ATTACHMENT J

Blum Collins LLP FEIR Letter 5-31-16

BLUM | COLLINS LLP

Aon Center
707 Wilshire Boulevard
Suite 4880
Los Angeles, California
90017

213.572.0400 phone
213.572.0401 fax

May 31, 2016

Matthew C. Bassi, Planning Director
Planning Department
City of Wildomar
23873 Clinton Keith Rd., Suite 201
Wildomar, CA 92595
mbassi@cityofwildomar.org

Via Email & U.S. Mail

Re: *Comments on Baxter Village Mixed Use DEIR and FEIR*

Dear Mr. Bassi and the City of Wildomar:

While we already sent you a comment letter, CEQA allows us to provide comments until the agency's final determination on a project. This is to follow up further on our comments regarding the Baxter Village Mixed Use Draft Environmental Impact Report ("DEIR") and Final Environmental Impact Report ("FEIR").

Regarding your health risk assessment ("HRA"), which is relevant not only to Air Quality but also to Land Use because it affects your General Plan consistency, *see* General Plan, Policy LU 10.2 ("Ensure adequate separation between pollution-producing activities and sensitive emission receptors, such as hospitals, residences, and schools"), we note it fails to address the particular acute, carcinogenic, and long-term developmental effects upon unborn infants, infants, and children. Please see as **Attachment A hereto** an EPA document regarding assessing these risks. OEHHA guidance requires that HRAs be conducted *outdoors, without the benefit of air filters, which almost certainly would have led to a cancer risk of over 10 in a million for the general population.* The HRA and DEIR should be revised to address these impacts and then recirculated.

We also note that Health Risk Assessments are not based on the scientific method because the scientific method requires one to (1) define a theory, (2) define an experiment to test the theory, and (3) compare the theory with the data from the experiment to validate or reject the theory. An HRA lacks the last two steps. The testing here will be done on the residents of the homes and apartment buildings although the data will never be gathered.

Regarding the Project's emission of criteria pollutants, you claimed in the DEIR that the emissions of NO_x would be reduced to less than significant levels by reduced energy

consumption but as stated in footnote 1 it was allegedly reduced emissions due to the mixed use nature of the Project upon which you were relying. The DEIR should have included the assumptions that went into this alleged reduction: you should have included the assumptions regarding truck and car emissions that went into both Tables 4.3.K and 4.3.M. This requires recirculation.

Regarding Biological Resources, we reiterate our concern that the surveys for the burrowing owl should be conducted closer in time to ground disturbance based on Appendix D, page 29 of the CDFW Staff Report on Burrowing Owl Mitigation. Also, on the same page of that Staff Report it says that one survey is not adequate to assure owls are not present: "failure to locate burrowing owls during one field season does not constitute evidence that the site is no longer occupied, particularly if adverse conditions influenced the survey results."

Concerning Mitigation Measure 4.4.6.3A, we believe you have failed to assure in perpetuity mitigation because the provision allows for "land acquired for purposes of in perpetuity mitigation *or* through purchase of mitigation credits *or* within an agency-accepted offsite permitee-responsible mitigation area."

Regarding Greenhouse Gas Emissions, you rely on a South Coast Air Quality Management District threshold for emissions per service population. This was a draft, unapproved threshold and it is inappropriate to rely upon it under Guidelines §15064.4(b)(3). The draft threshold is not based on substantial evidence because it includes both residents of the State of California and employees working in California, which is double-counting. It was inappropriate and not based on substantial evidence for you to include employees and customers and vendors in the service population. We also disagree with your conclusion that the Project would not conflict with any plan, policy or regulation adopted to reduce the emissions of greenhouse gases, regarding (1) SCAG's Regional Comprehensive Plan, (2) SCAG's RTP/SCS, and (3) the County of Riverside's Draft Climate Action Plan, which you omitted to mention entirely. A copy for the record is included as **Attachment C hereto**.

On Land Use, we have some additional comments regarding the Project's lack of consistency. Specifically, the Project is inconsistent with Land Use Policies LU 7.3 ("Promote the development of focused employment centers rather than inefficient strip commercial development"), LU 7.10 ("Locate job centers so that they have convenient access to the County's multi-modal transportation facilities,") LU 7.12 ("Improve the relationship and ratio between jobs and housing so that residents have an opportunity to live and work within the County"), LU 10.1 ("Provide sufficient commercial and industrial development opportunities in order to increase local employment levels and thereby minimize long-distance commuting"), LU 10.2 ("Ensure adequate separation between pollution-producing activities and sensitive emission receptors, such as hospitals, residences, and schools"), LU 10.4 ("Provide options to the automobile in communities, such as transit, bicycle and pedestrian trails, to help improve air quality"), LU 12.1 ("Provide land use arrangements that reduce reliance on the automobile and improve opportunities for pedestrian, bicycle and transit use in order to minimize

congestion and air pollution"), LU 12.2 ("Locate employment and service uses in areas that are easily accessible to existing and planned transportation facilities"), LU 12.3 ("Locate transit stations in community centers and at places of public, employment, entertainment, recreation, and residential concentrations"), LU 13.1 ("Preserve and protect outstanding scenic vistas and visual features for the enjoyment of the traveling public").

We also note that your General Plan is internally inconsistent where it purports to designate specific densities for areas designated Mixed Use Planning Area ("MUPA"), and the City is violating its provisions regarding MUPAs in its proposed actions on the Project. From what we can tell, this was done in the Housing Element, and we submit that action was invalid. The Riverside County General Plan adopted as Wildomar's specifically provided that the MUPA designation "is applied to areas outside Community Centers. The intent of this designation is not to identify a particular mixture or intensity of land uses, but to designate areas where a mixture of residential, commercial, office, entertainment, educational, and/or recreational uses, or other uses is planned." *See* General Plan, Table LU 4 – Land Use Designations Summary. The General Plan provides that "In order for Community Center designation to be considered [in lieu of MUPA], the project proponent is required to file a specific plan or specific plan amendment, wherein issues relating to density, traffic, provision of transit services, compatibility with other nearby land uses, fiscal impacts and other issues relating to the viability of the Community Center proposal are addressed and resolved." General Plan at LU-66. The City has ignored this provision regarding this Project, and that its purported adoption of specific densities for MUPAs is invalid.

In that respect, because no specific plan was developed here, the proposed actions also violate Policy LU 23.8, "Allow mixed use projects to develop in commercially designated areas in accordance with the Community Center Land Use Designation with special consideration of impacts to adjacent uses."

Regarding transit service, Policies including LU 23.5 require actual provision of transit service, not merely "fair share" payments toward potential future transit stops.

Regarding Transportation and Traffic, we stated before that you assumed 2850 trips due to internal capture, which is over 2 trips per day per resident. You responded that this was due not just to internal capture but to "pass-by reductions." As near as we can tell, "pass-by reductions" amount to the same thing: trips by residents, either at the beginning or end of the day. The estimate is excessive.

We dispute the propriety of your using 2013 traffic counts just because your original Notice of Preparation was in 2013. Clearly, in a County anticipated to double in population by 2020, it is not representative now.

Regarding both Hydrology and Water Quality and Public Utilities, you mentioned three things in your FEIR that require recirculation: (1) EVMWD's Contingency Plan and the fact that we are in a stage 4a drought, (2) that DWR has designated Elsinore Basin as

high priority for a Groundwater Management Plan, and (3) regarding imported water supply, DWR projections in 2010 said exports could be reduced 150 to 200 thousand acre feet "under mean hydrologic conditions," which still do not apply in Southern California.

As we noted in an earlier comment letter sent to you but not included with the FEIR, you failed to discuss Governor Brown's Executive Order B-29-15 and its mandate of 25% reduced water use statewide and in particular its prohibition on the use of potable water for outdoor irrigation for new construction other than by drip or microspray methods. This Executive Order was extended by other Executive Orders issued by the Governor in November of last year, Executive Order B-36-15, and Executive Order B-37-16, from May of this year (**Attachment B hereto**). The DEIR indicates the Project will use drip but not microspray methods. DEIR at 4.10-16.

Concerning Energy Consumption, you concede that Table 5.C in the DEIR is flawed, which you attribute to a "calculation error." In fact, your Revised Table 5.C in the FEIR comes up with completely different, dramatically higher numbers, which you attempt to obscure by showing daily fuel consumption rather than annual consumption. The fact that the Project will lead to the consumption of 1.5 million gallons of fuel annually, as opposed to 133, 491, is a significant impact which requires recirculation.

Relating to your Alternatives Analysis, we have the additional comment that your "No Project" Alternative's analysis is *contrary* to what is allowed under a MUPA designation, for the reasons we have addressed earlier in this letter.

Thank you for your consideration.

Sincerely,

Craig M. Collins

attachments: A-C

EPA/600/R-05/093F
September 2006

A Framework for Assessing Health Risks of Environmental Exposures to Children

National Center for Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC

DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Preferred Citation:
U.S. Environmental Protection Agency (EPA). (2006) A framework for assessing health risks of environmental exposures to children. National Center for Environmental Assessment, Washington, DC; EPA/600/R-05/093F. Available from the National Technical Information Service, Springfield, VA, and online at http://www.epa.gov/ncea.

CONTENTS

LIST OF TABLES vi
LIST OF FIGURES vii
LIST OF ABBREVIATIONS AND ACRONYMS viii
PREFACE ix
AUTHORS, CONTRIBUTORS, AND REVIEWERS xii

1. EXECUTIVE SUMMARY 1-1

2. INTRODUCTION AND PURPOSE 2-1

3. LIFESTAGE-SPECIFIC PROBLEM FORMULATION 3-1
3.1. PLANNING AND SCOPING 3-1
3.2. CONCEPTUAL MODEL 3-5
3.2.1. Exposure Considerations 3-5
3.2.2. Outcome Considerations 3-8
3.2.3. Integrating Exposure and Outcome Considerations 3-9
3.3. ANALYSIS PLAN 3-10

4. LIFESTAGE-SPECIFIC ANALYSIS 4-1
4.1. LIFESTAGE-SPECIFIC HAZARD CHARACTERIZATION 4-2
4.1.1. Introduction 4-2
4.1.2. Qualitative Evaluation of Individual Studies 4-3
4.1.2.1. Study Purpose 4-5
4.1.2.2. Study Design 4-5
4.1.2.3. Identifying Critical Windows of Exposures 4-6
4.1.2.4. Outcomes Related to Developmental Lifestage Exposure 4-6
4.1.2.5. Toxicokinetic Data 4-7
4.1.2.6. Toxicodynamic Data 4-7
4.1.2.7. Mode of Action Information 4-8
4.1.2.8. Qualitative Evaluation of Dose-Response 4-8
4.1.2.9. Variability Analysis 4-9
4.1.2.10. Uncertainty Analysis 4-10
4.1.3. Summarization of the Hazard Database 4-12
4.1.3.1. Evaluation of the Weight-of-Evidence of the Hazard Database 4-13
4.1.3.1.1. Temporality 4-14
4.1.3.1.2. Strength of the association 4-15
4.1.3.1.2.1. Variability analysis 4-16
4.1.3.1.2.2. Uncertainty analysis 4-16
4.1.3.1.3. Qualitative dose-response relationship 4-17
4.1.3.1.4. Experimental evidence 4-18
4.1.3.1.5. Reproducibility 4-18
4.1.3.1.6. Biological plausibility 4-19
4.1.3.1.7. Alternative or multiple explanations 4-20

CONTENTS (continued)

4.1.3.1.8. Specificity 4-20
4.1.3.1.9. Coherence 4-21
4.1.4. Iteration with Dose-Response and Exposure Characterization 4-23
4.1.5. Lifestage-Specific Hazard Characterization Narrative 4-24

4.2. LIFESTAGE-SPECIFIC DOSE-RESPONSE CHARACTERIZATION 4-25
4.2.1. Introduction 4-25
4.2.2. Mode of Action Conceptualization 4-28
4.2.2.1. Summarizing the Available Dose-Response Data 4-28
4.2.2.2. Mechanistic Data and Mode of Action (MOA) 4-30
4.2.2.3. Selection of Dose Metric Informed by MOA 4-30
4.2.3. Analysis in the Range of Observation and Dose-Response Models 4-32
4.2.4. Extrapolations and Risk Derivation from a Lifestage Approach 4-38
4.2.4.1. Duration and Route Adjustments 4-38
4.2.4.2. Interspecies and Intraspecies Adjustments 4-39
4.2.4.3. Low-Dose Extrapolation 4-43
4.2.4.4. Reference and Risk Value Derivation 4-44
4.2.5. Variability Analysis 4-45
4.2.6. Sensitivity Analysis 4-46
4.2.7. Uncertainty Analysis 4-46
4.2.8. Iteration with Hazard and Exposure Characterization 4-47
4.2.9. Lifestage-Specific Dose-Response Characterization Narrative 4-48

4.3. LIFESTAGE-SPECIFIC EXPOSURE CHARACTERIZATION 4-48
4.3.1. Introduction 4-48
4.3.2. Evaluation of Available Exposure Data 4-49
4.3.2.1. Chemical Properties, Environmental Sources, Fate, and Transport 4-54
4.3.2.2. Environmental Media Concentrations 4-55
4.3.2.3. Lifestage-Specific Exposure Measurement Data 4-55
4.3.2.4. Lifestage-Specific Exposure Factors 4-57
4.3.2.5. Cumulative Evaluation of Environmental Stressors 4-59
4.3.3. Lifestage-Specific Exposure Analysis 4-60
4.3.3.1. Exposure Measurement and Estimation Approach 4-61
4.3.3.2. Analysis Level or Tiered Assessment 4-62
4.3.3.2.1. Screening assessment 4-63
4.3.3.2.2. Refined assessment 4-64
4.3.3.2.3. Supplemental data collection 4-65
4.3.4. Variability Analysis 4-66
4.3.5. Sensitivity Analysis 4-67
4.3.6. Uncertainty Analysis 4-67
4.3.7. Iteration with Hazard and Dose-Response Characterization 4-68
4.3.8. Lifestage-Specific Exposure Characterization Narrative 4-69

CONTENTS (continued)

5. LIFESTAGE-SPECIFIC RISK CHARACTERIZATION 5-1
5.1. LIFESTAGE-SPECIFIC RISK CHARACTERIZATION SUMMARY 5-3
5.1.1. Key Information from the Analysis Phase 5-3
5.1.2. Scientific Assumptions 5-4
5.1.3. Risk Drivers 5-4
5.1.4. Strengths and Weaknesses 5-4
5.1.4.1. Variability 5-5
5.1.4.2. Sensitivity 5-5
5.1.4.3. Uncertainty 5-6
5.1.5. Key Conclusions 5-6
5.1.6. Alternative Risk Estimates Considered 5-7
5.1.7. Research Needs 5-7
5.2. RISK CONTEXT 5-8

6. SUMMARY AND IDENTIFICATION OF GAPS IN APPROACHES FOR CHILDREN'S HEALTH RISK ASSESSMENT 6-1

GLOSSARY G-1

REFERENCES R-1

LIST OF TABLES

3-1. Developmental lifestages and age groups for exposure assessments 3-7

3-2. Lifestage-specific database inventory sheet..... 3-11

4-1. Examples of lifestage-specific questions for evaluation of individual studies within hazard characterization 4-11

4-2. Examples of lifestage-specific questions for evaluation of the WOE of the hazard database 4-21

4-3. Examples of lifestage-specific questions for MOA conceptualization..... 4-31

4-4. Examples of lifestage-specific questions for analysis in the range of observation..... 4-38

4-5. Examples of lifestage-specific questions for extrapolations and risk derivation..... 4-45

4-6. Examples of lifestage-specific questions for dose-response variability, sensitivity, and uncertainty analyses..... 4-47

4-7. Examples of lifestage-specific questions for scenario development 4-53

4-8. Examples of lifestage-specific questions for evaluation of the available exposure data 4-59

4-9. Examples of lifestage-specific questions for exposure analysis level or tiered assessment 4-65

4-10. Examples of lifestage-specific questions for exposure variability, sensitivity, and uncertainty analyses 4-68

LIST OF FIGURES

2-1. Flow diagram for a lifestage-specific risk assessment framework 2-2

2-2. Lifestages of outcomes after developmental exposure 2-4

3-1. Flow diagrams for lifestage-specific problem formulation 3-2

4-1. Exposure to risk continuum 4-1

4-2. Flow diagram for lifestage-specific analysis 4-2

4-3. Flow diagram for lifestage-specific hazard characterization 4-4

4-4. Conceptual view of a WOE evaluation 4-14

4-5. Flow diagram for lifestage-specific dose-response characterization 4-26

4-6. Use of BBDR modeling 4-37

4-7. Interspecies and intraspecies adjustments with lifestage considerations 4-41

4-8. Flow diagram for lifestage-specific exposure characterization 4-50

4-9. Exposure routes during developmental lifestages 4-52

5-1. Flow diagram for lifestage-specific risk characterization 5-1

LIST OF ABBREVIATIONS AND ACRONYMS

ADAF	Age-dependent adjustment factors
AUC	Area under the curve
BBDR	Biologically based dose-response
BMD	Benchmark dose
BMDL	Benchmark dose lower confidence level
CAA	Clean Air Act
CatReg	Categorical regression
C_{max}	Maximum concentration
CHAD	Consolidated Human Activity Database
CSF	Cancer slope factor
CYP	Cytochrome P450
DAF	Dosimetric adjustment factor
EPA	U. S. Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FQPA	Food Quality Protection Act
GLP	Good laboratory practice
HEC	Human equivalent concentration
HED	Human equivalent dose
HEDS	Human Exposure Database System
LOAEL	Lowest-observed-adverse-effect level
MOA	Mode of action
MOE	Margin of exposure
NHEXAS	National Human Exposure Assessment Survey
NOAEL	No-observed-adverse-effect level
PBTK	Physiologically based toxicokinetic
POD	Point of departure
QRE	Quantitative risk estimation
RfC	Reference concentration
RfD	Reference dose
RfV	Reference value
SAR	Structure-activity relationship
TD	Toxicodynamic
TK	Toxicokinetic
TSCA	Toxic Substances Control Act
UF	Uncertainty factor
V_{max}	Maximum velocity
WOE	Weight-of-evidence

PREFACE

The mission of the U.S. Environmental Protection Agency (EPA) is to protect human health and the environment. In the early 1990s, the National Research Council (NRC) released a watershed report, *Pesticides in the Diets of Infants and Children*, regarding evaluation of risk to environmental exposures (NRC, 1993). Increased emphasis on protecting children from environmental exposures has evolved since this report due to mounting scientific evidence to support the vulnerability of the developing fetus and child. Legislative and administrative mandates have been enacted since this NRC report. In 1995, the EPA Administrator issued *Policy on Evaluating Health Risks to Children* (U.S. EPA, 1995a), which states that EPA will consider risks to infants and children consistently and explicitly as a part of risk assessments generated during its decision-making process, including the setting of standards to protect public health and the environment. Subsequent provisions in the Food Quality Protection Act (FQPA) (U.S. 104th Congress, 1996a) and the Safe Drinking Water Act (SDWA) Amendments (U.S. 104th Congress, 1996b) underscored this policy by focusing on the evaluation of children's exposures and toxicities in the context of risk assessment. Evaluation of environmental risks to children is an implicit consideration in human health risk assessment in other EPA legislative mandates (Clean Air Act [CAA] [U.S. 101st Congress, 1990]; Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] [U.S. 96th Congress, 1980], Toxic Substances Control Act [TSCA] [U.S. 94th Congress, 1976], Federal Insecticide, Fungicide, and Rodenticide Act [FIFRA] [U.S.104th Congress, 1996c]). In 1997, Presidential Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (Executive Order, 1997), gave further emphasis to the need for establishing potential risks from environmental exposures during childhood. The EPA subsequently published *Strategy for Research on Environmental Risks to Children* in 2000 (U.S. EPA, 2000f).

EPA risk assessment guidelines relevant to children's health issues have been published (U.S. EPA, 1991, 1996, 1998b, 2002a, 2005a,b,e), and other guidelines, policies, and recommendations are under development (U.S. EPA, 2002c). Implementation of the FQPA and the SDWA amendments required additional development of guidance and policy for protecting children's health. In response, the application of the FQPA 10-fold safety factor was discussed in the *Determination of the Appropriate FQPA Safety Factors(s) in Tolerance Assessment* (U.S. EPA, 2002d). Thus, there are a number of guidelines and policies related to children's health,

but no single, comprehensive document that can serve as a resource of information on children's health risk assessment.

In 1999, a draft report that collected information on current EPA guidance and practices was developed for the Office of Children's Health Protection (ICF Consulting, 1999). This report was a compendium of information on child-related risk assessment policy and methodology guidance at the time. This Framework document builds on that report and others referred to above by updating the information and linking to reference documents and other published information that can be used as a resource for those interested in children's health risk assessment.

Another major effort sponsored by EPA and others that serves as background for this document was a workshop held in Stowe, VT, July 30–August 2, 2001, organized by the International Life Sciences Institute (ILSI). The report of that workshop (ILSI, 2003) and subsequent publications (Daston et al., 2004; Ginsberg et al., 2004c; Landrigan et al., 2004; Morford et al., 2004; Olin and Sonawane, 2003) proposed a framework for children's exposures and health risk assessment and laid out a number of issues of concern. The Framework presented in this document builds on the efforts of the experts and participants at that workshop.

Parallel activities have been or are being developed at other agencies such as the U.S. Food and Drug Administration (FDA), which regulates pharmaceuticals, medical devices, biologics, food, animal feed and drugs, cosmetics, radiation-emitting devices, and combination products. For example, under the Best Pharmaceuticals for Children Act (U.S. FDA, 2002), an amendment to Section 11 of the Food and Drug Modernization Act (U.S. FDA, 1997), FDA's Office of Pediatric Therapeutics coordinates and facilitates all activities affecting the pediatric population, the practice of pediatrics, or pediatric issues within the FDA. Assessment of risks and benefits to children is conducted in compliance with the Pediatric Research Equity Act (U.S. 108th Congress, 2003), which requires that all applications for new active ingredients indications, dosage forms, dosing regimens, and routes of administration contain a pediatric assessment unless a waiver or deferral has been granted. Although the draft guidance document *Guidance for Industry - How to Comply with the Pediatric Research Equity Act* (U.S. FDA, 2005) may apply specifically to pharmaceutical testing and regulation, there can be significant overlap with assessments conducted to determine risk to children from environmental exposures. For example, *Guidance to Industry – Nonclinical Safety Evaluation of Pediatric Drug Products* (U.S.

FDA, 2006) addresses considerations on the evaluation of pharmaceuticals in juveniles, one of the lifestages discussed in this Framework.

Additionally, the International Programme for Chemical Safety of the World Health Organization recently developed a draft Environmental Health Criteria document entitled *Principles for Evaluating Health Risks Associated with Chemical Exposures to Children*. This EHC draft document serves as useful background information for using this EPA Framework.

Finally, EPA's Risk Assessment Forum has been working for several years to harmonize approaches to cancer and noncancer risk assessment (U.S. EPA, 1997c, 1998c). Efforts to develop a framework for a harmonized approach to human health risk assessment are underway, and the intent is for this Framework on health risks from environmental exposures to children to be incorporated into the overall framework.

AUTHORS, CONTRIBUTORS, AND REVIEWERS

AUTHORS

Stan Barone Jr., National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Rebecca C. Brown, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Susan Y. Euling, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Elaine Cohen Hubal, National Center for Computational Toxicology, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, NC.

Carole A. Kimmel, formerly of National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Susan Makris, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Hisham El-Masri, National Health and Environmental Effects Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, NC.

Jacqueline Moya, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Sherry G. Selevan, formerly of National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Babasaheb R. Sonawane, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Tracey Thomas, formerly of American Association for the Advancement of Science Fellow, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

Chad Thompson, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC.

INVITED INTERNAL AGENCY PANEL REVIEWERS

***Framework for Children's Health Risk Assessment (CHRA)*[1] and Harmonization of Human Health Risk Assessment Colloquium, October 5-6, 2004, Arlington, VA**

Hugh Barton, ORD, NCCT
Jerry Blancato, ORD, NCCT
Vicki Dellarco, OPPTS, OPP, HED

[1] *Framework for Children's Health Risk Assessment* was the previous title of this document.

Elizabeth Doyle, OW, OST, HECD
Brenda Foos Perkovich, OA, OCHP
Greg Miller, OA, NCEE, OPEI
Deirdre Murphy, OAR, OAQPS, ESD
Marian Olsen, Region 2
Jennifer Seed, OPPTS, OPPT, RAD
Linda Sheldon, ORD, NERL, HEASD
Daniel Stralka, Region 9
Vanessa Vu, OA, SAB

ADDITIONAL INTERNAL AGENCY REVIEWERS

Thomas Bateson, ORD, NCEA
Ila Cote, ORD, NCEA
Michael Firestone, OA, OCHP
Matt Heberling, ORD, NCEA
Sarah Levinson, Region 1
Kelly Maguire, OA, NCEE, OPEI
Lanelle Wiggins, OA, NCEE, OPEI
Tracey Woodruff, OA, NCEE, OPEI
William Wood, ORD, NCEA

INTERNAL AGENCY REVIEW PROJECT OFFICER

Marilyn Brower, formerly RAF

EXTERNAL PEER PANEL REVIEWERS

External Peer Review Workshop for *Draft Framework for Assessing Health Risks of Environmental Exposures to Children,* June 6–7, 2006, Washington, DC

James V. Bruckner, College of Pharmacy, University of Georgia, Athens, GA
Gary Ginsberg, Connecticut Department of Public Health, Hartford, CT
Lynn R. Goldman,[2] Johns Hopkins Bloomberg School of Public Health, Baltimore, MD
Melanie Marty, California Environmental Protection Agency, Oakland, CA
P. Barry Ryan, Rollins School of Public Health, Emory University, Atlanta, GA
Robin Whyatt, Columbia University School of Public Health, New York, NY

PUBLIC COMMENTERS

Richard A. Becker, American Chemistry Council, Arlington, VA
Shannon Cunniff, Department of Defense, Arlington, VA
Maxene R. Dwyer and Allison Jenkins, Tetra Tech EM Inc., Houston, TX
B. Sachau, Florham Park, NJ
Scott Slaughter, Center for Regulatory Effectiveness, Washington, DC

[2] Chair of the external peer review panel.

EXTERNAL AGENCY REVIEW PROJECT OFFICER

Stan Barone Jr., ORD, NCEA

ACKNOWLEDGEMENTS

Jonathan Francis, formerly ORD, NCEA
Elizabeth Fryer, ECFlex, Contractor to NCEA-Cin
Terri Konoza, ORD, NCEA
Lana Wood, ECFlex, Contractor to NCEA-Cin
Bette Zwayer, ORD, NCEA-Cin

1. EXECUTIVE SUMMARY

The purpose of this document is to provide an overarching framework for a more complete assessment of children's exposure to environmental agents and the resulting potential health risks within the U.S. Environmental Protection Agency's (EPA's) risk assessment paradigm. This Framework examines the impact of potential exposures during developmental lifestages and subsequent lifestages, while emphasizing the iterative nature of the analysis phase with a multidisciplinary team. In addition to outlining the risk assessment process from a lifestage perspective, the document points to published sources for more detailed information. Guidance, policies, and other relevant materials are referenced in the document and linked electronically (when copyright allows) to the actual reference documents for easy access. In addition, many terms are included in a glossary at the end of this document. This Framework is a conceptual overview of the considerations for evaluation of early-life exposures and subsequent outcomes and does not constitute EPA guidance defined as a step-by-step process or standard operating procedure.

The term "children" as used in this document is shorthand to include the stages of development from conception through adolescence. EPA is concerned about health risks that result from exposure to all lifestages; however, this document focuses on preconceptional exposure and exposure throughout development to adulthood. *Developmental exposure* is used throughout this document to define developmental lifestage exposures (preconception through adolescence). Health risks may be identified during the same lifestage as when the exposure occurred, or they may not become apparent until much later in life.

Lifestages are defined in this document as temporal stages of life that have distinct anatomical, physiological, and behavioral or functional characteristics that contribute to potential differences in vulnerability to environmental exposures. A lifestage approach to risk assessment considers the relevant periods of exposure in developmental lifestages and subsequent outcomes that may not be expressed until later lifestages. This approach explicitly considers existing data as well as data gaps for both exposure and health outcomes at various lifestages.

Information on mode(s) of action (MOA) that may inform lifestages is another main emphasis of this approach. Risk assessment using a lifestage approach is a shift in perspective

from the current methodology that focuses primarily on adults, and then, secondarily, looks for information that may suggest greater susceptibility from exposures at other lifestages.

The added value of using a lifestage approach to risk assessment is a more comprehensive evaluation of the potential for vulnerability of the population at various lifestages. Children may be more or less vulnerable than adults, but without data on exposure and response and without systematic evaluation of these data, determining which lifestage may be more vulnerable is challenging. The approach outlined here encourages evaluation of the potential for toxicity and any adverse health outcomes during all developmental lifestages, based on knowledge of external exposure, critical windows of development for different organ systems, MOAs, anatomy, physiology, and behavior that can affect external exposure and internal dose metrics (units of measurement for dose). The use of MOA information is integral to this Framework and is employed in a consistent manner to the *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005a) and the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (2005b). The MOA information is extended to the evaluation of all outcomes.

It is important to consider whether anything known about developmental lifestages would indicate particular vulnerability and incorporate that information into an assessment. This framework addresses the difficult issue of integrating toxicity data and exposure information, which is especially challenging when data are limited for particular lifestages (e.g., pregnancy and early childhood development).

The conceptual framework used in this document follows the basic components developed for other areas of risk assessment (U.S. EPA, 1997a, 1998a, 2003a) and includes problem formulation, analysis, and risk characterization as the three major phases in the process. Within this structure, questions for consideration in the process of scoping the problem to be addressed, reviewing the toxicity and exposure data, and characterizing the risks are posed as a way of prompting and refining the assessment process. Gaps in guidance needed for various aspects of assessing risk from children's exposure are also discussed. In particular, guidance is lacking for lifestage-specific evaluation of several system- and disease-specific areas, related biomarkers and outcomes, MOA(s), dose-response assessment, and exposure assessment. Also, guidance on the use of specific developmental or latent outcomes for application to risk assessments for various timing (exposure windows) and durations of exposure has not been

defined even though this issue is considered in many of the risk assessments currently being generated across EPA. Implementation of this Framework will necessitate development of guidance for children's health risk assessment.

2. INTRODUCTION AND PURPOSE

The purpose of this document is to provide an overarching framework for a more complete assessment of children's exposure to environmental agents and the resulting potential health risks. The term "children" as used in this document is shorthand to include the stages of development from conception through adolescence. EPA is concerned about health risks that result from exposure to all lifestages; however, this document focuses on exposures during preconception through adolescence. *Developmental exposure*, as used in this document, means developmental lifestage exposures (preconception through adolescence). Health risks may be identified during the same lifestage as when the exposure occurred, or they may not become apparent until much later in life.

The major encompassing question to be addressed by using this document is, What is the potential risk of environmental exposure during developmental lifestages? This Framework outlines the phases for assessing the risks of exposure to environmental agents during childhood, singly or in combination. This information can be used in various situations, depending on the problem to be addressed. For example, if an overall assessment of health risks is needed, the information on risks from developmental lifestage exposures can be incorporated into the overall assessment. If, on the other hand, the major concern is about health risks to children as a result of environmental exposure, the information derived from this process could be used directly to assess risk, set standards, and mitigate exposures.

In addition to outlining the process of assessing health risks as a result of environmental exposure during childhood, this framework uses existing sources for more detailed information which are referenced and linked to the actual reference documents (when copyright allows). These sources include guidelines, guidance documents, policies, and other relevant published materials that currently exist. This document incorporates this information while focusing on inherent and acquired susceptibility at different lifestages (e.g., children and adults), as well as the potential for greater exposure of environmental agents to children than adults.

The outline of this document follows the basic framework developed for other areas of risk assessment (U.S. EPA, 1997a, 1998a, 2003a) and includes problem formulation, analysis, and risk characterization as the three major phases in the process, each with a focus on lifestages (Figure 2-1, adapted from Daston et al., 2004; Olin and Sonawane, 2003). Each phase of the

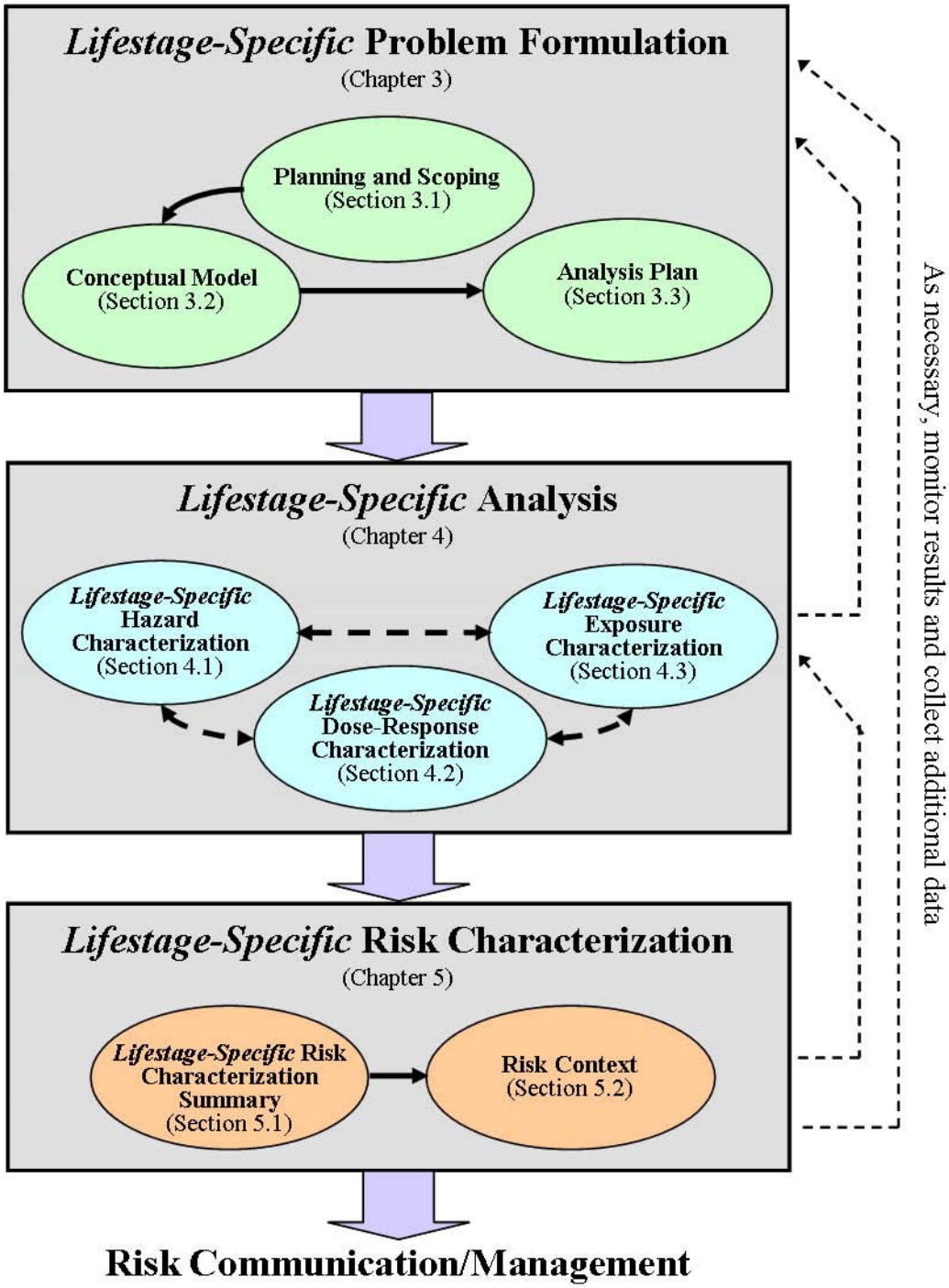


Figure 2-1. Flow diagram for a lifestage-specific risk assessment framework. This diagram presents the framework for lifestage-specific risk assessment used in this document. It is based on a number of documents on children's health risk assessment, including the ILSI workshop (Daston et al., 2004; Olin and Sonawane, 2003). It includes three phases also identified in *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998a) and *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003a).

process raises questions to consider when assessing potential health risks to children from environmental exposure. Assessing potential health risks to children as a result of their environmental exposure to toxicants includes considering risk from exposure before conception, during the prenatal period, and through childhood and adolescence (Figure 2-2). Lifestages are defined in this document as periods of life with distinct anatomical, physiological, and behavioral or functional characteristics that contribute to potential differences in vulnerability to environmental exposures. *Preconception* is any time before conception; the *prenatal* stage includes the embryonic and fetal stages from conception to birth; *infancy* is the period from birth through the first birthday; *child* encompasses all early postnatal lifestages from birth until *adolescence*, which occurs approximately between 12 and 21 years of age (with difference between genders). The continuum between the reproductive-age adult and aged adult begins at approximately 21 years of age and reaches aged adulthood at approximately 65 years. Broad exposure interval categories (e.g., child) are shown in Figure 2-2 for illustration, and divisions between lifestages are not precise (e.g., there is some reproductive age overlap between the adolescent and the adult periods) (U.S. EPA, 2005c, 2002a, Table 3-1). The lifestages from conception through adolescence comprise the period of development; adverse outcomes may occur during that same lifestage or later in life. Neither the outcomes nor the risks from these developmental exposures will necessarily be the same for all lifestages. Rather, the outcomes will depend on the underlying developmental processes that determine susceptibility at the time of exposure. A lifestage approach for evaluating potential risks to children is a hypothesis-driven approach that takes into account all relevant periods of exposure explicitly considering where data do and do not exist for exposure and health outcomes. It focuses attention on considerations of early-life exposure and potential outcomes, which may be latent in their manifestation. This is predicated on considerations of MOA(s) for all lifestages of exposures. MOA is defined in this Framework as the sequence of key events and processes, starting with interaction of a toxic agent with a cell, proceeding through functional and anatomical changes, and resulting in the adverse health outcomes. "A key event is an empirically observable precursor step that is itself a necessary element of the MOA or is a biologically based marker for such an element" (U.S. EPA, 2005a,b). Both toxicokinetic (TK) and toxicodynamic (TD) steps are part of the mechanism and MOA leading to the toxic response (Andersen et al., 2000; Clewell et al., 2002a). As stated in the latest cancer guidelines, "MOA is contrasted with

