptable approach to ensure that the analysis does not underestimate the cost effectiveness of proposed rules, SCAQMD does not discuss this approach in the public socioeconomic analyses for its rules.

One particular note regarding sensitivity analyses is the apparent difference between the methodologies used in the Socioeconomic Analyses for the 2007 and 2012 AQMPs. In the 2007 analysis, it is explicitly stated that a sensitivity analysis was performed to estimate unquantifiable control costs, but this step does not appear to have been included in the 2012 analysis. The 2007 analysis is a good example of an appropriate use of sensitivity analysis to examine unknown parameters, and it should have also been included in the 2012 analysis.

3.2.3 Equipment Life

The SCAQMD determines the useful equipment life through holding discussions with equipment manufacturers, industry and stakeholders, as well as conducting its own research. In our discussions with the SCAQMD, staff stated that they carefully review all proposed rules to avoid situations in which existing control equipment is required to be removed before the end of its useful life. In many cases, if existing rules are updated, additional control equipment can be added on to existing equipment to meet compliance. In cases where this is not possible, staff stated that they offer long lead times for compliance to ensure businesses have sufficient time to replace equipment, and in some cases the SCAQMD offers exemptions from the rule to businesses that would otherwise have to replace control equipment before the end of its useful life.

Some stakeholders have stated that SCAQMD regulations are updated so often that control equipment is required to be replaced before the end of its useful life (see Section 5 for detailed interview results). In our review of SCAQMD rules, we found that in practice this is rare. The only example we were able to identify of a SCAQMD rule requiring equipment to be replaced before the end of its useful life is Rule 1421 from 2002, which controlled perchloroethylene emissions from dry cleaning systems. In this rule, however, the value of machines required to be replaced before the end of their useful life was included as a cost in the socioeconomic analysis.

3.2.4 Transportation Control Measures

Table A-1 in Appendix A to 2012 Assessment indicates that the majority of the average annual control costs ($326 million out of $448 million) are from SIP-committed TCMs. As discussed in Section 3.1.2, the 2012 Assessment is unclear whether the TCMs are included as part of the AQMP. Our follow-up correspondence with the District has clarified that the SIP-committed TCMs should be considered part of the AQMP.[25] Thus the cost estimates for TCMs reported in Chapter 3 are appropriate if the socioeconomic reports make the baseline/policy scenario definition clear.[26]

[25] According to the SCAQMD staff, under the Health and Safety Code 40460, the SCAQMD has to incorporate the SCAG SIP-committed TCMs and their corresponding emission reductions into the AQMP. The TCMs are a small part of SCAG's RTP which are funded and implemented only if they meet the SCAQMD's air quality objectives.

[26] If TCMs are considered part of the baseline, then the costs for TCMs should not be included in the total cost of the control measures, because the total cost should only reflect the change in cost from the baseline. Appendix G to the Socioeconomic Report addresses this issue by analyzing the costs and benefits without the TCMs. However this issue could have been made clearer with a note in Appendix A of the 2012 Assessment clarifying whether the TCMs should be considered part of the AQMP.

3.2.5 Cost-Effectiveness Methodology

One of the critical components of the cost analysis is the determination of the cost effectiveness of each control. The cost-effectiveness methodology in the AQMP utilizes a discounted cash flow (DCF) method. Some commenters[27] suggested that the SCAQMD should use a levelized cash flow (LCF) method, and as discussed in Section 4.2.6, the LCF method is more commonly used by other agencies/organizations to determine the cost effectiveness of proposed rules. In general, the way the SCAQMD utilizes the DCF method tends to result in a lower estimate of cost effectiveness than the LCF method given the same costs, interest rates, and project life. The reason for this is due to differences in the calculations underlying each of the two methods.

The DCF method divides the present value of all capital and O&M costs over the life of the project by the total emission reductions over the life of the project:

$$Cost\ Effectiveness = \frac{Present\ Value\ of Capital\ Cost + Present\ Value\ of\ Operating\ Cost}{Emissions\ Reductions\ Over\ the\ Life\ of\ the\ Project}$$

The LCF method is conceptually similar, but it converts project costs into an annual value and divides them by the emissions reduced in a single year:

$$Cost\ Effectiveness = \frac{Annualized\ Capital\ Cost + Annual\ Value\ of\ Operating\ Cost}{Annual\ Emissions\ Reductions}$$

The difference in cost effectiveness occurs because, in the way that the SCAQMD has employed the DCF method, the numerator is discounted (it includes the present value of O&M costs over the life of the project), while the denominator is not discounted (it includes the total unadjusted value of the emissions reductions over the life of the project). By contrast, the LCF method compares costs and emission reductions in a single year, so neither the numerator nor the denominator is discounted.

The DCF and LCF methods both have their strengths and weaknesses. The LCF method implicitly assumes that the emission reductions are constant through time, and therefore cannot adequately accommodate a scenario in which emission reductions are variable through time, such as a case where a control loses effectiveness over time or a scenario where regulations are increasingly stringent over time. The DCF method is flexible enough to handle scenarios in which the emission reductions are variable. However, the drawback to the DCF method as currently employed by the SCAQMD is that it considers the value of emission reductions to be equal, regardless of when they occur. In an extreme hypothetical example, consider two controls that have the exact same cost and that will operate for a 10-year period. The first control reduces 100 tons of pollution in the first year, and none after that, while the second control reduces 100 tons of pollution in the tenth year, but none before that. The DCF method as it is currently used by the SCAQMD would find that these two controls have the same cost effectiveness, because they both reduce 100 tons over a 10-year period.

If the emission reductions of a set of proposed controls are constant through time, the DCF method and the LCF method would have the same ranking of the controls' cost effectiveness, but the absolute values of the cost effectiveness would be different.

[27] Abt Associates received from SCAQMD a comment on the AQMP from the Southern California Business Coalition, which discusses their preference for the LCF cost-effectiveness analysis method.

3.3 Review of Economic Impact Assessments

The purpose of this section is to provide a preliminary evaluation of the strengths and weaknesses of the SCAQMD's economic impact analyses, based on a review of these analyses from socioeconomic assessments of the six recent SCAQMD rules and the 2012 AQMP.

Exhibit E-3 in Appendix E includes a comparative matrix of strengths and weaknesses associated with the economic impact analysis within these socioeconomic assessments. Below we summarize the key findings and observations from our review.

3.3.1 Tools and Methods

Analytic approach and application of tools

In general, the analyses of economic impacts in the SCAQMD's socioeconomic assessments are straightforward in their approach and use a well-established and peer reviewed tool for conducting regional economic impact analysis—the REMI Policy Insight model—which has been customized for the four-county District.

However, the brief descriptions of the REMI modeling in the analyses omit the details necessary to judge the assumptions and implementation of the model for specific analyses. It would be desirable to include information or data that describe decisions and assumptions made by the REMI analyst. Lack of transparency about modeling inputs are, in part, the reason that some stakeholders view models like REMI as a "black box" which regulators use to achieve results that provide further justification for new regulations. For example, there are many steps needed in order to translate compliance costs or changes in revenue into inputs that can be accommodated within REMI, and many of these steps require expert judgment. In order to confirm that the approach and REMI modeling process is robust, the analyses should provide greater transparency about specific steps in the process, including the data and assumptions used. These details can be placed into an Appendix if the discussion of modeling details is not accessible to the primary audience for the assessments, but they should be provided nonetheless.

Our evaluation of REMI and its application was aided by REMI's technical staff and the District economists, who provided additional documentation and assisted in clarifying the modifications to REMI to include the regulatory benefits associated with the air quality improvements. REMI's method for including non-market benefits uses one of two options in adapting the migration equation in REMI to reflect amenities: (1) changes to the coefficients in the migration equation that are fixed effects reflecting the relative attractiveness of each location or (2) changes based on the equivalent of a proportionate change in the real relative compensation that adjusts the same fixed effects. In this second case it is computed in relation to the real relative compensation in the location experiencing the air quality change. The basic logic of the adjustment for amenities was developed by one of the founders of REMI model. This logic assumes that the location-specific fixed effects in the migration equation can be modified to represent policy changes in the factors (e.g., air quality) that may contribute to the attractiveness of modeled areas. Once the change is specified, REMI treats the impacts on other variables that contribute to the regional adjustments in a format that is consistent with the logic of the model. There are two aspects of our concerns. In a formal sorting model we would expect adjustment in the coefficients of the other variables contributing to the migration

equation as part of the equilibrium process. This is consistent with the logic of the Rosen-Roback framework and current research on sorting models (see Kuminoff, Smith and Timmins, 2003). For practical purposes it seems reasonable to assume for small changes the logic REMI uses would approximate the adjustments. However, the characterization of the size of the impact of the change in air quality is important. This leads to our second comment and the one that offers a change that can be implemented readily. This concern relates to the size of the adjustments to the fixed-effect coefficients. Based on our discussions with REMI and the economists of SCAQMD, we believe the magnitude of these adjustments must be properly normalized to reflect the baseline levels of all amenities and dis-amenities that contribute to the estimates for the relative attractiveness of one area compared to others. This modification would not require a change in REMI's structure but would require detailed analysis of the input information developed for REMI. Our concerns apply to both options that are in the model (i.e. adjustments using levels and those using proportionate changes in relative real compensation) for including the benefits of air quality improvements. It is difficult to conjecture about the effects of our proposed change. We believe it would require a reduction in the magnitude of the effects attributed to air quality benefits. However, at this stage this comment should be considered an informed "guess" that needs to be documented with a more specific assessment of REMI variables and the precise logic used to construct each type of modification to REMI.

REMI accounts for some interactions between wages, rents, and migration, but does so in terms of reduced form models that are not fully consistent with the logic used to estimate the economic benefits provided by air quality improvements. As discussed in Roback (1982), differences in the amenities between locations do not only affect relative wages, but also the prices for housing in places where amenities change due to regulation. Plantinga et al. (2013) estimate a migration equation based on amenities, relative wages, and housing costs and find that housing is a normal good and statistically significant. They rely on part of an equilibrium outcome that the Rosen-Roback logic describes. For local approximations with adjustment in the size of the estimated effects attributed to air quality gains the inconsistencies in the two models may not be important to the estimated adjustments. Nonetheless this is a conjecture and should be an area for future research –assessing the difference between small local effects and larger effects where models like REMI may be especially vulnerable. To correctly incorporate measures of non-market benefits their analysis would need to begin from a consistent framework that describes how migration is an adjustment mechanism that contributes to the Rosen-Roback model's equilibrium outcome. Plantinga et al. (2013) is an example of such logic. Kuminoff et al. (2013) discuss the logic of other local sorting models that are consistent.

Use of REMI as primary tool for economic analysis

Based on the sample of assessments reviewed, it appears that REMI is the primary tool used to estimate economic impacts for all or most SCAQMD socioeconomic assessments. Many of the SCAQMD's rules create significant impacts, for which REMI is the most appropriate tool for evaluation. However, REMI may not be as appropriate for evaluating the impacts of rules or regulatory changes which result in relatively small changes in comparison to revenues of affected industries (e.g., under $200,000 in annual costs for an industry class with $2 billion in annual revenues) and the magnitude of the District's economy. In these cases, the results of the REMI analyses often show changes in employment and competitiveness which are very likely within the standard error of the REMI. In Section 4.3, we discuss the use of other regional computable general equilibrium (CGE) models with GAMS and make comparison with the use of REMI.

Moreover, such modeling results may not be very helpful in understanding the effects of the SCAQMD's rules on groups of companies that reside within a much larger industry classification as represented in REMI. In these cases, we recommend consideration of other approaches such as industry-specific studies, case studies, and surveys, either in conjunction with or in lieu of REMI analysis, to gain insights on potential impacts on employment and competitiveness for specific groups of companies (e.g., small businesses). In some cases, other approaches may provide qualitative rather than quantitative information, but can nonetheless yield useful insights which can help fine-tune rules to improve effectiveness.

Approaches which involve engaging with stakeholders, such as the telephone interviews conducted under this review, can also build trust in the process and increase the acceptance of socioeconomic assessments and associated regulatory approaches. More recommendations are discussed in Section 6.

Treatment of uncertainty

As Polenske et al. noted in Massachusetts Institute of Technology's (MIT) 1992 review of the REMI model, the level of precision conveyed by REMI can be misleading, and results reported by the model often fall within the standard of error in the model.[28] Like many similar models, REMI does not provide probability distributions or standard errors for individual input variables or result categories such as employment impacts.[29] We fully recognize that there are inherent political challenges to reporting potential changes in jobs resulting from new (or changes to existing) regulatory programs. To generate credible analysis, however, the analyst must balance an understanding that every single job is important with the imperative to accurately convey results and present them with the appropriate level of confidence and a sense of the context within which they should be interpreted.

3.3.2 Breadth and adequacy of coverage

Describe specific REMI inputs

As noted earlier, it would be difficult for readers to ascertain the challenges in adapting REMI to include non-market effects. Rather than including two to three paragraphs of the boilerplate description of the REMI model in each socioeconomic analysis, we suggest instead giving a link to this general background description in a footnote, and providing a more detailed description of inputs to REMI, focusing special attention on how the scaling of the air quality benefits is made to reflect its importance relative to other site specific amenities. This description should be specific to each analysis. For example, an analysis of a rule which creates new cost elements for affected facilities should identify affected industries (and North American Industry Classification System, or NAICS, code(s), as appropriate) and describe how costs are represented within REMI (e.g., an increase in costs of production). The SCAQMD could also consider improving inputs to REMI, e.g., obtaining NETS data that gives employment at establishment level over time to cross validate.

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[28] Polenske, K. *et al.*, May 1992. "Evaluation of the South Coast Air Quality Management District's Methods for Assessing Socioeconomic Impacts of District Rules and Regulations, Volume I: Summary of Findings," prepared for the South Coast Air Quality Management District (Diamond Bar, CA).

[29] For example, REMI's most recent documentation of the Policy Insight model does not contain any discussion of uncertainty associated with underlying data sources and/or the model's methods and estimate relationships between economic variables (Documentation is available at: http://www.remi.com/products/pi [Accessed on June 19, 2014])

3.3.3 Presentation and Effective Communication

Provide more interpretation of results

Applying a robust economic modeling tool is necessary, but not always sufficient for clearly communicating the range of potential impacts and what drives those impacts. In some cases, the analyses provide a qualitative description of what drives changes in the patterns of impacts over time, which is very helpful for understanding why job levels increase in the near-term but then show a net loss over the full timeframe of the analysis. In other cases, however, an analysis reports out the absolute change in the impact category with almost no interpretation. We recommend providing as much interpretation as is credible based on available outputs and an analyst's expert judgment. This is another area where direct engagement with stakeholders can provide greater insights to augment the understanding of modeling results.

Present results consistently across analyses

In some cases, employment impacts are expressed in absolute terms only (i.e., number of jobs foregone annually); in other cases, impacts are also described as a percentage of the District's total. We recommend presenting both sets of results to convey not only the estimate but the larger context within which a projected impact takes place.

4. Review of Socioeconomic Assessments of Other Public Agencies

In addition to evaluating the SCAQMD's socioeconomic assessments, we also reviewed relevant rule assessments from several other public agencies/organizations we identified (see Section 2.2 for details on the identification process) and compared them with the SCAQMD's socioeconomic assessments.

We have reviewed about 63 regulatory impact analyses (including those for proposed rules or air quality plans) from 14 public agencies/organizations including the SCAQMD. Exhibit D-1 in Appendix D provides the list of the agencies/organizations as well as the rule assessments that we have reviewed. In the sections below, we summarize the review of other agencies/organizations' rule assessments and compare them with the SCAQMD's analyses;[30] the results of these comparisons are used for making recommendations in Section 6.

Socioeconomic assessments require technical staff with detailed knowledge of the methods used for these assessments as well as experience in dealing with the technical dimensions of atmospheric science, a variety of engineering disciplines, the regulatory and legal mandates that govern the assessment process. Evaluating the detail level of socioeconomic assessments must balance the expectations for documentation with the reality of the resources available to provide that detail level. Using the standard of what is feasible within a federal agency such is the USEPA would be inappropriate. The USEPA's staff and related resource greatly exceed that available to other agencies included in this review.

4.1 Review of Benefits Analyses

The benefits of an air quality regulation or plan generally consist of the effects of air quality improvements on human health and welfare. Among the 14 agencies/organizations we included in the review process, six have conducted benefits analyses: the Bay Area Air Quality Management District (BAAQMD), California Air Resources Board (CARB), NESCAUM, the San Joaquin Valley Air Pollution Control District (SJVAPCD), SCAQMD, and USEPA. All of them have assessed health benefits of air regulations, and half of them assessed welfare benefits. The USEPA has the most comprehensive analyses; others generally rely on USEPA's choices of primary studies and approaches.

Similar to the review of the SCAQMD's benefits analyses, we examine different analysis components within the benefits analyses from the identified agencies/organizations. We focus on making the comparison with the SCAQMD's benefits analyses. Below we summarize our evaluation of the human health benefits analyses and the welfare benefits analyses.

4.1.1 Health Benefits Analyses

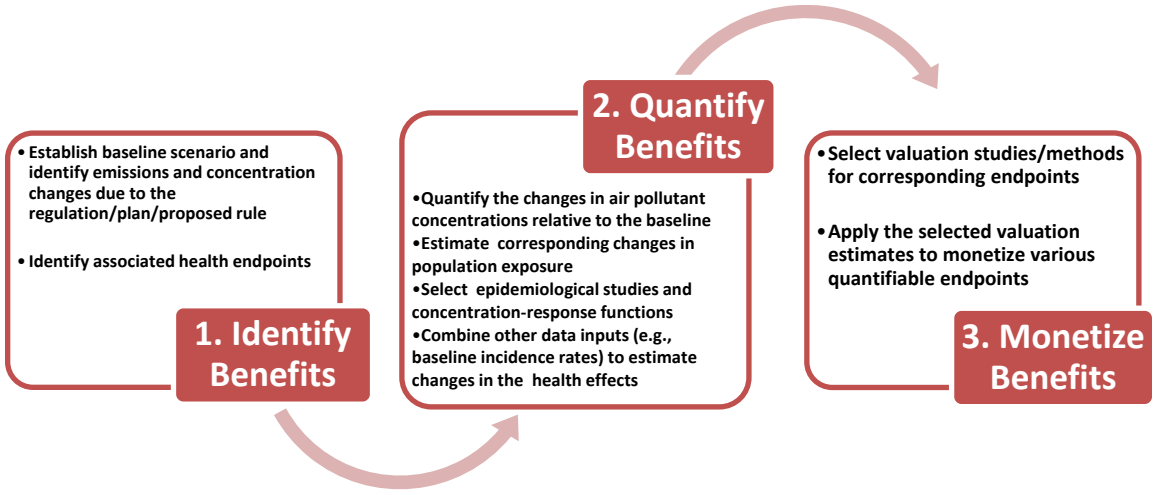
Exhibit 3 lays out a typical framework that most agencies/organizations use for conducting human health benefits analyses, which consists of three key steps:

[30] We also made comparison matrices in spreadsheet which are not included in this report due to space limit. These matrices were delivered to the SCAQMD as a separate deliverable.

- The impact of human activities on air quality, which requires estimating ambient concentrations of air pollutants in environmental media as a function of air emissions. Air quality modeling, such as the Community Multi-scale Air Quality (CMAQ) model or the American Meteorological Society/U.S. Environmental Protection Agency Regulatory Model (AERMOD), is usually used to characterize this relationship.
- The association between air quality and human health, which is often characterized in concentration-response functions estimated in epidemiological literature.
- Economic valuation to monetize health benefits, which estimates how much each unit of risk reduction (or, equivalently, a case of each adverse health effect avoided) is "worth to society." Some health effects can be valued on a market-value basis, and others may require a non-market valuation approach.

As shown in the Exhibit 3, there are various analysis components within each step. Our review focuses on key analysis components conducted by the six agencies/organizations.

Exhibit 3. Framework of Conducting Health Benefits Analyses



Baseline Characterization

It is critical to establish an appropriate baseline scenario in order to quantify incremental benefits relative to the baseline. Baseline characterization necessarily makes assumptions about the state of the economy and activities that would affect emissions. It takes account of rules and programs currently underway, and reflects attainment of the current standards. This is the first step in a benefits analysis.

As stated in USEPA's 2010 Guidelines to Preparing Economic Analyses, a proper baseline should incorporate assumptions about exogenous changes in the economy that may affect relevant benefits and costs (e.g., changes in demographics, economic activity, consumer preferences, and technology), industry compliance rates, other regulations promulgated by USEPA or other government entities, and behavioral responses to the proposed rule by firms and the public (USEPA, 2010b).

Among the six agencies/organizations that conducted health benefits analyses, three (the SCAQMD, USEPA, and NESCAUM) defined baseline scenario. USEPA conducted the most detailed analysis to carefully characterize the baseline. The SCAQMD's baseline characterization is inconsistent and somewhat confusing: TCMs were described as part of baseline but the congestion relief benefits

associated with TCM implementation was included as part of AQMP benefits. Section 3.1.2 provides detailed comments on the baseline issue.

Air Quality Modeling and Population Exposure Estimates

Based on our review, we found that there were three types of approaches used to estimate ambient pollutant concentrations. For the same agency, different rule assessments may use different approaches.

- *Photochemical models, such as CMAQ, the Comprehensive Air Quality Model with Extensions (CAMx), and the California Photochemical Grid Model (CALGRID).* CMAQ was used by the SCAQMD, USEPA, CARB, SJVAPCD and NESCAUM; it is the most often used approach based on this review. The SCAQMD also used CAMx in the 2007 Socioeconomic Assessment; NESCAUM also used CALGRID.
- *Photochemical models with regression analyses.* This approach was used only by the BAAQMD. The agency aimed to estimate the joint effects of ozone precursor pollutants by first using computer models to estimate the relationship between emissions and each pollutant concentration (marginal effects) and then applied regression techniques to convert the marginal effect into a the joint effect.
- *Air quality monitoring data and BenMAP*. CARB, SJVAPCD, and NESCAUM used BenMAP built-in monitoring data and algorithms to obtain baseline and control scenario air quality data.

With exception of the BAAQMD, the surveyed agencies/associations relied on BenMAP to estimate population exposure. The BAAQMD used the "backyard" exposure method.[31] The population data used in their analysis was from Association of Bay Area Governments (ABAG) 2007 population projections.

Our review shows that the SCAQMD's methods for air quality modeling and population exposure estimates are based on up-to-date models and are consistent with most other public agencies/organizations. However the baseline issue discussed above could affect the appropriateness of the air quality modeling inputs and outputs. For example, the 2012 Assessment does not make it clear whether/how the air quality improvement from implementing the SCAG's TCMs were included into the air quality modeling. This would then influence the ancillary benefits estimation that uses air quality improvement as an input (e.g., health benefits, visibility benefits, material benefits). Follow-up correspondence with the District Staff indicates that the TCMs were included in the baseline air quality modeling; thus those benefits are underestimated in the 2012 Assessment (because they would not capture the ancillary benefits resulted from the implementation of TCMs).

Estimation of Avoided Adverse Health Effects

With the air quality inputs and population exposure estimates, the next step to estimate avoided adverse health effects involves five analytical components: (1) selection of health endpoints; (2) selection of epidemiological relationships; (3) collection of baseline incidence rates; (4) consideration of mortality lag and (5) quantification of avoided adverse health effects based on (1)-(4). We discuss the methods used by the surveyed agencies/organizations below:

[31] The "backyard" exposure assumes that people are at home and outside in their yards all the time (24 hours a day, seven days a week).

- *Health endpoints selection*. Among the six agencies/organizations, USEPA provided the most detailed description of how health endpoints were selected; i.e., the choice of endpoints was based on causal relationships examined in the USEPA's Integrated Science Assessments (ISA) and the published literature. USEPA also listed the selected endpoints in tables with specific sources and citations. Other agencies/organizations generally used a set of endpoints that is consistent with those used by USEPA.[32]
- *Choice of epidemiological studies and C-R functions*. USEPA and CARB discussed the criteria for selecting studies and C-R functions, and provided detailed description (including tables listing the selected items). Other agencies/organizations generally followed USEPA's selection without discussion of whether USEPA's criteria are appropriate for their assessments except a few cases where agencies (i.e., the SCAQMD, CARB) used location-specific C-R functions rather than national functions.
- *Baseline incidence rates of the selected health endpoints*. All six agencies/organizations used BenMAP's built-in incidence rates. With exception of the SCAQMD and SJVAPCD, others provided some description of the data sources for baseline incidence rates. USEPA included the most detailed information.
- *Mortality lag consideration.* The mortality risk reductions from reduced $PM_{2.5}$ exposure (as a result of the regulations) have been found to be greater in the first year compared to subsequent years (USEPA SAB, 2004). USEPA's analyses typically assume a 20-year mortality lag (USEPA, 2011) and provide detailed description about mortality lag consideration.[33] It is unclear whether other agencies (i.e., non-EPA agencies) considered mortality lag, given that BenMAP does not handle mortality lag; no discussion of mortality lag is provided by other agencies.
- *Method to estimate avoided adverse health effects*. All agencies/organizations used a damage-function approach to estimate the health effects when data are available; most of them relied on BenMAP to do the calculation using the technical choices discussed above. There were a couple of exceptions where BenMAP was not used:[34]
    - Recognizing that a less resource- and time-intensive approach is sometimes desirable, USEPA developed estimates of national monetized benefits per ton (BPT) of emissions avoided for use in estimating benefits without the need to conduct detailed air quality and human health benefits modeling. USEPA's calculation of the benefits per ton values involved three principal steps, as described by Fann et al. (2009):

[32] Note that criteria pollutants are the major focus in the consideration of health endpoints. However, in some cases health effects of air toxics were also examined. For example, the BAAQMD included cancer risks in its multi-pollutant plan (BAAQMD, 2010) and USEPA assessed leukemia in the benefits and costs analyses of the CAAA (USEPA, 2011). The SCAQMD has not included air toxics, but has a plan to incorporate health benefits resulting from diesel particulates as stated in the Chapter 8 of the 2012 Assessment.