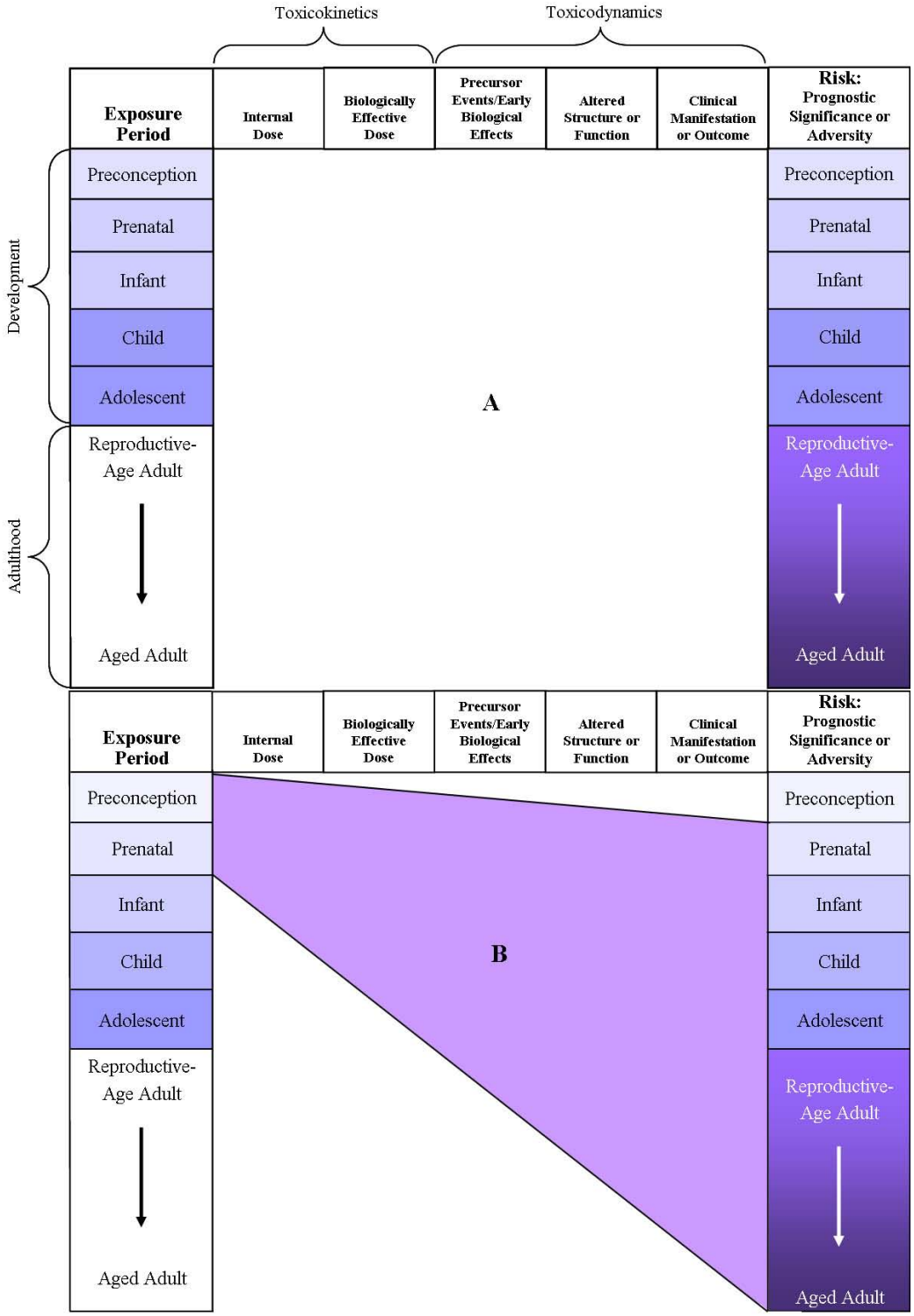
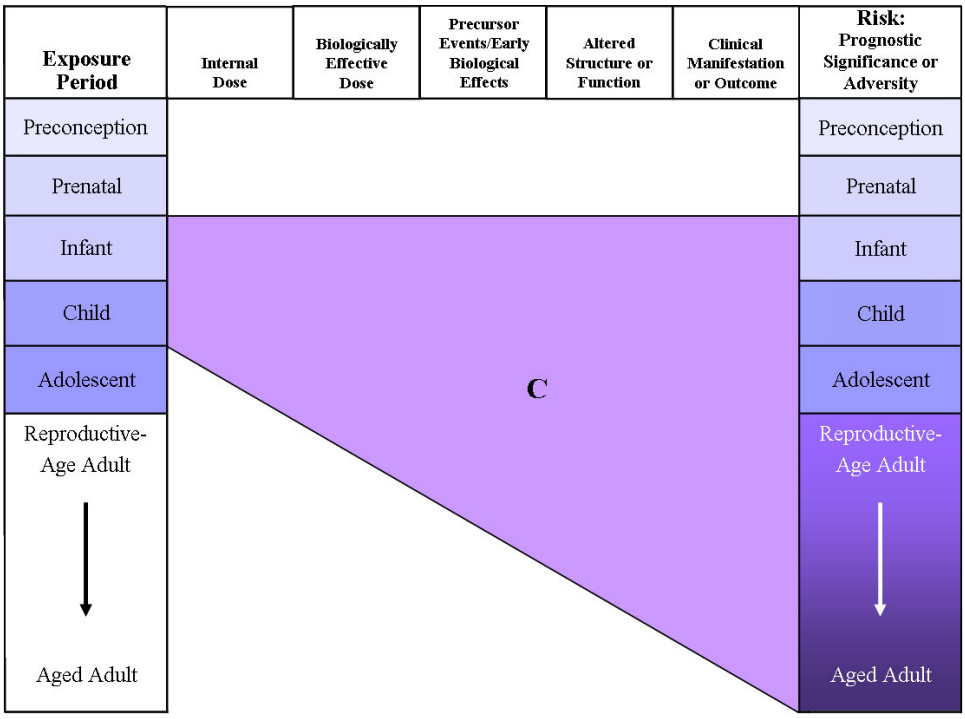
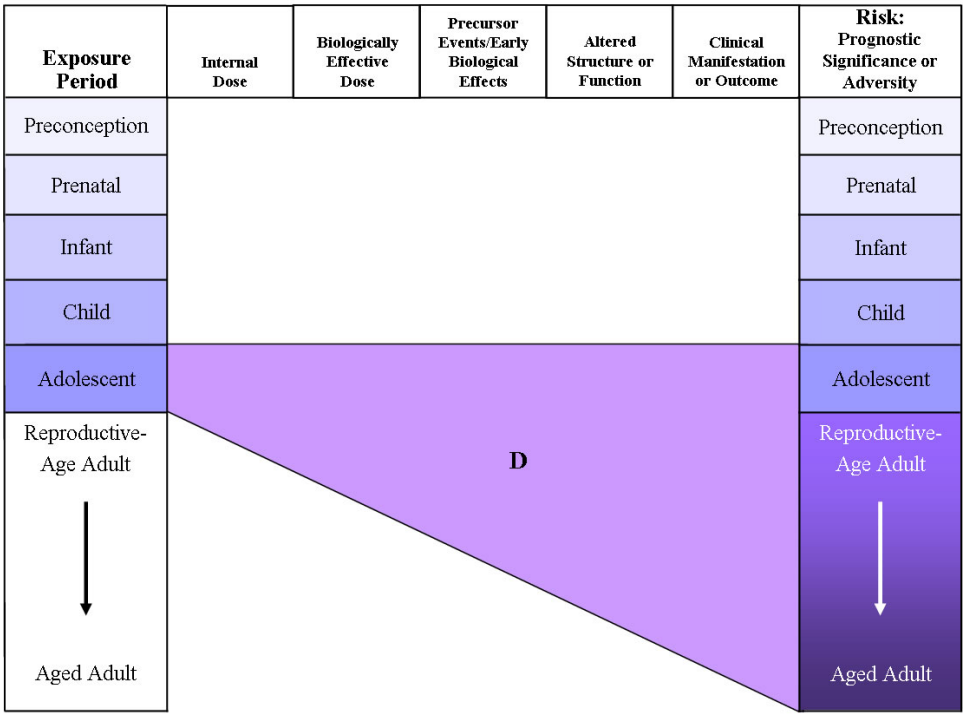


Figure 2-2. Lifestages of outcomes after developmental exposure. Panel A: In this figure, A illustrates the developmental lifestages of exposure considered in this document (shown in the shaded boxes on the left) and lifestages of potential outcomes considered in this document (shown in the shaded boxes on the right). The exposure to risk continuum is discussed across the top of the figure, and expanded upon in Figure 4-1. **Panel B:** Exposure during the preconception and prenatal stages may result in outcomes occurring in any lifestage beginning prenatally.





Panel C: Exposure during infancy and childhood may result in outcomes occurring in any lifestage beginning in infancy. **Panel D:** Exposure during the adolescent stage may result in outcomes occurring in any lifestage beginning in adolescence.

mechanism of action, which implies a more detailed understanding and description of events, often at the molecular level" (U.S. EPA, 2005a,b). Risk assessments may require a more refined definition of exposure intervals (e.g., bins) than the lifestages shown in Figure 2-2 because of rapid changes during development, even within a lifestage. For example, gestational exposure is typically evaluated for each trimester; however, specific periods of vulnerability (also known as critical windows) for particular outcomes might be much shorter period of time as discussed in a series of publications that resulted from an EPA-sponsored workshop (Selevan et al., 2000).

This report synthesizes the information currently available at EPA on assessing health risks as a result of children's exposures and is based in part on existing risk assessment guidelines, guidance, and science policies. Also, areas and topics are identified where further guidance and research is needed. Within this structure, questions to be considered in the process of reviewing data are posed as a way of prompting the data evaluation. This Framework is not a guideline or science policy paper but rather describes an overall vision of the structure, process, and the components considered important for assessing risks as a result of children's exposure. This document intends to provide documentation of the approaches for assessing risk to children. It is not intended to be prescriptive or to define a step-by-step process or standard operating procedure.

The primary intended users of this approach are risk assessors involved in hazard, dose-response, and exposure characterization. The central focus of this Framework is the prenatal stage, infancy, childhood, and adolescence, thus extending and expanding the approach in *Guidelines for Developmental Toxicity Risk Assessment* (U.S. EPA, 1991), which only focuses on prenatal outcomes. The Framework also takes a child-protective approach to assessing risk (Landrigan et al., 2004) by putting the child, rather than an environmental agent, at the focus of the evaluation. Children are not a unique population but rather childhood is a series of lifestages through which all individuals pass; therefore, a child-protective approach is inherently public health-oriented.

The added value of using a lifestage approach to assess risks to children from environmental exposure is a comprehensive evaluation of the potential for vulnerability of various lifestages. In contrast, assessments that use only available chemical-specific data, which are often limited to data from adults, do not necessarily account for the lack of data at other lifestages. The approach outlined here encourages evaluation of the potential for toxicity during

all developmental lifestages, based on what is known about critical windows of development for different organ systems and differences in anatomy, physiology, and behavior that can impact external exposure and internal dose metrics. In developing an assessment, the lack of data for certain lifestages is not meant to imply susceptibility and/or greater uncertainty in the assessment of risk from childhood exposure. Rather, the intent is to consider whether anything is known about lifestages that would indicate particular vulnerability during that stage and incorporate that information into the assessment. This document also addresses the difficult issue of integrating animal toxicity or adverse health outcome data and exposure information relevant for assessing risks to humans. This integration is especially challenging because of data limitations for particular periods during pregnancy and early childhood development. One result of using this framework will be more transparent and scientifically justifiable risk characterizations, while documenting data gaps and identifying priority data needs for children's risk.

The approach outlined here encourages evaluation of the potential for toxicity during all developmental lifestages, based on what is known about critical windows of development for different organ systems, MOAs, anatomy, physiology, and behavior that can affect external exposure and internal dose metrics.

Because of the complex issues to be considered for assessing risks from children's exposures, it is impossible for any one person to be an expert in all areas of this process. Thus, consultation and collaboration with appropriate experts in hazard, dose-response, and exposure assessment is recommended in all phases of the process.

3. LIFESTAGE-SPECIFIC PROBLEM FORMULATION

Problem formulation is a systematic planning phase that defines the problem to be addressed in the assessment. The purpose of a problem formulation phase is to aid in efficiency and transparency of the assessment. A general discussion of problem formulation can be found in the *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003a). The major components of problem formulation are no different whether applied to broad assessment (e.g., National Ambient Air Quality Standards, U.S. EPA, 2005d) of all lifestages of exposure or to a narrow assessment of specific lifestages of exposure (e.g., Superfund site). However, some of the specific considerations are different in a risk assessment for developmental exposures.

The lifestage-specific problem formulation phase establishes the context of the risk assessment and feeds into the lifestage-specific analysis phase (Chapter 4) and ultimately to lifestage-specific risk characterization (Chapter 5). A planning and scoping step (Section 3.1) initially characterizes exposures and outcomes during all developmental lifestages. The problem formulation results in two products. First, a conceptual model (Section 3.2) is developed which considers exposures (e.g., sources, receptors, stressors, pathways, individual characteristics) and outcomes. Second, an analysis plan (Section 3.3) is developed, where preliminary consideration of study methods, dose-response models, data gaps, and uncertainty and variability is used to inform hazard characterization, dose-response characterization, and exposure characterization (Figure 3-1).

These products are then used in the lifestage-specific analysis (Chapter 4), which comprises hazard characterization (Section 4.1), dose-response characterization (Section 4.2), and exposure characterization (Section 4.3). Iteration between each of the three analysis steps may lead to further refinement of the conceptual model and analysis plan.

3.1. PLANNING AND SCOPING

In the planning and scoping step, the assessment goals, breadth, and focus are established, and regulatory and policy factors are identified. This step includes defining and identifying the purpose, scope, participants/stakeholders, approaches, resources, and relevant past assessments available.

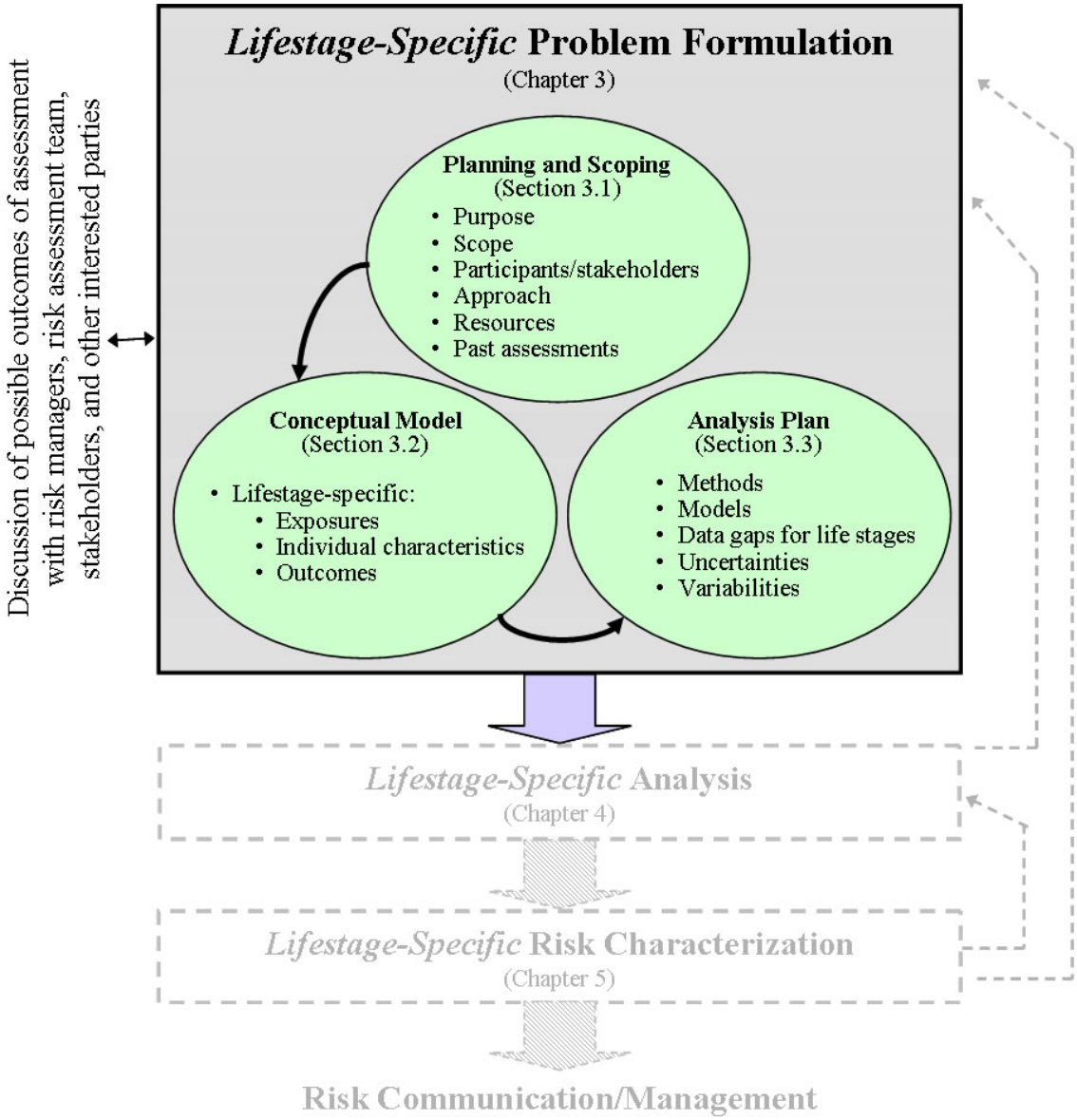


Figure 3-1. Flow diagram for lifestage-specific problem formulation. Problem formulation includes a planning and scoping step that initially characterizes exposures and outcomes during all developmental lifestages, and the development of two products: a conceptual model and an analysis plan.

Source: Adapted from U.S. EPA, 2003a, Figure 1-3.

A clear purpose of the assessment is defined in order to guide the lifestage-specific risk assessment strategy. Risk assessments are often conducted within the context of a regulatory requirement (e.g., CAA, U.S. 101st Congress, 1990; FQPA, U.S. 104th Congress, 1996a; SDWA, b), a community need, a health concern, or some other driving force (U.S. EPA, 2003a), and they require varying levels of scope or depth (U.S. EPA, 2005a, Section 1.2.2). For example, there may be judicial and societal considerations that may influence the timing and breadth of the assessment (e.g., consent agreement on soil contamination for a site-specific cleanup). These factors may influence the risk management options, management goals, key participants, data sources, selection of assessment outcomes, or the schedule for developing the assessment. The risk management and assessment planning teams need to develop dialogue on the regulatory basis for the risk assessment and determine what kind of information is needed to satisfy such requirements.

The scope sets the parameters of the assessment, allowing for decisions to include or exclude various elements. Screening level analyses of hazard and exposure may help refine the scope of the assessment. The scope can be narrow (e.g., at a site where soil screening levels are developed with lifestage-specific data) or broad (e.g., national rule-making, tolerance setting), depending upon the problem. Age-specific information on factors related to exposure and response are considered in the analysis plan (Section 3.3).

Choosing the appropriate participants for problem formulation will depend on the problem being addressed. The participants who have information, expertise, or a stake in the assessment process and conclusion(s) of the assessment are identified in this planning and scoping step. Stakeholders are broadly defined as the interested parties who are concerned with the decisions made about how a risk may be avoided, mitigated, or eliminated, and as those who may be affected by regulatory decisions. This process can include specialized expertise and a basic understanding of critical windows of exposure and optimum timing for evaluating outcomes. The risk assessment team (which may include epidemiologists, toxicologists, public health specialists, child behavior specialists, exposure assessors, chemists, and other technical experts) and the risk management team (which may include economists, policy analysts, engineers, and public health specialists) work together, informed by stakeholder input (which may include parents, pediatricians, community groups, non-governmental organizations, etc.) to develop the rationale, scope, and relevant outputs for the risk assessment and characterization

(U.S. EPA, 2001a). The conceptual model and analysis plan, including the possible outputs of the assessment, may require negotiation among the members of the risk assessment team. The *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003a, p. 21) provides guidelines for stakeholder involvement, which are based on the recommendations in *Science and Judgment in Risk Assessment* (NRC, 1994) and by the Presidential/Congressional Commission on Risk Assessment and Risk Management (1997a,b).

Methods used for risk assessment of health outcomes can have an impact on the economic evaluation in benefits analysis (Griffiths et al., 2002; U.S. EPA, 2000a, 2003b, 2005e) (Section 5.1.7). Bringing economists into the discussion at the problem formulation stage will help clarify the approaches needed for data evaluation and quantification that may be most useful for assessing benefits. Another key consideration here is the selection of outcomes for which economic valuation will be considered in the assessment, because this includes dialogue between risk assessors and economists.

Identifying available resources to achieve assessment goals within the time frame of the assessment involves a qualitative screening evaluation of resources, which may or may not identify whether children have a greater potential for higher exposures or greater intrinsic susceptibility. The evaluation includes a preliminary examination of the quality and quantity of the available data on exposure and outcomes. More detailed evaluations (refined assessment) may or may not be necessary or may not be possible, depending on the available data. Where adequate data exist (particularly on potential critical windows of exposure, level of exposure, individual and community characteristics, optimum timing of outcome evaluation, and the magnitude of concerns about the public health outcome), a more detailed approach can be employed to address important questions for the exposure and health effects characterization. These include identifying past assessments that relate to the purpose and scope of the assessment and that may assist the process with existing tools, methods, or models.

- Why is the risk assessment being done? What are the needs of the assessment? Is there a regulatory driver(s)?
- What is the public health concern? Is there a specific concern for developmental lifestage exposure?

- What is the risk question(s) being asked, and is it lifestage-specific? Will the assessment consider exposure at all lifestages or exposure at specific developmental lifestages?

- Which lifestage(s) (age bin[s]) is likely to have the greatest external exposure, the greatest internal dose, and the greatest inherent vulnerability?

- Have other risk assessments included consideration of health risks from children's exposures on this chemical (e.g., EPA, other federal agencies, other organizations)?

3.2. CONCEPTUAL MODEL

Within the conceptual model, the risk assessment team develops preliminary hypotheses about why adverse effects have occurred or may occur in the future. A conceptual model is developed, keeping in mind the relationships among the individual characteristics, exposures, and outcomes. The relationships are informed by the initial identification of lifestage-specific exposure scenarios, the lifestage of exposure, the optimum times for evaluation of outcomes that will be addressed and the identified characteristics and toxicologic outcomes of the chemical(s) that may contribute to latent effects from early exposure and children's risk.

A qualitative characterization of hazard and exposure for specific lifestages results in the accumulation of the information needed to develop a conceptual model that aids the segue from the problem formulation stage to the analysis phase. The conceptual model is the starting point for the lifestage-specific analysis phase (Chapter 4) and can be presented as a diagram, a flow chart, or a narrative description of the predicted key relationships (U.S. EPA, 2002b).

The following provides an approach to a preliminary evaluation of the available exposure data (Section 3.2.1), outcome data (Section 3.2.2), and the integration of the two (Section 3.2.3) to help define the conceptual model and aid in the development of a problem-driven analysis plan with a focus on lifestages.

3.2.1. Exposure Considerations

The exposure considerations include performing a preliminary examination of the data to determine the lifestages likely to be exposed, given the chemical properties and uses of the environmental agent(s) in the defined scope of the assessment. The preliminary examination involves a qualitative characterization of the sources, pathways of exposures (including exposure

media and routes), exposure scenarios (lifestages, time frames, locations, and activities), and pattern of exposures (magnitude and duration) to parents or children, as appropriate, including the potential for dietary, drinking water, soil and air exposures, and other exposure media (e.g., pharmaceuticals) (U.S. EPA, 1992, 2002c).

An issue to consider is whether all lifestages are at the same risk from a given exposure or whether a specific developmental lifestage is more vulnerable because of higher exposures or intrinsic susceptibility. This includes a qualitative understanding of lifestage-specific activity patterns to identify potentially highly exposed lifestages. Currently, EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005e) is to be used as a starting point for identifying and selecting age bins for analysis (see Table 3-1). This guidance includes expert analysis of existing generic exposure data. This guidance provides a detailed discussion of how these age groups were developed and how to implement them in an assessment. In brief, the recommended age groups are based on the current understanding of differences in behavior and physiology that may impact exposures to children. Information on critical windows of susceptibility also is factored into these age bin considerations for potential vulnerability at different lifestages.

Typically, the conceptual model will consider human exposure in the context of the source-to-effects paradigm (U.S. EPA, 2003b, Figure 1-3). When formulating an exposure assessment, it is useful to qualitatively evaluate this model from the "effects" back to the "source." In this way, potentially important time periods of exposure, exposure pathways, and vulnerable individuals or populations can be identified. However, as the risk assessment becomes more complex, some limitations in the source-to-effect model become apparent. Exposure assessments using a source-to-effect model are based on the characteristics of the specific source of the exposure (e.g., geographical location, release rate, point source) and not the characteristics of the lifestage being exposed. As a result, only individuals or populations with exposure to this specific source are included in the model. Yet, exposure may result from multiple independent sources, all of which could contribute toward total exposure to a chemical or mixture of chemicals. In this case, a person-oriented exposure assessment better characterizes the person and lifestage of interest along with the applicable sources than a population-oriented exposure assessment.

Table 3-1. Developmental lifestages and age groups for exposure assessments.

Lifestages	Age Groups[a]
Preconception	reproductive age adult
Prenatal	conception to birth
Infant	birth to <1 month
	1 to <3 months
	3 to <6 months
	6 to <12 months
Child	1 to <2 years
	2 to <3 years
	3 to <6 years
	6 to <11 years
Adolescent	11 to <16 years
	16 to <18 years
	18 to <21 years

[a] The age groupings from birth to adulthood are from U.S. EPA (2005e). These standard age groups were developed based on the results of a peer involvement workshop (U.S. EPA, 2000b) focused on developmental changes in behavior and physiology impacting exposures to children.

Below are some questions that are useful in framing the examination of exposure considerations.

- What data are available that characterize children's exposure?
- Will the risk assessment consider all possible sources, media, pathways, and routes of exposure (aggregate and cumulative), or is it confined to specific scenarios (e.g., children living near a specific Superfund site and potentially exposed via air, soil, and groundwater)?
- Is it suspected that individuals in developmental lifestages are actually being exposed to the compound?
- What are the potential exposure sources, media (e.g., breast milk, indoor air), pathways, and routes of exposure?

- What are the human lifestage behaviors (e.g., mouthing, crawling), activities (e.g., bathing, sleeping), and locations (e.g., indoors, outdoors, daycare) that may impact exposure?
- What other individual or community characteristics may be present that could put children at higher risk of exposure and thus make them more vulnerable (e.g., pre-existing diseases or disorders, belonging to a farm worker family, socio-economic status, poor nutrition, sanitation conditions, cultural practices)?
- What are elements of the physical environment that may impact exposure (e.g., altitude, climate, urban vs. rural)?

3.2.2. Outcome Considerations

In this screening approach, a preliminary identification of toxic effects is performed, including TK and TD profiles, including to what degree these data support a hypothesized MOA(s). Evaluating critical windows of susceptibility and number of critical effects that have been observed relevant to the problem or scenario of concern for the risk assessment can be used to qualitatively assess the database. This qualitative assessment assures that the risk assessment team is appropriately staffed and has the essential resources to meet the timetables established in the analysis plan.

Below are some questions that are useful in framing the examination of hazard and dose-response considerations.

- What toxicology, epidemiology, or other data are available that examine outcomes following exposure to the chemical(s) of interest?
- Are there any suspected MOAs and other factors to be considered for relevant child health outcomes?
- Are there TK (e.g., metabolic activation/conjugation) or TD (e.g., MOA) considerations during certain developmental lifestages that may make the chemical more or less toxic?
- What do we know about the properties of the chemical being evaluated that may be important for considering lifestage-specific risk?
- Does the chemical cause known organ-specific toxicity? How might these organs be differentially susceptible during development?
- What is known about critical windows of exposure (e.g., developmental windows of susceptibility) for humans? For the experimental animal species and strain?
- What is known about critical windows of effect (e.g., latent expression of developmental toxicity) for the experimental animal species and strain?

- Are there any toxicologic outcomes noted in animal or human studies that are signals of possible increased susceptibility of developmental lifestages (e.g., carcinogenicity, neurotoxicity, immunotoxicity, endocrine disruption)?
- What are the background rates for outcomes of concern in the general population?
- What dose metrics (AUC or C_{max}) are being considered for the lifestage-specific assessment?

3.2.3. Integrating Exposure and Outcome Considerations

The concepts of timing and dosimetry are incorporated as unifying factors for both exposure and hazard components of the analysis. In a child-centered approach, multiple stressors may need to be considered for a particular outcome of interest due to convergence on a common MOA, as well as possible confounding, effect modification, or bias present in some studies. Additional stressors may have an impact on behavior. For example, a person with asthma may be less active or spend less time outside where an exposure may occur. Dialogue between experts such as exposure scientists, health scientists, epidemiologists, and toxicologists will ensure that the critical windows of exposure and critical effects are sufficiently identified, at least at a qualitative level, for the development of a conceptual model and an adequate analysis plan (Section 3.3). Below are some questions that are useful when integrating exposure and response considerations.

- How do chemical sources, fate, and transport influence target outcomes for various lifestages?
- How do magnitude, patterns, and pathways of exposure influence target outcomes for various lifestages?
- How does lifestage-specific dosimetry impact the temporal resolution required for exposure assessment?
- Based on the transport and fate of the chemical under evaluation, do the available exposure and hazard data address the compound(s) to which children may actually be exposed?
- Can exposure to multiple stressors during a critical window of development lead to modification of a health outcome of interest (e.g., additivity, synergism, antagonism)?

3.3. ANALYSIS PLAN

The analysis plan identifies the methods, models, critical data gaps, major variabilities and uncertainties, and key assumptions to be considered as the problem-driven assessment moves forward to a more in-depth lifestage-specific analysis (Chapter 4). The analysis plan is a working outline that provides the rationale for the resources (expertise, time, and finances) required to complete the assessment. Examination of the most vulnerable age groups and key risk drivers relevant to the problem identified will help conscribe the assessment and shape the decision points and decision tree in the analysis plan.

A database inventory may be useful for identifying data gaps (Table 3-2). This table presents an example of a database inventory method. After assessing the available information on lifestages of exposure, the assessor can note whether there are the various types of information for each lifestage. For example, are there human studies assessing outcomes after *in utero* exposure? In many instances, few of these fields will have data. Input from the relevant risk managers may be needed on the scope of the conceptual model and analysis plan, particularly with respect to the questions the assessment is meant to answer. This exercise can facilitate identification of strengths and weaknesses in the database, especially with regard to a lifestage-specific assessment. Many of these boxes will be blank for most chemicals; these data gaps do not necessarily represent research needs, but the data gaps may be useful in identifying where more information would be helpful and communicate this need to conduct research. For example, if the problem formulation suggests that infants have a potentially high risk due to biological susceptibility or probability of increased exposure, then absence of data for that lifestage may affect the relevancy of the risk assessment to address the identified problem or question of the assessment.

Planning and scoping (Section 3.1), the conceptual model (Section 3.2), and the analysis plan (Section 3.3) are then used in the lifestage-specific analysis (Chapter 4), which comprises hazard characterization (Section 4.1), dose-response characterization (Section 4.2), and exposure characterization (Section 4.3). Further scoping may be considered in each of the three analysis steps, thus leading to further refinement of the conceptual model and analysis plan.

Table 3-2. Lifestage-specific database inventory sheet. Types of information are described in the left-hand column, and lifestages of exposure are shown in the top row.

Developmental lifestages

		Preconception	In Utero	Infant	Child	Adolescent	Adult
Lifestage-Specific Hazard Characterization	Human studies						
	Animal studies						
Lifestage-Specific Dose-Response Characterization	Toxicokinetic data						
	Toxicodynamic data						
	Mode of Action						
Lifestage-Specific Exposure Characterization	Chemical properties, environmental sources, fate and transport						
	Environmental media concentrations						
	Lifestage-specific exposure measurement data						
	Lifestage-specific exposure factors						

- Does the analysis plan focus on what are likely to be the most vulnerable age groups?
- Does the analysis plan focus on the key risk drivers?
- What decision points are needed in the analysis plan for the specific problem identified?

4. LIFESTAGE-SPECIFIC ANALYSIS

The analysis phase of risk assessment includes hazard characterization (Section 4.1), dose-response characterization (Section 4.2), and exposure characterization (Section 4.3), where data are analyzed, both qualitatively and quantitatively. Iterations among all three steps provide communication among the risk assessment team members and refine the focus on the key assessment questions identified in the problem formulation phase (Chapter 3). These iterations are performed to enhance, but not effectively delay, the final assessment.

Focusing on data with outcomes after exposure during developmental lifestages of greatest susceptibility (i.e., critical windows) is key to the lifestage-specific evaluation of hazard, dose-response, and exposure data. These data may identify critical windows of exposure and data gaps for particular lifestages of exposure. MOA information based on TK and TD data may inform the lifestage-specific analysis (Figure 4-1).

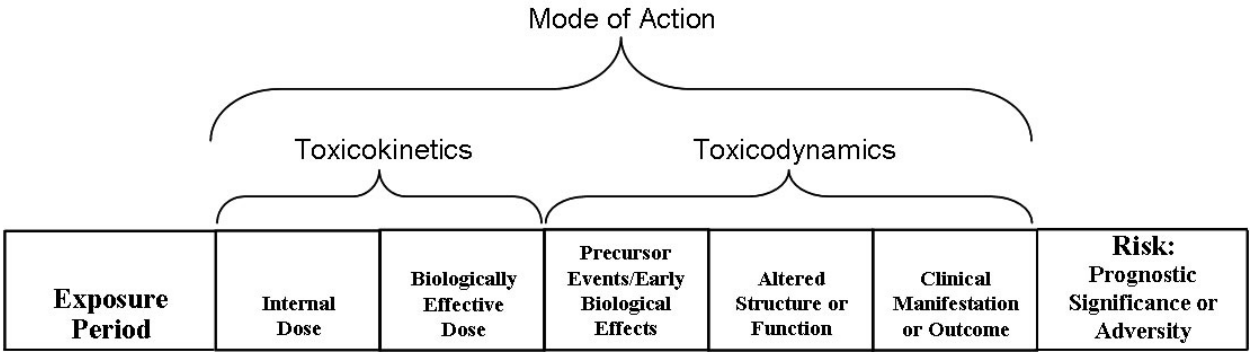


Figure 4-1. Exposure to risk continuum. This figure identifies the major elements in Figure 2-2a. This includes specific elements of TK and TD that may be lifestage-specific. This TK and TD information (MOA) can lead to increased characterization of the altered structural and functional outcomes

Source: Adapted from: Schulte, 1989.

The next three Sections (4.1, 4.2, and 4.3) discuss the three steps of the analysis phase and provide information to guide the assessor through the process (Figure 4-2). In order to link exposures and outcomes appropriately, an iterative process among all steps of the analysis is suggested for a robust risk characterization, the final phase in the risk assessment process (Chapter 5).

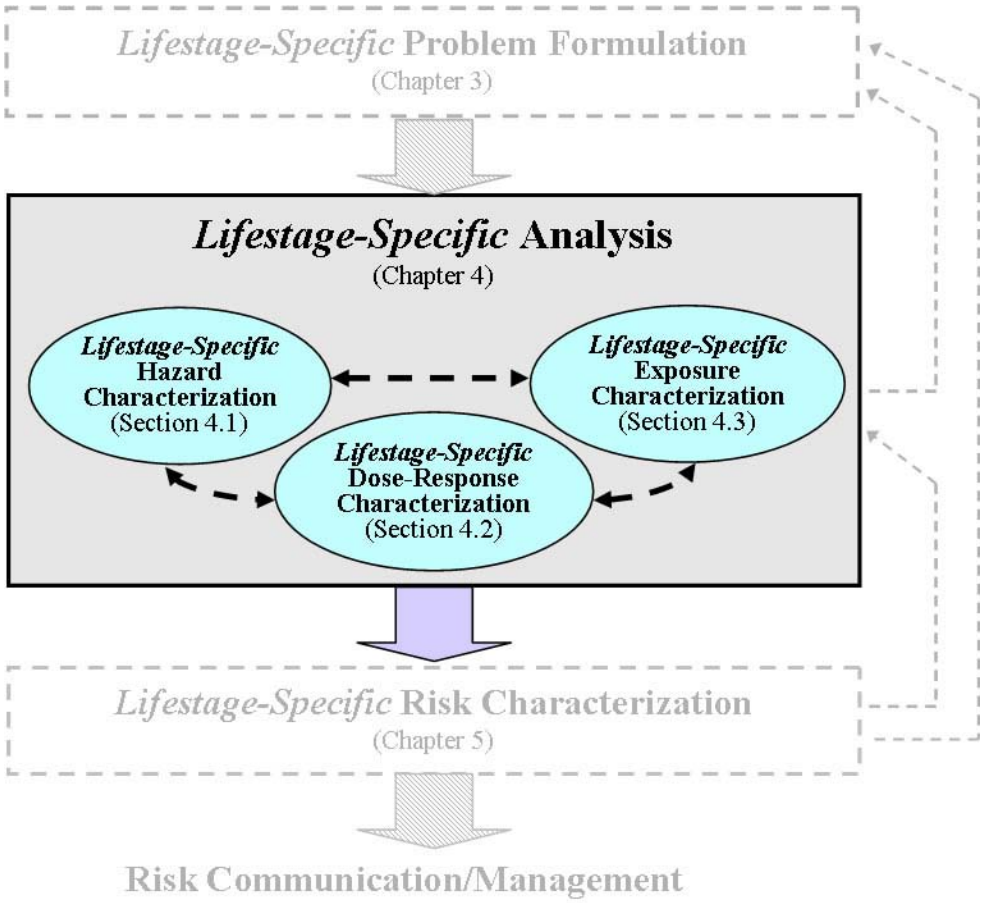


Figure 4-2. Flow diagram for lifestage-specific analysis. Following the problem formulation stage, the three steps of the analysis phase include hazard characterization (Section 4.1), dose-response characterization (Section 4.2), and exposure characterization (Section 4.3). This is followed by the risk characterization (Chapter 5) and risk communications/management phases.

4.1. LIFESTAGE-SPECIFIC HAZARD CHARACTERIZATION

4.1.1. Introduction

Hazard characterization is the analysis step in which the data are evaluated for potential adverse health effects. Hazard characterization begins with the identification of the human and animal toxicology studies to be included in the database. It includes the identification of any outcomes associated with exposure at specific doses. The primary purpose of a lifestage-specific hazard characterization is to develop a detailed description of the potential for health outcomes after exposure to the agent of interest during preconception or developmental lifestages. This begins with a description of each of the available studies (Section 4.1.2), considering critical windows of exposure and susceptibility, TK, TD, MOA, and dose-response information as well as the variability and uncertainty present in each study. The database is then synthesized from

the individual study evaluations, and the quality and quantity (i.e., the comprehensiveness) are characterized using a weight-of-evidence (WOE) evaluation (Section 4.1.3.1). This includes information about differences and similarities in experimental animal species versus humans regarding lifestage-specific TK and TD, the extent of the database for different lifestages, and lifestage-specific susceptibilities. The results of the hazard characterization are iterated with the dose-response and exposure analyses (Section 4.1.4) if indicated by the conclusions from summarizing the hazard database.

Finally, the lifestage-specific hazard characterization is summarized including a scientific rationale for the identification of relevant outcomes and susceptible lifestages based upon the data (Section 4.1.5). The identified outcomes and susceptible lifestages are further evaluated in the subsequent dose-response characterization step (Section 4.2). This information feeds into the comprehensive lifestage-specific risk characterization (Chapter 5).

Throughout the hazard characterization, relevance of the information to the overall goals of the assessment is considered. It may be appropriate to refine the conceptual model (Section 3.2) or analysis plan (Section 3.3) after thoroughly evaluating the available hazard data. For example, a conceptual model may focus on an exposure to a chemical or chemical class that results in thyroid tumors. Thyroid hormone is critical to development of the nervous system (Farwell et al., 2006; Pals et al., 2006; Ramos and Weiss, 2006; Santisteban and Bernal, 2005) and immune system (Bossowski et al., 2003; Lam et al., 2005). If development of these organ systems were not considered in the conceptual model for analysis of the chemical(s), then the conceptual model will need to be refined to consider the relevant critical windows of development.

Figure 4-3 illustrates a detailed approach to characterizing hazard from environmental exposures during development. More specific information on hazard characterization for developmental lifestage exposures can be found in the existing EPA risk assessment guidelines for developmental toxicity (U.S. EPA, 1991), reproductive toxicity (U.S. EPA, 1996), neurotoxicity (U.S. EPA, 1998b), and cancer (U.S. EPA, 2005b).

4.1.2. Qualitative Evaluation of Individual Studies

The objectives and scope of the risk assessment, defined in the problem formulation phase (Chapter 3), provide focus and a plan for identifying and examining all the relevant

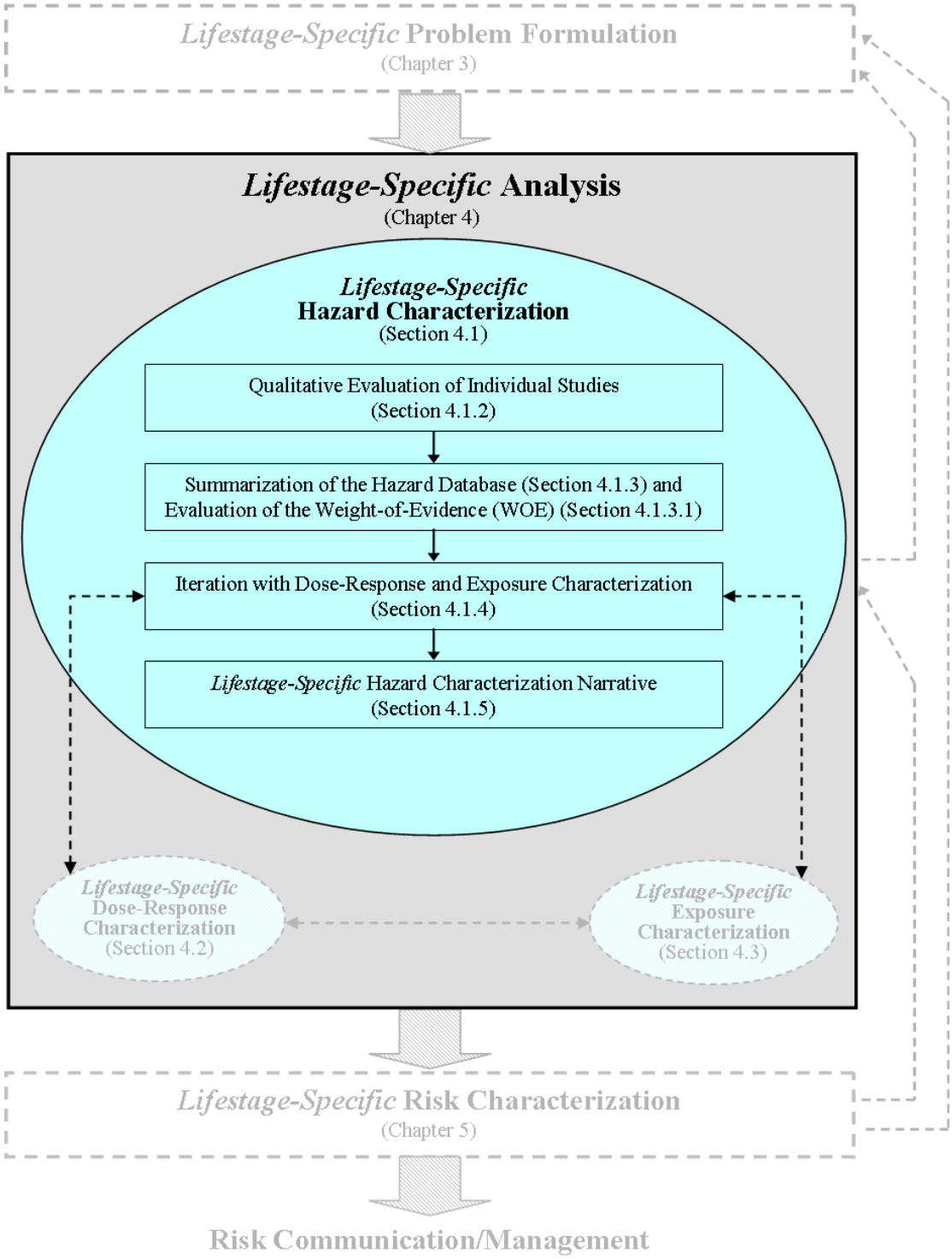


Figure 4-3. Flow diagram for lifestage-specific hazard characterization. The steps in hazard characterization include the evaluation of individual studies (Section 4.1.2), summarization of the hazard database (Section 4.1.3), an evaluation of the weight-of-evidence (Section 4.1.3.1), potential iteration with the other analysis steps (Section 4.1.4), and the hazard characterization narrative (Section 4.1.5). The dashed lines indicate where iterations may occur with other parts of the risk assessment process.

published human and experimental animal studies. A thorough qualitative evaluation of each study includes a complete description of the findings, an assessment of the study conduct and data quality, and a determination of sufficiency of data. To focus on risk from exposure to children, the evaluation process considers lifestage-specific information (pertaining to both the lifestage at which exposures occur and outcomes are observed) and issues within the overall context of the risk assessment. To assess study quality, the adequacy of the methods and results are characterized. In addition, it can be helpful to establish criteria for confidence in the evaluation and interpretation of the study findings that can be used later in the WOE evaluation (Section 4.1.3.1). The description of individual studies will contribute to the overall determination of the adequacy, strength, and completeness of the database for the characterization of hazard across lifestages. The following subsections describe topics to consider during the qualitative evaluation of each study, and example questions are addressed in Table 4-1.

4.1.2.1. *Study Purpose*

Describing the purpose of each study may provide information to evaluate the study as it relates to lifestages. For example, the study may be conducted in response to general risk evaluation issues, to explore an aspect of basic toxicology or biology, or to investigate a specific public health concern. The purpose of the study can range from hypothesis generation to hypothesis testing.

4.1.2.2. *Study Design*

A clear, concise description of the study design includes the number of subjects in each exposure group; descriptions of the study participants (e.g., gender, age); route, timing, and duration of exposure; and outcomes assessed. The timing of exposure and outcome assessment is important in relation to identifying and characterizing lifestage-specific risk. All of these are related to statistical power, which is further discussed in the WOE evaluation (Section 4.1.3.1). It is helpful to highlight strengths and weaknesses in the study design, particularly in relation to lifestage-specific assessments and how they may illuminate questions identified in the problem formulation (Chapter 3). For example, statistical power is a limitation that is often not discussed when studies are concluded to be “negative.”

4.1.2.3. *Identifying Critical Windows of Exposure*

An evaluation of the exposures (or dosing/treatment to experimental animals) to the study participants involves characterizing the timing and duration of the exposures (e.g., exposure during preconception and critical windows of pre- or postnatal development) that have occurred across the lifestages of the study individuals. The timing and the duration of exposure to test substance in experimental animal studies could be informed by data on the critical windows of development of organ systems.

A useful source of information is the proceedings of a workshop on critical windows of exposure for children (Selevan et al., 2000), which addresses the respiratory and immune systems (Dietert et al., 2000; Holladay and Smialowicz, 2000; Peden, 2000; Pinkerton and Joad, 2000), the reproductive system (Lemasters et al., 2000; Pryor et al., 2000), the nervous system (Adams et al., 2000; Rice and Barone, 2000), the cardiovascular and endocrine systems (Barr et al., 2000; Hoet et al., 2000; Osmond and Barker, 2000; Sadler, 2000), and cancer/neoplasms (Anderson et al., 2000; Olshan et al., 2000). The WHO draft document, *Principles for Evaluating Health Risks in Children Associated with Exposure to Chemicals* (WHO, 2006) also reviews critical windows of development by organ systems.

4.1.2.4. *Outcomes Related to Developmental Lifestage Exposure*

A description of study findings, including the relationship of the outcome (both the outcome itself and timing of the outcome assessment) to the time of exposure, is a primary goal of hazard characterization. This includes an explicit consideration of outcomes at various lifestages due to exposure occurring during developmental lifestage(s). Developmental lifestage exposures may result in early or latent effects (Selevan et al., 2000; WHO, 2006). The evaluation of each study includes whether and how study outcomes address questions raised during the problem formulation phase (Chapter 3). For example, if the problem formulation specifically identifies a potential for risk after exposure to pregnant women in a residential setting, then it is important to carefully evaluate any available human and experimental animal data that examines outcomes following gestational exposures. Toxicities resulting from alteration of precursor events may be expected to be different depending on lifestage. Alteration of a precursor event in a mature animal or adult human may not have any significant health consequence, where the same precursor event alteration in a developing organism may have significant health consequences.

4.1.2.5. *Toxicokinetic Data*

All available lifestage-specific TK data are included and described in order to determine the relevance and impact of the TK data in evaluating the study and to determine the impact of exposure on response across lifestages. TK data can be used to verify that indirect exposure of the fetus or neonate (e.g., via maternal circulation or breast milk) occurred without relying on observable outcomes. In some situations, internal dose can be measured, providing greater confidence in derivation of the dose metrics (Section 4.2.2.3). If TK data are available across lifestages, this information can aid in highlighting key lifestages for the assessment. For example, immaturity of specific metabolic enzymes or renal capabilities (e.g., elimination) can result in a more or less toxic response in the young. Therefore, information on the developmental profiles of enzymes or organ systems can help identify particularly susceptible age groups.

Studies may find increased susceptibility of immature individuals but lack TK data to assist in the interpretation of these findings. In that case, default assumptions are generally applied. Three typical examples are (1) internal dose is equivalent to dose at the portal of entry, (2) the dose to the fetus is equivalent to the dose administered to the maternal animal, or (3) the internal dose to the immature individual is equivalent to that of adults. However, these default assumptions may not be health protective; therefore, the availability and use of TK data will likely decrease uncertainty in the risk assessment.

4.1.2.6. *Toxicodynamic Data*

TD data include information about the steps between the toxicant's first interaction with the target organ and the subsequent toxic outcome. Describing TD data for specific lifestages may provide corroborative evidence of potentially susceptible lifestages for a given chemical. For example, if TD information for a chemical suggests effects on the nervous system via decreasing luteinizing hormone and disruption of the hypothalamic-pituitary-gonadal axis, then greater concern would be warranted in cases when there are lifestage-specific TK data. This TK data may demonstrate that the chemical is found in the brain only during a developmental lifestage when the blood-brain barrier is not fully formed.

4.1.2.7. *Mode of Action Information*

Consideration of MOA information (key TK and/or TD steps) can be useful in

- understanding the susceptibility differences among various lifestages,
- determining the most appropriate experimental animal model for relevance to humans,
- determining when human exposure or outcome data during lifestages are limited or not available,
- predicting types of effects that might be seen during particular lifestages, and
- predicting potential susceptible lifestages.

For example, if a chemical has an anti-androgen MOA, *in utero* and peri-pubertal intervals might be sensitive exposure windows for male reproductive outcomes. Further, differences in androgen activity by lifestage can explain some of the observed differences in susceptibility; for example, for the pesticide vinclozolin (Anway et al., 2006; Euling and Kimmel, 2001). It is also possible that the MOA for a given chemical differs among lifestages; this is one possible explanation for differences in outcomes after exposures during developmental lifestages versus adulthood. For example, diethylstilbestrol (DES) produces reproductive, developmental, and carcinogenic outcomes after *in utero* exposure which are not observed following adult exposure (Herbst, 1987; Mericskay et al., 2005; Robboy et al., 1982). Also, organophosphorous pesticides inhibit cholinesterase throughout one's lifespan, but certain of these pesticide's inhibitory effects on neuronal differentiation and migration, which are attributed to an alternative, noncholinergic MOA, occur only during *in utero* and early postnatal neurological development (Campbell et al., 1997; Chakraborti et al., 1993; Dam et al., 1998; Young et al., 2005). However, chemicals with more than one MOA, such as methoxychlor, have been described (Chapin et al., 1997; Gaido et al., 2000; Gray et al., 1999a). Therefore, it is possible that the activity of the different MOAs may vary across lifestages.

4.1.2.8. *Qualitative Evaluation of Dose-Response*

A detailed qualitative evaluation of the lifestage-specific dose-response profile is useful, but not always available, when interpreting the outcome for individual studies. A well-characterized dose-response relationship helps support the judgment of whether an outcome is due to exposure during a specific lifestage. The shape of the dose-response curve may or may not be monotonic in nature.

These dose-response data are carried forward into the WOE evaluation (Section 4.1.3.1.3) because determining the relationship between adverse responses and exposures is achieved through consideration of the results in context of the other studies in the database and may highlight the importance of borderline or suggestive findings in individual studies and, ultimately, refine the interpretation of the data. For example, a prenatal developmental toxicity study in rats may identify a treatment-related malformation (e.g., spina bifida) that occurs with a demonstrable dose-response relationship; in a two-generation reproduction study, the interpretation of incidences of spina bifida that are observed in litters from treated groups may take on greater weight in the overall hazard characterization even in spite of the lack of significant incidence or a clear dose-response.

4.1.2.9. *Variability Analysis*

There are a number of sources of variability, both intrinsic and extrinsic, in human and animal toxicologic data. Intrinsic, or biological, variability includes heterogeneity across lifestages and is expressed to some degree in each parameter being measured. Examples of intrinsic variables in both human and experimental animal studies include age, gender, and genetic factors. On the other hand, the sources of extrinsic variability are external to the study individuals and can often be attributed to methodological considerations, to errors in study design, or to variations in implementation. Examples of extrinsic variables for experimental animal studies include handling techniques, ambient temperature, and noise. For epidemiologic studies, examples include variations in recruitment or data collection procedures.

Variability can be adequately characterized by the appropriate statistical treatment of individual study data. For example in developmental toxicologic studies, all pups in one litter are used as the unit of measure (n=1) to address issues of between-litter variability in response. High levels of variability may affect the ability to identify associations and make the interpretation of study data difficult. A detailed consideration of variability with appropriate analyses contributes to a determination of the adequacy, strength, and reliability of a study and its conclusions. Variability can be a source of uncertainty in the evaluation and interpretation of individual studies (Section 4.1.3.1.2). High variability can sometimes render a study uninterpretable within the context of the rest of the data or result in reduced confidence in the

veracity of the study findings, thereby decreasing the confidence placed in the study and its value for use in the WOE evaluation (Section 4.1.3.1).

4.1.2.10. *Uncertainty Analysis*

Uncertainty from a variety of sources in lifestage-specific data can affect the assessment of risk. Uncertainties can result from data gaps (i.e., missing information), inadequacies in the study protocol or methodologies, inaccuracies in the reporting of study findings, or inconclusive results. After a thorough consideration and description of the uncertainties for each study, any resulting assumptions, extrapolations, or speculative interpretations are described and utilized in the risk characterization (Chapter 5). Detailing data gaps helps provide an adequate characterization of the uncertainties of the risk from developmental lifestage exposure. For example, in laboratory animal studies, if the toxicologic evaluation characterizes adverse outcomes following exposures that traditionally occur throughout all developmental lifestages, then future study exposure methods may need to incorporate direct dosing techniques during specific lifestages (e.g., in pre-weaning or juvenile experimental animals) (Bruckner and Weil, 1999; Zoetis and Walls, 2003). In particular, experimental animal studies of exposure during the juvenile period specifically are rare, although they are increasingly becoming more common as they gain greater prominence in regulatory hazard characterization (Hurtt et al., 2004; U.S. FDA, 2006). Developmental (*in utero*) studies are more common but are not done for all chemicals and are limited because they do not involve direct dosing in postnatal life. One- and two-generation reproduction studies are also not conducted for all chemicals and are often limited in having postnatal dosing only via nursing and involve a limited number of outcomes (e.g., reproductive outcomes). Developmental neurotoxicity, developmental immunotoxicity, and other organ system-specific developmental studies also are not commonly performed and have limitations regarding the exposure route and apical outcomes/organ systems assessed. Due to the iterative nature of the evaluation process and the consideration of information from multiple sources, data from other human or experimental animal studies, data on structure-activity relationships (SARs), or TK or TD information, may be used to address uncertainties identified in a given study.

Table 4-1. Examples of lifestage-specific questions for evaluation of individual studies within hazard characterization.

Topic	Lifestage-Specific Question(s)
Study Purpose (Section 4.1.2.1)	Was the purpose of the study to address a lifestage-specific hypothesis or public health concern?
Study Design (Section 4.1.2.2)	Did the study design and methods address specific lifestages of exposure and their outcomes? What lifestages were assessed? How was lifestage/age measured? What were the strengths and limitations of the study design in assessing lifestage-specific exposure and outcome? For human studies, how did the methods impact the validity and reliability to determine children's exposure and outcome? Were lifestage factors (potential confounders) examined and accounted for, where appropriate? In experimental animal studies, was an appropriate route and matrix (e.g., vehicle, formulation, duration) of exposure employed across various lifestages? Were the dose range and levels appropriate across lifestages evaluated? Was the power of the study adequate to detect an effect after exposure during a specific lifestage? Were sample sizes, inclusion of both sexes, and animal litter numbers considered?
Identifying Critical Windows of Exposure (Section 4.1.2.3)	What is known about critical windows of exposure for the outcome and chemical? Were the routes of exposure relevant to the age-related exposure pathways for the age groups of interest? Did the exposure interval cover different lifestages, partially or completely? • What exposure/dose levels were assessed during the lifestage(s) of development? Were they the same across all the lifestage(s) identified in the study? • Were lifestage-specific behaviors discussed that could influence the exposure (e.g., maternal nurturing behaviors, offspring nursing or weaning activities, or exploratory/play behaviors in the immature individual)? If so, in what direction would the dose likely be affected? Was exposure verified for critical lifestages? • In animals, what was the route of exposure and was it the same throughout all lifestages? Did exposure occur across more than one developmental lifestage(s) in the study? • For humans, was there more likely to be exposure(s) from this source during certain lifestages than others? If so, would this be expected to affect the results of the study and was this accounted for in the study? Were other possible sources of exposure considered for various lifestages?
Outcomes Related to Developmental Lifestage Exposure (Section 4.1.2.4)	What was the timing of assessment of outcomes? Were outcomes dependent upon the exposures during critical stages of development? How were latent effects assessed? Were lifestage-specific outcomes assessed in the study (e.g., different outcomes during different developmental stages vs. adult stages)? What methods were used to assess lifestage-specific outcomes after developmental lifestage exposures? Were they appropriate? What were their limitations (e.g., were relevant lifestage-specific outcomes not assessed)? Were biological plausibility and internal consistency of findings considered for lifestage-specific data? Did the authors make lifestage-specific conclusions in the study, and what were their assumptions and interpretations?
TK Data (Section 4.1.2.5)	Are there lifestage-specific differences in absorption, distribution, metabolism (toxification or detoxification), or elimination assessed in the study? At varying doses?

TD Data (Section 4.1.2.6)	Are there TD data for the specific lifestage(s) that relate to outcomes?
MOA Information (Section 4.1.2.7)	For the outcome(s) assessed in this study, what is known about the chemical's MOA after exposure at different lifestages? Is there information suggesting similarities or differences in MOA for different lifestages of exposure? Have precursor events (e.g., biomarkers) been identified for a particular outcome? If so, were precursor events similar across lifestages? Are the toxicities resulting from precursor events expected to be different depending on lifestage of the outcome? Are outcomes related to the MOA relevant to the lifestages of concern in this study? Are there different MOAs suspected for different lifestages? If there are multiple outcomes described at differing lifestages, then are these consistent with one or more MOAs?
Qualitative Evaluation of Dose-Response (Section 4.1.2.8)	Are there lifestage-specific dose-response relationships assessed in the study? What are the similarities and differences in dose-response across lifestage of exposure? What is the shape of the dose-response curve for lifestage-specific toxicologic outcomes?
Variability Analyses (Section 4.1.2.9)	What was the variability in the control data for parameters of normal growth and development and other outcomes for the lifestage of interest? Was this variability in measures within expected ranges? If not, could this mask detection of an outcome?
Uncertainty Analyses (Section 4.1.2.10)	Are there any lifestage data gaps or uncertainty considerations (i.e., were some lifestages exposed and/or assessed, while others were not)? Were critical windows of exposure and associated outcomes adequately addressed? Were lifestage-specific studies conducted with appropriate quality laboratory practices and standards (e.g., Good Laboratory Practice) (U.S. FDA, 1978)? Did the conduct of the study result in uncertainties in findings that are particularly pertinent to lifestage-specific data interpretation? Were any inadequacies in the data lifestage specific?

4.1.3. Summarization of the Hazard Database

After summarizing the relevant studies for the lifestage-specific hazard database (Section 4.1.2), the exposure-response array is assembled and then evaluated. Not all summarized studies judged may be useful to the risk assessment (NRC, 1994). Well-justified decisions to include or exclude a study are provided in the hazard narrative (Section 4.1.5). The adequacy of studies and characterization of the database are discussed in detail in *A Review of the Reference Dose and Reference Concentration Processes* (U.S. EPA, 2002a, Section 4.3).

The overall hazard database includes detailed descriptions of all available studies relevant to and critical for evaluating the hazard to children, specifically those with developmental exposures, effects, or outcomes. The database may also include *in vitro* data, MOA or mechanistic studies, and toxicity data in adults to help profile the toxicologic response in children, or the database may provide support for assumptions made during the hazard characterization. A careful review of the studies' exposure durations and lifestages may help to

determine the relative importance (weight) of the studies when estimating potential risks to children. Issues to consider include the pathways (including media and route), and whether they are relevant to children; the intervals of exposure, and whether they included critical lifestages; and issues suggestive of differential susceptibility of children or specific lifestages.

A detailed characterization of the study outcomes is also important for the characterization of the database. Often, the structure and presentation of data summaries are driven by the outcome data. Common links are examined across studies. For example, for one chemical with detailed MOA information, the summary could focus on hazard in relation to that MOA and what the MOA may predict about potential critical windows. For other chemicals, the description might focus on specific developmental outcomes, target organs, or susceptible lifestages. The emphasis of the hazard summary is on the relationships (i.e., patterns) across observed outcomes, in relationship to lifestages and MOA. For some chemicals, only very limited human or experimental animal hazard information may be available. However, detailing the lack of information about an agent (i.e., data gaps and uncertainties) is crucial to an adequate characterization of risk to children from environmental exposures.

4.1.3.1. *Evaluation of the Weight-of-Evidence of the Hazard Database*

During the evaluation of the hazard database, the major strengths and weaknesses of the available relevant data are identified and are summarized in the WOE evaluation. The WOE evaluation includes expert judgment of the completeness of the database. For this Framework, key themes were adapted to meet the needs of evaluating human and toxicologic studies relevant to children's health risk assessment. These key themes include temporality, strength of the association, qualitative dose-response relationship, experimental evidence, reproducibility, biological plausibility, alternative explanations, specificity, and coherence (Figure 4-4) (Hill, 1965; Gray et al., 2001; Seed et al., 2005; U.S. EPA, 2000c, Chapter 4; Vineis and Kriebel, 2006; Weed, 2005). Criteria for evaluating the key themes for the WOE may be developed during problem formulation (Chapter 3) to address specific assessment needs. The adequacy, strength, and completeness of the entire database are considered. The description of the database includes a qualitative exposure-response array, data gaps, uncertainties, and assumptions that are summarized in the hazard characterization narrative (Section 4.1.5).

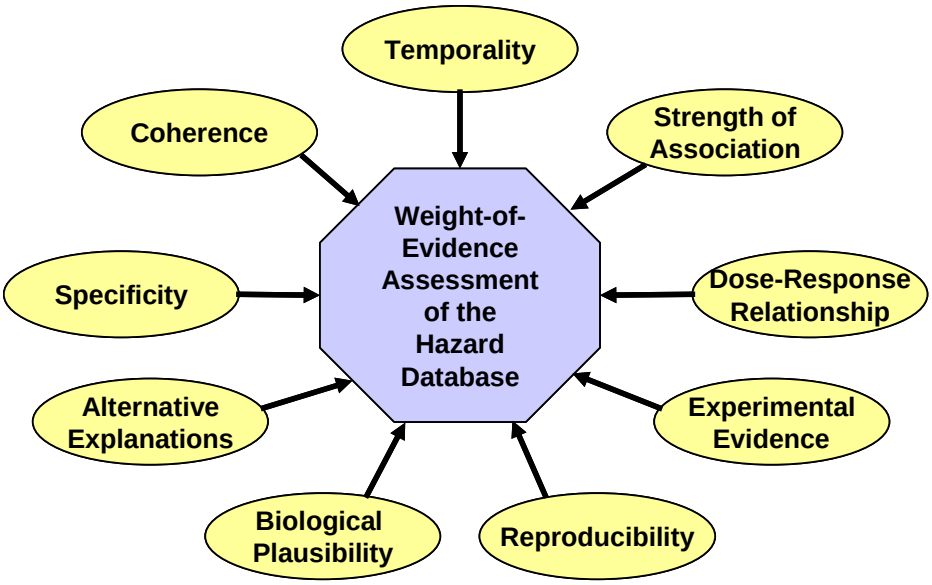


Figure 4-4. Conceptual view of a WOE evaluation. This figure illustrates the considerations within a WOE evaluation of toxicity data. The relative weight of each consideration will vary for each assessment.
Source: Adapted from Hill, 1965; Gray et al., 2001.

The principles developed by Hill (1965) focused on evaluating human studies, while Gray et al. (2001) focused on evaluating animal toxicology studies (Figure 4-4). Further details about EPA's WOE evaluation approach can be found in the *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (U.S. EPA, 1994), *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005a), *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b), *A Review of the Reference Dose and Reference Concentration Processes* (U.S. EPA, 2002a, Section 4.3.2.1), and *Determination of the Appropriate FQPA Safety Factor(s) in Tolerance Assessment* (U.S. EPA, 2002d, Section III). The following subsections describe the key themes that can be considered in the WOE evaluation, and example questions are presented in Table 4-2.

4.1.3.1.1. ***Temporality.*** Temporality is the basic premise that the exposure must occur prior to the outcome (U.S. EPA, 2002a, pp. 4-13 to 4-14). For developmental lifestage-specific data, temporality includes consideration of the relationship between the timing of exposure and outcome. Depending on what is known about potential critical windows of exposure (Section 4.1.2.3), more or less credence may be given to the association with the observed outcome. When developmental lifestage-exposure data exist, the temporal relationship between the

exposure and outcome(s) may be assessed. Further, when there are data that provide an accurate characterization of the timing of the exposure and outcome, the latency time between the exposure to the outcome may be determined. For example, exposure to dibutyl phthalate (DBP) during late gestation leads to a number of male reproductive developmental effects (e.g., decreased anogenital distance, increased nipple retention, and hypospadias) that are observed at different stages of development in the rat (Barlow and Foster, 2003; Gray et al., 1999b; Mylchreest et al., 1999, 2000).

4.1.3.1.2. ***Strength of the association.*** Greater weight is generally given to more rigorous studies as well as those with higher statistical power, and therefore, greater statistical precision. Strength of the association considers both rigor and statistical power. Rigor is the degree of proper design, conduct, and analysis of a study. It can be difficult to determine rigor because in some cases, study methods presented in published studies lack sufficient detail. Additionally, rigor is not simply equivalent to conduct under GLP regulations for nonclinical laboratory studies (U.S. FDA, 1978). Many older studies showing early-lifestage sensitivity to carcinogens were rigorously conducted, but before the GLP regulations were first published in 1978;[3] similarly, many rigorous studies in academic institutions do not follow GLP regulations. Statistical power is the ability of a study to detect effects of a relevant magnitude and relates to the sample size, the number of data points, the stratification of findings, and the background rates of the specific outcome(s).

For the evaluation of human studies, the strength of an observed association may be affected by the presence of uncontrolled or unmeasured confounders, the prevalence of effect modifiers in the study population, or bias. A confounder is a variable that can cause or prevent the detection of a change in an outcome of interest and is not an intermediate variable on the causal pathway between exposure and outcome but is associated with the factor under investigation. A confounding factor can often be controlled for or accounted for in the statistical analysis. An effect modifier is a variable that modifies the outcome of interest by a greater (synergistic or additive) or lesser (antagonistic) effect. An effect modifier can sometimes be identified through stratification of the data. Many effect modifiers and confounders are

[3] There are different GLP citations for U.S. FDA and U.S. EPA (including for FIFRA and TSCA). These have been updated several times over the years.

potentially lifestage specific, and whether and how these have been evaluated in the data analysis could affect the study outcomes or interpretation of study results. A lifestage-specific example of a confounder is maternal socio-economic status (SES), which can influence or bias the interpretation of the offspring's cognitive development. For animal toxicology studies, a lifestage-specific example of an effect modifier is maternal health status, such as maternal or offspring nutrition, which can influence the development and maturation of the young (Cappon et al., 2005; Fleeman et al., 2005). Another example is the timing of heat exposure and effects on skeletal development in the rat (Cuff et al., 1993; Kimmel et al., 1993).

4.1.3.1.2.1. ***Variability analysis.*** The sources of variability within individual studies (Section 4.1.2.9) are also important factors for the interpretation of the dataset. They can contribute to overall uncertainties in the database, including those uncertainties that are applicable to the lifestage-specific hazard characterization. Variability of response across studies and possible reasons for the variability are assessed and considered when developing an exposure-response array. For example, in animal studies the response variable could vary among studies performed when using different strains of the same experimental animal species or when studies are performed in different decades, possibly due to genetic drift in laboratory animal populations (Hartl, 2001; White and Lee, 1998).

4.1.3.1.2.2. ***Uncertainty analysis.*** In the evaluation of individual studies (Section 4.1.2), data gaps (missing information) may be identified that could impact the quality of the study, and these are considered in total when evaluating the database. In addition, when combining the data from all the studies, data gaps for the comprehensive database of information on the chemical can be assessed. For example, the combined studies may have assessed outcomes after exposure during all developmental stages except for the peri-pubertal period. If this were the case, then a data gap in coverage of this particular developmental lifestage of exposure would be noted. For any chemical assessment, there will be inevitable gaps in the available lifestage-specific information; it is the relative impact of missing or inadequate information to the overall goals of the assessment that are to be judged. In some cases, information gleaned from the toxicologic profiles of structurally-related chemicals or chemicals with a similar MOA can assist in interpreting the relative importance of a data insufficiency. Sometimes this information can

provide a way of bridging a data gap (Julien et al., 2004). When evaluating lifestage-specific uncertainties and data gaps, study design (e.g., measurements, exposure, and outcomes across lifestages) is addressed (U.S. EPA, 1991, Section 3.1.2.1; U.S. EPA, 1996, Section 3.3.1.5; U.S. EPA, 2002a, Section 4.3.1). The characterization of data gaps also includes a determination of whether required toxicologic studies (i.e., by statute or convention) are present (e.g., a rodent and a non-rodent prenatal developmental toxicity study, and a reproduction and fertility effects study).

Uncertainties arising from the absence of any other relevant data identified are addressed. The potential qualitative and quantitative impact of these missing data on the risk assessment (e.g., on the point of departure [POD]) is considered and may be useful in determining the magnitude of a database uncertainty factor (UF) during dose-response characterization (U.S. EPA, 2002a) (Section 4.2.4.4). Additionally, information from the exposure characterization (Section 4.3) could be useful when identifying any remaining uncertainties in the hazard characterization. For example, if the exposure characterization identifies a high potential of exposure to nursing infants, specific TK data on milk partitioning may be deemed particularly important in the risk assessment, and absence of these data could be considered an important source of uncertainty. Finally, the level of confidence in the final risk estimates is based on a detailed description of the assumptions and interpretations of the uncertainties in the overall database.

Sometimes, other types or sources of data can assist in satisfying an identified data gap or uncertainty. For example, if for a chemical being evaluated, there are no data relevant to the hazard characterization following exposure during a particular lifestage, data from a similar lifestage exposed for a different chemical that has been shown to produce the same active metabolite might be useful in informing the assessment and reducing uncertainties relevant to this data gap.

4.1.3.1.3. ***Qualitative dose-response relationship.*** The dose-response relationship demonstrates a predictable change in an effect as a function of exposure/dose. Studies that directly relate the exposure/dose to the degree of the effect (i.e., increasing dose results in increasing effects) give stronger weight to the evidence (exposure-response array). For example, an association between increasing blood lead levels and a lower IQ in children has been reported (Canfield et al., 2003).

In some cases, the failure to observe a dose-response relationship may be due to the choice of dose levels or dose spacing in given studies, to a threshold effect, or to a more complex (e.g., a U- or J-shaped) dose-response relationship. Also, an observed dose-response relationship may, in fact, be related to a confounder, if that confounder has a direct response on the effect, and may be associated with the exposure at higher doses but not at lower doses. This is further discussed in the hazard characterization narrative (Section 4.1.5) and the dose-response characterization (Section 4.2).

4.1.3.1.4. ***Experimental evidence.*** Experimental evidence is provided with hypothesis testing. This hypothesis testing includes manipulation of the exposure scenario with resulting alterations in the response or response rate of outcomes. Hill (1965) defined *experimental evidence*, as evidence that removal of the exposure or supplementation with an antidote leads to a reversal of the outcome. Experimental evidence or hypothesis testing would include manipulation of the exposure scenario with resulting alterations in the response or response rate of outcomes. For some agents, this concept can apply to a lifestage assessment. For example, cases of exogenous estrogen exposure in prepubertal boys can lead to gynecomastia (male breast development) that can be reversed after removal of the estrogenic agent (Edinin and Levitsky, 1982; Felner and White, 2000). However, for other agents, removal of the exposure after the critical window has passed may not result in a reversible effect. In addition, effects may not occur when the exposure occurs outside of a given critical window. If studies exist that demonstrate a particular exposure during a defined critical developmental window, then this could constitute experimental evidence of the importance of that critical window of exposure. For example, prenatal thalidomide exposure leads to altered limb bud development (Stevens and Fillmore, 2000), and prenatal alcohol exposure can result in the irreversible outcomes related to fetal alcohol syndrome (e.g., facial dysmorphogenesis, cognitive deficits, Rubert et al., 2006; Yelin et al., 2005). If there is a hypothesized MOA, *in vitro* or transgenic animal models (e.g., knock-out, knock-in, conditional expressors) may add further weight and experimental evidence to a hypothesized association.

4.1.3.1.5. ***Reproducibility.*** Reproducibility, also termed *corroboration* by Gray et al. (2001), means that specific effects are seen under varied conditions. In the case that a lifestage-specific

effect is consistently observed in similar studies, under varied conditions, in multiple laboratories, across species, and by various routes of exposure, stronger weight can be placed on the chemical's association with the effect since it is less likely that biases or confounding factors are responsible for the results. However, inconsistent findings may be notable. For developmental toxic agents, exposure occurring during only one specific lifestage, but not all developmental exposures, may result in the outcome of concern. What may appear as a lack of reproducibility may actually be the result of disparate study designs examining different critical windows. Therefore, caution is warranted in dismissing seemingly inconsistent findings without careful consideration.

4.1.3.1.6. ***Biological plausibility.*** Biological plausibility is the determination of whether an observed outcome could be attributed to the toxicologic insult, given the currently known science. Biological plausibility may be informed by such things as available information on the biologic mechanism of a toxic response or on TK and TD similarities and differences across species or strains or for various lifestages. Some differences in sensitivity between different rodent strains have been found (Spearow et al., 1999, 2001). A toxic response observed following developmental lifestage exposure may be different from the response after exposure to an adult, and the response may be explained by critical windows of susceptibility. Cross-species and cross-strain similarities or differences in developmental windows of exposures may impact comparison for the database as a whole. For example, certain prenatal stages in humans are comparable to certain postnatal stages in rodents. However, when intra- or interspecies lifestage-specific data are lacking, a default assumption that exposure during any lifestage in experimental animals causes similar effects in humans is often applied. Another default assumption is that a response observed in experimental animals is expected to occur in humans (U.S. EPA, 1991, 1996, 1998b, 2005a,b). Defining these assumptions and the uncertainties that they address is a key part of the WOE evaluation and the identification of data needs.

To move towards more quantitative interspecies comparisons will require a better understanding of developmental biology and ontogeny of different organ systems. Several relevant papers comparing organ and system development across species are available for reference (Hattis et al., 2004, 2005; Hurtt and Sandler, 2003a,b; Selevan et al., 2000). Comparison of specific physiological systems include the female (Beckman and Feuston, 2003)

and male (Marty et al., 2003) reproductive system, the cardiac system (Hew and Keller, 2003), the immune system (Holsapple et al., 2003), the central nervous system (Wood et al., 2003), the gastrointestinal system (Walthall et al., 2005), the renal system (Zoetis and Hurtt, 2003a), the respiratory system (Zoetis and Hurtt, 2003b), and osteogenesis (Zoetis et al., 2003).

4.1.3.1.7. ***Alternative or multiple explanations.*** One must consider and clearly articulate other explanations for the observed outcome(s) after the exposure of interest. It is important to consider whether these explanations are consistent with the database. Reasons for null findings must also be examined. Alternative hypotheses may also explain similar findings. If other hypotheses can be ruled out, then more weight can be given to the principal hypothesis or alternative hypotheses defined in problem formulation (Chapter 3). For example, a non-mutagenic MOA could be considered as an alternate explanation to the primary hypothesis of a mutagenic MOA leading to childhood leukemia. In another example, decreased pup body weight in a two-generation reproduction study may be the result of direct toxicity to the pups at a susceptible lifestage, or alternatively, the toxicant may be interfering with lactation in the dams, thereby depriving the pups of nutrition needed for normal growth. These alternative explanations could have very different implications for judgments about children's risk. This information is also discussed in the risk characterization when considering explanations for alternative risk estimates (Section 5.1.6).