[33] Specifically, 30 percent of the total estimated mortality effects occur in the first year, 50 percent are distributed evenly among years 2 through 5, and the remaining 20 percent are distributed evenly among years 6 through 20.

[34] For air toxics, the BAAQMD used a unit risk model to estimate the cancer risks associated with air toxics (BAAQMD, 2010). USEPA estimated avoided cases of leukemia associated with benzene exposure reduction, using a life-table based risk assessment model. The life-table model assessed age-specific risks at the Census tract level, based on county-level background rates of leukemia, age-specific benzene exposure data from HAPEM6 and an epidemiological dose-response function derived from a study of occupational benzene exposures (Crump, 1994). The life-table approach can also be used for assessing criteria pollutants.

        - An air quality model was used to estimate the changes in ambient $PM_{2.5}$ concentrations resulting from specified precursor emissions reductions under various scenarios; under each scenario the total tons (of the precursor emissions) reduced were calculated.
        - BenMAP was used to estimate the changes in incidence of the associated health effects and the monetized benefits of those incidence reductions under each scenario; and
        - National estimates of benefits per ton were calculated by dividing the national monetized benefits by the total tons of emissions reduced under each scenario.
    - CARB used an "incidence per ton" approach to estimate the health impacts associated with emissions changes (CARB, 2006). This approach is similar to the BPT approach described above, except that it stops at incidence estimation and does not monetize the benefits.
    - By definition, the BPT method is an approximation. The aggregate benefits associated with any proposed reductions in emissions for a region will depend on how the reduction is distributed across point and mobile sources. The use of a benefit-per-ton measure implies that any additional ton reduction would yield the same estimated gain. In fact, the reduction will depend both on where the ton is removed from and what the levels of emissions are from all other sources. Research over the past 25 years has documented and confirmed these issues (Oates, Portney and McGartland (1989), Muller and Mendelsohn (2009)). Thus the caveats and limitation of applying a BPT-type method include: (1) BPT estimates must be specific to a combination of emission type and source category because the benefits per ton of emissions depend on both the type of emissions (e.g., NOx vs. SO2) and the geographic distribution (relative to population centers) of the emitting sources; (2) the assumption needs to hold that the geographic distribution of controlled emitting sources in a source category (e.g., EGUs) and of emissions reductions in the current analysis are similar to the geographic distribution of emitting sources and emissions reduction in the analysis that derives the BPT estimates; (3) the estimated health benefits based on a BPT-type method is rough and should be interpreted with caution.

Our observations indicate that the SCAQMD has followed a standard approach to quantify the health effects of air regulations; however, the documentation does not provide sufficient information to evaluate whether the technical choices (e.g., C-R function, baseline incidence rates, population) are appropriate.

Economic Valuation of Health Impacts

To monetize health benefits, it is most common to multiply the estimated number of cases avoided by the economic value per case (the "unit value"). All agencies/organizations used methods consistent with the basic logic of the "unit value" approach and they generally relied on consistent methods for deriving the unit values. Willingness-to-pay estimates derived from non-market valuation studies were used for mortality, asthma exacerbation, and respiratory symptoms. When willingness to pay (WTP) values were not available, cost-of illness (COI) estimates based on market valuation were applied (e.g., hospitalizations, ED visits). BenMAP was again used by many agencies/organizations to estimate the monetized health benefits.

USEPA's Regulatory Impact Analyses (RIAs) provided considerable details on the specific valuation methods/literature used to derive the unit values. Other agencies/organizations often relied on the unit values used by USEPA, with a few exceptions:

- The SCAQMD used a meta-study by Kochi et al. (2006) to derive a unit value for premature mortality. The review of this valuation was provided in Section 3.1.1, including comparison with USEPA's valuation method.
- CARB derived COI estimates for morbidity endpoints based on California-specific valuation studies (CARB, 2006), which should be considered as a lower bound estimate of the economic losses associated with health effects.

Agencies (except USEPA and CARB) did not provide sufficient documentation of economic valuation. Discussion of valuation study selection, weight assignment to selected valuation functions, income elasticity, discounting, and adjustments for income growth were generally missing in the current documentation.

Environmental Justice Assessment

Among the six agencies/organizations, only USEPA and the SCAQMD (the 2012 Assessment) assessed differences in the air pollution exposures and health benefits for vulnerable and susceptible populations.[35]

In the 2012 Assessment, the SCAQMD quantitatively examined the $PM_{2.5}$ concentrations in "EJ areas" and qualitatively discussed the benefits of reduced health expenditure to the low-income households briefly (p. 3-10 of the 2012 Assessment). The "EJ areas" were defined as areas that exceed 10 percent of poverty rate with a cancer risk greater than 850 in a million or a $PM_{2.5}$ concentration greater than 19.02 μg/m3 (p. 5-4 of the 2012 Socioeconomic Assessment) based on District's existing EJ guidance. This definition is somewhat ad hoc and needs to be re-examined carefully. USEPA's EJ analysis is more comprehensive than the SCAQMD's and does focus on threshold specification. Instead USEPA has estimated rule impacts on different subpopulation groups (e.g., minorities). In the Transport Rule RIA, USEPA first identified potential disproportionately high risk of adverse effects on minority and/or low-income populations related to $PM_{2.5}$ exposures and examined the distribution of the $PM_{2.5}$-related benefits among vulnerable and susceptible populations.

4.1.2 Welfare Benefits Analyses

Welfare benefits include ecological benefits (e.g., impacts on forest health and population, wildlife quantity and habitats, crop yields, park visits, aesthetics, and recreational fishing) and non-ecological related benefits (e.g., visibility, material, noise, odor, and worker productivity). Welfare effects of air pollution are less studied than health effects and may be a source of continuing challenges for environmental agencies/organizations that wish to include welfare benefits in regulatory impact assessments. In the sections below, we provide a summary of several types of welfare benefits analyzed by the identified public agencies/organizations.

[35] Vulnerable populations are exposed to higher pollution levels, e.g., people living near highways. Susceptible populations are predisposed to disproportional harm from pollution exposure compared to others exposed to same level of pollution), e.g., children or the elderly.

Visibility Benefits

Three agencies/organizations (the SCAQMD, USEPA and NESCAUM) discussed visibility benefits of air regulations. NESCAUM qualitatively described visibility impairment in the economic assessment of Tier 3 Low Gasoline Program. Both SCAQMD and USEPA provided quantitative analyses, but used different methods.

USEPA has examined two types of visibility benefits: recreational visibility and residential visibility, using willingness-to-pay estimates. For recreational visibility in Class 1 area (e.g., national parks and wilderness areas), USEPA used WTP from contingent valuation studies (Chestnut and Rowe, 1990a; 1990b). For residential visibility, USEPA drew upon WTP values from Brookshire et al. (1979), Loehman et al. (1985) and Tolley et al. (1986). Detailed description about method, literature review, and uncertainty were provided in the assessment documents reviewed and results were presented in tables, figures and maps.

The studies USEPA used, as listed above, are quite old. There are more recent visibility studies for national parks and residence (e.g., Smith et al., 2005; IEc, 2013). Also there are meta-analyses of visibility studies for national parks (e.g., Smith and Osborne, 1996).

The SCAQMD's hedonic approach was evaluated in Section 3.1.2, where we raise concerns regarding Beron et al. (2001).

Ecological Benefits

Of the six agencies/organizations, the SCAQMD, USEPA, CARB and NESCAUM discussed the ecological benefits. Most of the assessments were qualitative. NESCAUM described ecosystem impacts from nitrogen oxide (NO_x) emissions in the economic assessment of Tier 3 Low Gasoline Program. CARB qualitatively discussed the biological impacts of the Ocean-going Vessels Rule. The SCAQMD quantified agricultural benefits associated with ozone reduction in the 2007 Assessment; the 2012 Assessment did not include ecological benefits.[36] USEPA, in most cases, provided qualitative discussions of the impact of changes in environmental and ecological effects, for example, the impacts of changes in deposition of nitrogen and sulfur to terrestrial and aquatic ecosystems. In the case of Clean Air Act Assessment (CAAA) (USEPA, 2011), USEPA quantified the impacts on the agriculture and forest productivity at the national scale, using exposure-response functions and the Forest and Agricultural Sector Optimization Model (FASOM).[37] In addition, USEPA conducted a case study analysis of a set of ecological effects in the Adirondack region of New York State. In this lake acidification case study, USEPA used CMAQ and the Model of Acidification of Groundwater in Catchments (MAGIC) to simulate acidic deposition. The agency then developed a statistical model to estimate the relationship between the acidification of lakes and their specific site characteristics. Finally, non-market valuation methods (i.e., a random utility model) were used to value the ecological benefits of CAAA in terms of recreational fishing in the Adirondack region (USEPA, 2011).

[36] Based on conversations with the SCAQMD technical staff, the agricultural benefits were estimated for the 2012 AQMP but were not included in the report because the benefits were very small.

[37] See information about FASOM at: http://agecon2.tamu.edu/people/faculty/mccarl-bruce/FASOM.html [Accessed on June 19, 2014]

Material Benefits

Of the six agencies/organizations, only SCAQMD and USEPA provided assessment of material benefits. In the CAAA assessment (2011), USEPA quantified material benefits due to reduction in SO_2 exposure. The major steps can be summarized as: (1) estimate the SO_2 ambient concentrations; (2) estimate the inventory of four exterior building and infrastructural materials in each county in 48 states, including carbonate stone, galvanized steel, carbon steel, and painted wood surfaces; (3) obtain the dose-response functions for man-made materials damages from two sources: the National Acid Precipitation Assessment Program (NAPAP) studies and the International Cooperative Program (ICP) on Effects on Materials; (4) estimate the material benefits as the avoided cost of future materials maintenance activities.

The literature used by USEPA was very old and updated/new studies have not been identified; as a result, USEPA no longer quantifies this category of benefits in more recent RIAs due to insufficient data.

The SCAQMD's material benefits analysis (reviewed in Section 3.1.2) suffers from similar problems as USEPA's, i.e., outdated literature and data.

Traffic Congestion Relief Benefits

Only the SCAQMD estimated the traffic congestion relief benefits in the AQMP Assessments. Our review is provided in Section 3.1.2 and recommendations are discussed in Section 6 below.

4.1.3 Uncertainty Analyses

In the benefits analyses we reviewed, all agencies/organizations provided discussions of uncertainty but at different levels of detail. The SCAQMD and SJVAPCD presented point estimates of benefits and provided a brief qualitative discussion of uncertainties. Other four agencies/organizations were able to do sampling-based uncertainty analyses for some sources of uncertainty (e.g., confidence intervals for the avoided deaths, taking into account the statistical uncertainty in the C-R function coefficients).

USEPA has put substantial effort in uncertainty characterization. For each data input, USEPA provided detailed discussion of quantifiable and unquantified uncertainties, including the sources of the uncertainty, the possible impact, the impact direction (negative or positive), and impact magnitude (e.g., Table 5-11 in the CAAA Assessment [USEPA, 2011]). For health benefits, USEPA addressed some uncertainties using sampling-based methods and local sensitivity analyses, but did not consider potential correlations in uncertainty distributions. For some of the parameters (e.g., alternate C-R function coefficient) evaluated using sampling-based methods, expert elicitation was used to derive uncertainty distributions, while for other parameters only statistical uncertainty was reflected. When quantification was not possible, USEPA provided qualitative descriptions to judge the uncertainty level and direction of the impact.

CARB also included a detailed uncertainty assessment. In addition to presenting confidence intervals for benefits estimates based on BenMAP outputs (generally reflecting statistical uncertainty), CARB conducted sensitivity analysis of C-R function choices in some cases. The agency also provided detailed qualitative discussion of uncertainties associated with the health benefits analysis.

The BAAQMD and NESCAUM quantified some uncertainties using standard BenMAP output, but did not provide a discussion of uncertainties.

4.2 Review of Cost Analyses

In addition to the benefits of an air regulation/plan/program, agencies/organizations typically estimate the costs of proposed rules. These costs include the capital and operating costs of equipment to control pollution, as well as administrative and other costs required to comply with the proposed regulations.

Similar to the review of the SCAQMD's cost analyses, we examined the components of the cost analyses of air quality regulations from other agencies/organizations. Below we compare and contrast the analyses from other organizations to those from the SCAQMD.

4.2.1 Data Sources for Capital and Operating Cost Estimates

The SCAQMD socioeconomic analyses reviewed were largely inconsistent in terms of the types of data used to estimate capital and operating costs of the pollution control equipment required to comply with proposed rules. In particular, the specific data sources were often not reported or cited. However, the SCAQMD is not alone in this regard. Many of the staff reports and socioeconomic analyses of rules proposed by other agencies/organizations gave similarly scant information on the data sources used to estimate control costs.

For example, in most of the staff reports for the BAAQMD rules, the reports simply state that costs were estimated by the BAAQMD staff, but they do not offer any details on the methodology for the estimation or any data sets used in the analysis. Similarly, the report on the NO_x reasonably availably control technology (RACT) from Ohio EPA states that costs were determined from a literature search, but it does not cite any of the literature used.

A few agencies/organizations, however, were much more transparent about the data sources used to estimate control costs. The cost-effectiveness analysis for SJVAPCD Rule 4566, which regulates composting operations, devotes an entire subsection of the report to explaining the sources of control cost data. Specifically, the agency solicited quotes from vendors of control equipment. In the only BAAQMD analysis that we reviewed where the costs were cited, the costs were derived based on data supplied by the only affected facility in the district, which were compared with other costs obtained through a literature search.[38]

It should be noted that many studies suggest that *ex ante* cost estimates developed by industry and in some cases by regulatory agencies are often considerably larger than actual implementation costs (e.g., Morgenstern, 2014; USEPA, 2012). Nevertheless, cost data from regulated entities can be used to estimate control costs, but where possible, these estimates should be validated with other cost data, published literature, and expert opinion.

In the analyses we reviewed, there were few examples where future control costs were considered. An exception is the RIA for the NAAQS for $PM_{2.5}$, where USEPA derived a cost curve that allows for the estimation of future unknown control costs. Similarly, Fowlie (2010) develops a model, using data from the Electric Power Research Institute (EPRI) model for NOx control options, to estimate capital and operating control costs for electric generation units. Her comparison documents the differences between the engineering approach and an economic method for estimating compliance costs.

[38] BAAQMD socioeconomic analysis for Regulation 9, Rule 13, regulating manufacturers of Portland cement.

Importantly, this analysis finds that other regulations, such as electricity rate regulations, are important drivers of the choices of control equipment that entities make in complying with emission reduction regulations.

4.2.2 Other Costs (Monitoring, Reporting, Administrative, etc.)

The SCAQMD does an excellent job of including reporting, monitoring, and other administrative costs, as compared with the analyses performed by other agencies/organizations.

The SCAQMD generally includes the administrative and other costs associated with implementing pollution controls, such as permit fees and testing requirements. The reports reviewed from other agencies/organizations were fairly evenly split regarding whether administrative and other costs, in addition to capital and operating costs, were included in the analysis. Some reports, such as NO_x RACT report from Ohio EPA, mentioned that personnel, monitoring, and other indirect administrative costs are included, but do not include details on what those costs actually were.

4.2.3 Discounting

The SCAQMD uses a four percent real discount rate in most of its cost analyses. Most other agencies/organizations (if they mention the time value of capital at all) tend to annualize capital costs rather than discount total project costs. Reports reviewed for rules from both the SJVAPCD and the San Diego County Air Pollution Control District (SDCAPCD) use a 10 percent interest rate over 10 years to annualize control costs. Discussion on discount rates choices is generally missing in the documents we reviewed.

Of all the reports reviewed across agencies/organizations, only USEPA offered a rationale for its choice of interest rate in the RIA of the Mercury and Air Toxics Standards (MATS). The agency used a rate of 6.15 percent, which it stated is an empirically informed price of raising capital for the electric power sector.

The choice of most agencies/organizations to annualize costs rather than discount them typically leads them to use the levelized cash flow method of determining the cost effectiveness of proposed rules, rather than the discounted cash flow method used by the SCAQMD. This is discussed further in Section 4.2.6.

4.2.4 Equipment Life

The SCAQMD's 2012 Assessment uses the useful life of the equipment in its control cost analyses (see our review of this component in Section 3.2.3).

Few other agencies/organizations state specific assumptions about the useful life of control equipment in their reports or socioeconomic analyses. Some agencies/organizations include implicit assumptions about the life of control equipment when they annualize capital costs over, for example, a period of ten years. None of the reports we reviewed discussed the difference between the useful life and the economic life of control equipment.

4.2.5 Uncertainty Analysis

Given that there are many uncertain parameters in cost analysis of proposed rules, including cost estimates and discount rates, some discussion of this uncertainty in the socioeconomic analyses is warranted. However, few reports reviewed from any of the agencies/organizations mention the

significant uncertainty inherent in their cost analyses, including uncertainty in the cost model itself or the particular compliance method regulated entities might use, if there are multiple options.

The US EPA is a notable exception, which dedicates a lengthy section of the MATS RIA to the uncertainty and limitations of the analysis. In addition, the RIA Industrial, Commercial, and Institutional Boilers conducted a scenario analysis of the control costs both with and without fuel savings from control technologies.

Other examples of the treatment of uncertainty in cost analysis include attempts at simplified sensitivity analyses or scenario analyses. For example the report on the BAAQMD Regulation 8, Rule 53, which regulates vacuum truck operations, calculated cost effectiveness using low- and high-cost scenarios. Furthermore, the test of the WESTAR economic analysis framework used both two percent and seven percent discount rates in the analysis.

4.2.6 Cost-Effectiveness Methodology

As discussed in Section 3.2.5, SCAQMD uses the discounted cash flow (DCF) method, rather than the levelized cash flow (LCF) method, to calculate the cost effectiveness of proposed rules. In the review of analyses performed by other agencies/organizations, it appears that few agencies/organizations outside of California calculate cost effectiveness. If costs are explicitly compared to the benefits of emission reductions at all, it is more common for an agency to calculate the net benefits, in which the costs of a rule are subtracted from the monetized benefits of the rule.

The other California agencies reviewed for this analysis, including the BAAQMD, SJVAPCD, SDCAPCD, the Sacramento Metropolitan Air Quality Management District (SMAQMD), and the Ventura County Air Pollution Control District (VCAPCD), each use a methodology more similar to the LCF, in which annualized costs are divided by the annual emission reductions. USEPA's Control Techniques Guidelines also calculate cost effectiveness in this manner.

The only instances of the use of the DCF method outside of the SCAQMD analyses that we found came from the SMAQMD analysis of Rule 411, which regulates NO_x from boilers, process heaters, and generators, and several of the rules from CARB.

As discussed in Section 3.2.5, an important drawback of the LCF method is that it examines the annualized costs and emission reductions for only one year. Therefore, it implicitly assumes that the emission reductions are constant through time. While each of the SCAQMD analyses using the DCF method that we reviewed also assume that emission reductions are constant through time, the DCF method is at least flexible enough to handle scenarios in which the emission reductions are variable, such as a case where a control loses effectiveness over time or a scenario where regulations are increasingly stringent over time.

The difference in the cost-effectiveness methodology used by SCAQMD makes it difficult to compare cost-effectiveness estimates of pollution control strategies across agencies. For example, a report from the SJVAPCD on the updates to the District's best available control technology (BACT) cost-effectiveness thresholds states that because the SCAQMD uses a different cost-effectiveness methodology that tends to result in lower estimates of cost effectiveness, these estimates could not be considered in the comparison across agencies (SJVAPCD, 2008).

4.3 Review of Economic Impact Analyses

We compare economic impact analyses by the SCAQMD with those from seven other agencies/organizations that assess economic impacts. SCAQMD and NESCAUM used REMI models in their analysis. The WESTAR report included a series of modeling recommendations along with a sample analysis. No proposed rules were analyzed in this report. VCAPCD did not conduct an economic impact analysis. Instead, they examined reports by CARB and the SCAQMD for similar rules, and based conclusions for their region on the SCAQMD's analysis. For example, in the analysis of Rule 74.2 Architectural Coatings, VCAPCD looked at SCAQMD's analysis of their similar Rule 1113 and considered the change in employment for SCAQMD to be a worst case scenario for VCAPCD. Other agencies, USEPA, SJVAPCD, SMAQMD, CARB, and BAAQMD each conducted economic analyses using an input-output (I-O) or computable general equilibrium (CGE) model.

I-O models use a matrix of multipliers that describe how each sector of the economy purchases inputs from other sectors. If a sector reduces its output because of regulation, the multipliers can be used to compute the indirect effects on other industries and the total loss of jobs throughout the economy. I-O multipliers are available from the Bureau of Economic Analysis (BEA) or from proprietary sources like IMPLAN.

The REMI model, used by the SCAQMD and NESCAUM, includes an I-O model with several enhancements. These include modules that estimate prices, wages, migration, and demographics. The SCAQMD's customized REMI model includes a regional disaggregation of the South Coast region. REMI also uses estimates of economic responses based on historical data to parameterize the model. REMI provides these proprietary response parameters and baseline data to users. Because the data and parameters are proprietary, the model is somewhat of a "black box" to those without access to a REMI license. REMI's website includes more detailed documentation of the model structure and calibration.

REMI includes benefits of improved air quality as an amenity to households that makes migration to the area more attractive with lower wages. This difference in wage represents the willingness to pay for improved air quality. Both market and non-market benefits are included along with costs in SCAQMD's 2012 report, as discussed in Section 3.3. For the most part USEPA does not currently include non-market or market benefits in its economy-wide models for policy analysis. An exception is the second prospective study Benefits and Costs of the Clean Air Act, 1990 to 2020 (USEPA, 2011). That study includes scenarios that use costs and a subset of human health benefits that can be monetized into market benefits to compute the net social cost of policy, and the non-market benefits are introduced by assuming avoided health effects can be treated as equivalent to increasing the labor endowment. This strategy fails to take account of the other ways air quality improvements influence economic outcomes. Moreover the logic used to translate health into labor equivalents is inconsistent with the methods used to estimate the damages from those health effects. Since this work was conducted, USEPA has continued to experiment with the inclusion of benefits in economy-wide models. Currently they have requested that the Science Advisory Board compose a committee to consider the appropriate use of economy wide models.

CGE models extend the I-O matrix to include households, governments, and other sources of demand that characterize the economy in a social accounting matrix (SAM). CGE models link entities throughout the economy through relative prices. Policy changes that influence prices in one or more sectors have additional effects on prices in all other sectors. Compliance costs can be implemented in

a CGE model by changing the purchases that a regulated sector makes from other sectors. This change in purchases impacts prices throughout the economy and affects the demand for material inputs and labor by industries and demand for consumption goods by households.

Regional CGE models must be custom built using a program based in a language such as GAMS. Examples of these models would be USEPA's EMPAX model and CARB's EDRAM model. Both a GAMS/CGE model and the REMI model have their advantages and disadvantages. While CGE models allow for a more detailed representation of input substitution that leads to feedback effects in other sectors through the use of nested constant elasticity of substitution (CES) production functions, balancing the underlying data and then programming the GAMS model requires an initial investment. After this process, the model can be customized to analyze complex combinations of regulations and can include detailed representations of relevant sectors.

Both a GAMS model and REMI will run at similar levels of aggregation (such as EMPAX's 35 sectors). REMI includes more detailed household groups, demographics, and migration patterns. This allows the users to examine sub-regional impacts, which may be more useful for a regional analysis. The SCAQMD's 2012 Assessment has reported job impacts and costs by sub-region as well as job impacts on high- versus low-paying jobs. Other agencies did not conduct such detailed analysis. Agencies can design their GAMS model to be released in an open-source fashion, to reduce the criticism for using a "black-box" model. However the model code requires some expertise to interpret, and the data used to calibrate the model may be proprietary (for instance, if based on an IMPLAN SAM).

The SCAQMD provided limited discussion of assumptions about markets and consumers in the 2012 Assessment appendix, which lacks key details on how costs and benefits are applied. CARB and USEPA provided some discussion of model structure and pointed to other model documentation reports that provide detailed information on the model assumptions. The BAAQMD, NESCAUM, and SMAQMD provided limited information on the assumptions that underlie macroeconomic modeling. WESTAR and SJVAPCD did not provide details on model assumptions.

Some of the agencies used a cost/sales test to determine if further economic analysis was necessary. This screening step was conducted before running the I-O or CGE models. If the ratio of compliance costs to revenues was over 10%, the rule was subject to further analysis. Combinations of Dun & Bradstreet, US Census, state labor data, and IRS data were used by these agencies to compute the ratio of compliance costs to profits (BAAQMD) or revenues (SJVAPCD).

Once the decision is made to run the macro model, compliance costs must be introduced to the model. The SCAQMD, WESTAR, and USEPA provided information about how costs are converted into expenditures and applied in the employment model. Each analysis assumes that compliance expenditures will affect the input demand for the affected industry. The compliance costs were converted into demand changes that were input to the models. With the exception of USEPA, the distribution of these costs to specific purchases was not discussed. USEPA used a matrix of compliance expenditures to compute the changes in input demand for each factor of production for each regulated industry. None of the reports that used input-output models for analysis described the methodology for applying costs across sectors and households.

4.3.1 Job Impacts

The models considered here report changes in employment in the number of jobs lost or gained with regulation. Percent changes in jobs may give a clearer picture of the magnitude of employment changes, as discussed in Section 6. Agencies that conduct a study of job impacts of regulation use either a CGE or an I-O model (REMI is classified as an I-O model with econometric and other extensions). CARB and WESTAR use custom built CGE models to examine changes in employment. USEPA's does not present employment changes in the CGE analysis at this time. However, for the MATS rule, USEPA used an approach based on the jobs per dollar of compliance expenditures estimated by Morgenstern et al. (2002), as well as a bottom-up analysis using outputs of the IPM electricity sector model. The BAAQMD and SJVAPCD used I-O models based on IMPLAN data, while SMAQMD used the BEA's RIMS II I-O model to predict direct and indirect job changes and NESCAUM used a REMI model, like SCAQMD.