4.1.3.1.8. ***Specificity.*** Specificity, as discussed by Hill (1965), entails a single cause and effect relationship resulting from exposure to an environmental agent. It may be difficult to define such a relationship for developmental outcomes since the alteration of organizational events may be altered during development and thus may lead to multiple outcomes, depending on the critical window of exposure (Barker hypothesis, Lau and Rogers, 2004). Evaluating specificity of a particular MOA, with regard to both the timing of exposure and individual outcomes, presents a challenge in part because so much time elapses between the occurrence of exposure and latency of expression of an outcome (Section 4.1.3.1.1). Specificity is defined within the context of this document as a determination of the relationship between one exposure, the effect(s), and whether each effect is mediated through a single or alternative MOAs. Exposure during a critical window may lead to several adverse outcomes; alternatively, the MOA may be unique for developmental

lifestage exposures when compared to later lifestage exposures. Similarly, the effect of one agent may vary depending on differences in critical windows of development for the target tissue or organ.

4.1.3.1.9. *Coherence.* Coherence summarizes all the principles discussed above and discusses the extent to which the data are similar in outcome and exposure/dose and whether they support each biologically plausible hypothesis or MOA. An observed association is given more weight when it is consistent across the database. This relates to both reproducibility (Section 4.1.3.1.5) and biologic plausibility (Section 4.1.3.1.6). An example of coherence is the observance of treatment-related increases in total resorptions at cesarean section in a prenatal developmental toxicity study and the corollary observation of reduced litter sizes at parturition in a two-generation reproduction study. Relating the existing database to the larger toxicologic database about structurally related chemicals or chemicals with a similar MOA can be useful to address coherence and bridge some data gaps. For example, for one chemical with detailed MOA information, the summary could focus on hazard in relation to that MOA and what the MOA may predict about potential critical windows. For other chemicals, the description might focus on specific developmental outcomes, target organs, or susceptible lifestages. SARs with other chemicals or chemical classes may be explored to determine the extent to which these data can inform the assessment via an MOA discussion or to help reduce uncertainties.

Table 4-2. Examples of lifestage-specific questions for evaluation of the WOE of the hazard database.

Topic	Lifestage-Specific Question(s)
Temporality (Section 4.1.3.1.1)	To what degree were the timing of exposures described, including the exposure level and the lifestage of exposure? Do time-course data exist following developmental lifestage exposures? Within the hazard database, are exposure intervals or timing of outcome assessments missing that are necessary in describing the relationship between the exposure and outcome timing?
Strength of the Association (Section 4.1.3.1.2)	How sufficient is the database for evaluating developmental lifestage exposure? Are the lifestage-specific data of adequate quality? Do the adequate quality studies comprise a database of adequate quantity? Did the relevant studies have sufficient statistical precision for confidence in the results? For human data, to what degree were confounding factors, effect modifiers, and other risk factors considered? Were the major demographic and other personal/community characteristics examined (e.g., age, sex, ethnic group, socioeconomic status, smoking

	status, occupational exposure)? To what degree were biases considered? **Variability Analysis** What sources of variability have been identified in the lifestage-specific database? What effect does this variability have on the interpretation of the lifestage-specific database? **Uncertainty Analysis** What are the significant data gaps in the database with regard to children's risk? • Which lifestages of exposure were assessed? Did exposure occur throughout all critical lifestages? Were relevant lifestage pathways of exposure and exposure intervals evaluated? Were there developmental stages during which exposure was intermittent or did not occur. What was the potential impact of any gaps in exposure? Were lifestage-appropriate biomarkers of exposure assessed? • Were all critical outcomes evaluated across lifestages? Have appropriate organ systems, tissues, and outcomes been adequately assessed for all lifestages of concern? Were lifestage-appropriate biomarkers of outcome assessed? • Does the extent of the database for risk from children's exposure indicate the need for follow-up studies to better define uncertainties for the specific assessment question and issues? What are the resulting uncertainties in the database with regard to children's risk? • Have any uncertainties in developmental exposure been identified? • Have any uncertainties in internal dose estimation been identified following developmental exposures (e.g., are there TK data that support the study design and the interpretation of the data for critical lifestages)? • Did the conduct of the studies in the database result in uncertainties in findings that are particularly pertinent to lifestage-specific data interpretation? Were some studies or data excluded on the basis of poor quality? Can information from the comparison of structurally related chemicals, or chemicals with a similar MOA with lifestage-specific data, be used to modify the impact of identified uncertainties or data gaps?
Qualitative Dose-Response Relationship (Section 4.1.3.1.3)	What is the nature of the dose-response relationship for developmental exposures and outcomes at all lifestages? What is the shape of the dose-response curve? Are there differences seen in dose-response curves for the same outcome between studies? Could confounding factors explain these differences? Are there differences in dose-response curves for specific lifestages?
Experimental Evidence (Section 4.1.3.1.4)	Has the hypothesized critical window of exposure been supported by additional epidemiologic data in humans or experimental evidence in animals? Do alterations or differences in exposure paradigms result in alterations in outcome?
Reproducibility (Section 4.1.3.1.5)	Were the findings examined for consistency within and across studies, laboratories, species, and strains? Could inconsistencies in findings be explained by differences in exposures during a critical window of development?
Biological Plausibility (Section 4.1.3.1.6)	If there are lifestage-specific findings, were they examined for biologic plausibility? Are there temporal differences between experimental animals and humans for the lifestages when exposures or specific outcomes occur (i.e., what are the comparable developmental events among the species and strains)? Are there any cross-species differences in developmental windows of exposures that impact comparison for the database as a whole? Was dosing/exposure during potential or known critical windows of exposure identified for both humans and experimental animals? Is the dosing route used for

	animals relevant to human exposure? Is the dose-response relationship seen in experimental animals at doses that are relevant to exposure at developmental lifestages in humans (i.e., environmental levels)? Are there any interspecies similarities or differences of effects for comparable lifestages of development? Are there any intraspecies (e.g., cross-strain) concordance of effects at lifestages of development? If not, are there underlying biological reasons to explain these differences? What are the key toxicologic and epidemiologic studies that provide the basis for health concerns following children's exposures? Do other valid studies support or contradict these findings? Are negative studies considered? What adverse outcomes at the lowest exposure levels were observed, and what is the basis for these observed outcomes? Have precursor events/biomarkers or the MOA been identified? Besides the developmental lifestage effects observed in the key studies, are there other health outcomes of concern? Have the appropriate studies been performed (within the database or elsewhere) to determine critical windows of exposure? If so, what are they? Did exposure intervals include known or suspected critical windows?
Alternative or Multiple Explanations (Section 4.1.3.1.7)	Should some data or studies be eliminated from consideration or inclusion in the WOE evaluation? To what degree were alternative explanations considered? Are studies with null findings considered? Are alternative hypotheses considered that might explain the observed lifestage-specific outcomes? Does an alternative hypothesis better explain the data than the primary hypothesis?
Specificity (Section 4.1.3.1.8)	Is there a specific outcome associated with a specific lifestage exposure? Are there multiple outcomes that manifest after developmental lifestage exposures? Can these be explained through a common MOA?
Coherence (Section 4.1.3.1.9)	Was a meta-analysis performed to combine epidemiologic or toxicologic studies? Do the data provide information about lifestage susceptibility? Is the relationship consistent across lifestages or specific to exposure during one or more lifestages? What types of human studies are available (e.g., case-control, cohort or human ecologic studies, or case reports or series)? Assuming relevant exposure routes considered for specified lifestages, were study results consistent? Could differences in pathways and intervals of exposure explain differences in study results for relevant lifestages?

4.1.4. Iteration with Dose-Response and Exposure Characterization

The information gathered in this hazard characterization step will subsequently be used in the dose-response characterization step (Section 4.2). For example, if there are data from the exposure-response array (e.g., no-observable-adverse-effect-levels [NOAELs], lowest-observable-adverse-effect-levels [LOAELs], benchmark doses [BMDs], BMD lower confidence limits [BMDLs]), or data supporting other quantitative approaches like quantitative risk

estimation (QRE), then this information is subsequently considered in dose-response characterization.

For human studies, consideration of and coordination with the exposure characterization step (Section 4.3) is helpful at this point in the process and can provide important context for the evaluation of the hazard outcomes, characterization of uncertainties, and identification of further testing or research needs.

4.1.5. Lifestage-Specific Hazard Characterization Narrative

In this final step in the hazard characterization, a scientific rationale for the selection of outcomes is clearly and concisely summarized. Included are considerations of lifestage-specific outcomes, including susceptibility of individuals, the impact of interindividual variability on response, and remaining uncertainties in the hazard evaluation. Lifestage-relevant outcomes in the lower dose ranges are described for use in the quantitative dose-response characterization (Section 4.2). For example, different low-dose ranges (e.g., NOAEL; LOAEL) may have been identified for different outcomes or for different lifestages of exposure, depending upon the routes and durations of exposure. The hazard characterization information is also combined with the exposure characterization information (Section 4.3) to determine a risk characterization that includes components for describing lifestage-specific risks (Chapter 5).

The report *A Review of the Reference Dose and Reference Concentration Processes* recommends summarizing the extent of the database by describing it as a continuum from a *minimal* to a *robust* database (U.S. EPA, 2002a, pp. 4-19). These terms define the continuum of database characteristics, with *minimal* describing the least amount of information that would be sufficient to conduct a risk assessment, and *robust* including data that fully characterize the potential toxicity of a chemical or group of chemicals. The intent is for the assessors to characterize and justify the extent of the database in a narrative form, including variabilities, data gaps, and uncertainties (e.g., lifestage-specific exposures and outcomes, TK and TD data, the types of outcomes evaluated and lifestages of assessment of outcomes, reversibility of effect, and latency to response) that aid in determining the extent of the database.

The lifestage-specific hazard characterization narrative includes thorough assessment of the overall variabilities (Section 4.1.3.1.2.1), uncertainties, and data gaps (Section 4.1.3.1.2.2) that have been identified in the database, both generally and specifically for evaluation across

lifestages. For example, well-justified decisions to include or exclude a given study from the database or exposure-response array are explicitly stated. The emphasis of the hazard summary is on the relationships (i.e., patterns) across observed outcomes in relationship to lifestages and MOA. Often, the structure and presentation of the summaries are driven by the outcome data. The database may also include *in vitro*, MOA, and exposure data and toxicity data in adults that help profile the toxicologic response in children or provide support for assumptions made during the hazard characterization. Following are some overarching questions to ask in the hazard characterization narrative:

- What are the lifestage-specific outcomes from the whole database that were identified in the lower dose range(s) (not just a single "critical effect")? What are the lifestage-specific outcomes relevant for use in quantitative dose-response characterization?

- What are the most susceptible lifestages for exposure (e.g., women of childbearing age [preconception and fetuses], breast feeding infants, toddlers or older children) from the available data? Is there justification for the most susceptible lifestage(s) provided by the data to support the relevant outcomes of concern?

4.2. LIFESTAGE-SPECIFIC DOSE-RESPONSE CHARACTERIZATION

4.2.1. Introduction

Ideally, the adverse health effects identified in the hazard characterization (Section 4.1) are linked to relevant environmental exposure predictions (Section 4.3) through a dose-response characterization. The nature and number of risk estimates is governed by the problem formulation (Chapter 3), hazard characterization (Section 4.1), and the available data. A lifestage-specific dose-response characterization (Figure 4-5) begins with the summary of the available data from the hazard characterization (Section 4.1) to conceptualize a MOA, to select dose-response models, and to apply extrapolations and derive risk values. Variability, sensitivity, and uncertainty are analyzed, and the results of the entire analysis are iterated, if necessary, with the hazard and exposure characterizations. The dose-response characterization culminates with a descriptive narrative of the data, models, estimates, and uncertainties applied in the dose-response estimate.

Consideration of differences in both human and experimental animals for routes and durations of exposure, TK and TD processes, and outcomes helps inform the selection of the

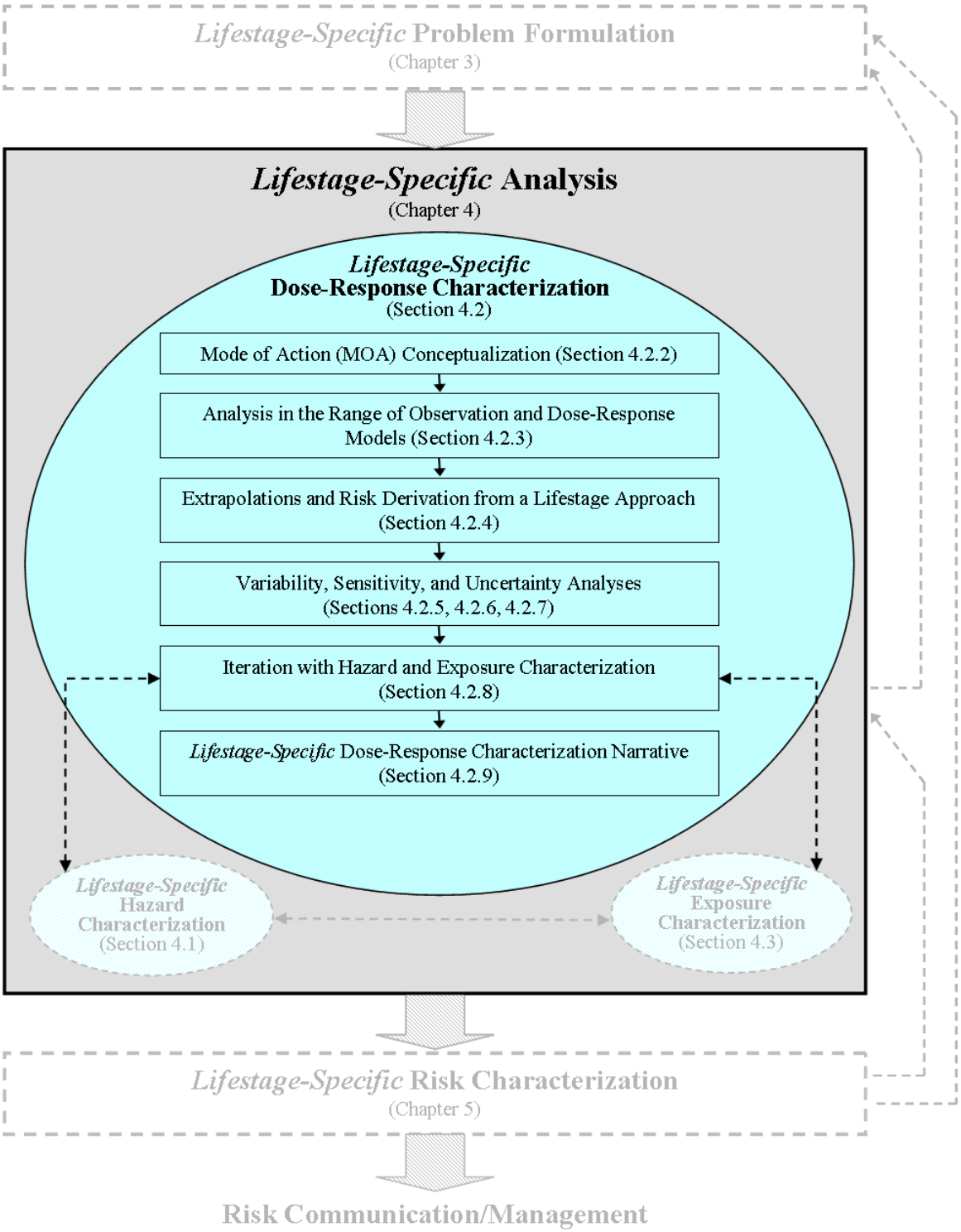


Figure 4-5. Flow diagram for lifestage-specific dose-response characterization. In the lifestage-specific dose-response characterization, a selection is made for the dose-response relationships for lifestages of interest based on input from the hazard data (Section 4.1) and the exposure data (Section 4.3). Appropriate extrapolations and risk value derivations are performed and described in the dose-response characterization.

most appropriate dose-response data and models for a given assessment. In the past, different analytical approaches have been used, depending on whether the outcomes were cancer or noncancer effects. More recently, there has been a recognition within the scientific community that the traditional dichotomy of cancer versus noncancer dose-response characterization is problematic, and approaches for characterizing outcomes to have either threshold (i.e. nonlinear) or non-threshold (i.e., linear) responses based upon their MOA(s) have been proposed (Bogdanffy et al., 2001). This *harmonized* approach recognizes that both cancer and noncancer outcomes can appropriately be characterized as threshold or non-threshold when data are available to support this selection.

Based on the problem formulation for a given risk assessment, an approach for carrying out a dose-response characterization is developed. As described in the problem formulation (Chapter 3), the scope and breadth of an assessment are established and generally fall into two categories, narrow and broad. The narrow or broad focus of the problem can restrict the dose-response characterization to more defined approaches. Regardless of the breadth of the assessment, the exposure scenario, or the hypothesized MOA of the environmental agent, the lifestage approach can add to the overall soundness and confidence in the assessment.

Dose-response values are typically categorized by route (oral, dermal, inhalation) and duration of exposure (acute, short-term, chronic). For instance, reference dose (RfD) and reference concentration (RfC) values can be calculated for various routes and durations of exposure (U.S. EPA, 2002a). Acute, short-term, and subchronic exposures are of particular concern because embryogenesis and prenatal, neonatal, and postnatal development provide ample opportunities for toxicant exposures to alter the regulation of development, which may lead to qualitatively different outcomes than equivalent exposures in adults.

Perhaps less apparent, however, is the applicability of long-term, or chronic, risk values to children. Although reference values (RfVs) derived from adult data are thought to be health-protective of sensitive populations (due to the application of intraspecies and database UFs), children may be chronically exposed to environmental toxicants. Chronic exposure is defined as exposure up to 10% of lifetime; therefore, seven years of exposure meets the EPA definition of chronic human exposure (U.S. EPA, 2002a). Thus if data suggest that a developmental lifestage is the most sensitive and sufficient data are available, an RfV could be derived from this

lifestage. In this derivation, the magnitude of the intraspecies and database UFs may be different than if the RfV were derived from adult data.

Unit risk estimates such as cancer slope factor (CSF) and inhalation unit risk (IUR) are used to define the exposure concentration that yields a given level of risk during a lifetime (e.g., 1×10^{-6}). Although the latency of time to tumor may mask detection of cancer from exposures occurring in developmental lifestages, early exposures may indeed increase the risk of tumor development in later lifestages. In fact, there is evidence to support the notion that susceptibility to tumor development from exposure to mutagenic chemicals during earlier lifestages is greater relative to exposure in later lifestages (U.S. EPA, 2005b). Depending on the goals stated in the problem formulation of a risk assessment (Chapter 3), consideration of studies that have examined cancer in adult humans and experimental animals following early-life exposure may be warranted.

4.2.2. Mode of Action Conceptualization

Dose-response characterization can proceed along two paths, one in which the quantitative dose-response values are developed with little or no insight into the MOA of an environmental toxicant, or one in which the dose-response values are informed by MOA. In the latter case, the assessment uses a broader body of scientific literature to look for commonalities in responses across studies, similarities to other chemicals, and mechanistic data from a wide array of studies and fields of specialization. MOA information is increasingly recognized in the scientific community as a foundation from which to build a dose-response characterization (Andersen et al., 2000; Andersen and Dennison, 2001; Clewell et al., 2002a; Preston, 2004). In order to conceptualize an MOA, the following are summarized: the available dose-response model(s), the mechanistic data that relate the critical effect(s) of interest to a particular dose metric, and the data supporting the choice of a likely or hypothesized dose metric. The following subsections describe topics to consider during the MOA conceptualization and example questions are addressed in Table 4-3.

4.2.2.1. *Summarizing the Available Dose-Response Data*

Quantitative assessments identify and summarize dose-response data to characterize the potential risks from exposure scenarios identified during the problem formulation (Chapter 3).

This process also interfaces with the exposure characterization (Section 4.3), where source-to-dose modeling informs assessors about the relevant exposure scenarios (i.e., route and duration) and likely ranges of external exposure levels for various lifestages. Because low-dose extrapolation has inherent uncertainties regarding MOA over dose ranges (Slikker et al., 2004a,b), the exposure characterization can help inform selection of the appropriate dose-response model from which to obtain a POD.

An exposure-response array can help identify critical outcomes (U.S. EPA, 2002a, Section 4.4.1) across dose ranges and aid in the conceptualization of the MOA. For instance, different effects at similar doses may originate through common mechanisms, and thus lend support to one or more MOAs. Alternatively, different effects across dose ranges may represent a gradient of effects operating through common mechanisms, and thus also lend support to one or more MOAs. It is also possible, of course, that different MOAs are operational across dose ranges, and an exposure-response array can be useful for defining the range of effects. Multiple responses can be described as a continuum of dose as well as continuum of lifestages when using this array. For instance, exposure-response arrays for various toxicity outcomes across developmental lifestages have been used to help inform outcome selection for dose-response. For example, exposure-response arrays have been used in the assessment of dibutyl phthalate (U.S. EPA, 2006a); where, using this approach, it becomes evident that adverse developmental effects occur at lower exposure levels than other adverse effects (e.g., hepatotoxicity). This approach is both important for dose-response characterization and is informative for risk characterization (Chapter 5). An alternative approach for summarizing the dose-response data is to use categorical regression (Section 4.2.3.1). This approach lumps different responses together by assigning key outcomes to severity categories–perhaps irrespective of MOA.

In circumstances where data exist for multiple lifestages, it is possible that effects at earlier lifestages pose greater risk due to the potential for irreversible changes (e.g., developmental neurotoxicity) or changes that confer an increase in risk to subsequent exposures in later lifestages. For instance, it is hypothesized that acute lymphocytic leukemia (the most prevalent childhood leukemia) results from an early (perhaps prenatal) initiation event forming a fusion gene, followed by a subsequent key event in later childhood (Greaves, 2003). If this initiation event could be ascribed to a particular environmental exposure, then this event could potentially be an important precursor event to consider due to the increased risk for latent

adverse effects, such as leukemia. Therefore, detailed MOA considerations can inform the selection of lifestage data for dose-response characterization. However, in cases where dose-response data do not exist for specific lifestages of concern (i.e., data gaps), MOA may be able to inform dose-response characterization for these lifestages by allowing for intraspecies (e.g., lifestage) extrapolation using biologically based modeling techniques (Section 4.2.3). Effects that are thought to share common key events in the proposed MOAs can give assessors confidence in choosing dose-response models that most closely relate to the underlying biology and adapt those models to other lifestages of interest.

4.2.2.2. *Mechanistic Data and Mode of Action*

The complexity of physiological development provides opportunity for toxic exposures to create TD effects that may or may not be relevant to all lifestages within a species. Developmental stages or age groupings (Table 3-1, U.S. EPA, 2005e) can be based on such metrics as growth rates/spurts, behavioral traits, organ systems, or perhaps functional development. It may be possible to plot these metrics for development throughout lifestages and across species. This comparison can aid in identification of organ systems (e.g., respiratory, cardiovascular, central and peripheral nervous systems, immune system) that might be at risk during comparable windows of exposure and can inform the decision of which effects and dose-response data are most useful. Although matching comparable lifestages across species is a challenge (U.S. EPA, 2002a, Table 3-1), such efforts have the potential to decrease the interspecies TD differences that influence dose-response relationships across species (Section 4.2.4.2).

4.2.2.3. *Selection of Dose Metric Informed by Mode of Action*

When physiologically based toxicokinetic (PBTK) models are available for a chemical, it may be possible to convert the external/applied dose in a study to an internal target tissue dose (i.e., dose metric). This can be an internal measure of the chemical or its metabolite(s) but can also be measures of adduct formations, cofactor depletion, etc. In addition to identifying the chemical moiety (e.g., adduct) of the dose metric, it is equally important to identify the most appropriate measure of the dose metric; frequently these are the average daily doses under the concentration versus time curve (area under the curve, AUC), peak concentration (C_{max}), or rate

of production. Selection of the appropriate dose metric for a given dose-response relationship is done in the context of what is known or hypothesized about the MOA, and thus is an inherently iterative process between dose-response characterization and hazard characterization (Section 4.1). In practical terms, the measured substance may not be the toxic moiety at the target tissue but rather a surrogate such as blood concentration of the parent compound or one or more of its metabolites. Another important consideration to the selection of the dose metric is the outcome. For example, peak concentration may be more important for some outcomes compared to others (e.g., neurotoxicity vs. tumors). When choosing among potential dose metrics, often the appropriate choice can be identified as the one that demonstrates a consistent relationship with positive and negative responses observed at various dose levels and across exposure scenarios within a single species (U.S. EPA, 2006b).

Clewell et al. (2002a) have proposed two criteria for dose metric determination: *plausibility*, defined as consistency with MOA and ability to simplify a complex dose-response relationship, and *conservatism*, defined as the selection of the dose metric that poses the highest risk or the lowest acceptable exposure level. It is the environmental exposure level to humans that is regulated as a result of risk assessment; thus, a potent dose metric is not synonymous with a potent external dose. Therefore, when there is insufficient data with which to determine the more appropriate dose metric, the one related to the most potent external exposure dose is often appropriate. More detailed information on dose metric selections is in *Approaches for the Application of Physiologically Based Pharmacokinetic (PBPK) Models and Supporting Data in Risk Assessment* (U.S. EPA, 2006b).

Table 4-3. Examples of lifestage-specific questions for MOA conceptualization.

Topic	Lifestage-Specific Question(s)
Summarizing the Available Dose-Response Data (Section 4.2.2.1.)	What dose-response data/models are available for lifestages of interest (e.g., preconception, pregnancy, infancy, childhood)? Are the exposure scenarios in these studies the scenarios of interest? Can route and duration extrapolations be employed using modeling techniques (Section 4.2.4)? If data are available for a different lifestage than is of interest, are these amenable to extrapolation to lifestages for which there is little or no data (Section 4.2.4)? Can an exposure-response array inform the most relevant studies and outcomes?
Mechanistic Data and MOA (Section 4.2.2.2.)	Are TD effects known or hypothesized? What are the relative expression levels of the key players (e.g., receptors, metabolic enzymes, DNA repair enzymes) in the known or hypothesized MOA at the lifestages of interest?

	If multiple outcomes are evident, are they likely linked by MOA? Do the outcomes share common mechanisms? Or, do the outcomes represent a gradient of the same MOA?
Selection of Dose Metric Informed by MOA (Section 4.2.2.3)	What is the human lifestage exposure scenario of interest (route, duration, and pattern)? Are animal data available regarding the dose metric that is likely to be relevant to the human lifestage of interest? Is the selected type of dose metric appropriate for both the outcome and the exposure (e.g., duration) of interest? Are there models available which can convert the external/applied dose used in a study to an internal delivered dose (i.e., a dose metric)?

4.2.3. Analysis in the Range of Observation and Dose-Response Models

A number of models are typically employed in order to determine PODs, which are used for extrapolations in dose-response characterization and margin of exposure (MOE) analysis in risk characterization (Section 5.1.3). Data for dose-response characterization in the range of observation come in many forms: empirical PODs derived from either a NOAEL, a LOAEL, or sophisticated models incorporating mechanistic data. The nature and amount of data required for each type of dose-response characterization might represent a hierarchy, although the more sophisticated dose-response models still rely on the same experimental animal studies from which a NOAEL or LOAEL can be derived, either as a basis for curve fitting mathematical models or a starting point from which to calculate an internal target tissue dose using other modeling techniques.

In *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005a), the EPA has adopted an approach that advocates the use of as much biologically informed dose-response data as possible, and suggests that "default" approaches be used only in instances where little data exists concerning an environmental toxicant of interest. PBTK modeling and BBDR modeling provide strong biological foundations for a chemical risk assessment; their application in risk assessment is discussed more thoroughly in *Approaches for the Application of Physiologically Based Pharmacokinetic (PBPK) Models and Supporting Data in Risk Assessment* (U.S. EPA, 2006b). Moreover, their use in conjunction with statistical modeling is perhaps the most rigorous and scientifically based approach to dose-response modeling (U.S. EPA, 1999a).

The following brief descriptions summarize the types of analyses used in dose-response characterization. Example questions are addressed in Table 4-4, including those based on limited data sets and those requiring rich data sets for dose-response characterization.

Traditional approaches to dose-response modeling of a toxicant with an assumed nonlinear MOA have relied (and continue to rely) heavily on the use of empirical data points for determining PODs. Often these are NOAEL and LOAEL values derived from experimental dosing conditions in toxicologic studies. Two main disadvantages of using these single point estimate values are that they do not consider the shape of the dose-response curve, and they do not allow for estimation of risks at any exposure level of interest (Allen et al., 1998). Thus the use of NOAEL and LOAEL values alone represents the bottom tier of dose-response models and are used most often when limited data are available concerning the toxicant of interest.

Empirical modeling approaches, sometimes called curve fitting or statistical modeling, represent an improvement over traditional NOAEL and LOAEL dose-response characterization techniques. In these approaches, statistical models are fit to empirical response data (e.g., tumors) or precursor events (e.g., signal transduction or changes in blood hormone level). In some instances, low-dose extrapolation beyond the observed response data can be informed by precursor data over the low-dose range (U.S. EPA, 2005a). In other instances, linear low-dose extrapolation may be employed for extrapolating from the range of observation down to, for instance, background levels, rates, or incidence. This form of statistical modeling has been used for noncancer outcomes to develop quantitative risk estimates (discussed at the end of this section). The draft *Air Quality Criteria for Lead* (U.S. EPA, 2006c) contains further discussions on implications for low-dose extrapolation using statistical modeling (i.e., linear and log linear models).

Another form of statistical modeling for determining PODs is BMD analysis (Crump, 1984).[4] The BMD is defined as the dose at which a predetermined change in response incidence (e.g., 5% or 10% change in critical effect such as pup body weight or pup mortality) occurs; with the 95% lower confidence limit being the BMDL (Allen et al., 1994a,b; Faustman et al., 1994; Kavlock et al., 1995; Kimmel et al., 1995; U.S. EPA, 1995b). An advantage of this approach is that it attempts to fit statistical models to existing dose-response data, regardless of whether the MOA is linear or nonlinear, taking into account all of the data points in an individual dose-response study (Brown and Strickland, 2003). Thus, unlike the NOAEL/LOAEL approach, the BMD is influenced by the shape of the dose-response curve for developmental outcomes (Allen et al., 1998). The selection of BMD may require studies with more dose groups and a higher

[4] EPA has developed software for BMD analysis, available at http://cfpub.epa.gov/ncea/cfm/bmds.cfm.

number of subjects, and therefore, can be performed only when the scientific database for an environmental chemical is relatively large. Because the BMDL depends on the study design, more rigorous studies generally have narrower confidence limits (Barnes et al., 1995). Importantly, the BMD approach is less sensitive to dose spacing, and thus a BMD can be determined in the absence of a NOAEL as well as for any increase in response level (Allen et al., 1998; Barnes et al., 1995). For further readings on choosing studies for BMD analysis, refer to the draft *Benchmark Dose Technical Guidance Document* (U.S. EPA, 2000d).

Categorical regression[5] analysis is similar to BMD analysis, but whereas BMD analysis uses a single study, categorical regression combines studies. In this method, data are pooled from different studies (possibly with different exposure parameters and outcomes) that are "assigned" to the same severity category (Brown and Strickland, 2003). An advantage to this approach is that a small number of studies can essentially be combined into one larger study and can thus narrow the confidence limits (Brown and Strickland, 2003). This methodology may be particularly useful in a lifestage approach where it is likely that fewer studies have been performed on the specific lifestages of interest or critical windows of susceptibility.

PBTK and BBDR modeling are perhaps the most amenable modeling techniques for using a lifestage approach as they are designed to mimic true biological processes and model whole organisms. Knowledge and understanding of TK differences during each lifestage (absorption, distribution, metabolism, and elimination), as well as anatomy and behaviors, are used in estimating delivered dose and may require modification of available adult models. Several reviews have described the variation in TK factors between adults and children (Besunder et al., 1988a,b; Bruckner, 2000; Clewell et al., 2002a,b, 2004; Hines and McCarver, 2002; McCarver and Hines, 2002).

Although the use of PBTK models for internal dose estimates is increasing, more effort is needed in developing such models for children's dosimetric adjustments across lifestages and experimental animal species. In this regard, pharmacokinetic data from pediatric pharmacologic studies could be appropriately applied for some portions of certain risk assessments for developmental lifestage environmental exposures. For instance, general knowledge of differences between adults and children in metabolic clearance of CYP3A-specific pharmaceutical substrates could be used by adjusting for these differences in activities in a TK

[5] EPA has developed CatReg software, available at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=18162.

model when the toxicant is thought to be metabolized by CYP3A (Ginsberg et al., 2004a,b). Ginsberg et al. (2002) compiled a database of 45 drugs for which TK data are available across lifestages.[6]

PBTK models are particularly useful for conducting extrapolations (e.g., route-to-route, duration, interspecies, including lifestage extrapolations). Other advantages are that these models can mimic any exposure scenario (continuous or otherwise) and changes in the underlying biology (e.g., development). For instance, if children are likely to be exposed to an environmental toxicant for one hour per day for five days a week (followed by 48 hours of no exposure), these models can predict the levels of metabolites of interest under these conditions. Similarly, numerous small exposure doses from breast milk to nursing infants could be modeled to determine steady-state levels of a toxicant at one month and at three months after birth. However, PBTK models are not necessarily applicable for extrapolating from short-term exposure studies to longer-term predictions. This is because the key events leading to the observed responses are not likely to be impervious to the effects of time and repeated exposure. Many dose-response relationships may be dependent on temporal changes in TD processes due to developmental- and exposure-induced changes (e.g., cell proliferation rates, DNA repair processes, receptor tolerance and desensitization, and age-related changes in physiologic parameters). Thus, it is feasible to predict steady-state levels of a compound in the body over long periods of time, yet the response to these levels may differ between short- and long-term durations of exposure. These differences due to duration of exposure highlight the importance of having dose-response data for the exposure duration and the lifestages of interest.

Application and review of PBTK models in risk assessment can be found in Ginsberg et al. (2004b), Pelekis et al. (2001), and U.S. EPA (2006b). There are some developmental lifestage PBTK models, some of which include infant exposure to chemicals such as dioxin in breast milk (Gentry et al., 2003; Lorber and Phillips, 2002), fetal exposure to ethylene glycol monomethyl ether (Gargas et al., 2000), and neonatal exposure to compounds such as lead (O'Flaherty, 1998) and perchlorate (Clewell et al., 2003; Clewell and Gearhart, 2002). Several pregnancy and lactation models have been reviewed (Corley et al., 2003).

[6] This database can be accessed at http://www2.clarku.edu/faculty/dhattis.

BBDR models represent the state of the art in dose-response characterization, where mechanistic TD data are modeled in such a way that responses can be predicted, even at low exposure levels. Usually, output from a PBTK model serves as the dose input to a BBDR model, relating that dose to a response outcome (Andersen and Dennison, 2001; Ashani and Pistinner, 2004; Setzer et al., 2001). In addition to lifestage-specific TK data, the relationship between the internal dose metric and response may require lifestage-specific TD data. Currently, relatively few BBDR models are available due to the inherent complexity of integrating TK and TD data. Model transparency, quality criteria, and short shelf-life of some models beyond initial publication also limit BBDR model development (DeWoskin et al., 2001). The use of BBDR models is expected to increase as toxicologic studies move beyond more frank effects toward molecular precursor events (Andersen and Dennison, 2001; Faustman et al., 1999).

In instances where the dose metric of a toxicant of interest is structurally related to another compound for which there exists a validated BBDR model, consideration of the application of this model to the toxicant being assessed may be warranted.[7] As stated in *Evaluation of BBDR Modeling for Developmental Toxicity: A Workshop Report*, "the challenge is to define…application of a quantitative BBDR model…generalizable to other compounds in a similar class and perhaps to certain other classes of compounds" (Lau et al., 2000). For example, two chemicals might be hypothesized to affect similar TD processes (e.g., activation of a particular receptor), yet a BBDR model may exist for only one of the chemicals. If a PBTK model is available (or can be developed) for the chemical that does not have a corresponding BBDR model, it is conceivable that the existing BBDR model might be sufficient for analyzing both chemicals.

The top line in Figure 4-6 represents a BBDR model for the dose-response of chemical A, where TK_A, TD_A, and R_A represent the TK, TD, and response of interest related to chemical A, respectively. In this scenario, the TD of chemical B (TD_B) is thought to be equivalent to that of chemical A (i.e., both have the same MOA from a TD perspective). If a PBTK model (but not a BBDR model) exists for chemical B (TK_B), then the predicted internal target tissue dose of chemical B can be integrated into the existing BBDR model for chemical A.

[7] Compounds with common TD effects may not necessarily be structurally related.

BBDR model exists for chemical A: $\{TK_A \rightarrow [TD_A = TD_B] \rightarrow R_A\}$

$\uparrow$

PBTK model exists for chemical B: $[TK_B]$

Figure 4-6. Use of BBDR modeling.

A probabilistic risk assessment approach has typically been used in exposure characterization and is increasingly being applied for dose-response characterization as data become available for physiological parameters such as genetic polymorphisms in TK and TD pathways (Beck et al., 2001; Pelekis et al., 2003). When readily measurable, inputs such as exposure dose and duration, intake rate, clearance, and body mass can be expressed as distributions and modeled in such a way as to estimate dose for a particular population, over a certain time frame, or at a specific location. Similarly, lifestage-specific parameters can be employed in order to estimate the variability in dose and response among lifestages (e.g., infants and children).

In regard to noncancer outcomes, one limitation applicable to many of the aforementioned dose-response modeling approaches is that the analyses are based on toxicologic outcomes as opposed to public health outcomes. QRE is a broad-based method for relating human exposures to non-toxicologic outcomes. For example, exposure to 1,2-dibromo-3-chloropropane can be linked to increases in infertility rates through mathematical modeling (Pease et al., 1991). In this regard, it is similar to BMD analysis, but whereas risk is typically defined by percent change (e.g., 1% or 5%) in a biological response (e.g., sperm count), QRE attempts to define risk (e.g., excess infertility cases) for all human exposure levels. The advantage of this approach over BMD is that a noncancer risk can be defined for any individual based on exposure level as is done for cancer assessments. Other examples of this type of analysis include associations among particulate matter and daily mortality and certain measures of morbidity (U.S. EPA, 2005d) and associations between acute ozone exposures and respiratory morbidity and mortality (U.S. EPA, 2005f). An inherent disadvantage to this approach is that acceptable levels of risk must be defined, whereas other approaches to noncancer dose-response modeling arguably rely less on value judgment.

Table 4-4. Examples of lifestage-specific questions for analysis in the range of observation.