4.3.2 Impacts on Economic Groups and Communities

Certain populations may be of interest to policy makers, such as low income households, if the changes in employment or consumption are expected to disproportionately affect these groups (i.e., EJ implications). The SCAQMD's REMI model included 808 different cohorts of age, gender, race, and ethnicity that can be used to examine impacts on different populations. These were aggregated into a smaller number of consumer groups for the studies. Some studies conducted additional community impact studies outside of the macroeconomic model. These included the BAAQMD analysis of the impact on households of the Clean Air Plan by owners versus renters and the type of building. CARB analyzed the impacts of LEV III on low-income communities in California. WESTAR's framework document suggested using the IMPLAN household income groups to look at the distribution of policy impacts, as well as separate analyses for small businesses, minority groups, and tribal impacts.

4.3.3 Competitiveness

Competitiveness measures how production costs in the regulated area compare to costs in other areas, to give a sense of how the businesses in the region will be affected by regulation. Several of the studies analyzed markets for local products, such as automotive painting, that consumers are likely to purchase within the local area. Sectors that produce goods that can be imported to the regulated area are at risk of losing competitiveness due to increasing production costs. Competitiveness impacts depend on whether businesses are able to pass on higher costs to consumers, who may then substitute imports for local production. These outcomes are affected by the elasticity of demand for the affected product, as well as the availability of substitutes.

Competitiveness can be measured in several different ways. SCAQMD used the share of local jobs to US jobs before and after the policy was applied to reflect whether the region's economy was expanding or contracting. None of the other studies we reviewed used this particular measure. SCAQMD also computed an index of local to national production costs to measure competitiveness, as well as reporting the percent change in prices. Other studies examined changes in imports and exports estimated by economic models to analyze changes in competitiveness. Refer to the Macro Comparison Matrix in Appendix E for additional measures of competitiveness used by different agencies.

4.3.4 Small Business

Many federal, state, and local rules require an analysis of the effects of regulation on small businesses. The definition of a small business may vary by region or by the sector under consideration. Small businesses are defined by the businesses' revenues, the number of employees, or the level of output.

None of the economic models used by these agencies were able to predict small business impacts because of their high level of aggregation; a separate small business analysis was required. The small business analysis typically involved two steps. First, small businesses were identified. Data sources for information on small businesses included Dun & Bradstreet firm data, Census data, and lists of permitted facilities. Second, cost to profits ratios were used to determine if a rule was burdensome to small businesses. If a given threshold for this ratio was exceeded, the rule may have affected the profitability of small businesses and lead to facility closures. For more details on the data sources, cost/profits thresholds, and definitions of small businesses used by different agencies, refer to the Macro Comparison Matrix.

4.3.5 Uncertainty Analysis

Uncertainty in the results of the macroeconomic analyses was investigated using a scenario-based approach in which multiple scenarios were considered and compared their results. The SCAQMD used this approach for the Offroad and VOC rules. BAAQMD ran three sensitivity scenarios in addition to the central scenario for the Clean Air Plan. CARB considered two additional runs for the LEV III analysis. The SMAQMD ran high and low cost scenarios, with an additional high cost scenario in which all costs are passed on to consumers for the auto coatings rule. The USEPA provided a qualitative discussion of uncertainties in their results, by describing whether actual impacts may be greater or smaller, but did not provide quantitative assessments. NESCAUM provides results based on different discount rates, emissions cap levels, and investments.

5. Stakeholder Interview Results

As part of this project, we conducted 23 stakeholder interviews. As described in Section 2.3.3, we summarized each interview session and then determined general themes raised by the commenters. In this section, we present stakeholders' comments under each common theme:

- Data inputs – data collection and selection for analysis components.
- Methodology/modeling – methods and models used in the socioeconomic assessments.
- Scope of analysis – the range of analysis components covered by SCAQMD's assessments.
- Uncertainty – assessment of the uncertainties associated with data inputs and model outputs.
- Documentation clarity and presentation – report organization, clarity of the methods/results description, and writing quality.
- Decision and rule making process – overall agency-level considerations during the decision/rule making process.
- Outreach – interactions with stakeholders, affected industries, and the general public.

5.1 Data Inputs

During the stakeholder interviews, many respondents expressed concerns regarding the data inputs the SCAQMD utilizes for its analysis components, such as cost and benefit analyses.

5.1.1 Data Collection for Cost Analyses

One of the predominant concerns voiced by the respondents dealt with the accuracy of the SCAQMD's cost data for its control cost analyses. Several respondents felt that the SCAQMD does not put sufficient effort into involving industries in the data collection process, limiting its insight into real cost structures within regulated industries. Furthermore, respondents noted that, even when the SCAQMD does collect data from industries, it distrusts the collected data, either not reporting it or not reporting the full range collected.

Respondents felt that the lack of accurate cost control data has led the SCAQMD to sometimes propose control measures without associated costs, or to assume a control cost that may conflict with general industry experience. Additionally, this disconnect may contribute to counterintuitive cost numbers in SCAQMD analyses.

Stakeholders' suggestions for the SCAQMD were straightforward, recommending that the SCAQMD collect more regulatory cost information and give it credence in its analyses. If some firms may be unwilling to coordinate with the SCAQMD directly, one respondent suggested that the SCAQMD partner with industry associations and let those associations collect the information in its stead.

5.1.2 Literature

Several respondents felt that some of the SCAQMD's analyses are based upon outdated literature. The visibility benefits study by Beron et al. (2001) was specifically pointed out as one that may be invalid now due to very different post-recession economic conditions. Furthermore, one respondent

felt that the SCAQMD sought to discredit a local study (not specified by the respondent) by the University of Southern California in favor of national studies.

5.1.3 Economic Valuation for Mortality Risk Change

Several respondents voiced concern over the use of the value of a statistical life (VSL) in the SCAQMD's health benefits assessments. Some felt that the VSL of $7 million was too high and did not take into account variations in population characteristics, such as the difference between a high school dropout and a PhD student.[39] However, another stakeholder commented that this use was consistent with other organizations' analyses. Finally, one respondent noted the difficulty of putting a number on qualitative issues such as life.

Another commenter recommended the use of VSLs in projecting future health risks for an individual and the possibility of illness-specific VSLs.

In a separate comment, a stakeholder pointed out that, while using USEPA's contingent valuation method may be reasonable, the values themselves may be unrealistic since the survey respondents are asked about hypothetical payments, and are not asked to make any actual expenditures.

5.2 Methodology and Modeling

Due to the critical nature of the topic, our interview questions placed particular emphasis on the technical aspects of SCAQMD's socioeconomic assessments. While the comments were wide-ranging, we have grouped them into the following categories: analyses assumptions, models/methods, and baseline specifications.

5.2.1 Analyses Assumptions

Several respondents noted that the SCAQMD uses an unreasonable assumption about equipment life. The SCAQMD overestimates the useful life of control equipment by not accounting for its own future regulations that require new equipment upgrades before normal equipment lifespans are up. In addition, some respondents thought that the SCAQMD's use of a 70 year exposure to air pollution for benefits calculations seems unrealistically high.

One respondent noted that the SCAQMD's regulatory authority in particular areas (e.g., mobile sources) may not be as certain as the AQMP assumes. As a result, the benefits calculated may be overstated in areas where the SCAQMD does not actually have authority to issue or enforce rules.

Respondents also felt that the SCAQMD assumptions are used without justification and without consideration for stakeholder input. One respondent suggested conducting a review of the SCAQMD's current estimates to help justify its current assumptions and/or revise assumptions where appropriate. One respondent also noted that the SCAQMD sometimes extrapolates too much based on data assumptions that may be problematic. In instances where definitive data are lacking within the agency, the SCAQMD should engage industry and other stakeholders to provide validated numbers that can better inform the assumptions.

[39] The VSL reported in the 2012 Assessment is $6.1 - $6.7 million at 2010 income levels in 2005 dollars.

5.2.2 Models/Methods

Several respondents found the SCAQMD's methods and use of models to be generally appropriate to the scope of its assessments, and more importantly, to be rigorous and technically strong. Furthermore, the SCAQMD was also praised for its efforts in staying current with analytical advancements. However, respondents also noted several areas for improvement. Of these, the one mentioned most frequently was to improve the detail and granularity of the analyses, especially in assessing economic and regional impacts.

Regulatory Cost Analysis

We observed conflicting comments regarding the SCAQMD's control cost estimates. Some respondents noted that the SCAQMD often underestimates control costs, caused, in part, by the SCAQMD's use of the discounted cash flow method rather than the levelized cash flow method. These respondents felt that the SCAQMD primarily looks at the costs of adopting new technologies, understating the importance of secondary and indirect costs due to long-term operation and maintenance for already installed technologies. In contrast, one respondent felt the SCAQMD overestimates control costs by basing estimates on current prices for control technology, which does not take into account the potential for technology prices to decrease over time. In addition, a few respondents believed that the cost estimates were quite accurate.

Benefits Assessment

Several respondents made positive comments on the benefits analyses, especially the health benefits analysis. They felt that the SCAQMD uses a standard, straightforward approach to examine the health impact of particulate air pollution and that the agency is at the forefront of this field. The Multiple Air Toxics Exposure Study (MATES) was cited as an example of the strength of the SCAQMD's health impact analyses and its utility in community-level EJ analyses. Meanwhile, one respondent expressed concern that BenMAP may not be accurate or detailed enough at a sub-regional level, that it does not consider spatial interaction, and that it has limited dispersion modeling.

There was also concern that the SCAQMD's reliance on modeling pollutant concentrations from mobile sources may inflate exposure estimates. Pollution detection methods have improved, and models now lag behind these capabilities.

Environmental Justice Analysis

The limited granularity of the SCAQMD's models is a significant concern in the context of environmental justice (EJ) analyses. The lack of community-level detail in the REMI model limits the SCAQMD's ability to understand the distributions of costs to communities in the basin. Many respondents also felt that the EJ analysis might be limited due to the SCAQMD's unrepresentative definition of an EJ community, which many felt to be widely different from what most organizations use. Some suggested using more descriptive information of EJ issues, claiming that data-driven analyses are subject to skepticism from the general public.

Economic Impact Analysis

Several respondents felt that the REMI model was not an appropriate model for assessing small business impacts and that it does not consider heterogeneity in firm size. There was also a concern that, due to its focus on employment, the REMI model may not capture the economic impacts of compensation effects; for example, that companies can maintain employment levels using lower

wages or benefits to accommodate new regulatory costs. Many respondents also felt that the REMI analysis glosses over the difference between job types, such as temporary versus permanent or high-income versus skilled wage jobs, which have different effects on economics and communities.

Furthermore, respondents felt that the inclusion of such a large number of sectors in REMI's job impact analysis limits the quality of the analysis for individual sectors. The SCAQMD was also criticized for averaging its model results to report a single long-term estimate, obscuring the details of the actual model projections. Several respondents mentioned that the definition the SCAQMD uses for small businesses is too narrow and does not align with industry standards.

Another concern is that the SCAQMD's analyses are too inwardly focused. One respondent noted that the REMI model lacks sensitivity to changes in competitive advantage and business costs and the resulting migration of businesses in and out of the region. The analyses are not clear about how the South Coast Air Basin interacts with other regions, limiting projections of job impacts via domestic and international trade and rulemaking impacts by the SCAQMD on other markets outside the basin.

Other Concerns

Finally, numerous respondents exhibited general concerns about the SCAQMD's choice of models for its analyses, pointing to illogical results (e.g., negative costs) and discrepancies between the SCAQMD's results and results from national-scale. In regards to the illogical results, one respondent suggested comparing results against the literature or simply reaching out to academics in the field to either corroborate or revise the results. More generally, they suggested that the agency keep the models/methods up to date and be explicit about their limitations.

A common suggestion from the stakeholders was to bring in outside experts to independently evaluate the SCAQMD's current methods and to either suggest alternative methods or help update the current methods. The REMI model was pointed out specifically as in need of updating or replacing. Another suggestion was for the SCAQMD to replicate the methods used by USEPA and other larger national or international organizations that have more resources for developing new analytical methods. Some respondents also noted that a third-party evaluator would be useful in identifying alternative policy options, rendering the CEQA analysis more useful as well.

5.2.3 Baseline Specification

Concerns regarding the baseline that the SCAQMD compares against its policy scenario were expressed during several stakeholder interviews; these concerns were related to both cost and benefits projections. Respondents specifically noted the SCAQMD's inclusion of the impacts of the Southern California Association of Governments (SCAG) Regional Transportation Plan when estimating economic costs and benefits, which seemed as if the SCAQMD was taking credit for benefits unrelated to its own regulations.

Another stakeholder felt that the SCAQMD should use the current state of employment and the basin's competitiveness against other regions as a baseline for its economic projections.

5.3 Scope of Analysis

Several respondents voiced support for the overall scope of the analyses in the SCAQMD socioeconomic assessments, noting that the SCAQMD assesses a comprehensive array of components

within the assessments. Meanwhile, respondents suggested various improvements to the benefits, economic impacts, EJ, and alternative policy analyses.

5.3.1 Benefits Analysis

The health benefits analysis was mentioned specifically as an area of strength in the socioeconomic assessments, with some respondents stating that the SCAQMD covers an appropriate range of analysis components.

Several respondents, on the other hand, noted their concern with the limited scope of the health analysis. For example, respondents felt that the assessment was limited by an overly cautious assessment of health effects, as it does not acknowledge potential health threats discussed in emerging literature and research. Additionally, one respondent was concerned that the assessment focuses primarily on $PM_{2.5}$, despite research that shows ultra-fine particulates may be most damaging; and it does not consider all potential pollutants and chemicals, such as diesel particulates and other air toxic pollutants. The respondent also noted the inherent limitations of a health risk assessment and suggested that the SCAQMD include health impact assessments and public health surveys to provide supplemental information. Furthermore, one respondent suggested that the SCAQMD analyze the impacts of air pollution on the enjoyment of outdoor recreational activities, either qualitatively or quantitatively. Since the region is inhabited by an outdoorsy population and has a large travel and tourism industry, these impacts could be important.

During the stakeholder interviews, a few respondents raised concerns regarding the potential health impacts of changes in socioeconomic conditions (e.g., job loss) due to regulations. These respondents felt that the SCAQMD should consider such indirect impacts of air regulations on public health, given the emerging literature on how poverty, unemployment, and other socioeconomic conditions tied to new regulations may affect public health.

Stakeholders suggested other components for the SCAQMD to consider in the future scope of its benefits analysis, including:

- Public health care costs,
- Public transportation infrastructure costs,
- Public utility infrastructure costs,
- Public safety risk, and
- Global warming costs.

In addition, some stakeholders felt that the SCAQMD is inconsistent in its consideration of health impacts. For example, in the SO_x Reclaim document, even though public health benefits are mentioned as part of the assessment process, the SCAQMD did not conduct a health benefits analysis for that rule. Several respondents were under the impression that the SCAQMD is under a mandate to conduct a benefits analysis.

5.3.2 Economic Impacts Analysis

The majority of comments related to the scope of analysis dealt with the economic analyses in the socioeconomic assessments. The most common concern was that the SCAQMD does not look at the

cumulative economic impact of federal, state, and SCAQMD regulations on the basin. Respondents were also concerned that the SCAQMD does not currently assess the stranded costs of assets that are devalued by new regulations, despite their considerable economic implications for companies. One respondent criticized the SCAQMD's focus on details rather than broader issues such as employment and regional competitiveness. Another respondent felt that the SCAQMD overlooks the unintended consequences of its regulations, such as preventing workers in lower classes from achieving middle class status. Respondents provided a wide range of suggestions for improving the scope of the SCAQMD's economic analyses, including:

- Address the required space and costs of retrofitting, since most assessments only look at new technology;
- Identify affected industries and whether they require funding to accommodate regulatory requirements;
- Analyze the impact of dedicated funding streams on the feasibility of proposed regulations;
- Assess the indirect impacts of costs on regulated businesses;
- Explore the current income gap and the potential for job migration out of the region due to regulations;
- Examine the impact of regulations on the competitiveness of green technology, jobs, and businesses; and
- Examine CARB's Assembly Bill 32 (AB 32) and its cap-and-trade program for lessons on how losing manufacturing jobs is linked to increasing regulatory costs.

Some respondents also felt that there is not sufficient effort put into the small business and localities analyses. One respondent noted that the SCAQMD focuses too much on the negative impacts (e.g., pollution) from small businesses, but does not evaluate the economic benefits of these businesses on their communities and the potential impacts from the loss of those businesses due to regulation.

5.3.3 Environmental Justice Analysis

Although many of our respondents were concerned that parts of the SCAQMD's economic analyses were insufficient, a few other respondents felt that the SCAQMD focuses too much on employment and manufacturing concerns rather than considering EJ issues. Several other respondents echoed this sentiment regarding the EJ analysis, stating that that component is too cursorily done without enough data-driven analysis. One respondent suggested that the SCAQMD move beyond the REMI model for this analysis. A variety of suggestions for improvement were provided, including:

- Analyze the impact of high air pollution on property values and rents and the resulting impacts, such as the geographic distribution of lower-income households across the region;
- Link the EJ analysis to sub-regional analyses;
- Examine all sources of air pollution along with EJ concerns;
- Examine each EJ community separately so that benefits and other impacts can be compared within each community;

- Emulate the analyses conducted by the State Land Commission in their environmental impact reports; and
- Analyze near-roadway exposures and hotspots of pollution and the connections with EJ communities.

5.3.4 Alternative Policy Analysis

One other area of concern noted by several respondents was the scope of the alternative policy analysis. One respondent felt that the SCAQMD simply presents the alternatives but does not sufficiently analyze why a given alternative may be preferable; a full cost-benefit comparison for the proposed plan and each of the alternatives was suggested as a solution.

Respondents also felt that the SCAQMD does not analyze the differences in assumptions between the listed alternatives, limiting the component's utility for decision-makers.

One respondent also noted that the SCAQMD should keep an open mind and analyze new, creative approaches, even if they are different from the standard regulatory policies, especially if those approaches are able to achieve air quality objectives without compromising the basin's economic competitiveness. Such creative solutions would achieve greater stakeholder buy-in from a wider variety of sectors. For example, certain voluntary programs may be able to achieve the same goals as more formal regulation. Both the environmental and business communities could each suggest an alternative that the SCAQMD would then compare against its own proposal.

5.3.5 Scope of Overall Assessment

During the stakeholder interviews, we also received several broader comments about the scope of the SCAQMD's assessments. One concern mentioned frequently was that the SCAQMD does not have retrospective analyses to reevaluate past assumptions and projections. Since many respondents felt that some of the SCAQMD projections are inaccurate, they felt that this could help the agency improve its models. One suggestion was to conduct a long-term analysis to compare projections for 20 years in the future against the resulting reality for individual sectors. Another respondent felt that a more routine retrospective analysis could be more useful for the agency.

Respondents also felt that the analyses are too internally focused on the South Coast Basin rather than comparing issues such as economic costs or public health benefits against other regions. The SCAQMD could also explore scenarios in which other regions adopt similar regulations and compare regional competitiveness in that context.

Other suggestions for the SCAQMD regarding the overall assessment scope include:

- Examine the importance of clean air for businesses in location decisions and compare against the economic costs of air quality regulations, and
- Accept that the public health benefits far outweigh the regulatory costs, and structure the assessment in a way that allows the governing board to focus more on timing and implementing economic relief.

5.4 Uncertainty

Respondent comments pertaining to uncertainty generally fell into two categories: comments on the results of the analyses and comments on the presentation of uncertainty in the reports.

In the first category, the most common complaint was that the SCAQMD underestimates regulatory costs and generally understates the negative impacts of its regulations. The second most common comment was that the SCAQMD overestimates the public health benefits from its regulations. On the other hand, one respondent felt that the SCAQMD underestimates air pollution impacts on health. In addition one respondent felt that the estimated increased competitiveness due to air regulations appeared to be an unrealistic result and could be subject to a large degree of uncertainty.

Overall, respondents felt that results in the socioeconomics assessments are presented without acknowledgment of the uncertainty associated with assumptions and inputs and were concerned about the SCAQMD's presentation of point estimates rather than range estimates. However, one respondent noted that the SCAQMD does discuss uncertainty in the benefits analyses; however, it did not do so with its cost analyses. This respondent felt that this discrepancy made the benefits section seem speculative and unscientific relative to the costs sections, and emphasized the importance of treating both sections equally in regards to uncertainty. Another respondent noted that the SCAQMD has identified key areas of uncertainty (e.g., health impact functions and air quality changes) in its socioeconomic assessments but did not make sufficient effort to fill those knowledge gaps through conducting and sponsoring new research.

Most respondents appear to agree that the SCAQMD should report uncertainty quantitatively in its assessments, such as its benefits estimates, number of jobs, and control cost estimates, to avoid confusion over the certainty of its results. For example, with cost estimates, one respondent suggested that the SCAQMD should bound its analysis with estimates from industry and acknowledge any discrepancies between industry and agency estimates. Sensitivity analyses were highlighted by respondents as ways for the SCAQMD to address uncertainties in future analyses. Furthermore, providing an exposition about the agency's confidence in its results would help policymakers make more informed decisions. One respondent also recommended that the agency examine the influence of individual model inputs and assumptions on the results, which would help decision makers to evaluate the importance of those inputs and, therefore, the accuracy of the results.

One respondent noted that the SCAQMD staff should seek to interpret model results rather than simply report the numbers, due to the uncertainty involved in the analyses. For example, a staff member may recognize a counterintuitive model result and understand what the result actually means in terms of projected impacts.

5.5 Documentation Clarity and Presentation

Comments regarding the documentation clarity and presentation are summarized in this section.

5.5.1 Methodology

While some respondents found the methodology to be clear and understandable, the majority found the descriptions of methods and models to be confusing and too complex for the average reader. One respondent felt that the methodology would be difficult even for a technical person to understand.

Specifically, the comments regarding methodology clarity and presentation include:

- *Reader expertise*. Since the average reader, including policymakers, may not have expertise in the fields of economics and public health, respondents recommended that the SCAQMD create a basic guidebook documenting the methodology and more technical elements in addition to the current assessment, as well as a terminology glossary for readers. One respondent also suggested inserting a preamble to generally describe how the SCAQMD conducted the assessment and the rationale behind specific decisions.

- *Model complexity*. Overall, many respondents noted that the models employed by the SCAQMD are exceptionally technical. While some commended the agency for using such complex methods, a few respondents felt that the models are too complex for a layperson to understand sufficiently, leading to a lack of understanding of the results.

- *Documentation*. Respondents found the methodology documentation within the report to be superficial and suggested that the SCAQMD include more details about sources of information, assumptions, and key studies cited. One respondent mentioned that too much information was placed in the appendices so that this respondent had to flip back and forth frequently. Another respondent felt that the linkage between emissions reductions and health benefits was not clearly stated in the assessment. One stakeholder suggested that the SCAQMD share the report drafts earlier and more often with stakeholders to receive feedback on report clarity.

- *Transparency*. Several respondents mentioned that there is insufficient transparency in the assessment regarding the models and assumptions used. One respondent felt that the SCAQMD does not include sufficient justification for the methods chosen. This respondent also felt that the SCAQMD manipulates its data and methods in order to achieve desired numbers, which contributes to the lack of transparency in the methods. The SCAQMD could improve transparency by, for example, clarifying potential differences in results if different methods were used.

- *General writing quality*. Respondents felt that the writing quality of the assessment was not adequate. One respondent suggested the agency contract a third-party reviewer to focus on improving readability.

5.5.2 Results

The majority of respondents found the presentation of assessment results to be clear and understandable, even for laypeople. However, one respondent noted that the SCAQMD should continue to improve the understandability of its results so that people are more likely to buy into the results.

One issue some respondents had with the assessment is that it is too lengthy, which they believed reduced the readers' willingness to put in the effort to understand the content. A few respondents suggested that the SCAQMD could make use of the executive summary to condense important information into short policy bullet-points. Such bullet-points would increase the utility of the assessment for stakeholders, the governing board, and other readers without technical expertise. Additionally, some respondents mentioned that presenting the results with simpler metrics would help people understand the impacts caused by proposed regulations; examples of a simple metric include projections of what impacted industries would look like with and without the regulation. One

respondent felt it was difficult to understand how the SCAQMD arrived at its conclusions in the competitiveness analyses.

5.6 Decision and Rule Making Process

The following section contains comments regarding the SCAQMD's decision and rulemaking processes, especially in terms of how the socioeconomic assessment fits into that process. One respondent specifically noted that it is unclear how components of the assessment, such as the competitiveness analysis, affect the SCAQMD decisions.

5.6.1 Rulemaking Considerations

Although the major purpose of the stakeholder interviews was to gather input on the SCAQMD's socioeconomic assessments, we received a wide variety of comments regarding the rulemaking considerations, focus, and the rules themselves.

Several respondents voiced concerns about what they view as the SCAQMD's single-minded focus on air quality without consideration for other public health issues or economic costs, especially given the increasing cost-benefit ratio (becoming more expensive to reduce smaller amounts of pollution). For example, one respondent cited a survey by the Public Policy Institute of California that found that only three percent of Californians considered the environment to be their top priority. A different respondent cited a survey of public health professionals about their top seven priority concerns regarding public health; air quality was not on the list. This respondent suggested the SCAQMD be transparent about their own ranking of priority considerations in the rulemaking process to improve the general level of agreement for their prioritization scheme.

Other respondents, however, seemed to disagree with this sentiment, noting that the SCAQMD's primary responsibility is to ensure that the region reaches attainment of federal and state air quality standards. One respondent noted that, although maintaining economic competitiveness is also within the SCAQMD's purview, it is misleading to conflate air pollution and dirty industries with economic competitiveness. Instead, the respondent felt that the region should work together to attract clean technology and industries into the region, which would result in important benefits in addition to improved air quality. The respondent emphasized that it is not the SCAQMD's role to attract these industries, nor is it the agency's responsibility to ensure that heavily polluting industries are able to stay.

Many respondents were concerned with how often the SCAQMD's regulations devalue assets in the regulated industries. While stranded assets were mentioned in other contexts (see Section 5.3.2), respondents also felt that the SCAQMD often writes new regulations before equipment lifespans are up, and thereby negating the investments many companies make to achieve compliance. This pattern, they contested, has dissuaded many companies from making necessary investments into compliance in fear of new regulations.

One respondent disagreed with the SCAQMD's feasibility analysis for control measures. The respondent felt that measures the SCAQMD defines as feasible may not actually be feasible for businesses. However, a different respondent stated that the Clean Air Act provides sufficient flexibility for economic feasibility by considering best available technologies. Therefore, the respondent felt that the SCAQMD focuses too much on regulatory costs beyond what the Clean Air Act considers.

There were also concerns over rulemaking consideration about small businesses. One respondent noted that the SCAQMD needs to focus more efforts on bringing small businesses into compliance, since they are likely to be hardest hit and have different concerns than larger businesses that are more likely to interact directly with the agency. In the past, the assumption was that bringing large businesses into compliance was sufficient; however, improvements from small businesses are now necessary for regional compliance. Respondents also stated that, although small businesses may require special attention, they must be held to the same standard as larger businesses.

Several respondents voiced concern over rulemaking consideration for EJ issues. Many argued that rising poverty levels in the region are partially attributable to the SCAQMD's regulations. Some felt that the negative influences of regulations on small businesses limit the recovery of many EJ communities from the economic recession. Furthermore, by reducing job growth for marginally educated workers, the agency has reduced those workers' upward economic mobility. However, in response to that sentiment, a few respondents noted that it is more important to provide necessary education and job advancement opportunities to ensure that those workers are able to survive in a clean workplace, rather than to keep them working in toxic environments.

On a separate note, one respondent said that the SCAQMD's strategy for EJ issues seems reactive, rather than proactive. However, another respondent felt that the SCAQMD should not focus its efforts on EJ issues, since its regulations should be designed to benefit the entire population equally.

We also received a variety of other comments regarding the SCAQMD's activities and regulations, including:

- The Port of Los Angeles Clean Truck Program was a successful voluntary program, and it is inappropriate for the SCAQMD to step in at this stage and try to police the process;
- By applying the 90th percentile for emissions as the standard for its warehouse regulations, the SCAQMD risks severely impacting the trucking industry;
- The SCAQMD's use of prescriptive measures and a command-and-control framework results in the agency's conflict with regulated entities;
- The SCAQMD seems to do the minimum regulation needed to meet the NAAQS by targeting small sources such as wood burning rather than regulating major air polluters (e.g., oil refineries);
- The SCAQMD board members are political appointments and do not have sufficient scientific or engineering experience to make appropriate air quality regulatory decisions;
- Since the economic costs of the SCAQMD regulations are so drastic, the agency should allow USEPA to regulate the region in their stead;
- The SCAQMD should look to change the way people power vehicles and move away from fossil fuels;
- The SCAQMD should seek to identify the Section 182-E5 Blackbox measures sooner to allow time for implementation, since there will be socioeconomic harm if they are not implemented; and

- The SCAQMD should examine its compliance with Title VI of the Civil Rights Act; California state health and safety codes, laws, and regulations; and CEQA and NEPA.

5.6.2 Assessment Credibility

One concern that came up repeatedly during the stakeholder interviews was related to the credibility of the socioeconomic assessment. Many felt that the rule assessment could be biased if the SCAQMD makes rules and conducts socioeconomic assessments. Some stated that the SCAQMD conducts the analyses after finalizing the regulation simply to justify its regulations rather than to truly inform their final rulemakings. Others mentioned that the SCAQMD conducts the assessment only to satisfy a mandate, resulting in an assessment that meets the minimum requirements. One respondent noted that the SCAQMD appears to cherry pick elements for the socioeconomic assessment to ensure that the results align with the agency's goals for their proposed rules. Therefore several respondents suggested using a third party to improve the credibility of the SCAQMD's socioeconomic assessments.[40]

Three lines of suggestions predominated in terms of how to use a third party: (1) fund a third party to do an independent assessment; (2) fund a third party to do a parallel assessment; (3) fund a third party to independently evaluate and help update the current assessment. The last of these was described in Section 5.2.2.

Most respondents, when bringing up the idea of an independent third-party assessment (i.e., the first option), usually discussed it in the context of the regulatory cost analysis. Many respondents appeared concerned that the SCAQMD is not the appropriate entity to examine the costs and economic impacts of its own regulations, especially when the agency is already analyzing the benefits.

Respondents seemed split on the second option. Some respondents felt that the ability to compare two parallel assessments could be useful in identifying weaknesses in the current assessment as well as establishing consensus for the format and methods to begin with. For example, one respondent recommended using localities and small businesses as subgroups in the comparison, to focus on differences in the details and granular elements. One respondent emphasized that, to minimize controversy, both SCAQMD and the third party would need to agree at the onset of the process about how to conduct the analyses and devise a strategy to sort out discrepancies in their conclusions. However, others were concerned that parallel reports would result in competition between the assessments, causing drama and tension between groups that supported one assessment over the other. One respondent simply noted that two assessments would be a waste of resources.

Other thoughts respondents had regarding the possibility of involving an independent third-party in the socioeconomic assessment process include:

- A local university or consulting firm would be most appropriate as the independent third party; and
- SCAQMD should avoid socioeconomic analyses conducted by independent experts that actively market their analyses since they may not be as informed as industry stakeholders.

[40] While the issue of a third-party assessment has been raised in the past, several respondents noted that SCAQMD leadership continually ignores those suggestions; however, one respondent noted that SCAQMD has not been afraid of hiring outside consultants when necessary in the past.

Several respondents also voiced concerns about the current review process for the SCAQMD socioeconomic assessment. Several respondents noted that the peer review of the socioeconomic assessment is conducted by people invested in the agency and its assessment. For example, the developer of some of the models used by the SCAQMD in its assessments (e.g., REMI) performed part of the review. They suggested that the SCAQMD ensure that any peer reviewers of its assessments are independent, meaning that they are not the SCAQMD contractors and are not receiving compensation from the agency for other projects beyond the review.

5.6.3 Outreach

In this subsection, we summarize the stakeholders' comments regarding the interaction between the SCAQMD and its stakeholders/general public during the decision/rulemaking process.

Stakeholder Outreach

While a few respondents commended the SCAQMD for its efforts in reaching out to industry for input on its analyses and assessment, a large majority had significant concerns. It was noted that, especially with small businesses, the SCAQMD does not sufficiently involve affected entities. Small businesses bear a greater burden from regulation because they learn about the regulations too late in the process to give sufficient feedback. This is especially true since they lack internal staff dedicated to understanding regulatory efforts by the SCAQMD and other agencies.

To alleviate this issue, respondents suggested the use of surveys and interviews to collect additional information from small businesses. Furthermore, one respondent recommended that the SCAQMD implement educational programs that small businesses can attend to assist them in understanding and complying with new regulations.

Respondents noted that even larger businesses learn about the regulations and the socioeconomic assessment too late in the process to provide useful feedback and recommendations on alternative policies. Several respondents felt that simply extending the feedback process and comment period from 30 days to 90 days would provide stakeholders adequate time to review the necessary information, collect constituent perspectives, and contribute meaningful feedback to the SCAQMD. Respondents also suggested that the SCAQMD present the results of the analyses earlier in the process, potentially even before drafting the assessment, so that stakeholder input can be better incorporated.

Even when industry participates in the process, one respondent notes that the SCAQMD often distrusts policy recommendations from industry, generally overlooking alternative perspectives. For example, one respondent felt that the SCAQMD uses stakeholder committees simply to present information rather than in a good-faith effort to receive feedback to use in revising their proposals. This has resulted in an overall impression that stakeholder input does not affect the outcomes of any the SCAQMD rulemakings and that they are already finalized even before reaching the public comment stage.

More interaction, such as a roundtable with industry and sharing preliminary results from the competitiveness analysis with industry to get inputs on potential impacts, would result in greater acceptance of assessment results and ownership of proposed regulations. One respondent suggested that involving stakeholders at the beginning of the process could help to determine the most appropriate methods for assessment analyses.

One respondent also suggested that the SCAQMD include outreach to businesses for collecting qualitative information regarding harm and economic disadvantage.

Public and Community Outreach

Several respondents felt that the SCAQMD's current methods for outreach, such as information postings and community meetings, may be unable to reach everyone from whom they hope to receive inputs. One respondent concerned that the business community has a strong say in the SCAQMD decisions, whereas public health interests do not appear to be strongly represented. Respondents suggested that the SCAQMD utilize informal meetings to build trust with affected entities and use newspapers and targeted social media to receive more general input. Furthermore, one respondent suggested partnering with community groups, such as churches, to achieve better attendance at meetings. These efforts would increase the public's engagement with and understanding of the SCAQMD regulations and other topics, such as externalities, which may increase their buy-in to proposed regulations.

Several respondents also tied the importance of community outreach to EJ concerns. Including EJ community stakeholders in the process would strengthen the relationship with these communities. This would also allow the SCAQMD to pull in more anecdotal information at a community level, strengthening its EJ analysis and increasing public involvement in the regulatory process. One respondent also suggested that the SCAQMD could create a job forecasting handbook based upon the types of jobs the agency's regulations will create in the future and distribute to the communities. This would allow community colleges to prioritize the types of training they should provide to these communities. If the SCAQMD examines issues such as education and skill enhancement opportunities, the agency can expand the utility of their assessment to address community issues as well.

6. Recommendations

Based on our review of the socioeconomic analyses of recent air quality regulations/plans conducted by the SCAQMD and other agencies/organizations, the SCAQMD's socioeconomic assessments are more comprehensive in both breadth and depth than the majority of the other agencies that are considered in this evaluation effort. In general, the SCAQMD uses a sound methodology in its health benefits, compliance cost, and economic impacts analyses.

- The cost analysis includes the major costs of the relevant control measures, including the capital, operations, and maintenance costs, as well as administrative costs. The cost effectiveness method (i.e., DCF method) is reasonable, although many other agencies use the LCF method. To allow comparison with other agencies' analyses, we recommend that the District include results based on LCF method in addition to the DCF results in its future analysis.
- The District staff uses EPA's BenMAP tool to estimate health benefits. BenMAP has been peer-reviewed and is a state of the art model for estimating health impacts of air pollution. The District staff has conducted customized BenMAP analysis with region-specific inputs (e.g., mortality concentration-response function and mortality valuation).
- For economic impact analysis, the District staff uses a well-established and peer reviewed tool — the REMI Policy Insight model—which has been customized for the four-county District.

Our evaluation does not simply provide a "rubber stamp" approval of existing practices. Where appropriate, we identify areas where changes may be warranted. Thus our evaluation identifies some scope for reconsideration of current practices in the SCAQMD's analysis methods. These recommendations are based on our review as well as the stakeholder interviews, and may offer opportunities for improvement. We highlight the most important recommendations in the bullet points below and provide detailed description of our recommendations in the rest of this section.

- The baseline and policy scenarios need to be clearly defined and consistently carried out through the entire analyses (see Section 6.1.1);
- There needs to be a strategy for systematic updating of the literature used in the socioeconomic analysis (see Section 6.1.2);
- The EJ analysis should be expanded (see Section 6.2.2);
- The uncertainty analysis needs to be improved (see Section 6.3);
- The reporting/documentation framework needs to be redesigned (see Section 6.4); and
- The transparency of the analyses needs to be increased (see Section 6.5).

6.1 Methodology

6.1.1 Baseline Definition and Benefits Attribution

The care in selecting and defining the baseline in regulatory impact assessment is important enough that USEPA devotes an entire chapter of its 2010 *Guidelines to Preparing Economic Analyses* to this topic. In that chapter, the following definition is given for the baseline:

> A baseline is defined as the best assessment of the world absent the proposed regulation or policy action. This "no action" baseline is modeled assuming no change in the regulatory program under consideration. This does not necessarily mean that no change in current conditions will take place, since the economy will change even in the absence of regulation. A proper baseline should incorporate assumptions about exogenous changes in the economy that may affect relevant benefits and costs (e.g., changes in demographics, economic activity, consumer preferences, and technology), industry compliance rates, other regulations promulgated by EPA or other government entities, and behavioral responses to the proposed rule by firms and the public." (USEPA, 2010b; p.5-1)

As described in Section 3.1.2, the SCAQMD's AQMP Socioeconomic Assessment did not use a consistent baseline definition throughout the analysis. Specifically, the role of the SCAG's TCMs in the baseline characterization is not clear. If TCMs are considered in the baseline as described in the 2012 Assessment (pp. 1-5 and 1-6), then the District should (1) remove the congestion relief benefits from the benefits analysis; (2) clarify that the emissions reduction-related benefits (health, visibility and material benefits) as a result of TCM implementation are not included in the benefits estimates;[41](3) remove TCM control costs from the cost analysis; (4) remove other economic impacts due to congestion relief benefits (i.e., do not import congestion relief benefits to REMI). Appendix G of the 2012 Assessment should then be used as the main results and be presented in Chapter 3 of the Assessment. We recommend that the District proceed with this option.

If the SIP-committed TCMs have to be incorporated as part of AQMP, then an appropriate baseline would be a business-as-usual forecast that includes non-committed TCMs, while the SIP committed TCMs would be included in the policy scenario. This approach implies two recommended revisions of the SCAQMD's analysis:

1. The SIP-committed TCM control costs and the co-benefits (e.g., air quality-related health and visibility improvements) realized from implementation of SIP-committed TCMs are attributable the AQMP. The 2012 Assessment has included the control costs of SIP-committed TCMs but has not included the co-benefits. To quantify these co-benefits, the District staff will need to revise the air dispersion modeling (i.e., CMAQ) to obtain estimates of changes in air pollutant concentrations that reflect the impact of the SIP-committed TCMs relative to the baseline that includes non-committed TCMs. Using this information, the downward bias in the AQMP benefits estimates can be remedied.
2. Because the congestion relief benefits do not come from improvements in air quality, it is less obvious that these benefits should be attributed to AQMP. In fact, congestion relief benefits were not included in air quality impact assessments by other agencies in our review. If congestion relief benefits must be included, we suggest using the estimates based only on SIP-committed TCMs, which are presented in Appendix H of the 2012 Assessment.[42]

[41] Based on our communication with the District staff, the TCMs were included in the baseline air quality modeling and therefore the health, visibility and material benefits estimates associated with TCM implementation were not counted as part of AQMP benefits. This is consistent with the baseline definition presented in the 2012 Assessment (pp. 1-5 and 1-6).

[42] Appendix H assumes that the estimated 2014 congestion relief benefits from the SIP-committed TCMs would apply to 2015-2035. If resources allow, the District should obtain more accurate data inputs from SCAG to re-estimate the benefits for 2015-2035.

The key challenge identified in discussions with the SCAQMD analysts was the difficulty in coordinating regulatory analyses done using different models and under different assumptions regarding the nature of existing rules. Furthermore, time and resource constraints can limit the ability to do separate analyses for each proposed set of regulations. For example, SCAG's analysis of TCMs did not distinguish between SIP-committed and uncommitted TCMs, which is the crux of our concerns about the baseline definition and the inclusion of congestion relief benefits in the 2012 Assessment. Implementing a re-analysis to address these concerns (as described above) may require considerable effort.

The resource constraints, however, do not reduce the importance of establishing consistent definitions of the baseline and the rule-related changes from that baseline. In fact, the resource considerations reinforce the need to have a well-defined process for specifying: (i) the baseline and the impacts associated with each new or amended rule (e.g., what is assumed about related regulations); and (ii) the relationship between these proper definitions and what would be ultimately used in the resource-constrained analysis. Of course, this approach implies there will be further challenges in characterizing the uncertainty in the results that could be feasibly developed relative to the results that would have been developed with sufficient resources.

6.1.2 Literature Review and Selection

We recommend that the District institute a systematic process to review recent publications in specific areas and determine which studies are relevant to its socioeconomic assessments. At the minimum, the SCAQMD should examine review articles/documents periodically (e.g., every 3-5 years) for the important elements of the socioeconomic analyses. We make specific suggestions below, starting with the most important elements of the socioeconomic assessments:

- *Epidemiological studies that link air pollution and health*. USEPA regularly conducts comprehensive epidemiological literature reviews for its Integrated Science Assessments (ISAs). The SCAQMD could make use of USEPA's ISAs and conduct supplemental literature reviews. In addition, the District should specify the selection criteria for studies and C-R functions (e.g., choose local epidemiological studies where possible; consider overlap between morbidity and mortality endpoints; consider double counting across pollutants).
- *VSL studies*. Although the current choice (Kochi et al., 2006) may be appropriate, recent literature has discussed the studies to be used in a VSL meta-analysis, with special focus on the risk measures used in the primary studies. Questions are now being raised as to whether all past studies should be included, especially when the older studies use inferior risk measures. Given the importance of the VSL estimates for measuring the health benefits from air quality improvements, this new research, including the more recent Kochi work, deserves careful review. We recommend the District review more recent VSL studies (see some suggestions below); several new studies consider the effects of heterogeneity in preferences and individual circumstances for measures of the VSL, which the District may wish to incorporate in its future analysis.

    - Doucouliagos, Chris, T.D. Stanley, and Margaret Giles. 2012. "Are Estimates of the Value of a Statistical Life Exaggerated?" Journal of Health Economics 31:197–206.

- Doucouliagos, Hristos, T.D. Stanley, and W. Kip Viscusi. 2014. "Publication Selection and the Income Elasticity of the Value of a Statistical Life." Journal of Health Economics 33:67–75.
- Kochi, Ikuho, and Laura O. Taylor. 2011. "Risk Heterogeneity and the Value of Reducing Fatal Risks: Further Market-Based Evidence." Journal of Benefit-Cost Analysis 2(3):1–28.
- Viscusi, W. Kip. 2013. "Using Data from the Census of Fatal Occupational Injuries to Estimate the "Value of a Statistical Life."" Monthly Labor Review October:1–17.
- USEPA. 2010. Valuing Mortality Risk Reductions for Environmental Policy: A White Paper. SAB Review Draft.

- *Job impact analysis*. We recommend that the SCAQMD keep abreast of the findings from USEPA's ongoing efforts in this area. USEPA is currently reviewing methodology for employment effects of regulation (see Belova et al., 2013). In addition, Bartik (2012) provided a good review of the issues in job impact analysis. The SCAQMD should pay attention to new developments in this area.

- *EJ Analysis.* We recommend that the District review the USEPA's guidance documents to help construct strategies to expand EJ analysis in its socioeconomic assessments. USEPA has invested substantial effort to develop guidance for conducting EJ analysis and incorporating it into rulemaking.
  - Interim Guidance on Considering Environmental Justice During the Development of an Action. 2010. Available at: http://www.epa.gov/environmentaljustice/resources/policy/considering-ej-in-rulemaking-guide-07-2010.pdf [Accessed on June 19, 2014]
  - Draft EJ Technical Guidance. 2013. Available at: http://yosemite.epa.gov/sab/sabproduct.nsf/fedrgstr_activites/0F7D1A0D7D15001B8525783000673AC3/$File/EPA-HQ-OA-2013-0320-0002[1].pdf [Accessed on June 19, 2014]
  - In addition, there are recent studies on regulatory EJ analysis that the District may wish to review. For example, Maguire and Sheriff (2011) present various tools/methods for distribution benefits analysis to rank regulatory options. Post et al. (2011) present similar tools and approaches, and demonstrate them using a national regulation of heavy duty diesel rule. Building upon Maguire and Sheriff (2011), Sheriff and Maguire (2013) investigate the appropriateness of inequality indices for ranking distributions of both good and bad health and environmental outcomes, and demonstrate these methods in the context of emissions standards affecting indoor air quality.

- *Valuation for morbidity endpoints*. We suggest that the SCAQMD conduct a literature search and review of WTP studies relevant to morbidity valuation. When WTP studies for morbidity valuation are not available or appropriate, the District should consider using cost-of-illness (COI) estimates to provide a lower-bound measure of the tradeoffs individuals would make to avoid the illness (e.g., hospital admissions and emergency department visits). We recommend that the District use local COI estimates because healthcare costs vary by region. The District staff may consider using the COI estimates that CARB has developed for California or the South Coast Basin.

- *Visibility studies*. We recommend that the SCAQMD conduct a literature search and review for more recent hedonic studies for the visibility analysis to avoid the issue in the second stage analysis in the Beron et al. (2001) (see Section 3.1.2 for our detailed comments). Alternatively, the agency could review recent stated preference studies that examine WTP for visibility improvement (e.g., Smith et al., 2005; IEc, 2013) and compare them with the hedonic studies. In addition, there are a few meta-analyses of visibility studies for national parks (e.g., Smith and Osborne, 1996). The District could also consider sponsoring a meta-analysis of hedonic studies that examine viewshed valuation.
- *Material benefits*. We recommend conducting a comprehensive literature search on this topic and evaluating the sufficiency of data and information; the studies listed below could serve as a starting point. If there are insufficient data to conduct a quantitative analysis for this benefit category, we suggest including it in the un-quantified benefits.
    - Watt, J., Jarrett, D., and Hamilton, R. 2008. Dose–response functions for the soiling of heritage materials due to air pollution exposure. Science of the total environment, 400(1), 415-424.
    - Brimblecombe, P., and Grossi, C. M. 2005. Aesthetic thresholds and blackening of stone buildings. Science of the Total Environment, 349(1), 175-189.
    - Watt J, Hamilton RS. Soiling of buildings by particulate matter. 2003. In: Brimblecombe P, editor. The Effects of Air Pollution on the Built Environment. London: Imperial College Press. 428 pp.

6.1.3 Benefits transfer

As described in Section 3.1.1, the methods used to adapt existing research to fit the needs of a policy assessment (i.e., "benefits transfer") can pose challenges for public agencies that conduct benefits analyses. These issues involve transferring the published C-R functions and valuation estimates to affected populations and locations for changes in ambient concentrations of pollutants that may be outside the range of experience in the primary studies being used for the analysis. We have the following suggestions for the District to improve the benefits transfer approach used in its socioeconomic assessments.

- Evaluate the appropriateness of function transfer when using C-R functions developed based on national or non-CA regional data, and include a discussion in the socioeconomic assessment.
- Provide details about income elasticity choices for the VSL and other WTP estimates adjustment and perform sensitivity analysis of income elasticity. For the United States, the USEPA (2010b) guidance suggests a core value of 0.4 and a sensitivity range of 0.08–1 for VSL income elasticity.
- Use regional average income level (rather than sub-regional income levels) to make the income adjustment for the VSL values. Meanwhile, the District should keep track of more evidence of cross-sectional income adjustment and consider conducting spatial income adjustment in a sensitivity analysis. The analysis of spatial income adjustment may have EJ implications that can be discussed in the socioeconomic report.

- Justify the use of 2010 real income or choose a more appropriate year. The choice should correspond to the year with projected impacts.

6.1.4 Useful life of pollution control equipment

As stated in Section 3.2.3, the current practice the SCAQMD conducts to determine the useful life of control equipment is appropriate. Compared with many other agencies, the SCAQMD uses more transparent procedure to examine and determine useful life of equipment (i.e., discussions with manufactures, industries, and stakeholders).

We recommend that the SCAQMD continue to review rules to ensure that compliance deadlines are set such that control equipment is not required to be replaced before the end of its useful life. In cases where this is not possible, we recommend that SCAQMD account for the value of the equipment required to be replaced as a cost of the rule, as it did with Rule 1421.

6.1.5 Cost Effectiveness Analysis

As discussed above, the method the SCAQMD uses for calculating cost effectiveness (the DCF method) is different from the methods that most other agencies/organizations use. Most other agencies/organizations in California use the LCF method. For this reason, the cost effectiveness estimates from the SCAQMD cannot be directly compared with estimates from other districts, although the choice between DCF and LCF does not affect the ranking of the cost effectiveness for the control measures. If the SCAQMD would prefer to continue to use the DCF method to maintain consistency with previous analyses, we recommend that it at least conduct a separate analysis using the LCF method, which could be included in an appendix.

6.1.6 Economic Impact Analysis

We recommend that the SCAQMD continue using their customized REMI model, with an updated review of the parameters and equations. This review should include the response parameters used in the REMI model, such as elasticities. We discuss the advantages and disadvantages of REMI versus a custom-built CGE model in Section 4.2. While both modeling frameworks have their advantages, the expense of building a new custom CGE model would outweigh the potential benefits. Meanwhile the SCAQMD could collaborate with USEPA to launch a modeling forum to evaluate REMI versus alternative modeling tools. Section 6.5.2 provides more discussion on this.

We recommend that the SCAQMD initiate a research task to consider the weighting of estimates of air quality benefits to reflect the relative importance of air quality changes compared to other area specific amenities. Since the adjustment is to a location-specific fixed effect in the migration equation, it reflects both positive and negative influences associated with each area in relationship to others. The issues associated with developing these weights need to consider what the set of important location specific factors should be, how the baseline conditions in relation to air quality should be defined, and the appropriate weighting for a migration equation. The nature of the adjustment would depend on whether the option to use levels or proportionate equivalent change in relative real compensation. Pending the development of this research SCAQMD could consider using weights based on the literature developing indexes for the quality of life in each area and include analyses based on alternative assumptions about the weighting of air quality benefits as additional scenarios along with an explanation of the reasons for providing a range of estimates. At this stage we do feel that current practices of giving the air quality benefits relative to an income measure a weight of one is appropriate. The challenge is in developing a justifiable set of weights. We would expect

these weights would be less than one. Pending the development of the research necessary to develop the weights a strategy that uses a set of different weights based on this literature would identify the issue and provide users a sense of its potential importance. Ideally, SCAQMD economists would plan activities that would evaluate the proper scaling of estimated of air quality benefits to be consistent with REMI and with the literature on the relative contributions of environmental and other amenities to the relative attractiveness of different areas.