Topic	Lifestage-Specific Question(s)
Selection of Dose-Response Models (Section 4.2.3)	What data were used to develop the dose-response curve? Are data available from the lifestage and exposure scenario of interest? Were there differences (e.g., in potency) in the dose-response curves for different lifestages? Was a model used to develop the dose-response curve and, if so, which one? What rationale supports this choice? For example, how was the benchmark response chosen? What modeling approaches are amenable to the available dose-response data? Is there sufficient data to support, for example, the use of biological modeling approaches?

4.2.4. Extrapolations and Risk Derivation from a Lifestage Approach

After PODs have been established from various dose-response studies or modeling techniques, low dose extrapolation is performed in order to derive dose-response values. Again, this may be done for assessments of narrow or broad scope (Section 3.1), and will have regulatory implications for various adjustments in order to extrapolate to the exposure scenarios and lifestages of interest. As described below, these adjustments may involve sophisticated approaches or default approaches that have developed over time. Despite the term *default*, many of these approaches are informed and supported by empirical evidence. For example, empirical analysis supports the use of body weight scaling (see below) to adjust for TK differences across species.

However, the use of more sophisticated techniques does not necessarily result in refinements of final reference or risk values. For instance, a recent assessment of xylenes resulted in nearly identical RfC values using either default approaches starting from a NOAEL or sophisticated PBTK modeling (U.S. EPA, 2003c). Despite the fact that this may be a possible outcome, the use of sophisticated techniques, MOA information, and lifestage analyses certainly improve the confidence that dose-response values (i.e., RfVs and risk values) are health protective. The following subsections describe topics to consider for extrapolations and risk derivation, and example questions are addressed in Table 4-5.

4.2.4.1. *Duration and Route Adjustments*

Experimental animal studies almost always employ discontinuous exposure protocols and therefore use continuous dose adjustment. Although such adjustments are conservative from a risk evaluation standpoint (i.e., they shift the dose-response curve leftward), mathematical adjustments do not necessarily maintain the dose-response relationship (i.e., AUC) that likely

reflects the MOA by which a response is generated. An alternative to continuous dose adjustment is to use PBTK models to determine (*in silico*) an applied dose (continuous or otherwise) that results in the same AUC or C_{max} which simulates that which could have been generated in the experimental animal under the original laboratory study conditions. This may require parameterization with lifestage- and species-specific data. Developmental windows of susceptibility are relatively short, thus the changing underlying biology during development suggests that C_{max} may be a more relevant dose metric in young children than AUC. Since the minimal exposure period to elicit an increased risk is often not known, especially during a window of vulnerability, the choice of exposure period is a critical decision point that integrates TK, TD, and exposure information.

For route-to-route extrapolation, default equivalent dose adjustments can be used. For example, standard mg/kg/day adjustments assume similar TK and TD processes between experimental animals and humans. However, such assumptions are tenuous because different cell types, enzymes, and proliferation rates exist across portals of entry. PBTK models can be used to predict target dose across routes by incorporating route-specific TK factors. A limitation, however, is that route extrapolations are not useful in instances where the critical effects are specific to the portal of entry. For more on route and duration adjustments, see *Approaches for the Application of Physiologically Based Pharmacokinetic (PBPK) Models and Supporting Data in Risk Assessment* (U.S. EPA, 2006b) and *A Review of the Reference Dose and Reference Concentration Processes* (U.S. EPA, 2002a).

4.2.4.2. *Interspecies and Intraspecies Adjustments*

The EPA RfC process describes the interspecies adjustment from experimental animals to human equivalent concentration (HEC) via dosimetric adjustment factors (DAFs) (U.S. EPA, 2002a). For oral exposures, default interspecies extrapolation based on body weight (BW) scaling, either BW^1 or $BW^{3/4}$, have been employed. In particular, $BW^{3/4}$ scaling is typically thought to account for TK differences among species, and therefore, often reduces the interspecies UF from 10 to 3 (U.S. EPA, 2002a). Recent harmonization efforts at EPA advocate the adoption of $BW^{3/4}$ scaling for RfD derivation in instances where there are limited data with which to perform an assessment (U.S. EPA, 2006d). This has been proposed in an effort to harmonize oral RfD methodology with RfC methodology. In addition, this effort also aims to

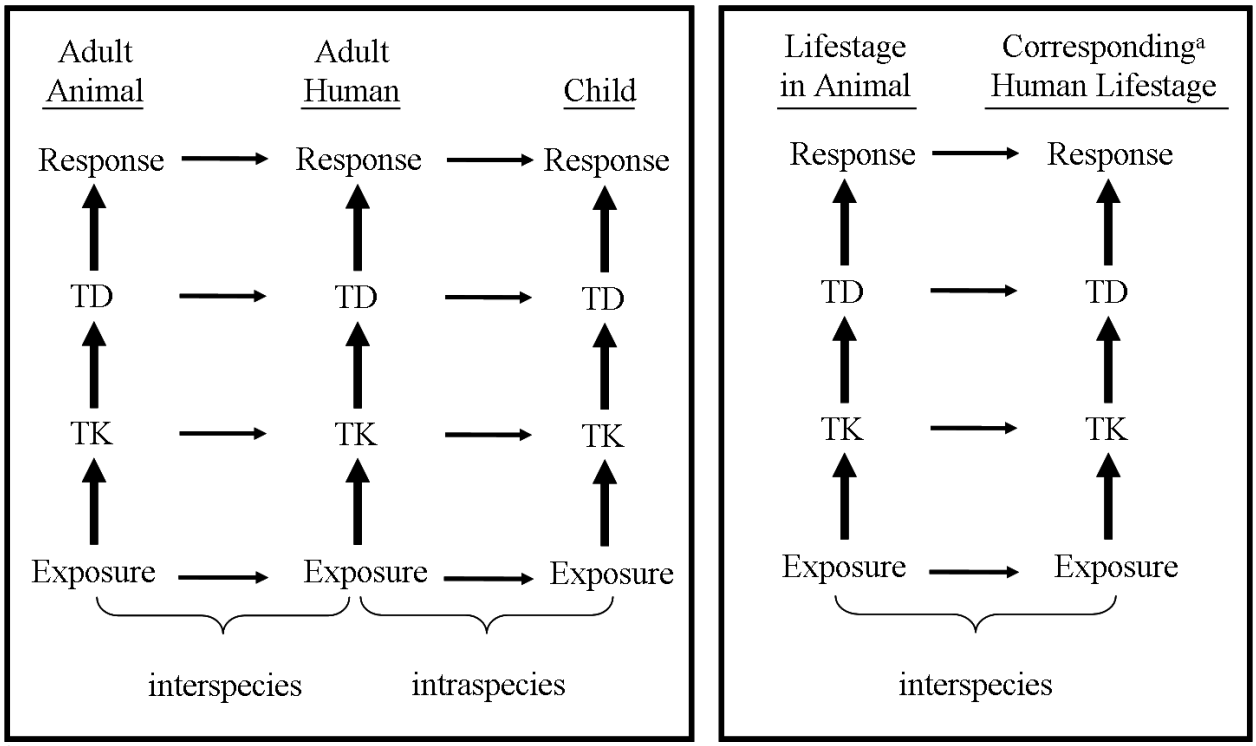
harmonize the use of $BW^{3/4}$ scaling in the application of DAFs for oral cancer assessments (U.S. EPA, 2006a).

For inhalation exposures, DAFs are applied on the basis of physicochemical, anatomical, and physiological parameters. These parameters include such factors as species-to-species ratios of surface area:ventilation rate, blood:gas partition coefficients, and regional deposition dose ratios for particulate matter. In the case of children, it is currently recommended that HECs and human equivalent doses (HEDs) be determined experimentally and theoretically (U.S. EPA, 2002a). In the absence of DAFs, simple ventilation rate adjustments can be made for HECs. Finally, it is worth noting that DAFs are thought to be most appropriately applied for chronic exposures, where the dose metric is likely best represented by AUC; discussion of adjustments for acute exposures can be found elsewhere (U.S. EPA, 2002a).

In addition to interspecies adjustments, $BW^{3/4}$ scaling may also be useful for intraspecies adjustments based on lifestage (U.S. EPA, 2006d). Pharmaceutical data indicate that TK processes (e.g., chemical half life) in children may also scale to $BW^{3/4}$, particularly in children over two months of age (Ginsberg et al., 2002, 2004a,b; Hattis et al., 2004). Under two months of age, however, the immaturity of such processes likely precludes scalability.

When more data are available for carrying out an assessment, lifestage considerations can be incorporated using either intraspecies adjustments or interspecies extrapolation (Figure 4-7). Adjustments across human lifestages from adult to earlier developmental stages includes exposure, TK, and TD considerations (Barton, 2005), and this process can be qualitative or quantitative (Ginsberg et al., 2002). Qualitatively, adult:child ratios for TK processes representing various metabolic pathways can be used to predict the relative difference in TK processes between children and adults for a toxicant that is metabolized by the same pathway. For example, the mean half-lives of several pharmaceuticals metabolized by CYP3A can be compared in adults and children; this ratio could then be used to adjust the intraspecies UF for an environmental toxicant that is known to be metabolized by CYP3A. Quantitatively, adult PBTK models (if available) could be parameterized in order to predict the dose metric in children. The left panel in Figure 4-7 depicts the frequent case where adult animal toxicity data is used to extrapolate to humans. If sufficient data and models are available, a subsequent intraspecies (or lifestage) extrapolation could be performed. The right panel depicts a less-frequent (but preferred) case where toxicity data in a lifestage of interest is used for interspecies extrapolation

to the corresponding lifestage of interest in humans. Importantly, this approach requires a qualitative or quantitative evaluation of how homologous the animal lifestage is relative to the lifestage of interest in humans. In the former case, such TK changes might increase the intraspecies UF with respect to TK consideration; it has been shown, for example, that such differences between adults and infants can exceed 3.2-fold (Hattis et al., 2004). In the latter case, the intraspecies UF may be reduced due to the improved characterization of TK. The advantage to this approach is that assessors may have greater confidence in extrapolating within the human species; on the other hand, this approach requires that the underlying toxic response and MOA are concordant across lifestages. This assumption may add additional uncertainty to the dose-response characterization.



[a]Importantly, this approach requires a qualitative or quantitative evaluation of how homologous the animal lifestage is relative to the lifestage of interest in humans.

Figure 4-7. Interspecies and intraspecies adjustments with lifestage considerations.

More often, however, the data needed for lifestage extrapolation will be available only in experimental animals and thus will often require both qualitative and quantitative adjustments (Barton, 2005) (Figure 4-7, right panel). Qualitative adjustments include determining the

developmental stages in experimental animals and humans that exhibit the same window of susceptibility related to the critical outcome of interest. This may require both empirical evidence and expert judgment. Several articles have examined the relative development of organ systems across species (reviewed in Hurtt and Sandler, 2003a,b; Selevan et al., 2000; WHO, 2006). Quantitative adjustments are then needed to account for the TK differences that exist across species at the equivalent (with respect to the window of susceptibility) lifestages. For instance, rodents are born at an overall developmental stage roughly equivalent to the end of the second human trimester. Thus, if equivalent windows of susceptibility exist at these two different lifestages across species, then altogether different PBTK models and TK data would be needed to calculate the equivalent internal dose, i.e., a lactational model for the rodent and a pregnancy model for the human.

An advantage of this approach is that the assessor starts with age-relevant developmental effects (e.g., two-generation reproduction studies) as opposed to assuming concordance of effects across lifestages. This will likely have the effect of reducing the interspecies UF due to TK adjustments and due to a general increase in confidence that TD differences (if they exist) have been minimized. One caveat is that human data (from controlled exposures or epidemiologic studies) with which to test the predictive capability of the model is often nonexistent. Additionally, if extrapolation requires the use of different model structures (e.g., perinatal exposure in rats and fetal exposure in humans), then each model, with its own inherent uncertainties, may add to the overall uncertainty in the extrapolation (U.S. EPA, 2006b).

Because the majority of data concerning a chemical will pertain to nonhuman species, TK and TD data are important elements for lifestage-specific dose-response characterization. It is for this reason that PBTK and BBDR models have been emphasized for dose-response modeling under the lifestages approach. There are several examples where existing adult models have been adapted to developmental lifestages. Gentry et al. (2003) incorporated new tissue compartments and parameters into a previously published PBTK model for modeling isopropanol and acetone metabolism in adult humans and rats (Clewell et al., 2001). These additions include compartments for the uterus, mammary tissue, placenta, and fetus (Gentry et al., 2003), some of which are modeled to account for growth throughout gestation. Physiological parameter values were derived from numerous previous publications; currently, the EPA is developing relational databases for human and rodent physiological parameters so that these

values become more standardized and reduce some of the variability and uncertainty in PBTK models.[8] Pelekis et al. (2003) demonstrated the use of a lifestage approach by applying probabilistic analysis to a previously published PBTK model. Briefly, this study modeled daily exposure of individuals to dichloromethane from birth to 70 years of age using age-specific physiological parameters, partition coefficients, and CYP2E1 age-specific metabolic data. This model does not take into account age-related differences in exposure, nor are TD factors addressed (Figure 4-7, left panel). Lifestage data have also been used in BBDR modeling. For instance, a BBDR model has been developed for modeling the developmental effects on fetuses following maternal exposure to 5-fluorouracil on gestational day 14 resulting in birth defects and birth weight in rats (Figure 4-7, right panel) (Lau et al., 2000). This model employs a PBTK component that describes the formation of the metabolite, relates the metabolite levels to deoxyribonucleotide pool perturbation, and relates this perturbation to low fetal birth weight (Shuey et al., 1994) and fetal malformation (Lau et al., 2001; Setzer et al., 2001; Shuey et al., 1994).

4.2.4.3. *Low-Dose Extrapolation*

Ideally, extrapolation beyond the range of observation is informed by MOA. When MOA is not known, it is possible that the shape of the dose-response curve can be informative for low-dose extrapolation; however, Lutz et al. (2005) have demonstrated that these shapes can sometimes be misleading. For instance, the linearity of the dose-response curve often seen in epidemiologic studies may be due in part to interindividual genetic and life style differences as well as other issues related to epidemiologic studies such as difficulties in dose reconstruction. Conversely, Lutz et al. (2005) also demonstrated that animal bioassay studies that suggest a threshold effect may be misleading. For instance, *in silico* simulations of dose-response relationships can result in threshold (or J-shaped) relationships by chance; thus animal bioassays, often unrepeated, may suggest a relationship that does not exist in reality. Conolly et al. (2005), also using *in silico* methods, demonstrated that modeling of adaptive responses to DNA damage can result in both linear and threshold dose-response relationships depending upon model

[8] Conversely, these databases can be used to incorporate variability in physiological parameters into probabilistic modeling techniques.

assumptions. Taken together, these studies highlight the importance of a strong understanding of MOA for choosing the most appropriate low-dose extrapolation approach.

The *Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005a) advocate an MOA approach to low-dose extrapolation of cancer outcomes, where low-dose linear extrapolation is performed when a carcinogen is thought to act through a linear MOA (e.g., mutagenesis) or when the MOA for a carcinogen is not understood. This is based, in part, on the concept of additivity (Crump et al., 1976), where any amount of a carcinogen adds to the underlying biological processes that are responsible for the background incidence of a particular cancer.

Nonlinear extrapolation is used when the MOA can be demonstrated to result from a threshold (i.e., nonlinear) MOA and can be used for both cancer and noncancer outcomes. Although nonlinear extrapolation approaches are frequently used for noncancer outcomes, risk based approaches to noncancer outcome low-dose extrapolation, with potential relevance to cost-benefit analysis, have been proposed (Clewell and Crump, 2005; Gaylor and Kodell, 2002). There may also be biological support for low-dose linear extrapolation for certain noncancer outcomes. For example, 1,2-dibromo-3-chloropropane is thought to reduce sperm count by interaction with DNA (Pease et al., 1991); thus, like for mutagens, there may be a scientific rationale for using low-dose linear extrapolation for this compound.

4.2.4.4. *Reference and Risk Value Derivation*

Lifestage extrapolations for RfV and risk value derivations can affect the magnitude of the UFs applied in the final risk value derivation. Current practices for RfC and RfD derivation and the application of UFs are outlined in *A Review of the Reference Dose and Reference Concentration Processes* (U.S. EPA, 2002a). New guidance on CSF derivation from early-life exposure to environmental agents can be found in the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b). In brief, the new guidance states that for toxicants acting through a mutagenic MOA where data concerning early life susceptibility are lacking, early life susceptibility should be assumed and the following age-dependent adjustment factors (ADAFs) should be applied to the CSF:

- 10-fold for exposure occurring before 2 years of age
- 3-fold for exposure occurring between the ages of 2 and 16
- no adjustment after 16 years of age

No such adjustments are advocated for toxicants with either an unknown or non-mutagenic MOA. These adjustments are based, in part, on analyses indicating an increased incidence of tumor formation from early-life exposure as compared to adult exposure.

Historically, lifestage-related uncertainties have been folded into the database UF when the MOA is nonlinear. Lifestage-specific data gaps do not necessarily imply a greater database UF; rather, the method helps focus attention on the most critical data gaps deserving of additional uncertainty weighting. This additional weighting following uncertainty analysis (Section 4.2.7) would support prioritization of data needs. Indeed, the rationale for using the lifestage approach is to better characterize individual risk and thus decrease uncertainty in risk assessment.

Table 4-5. Examples of lifestage-specific questions for extrapolations and risk derivation.

Topic	Lifestage-Specific Question(s)
Duration and Route Adjustments (Section 4.2.4.1)	Do default duration adjustments maintain the relationship between exposure and response? Are the effects specific to the portal of entry? Can existing models be used to extrapolate to the lifestage-specific exposure scenario of interest using PBTK models?
Interspecies and Intraspecies Adjustments (Section 4.2.4.2)	Should the same interspecies factors (e.g., DAFs) be applied in deriving HECs and human equivalent doses for all lifestages? Can developmental lifestage dose-response characterization be conducted based on adult animal or human data (Figure 4-7)? Can developmental lifestage dose-response characterization be conducted based on developmental lifestage animal data (Figure 4-7)? What data are available to perform extrapolations for developmental lifestages?
Low-Dose Extrapolation (Section 4.2.4.3)	Is the MOA known? Is the chemical a known mutagen? Do statistical modeling approaches result in reasonable results in the low-dose range? Are PBTK models available? Can, for instance, a BMD_{10} be based on internal dose metric rather than applied dose?
Reference and Risk Value Derivation (Section 4.2.4.4)	Is the toxicant of interest mutagenic? If so, is there sufficient data to argue against using an ADAF? Have inter- and intra-species TK and TD differences been addressed through modeling? Are there significant concerns about a missing lifestage? What impact will this have on the database UF?

4.2.5. Variability Analysis

Variability analysis evaluates the range of values for a parameter in a population. This is particularly useful when sensitivity analysis has identified a key parameter as having a significant impact on model output. When an outcome is predicted to be sensitive to certain

parameters, probabilistic approaches (e.g., Monte Carlo simulation) can be incorporated into models (U.S. EPA, 2006b). This type of analysis, for instance, allows assessors to predict upper and lower bounds on a dose metric level in an experimental species; thus multiple calculations of the relevant exposure concentration for humans could be calculated and perhaps used for subsequent risk derivation.

Model evaluation may not be the final step in the dose-response process. Sensitive parameters provide red flags that are examined carefully for variability of these parameters within the population. Alternatively, the sensitivity might suggest the need for careful examination and consideration of susceptible lifestages. Example questions regarding dose-response variability are in Table 4-6.

4.2.6. Sensitivity Analysis

Sensitivity analysis allows risk assessors to examine which parameters in a model are most important to the outcome of concern. This analysis is a key evaluation technique for PBTK models. This analysis can identify the key parameters that can be further examined for accuracy, either through available data or estimation. In addition, selection of sensitive parameters could help in identifying more susceptible lifestages. For instance, model sensitivity to ventilation rate provides a starting point for addressing lifestage differences. Example questions regarding dose-response sensitivity are in Table 4-6.

4.2.7. Uncertainty Analysis

Uncertainty analysis can have both quantitative and qualitative components. Model uncertainty comprises that which is unknown about how well a model reflects the underlying biology. Models are approximations of biological processes, and therefore, have inherent shortfalls. Quantitative elements include model structure, choice of dose metric, and extrapolation procedures. Often these elements can be altered in order to compare model results. Results from this type of analysis, together with reasons supporting the various choices used in each model, can be expressed as subjective probabilities that each model is correct. Qualitative elements of uncertainty analysis include such things as choice of experimental animal species or the applicability of experimental animal species to the human lifestage of interest (Section 4.2.4.2). These particular efforts enhance the scientific underpinnings of the dose-response

characterization and are explicitly carried forward in the dose-response narrative (Section 4.2.9) through to the risk characterization (Chapter 5). See the final *Approaches for the Application of Physiologically Based Pharmacokinetic (PBPK) Models and Supporting Data in Risk Assessment* (U.S. EPA, 2006b) for an in-depth treatment of PBTK model evaluation. Example questions regarding dose-response uncertainty are in Table 4-6.

Table 4-6. Examples of lifestage-specific questions for dose-response variability, sensitivity, and uncertainty analyses.

Topic	Lifestage-Specific Question(s)
Variability Analysis (Section 4.2.5)	How has variability been incorporated into a dose-response model? Have "average" individuals for one or more age groups been modeled, or has population variability (across age groups) been incorporated using probabilistic approaches? Are the differences in model outcomes among different age groups or the entire population greater or lesser than the typical intraspecies UF of 10?
Sensitivity Analysis (Section 4.2.6)	What lifestage-specific parameters (inputs) have been included in the dose-response model? What parameters have the greatest influence on the dose-response model outcome? Are the parameters to which a model is most sensitive likely to vary across lifestages? What is the likely impact of such differences on model predictions?
Uncertainty Analysis (Section 4.2.7)	Can the outcomes of multiple dose-response models and/or multiple variations (e.g., structures or curve fits) of such models be compared? How much do these outcomes differ? Can variability and uncertainty in a parameter be distinguished from one another? Is the variability true variation or is it a large component uncertainty that can be reduced through more lifestage-specific data collection or research?

4.2.8. Iteration with Hazard and Exposure Characterization

During the dose-response characterization, situations may arise where information obtained can lead to iteration with hazard characterization (Section 4.1). For instance, it is conceivable that evaluation of a PBTK model could lead to the conclusion that the model inadequately predicts empirical data. While this could be due to deficiencies in the model, it could also suggest that the dose metric previously hypothesized to be associated with a response may not be correct and thus may require a re-evaluation of the MOA. Such a situation may arise when the dose-response relationship between exposure and response does not become clearer when based on an internal dose metric.

Analysis of dose-response data could also warrant re-examination of the exposure characterization (Section 4.3). For example, data that indicate a sensitive dose-response relationship at environmentally relevant low-exposure levels, particularly in the context of precursor events, may suggest that certain exposure scenarios are more important than initially

thought and perhaps be an impetus for further characterization and refinement of exposure models employed for predicting external doses.

4.2.9. Lifestage-Specific Dose-Response Characterization Narrative

The dose-response narrative summarizes recommended estimates, data supporting those estimates, modeling approaches, a POD narrative, key default assumptions, uncertainty, sensitivity, and variability. The narrative also provides identification of susceptible lifestages and quantification of their susceptibility. A discussion of the strengths and limitations of the dose-response characterization are presented, highlighting significant issues in developing risk values, including alternative approaches considered equally plausible, and how these issues were resolved. Dose-response estimates may be accompanied by the descriptors used in the WOE evaluation (Section 4.1.3.1). For instance, a toxicant may be described as "likely to be carcinogenic to humans" when exposed by "oral route" (U.S. EPA, 2005a). In this regard, risk managers will be able to put each estimate into context. Questions to ask during the dose-response characterization narrative include the following:

- What were the results of variability, sensitivity, and uncertainty analyses?
- Are there data needs that should be highlighted to direct future research (by various scientific bodies and processes)?
- Are there lessons/implications for past, current, or future assessments?

4.3. LIFESTAGE-SPECIFIC EXPOSURE CHARACTERIZATION

4.3.1. Introduction

Exposure characterization is the analysis step in which human interaction with the environmental agent of concern is evaluated. Exposure (sometimes referred to as potential dose) is the pattern of contact of an individual with a toxic agent. To characterize exposure, an assessor needs information on the concentrations of a pollutant in exposure media, the activities that result in contact, and the transfer rates from the exposure media to the individual. Exposure results in an internal dose when the agent is transferred into and taken up by the body. Clearly, not all exposures will result in a significant dose (e.g., contaminated hands may be washed before dermal absorption or oral transfer can occur). Yet, it is the dose at the target tissue that will ultimately cause health effects. The primary purpose of a lifestage-specific exposure

characterization is to get a detailed description of the potential for exposure during preconception or developmental lifestages.

Exposure characterization (Figure 4-8) begins in the problem formulation phase (Chapter 3) with identification of potential sources, pathways, and scenarios. The resulting conceptual model (Section 3.2) is used to guide collection of available exposure data and other required information for exposure characterization. The assessor identifies and evaluates potentially significant exposure scenarios in order to conduct a lifestage-specific exposure characterization. Variability, sensitivity, and uncertainty analyses are conducted to determine impact of the available exposure data on the resulting analysis. The results of the exposure characterization are iterated with the hazard and dose-response characterizations if a critical window of susceptibility is identified that was not considered in the initial exposure characterization or if an important exposure period is identified that was not considered in the hazard or dose-response characterization. Finally, the assessor writes a summary of the exposure characterization, which includes a discussion of the confidence in the analysis results based on available data. This information feeds into the comprehensive lifestage-specific risk characterization (Chapter 5).

Throughout the exposure characterization, the assessor keeps in mind the relevance of the information to the overall goals of the assessment. It may be appropriate to refine the conceptual model (Section 3.2) or analysis plan (Section 3.3) after more thoroughly evaluating the available exposure data. For example, a conceptual model may focus on exposure to a chemical that is transformed in the environment before there is potential for a child to contact the agent. If the final form of the compound relevant for exposure was not considered in the conceptual model, then the conceptual model will need to be refined to consider all relevant agents.

4.3.2. Evaluation of Available Exposure Data

The objectives and scope of the risk assessment, defined in the problem formulation phase (Chapter 3), provide focus for identifying all the relevant human exposure data and other required information. To characterize exposure for a broad (e.g., national-scale) risk assessment will require distributional exposure factor data for all relevant lifestages. A narrow (e.g., site-specific) assessment will require measured or modeled environmental concentrations to estimate potentially significant exposures for all relevant lifestages.

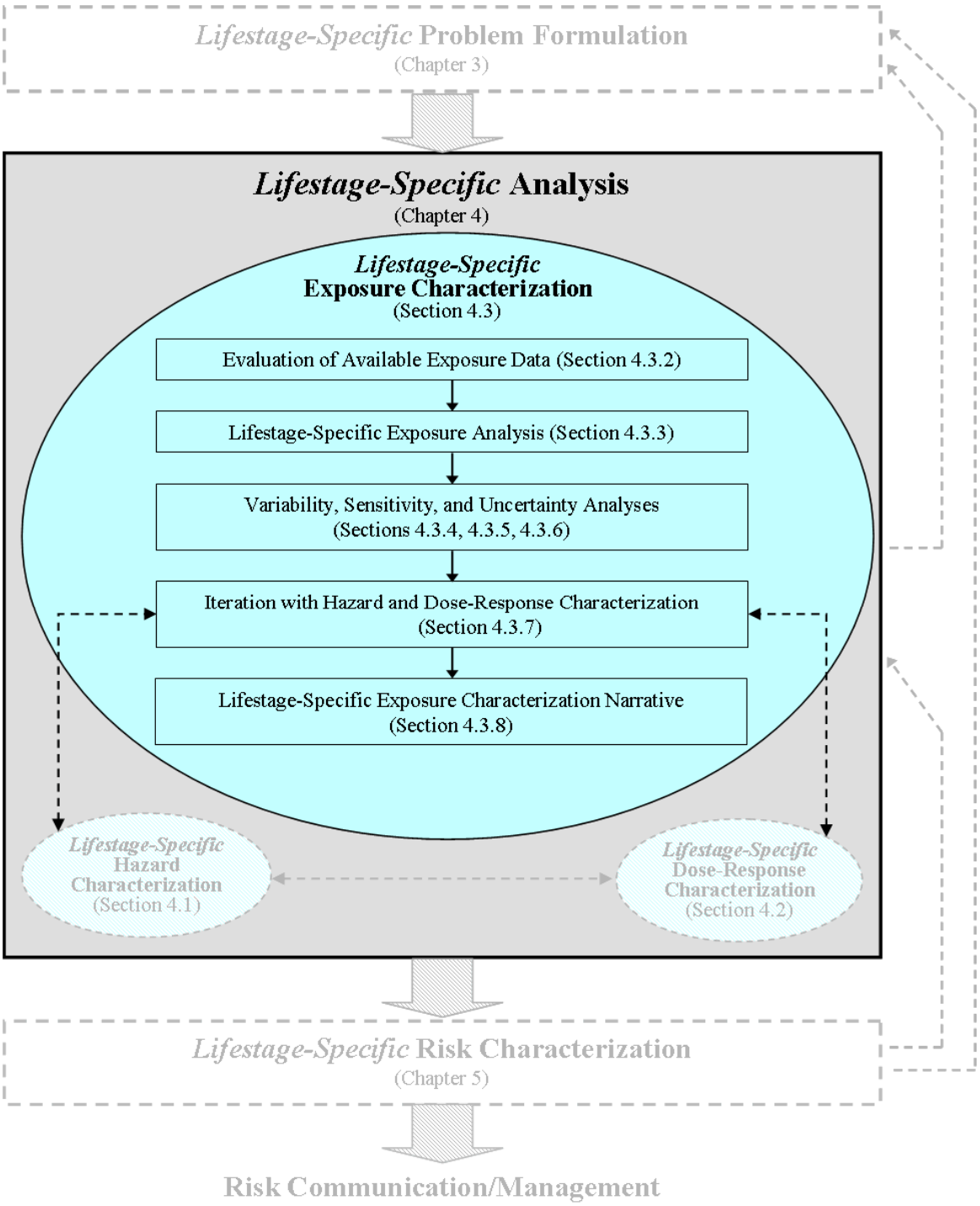


Figure 4-8. Flow diagram for lifestage-specific exposure characterization. Using the lifestage-specific exposure information identified in problem formulation (Chapter 3), exposure is estimated using a tiered approach. The lifestage-specific exposure is characterized by discussing the variability and uncertainty in the results. Key sources of variability and uncertainty can be assessed using sensitivity analysis. Iteration with hazard characterization (Section 4.1) and dose-response characterization (Section 4.2) (illustrated by dashed arrows) occurs throughout this process to ensure that critical windows of exposure are considered.

To focus on risk from exposure to children, the most appropriate data will be on sources and exposure media concentrations that have been identified in the locations where children spend time, which may change by developmental lifestage. For example, sources may be identified in

- residence and workplace for pregnant and lactating women;
- residence, daycare, and outdoor play areas for infants and toddlers;
- residence, school, and locations of after-school activities for school-age children; and
- residence, school, and locations of after-school activities and workplace for adolescents.

For a given source, exposure media (e.g., water, soil/dust/sediments, food, and objects/surfaces) and exposure routes (i.e., inhalation, ingestion, dermal absorption, and indirect ingestion) define the pathway of exposure (U.S. EPA, 2002c, 2003a). Figure 4-9 highlights the stages of development and their relevant exposure routes. The result of evaluating the exposure data would be a table in which potential exposure routes are identified for each exposure medium (direct and indirect) (Hubal et al., 2000).

Exposure media may also change with lifestage. For example, the fetus will be exposed to cord blood and amniotic fluid, the infant to breast milk, the teething child to many objects for mouthing, the school-age child to pesticides used in the classroom, and the adolescent to vocational or recreational hazards.

For any given pathway, a set of associated exposure scenarios describes how an exposure takes place and is used to estimate distribution of exposure. An exposure scenario is defined by the combination of all the discussed details (Hubal et al., 2000). Example questions for refining life-stage specific scenarios to facilitate exposure analysis are presented in Table 4-7.

Children may experience unique exposure patterns that are important to consider in relation to their kinetic development and critical windows for effects. Therefore, the assessor must carefully consider the temporal scale for estimating exposures and doses in children. Exposure estimates may be presented as

- peak doses
- exposures occurring over a very short period of time (e.g., minutes)
- time weighted averages (e.g., TWA over 8 hours)
- single day doses (representing the sum over 24 hours)

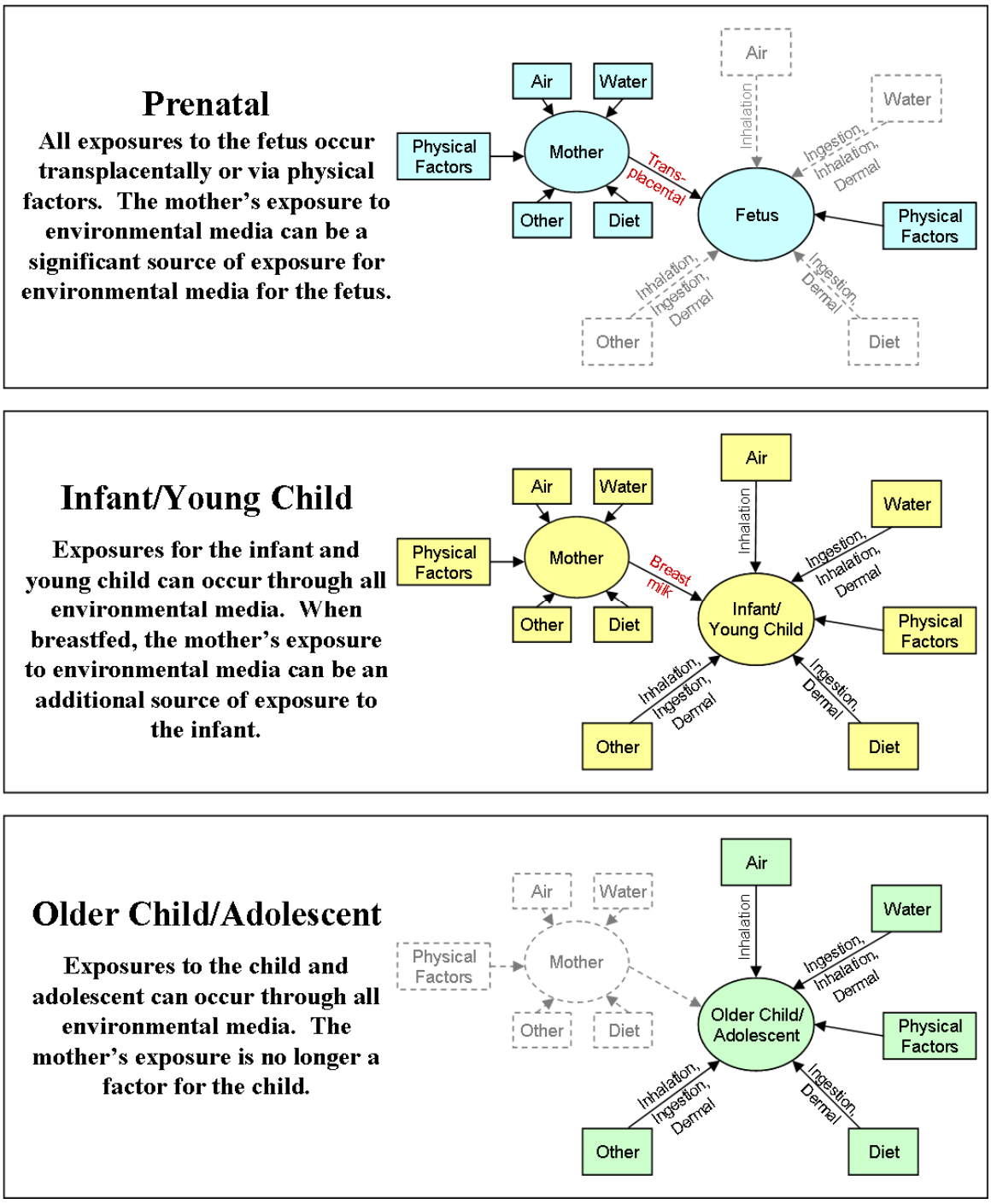


Figure 4-9. Exposure routes during developmental lifestages. The solid lines represent relevant exposure, while dotted lines represent exposures that are not relevant to the specific lifestage. During gestation, the majority of exposures (except for physical factors) occur transplacentally through exposure to the mother. After birth, exposures may either be directly to the child, with an additional route from the mother for those agents that may be present in human milk.

Table 4-7. Examples of lifestage-specific questions for scenario development.

Sources of Exposure	What are the sources of exposure to chemicals or agents that are of special concern for children? Where in the environment can the child come into contact with the chemical? In what quantities? If it is a consumer product, how is it used by children?
Pathways of Exposure	What are all the potential exposure media (e.g., breast milk)? What are all the potential exposure routes (hand-to-mouth ingestion)? What are the specific pathways that may be of concern for children (e.g., absorption from amniotic fluid, ingesting breast milk, ingestion of food eaten off contaminated floor)? How are parents and/or children being exposed, from the source to the absorbed dose, for all pathways of exposure?
Lifestages of Exposure	What are the potentially exposed lifestages? Are there any community factors that may put a subgroup of children at higher risk (e.g., ethnic, cultural, racial, or socioeconomic groups)? Are there any individual characteristics that may put an individual child at higher risk (e.g., health status, nutritional status, genetic susceptibility)?
Exposure Patterns	What is the relevant time frame of exposure (e.g., acute, short term, chronic, intermittent)?
Locations of Exposure	What are the potential locations of exposure (e.g., in utero, residence, school, outdoors, indoors)? Are there other relevant factors that may be relevant for identifying exposure scenarios for specific lifestages? Geographical location? Urban, rural? Near water bodies? Near parks? Near industrial sites?
Activities and Behaviors	What are the potential activities (e.g., mouthing, playing soccer, mowing lawns) at the lifestages of concern that may lead to exposure? What developmental stage-specific behaviors may lead to contact with the chemicals? How do the behaviors vary among children of various ages?

- short-term average daily doses (e.g., averaged over a month or a year)
- lifetime average daily doses

A potential problem with the time integration of exposure estimates is that the pattern of exposure can be obscured. If the exposure pattern is relatively continuous and at a constant level, the time averaged doses will be close in magnitude to single-day dose estimates and will match actual human experience. However, when infrequent exposure events of high magnitude and short duration are averaged, they are equated with continuous, lower-level exposures that do not match human experience.