Over the longer term the SCAQMD should consider evaluating REMI's logic for incorporating amenities using the migration equation in relation to the more current logic that links migration to the equilibriums in labor and housing markets. We also encourage the SCAQMD to keep abreast of the USEPA's development of methods for applying benefits in economy-wide models.

6.2 Scope of analysis

6.2.1 Welfare Benefits

An important emerging research area is the impact of climate change on air quality (USEPA 2009; Weaver et al., 2009) and the associated damage to human health and welfare (Post et al., 2012, Bell et al., 2007, US Forest Service 2011). Air quality regulations may play a more pronounced role in the context of changing climate. For example, ozone rules could help reduce the increases in ozone levels due to climate change and thus bring additional benefits. The District may wish to direct special attention to studies in this area and evaluate the possibility that climatic changes would alter the nature of the health effects associated with air pollution. It is also possible that policies associated with conventional air pollutants would have ancillary effects that serve to reduce greenhouse gas emissions. At present the benefits attributed to these types of effects are difficult to quantify. Nonetheless they should be identified as a consideration for future socioeconomic assessments.

As ecological benefits have received increasing attention in recent years, the SCAQMD may want to expand the economic impact analysis in this direction. For example, the SCAQMD may want to keep track of research in ecological benefits analyses that USEPA performs and conduct additional literature reviews. This can be incorporated into the systematic review process as discussed in Section 6.1.2.

6.2.2 Environmental Justice Analysis

Environmental justice (EJ) means that all people, regardless of race, color, national origin, or income, receive fair treatment and equal environmental protection, and have the opportunity for meaningful involvement in decisions that will affect the environment and/or the health of their community (USEPA, 2004).

For the past thirty years, the academic literature has used a variety of methods for quantifying the relationship between environmental quality and vulnerable sub-populations; however, there has been little attempt to develop a consistent framework to be used across studies, much less one suitable for the questions likely to be important for regulatory analysis (Maguire and Sheriff, 2011).

In the regulatory context, two types of EJ questions need to be addressed. The first type of question is related to the identification of the vulnerable population and locations at potentially high risk in the baseline and policy scenario. Where are these people located? What exposure level they are facing? What baseline health conditions they have? The other type of question is about distributional analysis of the regulation impact. Do some subgroups enjoy greater reductions in health risks as a result of a given rule or regulation? Do the pollutant exposures experienced by different subgroups become less

unequal after the rule is implemented? How do the policy options being considered improve or worsen the distribution of the exposure or health risks with respect to vulnerable subgroups?

To answer the first type of questions, EJ screening tools are usually useful. These screening tools combine data on environmental releases, demographic characteristics, and other parameters to identify communities and locations potentially subject to disproportionate risk or exposure, typically based on a profile of existing emissions or releases. We summarize such tools in Appendix H for the District to review and consider for its future analysis. For example, Lewis and Bennett (2013) used USEPA's Risk Screening Environmental Impact Tool (RSEI) to define geographic areas reflecting calculated risk values pertaining to exposed populations and toxic releases in four counties of New York. This approach permits geospatial mapping and exploratory spatial data analysis and can be used by states to effectively address concentrations of toxic releases as part of their environmental justice programs and policies.

Regarding the second type of questions, only a few recent studies have explored distributional analysis in a regulatory context (e.g., Post et al., 2011; Maguire and Sheriff, 2011; Sheriff and Maguire, 2013). In summary, the methods/tools proposed fall into three categories: visual dispalys (e.g., GIS maps, Lorenz curves, concentration curves), subgroup-specific summary statistics (e.g., mean or median exposure/health effects), regression techniques, and inequality indices (e.g., Gini coefficient and Atkinson index). Each method/tool has advantages and limitations. For example, regression analysis can be effective in determining causality (e.g., if income is a determining factor in pollution exposure) but it does not appear to be well suited for ranking impacts of regulatory options. Lorenz curves are straightforward to use for ranking regulatory options when there are sharp differences in policy options but are not informative if policy alternatives generate curves that cross each other. Inequality indices overcome the above issues; they provide a means of evaluating the distribution of environmental outcomes both within and across subgroups. Moreover, due to their associated social evaluation functions, inequality indices provide a transparent and consistent means of ranking policy alternatives. But they do so at the cost of imposing restrictive value judgments on the analysis, especially with respect to the level of inequality aversion.

We recommend that the SCAQMD expand current EJ analysis and conduct more screening analyses using appropriate tools/methods. In addition, the District should review recent studies on distributional benefits analysis and choose appropriate methods for its future EJ analysis. Inequality indices seem to be a promising tool to use under regulatory context. If the District chooses this method, sensitivity analysis over a range of inequality aversion parameter values should be done to moderate the normative influence on the results.

6.2.3 Control Cost Analysis

Because new regulations often require regulated facilities to upgrade or retrofit existing controls, the SCAQMD should ensure that their control cost estimates include an estimate of the cost of retrofitting existing controls.

In addition, the SCAQMD should set up a mechanism that allows monitoring and evaluating new developments in the methods used to estimate regulatory costs, especially by USEPA and other prominent agencies/organizations. For example, in USEPA's recent regulatory impact analysis for the proposed carbon pollution regulations for existing power plants, the agency includes an expansive definition for the mechanisms that can be used at the state or regional level as the means of complying with the regulation. In the proposed rule, states can assume that compliance will take place

through a variety of different mechanisms, ranging from efficiency improvements for electricity using appliances and fuel-switching at the power plants to the implementation of demand-side management programs to reduce the demand for electricity. Because these options will have very different costs, the cost analyses performed will depend on the compliance strategies employed by each state. The SCAQMD should analyze proposed rules and legislation to determine whether they contain similarly broad options for implementation, and if so, the District staff should be prepared to evaluate the feasibility and the cost implications of each approach. This proposal would include developing scenarios to account for the differences in costs based on the implementation of different regulatory options. Furthermore, we recommend that the SCAQMD discuss with USEPA how cost analyses should be prepared for such similarly broad regulations.

6.2.4 Sectoral Economic Impact Analysis

Although we support the continued use of the REMI model, there are instances where REMI cannot provide a full picture of the regulatory burden. We suggest that the SCAQMD use partial-equilibrium models of affected industries and additional small business analysis for those sectors that are targeted by regulation. REMI is run at a high level of aggregation that may not represent the impacts on specific industries. Small businesses are also not represented in the REMI model. These analyses should include the cumulative effect of all rules that affect the industry. This can be done by changing the baseline forecast to represent all rules applied to the industry that are in place. This analysis may be qualitative in many instances, as described in several of the comparison studies.

In addition, we recommend that the District review the Resource for the Future's Haiku modeling structure for regional electricity markets and interregional electricity trade, as an example of a modeling platform for partial equilibrium sectoral analysis. These types of models allow examination of regulatory impacts at a small scale.

6.3 Uncertainty

Substantial emphasis has been placed in recent years on the need to improve the characterization of uncertainty surrounding estimates of benefits and costs associated with reduced air pollution. OMB's (2003) Circular A-4, which provides guidance to federal agencies on developing regulatory impact analysis as required by Executive Order 12866, for example, contains a section on the "Treatment of Uncertainty." Given the potential magnitude of the benefits and costs resulting from the AQMP, the SCAQMD will likely need to present a more careful analysis of the uncertainty surrounding its benefits and costs estimates.

A key component of uncertainty analysis is the characterization of the uncertainty surrounding inputs to the analysis, such as the level of economic activity and emissions, air quality concentrations, benefits receptors' profiles, the linkage between endpoints and air quality, the linkage between changes of endpoints and economic value,[43] income elasticity, and discount rates. Uncertainty analysis also considers the implications of any assumptions regarding these inputs for the uncertainty associated with the results of the analysis. For estimates (such as total monetized benefit estimates) that depend on estimating many different input variables, this requires procedures to estimate the

[43] The valuation has to do with the incremental risk in addition to what one faces --we assume tradeoff is locally constant when we use a VSL. BenMAP doesn't include averting behavior, which may be taking place; thus it may cause misrepresentation of C-R relationship and valuation.

combined effects of these multiple sources of variation (both statistical/estimation uncertainty and errors in the assumptions associated with input data) on the uncertainty surrounding the final estimate.

One approach that has been commonly used in past benefits analyses (by USEPA and other agencies in our review) is to provide confidence bounds around point estimates, describing the uncertainty from those inputs for which the uncertainty can readily be quantified (e.g., sampling error associated with estimated parameters), and qualitative discussion for those uncertain inputs for which the uncertainty cannot be quantified. This approach, however, has the obvious drawback that the final characterization of uncertainty likely understates the actually uncertainty, since it is based on only a (possibly small) subset of the many sources of uncertainty that contribute to the total uncertainty about the benefits. To address this problem, an "integrated uncertainty" approach has been suggested, in which the analyst provides probabilities for the possible values of each uncertain input to an analysis. This approach is also highly problematic, however, because the probabilities provided are subjective (and it is often not clear what they are based on) and do not account for correlations among the input variables, making the resulting characterization of overall uncertainty similarly subjective, although providing a false sense of security.

A key issue in benefit-cost assessment is the determination of how much of a change in key assumptions would be needed to change the final estimates and whether this change would fall within a plausible range. Sensitivity and scenario analyses are a useful tool for this purpose, as they can generate a range for the benefits estimates as their input parameters vary. For example, to characterize the uncertainty of population projection data, one could conduct a scenario analysis based on different population projection scenarios (e.g., REMI, ICLUS, Woods &Poole, and Census-based), which may result in a wide range of benefits estimates. The ranges can be expressed in figures to succinctly convey the uncertainty information. Post et al. (2012) provides a good example of a comprehensive scenario analysis.

Specifically, we recommend that the District provide confidence intervals for the point estimates where possible; conduct sensitivity/scenario analyses to estimate the lower and upper bound of the impact; and provide detailed qualitative discussion for unquantifiable uncertainties. We include some example uncertainty analyses below.

- BenMAP provides confidence interval estimates for health benefits, which should be reported in the health benefits analysis.
- The District should conduct a sensitivity analysis by specifying a set of plausible scenarios and considering how the results would change, such as using the VSL estimates based on SP studies from the Kochi study (see Fraas and Lutter, 2013).
- When congestion relief is relevant to the policy being evaluated, the associated benefits attributed to travel time savings need to be presented for varying assumptions about underlying congestion, as determined by assumed macroeconomic factors and exogenous travel demand and capacity factors.
- For cost analyses, the SCAQMD should address issues of uncertainty in control cost data and the economic life of control equipment. With regard to control costs in particular, we recommend that the SCAQMD compare cost estimates from multiple sources, including estimates from regulated entities, vendors of control cost equipment, published literature, and expert opinion in scenario analyses.

- The SCAQMD should address the uncertainty inherent in estimating costs that may be incurred in the future in a qualitative discussion, including, where appropriate, a review of relevant studies that perform retrospective analysis of cost estimates. Retrospective analyses will help to put the range of control costs into perspective and to assess the likelihood of whether the estimated costs may be overestimates or underestimates of the actual implementation costs. Examples of such retrospective analyses include USEPA (2012) and Morgenstern (2014).
- Because in many cases there is more than one discount rate that could be appropriate for the analysis, we also recommend that the SCAQMD perform a sensitivity analysis using several discount rates to determine the effect of the discount rate on the outcome of the analysis.
- In addition, the SCAQMD should use a sensitivity analysis to estimate the costs of proposed controls that are deemed "unquantifiable" due to a lack of appropriate data. This method was used in the socioeconomic analysis of the 2007 AQMP, where the lowest and highest values of cost effectiveness as estimated for the quantifiable measures were used to approximate the cost of the unquantifiable measures. However this method was not included in the 2012 AQMP. We recommend that this method be used in future cost analyses, or at least for the SCAQMD to offer a rationale for why unquantifiable costs are not estimated.
- We recommend that SCAQMD analyze the uncertainty in economic modeling results (e.g., job impact) by comparing the base scenario with additional useful scenarios. The 2012 Assessment provides results for additional scenarios, but these results should be put into context – how do they vary from the central case, and what are the assumptions that drive these differences?

6.4 Documentation clarity and presentation

We recommend that the SCAQMD redesign its reporting/documentation system to consider different types of audiences and to increase transparency. The current documentation developed by the District is too detailed for lay public but not detailed enough for technical persons. The new reporting system could include three types of documentation: a methodology guidebook mainly for District staff and interested parties, a summary report for lay public and a detailed report for a technical audience.[44] We elaborate each type of documentation below.

- The methodology guidebook could serve as a good resource for understanding socioeconomic analyses conducted by the SCAQMD. This documentation does not need to include rule-specific analysis or be updated frequently. Instead, it should document the methodology framework and typical approaches used by the SCAQMD economists. This guidebook would need to be updated only when new methods/ models/ tools/studies are adopted for regulatory socioeconomic assessments.
- The technical report should include an executive summary and provide detailed descriptions of the methods and results for a rule/plan-specific socioeconomic assessment so that the technical experts are able to evaluate what was done. The details currently found in staff reports could be

[44] For example, EPA/OAQPS developed an economic analysis resource document to guide its regulatory economic analyses. For the CAAA analysis, EPA developed a summary report (http://www.epa.gov/cleanairactbenefits/feb11/summaryreport.pdf [Accessed on June 19, 2014]) and a full detailed report (http://www.epa.gov/cleanairactbenefits/feb11/fullreport_rev_a.pdf [Accessed on June 19, 2014]).

included here. Whenever necessary, this documentation could cite the methodology guidebook so that readers could refer to the guidebook for additional technical details.

- The summary report for the lay public is also rule-specific and should include detailed background information and educational materials but only brief descriptions of methodology in non-technical language. The summary for the lay public could cite the technical report and the methodology guidebook so people would know where to locate detailed methodology documentation.

In addition to the above recommendation of a new reporting system, we also have some specific suggestions to improve the clarity of the socioeconomic assessments we reviewed:

- Be clearer about the specific data sources or methodologies used to estimate the capital and operating costs of pollution controls. The costs estimates are listed in many of the SCAQMD reports we reviewed, but the data sources or methodologies used to estimate them were generally not clearly explained. Furthermore, in some cases, the cost estimates were not clearly listed. For future analyses, we recommend that the SCAQMD clearly list all cost estimates, and explain the data sources and methodologies used to determine the cost estimates, including any assumptions used in the analysis.
- While there are many cases where the SCAQMD staff reports include more in-depth information about the underlying sources used to estimate a range of control costs, this level of information is typically missing from the socioeconomic analyses. We recommend that more of this type of detail be included in the socioeconomic analyses, or, at a minimum, that the socioeconomic analyses refer to the more in-depth discussion in the staff report. Otherwise, readers of the socioeconomic analyses may not fully understand the complete methodology used to estimate control costs.
- Be clearer about the rationale for the discount rate used in the cost analysis. In discussions with the SCAQMD staff, it was suggested that a four percent real discount rate has been used in all analyses since 1987 to maintain consistency with previous analyses. However, this rationale is not mentioned in any of the socioeconomic analyses of recent air quality rules, nor is there any discussion of whether this discount rate continues to be an appropriate representation for the time value of capital in control cost analyses. In fact, this real discount rate could be seen as high when compared with rates suggested by the Office of Management and Budget (OMB), which only go as high as 1.9 percent.[45] We recommend that the SCAQMD include a discussion of the rationale behind the choice of discount rate in its analyses.
- Include more descriptive details of the benefits analysis methods, such as the following:
    - Selection of health endpoints/epidemiological studies/C-R functions with a comprehensive list of the sources and citations;
    - Justification of using Koshi et al. (2006);

[45] Office of Management and Budget. 2013. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Circular A-94, Appendix C. Available at http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c. Last accessed June 19, 2014.

- Discount rates selection;
- Air quality modeling inputs and CMAQ configuration;
- Baseline incidence rates and population projections used in the health benefits analysis; ensure this population projection is consistent with SCAG's population forecast; and
- Attribution of traffic congestion relief benefits from SCAG TCMs to the AQMP.

➢ We suggest that the SCAQMD avoid false precision when presenting results for numbers of jobs or dollars of economic impact. This can be done by rounding the results to a sensible level of precision, for example, by expressing employment changes in thousands of jobs. Alternatively, USEPA often presents percentage changes in indicators to give a sense of the magnitude of the changes caused by regulation. Models such as REMI give insight into the relative economic performance under regulatory scenarios. The REMI modelers that we contacted suggested that reporting changes in economic impacts in $10,000 increments, with numbers of jobs rounded at the client's discretion.

6.5 Process Improvement to Increase Transparency

During the stakeholder interviews, one outstanding comment is about the lack of transparency in the SCAQMD's socioeconomic assessments and the need for independent third party involvement. We believe that improving transparency may be the best way to deal with the independence issue, as performing analyses outside the agency may not necessarily assure independence. We therefore recommend that the District staff should continue conducting the socioeconomic analyses with support from external consultants (when necessary), but the District should make process improvement to increase transparency. In the subsections below, we describe our recommendations for improving transparency through a better process to guide, monitor, and evaluate the SCAQMD's socioeconomic assessments.

6.5.1 Science Advisory Group

As mentioned in the Introduction, there is a Scientific, Technical & Modeling Peer Review Advisory Group that has the responsibility to oversee the tools and methods that the SCAQMD uses in the socioeconomic analyses. However, the actual role of this Group is unclear and stakeholders are not well aware of its existence (no one mentioned this advisory group during the interviews).

We recommend that the standing scientific advisory group should play a more important role during the SCAQMD's socioeconomic assessment process. Specifically,

➢ The Group members should be carefully selected to include top technical experts in the relevant fields.

➢ There needs to be a formal involvement of this Advisory Group. We suggest learning from the structure that is used for the USEPA's Science Advisory Board (SAB). First, the SCAQMD could submit charge questions to the advisory group; these questions could be scoping questions, on-going technical questions or requests for specific types of peer review. Second, the advisory group needs to prepare formal responses in writing to the charge questions. These documents should be publicly available. The SCAQMD should provide modest staff support to the committee to facilitate their preparation of these responses. The actions taken by the SCAQMD to address the recommendations should also be part of the

public record. After the SCAQMD addresses the suggestions/comments from the advisory group, the advisory group should meet again to evaluate whether the revision appropriately incorporated their comments/recommendations.

- This advisory group should review the assessments for major rules, as well as important methodological decisions that would affect all rules. Examples of such important topics include:
    - Systematic literature review strategy as described in Section 6.1.2 and 6.2.1.
    - The use of REMI and comparison with alternative models (e.g., partial equilibrium models).
    - Spatial income adjustment and age adjustment for the VSL values.
    - Application of benefit-per-ton approach to estimate health benefits —what spatial domain/conditions are needed for this approach to work well for the region?
    - The new approach to cost analysis as mentioned in Section 6.2.3, which involves developing scenarios to account for the differences in costs based on the implementation of different regulatory options.

6.5.2 Outreach to Strengthen Public Participation

As the socioeconomic analyses are likely to become more complex over time, the District needs to combine resources from many sources. The SCAQMD has been conducting considerable outreach activities. We recommend continuing and expanding the current outreach effort, which could also help improve transparency. Two types of outreach are needed here. First, the SCAQMD could do more educational outreach to describe the activities the District conducts for the socioeconomic assessment (e.g., data collection, methods, and development of the non-technical summary for lay public). This could help address the understanding gap we observed in several stakeholder interviews. Second, the SCAQMD could more frequently reach out to stakeholders (via survey/interview or round table meetings), small businesses, and independent consultants to collect data inputs, comments, and suggestions at multiple stages of the socioeconomic assessment process, and ensure the incorporation of collected information in the socioeconomic report.

The District could create forums to collect inputs/comments from the public. For example, the District could create a modeling forum to compare REMI with alternative modeling tools for regulatory economic impact analysis.

In addition, the socioeconomic report should document the District's outreach efforts. For example, the executive summary should highlight public's participation in the report; the San Joaquin Valley 2012 $PM_{2.5}$ Plan provided an example for documenting public participation and consultant work in the executive summary.

6.5.3 External peer review

For the AQMP assessments, the SCAQMD has conducted external peer review (e.g., Appendix F documents the comments received from the peer review). We suggest continuing this current practice and applying it to some major/important rule assessments as well. In addition, the peer review should be as transparent as possible. For example, the peer review comments and response should be

carefully documented and the peer reviewers should not be the tool/model developer. The peer review effort should also be mentioned in the executive summary of the socioeconomic report.

7. References

AAA Association (AAA). 2012. Your Driving Cost.

Alberini, A. & M. Scasny. 2010. Labels and perceptions in mortality risk reduction valuations. In fourth world congress of environmental and resource economics.

American Transportation Research Institute (ATRI). 2011. An Analysis of the Operational Cost of Trucking: 2011 Update. Retrieved August 8, 2012, from http://atri-online.org/2011/06/15/an-analysis-of-the-operational-costs-of-trucking-a-2011-update/. Last accessed June 19, 2014.

Australian Government. 2008. Best Practice Regulation Guidance Note: Value of statistical life. Office of Best Practice Regulation, Department of Finance and Deregulation.

Bay Area Air Quality Management District (BAAQMD). 2010. Multi-Pollutant Evaluation Method: Technical Document. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Plans/2010%20Clean%20Air%20Plan/Resource%20and%20Tec/Multi-Pollutant%20Evaluation%20Method%20Technical%20Document-April%202010.ashx?la=en. Last accessed June 19, 2014.

Banzhaf, H.S. & R.P. Walsh. 2008. Do people vote with their feet? An empirical test of Tiebout's mechanism. American Economic Review 98: 843-863.

Banzhaf, H.S. 2011. Regulatory Impact Analyses of Environmental Justice Effects. Unpublished paper. Accessed at http://works.bepress.com/spencer_banzhaf/2.

Bartik, T.J. 2012. Including Jobs in Benefit Cost Analysis. Annual Review of Resource Economics 4: 55-74.

Bell, M.L., R. Goldberg, C. Hogrefe, P.L. Kinney, K. Knowlton, B. Lynn, J. Rosenthal, C. Rosenzweig, & J.A. Patz. 2007. Climate change, ambient ozone, and health in 50 U.S. cities. Climate Change 82: 61-76.

Belova, A., W.B. Gray, J. Linn, & R.D. Morgenstern. 2013. Environmental Regulation and Industry Employment: A Reassessment. CES 13-36. Available at: http://www2.census.gov/ces/wp/2013/CES-WP-13-36.pdf. Last accessed June 19, 2014.

Beron, K., J. Murdoch, & M. Thayer. 2001. The Benefits of Visibility Improvement: New Evidence from the Los Angeles Metropolitan Area. Journal of Real Estate Finance and Economics. 22: 319-337.

Bieri, D.S., N.V. Kuminoff & J.C. Pope. 2013. "National expenditures on Local Amenities." Working Paper. Available at: http://cbey.yale.edu/uploads/Environmental%20Economics%20Seminar/BKP1.pdf. Last accessed June 26, 2014.

Brookshire, D.S., M.A. Thayer, W.D. Schulze & R.C. D'Arge. 1982. Valuing Public Goods: A Comparison of Survey and Hedonic Approaches. American Economic Review. 72 (1): 165-177.

Brulle, R.J. & D.N. Pellow. Environmental justice: human health and environmental inequalities. Annual Review of Public Health. 2006; 27:103–124.

California Air Resources Board (CARB). 2006. Final Emission Reduction Plan for Ports and Goods Movement in California. Available at: http://www.arb.ca.gov/planning/gmerp/plan/final_plan.pdf. Last accessed June 19, 2014.

Chestnut, L.G. & R.D. Rowe. 1990a. "New National Park Visibility Value Estimates." In Visibility and Fine Particles, Transactions of an AWMA/EPA International Specialty Conference, C.V. Mathai, ed. Air and Waste Management Association, Pittsburgh.

Chestnut, L.G. & R.D. Rowe. 1990b. Preservation Values for Visibility Protection at the National Parks. Prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, and National Park Service, Air Quality Management Division. Available at: http://yosemite.epa.gov/ee/epa/eerm.nsf/vwGA/EE97D10D71E3FAD08525662400766534. Last accessed June 19, 2014.

Crump, K.S. 1994. Risk of benzene-induced leukemia: A sensitivity analysis of the Pliofilm Cohort with additional follow-up and new exposure estimates. Journal of Toxicology and Environmental Health 42: 219-242.

Cummings, R., H. Burness & R. Norton. 1985. Measuring Household Soiling Damages from Suspended Air Particulates: A Methodology Inquiry. Volume V of Methods Development for Environmental Control Benefits Assessment. Washington, D.C.: U.S. Environmental Protection Agency.

Doucouliagos, H., T.D. Stanley & W.K. Viscusi. 2014. Publication selection and the income elasticity of the value of a statistical life. Journal of Health Economics 33: 67-75.

European Commission. 2009. Impact Assessment Guidelines. SEC 92.

Fann, N., C.M. Fulcher & B.J. Hubbell. 2009. The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution. Air Quality, Atmosphere & Health 2: 169-176.

Fowlie, M. 2010. Emissions Trading, Electricity Restructuring, and Investment in Pollution Abatement. American Economic Review 100: 837-869.

Fraas, A. & R. Lutter. 2013. Uncertain Benefits Estimates for Reductions in Fine Particle Concnetrations. Risk Analysis 33 (3).