The following subsections describe information required to characterize exposure. Data and other information used to assess exposure include chemical properties, environmental sources, fate and transport (Section 4.3.2.1), environmental media concentrations (Section 4.3.2.2), lifestage-specific exposure measurement data (Section 4.3.2.3), lifestage-specific exposure factors (Section 4.3.2.4), and cumulative evaluation of environmental stressors (Section 4.3.2.5). Although there have been several large human exposure studies conducted to collect

integrated data on environmental concentrations, personal exposure measurements, and time-activity data (e.g., *Human Exposure Measurements: National Human Exposure Assessment Survey* [NHEXAS][9]), these studies have focused on the adult lifestage. As such, these data may be useful for characterizing preconception exposures to the parent but less so for accurately characterizing exposures to pregnant women and to very young children. Nevertheless, these provide a significant data source that should be evaluated with respect to the utility for addressing the significant life-stage exposures of a given assessment. The Human Exposure Database System (HEDS)[10] is an integrated database system that contains information related to many of these EPA human exposure research studies. Some additional life-stage specific resources are described in the following subsections and example questions for each section are presented in Table 4-8.

4.3.2.1. *Chemical Properties, Environmental Sources, Fate, and Transport*

An agent of concern may be released into the ambient environment from multiple sources (e.g., industrial, agricultural, mobile, household, and natural sources). Also, the agent of concern may be released directly into exposure media (e.g., via occupational activities, residential use of consumer products, and cooking activities) of direct concern for a lifestage-specific assessment.

Once a chemical is released into the environment, it may be chemically modified or transported, in its original or transformed state, into an exposure medium of concern for children (e.g., outdoor air, residential water, food, and/or breast milk). Scientists and engineers can predict the environmental movement of a chemical using information on chemical properties (e.g., volatilization rate, water solubility, soil/water partitioning coefficients, chemical state, and bioavailability) and environmental conditions (e.g., soil characteristics, amount of rainfall, wind direction, and presence of water bodies). Information on the form, fate and transport of the agents in the residential environment is also required for exposure characterization and can be predicted based on properties of the chemicals and residential environment (e.g., size of rooms, surface types, air exchange).

Information on these types of releases and associated fate and transport may be generally required for risk assessment and is not lifestage specific. However, information on chemical

[9] The NHEXAS database is available online at http://www.epa.gov/heasd/edrb/nhexas.htm.
[10] The HEDS database is available online at http://www.epa.gov/heds.

properties is required to identify potential lifestage concerns as well as particular scenarios and pathways that may be of particular concern for children. For example, if a chemical is lipid soluble, an infant's ingestion of breast milk may be an important route of exposure to consider. As another example, if a chemical is highly volatile, the inhalation pathway will be of particular concern because on a body-mass basis, young children have higher ventilation rates than adults.

4.3.2.2. *Environmental Media Concentrations*

Exposure characterization requires information on contaminant concentrations in the exposure media in the environment where the individual spends time. Contaminant concentrations can be measured directly in the exposure medium of interest or predicted by using information on the release of the contaminant and subsequent fate and transport in the environment. Site-specific assessments will require measured and/or model information on concentrations of an agent in the relevant media (e.g., soil, water, indoor air). For broad (e.g., population-based) assessments, information may be available in the literature.

The largest exposure study conducted to collect exposure media concentration data for children is A Pilot Study of Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants (CTEPP) (Morgan et al., 2006). In this study, concentrations of a wide range of environmental contaminants were measured in multiple media in the homes and daycares of children from ages 3 to 5 years. Exposure media concentration data was also collected for children in the Minnesota NHEXAS study (Adgate et al., 2004). Recently there has also been considerable research conducted to develop residential models for several environmental contaminants including pesticides (Stout and Mason, 2003) and pthalates (Xu and Little, 2006). These models use data collected in controlled laboratory settings and test house situations and may provide insight into potential pathways for lifestage-specific exposures.

4.3.2.3. *Lifestage-Specific Exposure Measurement Data*

Additional data may also be available that provide a more direct measure of exposure. Personal monitoring techniques, such as the collection of personal air or duplicate diet samples, are used to directly measure exposure to an individual during particular time intervals. In children especially, different factors might affect the child's dose. It is important to give consideration to measurement techniques at the physical locations where the child spends his/her

time (e.g., home, school, daycare) as well as the child's characteristics and behaviors. For example, the breathing zone of a child is closer to the floor than the breathing zone of an adult, and concentrations of chemicals that are heavier than air may be higher in areas closer to the ground. Some of these types of data are available in the CTEPP study (Morgan et al., 2006) and in other smaller studies that have been published in the literature (Adgate et al., 2004; Cohen Hubal et al., 2006; Liu et al., 2003; MacIntosh et al., 2001).

For some environmental contaminants, biomarkers can serve as a useful measure of direct exposure aggregated over all sources and pathways. However, few studies using biomarkers have collected all the information required to accurately estimate exposure. The most significant source of biomonitoring information is the *Third National Report on Human Exposure to Environmental Chemicals* (CDC, 2005), collected as part of the National Health and Nutrition Examination Survey (NHANES) study.[11] This study measured a wide range of chemicals in the blood and urine of a representative sample of the U.S. population. However, young children (under 6 years) are only monitored for a select group of chemicals in this study (lead, mercury, pthalates, and organophosphates). Other lifestage-specific biomonitoring data have been collected in studies conducted by the National Institute of Environmental Health Sciences (NIEHS)/EPA Centers for Children's Environmental Health and Disease Prevention Research (Kimmel et al., 2005). Several of these centers have collected data from a variety of biological media from both pregnant mothers and their infants. Additional information on collection and interpretation of biomonitoring data for lifestage-specific exposure characterization is presented by Barr et al. (2005).

It is important to note that biomonitoring data may demonstrate exposure, although it may be difficult to translate into estimates of exposure. Biomonitoring may be useful for quantifying exposures at the population level, if the relationship between the substance found in the body and the amount of substance the child was in contact with can be established. Currently, there are significant research efforts associated with interpreting biomonitoring data for assessing human exposure to environmental agents (Albertini et al., 2006; NRC, 2006).

[11] Details on the NHANES study are available online at http://www.cdc.gov/nchs/nhanes.htm.

4.3.2.4. *Lifestage-Specific Exposure Factors*

In addition to information on sources, exposure media concentrations, and human exposure measurements, exposure factor data (time-activity data; product use; and air, fluid, and dietary intake rates) are required to characterize exposure. Information is required on activities and behaviors that result in significant exposures (e.g., breast feeding, mouthing, sports, after-school employment) for each lifestage. The most current version of *Child-Specific Exposure Factors Handbook* (U.S. EPA, 2002c) could be the starting point for identifying these values. The purposes of the *Child-Specific Exposure Factors Handbook* are to summarize key data on human behaviors and characteristics that affect children's exposure to environmental contaminants and to recommend values to use for these factors. Data contained in the handbook includes drinking water consumption; soil ingestion; inhalation rates; dermal factors including skin surface area and soil adherence factors; consumption of produce, fish, meats, dairy products, homegrown foods, and breast milk; activity patterns; body weight; and consumer products. Age-specific activity data are also available from the *Consolidated Human Activity Database* (CHAD).[12]

Within each lifestage there may be a series of critical developmental periods for which exposure could be characterized. These periods may be defined on the basis of exposures that can affect development (e.g., parental preconception exposures, U.S. EPA, 1991, 1996), or windows of potentially high exposure due to age-specific behaviors (e.g., crawling, teething), activities (e.g., types of sport/other activities, length of sport seasons, physical education requirements), and physiology. Behavior varies by developmental stage, and this may have a significant impact on exposure.

EPA has recommended a standard set of age groups (Table 3-1) for exposure assessors to consider when assessing childhood exposure and potential dose to environmental contaminants and for purposes of designing exposure monitoring studies (U.S. EPA, 2005e). These age groups reflect a consideration of developmental changes in various behavioral, anatomical, and physiologic characteristics that impact exposure and potential dose. Data from the *Child-Specific Exposure Factors Handbook* emphasize the value of independently assessing the relevant age group where sufficient data are available. In the case of vegetable intake, data indicate that biases are introduced when combining age groups, especially for the <1-year-olds

[12] The CHAD database is available online at http://www.epa.gov/chadnet1/.

because children 6 to <12 months eat three times as many vegetables than children 3 to <6 months old.

Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants (U.S EPA, 2005e) also recognizes that exposure factors data may not be available for many of the recommended age groupings or that a specific age group may not need to be the subject of a particular assessment; therefore, flexibility and professional judgment is essential in applying these generic age groupings. There may be instances where combining some of these age groups (e.g., combining the first three groups into one representing birth to < 6 months) could be considered when estimating exposure or potential dose, especially if little variation is expected. For example, there is little variation in ventilation rates for children between 11 and 18 years. Therefore, these age categories can be combined into one age group representing 11 to <18 years. In addition, there may be instances where it is not necessary to address every age group in Table 3-1 because the focus of a risk assessment may be on toxicity data that indicate a health effect for which only one or two of the age groups represent a critical window.

Exposure factors and resulting effects during developmental stages may be a function of additional individual and population characteristics. These factors may be characteristics of the communities in which children live and include, for example, SES, family size, ethnicity, cultural setting, geographical location, and seasonal considerations (e.g., temperature, humidity, rainfall, sun exposure). Other factors specific to the individual child include genetic susceptibility, nutritional status, and health status. Mechanisms of vulnerabilities associated with individual and community characteristics include differences in susceptibility, differential exposure, differential preparedness, and differential ability to recover. These mechanisms are defined and discussed in the *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003a, pp. 39–42). Discussion on other risk factors, effect modifiers, and confounders is detailed in *Guidelines for Developmental Toxicity Risk Assessment* (U.S. EPA, 1991, Section 3.1.2.1.1.c, pp. 24–25) and *Guidelines for Reproductive Toxicity Risk Assessment* (U.S. EPA, 1996, Section 3.3.1.5.3, pp. 60–61).

4.3.2.5. *Cumulative Evaluation of Environmental Stressors*

The focus of this section is the examination of vulnerability associated with differential exposure due to lifestage. It is difficult to separate consideration of vulnerability due to lifestage from consideration of vulnerability due to other key individual (e.g., ethnicity, dietary preferences) and community characteristics (e.g., social and physical home environment, religious/cultural practices) that may influence or modify exposures. In order to fully characterize risk to children, consideration could include environmental heath disparities (e.g., residential segregation) (Gee and Payne-Sturges, 2004) and the built environment (e.g., design and integrity of housing, land use and planning) (Cummins and Jackson, 2001).

EPA is examining the full range of issues related to characterizing risks to children through a variety of initiatives, including development of *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003a). As EPA develops further guidance for cumulative risk assessment, the full range of vulnerabilities will be considered more consistently in both hazard characterization (Section 4.1) and exposure characterization. A child-centered approach (Section 3.2.3) to cumulative risk assessment may be useful in moving these issues forward (WHO, 2006, Chapter 5).

Table 4-8. Examples of lifestage-specific questions for evaluation of the available exposure data.

Topic	Lifestage-Specific Question(s)
Chemical Properties, Environmental Sources, Fate, and Transport (Section 4.3.2.1)	What are the physical and chemical properties of the chemicals or agents? What is known about their fate and transport? What are the environmental conditions (e.g., wind direction, rainfall) that may affect the fate and transport of the chemical(s)? In the case of a release of an air pollutant, are there areas highly populated by children that are downwind from the release (e.g., schools, play grounds)? What are potential chemical sources (industrial, agricultural, occupational, residential, consumer product) of the compound? What are the release rates from the chemical source? What is known about the manufacturing processes that may lead to information about where the chemical can be found (e.g., children's toys, play ground equipment, certain foods)? Are there data on the temporal and spatial patterns of compound release and transport relevant for specific lifestages? Is the release from the source continuous, periodic, or intermittent? What does the fate of the compound imply for exposure? Is the exposure to the released compound a byproduct created in the manufacturing process or a degradation product? If not, what are the compounds that should be assessed?
Environmental Media Concentrations	What are the concentrations of the chemicals in various media (e.g., air, water, food, breast milk, on surfaces, in consumer products) that the child may come into contact with during an exposure?

(Section 4.3.2.2)	Are the ranges and distributions of environmental media concentration data relevant for children's exposure? What bioavailability data are there for the chemical(s) from the various exposure media? How are the concentrations in environmental media changing over time? Are these intermittent? If environmental monitoring data are not available, are there models that can be used to predict the concentration at the exposure point?
Lifestage-Specific Exposure Measurement Data (Section 4.3.2.3)	Are relevant exposure measurements available for various lifestages (parents, infants, and children)? Are these direct or indirect measurements of exposure (e.g., personal air, handwipes, duplicate diet, biomarkers of exposure)? Are there biomonitoring data that demonstrate exposure potential? Is additional information available to use the biomonitoring data to estimate a population's exposure? Are there lifestage-specific data in biological media (e.g., maternal cord blood, placenta, meconium)? Can these be used to estimate exposure or to indicate potentially critical windows of exposure?
Lifestage-Specific Exposure Factors (Section 4.3.2.4)	What are the child-specific exposure factors (U.S. EPA, 2002c) that characterize the exposure scenarios? What are the ranges or distributions of exposure factors for relevant lifestages? Are time-activity data available for all relevant lifestages? Are dietary data available for all relevant lifestages? How do differences in diet during specific lifestages impact exposure? Are product-use data available for all relevant lifestages (e.g., pregnant women, children)? Are the products used by children or in proximity of children? Are data available for other children's exposure factors (e.g., contact rates for the individual with exposure media, contaminant transfer efficiency from the contaminated medium to the individual)? Do children's physiological parameters influence exposure to the specific agent (e.g., body weight, uptake rates – inhalation, dermal absorption, gastrointestinal absorption)? If so, are there data available (Hattis, 2004)?
Cumulative Evaluation of Environmental Stressors (Section 4.3.2.5)	Are there data indicating potentially important co-exposures with chemicals that may interact to increase health risk for a sensitive lifestage? Are there data on relevant non-chemical stressors that may impact exposure and/or increase vulnerability of specific lifestages (e.g. SES, health status)? Are there any community factors that may put a subgroup of children at higher risk (e.g., ethnic, cultural, racial, or socioeconomic groups)? Are there any individual characteristics that may put an individual child at higher risk (e.g., health status, nutritional status, genetic susceptibility)?

4.3.3. Lifestage-Specific Exposure Analysis

Based on the data and information identified for exposure characterization (Section 4.3.2), the scenarios developed during problem formulation (Chapter 3) could be refined to facilitate exposure analysis. Exposure estimates may be developed for all relevant lifestage-specific scenarios. At this point in the assessment, patterns of exposure will be characterized (intermittent, continuous, acute, or chronic) and exposure levels will be quantified. Because children may have higher exposures (Section 4.3.2.4) or because they may experience unique

exposure patterns (Section 4.3.2.5), exposures may be significant during critical windows, which can then affect the outcomes observed.

The health effect of concern is considered when selecting the appropriate temporal scale for estimating exposure/dose. Depending upon the problem, it may be important to consider peak exposures as well as exposures that have been averaged over a specified period of time (U.S. EPA, 2005e). Assessments of agents with multiple sources or in multiple media may require additional analysis to estimate children's exposure patterns. This would indicate that even for a screening-level analysis (Section 4.3.3.2.1), a large number of factors may need to be collected and tracked, along with their associated variabilities and uncertainties. Thus to efficiently and effectively assess children's exposures, a person/population-oriented approach (Section 3.2.1) may be needed for all but the most basic assessments.

To conduct the lifestage-specific exposure characterization, a calculation approach described in Section 4.3.3.1 is selected on the basis of available data and the risk assessment questions that were defined during the problem formulation phase (Chapter 3). Typically, an exposure characterization will begin with a screening-level assessment (Section 4.3.3.2.1) and then, if there appear to be significant exposures or an unacceptable level of uncertainty, a second, more refined level of analysis will be conducted (Section 4.3.3.2.2). This type of tiered level analysis is often used to facilitate efficient allocation of resources. Often, two or more calculation approaches will be used and the results compared in the exposure characterization narrative (Section 4.3.8). The following subsections describe each tier, and example questions are presented in Table 4-9.

4.3.3.1. *Exposure Measurement and Estimation Approach*

Three approaches may be used to calculate exposures: (1) the point-of-contact approach, (2) the scenario evaluation approach, and (3) the dose reconstruction approach. Each approach has advantages and disadvantages over another.

The point-of-contact approach, sometimes referred to as the direct approach, involves measurements of chemical concentrations at the point where exposure occurs (at the interface between the person and the environment) and records of the length of contact with each chemical. This approach does not take into account an individual's characteristics or behaviors.

The scenario evaluation approach, sometimes referred to as the indirect approach, utilizes data on chemical concentration, frequency, and duration of exposure as well as information on the exposed lifestage. Child-specific behaviors and physiologic characteristics may be assumed on the basis of exposure factor data (U.S. EPA, 2002c) or from exposure study databases (the *Consolidated Human Activity Database* [CHAD]; the *Human Exposure Database System* [HEDS]),[13] or they can be obtained specifically for the assessment (e.g., by questionnaire, diary, videotaping). Chemical concentration may be determined by sampling and analysis or by use of fate and transport models (including simple dilution models). Models can be particularly helpful when resources for additional sampling are limited but some analytical data are available.

Finally, the dose reconstruction approach allows exposure to be estimated from dose, which can be reconstructed through internal indicators (e.g., biomarkers, body burden, excretion levels) after the exposure has taken place. The use of biomarkers of exposure or effect may provide a more detailed analysis; however, only a few examples currently exist for applying this approach successfully. At the present time, much of biomarker data are difficult to interpret, either because the presence of a biomarker may not be unique (e.g., many stressors result in a change in the same biomarker) or there may not be adequate exposure pathway information to link the biomarker to the exposure. Currently, this approach is most successful for persistent compounds.

4.3.3.2. *Analysis Level or Tiered Assessment*

Typically, an exposure characterization will begin with a screening-level assessment and then, if there appears to be significant exposures or an unacceptable level of uncertainty, a second, more refined level of analysis will be conducted. Probabilistic techniques may be used at either level of analysis depending on the types of scenarios being evaluated. The major difference between the levels of assessment described below is related to the assumptions that are used.

The first tier screening assessment (Section 4.3.3.2.1) is used to identify and prioritize potentially important exposures. After results of the screening assessment are compared with results of the hazard characterization (Section 4.1), a more refined assessment (Section 4.3.3.2.2)

[13] The CHAD database is available online at http://www.epa.gov/chadnet1; the HEDS database is available online at http://www.epa.gov/heds.

may be required, using more realistic estimates of exposure for selected scenarios to reduce the uncertainty. This second tier is generally more resource-intensive than the first tier and is used to refine estimates for exposure scenarios that were identified as potentially significant in the screening assessment. Finally, if a high level of uncertainty remains around estimates of exposure following a refined assessment, supplemental data collection may be needed.

4.3.3.2.1. ***Screening assessment.*** The purpose of a screening tier is to identify probable pathways and scenarios and to rule out insignificant ones. Bounding values for exposure factors and conservative simplifying assumptions are used at this level of analysis. As a result, the output may have a high level of uncertainty. Historically, deterministic calculations were used in most screening-level exposure analyses. However, exposure assessments have become increasingly complex, and probabilistic techniques may be useful when, for example, exposure parameters have large variability or when multiple sources exist (U.S. EPA, 2001b).

Based on the bounding assumptions used in this level of analysis and comparison with the hazard characterization (Section 4.1), a set of potentially significant exposure scenarios for relevant age groups will be identified. In the screening-level analysis, differences in exposure between children of different developmental stages are identified. For some specific exposure scenarios and compounds, combining or subdividing some of the age groups may be appropriate, for example, where variation in exposure factors and resulting exposures is insignificant (U.S. EPA, 2005e).

Limited data may be an impediment in conducting accurate lifestage-specific assessments, and for making decisions regarding combining or eliminating age groups. When making an assessment and limited data is available, the assessor should use the recommended age groups (U.S. EPA, 2005e) as a starting point. Then, based on qualitative information, the assessor can determine if little variability is expected among some age groups, in which case the age bins can be combined. If data are not available to make this determination, then this can be described as an area of uncertainty and identified as an area for future research. A possible approach to estimating exposure factors and dose when data are not available uses age-dependent curve fitting to help fill in the data gaps. Any assumptions used in assessing exposure for a particular age bin should be discussed in the assessment.

Once screening-level estimates of exposure are developed for each scenario and each age group, the questions in Table 4-9 could be considered. In order to identify and understand the importance of parameters and uncertainties in these exposure estimates, a sensitivity analysis is generally conducted on the potentially significant scenarios. For a screening assessment to have value, the potential range of parameter values is considered when conducting the sensitivity analysis (e.g., some parameters can vary only between 0 and 1; others can vary by three orders of magnitude). In addition, the uncertainty associated with assumptions that are based on little or no data would need to be evaluated before any conclusions about the level of "conservatism" can be made. Methods for conducting a sensitivity analysis are discussed further in Section 4.3.5.

4.3.3.2.2. ***Refined assessment.*** This tier of the analysis level provides more detail for potentially relevant scenarios and potentially vulnerable age groups. The goal of this tier is often to estimate the distribution of exposure for the relevant lifestages. Based on results of the sensitivity analysis conducted for the screening-level assessment, significant exposure factors and important assumptions are revisited to develop more realistic estimates of exposure.

This more advanced analysis may include the application of sophisticated modeling tools to develop exposure estimates for use in regulatory decisions. A variety of modeling tools have been developed over the years to facilitate exposure assessment (Price et al., 2003, and references therein for review of available tools). Some of the types of models available include total source models (e.g., aggregate and cumulative models developed to meet requirements of FQPA); multi-route models of exposure (e.g., local waste site models, tap-water exposure models), models of exposures to specific sources or routes (e.g., dietary models, consumer product models), indoor air models, and occupational models. Few of these models are designed currently to specifically address lifestage exposures. As a result, data on the age bins used in the models and outputs produced by the models may not address the specific age groups of interest for a complete lifestage-specific assessment. This issue is discussed further in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005e).

Limitations of the data, model results, and associated uncertainties remaining in the refined tier are considered and addressed in this analysis. Available exposure data sets may not

allow modelers or risk assessors to directly extract data from the underlying sources to conduct lifestage-specific analyses. Potential approaches to address this issue include the following:

- reorganizing the exposure input data set to conform to the age groupings;
- using probabilistic sampling techniques to go beyond the categorical limits of the underlying database to utilize all the data, and then formatting the probabilistic model output into the desired age groupings to represent exposure doses; and
- developing a weighting scheme for the underlying data set to align it with the desired age groupings.

The exposure data may need to be statistically weighted so that equal weight is given to all ages within the group when estimating the group mean and variability statistics.

4.3.3.2.3. ***Supplemental data collection.*** Based on results of the refined assessment and the associated sensitivity and uncertainty analyses, specific data needs may be identified. If the objectives of the risk assessment indicate that any specific uncertainties in the exposure characterization be addressed, collection of new data to address them may be needed and additional analyses conducted.

Table 4-9. Examples of lifestage-specific questions for exposure analysis level or tiered assessment.

Topic	Lifestage-Specific Question(s)
Screening Assessment (Section 4.3.3.2.1)	Do these results address the questions posed in the problem definition phase of the risk assessment? What are the bounding assumptions used to identify relevant sources, pathways, and scenarios? What is the potential magnitude of exposures? How do potentially relevant scenarios and potentially vulnerable age groups compare with critical windows identified in the hazard characterization? How do these lifestages compare to the critical windows identified based on the TK and TD vulnerabilities (Section 4.1)? How do potential exposure levels compare with hazard levels (e.g., MOE)? Which exposure factors drive the results of the screening assessment and why? What is the potential variability of exposure factors (e.g., orders of magnitude vs. factor of 2 or 3)? Is the available exposure information adequate? What criteria are used to determine adequacy? What are the significant exposure data needs that may require additional exposure data?
Refined Assessment (Section 4.3.3.2.2)	Were the exposure data adequate to sufficiently investigate and identify relevant differences across age groups? What is the central tendency of the distribution of the exposure when compared with the high-

	end exposures? How do potential exposure levels compare with dose-response characterization results? Which developmental stage of children (age bins) represent the highest exposures? Is the available exposure information adequate for a more refined assessment? What additional criteria are used to determine adequacy? What are the significant exposure data needs that may require additional exposure data? What are the available exposure assessment models? Are distributions available for exposures of interest (e.g., by media, source, pathway)? If not, do they need to be developed? Are there sufficient data for their development? How will variability and uncertainty be addressed? What are the time patterns of exposure? How will exposure monitoring data, PBTK modeling, and biomonitoring data be incorporated? What are the additional stressors and their cumulative impact?
Supplemental Data Collection (Section 4.3.3.2.3)	Have any critical data needs been identified?

4.3.4. Variability Analysis

Variability refers to the inherent lack of uniformity in a population that cannot be reduced with additional data but can be presented by providing ranges or distributions of the exposure. Differences among individuals in a population are referred to as inter-individual variability. Differences associated with an individual over time are referred to as intra-individual variability.

Among children, inter-individual variability is due to rapid physiologic and behavioral changes. Even within a relatively narrow age group, variability may be large. For oral and dermal exposures, variability in exposure/dose is due to factors such as gross motor development, fine motor development, cognitive development, and social development. For inhalation exposures, relevant factors influencing variability in exposure/dose include, for example, activity level and breathing behavior (e.g., the transition from mouth to nasal breathing) (U.S. EPA, 2005e). Infants may be breast-fed or bottle-fed. Young children may have higher contact with surfaces than do older children and they explore their environment by mouthing objects. Physiologic characteristics affecting variability in exposure/dose include anatomical characteristics (e.g., body weight and proportion of body fat) and specific organ and physiologic systems. For example, infants have immature immune systems, and renal functions are less than those predicted by surface area (U.S. EPA, 2005e).

This variability affects the determination of upper percentiles of exposure and its associated risk. That is, given a high-quality/high-quantity set of data for each age group, there may still be significant variability for a particular exposure factor, set of factors, or exposure pathway. The better the data and the characterization of this variability, the better the basis for final selection of age groups for a specific assessment. Example questions are presented in Table 4-10.

4.3.5. Sensitivity Analysis

Sensitivity analysis is defined as the assessment of the impact of changes in input values on model outputs. Its main purpose in any exposure characterization is to determine which variables in the model equations and what pathways or scenarios most affect the exposure estimate. These techniques can also be used to assess key sources of variability and uncertainty for the purpose of prioritizing additional data collection or research. This is particularly relevant in children's assessments because they are often based on limited data. Because the variables of particular interest are those that have an impact on lifestage-specific estimates, the sensitivity analysis may need to focus considerable attention on the impact of exposure factors related to children's behavior. These factors affect the exposure patterns in space and time and are also typically the most uncertain. Example questions are presented in Table 4-10.

4.3.6. Uncertainty Analysis

Uncertainty is described as a lack of knowledge about factors affecting exposure or risk. Uncertainty in the exposure estimates may be a result of limited data for significant exposure factors for a particular age group. Uncertainty may also be due to assumptions made in development of the model. For example, soil ingestion studies in the literature have focused on children between 2 and 7 years of age, resulting in a lack of data for children less than 2 years of age. Uncertainties are acknowledged and characterized to the extent possible.

Probabilistic assessments can be useful statistical tools for analyzing variability and uncertainty in risk assessments, given that adequate data are available. The Monte Carlo analysis can be used to better characterize variability and uncertainty across the population, and to compare one lifestage (e.g., infants) to another (e.g., adults). General issues to consider when applying these quantitative methods are described in EPA's *Guiding Principles for Monte Carlo*

Analysis (U.S. EPA, 1997b). The EPA sponsored workshop in 1998 discussed issues regarding the selection of input distributions for probabilistic assessments (U.S. EPA, 1999b). Methodologies for selecting parametric distributions to be used in probabilistic assessments are described in *Options for Developing Parametric Probability Distributions for Exposure Factors* (U.S. EPA, 2000b). Example questions are presented in Table 4-10.

Table 4-10. Examples of lifestage-specific questions for exposure variability, sensitivity, and uncertainty analyses.

Topic	Lifestage-Specific Question(s)
Variability Analysis (Section 4.3.4.)	If different approaches were used to estimate exposure for different lifestages or within a lifestage, what were the results? Can they be compared and, if so, how do they compare? Which approach is more appropriate? Does the lifestage-specific assessment capture the variability in the exposed groups? What are the ranges or distributions of exposure? What are the route, level, timing (i.e., lifestage), and duration of exposure used in the experimental animal studies as compared with expected human exposures? Are the available data from the same route of exposure as the expected human exposures? If not, are TK data available to extrapolate across routes of exposure? Are experimental animal data available from the same lifestages as the expected exposed human lifestage? If not, are TK data available to extrapolate across species and lifestages? What information was used to support duration adjustment and to calculate the human equivalent concentration or dose? How far does one need to extrapolate from the observed data to environmental exposures (i.e., MOE)? One, two or multiple orders of magnitude? What is the impact of such an extrapolation?
Sensitivity Analysis (Section 4.3.5)	What parameters have the greatest influence on the exposure model outputs? What is the adequacy of the data for the parameters that are identified in the sensitivity analysis as the most important parameters?
Uncertainty Analysis (Section 4.3.6.)	What are the uncertainties in the estimates, both within and across lifestages? What are the data limitations and how do they compare across lifestages? What data gaps exist, both within and across lifestages? How significant are these data gaps? How sensitive are the results to these data gaps? Is it feasible or desirable to collect more data pertaining to particular lifestages? Could the exposure estimates be refined if more data were available?

4.3.7. Iteration with Hazard and Dose-Response Characterization

Following exposure characterization, coordination, and communication with the hazard and dose-response assessors (Sections 4.1 and 4.2) may be useful. For example, if a screening-level analysis revealed that the 0–1 year age bin was more highly exposed due to nursing ingestion than was any other lifestage, an assessor may be prompted to re-evaluate hazard and

dose-response characterization to make sure that potential vulnerabilities during this age window are well understood or if further data needs could be identified.

4.3.8. Lifestage-Specific Exposure Characterization Narrative

The results of the exposure characterization are summarized in a narrative that includes a discussion of the results, analysis, and conclusions. The narrative includes a discussion of the key assumptions, limitations, and uncertainties associated with the exposure estimates and any potential bias in the results. Variability analysis (Section 4.3.4), sensitivity analysis (Section 4.3.5), and uncertainty analysis (Section 4.3.6) are summarized. It is useful to also include a description of how the exposure characterization can be improved and uncertainties be reduced by additional research or collection of data. Through this narrative, the results of the exposure characterization are communicated in a clear and concise manner to the risk manager. These results include considerations of childhood variability and uncertainty within the exposure characterization.

The focus of the exposure characterization is to identify age groups and address vulnerability resulting from differential exposure. It is impossible to completely separate consideration of exposure and potential dose from consideration of internal dosimetry and response; therefore hazard characterization (Section 4.1), dose-response characterization (Section 4.2), and exposure characterization are intimately linked. For example, information on exposure scenarios of a compound to humans ensures that hazard information is relevant to the measured exposure. Also, understanding the dosimetry of an absorbed agent can inform the temporal resolution needed in the exposure data and characterization. Some questions to consider when summarizing the exposure characterization narrative include the following:

- What is the basis for the exposure characterization (i.e., monitoring, modeling, or other analyses of exposure distributions)?
- How was the central tendency estimate developed? What factors or methods were used in developing this estimate?
- How was the high-end estimate developed? What factors or methods were used in developing this estimate?
- How do the adverse health effects identified in the hazard characterization phase (Section 4.1) inform the identification of exposures of greatest relevance for the observed outcomes?

- How do patterns of exposure (continuous vs. intermittent) and half-life in the body influence the health outcome? What are the exposures during critical windows in development?
- Are there particular developmental stages during which children are highly exposed? Do health outcomes vary during different developmental periods? How does this inform identification of the exposures of greatest biological significance for the observed outcomes?
- How does information on dosimetry indicate the level of temporal resolution needed in exposure data and modeling? What dose metrics are being considered for child-related assessments?
- How does the fate of the agent being evaluated affect exposure in children? Are children exposed to other agents with a similar MOA to the one being assessed? Is sufficient MOA information available to consider a cumulative exposure assessment?

5. LIFESTAGE-SPECIFIC RISK CHARACTERIZATION

Risk characterization is the final phase of the risk assessment process (Figure 5-1). This final phase of the risk assessment utilizes the information from the problem formulation (Chapter 3) and analysis (Chapter 4) phases. After risk characterization is put into context (Section 5.2), the information is utilized in risk communication and risk management.

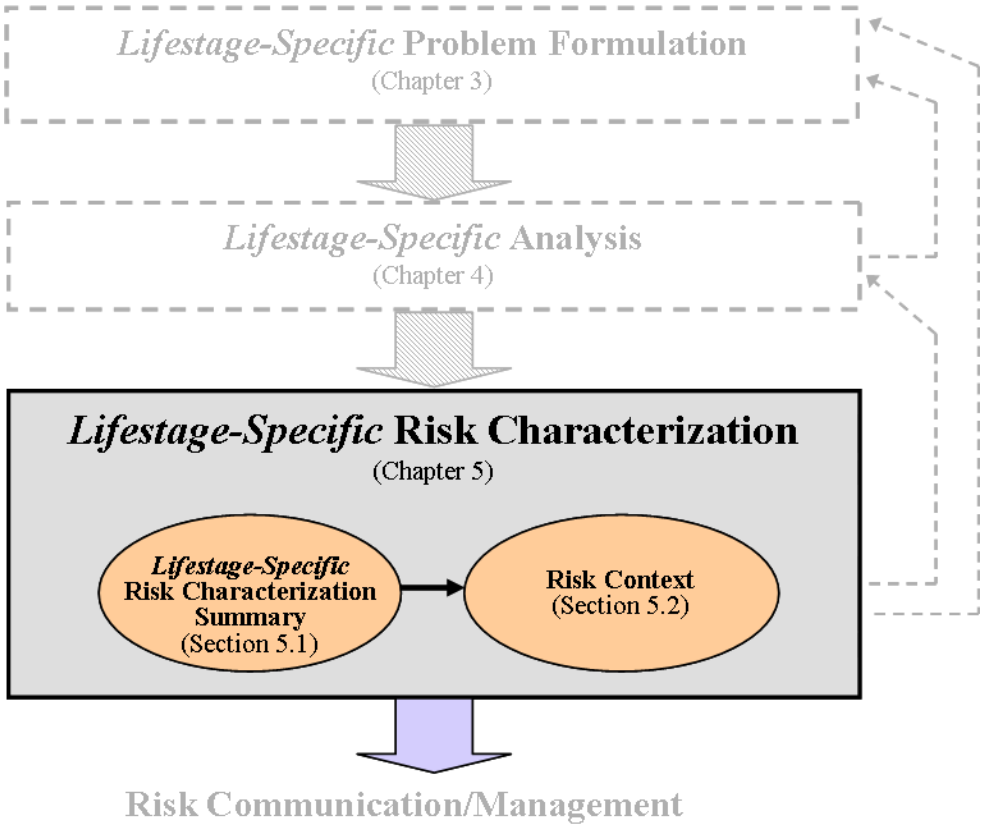


Figure 5-1. Flow diagram for lifestage-specific risk characterization.

The risk characterization describes the overall picture of health risks resulting from children's exposures, in which the hazard characterization (Section 4.1), dose-response characterization (Section 4.2), and exposure characterization (Section 4.3) components of the analysis phase are integrated and summarized. Major non-technical conclusions are drawn that inform the risk managers, who will make risk decisions in context with the problem identified in problem formulation (Chapter 3).

During hazard characterization (Section 4.1), an assessor evaluates and describes the information on the capacity of an environmental agent's exposure during developmental lifestages to cause outcomes at any lifestage in both laboratory animals and humans. The qualitative WOE evaluation is based both on the type and quality of data derived from humans and laboratory animals and on the integration of ancillary data (SAR, genetic toxicity, TK, TD, and MOA).

The dose-response characterization (Section 4.2) focuses on quantitative relationships between exposure during developmental lifestages of concern and critical outcomes during lifestages of concern identified in the hazard characterization (Section 4.1). Methods for assessing dose-response relationships often depend on assumptions used in the absence of data. Thus, assumptions are clearly articulated in the risk characterization section.

The exposure characterization (Section 4.3) describes the basis for values used in exposure scenarios. Exposure estimates are based on a combination of available data and assumptions. In exposure characterizations, the quality and representativeness of the available data are discussed. Then, in turn, the assumptions made, the general logic to develop these assumptions, and the effect that they may have on the results are also discussed. The major factors considered to contribute to the greatest uncertainty in the exposure characterization are described and linked to information from sensitivity analyses. Lack of exposure data or limitations of specific types of data are described.

Detailed guidance on integration of these analysis steps into a risk characterization is provided in EPA's *Science Policy Handbook: Risk Characterization* (U.S. EPA, 2000e). Other sources of information that provide guidance regarding children's health risk assessment include the EPA guidelines for developmental toxicity (U.S. EPA, 1991), reproductive toxicity (U.S. EPA, 1996), neurotoxicity (U.S. EPA, 1998b), and cancer risk assessment (U.S. EPA, 2005a,b). In addition, the NRC report Science and Judgment in Risk Assessment (NRC, 1994) provides additional information about the risk characterization process.

The issues to be addressed in risk characterization are provided in example questions, with an emphasis on lifestage-specific issues, to guide the assessor through this process. The information to answer these questions is derived from the analysis phase (Chapter 4) and used in the risk characterization. The questions that follow are a modification of those presented in EPA's *Science Policy Handbook: Risk Characterization* (U.S. EPA, 2000e) and those developed

for risk characterization within the *Guidelines for Reproductive Toxicity Risk Assessment* (U.S. EPA, 1996).

5.1. LIFESTAGE-SPECIFIC RISK CHARACTERIZATION SUMMARY

A lifestage-specific risk characterization includes a concise description of the key qualitative and quantitative aspects of the analysis. This includes a discussion of the critical windows for duration and timing of exposure and outcome. Then, the assessor identifies and describes the assumptions, uncertainties, and significant data gaps that could affect the major conclusions. Finally, the summary includes a qualitative and quantitative justification for the application of lifestage-specific adjustments for duration-specific health values (e.g., use of lifestage-specific RfV for a specific duration of exposure) if the assessment warrants it. Three basic questions this Framework highlights are (U.S. EPA, 2000e, p.39)

- Have the potential hazards to children been adequately characterized?
- Were the potential hazards incorporated into dose-response characterization (Section 4.2)?
- Have the exposures to children been adequately characterized?

5.1.1. Key Information from the Analysis Phase

The assessor reviews the narratives for the three analysis steps of the risk assessment (Chapter 4) in order to determine the key information relevant to children's risk. In the narrative, the assessor identifies the key studies, summarizes the WOE, presents the justification for the calculated major risk estimates, and articulates the defaults and assumptions. The assessor considers how the key information from the analysis phase relates back to the purpose and scope of the assessment. The following are sample questions to ask when considering the key information from the analysis phase of the assessment:

- What lifestages were assessed? Are there any highly exposed subgroups?
- What are the most significant lifestage-specific exposure scenarios? What are the ranges of exposures?
- What are the critical effects observed following developmental lifestage exposures? Do they differ qualitatively and/or quantitatively from adults who are exposed?