Galiani, S., A. Murphy & J. Pantano. 2012. "Estimating Neighborhood Choice Models: Lessons from a Housing Assistance Experiment". Working Paper Series, Washington University in St. Louis.

George, R.S. 1989. Air Quality Management Plan, 1989 Revision, Appendix IV-D: Discount Cash Flow Method as Applied to the Cost Analysis of Control Measures. South Coast Air Quality Management District.

Hammitt J.K. & K. Haninger. 2010. Valuing fatal risks to children and adults: effects of disease, latency, and risk aversion. Journal of Risk and Uncertainty 40: 57-83.

Interdepartmental Group on Costs and Benefits (IGCB). 2007. An Economic Analysis to inform the Air Quality Strategy. Updated third report of the Interdepartmental Group on Costs and Benefits (IGCB). Volume 3. Annex 2 – Valuing the health benefits associated with reductions in air pollution – recommendations for valuation. Department of Environmental, Food and Rural Affairs.

Industrial Economics, Inc. (IEc). 2013. National Park Service Visibility Valuation Study: Pilot Survey Results. Final Report.

Klaiber, H.A. & V.K. Smith. 2013. Quasi Experiments, Hedonic Models, and Estimating Trade-offs for Local Amenities. Land Economics 89 (3): 413-431.

Kochi, I., B. Hubbell & R. Kramer. 2006. An Empirical Bayes Approach to Combining and Comparing Estimates of the Value of Statistical Life for Environmental Policy Analysis. Environmental & Resource Economics 34 (3): 385-406.

Krewski D., M. Jerrett, R.T. Burnett, R. Ma, E. Hughes, Y. Shi, M. Turner, C.A. Pope III, G. Thurston, E.E. Calle & M.J. Thun. 2009. Extended Follow-up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. HEI Research Report, 140, Health Effects Institute, Boston, MA.

Kuminoff, N., C. Parmeter & J. Pope. 2010. Which Hedonic Models Can We Trust to Recover the Marginal Willingness to Pay for Environmental Amenities. Journal of Environmental Economics and Management 60 (3): 145-160

Lindhjem, H., S. Navrud, N.A. Braathen & V. Biausque. 2011. Valuing Mortality Risk Reductions from Environmental, Transport, and Health Policies: A Global Meta-Analysis of Stated Preference Studies. Risk Analysis 31 (9): 1381-1407.

Loehman, E.T., D. Boldt & K. Chaikin. 1985. Measuring the Benefits of Air Quality Improvements in the San Francisco Bay Area. From Methods Development for Environmental Control Benefits Assessment, Volume IV. Prepared for the U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation, September. Grant #R805059-01-0 Available at: http://yosemite.epa.gov/ee/epa/eerm.nsf/vwGA/e85705387833398f8525644d0053bdd0!OpenDocument#_Section6. Last accessed June 19, 2014.

Maguire, K. & G. Sheriff. 2011. Comparing Distributions of Environmental Outcomes for Regulatory Environmental Justice Analysis. International Journal of Environmental Research and Public Health 8: 1707-1726.

Morello-Frosch, R., M. Pastor, C. Porras & J. Sadd. 2002. Environmental justice and regional inequality in Southern California: Implications for future research. Environmental Health Perspectives 110: 149-154.

Morgenstern, R.D., W.A. Pizer & J.S. Shih. 2002. Jobs versus the Environment: an Industry-Level Perspective. Journal of Environmental Economics and Management 43 (3): 412-436

Morgenstern, R.D. 2014. Retrospective Analysis of Federal Regulation. Resources for the Future. Presentation to California Air Resources Board. Available at http://www.arb.ca.gov/research/lectures/speakers/morgenstern/morgenstern.pdf. Last accessed June 19, 2014.

Muller, N.Z. & R. Mendelsohn. 2009. Efficient Pollution Regulation: Getting the Prices Right. American Economic Review 99 (5): 1714-1739

Murray, D.R., M.A. Atwater & J. Yocom. 1985. Assessment of Material Damage and Soiling from Air Pollution in the South Coast Air Basin. Sacramento, California: California Air Resources Board.

Oates, W.E., P.R. Portney & A.M. McGartland. 1989. The Net Benefits of Incentive-Based Regulation: A Case Study of Environmental Standard Setting. American Economic Review 79 (5): 1233-1242.

Office of Management and Budget. 2013. Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses. Circular A-94, Appendix C. Available at http://www.whitehouse.gov/omb/circulars_a094/a94_appx-c. Last accessed June 19, 2014.

Plantinga, A.J., C. Detang-Dessandre, G.L. Hunt & V. Piguet. 2013. Housing Prices and Inter-Urban Migration. Regional Science and Urban Economics 43: 296-306.

Polenske, K., K. Robinson, H.Y. Hong, X. Lin, J. Moore & B. Stedman. 1992. Evaluation of the South Coast Air Quality Management District's Methods for Assessing Socioeconomic Impacts of District Rules and Regulations, Volume I: Summary of Findings. Prepared for the South Coast Air Quality Management District (Diamond Bar, CA).

Post, E.S., A. Belova & J. Huang. 2011. Distributional Benefit Analysis of a National Air Quality Rule. International Journal of Environmental Research and Public Health 8 (6): 1872-1892.

Post, E.S., A. Grambsch, C. Weaver, P. Morefield, J. Huang, L.Y. Leung, C. Nolte, P. Adams, X. Liang, J. Zhu & H. Mahoney. 2012. Variation in Estimated Ozone-Related Health Impacts of Climate Change due to Modeling Choices and Assumptions. Environmental Health Perspectives 120 (11): 1559-1564.

Roback, J. 1982. Wages, Rents, and the Quality of Life. The Journal of Political Economy. 90 (6): 1257-1278.

Sheriff, G. and K. Maguire. 2013. Ranking Distributions of Environmental Outcomes Across Population Groups. NCEE Working Paper Series. Working Paper # 13-04.

Southern California Association of Governments (SCAG). 2012. Regional Transportation Plan. Los Angeles, California: Southern California Association of Governments.

San Joaquin Valley Air Pollution Control District (SJVAPCD). 2008. Update to Rule 2201 Best Available Control Technology (BACT) Cost Effectiveness Thresholds: Final Staff Report. Available at:

http://www.valleyair.org/busind/pto/bact/May%202008%20BACT%20cost%20effectiveness%20threshold%20update%20staff%20report.pdf. Last accessed June 19, 2014.

Smith, A.E., M.A. Kemp, T.H. Savage & C.L. Taylor. 2005. Methods and Results from a New Survey of Values for Eastern Regional Haze Improvements. Journal of the Air & Waste Management Association 55: 1767-1779.

Smith, V.K. & L. Osborne. 1996. Do contingent valuation estimates pass a scope test? A meta analyses. Journal of Environmental Economics and Management 31 (3): 287-301

Tolley, G.S. et al. 1986. Valuation of Reductions in Human Health Symptoms and Risks. University of Chicago. Final Report for the U.S. Environmental Protection Agency, Office of Policy Analysis. Available at: http://yosemite.epa.gov/ee/epa/eerm.nsf/a7a2ee5c6158cedd852563970080ee30/eaa2842b3d2bc2798525644d0053bf48!OpenDocument#_Section6. Last accessed June 19, 2014.

Treasury Board of Canada, Secretariat. 2007. Canadian Cost-Benefit Analysis Guide: Regulatory Proposals (Interim).

USEPA. 2004. Toolkit for Assessing Potential Allegations of Environmental Injustice. EPA 300-R-04-002.

USEPA. 2009. Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone (An Interim Report of the U.S. EPA Global Change Research Program). EPA/600/R-07/094F. Washington, DC:U.S. EPA.
USEPA. 2010a. Guidelines to Preparing Economic Analyses: Chapter 5. Available at: http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-05.pdf/$file/EE-0568-05.pdf. Last accessed June 19, 2014.

USEPA. 2010b. Valuing Mortality Risk Reductions for Environmental Policy: A White Paper. SAB Review Draft. Available at: http://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/0/34D7008FAD7FA8AD8525750400712AEB/$File/White+Paper+(Dec.+2010).pdf. Last accessed June 19, 2014.

USEPA. 2011. The Benefits and Costs of the Clean Air Act from 1990 to 2020 (Final Report – Rev. A). Available at: http://www.epa.gov/cleanairactbenefits/feb11/fullreport_rev_a.pdf. Last accessed June 19, 2014.

USEPA. 2012. Retrospective Analysis of the Costs of EPA Regulations. National Center for Environmental Economics. Available at: http://yosemite.epa.gov/EE%5Cepa%5Ceed.nsf/webpages/RetroCost.html/$file/retro-cost-3-30-12.pdf. Last accessed June 19, 2014.

USEPA Science Advisory Board (SAB). 2004. Advisory Council on Clean Air Compliance Analysis Response to Agency Request on Cessation Lag. Letter from the Health Effects Subcommittee to the U.S. Environmental Protection Agency Administrator. December.

US Forest Service. 2011. AirFire understanding weather, climate, air quality, and wildland fire. Available: www.airfire.org/bluesky/. Last accessed June 19, 2014.

Viscusi, W.K. 2010. The heterogeneity of the value of statistical life: Introduction and overview. The Journal of Risk and Uncertainty, 40:1–13

Viscusi, W.K. 2011. Policy challenges of the heterogeneity of the value of statistical life. Foundations and Trends in Microeconomics. 6 (2): 99–172.

Viscusi, W.K. & J.E. Aldy. 2003. The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World. The Journal of Risk and Uncertainty 27 (1): 5-76.

Weaver, C.P., X.Z. Liang, J. Zhu, P.J. Adams, P. Amar, J. Avise, et al. 2009. A preliminary synthesis of modeled climate change impacts on U.S. regional ozone concentrations. Bulletin of the American Meteorological Society 90 (12): 1843-1863.

Appendix A. The List of Contacted Public Agencies

Exhibit A-1. The List of Contacted Public Agencies

State	Agency/Organization Level	Agency/Organization Name	Responded to Inquiry	Conducts Assessments
Arizona	State	Arizona Department of Environmental Quality, Air Quality Division		
Arizona	Local	Maricopa County Air Quality Department	X	
Arizona	Local	Pima County Department of Environmental Quality	X	
Arizona	Local	Pinal County Air Quality Control District		
California	State	California Air Resources Board	X	X
California	Local	Bay Area Air Quality Management District	X	X
California	Local	Monterey Bay Unified Air Pollution Control District	X	
California	Local	Sacramento Metropolitan Air Quality Management District	X	X
California	Local	San Diego County Air Pollution Control District	X	X
California	Local	San Joaquin Valley Unified Air Pollution Control District	X	X
California	Local	Ventura County Air Pollution Control District	X	X
Colorado	State	Colorado Department of Health, Air Pollution Control Division	X	X
Delaware	State	Delaware Department of Natural Resources and Environmental Control, Division of Air & Waste Management		
Minnesota	State	Minnesota Pollution Control Agency, Policy and Planning Division, Major Facilities, Air Quality Section	X	X
Missouri	State	Missouri Department of Natural Resources, Division of Environmental Quality, Air Pollution Control Program	X	X
Ohio	State	Ohio Environmental Protection Agency, Division of Air Pollution Control	X	X
Ohio	Local	Akron Regional Air Quality Management District	X	
Ohio	Local	Canton City Health Department, Air Pollution Control Division	X	
Ohio	Local	Cleveland Department of Public Health, Division of Air Quality	X	
Ohio	Local	Dayton Regional Air Pollution Control Agency	X	

State	Agency/Organization Level	Agency/Organization Name	Responded to Inquiry	Conducts Assessments
Ohio	Local	Hamilton County Department of Environmental Services	X	
Ohio	Local	Lake County General Health District, Air Pollution Control Program		
Ohio	Local	Mahoning-Trumbull Air Pollution Control Agency	X	
Ohio	Local	Portsmouth Local Air Agency		
Ohio	Local	City of Toledo Division of Environmental Services, Air Resources Section	X	
Pennsylvania	State	Pennsylvania Department of Environmental Protection, Bureau of Air Quality		
Pennsylvania	Local	Allegheny County Health Department, Air Quality Program	X	
Pennsylvania	Local	Philadelphia Department of Public Health, Air Management Services Program	X	X
Tennessee	State	Tennessee Department of Environment and Conservation, Division of Air Pollution Control		
Tennessee	Local	Chattanooga-Hamilton County Air Pollution Control Bureau		
Tennessee	Local	Knox County Air Quality Management	X	
Tennessee	Local	Memphis-Shelby County Health Department, Pollution Control	X	
Tennessee	Local	Metro Public Health Department, Pollution Control Division	X	
Texas	State	Texas Commission on Environmental Quality	X	X
Texas	Local	City of Austin Air Quality Program	X	
Texas	Local	City of Dallas Air Pollution Control	X	
Texas	Local	Fort Worth Environmental Management Department, Air Quality Division	X	
Texas	Local	Galveston County Health District, Air Pollution Services	X	
Texas	Local	Harris County Public Health and Environmental Services Pollution Control Services Department		
Texas	Local	Houston Department of Health and Human Services, Environmental Health Division, Bureau of Air Quality Control	X	
Texas	Local	City of San Antonio, Office of Environmental Policy	X	
Wisconsin	State	Wisconsin Department of Natural Resources, Bureau of Air Management	X	X
	Regional	Southeastern Local Air Pollution Control Agencies and Southeastern States Air Resource Managers, Inc.	X	

State	Agency/Organization Level	Agency/Organization Name	Responded to Inquiry	Conducts Assessments
	Regional	Lake Michigan Air Directors Consortium	X	
	Regional	Western States Air Resources Council	X	X
	Regional	Capital Area Council of Governments	X	
	Regional	Northeast States for Coordinated Air Use Management		X
	Federal	United States Environmental Protection Agency		X

Appendix B. Short-Survey Questions to Identified Public Agencies

1. Can you provide a description of pre-screening activities to determine the rules requiring assessment and the related allocation of resources for theses assessments?
2. What is the typical timeline for conducting socioeconomic assessments for rules at your agency?
3. What is the role of external consultants during your assessment process?
4. What is the role of public participation in the review process for assessments?
5. How do you use the assessments in agency decision making process?
6. What is the size of in-house agency staff assigned for conducting the rule assessment? What is the annual work load

Appendix C. A Summary of Agencies' Rulemaking and Assessment Process

As mentioned in Section 2.2.3, we scheduled conference calls with the agencies/organizations who agreed to talk with us about their rule making and assessment process. Some agencies/organizations provide such information via email.

Exhibit C-1. Final List of Contacted Public Agencies and Organizations

Agency/Org	Rulemaking Process	Socioeconomic Assessment Effort (e.g., frequency, typical timeline, role)	Staff Involved and Workload	Role of External Consultants
SCAQMD	Similar process as CARB except some difference in the workshop schedules	- Conducts the socioeconomic assessment for the AQMP regularly (about every 5 years), which includes benefits, costs and economic analyses. - Specific rule assessments typically include cost and economic analyses but not benefits analyses. - 3-6 months for the assessment for proposed rules; 6-12 months for an AQMP Assessment - Scientific and Technical & Modeling Peer Review Advisory Group (STAMPRAG) oversees the socioeconomic assessment effort	2 full-time staff work on rules socioeconomic assessments	Used external consultants to support various pieces of the assessments (e.g., health benefits, visibility benefits). The control cost analysis and economic impact analysis were done in-house. Also use consultants for peer review.
BAAQMD	Similar process as CARB (see below)	- Socioeconomic assessment is required for mandatory rules (e.g., emissions regulations) but not required for administrative rules (e.g., fee rule). - The assessments conducted in the past almost always indicate	5 people develop rules; socioeconomic assessments take 5-10% of the 5 people's workload	Used two contractors for independent rule assessments; the contractors collect data for the analyses and the BAAQMD also provides some data to the

Agency/Org	Rulemaking Process	Socioeconomic Assessment Effort (e.g., frequency, typical timeline, role)	Staff Involved and Workload	Role of External Consultants
		insignificant economic impacts. - Needs 6-12 months to initiate the socioeconomic assessment process; about 3-4 months to do the assessments. - Has internal review panel but does not do peer-review.		contractors.
CARB	- Before proposing any new rules, CARB holds public workshops to get public feedback about the potential regulation - Develop the rule and the impact assessments based on the public feedback - Make the rulemaking packet publicly available 45 days before the board hearing - 30 days for public to comment and for CARB to address public comments. Usually CARB makes minor revisions based on public comments. - Present the proposed rule to the Board - After the Board hearing, there is a second round of comments period that usually lasts 15 days.	- The rule impact assessment typically takes a few months for small rules and longer (up to a couple of years) for large rules. - The impact assessments are used for prioritizing the impacts and the sectors to regulate. - CARB is currently developing retrospective analysis for some recent rules; results are not publicly available yet.	A large number of staff for major rulemaking packet; a few lead staff with supporting team for impact analysis.	If needed, CARB also hires external consultants to support their impact assessments and reviews.
Minnesota AQS*				
Missouri AQCD*				
NESCAUM	NESCAUM is a non-profit membership association of state air agencies. The member states do their own rulemakings; NESCAUM	- They do impact assessments of rules or potential rules, but not typically in the legal sense of supporting a	Among the 20 staff, only a small portion was involved in rule	Uses external consultants occasionally.

Agency/Org	Rulemaking Process	Socioeconomic Assessment Effort (e.g., frequency, typical timeline, role)	Staff Involved and Workload	Role of External Consultants
	is not usually involved into rulemaking. There is no regional rulemaking authority.	specific rulemaking. - The effort is project and funding-based.	impact assessment.	
Ohio EPA, Division of Air Pollution Control	The process involves 2 phases for each rule: "interested parties draft" (IP) phase, and "proposed rule" phase. In the IP phase, the agency prepares the Business Impact Analysis (BIA) form. In the proposed phase, they complete a Rule Summary and Fiscal Analysis (RSFA) form and submit to the Joint Committee on Agency Rule Review.	Ohio EPA does not use modeling tools in their fiscal analysis. These analyses focus on direct impacts to potentially affected parties. To assess these impacts, the agency contacts representatives of the industry to determine general costs.	One staff dedicated full-time to rulemaking, who consults other in-house experts when needed	Does not use external consultants
Philadelphia Department of Public Health, Air Management Services Program	Philadelphia AMS enforces Title 3 of the Philadelphia Code and the Air Management Regulations. AMS starts with a regulation that does not include any assessments (the ideal regulation). They then gather data (socioeconomic and/or rule impact assessments) and modify the regulation, balancing the cost to the regulated community versus the impact to the public health of the citizens of Philadelphia.	- AMS does a search of state/local air agencies to see if they have rules that are similar to the proposed regulations. They use that as a starting point, and then contact the agency for additional documentation they may have. Depending on the situation (new regulation or modifying a regulation), the amount of effort will vary. - Any new/modified regulation will take at least 12 months (if not longer).	Much of the research is done by the Program Services unit of AMS (currently 4 staff).	External consultants are normally brought on board on an as needed basis
SDAPCD	The agency mainly relies on existing SIAs developed by other air districts for similar measures, as the agency usually adopts measures only after they have been implemented elsewhere and have proven to be feasible; therefore significant adverse	- The agency uses the established criteria from the State mandate for SIAs to determine which rules require assessments. - It typically prepares the SIA in house by reviewing the SIA reports	3 persons work on rule development; each works on 1 to 2 rulemakings per year. Rule writers are responsible for	Used consultants in a few instances when there appears to be a possibility of significant impacts and when the agency prepares a new, comprehensive air

Agency/Org	Rulemaking Process	Socioeconomic Assessment Effort (e.g., frequency, typical timeline, role)	Staff Involved and Workload	Role of External Consultants
	socioeconomic impacts will not be expected.	developed by other air districts, incorporating any information that may apply to the San Diego region, and supplementing with its own data where appropriate and available. - If significant impacts were found (e.g., job impact), the agency would try to mitigate the impact by amending the proposal (e.g., giving a longer timeframe for implementation or changing the applicability threshold). - The time commitment is a small percentage of the overall timeline for the rule development.	preparing the SIAs as part of the rulemaking process.	quality plan.
SJAPCD	- Similar to CARB but go beyond the minimum requirements for adopting a rule, for example, SJAPCD holds many public workshops during the rulemaking process.	- In the planning phase (e.g., 2012 PM2.5 Plan), the agency conducts qualitative health risk assessments for each control measures to prioritize them (required by the Health Risk Reduction Strategy). The PM Plan also included a BenMAP analysis for health benefits, which is not required. There is no economic impact analysis at the Plan level. - During the rulemaking process, cost analysis and economic analysis are conducted to indicate the feasibility of the rule. At public scoping meetings prior to the development of a draft rule, stakeholders are asked to	7-8 full time air quality specialists working with experts from many different sources; they are responsible for preparing the full rulemaking packet including the socioeconomic assessments.	- Contracted an independent economist to do the economic impact analysis, using estimates compliance costs and lists of affected businesses provided by the SJAPCD as well as other economic data. - The consultants work with the agency to get useful information and directions.

Agency/Org	Rulemaking Process	Socioeconomic Assessment Effort (e.g., frequency, typical timeline, role)	Staff Involved and Workload	Role of External Consultants
		provide specific cost and technical data, and participate in the economic analysis of prospective controls as part of a focus group. Once a draft rule has been prepared, the cost data is used to develop a draft District cost-effectiveness analysis, which is included in the staff report and presented for review at subsequent public workshops. - Economic analysis was conducted by a contractor. - The rulemaking and economic impact assessments can take multiple years (did not want to give a range of time frame).		
SMAQMD	Similar to CARB	- A rulemaking project typically lasts 8 – 24 months. The staff members generally prepare socioeconomic assessments for the rules on which they work. - The socioeconomic assessment is prepared not only to meet statutory requirements. The Board of Directors considers them to be an essential part of policy decision-making. - The agency often asks public commenters to provide their own cost information, if available, to	2.5 full loaded staff plus a supervisor work on rulemaking packet; each works on 2 – 5 rules.	The agency hires independent firm to assist the impact analysis in some cases (e.g., Rule 459).

Agency/Org	Rulemaking Process	Socioeconomic Assessment Effort (e.g., frequency, typical timeline, role)	Staff Involved and Workload	Role of External Consultants
		consider in the rule assessment.		
USEPA	- USEPA first considers the source types and control measure types affected to determine the resources required. - USEPA has in-house tools to screen rules, and staff time is allocated depending on availability. - For MACT rules there is more reliance on contractors; for MACT and NSPS rules, stakeholders are consulted throughout the process, and analysis that stakeholders provide is reviewed and considered. - After the proposal, there is the public comment period. Before the rule gets finalized there is interagency review.	- The timeframe depends on the number of industries and sources, the number of control strategies, the existing emissions inventory, and what sources are controlled. QA activities can also add to the timeline. For a NAAQS assessment, at least 4-6 months for a single control strategy. For multiple control strategies, it takes 8-9 months. The timeline can be shortened for a single-sector NSPS rules. - RIAs are generally conducted to meet the requirements under the Executive Order 13563, Executive Order 12866, and OMB Circular A-4.	A NAAQS analysis of a single strategy requires about 2 FTEs for the 4-9 month timeline. This can increase to 3 FTEs if software tools need to be developed.	Cost analysis for MACT and NSPS rules rely heavily on contractors. NAAQS rules depend less on contractors, depending on the USEPA office conducting analysis and the number of sources.