- How were the exposure scenarios and lifestage(s) accounted for in dose-response characterization (Section 4.2)?
- What are the key studies for TK, TD, and MOA? Does available MOA information aid in the interpretation of the hazard data for different lifestages? What are the implications of the hypothesized MOAs for potential adverse effects and their relationship to risk?

5.1.2. Scientific Assumptions

During risk characterization, scientific assumptions and defaults used in the analysis phase (Chapter 4) are described. An example of an assumption is using a ¾ body weight scaling for inhalation dosimetry in children (U.S. EPA, 2006d). It is important to transparently document these assumptions and rationale for decisions made in the assessment.

- What are the major scientific assumptions related to children's risks and how are they addressed?
- Was SAR information or MOA information used to bridge chemical-specific data gaps for specific lifestages of concern?

5.1.3. Risk Drivers

The development of MOE or hazard quotients for critical effects that might occur during specified exposures scenarios for certain lifestages may provide worst case scenarios and provide some appreciation of relative risk for different adverse outcomes for different exposure scenarios.

- What are the risk drivers, and what are the policy implications?
- Are specific exposure scenarios during specific lifestages major risk drivers?
- Are specific critical windows of exposures contributing to the critical outcomes that are the major risk drivers?

5.1.4. Strengths and Weaknesses

Characterizing the strengths and weaknesses of the database is central to a lifestage-specific risk characterization. In many cases, the information on outcomes following exposure during developmental lifestages will be very limited but substantial enough to invoke concern or consideration of the strengths of the database. Weaknesses in the database will influence the lifestage-characterization of the variability (Section 5.1.4.1), sensitivity (Section 5.1.4.2), and uncertainty (Section 5.1.4.3). Integration of the WOE evaluation (Section 4.1.3.1) with the

variability, sensitivity, and uncertainty analyses for dose-response (Sections 4.2.5, 4.2.6, and 4.2.7) and exposure (Sections 4.3.4, 4.3.5, and 4.3.6) provide further characterization and integration of the strengths and weaknesses of the overall assessment. This summary strives for balance by describing the areas of confidence and uncertainty in the assessment.

5.1.4.1. *Variability*

Explicit acknowledgment of sources of variability is considered in the risk characterization phase. By summarizing the findings from the variability analyses conducted in the analysis phase (Sections 4.1.2.9, 4.1.3.1.2.1, 4.2.5, and 4.3.4), it may be possible to determine whether different approaches provide similar risk estimates. Answers to the following questions may be helpful to describe the overall variability of the assessment:

- Does the assessment capture the variability in the exposed population? How is variability addressed?
- Who is most at risk (e.g., physiologically, genetically, highly exposed)?
- What is the relevance of experimental animal studies to humans at particular lifestages?
- What are the limitations of the data available regarding variability? What data gaps related to variability exist?
- Are there biological, behavioral, ethnic, racial, or socioeconomic factors that may affect variability in human exposure or response?

5.1.4.2. *Sensitivity*

The findings from the sensitivity analyses conducted in the analysis phase (Sections 4.2.6 and 4.3.5) are summarized in the risk characterization phase in order to underscore the strengths and the weaknesses related to the derivations of health values and exposure values in the assessment. Answers to the following questions may help describe the overall sensitivity of the assessment:

- What parameters have the greatest influence on the dose-response and exposure model outputs?
- Are the parameters to which a model is most sensitive likely to vary across lifestages? What is the likely impact of such differences on model predictions on defining variability or uncertainty in the assessment?
- What are the limitations of the data available regarding sensitivity? What data gaps related to sensitivity exist?

5.1.4.3. *Uncertainty*

Uncertainty originating from various data sources can have an impact on risk analysis. Explicit acknowledgment of sources of uncertainty described in the analysis phase (Sections 4.1.2.10, 4.1.3.1.2.2, 4.2.7, and 4.3.6) is considered when integrating the uncertainties in the risk characterization. This summary includes clear and concise statements about the limitations of the data from the analysis phase for this lifestage-specific assessment and may include discussion of uncertainties in other related assessments. Critical data gaps, defined by the impact they have on the risk assessment, are identified and described. These critical data gaps may require consideration and application of uncertainty factors (e.g., database UF). In addition, uncertainty or critical data gaps may suggest further studies that may provide new information or insight to reduce uncertainties in a future risk assessment. Answers to the following questions may prove helpful in describing the overall uncertainty of the assessment:

- What are the uncertainties in the assessment for different lifestages of development? How are these uncertainties addressed?
- How are the limitations of the available data related to uncertainty? What significant data gaps exist relevant to uncertainty? How do these impact the magnitude of uncertainty in the assessment?
- What are the priority data-needs studies that could produce information that may reduce uncertainties in lifestage-specific risk assessment?
- What are the degrees of confidence in the dose-response and exposure model(s) that are used to derive risk values?

5.1.5. Key Conclusions

A description of critical effects and the supporting evidence for these conclusions is included in this section. Attendant risk numbers or a range of risk values for the critical effects can illustrate some degree of certainty for the key conclusions. For outputs of this analysis to be most useful in benefits analysis (Chapter 3), the outcomes that are quantified are expressed as changes in adverse outcomes or precursor effect (e.g., change in incidence of illness or symptoms) that are readily understood by the public. Reliance on single point risk estimates for key conclusions may not be very useful for benefits analysis.

- What are the major qualitative conclusions regarding risk from developmental exposure? What is the degree of confidence in the conclusions?

- What are the quantitative estimates of the risk from developmental exposure? How do risks compare across lifestages? What is the degree of confidence in the risk estimates?
- Are there any broad risk implications for classes of compounds (e.g., SAR-related, same MOA)? Lifestages (e.g., in male fetuses, the period of sexual differentiation *in utero* is sensitive to exposure to anti-androgens)?

5.1.6. Alternative Risk Estimates Considered

Consideration of alternative hypotheses to explain lifestage-specific outcomes and the related exposures (Section 4.1.3.1.7) is part of transparency. Principles of parsimony (economy or simplicity of assumptions in logical formulation) should be considered in the presentation of alternatives and related to the lifestage-specific data that exist. The following examples are questions to consider regarding alternative risk estimates:

- What are the results of different analysis approaches (i.e., modeling, monitoring, and probability distributions)?
- Were adults considered to be more or less sensitive than other lifestages?
- What is the relative difference in the final risk value when using adult versus developmental lifestages of exposure? What is the relative difference in the final risk value when using a default versus a data rich approach?
- Are alternative hypotheses considered that might explain the observed lifestage-specific outcomes? Does an alternative hypothesis provide different risk estimates than the primary hypothesis?

5.1.7. Research Needs

The characterization of risk in many cases reveals lifestage-specific data gaps, but not all of these data gaps may translate into critical research needs. Research needs may be based upon qualitative or quantitative considerations in the database and the prioritization of research needs helps determine whether specific new data could potentially reduce uncertainty in the assessment. Questions to consider when assessing research needs for characterizing variability and uncertainty in risk estimates include the following:

- What are the priority lifestage-specific research needs? Are these chemical-specific, chemical class-specific, or basic research needs?
- Can priorities be assigned if more than one lifestage-specific research need is identified?

- Can the impact of the research be estimated (e.g., reduction of uncertainty in the assessment)?
- What are the key sources of variability, sensitivity, and uncertainty for the purpose of prioritizing additional data collection or research?

5.2. RISK CONTEXT

The risk characterization is anticipated to provide an answer to the problem formulation (Chapter 3), which may have included an initial screening of risk for prioritization and a preliminary estimation of risk). If the statement of the problem evolved during the analysis phase (Chapter 4), then this process is summarized in the risk characterization phase.

The risk estimates in this lifestage-specific assessment are described in the context of other similar or related risk assessments. The science policy assumptions employed in this assessment are clearly articulated in order to compare with previous decisions. Discussion of alternative hypotheses, alternative MOAs, and alternative risk estimates can be included to provide context to other previous risk decisions. The risk context could include discussion of cumulative and multiple exposures and their potential impact on a common MOA(s).

The risk context can also provide background for developing risk communication materials, which could include risk perception in light of related or prior risk decisions. Questions regarding risk context include the following:

- Where appropriate, can this risk be compared with other risks characterized by EPA or by other federal or state agencies? Have these other previous assessments reached similar or significantly different conclusions? What are the limitations of making these comparisons?
- What science policy (default) assumptions were employed in each of the three steps of the analysis phase?
- What were the scientific assumptions in each of the three steps of the analysis phase that may have policy implications?
- What alternative hypotheses were evaluated? What is the justification for the decision to choose one hypothesis over another?
- Is there reason to be concerned about cumulative or multiple exposures to classes of agents with a similar mechanism or MOA?
- Are there significant community concerns or common risks with which people may be familiar that may influence public perception of risk to children?
- Is the risk characterization information presented in a way that could be used for benefit analysis?

- Is the risk characterization information presented in a way that could be used for benefit analysis?

6. SUMMARY AND IDENTIFICATION OF GAPS IN APPROACHES FOR CHILDREN'S HEALTH RISK ASSESSMENT

This Framework summarizes the process for assessing health risks resulting from children's exposure to environmental agents using a phased approach that includes problem formulation (Chapter 3), analysis (Chapter 4), and risk characterization (Chapter 5). It uses many EPA documents that have outlined similar risk assessment approaches (U.S. EPA, 1998a, 2003a) and a workshop report that identified the need for and began the development of an approach to assessing children's risk from environmental exposures (ILSI, 2003).

This Framework is a conceptual overview of the considerations for evaluation of early life exposures and subsequent outcomes and does not constitute EPA guidance defined as a step-by-step process or standard operating procedure. This overview is accomplished by posing targeted questions to address each phase of the process and by referencing appropriate guidelines, guidance documents, and other relevant reports and literature. These references, including several EPA risk assessment guidelines related to health risks from children's exposures, can be drawn upon for more detailed information. One of the most relevant references is the *Guidelines for Developmental Toxicity Risk Assessment* (U.S. EPA, 1991) that focuses primarily on the effects of prenatal exposures and, to a limited extent, on postnatal exposures and outcomes. Other EPA guidelines or guidance are focused on system- or disease-specific issues that include the effects of developmental exposures, specifically reproductive toxicity (U.S. EPA, 1996), neurotoxicity (U.S. EPA, 1998b), and cancer (U.S. EPA, 2005a,b). Guidelines or guidance on the effects of developmental exposures on other systems (e.g., respiratory, immune, renal, hepatic, cardiovascular, and, to some extent, endocrine) or outcomes (e.g., biomarkers of exposure or effect, toxicogenomics data) are lacking.

The relevance of specific developmental exposures on latent outcomes for application to risk assessments for various durations of exposure (i.e., acute, short term, and subchronic) is considered in many of the risk assessments currently being generated across EPA, although this issue has not been thoroughly explored to date. The document *A Review of the Reference Dose and Reference Concentration Processes* previously identified data needs and alternative approaches and strategies for developing testing guidelines; these have not yet been addressed and are reiterated below (U.S. EPA, 2002a, Section 5). In addition, there is a need for focused guidance on dose-response assessment after developmental exposures, despite the fact that a

good deal of research and methods development on BMD (U.S. EPA, 2000d) and biological modeling (Clewell et al., 2002a; Ginsberg et al., 2004b; Lau et al., 2000, 2001; Setzer et al., 2001) has been done using developmental data in experimental animals and humans. With regard to exposure assessment, there is limited EPA guidance on approaches specific to children at different lifestages, with the exception of the interim document *Child- Specific Exposure Factors Handbook* (U.S. EPA, 2002c) and the *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005e). Methods for both screening level and more detailed quantitative estimates of children's exposures are needed. Data for the recommended age groups (U.S. EPA, 2005e) are limited or nonexistent for some exposure factor determinations. The *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003a) addresses generic concepts and approaches to evaluate cumulative risk; however, there is no specific guidance on developmental lifestage risk from cumulative exposures.

The integration of toxicity data and children's exposure estimates is an area for which no guidance exists but is needed. This integration is important because one exposure can lead to multiple outcomes, particularly for developmental exposures. In addition, the characteristics for each age group of concern to environmental agents can differ significantly for exposure and susceptibility. Therefore, guidance is also needed on using information on biological processes underlying development, MOA information, chemical-specific mechanisms, and anatomical, physiological, and behavioral characteristics at different developmental lifestages to determine critical times for exposure and the corresponding outcomes of concern.

At this time, significant research questions remain unanswered on the use of available exposure data to assess children's risk, such as

- How can biomonitoring data be interpreted to characterize exposure? How can available adult biomonitoring data be applied to children?
- How can available data from children be interpreted across developmental stages for which there are limited data?
- How can activity pattern data be used to classify children for exposure characterization?
- What resources or approaches can one use to address risk methodology for extrapolating inhalation dose to developmental lifestages?

- Can guidance be developed on incorporating critical window of vulnerability to reduce uncertainty, specifically for the time frame over which exposure should be averaged?
- How can risks be extrapolated to developmental exposure to non-genotoxic carcinogens?
- How can developmental lifestage-specific MOAs influence latent expression of adverse outcomes?
- Since TK and TD in children can rarely be studied, how can model variability in internal dose and sensitivity to toxicant action be better characterized?

Many of these questions are actively being investigated. These efforts will likely contribute to future guidance and policy papers on specific issues related to children's exposure and subsequent outcomes.

GLOSSARY

Activity Pattern Data – Information on human activities used in exposure assessments. The information may include a description of the activity, frequency of activity, duration spent performing the activity, and the microenvironment in which the activity occurs.

Adverse Effect – A biochemical change, functional impairment, or pathologic lesion that affects the performance of the whole organism or reduces an organism's ability to respond to an additional environmental challenge.

Age-Dependent Adjustment Factors (ADAF) – Adjustments to cancer slope factors that recognize the increased susceptibility to cancer from early life exposures to mutagens in the absence of chemical-specific data.

Area Under the Curve (AUC) – The area of the time x concentration curve that helps to define the internal dose.

Benchmark Dose (BMD) – A dose that produces a predetermined change in response rate of an adverse effect (called the benchmark response or BMR) compared to background.

Benchmark Dose Lower Confidence Level (BMDL) – A statistical lower confidence limit on the dose at the BMD.

Benefits Analysis – A method that develops monetary values comparing costs and benefits to inform the policy making process (U.S. EPA, 2000a).

Bias – A trend in methodology or analysis that can lead to systematic deviations from the true data.

Biologically Based Dose-Response (BBDR) Model – A predictive model that describes biological processes at the cellular and molecular level linking the target organ dose to the adverse effect.

Biomarker – A biological molecule or biochemical indicator of exposure or biological changes resulting from exposures, or markers of risk or susceptibility.

Biomonitoring – The assessment of human exposure to chemicals by the measurement of the chemicals or their metabolites (breakdown products) in human tissues or fluids such as blood or urine. Blood and urine levels reflect the amount of the chemical in the environment that actually gets into the body.

Body Burden – The amount of a particular chemical, especially a potentially toxic chemical, stored in the body at a particular time as a result of exposure. Body burdens can be the result of long-term or short-term storage, e.g., the amount of a metal in bone, the amount of a lipophilic

substance such as PCB in adipose tissue, or the amount of carbon monoxide (as carboxyhemoglobin) in the blood.

Bounding Estimate – An estimate of exposure, dose, or risk that is higher than that incurred by the person in the population with the highest exposure, dose, or risk. Bounding estimates are useful in developing statements that exposures, doses, or risks are "not greather than" the estimated value.

Cancer – A disease of heritable, somatic mutations affecting cell growth and differentiation and characterized by an abnormal, uncontrolled growth of cells.

Case-Control Study – An epidemiologic study that compares subjects with the disease of interest (cases) to subjects without the disease (controls). The groups are compared with respect to exposure history to ascertain whether they differ in the proportion exposed to the chemical(s) under investigation.

Case Report – A description of a person in a population or study group identified as having a particular disease, health disorder, or condition under investigation, without a comparison made to a control.

Child – Conception to maturation of all organ systems, approximately 21 years of age.

Concentration – The ratio of the mass or volume of a solute to the mass or volume of the solution or solvent.

Conceptual Model – A written description or a visual representation of actual or predicted relationships between humans or ecological entities and the chemicals or other stressors to which they may be exposed.

Confounder (or Confounding Factor) – A condition or variable that is both a risk factor for disease and is associated with an exposure or outcome of interest. This association between the exposure of interest and the confounder may make it falsely appear that the exposure of interest is associated with the outcome.

Critical Effect – The first adverse effect, or its known precursor, that occurs to the most sensitive species as the dose rate of an agent increases.

Critical Window of Exposure – Developmental period when vulnerability to exposures is increased and can result in developmental effects.

Cumulative Impact – The combination of aggregate exposures to multiple agents or stressors.

Detoxification – Process of chemical modification that make a toxic molecule less toxic.

Dose – The amount of a substance available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism.

- *Absorbed Dose* is the amount crossing a specific absorption barrier (e.g., the exchange boundaries of skin, lung, and digestive tract) through uptake processes.
- *Biologically Effective Dose* is the amount of the chemical available for interaction by any particular organ or cell.
- *Internal Dose* is a more general term denoting the amount absorbed without respect to specific absorption barriers or exchange boundaries.
- *Potential Dose* is the amount ingested, inhaled, or applied to the skin.

Dose Metric – The target tissue dose that is closely related to ensuing adverse response. Dose metrics reflect the biologically active form of the chemical, its level, and duration of exposure, and its intensity. Examples of units of measurement for dose are AUC, maximum concentration.

Dose-Response Assessment – The determination of the relationship between the magnitude of administered, applied, or internal dose and a specific biological response. Response can be expressed as measured or observed incidence, percent response in groups of subjects (or populations), or the probability of occurrence of a response in a population.

Dose-Response Curve – A graphical representation of the quantitative relationship between administered, applied, or internal dose of a chemical or agent, and a specific biological response to that chemical or agent.

Dosimetric Adjustment Factor (DAF) – A multiplicative factor used to adjust observed experimental or epidemiological data to human equivalent concentration for assumed ambient scenario.

Dosimetry – A process of measuring or estimating dose.

Effect Modifier – A variable that modifies the outcome of interest by a greater (synergistic) or lesser (antagonistic) effect. An effect modifier can be identified through stratification of the data.

Environmental Fate – The destiny of a chemical or biological pollutant after release into the environment. Environmental fate involves temporal and spatial considerations of transport, transfer, storage, and transformation.

Epidemiology – The study of the distribution and determinants of health-related states or events in specified populations.

Exposure – Contact made between a chemical, physical, or biological agent and the outer boundary of an organism. Exposure is quantified as the amount of an agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut).

- *Acute Exposure* is exposure by the oral, dermal, or inhalation route for 24 hours or less.
- *Chronic Exposure* is repeated exposure by the oral, dermal, or inhalation route for more than approximately 10% of the life span in humans (more than approximately 90 days to 2 years in typically used laboratory animal species).

- *Intermittent Exposure* is a repeated exposure in which there is no effect of one exposure on the effect of the next; this definition implies sufficient time for the chemical and its metabolites to subchronic clear the biological system before the subsequent exposure (i.e., non-cumulative toxicokinetics).
- *Longer-Term Exposure* is repeated exposure by the oral, dermal, or inhalation route for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days up to approximately 90 days in typically used laboratory animal species).
- *Short-Term Exposure* is multiple or continuous exposure to an agent for a short period of time, usually 1 week.

Exposure Assessment – An identification and evaluation of the human population exposed to a toxic agent that describes its composition and size and the type, magnitude, frequency, route, and duration of exposure.

Exposure Concentration – The concentration of a chemical in its transport or carrier medium at the point of contact.

Exposure Factor – Variables that define how exposure to a chemical or agent takes place (e.g., concentration, intake, body weight).

Exposure Media – Major environmental categories that surround or contact humans, animals, plants, and other organisms (surface water, ground water, soil, or air) and through which chemicals or pollutants move.

Exposure Pathway – The physical course a chemical or pollutant takes from its source to the organism exposed.

Exposure Route – The way a chemical or pollutant enters an organism after contact, e.g., by ingestion, inhalation, or dermal absorption.

Exposure Scenario – A combination of facts, assumptions, and inferences that define a discrete situation where potential exposures may occur. These may include the source, the exposed population, the time frame of exposure, microenvironment(s), and activities. Scenarios are often created to aid exposure assessors in estimating exposure.

Database (Extent of) **–** *Minimal Database* is a database in which no human data are available, and route-specific toxicity data are limited to dose-response data applicable to the duration in question with assessment of outcomes other than mortality. A study showing only effect levels for mortality or other extremely severe toxicity would not be sufficient to set a reference value. *Robust Database* is a database that includes extensive human and/or animal toxicology data that cover route-specific information on many health outcomes, durations of exposure, timing of exposure, lifestages, and susceptible subpopulations (see U.S. EPA, 2000b, pages 4-19).

Hazard Assessment – The process of determining whether exposure to an agent can cause an increase in the incidence of a particular adverse health effect (e.g., cancer, birth defect) and whether the adverse health effect is likely to occur in humans.

Hazard Characterization – A description of the potential adverse health effects attributable to a specific environmental agent, the mechanisms by which agents exert their toxic effects, and the associated dose, route, duration, and timing of exposure.

Human Equivalent Concentration (HEC) or Dose (HED) – The human concentration (for inhalation exposure) or dose (for other routes of exposure) of an agent that is believed to induce the same magnitude of toxic effect as the experimental animal species concentration or dose. This adjustment may incorporate toxicokinetic information on the particular agent, if available, or use a default procedure, such as assuming that daily oral doses experienced for a lifetime are proportional to body weight raised to the 0.75 power.

Intake Rate – Rate of inhalation, ingestion, and dermal contact, depending on the route of exposure. For ingestion, the intake rate is simply the amount of food containing the contaminant of interest that an individual ingests during some specific time period (units of mass/time). For inhalation, the intake rate is the rate at which contaminated air is inhaled. Factors that affect dermal exposure are the amount of material that comes into contact with the skin and the rate at which the contaminant is absorbed.

Key Event – A key event is an empirically observable precursor step that is itself a necessary element of the mode of action (U.S. EPA, 2005a,b). Toxicokinetic and toxicodynamic steps that lead to a toxic response can be considered as key event(s).

Lifestage Approach – The comparison of exposure and effect data across different lifestages from conception to old age. This approach provides a temporal context in which to evaluate data for risk assessment.

Longitudinal Study – An epidemiologic study comparing subject with an exposure of interest to those without the exposure. These two cohorts are then followed over time to determine the differences in the rates of disease between the exposure subjects.

Low-Dose Extrapolation – An estimate of the response at a point below the range of the experimental data, generally through the use of a mathematical model.

Lowest-Observed-Adverse-Effect Level (LOAEL) – The lowest exposure level at which there are biologically significant increases in frequency or severity of adverse effects among the exposed population when compared with an appropriate control group.

Margin of Exposure (MOE) – The ratio of the point of departure (POD) over an exposure estimate (MOE = POD/Exposure).

Mechanism of Action – The complete sequence of biological events (i.e., including toxicokinetic and toxicodynamic events) from exposure to the chemical to the ultimate cellular and molecular consequences of chemical exposure that are required in order to produce the toxic effect. However, events that are coincident but not required to produce the toxic outcome are not included.

Media – see Exposure Media.

Meta-Analysis – Any systematic method that uses statistical analysis to integrate the data from a number of independent studies.

Mode of Action – The sequence of key event(s) (i.e., toxicokinetics and toxicodynamics) after chemical exposure upon which the toxic outcome depend.

Model – A mathematical function with parameters that can be adjusted so that the function closely describes a set of empirical data. A mechanistic model usually reflects observed or hypothesized biological or physical mechanisms and has model parameters with real world interpretation. In contrast, statistical or empirical models selected for particular numerical properties are fitted to data; model parameters may or may not have real world interpretation. When data quality is otherwise equivalent, extrapolation from mechanistic models (e.g., biologically based dose-response models) often carries higher confidence than extrapolation using empirical models (e.g., logistic model).

No-Observed-Adverse-Effect Level (NOAEL) – The highest exposure level at which there are no biologically significant increases in the frequency or severity of adverse effect between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse or precursors of adverse effects.

Outcome – A clinical manifestation of biological effects that results from an exposure.

Pathway – see Exposure Pathway.

Person-Oriented Model – An approach in which the individual's exposure-related characteristics are defined first and then used to determine the probability of the individuals' being exposed to a specific source and the resulting dose.

Physiologically based Toxicokinetic (PBTK) Model – A model that estimates the dose to a target tissue or organ by taking into account the rate of absorption into the body, distribution among target organs and tissues, metabolism, and excretion. (Also referred to as physiologically based pharmacokinetic model.)

Point-of-Contact Approach – An approach to quantifying exposure by taking measurements of concentration over time at or near the point of contact between the chemical and an organism while the exposure is taking place.

Point of Departure (POD) – The dose-response point that marks the beginning of a low-dose extrapolation. This point can be the lower bound on dose for an estimated incidence or a change in response level from a dose-response model (BMD) or a NOAEL or LOAEL for an observed incidence, or change in level of response.

Portal of Entry – The point at which the contaminant enters the body (e.g., mouth, nose, skin).

Precursor Event – An early condition or state preceding the pathological onset of a disease.

Reference Concentration (RfC) – An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, a LOAEL, or a benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. It is generally used in EPA's noncancer health assessments.

Reference Dose (RfD) – An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, a LOAEL, or a benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. It is generally used in U.S. EPA's noncancer health assessments.

Reference Value (RfV) – An estimation of an exposure for (a given duration) to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse effects over a lifetime. It is derived from a BMDL, a NOAEL, a LOAEL, or another suitable POD, with uncertainty/variability factors applied to reflect limitations of the data used.

Risk (in the context of human health) – The probability of adverse effects resulting from exposure to an environmental agent or mixture of agents.

Risk Assessment (in the context of human health) – The evaluation of scientific information on the hazardous properties of environmental agents (hazard characterization), the dose-response relationship (dose-response assessment), and the extent of human exposure to those agents (exposure assessment). The product of the risk assessment is a statement regarding the probability that populations or individuals so exposed will be harmed and to what degree (risk characterization).

Risk Characterization – The integration of information on hazard, exposure, and dose-response to provide an estimate of the likelihood that any of the identified adverse effects will occur in exposed people.

Risk Management (in the context of human health) – A decision-making process that accounts for political, social, economic, and engineering implications together with risk-related information in order to develop, analyze, and compare management options and select the appropriate managerial response to a potential chronic health hazard.

Route – see Exposure Route.

Structure-Activity Relationship (SAR) approach to toxicology screening – This approach elucidates the relationship between features of chemical structure and biological activity. It is based on the premise that the biological fate and activity of a chemical (i.e., whether it is absorbed, metabolized, or bioaccumulated and whether it interacts at a molecular level to exert a response) is ultimately determined by chemical structure.

Scenario Evaluation Approach – An approach to quantifying exposure by measurement or estimation of both the amount of a substance contacted and the frequency/duration of contact and subsequently linking these together to estimate exposure or dose.

Sensitivity Analysis – Refers to the variation in output of a model with respect to changes in the values of the model input(s). Sensitivity analysis can provide a quantitative ranking of the model inputs based on their relative contributions to model output variability and uncertainty (U.S. EPA 2001b).

Short-Term Exposure – Repeated exposure by the oral, dermal, or inhalation route for more than 24 hours, up to 30 days.

Slope Factor – An upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per mg/kg/day, is generally reserved for use in the low-dose region of the dose-response relationship, i.e., for exposures corresponding to risks less than 1 in 100.

Source – The origin of an agent for the purposes of an exposure assessment.

Source-to-Dose Model – An approach where an environmental agent is followed from its source to the resulting dose.

Stakeholder – An interested party who is concerned with the decisions made about how a risk may be mitigated, avoided, reduced, or eliminated, and the communities that may be impacted by regulatory decisions.

Stressor – Any entity, stimulus, or condition that can modulate normal functions of the organism or induce an adverse response (e.g., agent, lack of food, drought).

Superfund – Federal authority, established by the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (U.S. 96th Congress, 1980) to respond directly to releases or threatened releases of hazardous substances that may endanger health or welfare.

Susceptibility – Increased likelihood of an adverse effect or an exposure, often discussed in terms of relationship to a factor, that can be used to describe a human subpopulation (e.g., lifestage, demographic feature, or genetic characteristic).

Susceptible Subgroups – May refer to lifestages (e.g., children or the elderly), or to other segments of the population (e.g., asthmatics, the immune-compromised, or the highly exposed). The term is likely to be chemical-specific, and may not be consistently defined in all cases.

Target Organ – The biological organ most adversely affected by exposure to a chemical, physical, or biological agent.

Toxicity – Deleterious or adverse biological effects elicited by a chemical, physical, or biological agent.

Toxicodynamic (TD) – The determination and quantification of the sequence of events at the cellular and molecular levels leading to a toxic response to an environmental agent (sometimes referred to as pharmacodynamics, also MOA.

Toxicokinetic (TK) – The determination and quantification of the time course of absorption, distribution, metabolism, and excretion of chemicals (sometimes referred to as pharmacokinetics).

Toxification – Metabolic conversion of a potentially toxic substance to a product that is more toxic.

Uncertainty – Uncertainty occurs because of a lack of knowledge. It is not the same as variability. For example, a risk assessor may be very certain that different people drink different amounts of water but may be uncertain about how much variability there is in water intakes within the population. Uncertainty can often be reduced by collecting more and better data, whereas variability is an inherent property of the population being evaluated. Variability can be better characterized with more data but it cannot be reduced or eliminated. Efforts to clearly distinguish between variability and uncertainty are important for both risk assessment and risk characterization.

Uncertainty Factor (UF) – One of several, generally 10-fold, default factors used in operationally deriving the RfD and RfC from experimental data. The factors are intended to account for

- variation in susceptibility among the members of the human population (i.e., interindividual or intraspecies variability)
- uncertainty in extrapolating experimental animal data to humans (i.e., interspecies uncertainty);
- uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (i.e., extrapolating from subchronic to chronic exposure)
- uncertainty in extrapolating from a LOAEL rather than from a NOAEL and
- uncertainty associated with extrapolation when the database is incomplete.

Variability – Variability refers to true heterogeneity or diversity. For example, among a population that drinks water from the same source and with the same contaminant concentration, the risks from consuming the water may vary. This may be due to differences in exposure (i.e., different people drinking different amounts of water and having different body weights, different exposure frequencies, and different exposure durations) as well as differences in response (e.g., genetic differences in resistance to a chemical dose). Those inherent differences are referred to as variability. Differences among individuals in a population are referred to as *interindividual variability*; differences for one individual over time is referred to as *intraindividual variability*.

Vulnerability – A matrix of physical, chemical, biological, social, and cultural factors which result in certain communities and subpopulations being more susceptible to environmental toxins, being more exposed to toxins, or having compromised ability to cope with and/or recover from such exposure. Four types of vulnerability are considered with regard to a

lifestage approach: susceptibility or sensitivity, differential exposure, differential preparedness, and differential ability to recover (NEJAC, 2004).

Weight-of-Evidence (WOE) – An approach requiring a critical evaluation of the entire body of available data for consistency and biological plausibility. Potentially relevant studies are judged for quality and studies of high quality given much more weight than those of lower quality (see U.S. EPA, 2000b, pages 4-11-12).

REFERENCES[14]

Adams, J; Barone, S, Jr; LaMantia, A; et al. (2000) Workshop to identify critical windows of exposure for children's health: neurobehavioral workgroup summary. Environ Health Perspect 108(Suppl 3):535-544. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/535-544adams/adams-full.html.

Adgate, JL; Church, TR; Ryan, AD; et al. (2004) Outdoor, indoor, and personal exposure to VOCs in children. Environ Health Perspect 112:1386-1392. Available online at http://www.ehponline.org/members/2004/7107/7107.html.

Albertini, R; Bird, M; Doerrer, N; et al. (2006) The use of biomonitoring data in exposure and human health risk assessments**.** Environ Health Perspect [e-pub before print]. Available online at http://www.ehponline.org/docs/2006/9056/abstract.html.

Allen, BC; Kavlock, RJ; Kimmel, CA; et al. (1994a) Dose-response assessment for developmental toxicity. II. Comparison of generic benchmark dose estimates with no observed adverse effect levels. Fundam Appl Toxicol 23(4):487-495. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=7867900&query_hl=2&itool=pubmed_docsum.

Allen, BC; Kavlock, RJ; Kimmel, CA; et al. (1994b) Dose-response assessment for developmental toxicity. III. Statistical models. Fundam Appl Toxicol 23(4):496-509. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=7867901&query_hl=2&itool=pubmed_docsum.

Allen, B; Gentry, R; Shipp, A; et al. (1998) Calculation of benchmark doses for reproductive and developmental toxicity observed after exposure to isopropanol. Reg Toxicol Pharmacol 28(1):38-44. Available online at: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Retrieve&list_uids=9784431&dopt=Citation.

Andersen, ME; Dennison, JE. (2001) Mode of action and tissue dosimetry in current and future risk assessments. Sci Total Environ 274(1-3):3-14. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Retrieve&list_uids=11453304&dopt=Citation.

Andersen, ME; Meek, ME; Boorman, GA; et al. (2000) Lessons learned in applying the U.S. EPA proposed cancer guidelines to specific compounds. Toxicol Sci 53:159-172. Available online at http://toxsci.oxfordjournals.org/cgi/reprint/53/2/159.

Anderson, LM; Diwan, BA; Fear, NT; et al. (2000) Critical windows of exposure for children's health: cancer in human epidemiological studies and neoplasms in experimental animal models. Environ Health Perspect 108(Suppl 3):573-594. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/573-594anderson/anderson-full.html.

Anway, MD; Leathers, C; Skinner, MK. (2006) Endocrine disruptor vinclozolin induced epigenetic transgenerational adult onset disease. Endocrinology [Epub ahead of print]. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16973726&query_hl=2&itool=pubmed_docsum.

Ashani, Y; Pistinner, S. (2004) Estimation of the upper limit of human butyrylcholinesterase dose required for protection against organophosphates toxicity: a mathematically based toxicokinetic model. Toxicol Sci 77(2):358-367. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14600276&query_hl=13.

[14] All references are hyperlinked to the online document when available. Due to copyright regulations, there may be links to sites where the document is available for purchase. Note that links may change over time.

Barlow, NJ; Foster, PM. (2003) Pathogenesis of male reproductive tract lesions from gestation through adulthood following *in utero* exposure to di(n-butyl) phthalate. Toxicol Pathol 31(4):397-410. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=12851105&query_hl=4&itool=pubmed_docsum.

Barnes, DG; Daston, GP; Evans, JS; et al. (1995) Benchmark dose workshop: criteria for use of benchmark dose to estimate a reference dose. Reg Toxicol Pharmacol 21(2):296-306. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=7644719&query_hl=25.

Barr, M, Jr; DeSesso, JM; Lau, CS; et al. (2000) Workshop to identify critical windows of exposure for children's health: cardiovascular and endocrine work group summary. Environ Health Perspect 108(Suppl 3):569-571. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/569-571barr/barr-full.html.

Barr, DB; Wang, RY; Needham, LL. (2005) Biologic monitoring of exposure to environmental chemicals throughout the life stages: requirements and issues for consideration for the National Children's Study. Environ Health Perspect 113(8):1083-1091. Available online at http://www.ehponline.org/members/2005/7617/7617.html.

Barton, H. (2005) Computational pharmacokinetics during developmental windows of susceptibility. J Toxicol Environ Health A: 68(11-12):889-900. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=16020183&query_hl=8.

Beck, BD; Mattuck, RL; Bowers, TS; et al. (2001) The development of a stochastic physiologically based pharmacokinetic model for lead. Sci Total Environ 274(1-3):15-19. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11453291&query_hl=27.

Beckman, DA; Feuston, M. (2003) Landmarks in the development of the female reproductive system. Birth Defects Res B Dev Reprod Toxicol 68(2):137-143. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12866705&query_hl=23.

Besunder, JB; Reed, MD; Blumer, JL. (1988a) Principles of drug biodisposition in the neonate. A critical evaluation of the pharmacokinetic-pharmacodynamic interface (Part I). Clin Pharmacokinet 14:189-216. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=3292100&query_hl=25.

Besunder, JB; Reed, MD; Blumer, JL. (1988b) Principles of drug biodisposition in the neonate. A critical evaluation of the pharmacokinetic-pharmacodynamic interface (Part II). Clin Pharmacokinet 14(5):261-286. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=3293867&query_hl=25.

Bogdanffy, MS; Daston, G; Faustman, EM; et al. (2001) Harmonization of cancer and noncancer risk assessment: proceedings of a consensus-building workshop. Toxicol Sci 61(1):18-31. Available online at http://toxsci.oxfordjournals.org/cgi/content/abstract/61/1/18.

Bossowski, A; Urban, M; Stasiak-Barmuta, A. (2003) Analysis of changes in the percentage of B (CD19) and T (CD3) lymphocytes, subsets CD4, CD8 and their memory (CD45RO), and naïve (CD45RA) T cells in children with immune and non-immune thyroid disease. J Pediatr Endocrinol Metab 16(1):63-70. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=12585342&query_hl=3&itool=pubmed_docsum.

Brown, KG; Strickland, JA. (2003) Utilizing data from multiple studies (meta-analysis) to determine effective dose-duration levels. Example: rats and mice exposed to hydrogen sulfide. Reg Toxicol Pharmacol 37(2):305-317.

Available online at
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12726759&query_hl=5.

Bruckner, JV. (2000) Differences in sensitivity of children and adults in chemical toxicity. The NAS panel report. Reg Toxicol Pharmacol 31(3):280-285. Available online at
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=10915586&query_hl=32.

Bruckner, JV; Weil WB. (1999) Biological factors which may influence an older child's or adolescents responses to toxic chemicals. Reg Toxicol Pharmacol 29(2 Pt. 1):158-164. Available online at
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=Abstract&list_uids=10341146&query_hl=1&itool=pubmed_docsum.

Campbell, CG; Seidler, FJ; Slotkin, TA. (1997) Chlorpyrifos interferes with cell development in rat brain regions, Brain Res Bull 179-189. Available online at
http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6SYT-3S9C423-8-G&_cdi=4843&_user=14684&_orig=search&_coverDate=12%2F31%2F1997&_qd=1&_sk=999569997&view=c&_alid=451503315&_rdoc=1&wchp=dGLbVlb-zSkWW&md5=2b06d49bfa93589b123d65117b20d17c&ie=/sdarticle.pdf.

Canfield, RL; Henderson, CR, Jr; Cory-Slechta, DA; et al. (2003) Intellectual impairment in children with blood lead concentrations below 10 microg per deciliter. N Engl J Med 348(16):1517-1526. Available online at
http://content.nejm.org/cgi/content/abstract/348/16/1517.