Appendix D. Overview of Agencies and Rule/Assessment Included in the Evaluation

Exhibit D-1. Overview of Agencies and Assessments Included in the Evaluation

Agency	Rule and Rule Assessments	Control Cost	Benefits	Economic Impact
BAAQMD	Regulation 8, Rule 3: Architectural Coatings (2009)	X		
	Regulation 2, Rule 5 (2009)	X		
	Socio-Economic Impact Study of the Proposed Bay Area 2012 Clean Air Plan, Control Measure SSM-1, Regulation 12: Miscellaneous Standards of Performance, Rule 13: Foundry and Forging Operations and Regulation 6: Particulate Matter, Rule 4: Metal Recycling and Shredding Operations (2012)	X		
	Final Clean Air Plan Socioeconomic Impact Analysis (2010)		X	X
	Multi-Pollutant Evaluation Method Technical Document (2010)		X	
	Regulation 9, Rule 10 Nitrogen Oxides And Carbon Monoxide From Boilers, Steam Generators And Process Heaters In Petroleum Refineries (2010)	X		
	Regulation 9, Rule 13: Nitrogen Oxides, Particulate Matter, And Toxic Air Contaminants From Portland Cement Manufacturing (2012)	X		X
	Regulation 6: Particulate Matter, Rule 3: Wood-burning Devices (2008)	X		
	Regulation 8, Rule 50: Polyester Resin Operations (2009)	X		X
	Regulation 12 Miscellaneous Standards Of Performance, Rule 12 Flares at Petroleum Refineries (2005)	X		
	Regulation 8, Rule 53: Vacuum Truck Operations (2012)	X		
CARB	LEV III – Advanced Clean Cars program (2011)	X		X
	Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline, including the supplemental materials (2008)	X	X	X
	Emission Reduction Plan for Ports and Goods Movement, including Appendix A (2006)		X	
	Truck and Bus Rule, including Appendix D (2008)	X	X	
	Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology (2010)		X	

Agency	Rule and Rule Assessments	Control Cost	Benefits	Economic Impact
Colorado APCD	Proposed Revisions to the Air Quality Control Commission's Regulation Number 6, Part B Non-Federal NSPS for Specific Facilities and Sources (2013)			
Minnesota AQS*	MPCA Review of Minnesota Power's Boswell 3 Emission Reduction Plan			
	Proposed Amendments to Rules Relating to Air Emissions Permits, Minnesota Rules Chapter 7005, 7007, 7011 and 7019			
Missouri AQCD*	Regulatory Impact Report in preparation for Proposing Amendment 10 CSR 10-5.220			
NESCAUM	Reducing GHG Emissions from Light-Duty Motor Vehicles (2004)	X		
	Reducing Heavy-Duty Long Haul Combination Truck Fuel Consumption and CO_2 Emissions (2009)	X		
	Low Sulfur Heating Oil in the Northeast States (2005)	X		
	Regional Greenhouse Gas Initiative (RGGI) (2012)			X
	Tier 3 low gasoline program assessment (2011)		X	
	Public Health Benefits of Reducing Ground-level Ozone and Fine Particle Matter in the Northeast U.S. (2008)		X	
Ohio EPA	Fiscal Analysis of Nitrogen Oxides – Reasonably Available Control Technology (NO_x RACT) (2013)	X		
Philadelphia AMS	Regulation XIV: Control of Perchloroethylene from Dry Cleaning Facilities (2013)	X		
SJVAPCD	Revised Proposed New Rule 4566 (Organic Material Composting Operations) (2011)	X		X
	Revised Proposed Amendments to Rule 4570 (Confined Animal Facilities) (2010)	X	X	X
	Revised Proposed Rule 4702 (2011)	X		X
SCAQMD	Socioeconomic Assessment of the Air Quality Management Plan (2012 and 2007) as well as the AQMP documents	X	X	X
	Proposed Rule 1304.1—Electrical Generating Facility Fee for Use of Offset Exemption (September 2013)	X		X
	Proposed Amended Regulation ─Regional Clean Air Incentives Market (RECLAIM) (November	X		X

Agency	Rule and Rule Assessments	Control Cost	Benefits	Economic Impact
	2010)			
	Proposed Amended Rule1146.1─Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (August 2008)	X		X
	Proposed Rule 1143—Consumer Paint Thinners and Multi-purpose Solvents (February 2009)	X		X
	Proposed Rule 2449—Control of Oxides of Nitrogen Emissions from Off-road Diesel Vehicles (May 2008)	X		X
	Proposed Amended Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters (April 2006)	X		X
SDAPCD	Rule 67.20 - Motor Vehicles and Mobile Equipment Refinishing Operations (1996)	X		
	Rule 67.20.1 - Motor Vehicle and Mobile Equipment Coating Operations (2010)	X		
	Proposed Amended Rule 67.11 - Wood Products Coating Operations (2011)	X		
SMAQMD	Amendments to Rule 459 - Automotive, Truck and Heavy Equipment Refinishing Operations (2011)	X		X
	Amendments to Rule 448 - Gasoline Transfer into Stationary Storage Containers (2008)	X		
	Amendments to Rule 449 - Transfer of Gasoline into Vehicle Fuel Tanks (2008)	X		
	Rule 411 - NO_x from Boilers, Process Heaters and Steam Generators (2005)	X		
	Rule 301 - Permit Fees - Stationary Source (2005)			
	Amendments to Rule 451 - Surface Coating of Miscellaneous Metal Parts and Products (2010)			X
	Rule 414 - Water Heaters, Boilers and Process Heaters Rates Less than 1,000,000 BTU Per Hour (2010)	X		X
	Rule 421 - Mandatory Episodic Curtailment of Wood and Other Solid Fuel Burning (2007)	X		X
	Amendments to Rule 421 - Mandatory Episodic Curtailment of Wood and Other Solid Fuel Burning (2009)	X		X
	Rule 417 - Wood Burning Appliances (2006)	X		
TCEQ	Final Regulatory Impact Determination for Amendments to §§114.1, 114.2, 114.21, 114.50, 114.53, 114.82-114.84, 114.87			
USEPA	Regulatory Impact Analysis for the Mercury and Air Toxics Standards (2011)	X		X

Agency	Rule and Rule Assessments	Control Cost	Benefits	Economic Impact
	Regulatory Impact Analysis for National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, or Institutional Boilers and Process Heaters	X		X
	The Benefits and Costs of the Clean Air Act from 1990 to 2020 - Final Report (2011)	X	X	X
	Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter (2013)	X	X	
	Regulatory Impact Analysis (RIA) for the Final Transport Rule (2011)		X	X
	Final Regulatory Impact Analysis (RIA) for the NO2 NAAQS (2010)		X	
	Final Regulatory Impact Analysis (RIA) for the SO2 NAAQS (2009)		X	
VCAPCD	Amendments to Rule 74.2, Architectural Coatings (2009)	X		
	Revisions to Rule 74.19, Graphic Arts (2011)	X		
	Revisions to Rule 74.11, Residential Water Heaters (2009)	X		
	Revisions to Rule 74.12, Surface Coating of Metal Parts and Products (2008)	X		
	Rule 74.31, Metalworking Fluids and Direct-Contact Lubricants (2013)	X		
	Revisions to Solvent Cleaning Requirements: Rule 74.13, Aerospace Assembly and Component Manufacturing Operations; Rule 74.20, Adhesives and Sealants; Rule 74.24, Marine Coating Operations (2012)	X		
WESTAR	Framework for Economic Analysis of WRAP Strategies (2005)	X		X
	Economic Analysis Framework Test Application (2005)	X		X
Wisconsin BAM	Proposed rules affecting NR 404 and NR 484 pertaining to adopting the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide (SO2) and nitrogen dioxide (NO2) (2011)			
* Minnesota AQS and Missouri AQCD responded on May 2, 2014, and the analysis of their assessments has not yet been completed as of the submission of this draft.				

Appendix E. Comparison Matrices of the SCAQMD Review

Exhibit E-1. Strengths and Weaknesses of the Benefits Analysis in Recent SCAQMD Socioeconomic Assessments

Analysis component	Method/data summary	Comment (pros and cons)	Recommendation
Health effects and concentration-response function	Included PM2.5-related health effects, i.e., premature mortality, respiratory and CVD hospitalization, ED visits, asthma attacks, MRAD, acute respiratory symptoms, and non-fatal heart attacks. Used a mortality C-R function estimated for LA Metro Area from Krewski et al. (2009) Table 23.	Pros: included health effects from comprehensive categories related to PM2.5 Cons: (1) did not discuss why/how those health endpoints and C-R functions were chosen or whether/how function transfer was used (e.g., when a study used was not conducted in their area); (2) did not discuss whether/how pooling was conducted to incorporate multiple functions from different studies; (3) when reporting the relative risk, only listed the mean value (1.17); (4) mixed the C-R function description with valuation description which can cause confusion; (5) did not include health effects related to other pollutants such as Ozone; (6) did not mention baseline incidence data, which is an input to the C-R functions.	(1) include a discussion on health endpoints and C-R function selection (e.g., scientific evidence of causal relationship) and a full list of selected functions in appendix and cross -reference in Chapter 3; (2) if function pooling was done, suggest including details about it in appendix and cross-reference in Chapter 3; (3) include the confidence interval when mentioning RR as well as the specific source. For example, the RR for all-cause mortality is from Krewski et al. (2009) Table 23; (4) separate out C-R function discussion and valuation; (5) include ozone related benefits as well as other pollutants (e.g., NO2, SO2); (6) include details on other inputs in the appendix, e.g., incidence data, population.
Health effects valuation method	For premature mortality, used a study Kochi et al. (2006) where the VSL ranges between $6.1 and $6.7 million (in 2005 dollar and 2010 real income). For other health effects, used COI with unit values listed in Table 3-4.	Pros: used a local VSL study to reflect the local WTP. Cons: (1) mortality lag was not considered/mentioned; (2) did not describe studies used in the valuation of morbidity endpoints; (3) did not specify dollar year for the unit values provided in Table 3-4; (4) did not discuss income growth, discounting, and inflation; (5) did not provide a justification of using Kochi et al. (2006) . The concern here is that there is only one local study and it is not clear how good it is.	(1) include details on valuation methods into an appendix (e.g., mortality lag, studies used, income growth, discounting, end-of-life costs, double-counting of benefits...) and cross reference in Chapter 3; (2) should briefly mention BenMAP was used to conduct the health benefit analysis and reference to appendix for more details; (3) provide description of valuation study selection criteria and justification of using Kochi et al. (2006); and conduct a sensitivity analysis using VSL estimates from other studies (could consider using a pooled VSL value); (4) characterize uncertainties in the valuation numbers through confidence

Analysis component	Method/data summary	Comment (pros and cons)	Recommendation
			intervals or a range of values.
Pollutants included in the health benefit analysis and thresholds	PM2.5 only. No thresholds were used.	Pros: explicitly discussed thresholds Cons: (1) did not include health effects due to concentration reduction in other air pollutants; (2) it mentioned that the federal PM2.5 standards were exceeded at only one air monitoring station and that the majority of the Region's population is currently exposed to unhealthful air (p. 3-9). Why would noncompliance at 1 station make the majority exposed to unhealthful air?	(1) incorporate health benefits resulting from reductions in other pollutants such as ozone, NO2, and SO2; (2) identification of possible significant pollutant thresholds for future analysis; (3) provide explanation of the impact of 1-station noncompliance on the majority of the Region's population.
Health benefits to low-income group (EJ)	Discussed the impacts on low-income households on p. 3-10	Cons: Since the whole health benefit analysis did not examine income groups, it is a little awkward to discuss it.	(1) if impact on income groups were not conducted, may consider moving the discussion of such impact and efficiency/equity tradeoff to the summary/discussion section or future improvement section; (2) Expand EJ analysis by analyzing benefits to different racial and income groups when data are available and discuss policy implication of the EJ analyses results.

Analysis component	Method/data summary	Comment (pros and cons)	Recommendation
Visibility data	Mentioned that visibility data were obtained from empirical visibility models.	Pros: used the data at a fine resolution level. Cons: did not specify visibility data source and modeling. The data description is generally poor for many input variables.	Provide some data description in Chapter 3 and include details in appendix, e.g., provide a citation for the empirical visibility models.
Visibility benefit valuation method	Used hedonic approach based on Beron et al. (2001), which was performed for 4 counties around LA area at census tract level, where dependent variable is housing sale price and independent variables were net household income, percent of college degrees for people 25+, and visibility. Predicted values from the hedonic equation represent the lifetime value per house; then annualized the lifetime value assuming 50 years of lifetime and 4% interest rate. Then multiply by the number of households to get total values of visibility benefits. Future income and education data were estimated based on the growth rate developed using ACS 2005-2009. Visibility data came from empirical visibility models. The projected number of households at county level was from the SCAG forecast and then distributed to sub-regions based on 2006-2010 ACS household counts for each sub region. To avoid double counting of other benefits reflected in the WTP (e.g., health and material benefits), 45% is applied to adjust the total value to account for the visibility aesthetics only. Valuation was done in benchmark years (2014, 2023, 2030, and 2035) and linearly	Pros: used a local hedonic study to reflect local WTP. The empirical visibility models were developed for four locations in the Basin. Cons: (1) The details of the methods were not sufficient. For example, whether ACS sampling uncertainty was reflected in the modeling and projections? Whether there is omitted variable bias? (2) Descriptions were not clear about what the number 50 was and why 50 years was used? Also, how was the 4% interest rate chosen?	(1) Be specific about the assumptions made for lifetime of houses, interest rate, and adjustment factor for avoid double counting; and provide some discussion about them. Move the text about double counting in the appendix (A-6) to Chapter 3. (2) Provide more details about the methods and data sources used to estimate visibility benefits. If those details were included in Beron et al. (2001), provide a summary/table in the appendix. (3) Consider using Woods &Poole projections on income & education.

Analysis component	Method/data summary	Comment (pros and cons)	Recommendation
	interpolated for years between them.		

Analysis component	Method/data summary	Comment (pros and cons)	Recommendation
Material benefit analysis method	Used the relationship between costs of repainting and TSP estimated in Murray et al. (1985) for commercial buildings and the relationship between additional cleaning costs and TSP estimated in Cummings et al. (1985) for residential properties. Convert available PM2.5 concentration data to TSP using a ratio of 4.81 (which was used in Murray et al. (1985)). Assumed the damage to commercial properties was 3% of the damage to residential properties. Valuation was done at county level in benchmark years (2014, 2023, 2030, and 2035) and linearly interpolated for years between them.	Cons: (1) valuation was based on very old studies, including the conversion ratio of 4.81; (2) did not specify where the 3% assumption comes from; (3) the appendix on Materials subsection did not add additional details.	(1) suggest including data sources in the appendix and remove repeated descriptions in the appendix; (2) conduct literature search to identify newer studies; (3) if there is not sufficient information/data to conduct a quantitative analysis for this benefit category, suggest including it to the un-quantified benefit section (e.g., USEPA used to quantify material benefits but dropped it in its recent RIA due to lack of data/information).

Analysis component	Method/data summary	Comment (pros and cons)	Recommendation
Traffic congestion reduction data/method	Assessed the congestion relief benefits due to (1) reductions in daily vehicle miles traveled (VMT) and (2) daily vehicle hours traveled (VHT) as a result of implementing SCAG's TCMs. The data on reductions in VMT and VHT were provided by SCAG at 4x4km grid cell level (Confirm with SUE). Daily VMT reductions at grid cell level were aggregated to annual reductions at sub-region level for each vehicle type (autos and trucks). Then multiplied by the operating and maintenance cost per mile of that vehicle type to obtain the benefit of reduced travel (cost data for autos from AAA, 2012 and cost data for trucks from ATRI, 2011). The benefit of VHT reductions for the sub-regions was calculated as the product of VHT reductions and hourly wage rate (i.e., opportunity cost of saved time). Only VHT reductions for business and commute trips were included (assumed 8% of total VHT reductions were for business trips and 73% for commute trips based on SCAG, 2012a). The hourly wage rate for commute trips was assumed to be one-half of the average wage rate of all workers in LA county. The hourly rate for business trips was assumed to be the truck drivers' hourly rate.	Pros: Considered benefits from both VMT and VHT reductions. Differentiated the business vs. commute trips. Cons: (1) Data sources and calculation methods were not clearly described, e.g., should specify the data source for the projected VHT reduction in the first sentence on p. 3-14. (2) The current appendix on congestion reduction did not add additional details. (3) The description about benefit from the SI-committed TCMs vs. all TCMs (last paragraph on p. 3-12 and the top of p. 3-13) is confusing. (4) This benefit is due to implementing SCAG's TCMs rather than implementing SCAQMD's AQMP, which may make it not comparable with benefits from other categories.	(1) Include details on data and methods in the appendix. (2) Move the description about SI-committed TCMs between 2014 and 2035 to the end of that section to improve continuity/flow. (3) Include a justification of including benefits due to TCMs to AQMP's benefits

Analysis component	Method/data summary	Comment (pros and cons)	Recommendation
Un-quantified benefits	Identified the areas that are not quantifiable at the moment and briefly discussed each of these areas, including health, material and traffic congestion relief benefits.	Cons: (1) the first paragraph in this section mentioned plant life and livestock but no discussion was provided for this area. (2) For the un-quantified health benefits, the discussion was quite general and vague without listing the unquantifiable health effects. (3) The appendix for this section basically repeated the main texts.	(1) Add the discussion about plant life and livestock; (2) provide a list of unquantifiable health effects and a discussion of the current gaps; (3) For Material Benefit, the first sentence needs to be revised: take out PM2.5 from the parenthesis since it is "In addition to". (4) Remove appendix for this section as it does not add any value.
Typos/Errors		(1) p. 1-6: "Ethnic" should not be included in the box of "Policy Considerations" because the whole report did not examine impact on ethnic groups; (2) p. 3-9: "Kridging" should be spelled as "Kriging", and it is "Land-use regression model" that was used rather than "kriging model" in Krewski et al. (2009). (3) In the second paragraph on p. 3-9, remove "from" in "from acute respiratory symptoms". (4) The first sentence in the last paragraph on p. 3-9 does not seem to be smooth. (5) $ year is missing in Table 3-4. (6) Line 6 in the second paragraph of Visibility subsection on p. A-5 has "concentration of visibility reducing particulate chemical species"; suggest rephrasing this to make a better sense. (7) In Table 3-7, the "2000 dollars" should probably be "2005 dollars"	

Exhibit E-2. Strengths and Weaknesses of Control Cost Analyses in Recent SCAQMD Socioeconomic Assessments

SCAQMD Assessment	Tools and Methods	Depth and Adequacy of Coverage/ Completeness	Effective Communication and Presentation
2012 Socioeconomic Assessment of the Air Quality Management Plan (AQMP)	-The DCF method should be revised to discount the stream of future emissions reductions. -Good use of M&S Index to convert to 2005 dollars.	-Could use discussion of uncertainties surrounding key assumptions and a sensitivity analysis to gauge their importance to the final cost effectiveness estimates	-Would benefit from a more detailed description of the cost effectiveness methodology and assumptions.
Proposed Rule 1304.1—Electrical Generating Facility Fee for Use of Offset Exemption	-Good use of sensitivity analysis of multiple assumptions to address underlying uncertainties		-The report explains the fee well, but does not offer much explanation of the control measures the fee will support.
Proposed Amended Regulation ─Regional Clean Air Incentives Market (RECLAIM)		-It was good that monitoring requirements were listed for fluid catalytic cracking units, but monitoring requirements (and costs) for other facilities were not listed.	-Some of the cost assumptions are listed, but it is unclear whether they refer to the cost of a control at a single facility or at all affected facilities. -It is also unclear from the report if the 4% interest rate is used only to amortize capital costs, or also to discount future O&M costs.
Proposed Rule 1143—Consumer Paint Thinners and Multi-purpose Solvents	-It was good that the control costs are distributed to four types of compliant projects based on assumed market penetration. However, it could benefit from a sensitivity analysis of different market penetration rates.	-It was good that the administrative costs from the permit application fee were included in the control costs.	-The use of multiple scenarios was an effective way to explain how control costs could be distributed between consumers and manufacturers.

SCAQMD Assessment	Tools and Methods	Depth and Adequacy of Coverage/ Completeness	Effective Communication and Presentation
Proposed Amended Rule 1146.1—Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters	-Cost assumptions are clearly laid out. Good use of capacity factor to help determine O&M costs.	-It was good that monitoring, source testing, and administrative costs were included.	
Proposed Rule 2449—Control of Oxides of Nitrogen Emissions from Off-road Diesel Vehicles	-Good use of multiple scenarios to explore options where engine rebuilds occur on a normal schedule, rather than an accelerated schedule. However, the analysis could benefit from a scenario where some but not all engines are rebuilt on an accelerated schedule.	-It was good that the O&M costs included increased costs for electricity and gas, but decreased costs for diesel from more efficient engines.	It is stated that it is assumed that capital expenditures would be financed at a real interest rate of 4%, but it is not clear from the report whether this rate was also applied to discount future O&M costs.
Proposed Amended Rule 1146.2 - Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters	-Basic capital and O&M costs were not listed. It was difficult to determine the methodology used to estimate cost effectiveness.	-There is not enough information on the methodology to judge its completeness.	-Could benefit from more information about the methodology and assumptions used in the analysis.

Exhibit E-3. Strengths and Weaknesses of Economic Impact Analyses in Recent SCAQMD Socioeconomic Assessments

SCAQMD Assessment	Tools and Methods	Depth and Adequacy of Coverage/ Completeness	Effective Communication and Presentation
2012 Socioeconomic Assessment of the Air Quality Management Plan (AQMP)	-REMI is still a state-of-art, nationally recognized tool for regional economic impact assessment -Implemented recommendation from MIT to calibrate REMI's baseline projections w/SCAG's forecasts for population and economic growth	*-Lacks discussion of uncertainties associated with REMI (i.e., underlying data and methods) and other aspects of economic analysis (i.e., cost and revenue estimates which become inputs to REMI)*	*-Would benefit from adding discussion of how annual estimates of costs and benefits are conveyed to REMI, how industry classifications are determined, and other steps in the process of using REMI and interpreting results* *-Reporting absolute changes in impacts only, and as point estimates rather than ranges, suggests very high levels of precision and certainty*
Proposed Rule 1304.1—Electrical Generating Facility Fee for Use of Offset Exemption	-Good use of sensitivity analysis of multiple assumptions to address underlying uncertainties	*-Mentions contributions from compliance w/1304 toward ozone and PM standards, but does not expand on what that means for interpretation of 1304 impacts*	-Strong discussion of drivers of temporal patterns in jobs impacts *-Not clear of basis for statement that jobs foregone due to 1304 are similar to other rules, tone of discussion borders on editorializing*
Proposed Amended Regulation ─Regional Clean Air Incentives Market (RECLAIM)	-Evaluated multiple compliance cost scenario to address uncertainties in compliance pathways	-Provides year-by-year changes in employment levels for all 3 scenarios -Good discussion of employment impact dynamics for WSPA scenario *-For ETS scenario, inconsistent treatment of estimates of jobs gained (described quantitatively) versus jobs foregone (which are described as "…in*	*-Impacts described in absolute terms as point estimates, without any discussion of uncertainty ranges*

SCAQMD Assessment	Tools and Methods	Depth and Adequacy of Coverage/ Completeness	Effective Communication and Presentation
		noise of REMI model")	
Proposed Rule 1143—Consumer Paint Thinners and Multi-purpose Solvents	-Use of alternative approaches to estimating compliance costs appropriately reflects underlying uncertainty	*-Assumptions for both compliance scenarios seem conservative; needs more discussion of why key assumptions were made and their influence on results*	-Discussion makes clear that the analysis was done w/slightly out-of-date REMI data (2005) -Good explanation of temporal patterns in job impacts *-Recommend reporting impacts in percentage terms, as well as absolute terms*
Proposed Amended Rule 1146.1─Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters	*--Discussion of employment impacts should explain how patterns in interim years (b/n 2012, 2015, and 2020) results in avg. annual jobs foregone* *--Similarly, explanation of temporal patterns in reported competitiveness impacts would increase transparency of results*		*-Would benefit from table or other graphic illustrating how compliance costs are aggregated and distributed over time period of analysis*
Proposed Rule 2449—Control of Oxides of Nitrogen Emissions from Off-road Diesel Vehicles		*-Would benefit from more explanation of magnitude in differences in jobs impacts between base case and SOON, which seem disproportionate to the differential compliance cost between the two cases*	

SCAQMD Assessment	Tools and Methods	Depth and Adequacy of Coverage/ Completeness	Effective Communication and Presentation
Proposed Amended Rule 1146.2 - Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters		-Description of allocation of replacement costs is helpful but similar explanation on other cost categories also needed	-Good discussion of temporal patterns in job impacts *--Recommend reporting jobs and other impacts in percentage terms, as well as absolute changes*

Appendix F. The List of Interviewed Stakeholder Organizations

Organization Name
American Lung Association in California
BizFed, Los Angeles County Business Federation
California Council for Environmental and Economic Balance
California Manufacturers Association/Terra Furniture
California Small Business Alliance
California Trucking Association
City of LA Economic & Workforce Development Department
Coalition for a Safe Environment
Coalition for Clean Air
EarthJustice
Inland Empire Economic Partnership
Los Angeles County Economic Development Corporation
Majestic Realty Company
Natural Resources Defense Council
Orange County Business Council
Physicians for Social Responsibility - LA
Port of Long Beach
Riverside County
Sanitation Districts of Los Angeles County
Sierra Club California
Southern California Gas Company/San Diego Gas & Electric
University of Southern California
Western States Petroleum Association

Appendix G. Stakeholder Interview Instrument

I1

My name is xx with Abt Associates, and I am with xx. We will be conducting the interview today. Thank you for agreeing to participate in this interview with us.

I2

This interview may be recorded to help us better evaluate the interview results. These recordings will only be used by Abt for review purposes and will not be shared with South Coast AQMD. We will delete them after we complete this project. Is it ok to record this interview?

Yes

No

Refuse, Don't Know

I3

Now I will provide some background information to you. As we said in our email to you, we were contracted by the SCAQMD to conduct an independent review of socioeconomic assessments of the SCAQMD's rules, proposed regulations and AQMP. In addition to reviewing SCAQMD's socioeconomic assessments, we are reviewing similar assessments from other public agencies such as U.S. EPA, California Air Resources Board; and we are conducting stakeholder interview to collect stakeholder's feedback on South Coast AQMD's Socioeconomic Assessments. The SCAQMD may use the outputs from this project to improve their assessments in the future. As you may know, the SCAQMD uses socioeconomic assessments to make decisions in their rulemaking and planning process. Various stakeholders participate in their rulemaking and planning process. We would like to hear your opinions about South Coast AQMD's socioeconomic impact assessments and therefore our conversation requires some basic understanding of South Coast AQMD's regulations and the socioeconomic assessments. Are you familiar with the SCAQMD's socioeconomic assessments? Did you have a chance going through the example assessments we sent to you in email or some parts of it?

Yes [SKIP to Q1]

No [RETURN to I2]

Refuse, Don't Know

I4

Before we begin I just need to let you know that a summary of interview results will be made public. If an individual quote is mentioned in the summary report, the respondents name and affiliation will not be revealed. However, individual results can be subject to public records requests.

Now I will start asking you the questions. I will first ask you to rank the importance of the analysis components of the SCAQMD's socioeconomic assessments; then I will invite you to comment on each analysis component; then I will ask your additional comments where you are welcome to provide any of your general or specific comments.

Q1

In our review process, we are evaluating the analyses of compliance costs, benefits (health and welfare benefits) and economic impacts (e.g., job impacts) of SCAQMD's regulations.

I am now going to describe different analysis components included in some of the AQMD Socioeconomic Assessments. I'd like you tell me whether **you think** the component is "very important", "Moderately/somewhat important", "Not important", or "don't know/no opinion". OK? Would you like me to repeat? [(do not read) Interviewer provides necessary explanation of each element and record the answer by marking 1-4]

A. Estimate the benefits of regulations
B. Estimate the costs of regulations
C. Assess the regulatory impacts on employment.
D. Assess the regulatory impacts on the region's competitiveness (i.e., region's share of jobs, production costs and prices, international trade)
E. Estimate the regulatory impacts on individual localities and small business within the south coast district.
F. Assess the impacts on subpopulations (e.g., different income levels, minorities) – environmental justice.
G. Assess alternative policy options.

1. Very important
2. Moderately/somewhat important
3. Not important
4. Don't Know/No Opinion

Q2 [(do not read) If the answer to A in Q1 is 1-2, then ask; otherwise skip to next question]

Q2a What's your opinion on the strengths and weaknesses of the SCAQMD's regulatory benefits analyses? [(do not read) Interviewer should guide the interviewee to discuss the weakness and strengths]

[ENTER TEXT]

_____

Q2b Do you have any specific suggestions for how can the South Coast AQMD improve their benefits analyses in their Socioeconomic Assessments? [(do not read) If Yes, ask, what are your specific suggestions for improvements? Interviewer can ask about additional tools that can be utilized as well as uncertainty issues/sensitivity analysis here if not discussed already]

[ENTER TEXT]

_____

Q3 [(do not read) If the answer to B in Q1 is 1-2, then ask; otherwise skip to next question]

Q3a What's your opinion on the strengths and weaknesses of the SCAQMD's regulatory cost analyses? [(do not read) Interviewer should guide the interviewee to discuss the weakness and strengths]

[ENTER TEXT]

_____

Q3b Do you have any specific suggestions for how can the South Coast AQMD can improve their cost analyses in their Socioeconomic Assessments, such as additional tools that can be utilized as well as uncertainty issues/sensitivity analysis? [(do not read) If Yes, ask, what are your specific suggestions

for improvements? Interviewer can ask about additional tools that can be utilized as well as uncertainty issues/sensitivity analysis here if not discussed already]

[ENTER TEXT]

Q4 [(do not read) If the answer to C in Q1 is 1-2, then ask; otherwise skip to next question]

Q4a What's your opinion on the strengths and weaknesses of the SCAQMD's environmental justice (EJ) analyses, that is, the benefit and cost impacts of regulations on individuals of different income levels? [(do not read) Interviewer should guide the interviewee to discuss the weakness and strengths]

[ENTER TEXT]

Q4b Do you have any specific suggestions for how can the South Coast AQMD can improve their EJ analyses in their Socioeconomic Assessments, such as additional tools that can be utilized as well as uncertainty issues/sensitivity analysis? [(do not read) If Yes, ask, what are your specific suggestions for improvements? Interviewer can ask about additional tools that can be utilized as well as uncertainty issues/sensitivity analysis here if not discussed already]

[ENTER TEXT]

Q5 [(do not read) If the answer to D in Q1 is 1-2, then ask; otherwise skip to next question]

Q5a What's your opinion on the strengths and weaknesses of the SCAQMD's job impact analyses? [(do not read) Interviewer should guide the interviewee to discuss the weaknesses and strengths]

[ENTER TEXT]

Q5b Do you have any specific suggestions for how can the South Coast AQMD can improve their job impact analyses in their Socioeconomic Assessments, such as additional tools that can be utilized as well as uncertainty issues/sensitivity analysis? [(do not read) If Yes, ask, what are your specific suggestions for improvements? Interviewer can ask about additional tools that can be utilized as well as uncertainty issues/sensitivity analysis here if not discussed already]

[ENTER TEXT]

Q6 [(do not read) If the answer to E in Q1 is 1-2, then ask; otherwise skip to next question]

Q6a What's your opinion on the strengths and weaknesses of SCAQMD's competitiveness impact analyses? [(do not read) Interviewer should guide the interviewee to discuss the weaknesses and strengths]

[ENTER TEXT]

Q6b Do you have any specific suggestions for how can the South Coast AQMD can improve their competitiveness analyses in their Socioeconomic Assessments, such as additional tools that can be utilized as well as uncertainty issues/sensitivity analysis? [(do not read) If Yes, ask, what are your specific suggestions for improvements? Interviewer can ask about additional tools that can be utilized as well as uncertainty issues/sensitivity analysis here if not discussed already]

[ENTER TEXT]

Q7 [(do not read) If the answer to F in Q1 is 1-2, then ask; otherwise skip to next question]

Q7a What's your opinion on the strengths and weaknesses of the SCAQMD's impact analyses on individual localities and small business? [(do not read) Interviewer should guide the interviewee to discuss the weaknesses and strengths]

[ENTER TEXT]

Q7b Do you have any specific suggestions for how can the South Coast AQMD can improve this analysis in their Socioeconomic Assessments, such as additional tools that can be utilized as well as uncertainty issues/sensitivity analysis? [(do not read) If Yes, ask, what are your specific suggestions for improvements? Interviewer can ask about additional tools that can be utilized as well as uncertainty issues/sensitivity analysis here if not discussed already]

[ENTER TEXT]

Q8 [(do not read) If the answer to G in Q1 is 1-2, then ask; otherwise skip to next question]

Q8a What's your opinion on the strengths and weaknesses of the SCAQMD's alternative policy analyses? [(do not read) Interviewer should guide the interviewee to discuss the weaknesses and strengths]

[ENTER TEXT]

Q8b Do you have any specific suggestions for how can the South Coast AQMD can improve their CEQA analysis in their Socioeconomic Assessments, such as additional tools that can be utilized as well as uncertainty issues/sensitivity analysis? [(do not read) If Yes, ask, what are your specific suggestions for improvements? Interviewer can ask about additional tools that can be utilized as well as uncertainty issues/sensitivity analysis here if not discussed already]

[ENTER TEXT]

Q9

Q9a How clear and understandable is the *methodology* that was described in the Socioeconomic Assessments documents/reports? Whether/how the South Coast AQMD should improve the way they describe the methodology and the procedures used in their economic impact analyses?

[ENTER TEXT]

Q9b How clear and understandable is the *results* that were reported in the Socioeconomic Assessments documents/reports? Whether/how the South Coast AQMD should improve the way they report the results of their economic impact analyses?

[ENTER TEXT]

Q10

Q10a How can the South Coast AQMD make their Socioeconomic Assessments a more effective tool to help decision-makers formulate policy that contributes to improving public health while at the same time maintaining economic strength and long term sustainability of the region?

[ENTER TEXT]

Q10b What types of analyses, if not included in the above questions, would you like to see included in future assessments?

[ENTER TEXT]

Q10c

[(do not read) Interviewer: probe for details. Why is it important? How should the analysis be performed?]

[ENTER TEXT]

Q11

Are there other areas not covered in this interview that you would like to provide comments and suggestions?

[ENTER TEXT]

Q12

Do you have any comments about the capacity and/or capability of AQMD staff to analyze the impacts?

[ENTER TEXT]

CLOSE:

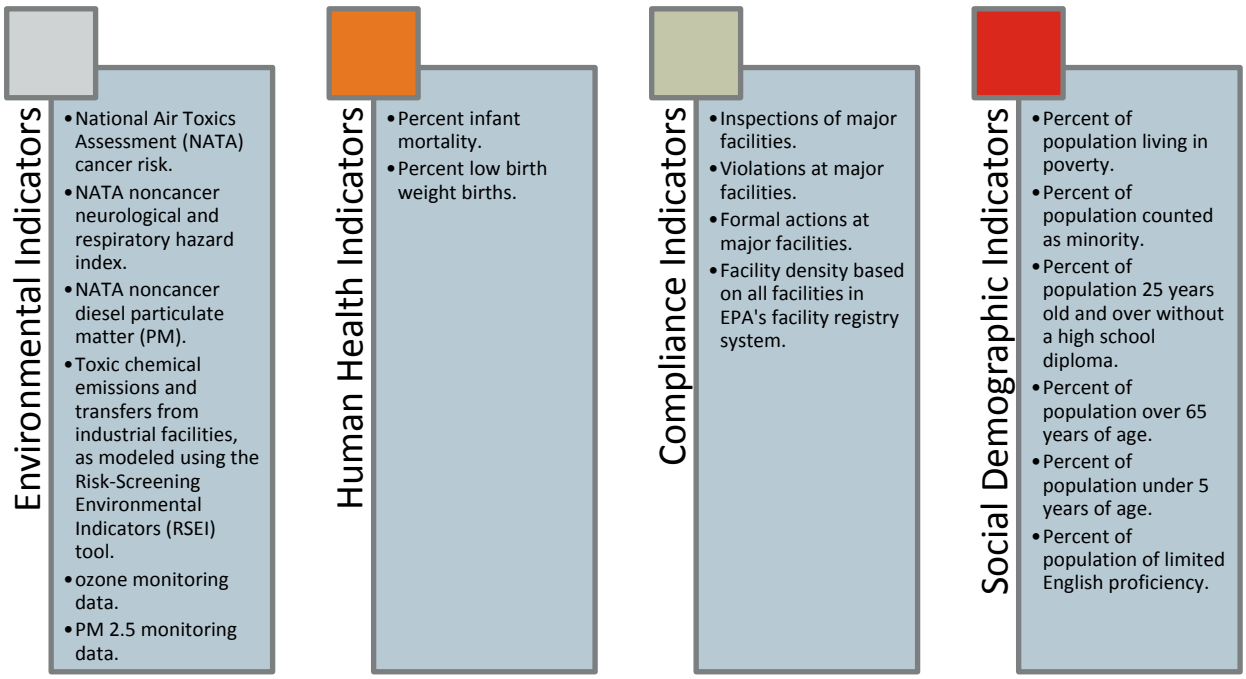
That's all the questions I have. Thanks for your participation in this interview. Please feel free to contact us if you have further comments/questions/suggestions.

Appendix H. Environmental Justice Screening Tools

EJSEAT (Environmental Justice Strategic Enforcement Assessment Tool) is a national multi-component indicator for EJ assessment intended to be used for strategic targeting and enforcement. Developed by the Office of Enforcement and Compliance Assurance, EJSEAT combines socio-demographic, health, environmental, and compliance/enforcement tract-level data (except health, which is at the county level), normalized within state. It relies on data from 18 select federally-recognized or managed databases and uses a simple algorithm to identify areas with potential EJ issues. The tool defines indicators in four categories (see *Figure 1*). The indicators are expressed over a scale of 0 to 100 and are combined across the four areas. The scales are calculated separately for each state, thereby allowing state program independence in setting priorities and methods, while still allowing for a comparison of facilities within the same state.

EJSEAT is currently a draft tool in development, intended for internal EPA use only. For more information, see http://www.epa.gov/compliance/ej/resources/policy/ej-seat.html

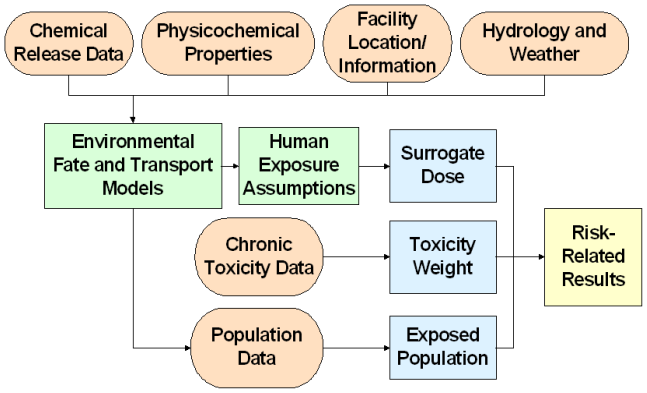
Figure 1: EJSEAT indicators of disproportionately high and adverse environmental and public health burdens.



RSEI (Risk Screening Environmental Indicators) is a screening-level model for assessing the potential health impacts of industrial chemical releases. Developed by Abt Associates for EPA's Economic and Policy Analysis Branch (EPAB) in OPPT's Economics, Exposure and Technology Division (EETD), the tool incorporates risk concepts (toxicity, dose, population) to produce unitless scores of the relative risk impact of chemical releases by industrial sources. *Figure 2* illustrates the RSEI calculation framework. The tool is currently used by EPA program offices (OPPT, OW, OECA,

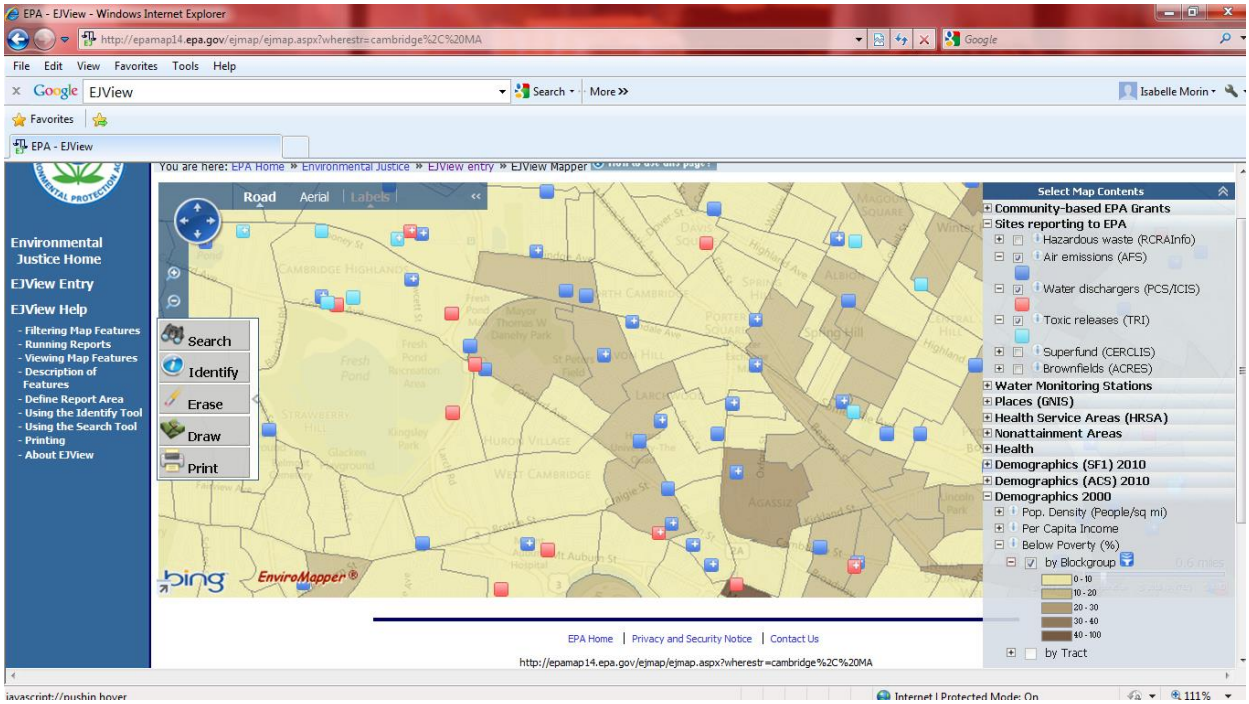
Regional Office), state environmental protection departments, regulated industries, and by community groups. While the tool was specifically designed to answer questions regarding trends in relative risk over time or the relative contribution of various chemicals and releases to risk to which a given community is exposed, it also contains data that are relevant to exploring issues related to environmental justice. To illustrate, the RSEI Air Microdata provides data on chemical releases at a cell resolution that is less than 1 km-1km in size. These cells are matched to block-level Census data, providing the demographic profile of exposed populations. These detailed data layers allow the identification of hotspots for cancer and non-cancer effects and their demographic characteristics (e.g., % minority, % poor). Preliminary analyses of the Air Microdata by Abt Associates suggest that hotspots are characterized by a greater proportion of minority and poor people than are present in the general U.S. population. For more information see http://www.epa.gov/oppt/rsei/.

Figure 2: RSEI Calculation Framework.



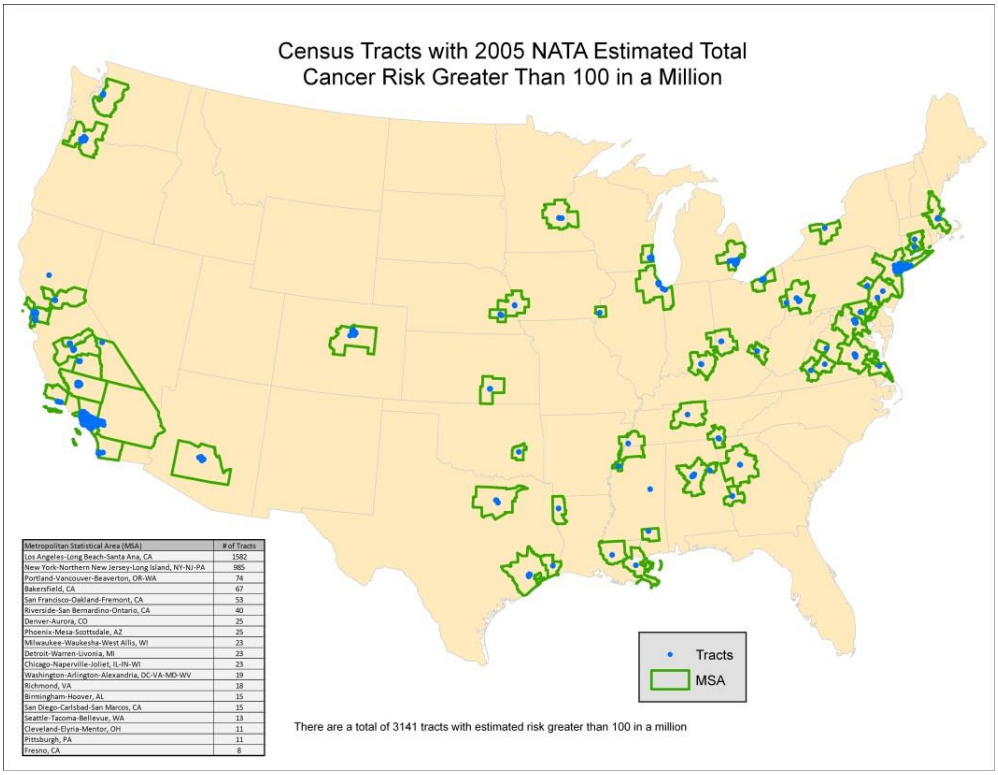
EJView – formerly known as the Environmental Justice Geographic Assessment Tool, is a mapping tool that allows users to create maps and generate detailed reports based on the geographic areas and data sets they choose (by specifying an address, a city and state, a ZIP code, etc.). The tool includes data from multiple factors that may affect public and environmental health within a community or region, such as demographic, health, environmental, and facility-level data. *Figure 3* shows an example screen overlaying the percent of population below poverty with air releases, water dischargers, and TRI reporters. For more information, see http://epamap14.epa.gov/ejmap/entry.html.

Figure 3: Example EJView screen.



NATA (EPA's National-Scale Air Toxics Assessment) – is described by EPA as "a state-of-the-science screening tool for State/Local/Tribal Agencies to prioritize pollutants, emission sources and locations of interest for further study in order to gain a better understanding of risks." The purpose of NATA is to identify and prioritize air toxics, emission source type, and locations that are of the greatest potential concern in terms of contributing to population risk. The most recent NATA, released by EPA in 2011, is based on the 2005 emissions year. It provides information on 177 of the 187 Clean Air Act air toxics plus diesel particulate matter. *Figure 4* shows an example map of cancer risk calculated from the 2005 NATA. While the maps prepared by EPA do not include demographic information directly, they can readily be overlaid with these data to identify EJ considerations. For more information, see http://www.epa.gov/ttn/atw/natamain/

Figure 4: Example map output from 2005 NATA.



Metropolitan Statistical Area (MSA)	# of Tracts
Los Angeles-Long Beach-Santa Ana, CA	1582
New York-Northern New Jersey-Long Island, NY-NJ-PA	985
Portland-Vancouver-Beaverton, OR-WA	74
Bakersfield, CA	67
San Francisco-Oakland-Fremont, CA	53
Riverside-San Bernardino-Ontario, CA	40
Denver-Aurora, CO	25
Phoenix-Mesa-Scottsdale, AZ	25
Milwaukee-Waukesha-West Allis, WI	23
Detroit-Warren-Livonia, MI	23
Chicago-Naperville-Joliet, IL-IN-WI	23
Washington-Arlington-Alexandria, DC-VA-MD-WV	19
Richmond, VA	18
Birmingham-Hoover, AL	15
San Diego-Carlsbad-San Marcos, CA	15
Seattle-Tacoma-Bellevue, WA	13
Cleveland-Eyria-Mentor, OH	11
Pittsburgh, PA	11
Fresno, CA	8

C-FERST (Community-Focused Exposure and Risk Screening Tool) – is a user-friendly, web-based tool designed as a "one-stop shop" to help identify and prioritize community environmental issues and to assess human exposures and health risks, using the best available information and science. The tool is aimed at helping communities identify and prioritize key environmental stressors and to make publicly accessible research in cumulative risk assessments. In addition to display the various environmental stressors (air releases, by pollutants) affecting a community, the tool provides information on available resources to communicate the risk and take actions to reduce exposure (http://www.epa.gov/heasd/c-ferst/).

EJSCREEN is a nationally-consistent environmental justice screening and mapping tool, which aims to build upon lessons learned from prior screening tools (e.g., EJSEAT and EJVIEW described above) and reviews of those tools, consolidate duplicative activities, foster consistency of data and methods, incorporate updated data, improve spatial resolution, include a wider set of environmental factors, draw upon the evolving relevant science, and consider the policy decisions inherent in any such screening tool. EJSCREEN's purpose is to screen geographic areas based on environmental and vulnerability indicators, for example to serve as a first step in identifying overburdened communities that may warrant additional investigation by EPA. The tool currently provides 12 environmental indicators that can be combined with demographic information to estimate 12 separate "primary EJ indices" at the Census block group level of geographic resolution (see Table 1). Users of the tool faced with multiple considerations in identifying overburdened communities may prefer one composite Primary EJ Index, which requires combining individual environmental indicators into one composite environmental indicator. Abt Associates has been assisting EPA in the development of

EJSCREEN, including support for the Science Advisory Board (SAB) consultation, technical, editorial and graphics assistance in preparation for the eventual release of the EJSCREEN tool.

Table 1. Information on Environmental Indicators Included in EJSCREEN.

Indicator	Rationale for Inclusion	Place on the Exposure–Risk Continuum	Key Medium
Air Toxics Cancer Risk: Lifetime inhalation cancer risk	• EJ studies of HAPs include Morello-Frosch and Jesdale (2005); Liu (2001); and Maantay et al. (2010). • NATA cancer risk included in OAR's CenRANK, OECA's EJSEAT, and some Regional screening tools.	Risk/Hazard	Air
Air Toxics Respiratory Hazard Index: Ratio of exposure concentration to reference concentration (RfC)	• EJ studies of HAPs include Morello-Frosch and Jesdale (2005); Liu (2001); and Maantay et al. (2010). • NATA noncancer impacts included in OAR's CenRANK, OECA's EJSEAT, and some Regional screening tools.		
Air Toxics Neurological Hazard Index: Ratio of exposure concentration to RfC	• EJ studies of HAPs include Morello-Frosch and Jesdale (2005); Liu (2001); and Maantay et al. (2010). • NATA noncancer impacts included in OAR's CenRANK, OECA's EJSEAT, and some Regional screening tools.		
Diesel Particulate Matter (DPM): ($\mu g/m^3$)	• DPM included in NATA.	Potential Exposure	
Fine Particulate Matter ($PM_{2.5}$): Annual average ($\mu g/m^3$)	• EJ studies of $PM_{2.5}$ include Liu (2001); Fann et al. (2011); Post et al. (2011); Miranda et al. (2011); and Levy et al. (2007). • $PM_{2.5}$ included in EJSEAT and CenRANK screening tools.		
Ozone: Summer seasonal average of daily maximum 8-hour concentration in air (ppb)	• EJ studies of ozone include Liu (2001) and Fann et al. (2011). • Ozone included in EJSEAT and CenRANK screening tools.		
Lead Paint Indicator: Percentage of housing units built before 1960	• EJ studies of exposure to lead paint include Liu (2001).		Dust/ Lead Paint
Traffic Proximity and Volume: Count of vehicles (average annual daily traffic) at major roads within 500 meters, divided by distance in km	• EJ studies of proximity to traffic include Liu (2001) and Maantay et al. (2010). • The California EJ screening method considers proximity to transportation infrastructure.	Proximity/ Quantity	Air/ Other
Proximity to RMP Facilities: Count of facilities within 5 km, weighted by inverse distance	• EJ studies of proximity to various types of sites and the possibility or frequency of chemical accidents include Liu (2001) and Maantay et al. (2010). • EJ screening tools have included measures of proximity to various industrial sites.		Waste/ Water/ Air
Proximity to TSDF Facilities Count of major TSDF facilities within 5 km, weighted by	• Issues around EJ and TSDFs influenced the early origins of EJ work (GAO, 1983; UCC, 1987) and have been the topic of ongoing research (Oakes et al., 1996; Boer et al., 1997; Been and Gupta, 1997; Pastor et al., 2001; Saha and Mohai, 2005; Mohai and Saha, 2007; UCC, 2007).		

Indicator	Rationale for Inclusion	Place on the Exposure–Risk Continuum	Key Medium
inverse distance	• EJ screening tools have included measures of proximity to hazardous waste sites.		
Proximity to Superfund Sites: Count of NPL facilities within 5 km, weighted by inverse distance	• Studies on disparities in Superfund sites include Liu (2001) and Maantay et al. (2010). • EJ screening tools have included measures of proximity to Superfund sites.		
Proximity to Major Water Dischargers: Count of NPDES major facilities within 5 km, weighted by inverse distance	• EJ studies of proximity to water dischargers include Liu (2001) and Maantay et al. (2010). • Some EJ screening tools have had indicators related to potential water quality concerns.		Water

Abbreviations: HAP = Hazardous Air Pollutant; NATA = National Air Toxics Assessment; NPL = National Priority List; NPDES = National Pollutant Discharge Elimination System; OAR = EPA's Office of Air and Radiation; OECA = EPA's Office of Enforcement and Compliance Assurance; RMP = Risk Management Plan; TSDF = Treatment, Storage, and Disposal Facilities.