Cappon, GD; Fleeman, TL; Chapin, RE; et al. (2005) Effects of feed restriction during organogenesis on embryo-fetal development in rabbit. Birth Defects Res B Dev Reprod Toxicol 74(5):424-430. Available online at
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16249998&query_hl=11&itool=pubmed_docsum.

CDC (Centers for Disease Control and Prevention). (2005) Third national report on human exposure to environmental chemicals. Department of Health and Human Services, Atlanta, GA. NCEH Pub. No. 05-0570. Available online at http://www.cdc.gov/exposurereport/3rd/pdf/thirdreport.pdf.

Chapin, RE; Harris, MW; Davis, BJ; et al. (1997) The effects of perinatal/juvenile methoxychlor exposure on adult rat nervous, immune, and reproductive system function. Fundam Appl Toxicol 40(1):138-157. Available online at
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=9398496&query_hl=5&itool=pubmed_docsum.

Chakraborti, TK; Farrar, JD; Pope, CN. (1993) Comparative neurochemical and neurobehavioral effects of repeated chlorpyrifos exposures in young and adult rats, Pharmacol Biochem Behav 46:219-224. Available online at
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=7504821&query_hl=17&itool=pubmed_docsum.

Clewell, HJ; Crump, KS. (2005) Quantitative estimates of risk for noncancer endpoints. Risk Analysis 25(2):285-289. Available online at
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15876204&query_hl=17.

Clewell, RA; Gearhart, JM. (2002) Pharmacokinetics of toxic chemicals in breast milk: use of PBPK models to predict infant exposure. Environ Health Perspect 110(6):A333-337. Available online at
http://ehp.niehs.nih.gov/members/2002/110pA333-A337clewell/clewell-full.html.

Clewell, HJ, III; Gentry, PR; Gearhart, JM; et al. (2001) Development of a physiologically based pharmacokinetic model of isopropanol and its metabolite acetone. Toxicol Sci 63(2):160-172. Available online at

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11568359&query_hl=36.

Clewell, HJ, III; Andersen, ME; Barton, HA. (2002a) A consistent approach for the application of pharmacokinetic modeling in cancer and noncancer risk assessment. Environ Health Perspect 110(1):85-93. Available online at http://ehp.niehs.nih.gov/members/2002/110p85-93clewell/clewell-full.html.

Clewell, HJ; Teeguarden, J; McDonald, T; et al. (2002b) Review and evaluation of the potential impact of age- and gender-specific pharmacokinetic differences on tissue dosimetry. Crit Rev Toxicol 32(5):329-389. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12389868&query_hl=38.

Clewell, RA; Merrill, EA; Yu, KO; et al. (2003) Predicting neonatal perchlorate dose and inhibition of iodide uptake in the rat during lactation using physiologically-based pharmacokinetic modeling. Toxicol Sci 74(2):416-436. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12805655&query_hl=42.

Clewell, HJ; Gentry, PR; Covington, TR; et al. (2004) Evaluation of the potential impact of age- and gender-specific pharmacokinetic differences on tissue dosimetry. Toxicol Sci 79(2):381-393. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15056818&query_hl=34.

Cohen Hubal, EA; Egeghy, P; Leovic, K; et al. (2006) Measuring potential dermal transfer of a pesticide to children in a child care center. Environ Health Perspect 114(2)264-269. Available online at http://www.ehponline.org/members/2005/8283/8283.html.

Conolly, RB; Gaylor, DW; Lutz, WK. (2005) Population variability in biological adaptive responses to DNA damage and the shape of carcinogen dose-response curves. Toxicol Appl Pharmacol 207(Suppl. 2):S570-S575. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15996697&query_hl=19.

Corley, RA; Mast, TJ; Carney, EW; et al. (2003) Evaluation of physiologically based models of pregnancy and lactation for their application in children's health risk assessments. Crit Rev Toxicol 33(2):137-211. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12708613&query_hl=51.

Crump, KS. (1984) A new method for determining allowable daily intakes. Fundam Appl Toxicol 4(5):854-871. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=6510615&query_hl=2.

Crump, KS; Hoel, DG; Langley, CH; et al. (1976) Fundamental carcinogenic processes and their implications for low dose risk assessment. Cancer Res 36(9 Pt. 1):2973-2979. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=975067&query_hl=12.

Cuff, JM; Kimmel, GL; Kimmel, CA; et al. (1993) Relationship between abnormal somite development and axial skeletal defects in rats following heat exposure. Teratology 48(3):259-266. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=8248863&query_hl=15&itool=pubmed_docsum.

Cummins, SK; Jackson, RJ. (2001) The built environment and children's health. Pediatr Clin North Am 48(5):1241-1252. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=11579672&query_hl=19&itool=pubmed_docsum.

Dam, K; Seidler, FJ; Slotkin, TA. (1998) Developmental neurotoxicity of chlorpyrifos: delayed targeting of DNA synthesis after repeated administration. Brain Res Dev Brain Res 108:39-45. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=9693782&query_hl=19&itool=pubmed_docsum.

Daston, G; Faustman, E; Ginsberg, G; et al. (2004) A framework for assessing risks to children from exposure to environmental agents. Environ Health Perspect 112(2):238-56. Available online at http://ehp.niehs.nih.gov/members/2003/6182/6182.html.

DeWoskin, RS; Barone, S, Jr; Clewell, HJ; et al. (2001) Improving the development and use of biologically based dose response models (BBDR) in risk assessment. Hum Ecol Risk Assess 7(5):1091-1120. Available online at http://www.crcjournals.com/eJournals/articles/article_synopsis.asp?id=29393.

Dietert, RR; Etzel, RA; Chen, D; et al. (2000) Workshop to identify critical windows of exposure for children's health: immune and respiratory systems work group summary. Environ Health Perspect 108(Suppl 3):483-490. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/483-490dietert/dietert-full.html.

Edidin, DV; Levitsky, LL. (1982) Prepubertal gynecomastia associated with estrogen-containing hair cream. Am J Dis Child 136(7):587-588. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=7091084&query_hl=37&itool=pubmed_docsum.

Euling, SY; Kimmel, CA. (2001) Developmental stage sensitivity and mode of action information for androgen agonists and antagonists. Sci Total Environ 2:274(1-3):103-113. Available online at http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6V78-43B2999-9-4&_cdi=5836&_user=14684&_orig=search&_coverDate=07%2F02%2F2001&_qd=1&_sk=997259998&view=c&_alid=451506870&_rdoc=1&wchp=dGLbVzz-zSkWA&md5=a9cf7b77fb2e20fffb99e54884fba331&ie=/sdarticle.pdf.

Executive Order. (1997) Executive Order 13045–Protection of children from environmental health risks and safety risks. Fed Reg 62(78):19883-19888. Available online at http://www.epa.gov/fedrgstr/eo/eo13045.htm.

Farwell, AP; Dubord-Tomasetti, SA; Pietrzykowski, AZ; et al. (2006) Dynamic nongenomic actions of thyroid hormone in the developing rat brain. Endocirnology 147(5):2567-2574. Available online at http://endo.endojournals.org/cgi/reprint/147/5/2567.

Faustman, EM; Allen, BC; Kavlock, RJ; et al. (1994) Dose-response assessment for developmental toxicity. I. Characterization of database and determination of no observed adverse effect levels. Fundam Appl Toxicol 23(4):478-486. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=7867899&query_hl=2&itool=pubmed_docsum.

Faustman, EM; Lewandowski, TA; Ponce, RA; et al. (1999). Biologically based dose response models for developmental toxicants: lessons from methylmercury. Inhal Toxicol 11(6-7):559-572. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11202998&query_hl=65.

Felner, EI; White, PC. (2000) Prepubertal gynecomastia: indirect exposure to estrogen cream. Pediatrics 105(4):E55. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=10742376&query_hl=40&itool=pubmed_docsum.

Fleeman ,TL; Cappon, GD; Chapin, RE; et al. (2005) The effects of feed restriction during organogenesis on embryo-fetal development in the rat. Birth Defects Res B Dev Reprod Toxicol 74(5):442-449. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16193501&query_hl=11&itool=pubmed_docsum.

Gaido, KW; Maness, SC; McDonnell, DP; et al. (2000) Interaction of methoxychlor and related compounds with estrogen receptor alpha and beta, and androgen receptor: structure-activity studies. Mol Pharmacol 58(4):852-858. Available online at http://molpharm.aspetjournals.org/cgi/content/full/58/4/852.

Gargas, ML; Tyler, TR; Sweeney, LM; et al. (2000) A toxicokinetic study of inhaled ethylene glycol monomethyl ether (2-ME) and validation of a physiologically based pharmacokinetic model for the pregnant rat and human. Toxicol Appl Pharmacol 165(1):53-62. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=10814553&query_hl=69.

Gaylor, DW; Kodell, RL. (2002) A procedure for developing risk-based reference doses. Reg Toxicol Pharmacol 35(2 Pt. 1):137-141. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12051999&query_hl=22.

Gee, GC; Payne-Sturges, DC. (2004) Environmental health disparities: a framework integrating psychosocial and environmental concepts. Environ Health Perspect 112(17):1645-1653. Available online at http://www.pubmedcentral.gov/articlerender.fcgi?tool=pubmed&pubmedid=15579407.

Gentry, PR; Covington, TR; Clewell, HJ. (2003) Evaluation of the potential impact of pharmacokinetic differences on tissue dosimetry in offspring during pregnancy and lactation. Reg Toxicol Pharmacol 38(1):1-16. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12878049&query_hl=73.

Ginsberg, G; Hattis, D; Sonawane, BR; et al. (2002) Evaluation of child/adult pharmacokinetic differences from a database derived from the therapeutic drug literature. Toxicol Sci 66(2):185-200. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11896285&query_hl=77.

Ginsberg, G; Hattis, D; Miller, R; et al. (2004a) Pediatric pharmacokinetic data: implications for environmental risk assessment for children. Pediatrics 113(4 Suppl):973-983. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15060190&query_hl=79.

Ginsberg, G; Hattis, D; Sonawane, BR. (2004b) Incorporating pharmacokinetic differences between children and adults in assessing children's risks to environmental toxicants. Toxicol Appl Pharmacol 198(2):164-183. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15236952&query_hl=83.

Ginsberg, Gl; Slikker, W, Jr; Bruckner, J; et al. (2004c) Incorporating children's toxicokinetics into a risk framework. Environ Health Perspect 112(2):272-283. Available online at http://ehp.niehs.nih.gov/members/2003/6013/6013.html.

Gray, LE, Jr; Ostby, J; Cooper, RL; et al. (1999a) The estrogenic and antiandrogenic pesticide methoxychlor alters the reproductive tract and behavior without affecting pituitary size or LH and prolactin secretion in male rats. Toxicol Ind Health 15(1-2):37-47. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=10188190&query_hl=7&itool=pubmed_docsum.

Gray, LE, Jr; Wolf, C; Lambright, C; et al. (1999b) Administration of potentially antiandrogenic pesticides (procymidone, linuron, iprodione, chlozolinate, p,p'-DDE, and ketoconazole) and toxic substances (dibutyl- and diethylhexyl phthalate, PCB 169, and ethane dimethane sulphonate) during sexual differentiation produces diverse profiles of reproductive malformations in the male rat. Toxicol Ind Health 15(1-2):94-118. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=10188194&query_hl=28&itool=pubmed_docsum.

Gray, GM; Baskin, SI; Charnley, G. (2001) The Annapolis accords on the use of toxicology in risk assessment and decision-making: an Annapolis center workshop report. Toxicol Methods 11(3):225-231. Available online at http://taylorandfrancis.metapress.com/openurl.asp?genre=article&id=doi:10.1080/105172301316871626.

Greaves, M. (2003). Pre-natal origins of childhood leukemia. Rev Clin Exp Hematol 7(3):233-245. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15024967&query_hl=7.

Griffiths, CW; Dockins, C; Owens, N; et al. (2002) What to do at low doses: a bounding approach for economic analysis. Risk Anal 22(4):679-88. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12224742&query_hl=86.

Hartl, DL. (2001) Genetic management of outbred laboratory rodent populations. Charles River Laboratories. Research Models. Available online at http://www.criver.com/flex_content_area/documents/rm_gt_r_genetic_management_outbred_rodent.pdf.

Hattis, D. (2004) Human interindividual variability in parameters related to susceptibility for toxic effects. Available online at http://www2.clarku.edu/faculty/dhattis.

Hattis, D; Goble, R; Russ, A; et al. (2004) Age-related differences in susceptibility to carcinogenesis: a quantitative analysis of empirical animal bioassay data. Environ Health Perspect 112(4):1152-1158. Available online at http://ehp.niehs.nih.gov/members/2004/6871/6871.html.

Hattis, D; Goble, R; Chu, M. (2005) Age-related differences in susceptibility to carcinogenesis. II. Approaches for application and uncertainty analyses for individual genetically acting carcinogens. Environ Health Perspect 113(4):509-516. Available online at http://ehp.niehs.nih.gov/members/2005/7564/7564.html.

Herbst, AL. (1987) The effects in the human of diethylstilbestrol (DES) use during pregnancy. Princess Takamatsu Symp 18:67-75. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=3506546&query_hl=10&itool=pubmed_DocSum.

Hew, KW; Keller, KA. (2003) Postnatal anatomical and functional development of the heart: a species comparison. Birth Defects Res B Dev Reprod Toxicol 68(4):309-320. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14666994&query_hl=93.

Hill, AB. (1965) The environment and disease: association or causation? Proc R Soc Med 58:295-300. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=14283879.

Hines, RN; McCarver, DG. (2002) The ontogeny of human drug-metabolizing enzymes: phase I oxidative enzymes. J Pharmacol Exp Ther 300(2):355-360. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11805191&query_hl=95.

Hoet, JJ; Ozanne, S; Reusens, B. (2000) Influences of pre- and postnatal nutritional exposures on vascular/endocrine systems in animals. Environ Health Perspect 108(Suppl 3):563-568. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/563-568hoet/hoet-full.html.

Holladay, SD; Smialowicz, RJ. (2000) Development of the murine and human immune system: differential effects of immunotoxicants depend on time of exposure. Environ Health Perspect 108(Suppl 3):463-474. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/463-473holladay/holladay-full.html.

Holsapple, MP; West, LJ; Landreth, KS. (2003) Species comparison of anatomical and functional immune system development. Birth Defects Res B Dev Reprod Toxicol 68(4):321-334. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14666995&query_hl=97.

Hubal, EA; Sheldon, LS; Zufall, MJ; et al. (2000) The challenge of assessing children's residential exposure to pesticides. J Exposure Anal Environ Epidemiol 10(6 Pt. 2):638-649. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11138656&query_hl=99.

Hurtt, ME; Sandler, JD. (2003a) Comparative organ system development: introduction. Birth Defects Res B Dev Reprod Toxicol 68(2):85. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12866700&query_hl=102.

Hurtt, ME; Sandler, JD. (2003b) Comparative organ system development: continuing the series. Birth Defects Res B Dev Reprod Toxicol 68(4):307-308. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14666993&query_hl=104.

Hurtt, ME; Daston, G; Davis-Bruno, K; et al. (2004) Workshop Summary - Juvenile animal studies: testing strategies and design. Birth Defects Res (Part B) 71(4):281-288. Available online at http://www3.interscience.wiley.com/cgi-bin/abstract/109595570/ABSTRACT.

ICF Consulting. (1999) Child-related risk assessment policy and methodology guidance document survey (draft). Office of the Administrator, Office of Children's Health Protection, Meg Kelly. Washington, DC: ICF Consulting.

ILSI (International Life Sciences Institute). (2003) Workshop to develop a framework for assessing risks to children from exposures to environmental agents. Washington, DC: ILSI Press, Risk Science Institute. Available online at http://rsi.ilsi.org/NR/rdonlyres/1B183267-ADF3-4FEC-9CA2-339DD1482FC2/0/WorkshopReportFinal.pdf.

Julien, E; Willhite, CC; Richard, AM; et al. (2004) Challenges in constructing statistically based structure-activity relationship models for developmental toxicity. Birth Defects Res A Clin Mol Teratol 70(12):902-911. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15558547&query_hl=106.

Kavlock, RJ; Allen, BC; Faustman, EM; et al. (1995) Dose-response assessments for developmental toxicity. IV. Benchmark doses for fetal weight changes. Fundam Appl Toxicol 26(2):211-222. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=7589910&query_hl=2&itool=pubmed_docsum.

Kimmel, CA; Cuff, JM; Kimmel, GL; et al. (1993) Skeletal development following heat exposure in the rat. Teratology 47(3):229-242. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=8475466&query_hl=15&itool=pubmed_docsum.

Kimmel, CA; Kavlock, RJ; Allen, BC; et al. (1995) The application of benchmark dose methodology to data from prenatal developmental toxicity studies. Toxicol Lett 82-83:549-554. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=8597108&query_hl=2&itool=pubmed_docsum.

Kimmel, CA; Collman, GW; Fields, N; et al. (2005) Lessons learned for the National Children's Study from the National Institute of Environmental Health Sciences/U.S. Environmental Protection Agency Centers for Children's Environmental Health and Disease Prevention Research. Environ Health Perspect 113(10):1414-1418. Available online at http://www.ehponline.org/docs/2005/7669/abstract.html.

Lam, SH; Sin, YM; Gong, Z; et al. (2005) Effects of thyroid hormone on the development of immune system in zebrafish. Gen Comp Endocrinol 142(3):325-335. Available online at http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WG0-4FWKDR3-1&_coverDate=07%2F31%2F2005&_alid=456156585&_rdoc=1&_fmt=&_orig=search&_qd=1&_cdi=6808&_sort=d&view=c&_acct=C000001678&_version=1&_urlVersion=0&_userid=14684&md5=ab62ec8973d3f8d8b342c1db911841a7.

Landrigan, P; Kimmel, CA; Correa, A; et al. (2004) Children's health and the environment: public health issues and challenges for risk assessment. Environ Health Perspect 112(2):257-265. Available online at http://ehp.niehs.nih.gov/members/2003/6115/6115.html.

Lau, C; Rogers, JM. (2004) Embryonic and fetal programming of physiological disorders in adulthood. Birth Defects Res C Embryo Today 72(4):300-312. Available online at http://www3.interscience.wiley.com/cgi-bin/abstract/109867211/ABSTRACT.

Lau, C; Andersen, ME; Crawford-Brown, DJ; et al. (2000) Evaluation of biologically based dose-response modeling for developmental toxicity: a workshop report. Reg Toxicol Pharmacol 31(2 Pt. 1):190-199. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=10854125&query_hl=111.

Lau, C; Mole, ML; Copeland, MF; et al. (2001) Toward a biologically based dose-response model for developmental toxicity of 5-fluorouracil in the rat: acquisition of experimental data. Toxicol Sci 59(1):37-48. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11134542&query_hl=114.

Lemasters, GK; Perreault, SD; Hales, BF; et al. (2000) Workshop to identify critical windows of exposure for children's health: reproductive health in children and adolescents work group summary. Environ Health Perspect 108(Suppl 3):505-509. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/505-509lemasters/lemasters-full.html.

Liu, LJS; Box, M; Kalman, D; et al. (2003) Exposure assessment of particulate matter for susceptible populations in Seattle. Environ Health Perspect 111(7):909-918. Available online at http://www.ehponline.org/members/2003/6011/6011.html.

Lorber, M; Phillips, L. (2002) Infant exposure to dioxin-like compounds in breast milk. Environ Health Perspect 110(6):A325-332. Available online at http://ehp.niehs.nih.gov/members/2002/110pA325-A332lorber/lorber-full.html.

Lutz, WK; Gaylor, DW; Conolly, RB; et al. (2005) Nonlinearity and thresholds in dose-response relationships for carcinogenicity due to sampling variation, logarithmic dose scaling, or small differences in individual susceptibility. Toxicol Appl Pharmacol 207(Suppl. 2):S565-S569. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15982698&query_hl=24.

MacIntosh, DL; Kabiru, CW; Ryan, PB. (2001) longitudinal investigation of dietary exposure to selected pesticides**.** Environ Health Perspect 109(2):145-150. Available online at http://www.ehponline.org/members/2001/109p145-150macintosh/macintosh-full.html.

Marty, MS; Chapin, RE; Parks, LG; et al. (2003) Development and maturation of the male reproductive system. Birth Defects Res B Dev Reprod Toxicol 68(2):125-136. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12866704&query_hl=116.

McCarver, DG; Hines, RN. (2002) The ontogeny of human drug-metabolizing enzymes: phase II conjugation enzymes and regulatory mechanisms. J Pharmacol Exp Ther 300(2):361-366. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11805192&query_hl=118.

Mericskay, M; Carta, L; Sassoon, D. (2005) Diethylstilbestrol exposure *in utero*: a paradigm for mechanisms leading to adult disease. Birth Defects Res A Clin Mol Teratol 73(3):133-135. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=15751030&query_hl=8&itool=pubmed_docsum.

Morford, LL; Henck, JW; Breslin, WJ; et al. (2004) Hazard identification and predictability of children's health risk from animal data. Environ Health Perspect 112(2):266-271. Available online at http://ehp.niehs.nih.gov/members/2003/6014/6014.html.

Morgan, MK; Sheldon, LS; Croghan, CW; et al. (2006) A pilot study of children's total exposure to persistent pesticides and other persistent organic pollutants (CTEPP). Volume I: Final Report. Contract Number 68-D-99-011, U.S. Environmental Protection Agency, Office of Research and Development, Research Triangle Park, NC. Available online at http://www.epa.gov/heasd/ctepp/ctepp_report.pdf.

Mylchreest, E; Sar, M; Cattley, RC; et al. (1999) Disruption of androgen-regulated male reproductive development by di(n-butyl) phthalate during late gestation in rats is different from flutamide. Toxicol Appl Pharmacol 156(2):81-95. Available online at http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6WXH-45FK0Y0-67-1&_cdi=7159&_user=14684&_orig=search&_coverDate=04%2F15%2F1999&_qd=1&_sk=998439997&view=c&_alid=451508681&_rdoc=1&wchp=dGLbVtb-zSkzk&md5=ad20cd594f6ddeb5a209898f1b8f77b5&ie=/sdarticle.pdf.

Mylchreest, E; Wallace, DG; Cattley, RC; et al. (2000) Dose-dependent alterations in androgen-regulated male reproductive development in rats exposed to Di(n-butyl) phthalate during late gestation. Toxicol Sci 55(1):143-151. Available online at http://toxsci.oxfordjournals.org/cgi/reprint/55/1/143.

NEJAC (National Environmental Justice Advisory Council). (2004) Ensuring risk reduction in communities with multiple stressors: environmental justice and cumulative risks/impacts. Cumulative Risks/Impacts Work Group. Available online at http://www.epa.gov/compliance/resources/publications/ej/nejac/nejac-cum-risk-rpt-122104.pdf.

NRC (National Research Council). (1993) Pesticides in the diets of infants and children. Washington, DC: National Press Academy. Available online at http://www.nap.edu/catalog/2126.html.

NRC. (1994) Science and judgment in risk assessment. Committee on Risk Assessment of Hazardous Air Pollutants, Board on Environmental Studies and Toxicology, Commission on Life Sciences. Washington, DC: National Press Academy. Available online at http://www.nap.edu/catalog/2125.html.

NRC. (2006) Human biomonitoring for environmental chemicals. Committee on Human Biomonitoring for Environmental Toxicants. Washington, DC: The National Academies Press. Available online at http://www.nap.edu/catalog/11700.html.

O'Flaherty, EJ. (1998) A physiologically based kinetic model for lead in children and adults. Environ Health Perspect 106(Suppl. 6):1495-1503. Available online at http://ehp.niehs.nih.gov/members/1998/Suppl-6/1495-1503oflaherty/oflaherty-full.html.

Olin, SS; Sonawane, BR. (2003) Workshop to develop a framework for assessing risks to children from exposure to environmental agents. Environ Health Perspect 111(12):1524-1526. Available online at http://ehp.niehs.nih.gov/members/2003/6183/6183.html.

Olshan, AF; Anderson, L; Roman, E; et al. (2000) Workshop to identify critical windows of exposure for children's health: cancer work group summary. Environ Health Perspect 108(Suppl 3):595-597. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/595-597olshan/olshan-full.html.

Osmond, C; Barker, DJP. (2000) Fetal, infant, and childhood growth are predictors of coronary heart disease, diabetes, and hypertension in adult men and women. Environ Health Perspect 108(Suppl 3):545-553. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/545-553osmond/osmond-full.html.

Pals, K; Vankelecom, H; Denef, C. (2006) Triiodothyronine expands the lactotroph and maintains the lactosomatrotroph population, whereas thyrotrophin-releasing hormone augments thyrotroph abundance in aggregate cell cultures of postnatal rat pituitary gland. J Neuroendocrinol 18(3):203-216. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16454804&query_hl=5&itool=pubmed_docsum.

Pease, W; Vandenberg, J; Hooper, K. (1991) Comparing alternative approaches to establishing regulatory levels for reproductive toxicants: DBCP as a case study. Environ Health Perspect 91:141-155. Available online at http://ehp.niehs.nih.gov/members/1991/091/91015.PDF.

Peden, DB. (2000) Development of atopy and asthma: candidate environmental influences and important periods of exposure. Environ Health Perspect 108(Suppl 3):475-482. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/475-482peden/peden-full.html.

Pelekis, M; Gephart, LA; Lerman, SE. (2001) Physiological-model-based derivation of the adult and child pharmacokinetic intraspecies uncertainty factors for volatile organic compounds. Reg Tox Pharmacol 33(1):12-20. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11259175&query_hl=132.

Pelekis, M; Nicolich, MJ; Gauthier, JS. (2003) Probabilistic framework for the estimation of the adult and child toxicokinetic intraspecies uncertainty factors. Risk Anal 23(6):1239-1255. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14641898&query_hl=134.

Pinkerton, KE; Joad, JP. (2000) The mammalian respiratory system and critical windows of exposure for children's health. Environ Health Perspect 108(Suppl 3):457-462. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/457-462pinkerton/pinkerton-full.html.

Presidential/Congressional Commission on Risk Assessment and Risk Management. (1997a) Final Report Volume 1: Framework for Environmental Health Risk Management. Available online at http://www.riskworld.com/Nreports/1997/risk-rpt/pdf/EPAJAN.PDF.

Presidential/Congressional Commission on Risk Assessment and Risk Management. (1997b) Final Report Volume 2: Risk Assessment and Risk Management in Regulatory Decision-Making. Available online at http://www.riskworld.com/Nreports/1997/risk-rpt/volume2/pdf/v2epa.PDF.

Preston, RJ. (2004) Children as a sensitive subpopulation for the risk assessment process. Toxicol Appl Pharmacol 199(2):132-141. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15313585&query_hl=140.

Price, PS; Chaisson, CF; Koontz, M; et al. (2003) Construction of a comprehensive chemical exposure framework using person oriented modeling. Developed for The Exposure Technical Implementation Panel, American Chemistry Council, Contract #1388. Available online at http://www.thelifelinegroup.org/lifeline/documents/comprehensive_chemical_exposure_framework.pdf.

Pryor, JL; Hughes, C; Foster, W; et al. (2000) Critical windows of exposure for children's health: the reproductive system in animals and humans. Environ Health Perspect 108(Suppl 3):491-503. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/491-503pryor/pryor-full.html.

Ramos, HE; Weiss, RE. (2006) Regulation of nuclear coactivator and corepressor expression in mouse cerebellum by thyroid hormone. Thyroid 16(3):211-216. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dept=AbstractPlus&list_uids=16571082&query_hl=5&itool=pubmed_docsum.

Rice, D; Barone, S, Jr. (2000) Critical periods of vulnerability for the developing nervous system: evidence from humans and animal models. Environ Health Perspect 108 (Suppl 3): 511-533. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/511-533rice/rice-full.html.

Robboy, SJ; Taguchi, O; Cunha, GR. (1982) Normal development of the human female reproductive tract and alterations resulting from experimental exposure to diethylstilbestrol. Hum Pathol 13(3):190-198. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=7076207&query_hl=10&itool=pubmed_DocSum.

Rubert, G; Minana, R; Pascual, M; et al. (2006) Ethanol exposure during embryogenesis decreases the radial glial progenitorpool and affects the generation of neurons and astrocytes. J Neurosci Res 84(3):483-496. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16770775&query_hl=43&itool=pubmed_DocSum.

Sadler, TW. (2000) Susceptible periods during embryogenesis of the heart and endocrine glands. Environ Health Perspect 108 (Suppl 3):555-561. Available online at http://ehp.niehs.nih.gov/members/2000/suppl-3/555-561sadler/sadler-full.html.

Santisteban, P; Bernal, J. (2005) Thyroid development and effect on the nervous system. Rev Endocr Metab Disord 6(3):217-228. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16151626&query_hl=5&itool=pubmed_docsum.

Schulte, PA. (1989) A conceptual framework for the validation and use of biologic markers. Environ Res 48(2):129-144. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=2647488&query_hl=11&itool=pubmed_docsum.

Seed, J; Carney, EW; Corley, RA; et al. (2005) Overview: Using mode of action and life stage information to evaluate the human relevance of animal toxicity data. Critical Reviews in Toxicology 35(8-9):663-672. Available online at http://journalsonline.tandf.co.uk/openurl.asp?genre=article&eissn=1547-6898&volume=35&issue=8&spage=663.

Selevan, SG; Kimmel, CA; Mendola, P. (2000) Identifying critical windows of exposure for children's health. Environ Health Perspect 108(Suppl 3):451-555. Available online at http://ehp.niehs.nih.gov/docs/2000/suppl-3/toc.html.

Setzer, RW; Lau, C; Mole, ML; et al. (2001) Toward a biologically based dose-response model for developmental toxicity of 5-fluorouracil in the rat: a mathematical construct. Toxicol Sci 59(1):49-58. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11134543&query_hl=142.

Shuey, DL; Lau, C; Logsdon, TR; et al. (1994) Biologically based dose-response modeling in developmental toxicology: biochemical and cellular sequelae of 5-fluorouracil exposure in the developing rat. Toxicol Appl Pharmacol 126(1):129-44. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=8184423&query_hl=144.

Slikker, W, Jr; Andersen, ME; Bogdanffy, MS; et al. (2004a) Dose-dependent transitions in mechanisms of toxicity. Toxicol Appl Pharmacol 201(3):203-225. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15582645&query_hl=146.

Slikker, W, Jr; Andersen, ME; Bogdanffy, MS; et al. (2004b) Dose-dependent transitions in mechanisms of toxicity: case studies. Toxicol Appl Pharmacol 201: 226-294. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=15582646&query_hl=148.

Spearow, JL; Doemeny, P; Sera, R; et al. (1999) Genetic variation in susceptibility to endocrine disruption by estrogen in mice. Science 285(5431):1259-61. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=10455051&query_hl=150.

Spearow, JL; O'Henley, P; Doemeny, P; et al. (2001) Genetic variation in physiological sensitivity to estrogen in mice. APMIS 109(5):356-64. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11478683&query_hl=152.

Stephens, TD; Fillmore, BJ. (2000) Hypothesis: thalidomide embryopathy-proposed mechanism of action. Teratology 61(3):189-195. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=10661908&query_hl=30&itool=pubmed_docsum.

Stout, DM; Mason, MA. (2003) The distribution of chlorpyrifos following a crack and crevice type application in the US EPA Indoor Air Quality Research House. Atmos Environ 37(38):5539-5549. Available online at http://www.ingentaconnect.com/content/els/13522310/2003/00000037/00000039/art00771;jsessionid=bc6yzy645lwj.alice

U.S. 94th Congress. (1976) Toxic Substances Control Act (TSCA). Public Law (PL) 94-469. Available online at http://www.epa.gov/region5/defs/html/tsca.htm.

U.S. 96th Congress. (1980) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). P.L. 96-510. Available online at http://www.epa.gov/superfund/action/law/cercla.htm.

U.S. 101st Congress. (1990) Clean Air Act (CAA) Amendments. PL 101-549. Available online at http://www.epa.gov/air/oaq_caa.html/.

U.S. 104th Congress. (1996a) Food Quality Protection Act (FQPA). PL 104-170. Available online at http://www.epa.gov/pesticides/regulating/laws/fqpa/.

U.S. 104th Congress. (1996b) Safe Drinking Water Act (SDWA) Amendments. PL 104-182. Available online at http://www.epa.gov/safewater/sdwa/text.html.

U.S. 104th Congress. (1996c) Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). PL 104-170. Available online at http://www.epa.gov/region5/defs/html/fifra.htm.

U.S. 108th Congress (2003) Pediatric Research Equity Act. PL 108-155. Available online at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_public_laws&docid=f:publ155.108.

U.S. EPA (Environmental Protection Agency). (1991) Guidelines for developmental toxicity risk assessment. Fed Reg 56(234):63798-63826. Available online at http://www.epa.gov/ncea/raf/pdfs/devtox.pdf.

U.S. EPA. (1992) Guidelines for exposure assessment. Risk Assessment Forum, Washington, DC; EPA/600/Z-92/001. Available online at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=15263.

U.S. EPA. (1994) Methods for derivation of inhalation reference concentrations and application of inhalation dosimetry. Office of Research and Development, Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Research Triangle Park, NC; EPA/600/8-90/066F. Available online at http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=71993.

U.S. EPA. (1995a) Policy on evaluating health risks to children. Office of the Administrator, Washington, DC. Available online at http://www.epa.gov/osa/spc/2poleval.htm.

U.S. EPA. (1995b) Application of benchmark dose methodology to data from prenatal developmental toxicity studies. Washington, DC; EPA/600/A-95/135. Available online at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=40957.

U.S. EPA. (1996) Guidelines for reproductive toxicity risk assessment. Risk Assessment Forum, Washington, DC; EPA/630/R-96/009. Available online at http://cfpub.epa.gov/ncea/raf/pdfs/repro51.pdf.

U.S. EPA (1997a) Guidance on cumulative risk assessment. Part 1. Planning and scoping. Office of the Administrator, Washington, DC. Available online at http://www.epa.gov/osa/spc/pdfs/cumrisk2.pdf

U.S. EPA. (1997b) Guiding principles for Monte Carlo analysis. Office of Research and Development, Risk Assessment Forum. Washington, DC; EPA/630/R-97/001. Available online at http://www.epa.gov/ncea/raf/montecar.pdf.

U.S. EPA. (1997c) Summary of the U.S. EPA colloquia on a framework for human health risk assessment: Volume 1. Risk Assessment Forum, Washington, DC; EPA/600/R-99/001. Available online at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=12186.

U.S. EPA. (1998a) Guidelines for ecological risk assessment. Fed Reg 63(93):26846-26924. EPA/630/R-95/002F. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=36512.

U.S. EPA. (1998b) Guidelines for neurotoxicity risk assessment. Federal Register 63(93):26926-26954. EPA/630/R-95/001F. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=4555.

U.S. EPA. (1998c) Summary of the U.S. EPA colloquium on a framework for human health risk assessment: Volume 2. Risk Assessment Forum, Washington, DC. Available online at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55007.

U.S. EPA (1999a) Toxicological review for ethylene glycol monobutyl ether. Available online at http://www.epa.gov/iris/toxreviews/0500-tr.pdf.

U.S. EPA. (1999b) Report of the workshop for selecting input distributions for probabilistic assessments. Office of Research and Development, Washington, DC; EPA/630/R-98/004. Available online at http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=12487.

U.S. EPA. (2000a) Guidelines for preparing economic analyses. Office of the Administrator, Washington DC; EPA/240-R-00-003. Available online at http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

U.S. EPA. (2000b) Options for development of parametric probability distributions for exposure factors. National Center for Environmental Assessment, Office of Research and Development, Washington DC; EPA/600/R-00/058. Available online at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=20867.

U.S. EPA. (2000c) Stressor identification guidance document. Office of Research and Development, Washington, DC. EPA 822-B-00-0025. Available online at http://www.epa.gov/waterscience/biocriteria/stressors/.

U.S. EPA. (2000d) Benchmark dose technical guidance document (external review draft). Risk Assessment Forum, Washington, DC; EPA/630/R-00/001. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=4727.

U.S. EPA. (2000e) Science policy handbook: risk characterization. Science Policy Council, Washington, DC; EPA/100/B/00/002. Available online at http://www.epa.gov/osa/spc/pdfs/rchandbk.pdf.

U.S. EPA. (2000f) Strategy for research on environmental risks to children. Office of Research and Development, Washington, DC; EPA/600/R-00/068. Available online at http://www.epa.gov/ncea/pdfs/strat4resrch.pdf.

U.S. EPA. (2001a) Risk assessment guidance for Superfund (RAGS): Volume I - human health evaluation manual (Part D, standardized planning, reporting and review of Superfund risk assessments). Office of Emergency and Remedial Response, Washington, DC; 9285.7-01D. Available online at http://www.epa.gov/oswer/riskassessment/ragsd/index.htm.

U.S. EPA. (2001b) Risk assessment guidance for Superfund (RAGS): process for conducting probabilistic risk assessments. Volume 3, Part A. Office of Solid Waste and Emergency Response, Washington, DC; EPA/540/R-02/002. Available online at http://www.epa.gov/oswer/riskassessment/rags3a/index.htm.

U.S. EPA. (2002a) A review of the reference dose and reference concentration processes. Risk Assessment Forum, Washington, DC; EPA/630/P-02/002F. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=36836.

U.S. EPA. (2002b) Lessons learned on planning and scoping for environmental risk assessments. Planning and Scoping Workgroup of the Science Policy Council Steering Committee. Available online at http://www.epa.gov/osa/spc/pdfs/handbook.pdf.

U.S. EPA. (2002c) Child-specific exposure factors handbook (interim report). Office of Research and Development, National Center for Environmental Assessment, Washington, DC; EPA/600/P/00/002B. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=36528.

U.S. EPA. (2002d) Determination of the appropriate FQPA safety factor(s) in tolerance assessment. Office of Pesticide Programs, Office of Pesticide Programs, Washington, DC. Available online at http://www.epa.gov/oppfead1/trac/science/determ.pdf.

U.S. EPA. (2003a) Framework for cumulative risk assessment. Risk Assessment Forum, Washington, DC; EPA/630/P-02/001F. Available online at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=54944.

U.S. EPA. (2003b) Children's health valuation handbook. Office of Children's Health Protection and National Center for Environmental Economics. Office of Policy, Economics and Innovation, Washington, DC; EPA-100-R-03-003. Available online at http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/HandbookChildrensHealthValuation.html.

U.S. EPA. (2003c) Toxicological review of xylenes. Office of Research and Development, National Center for Environmental Assessment, Washington, DC; EPA 635/R-03/001. Available online at http://www.epa.gov/iris/toxreviews/0270-tr.pdf.

U.S. EPA. (2005a) Guidelines for carcinogen risk assessment. Risk Assessment Forum, Washington, DC; EPA/630/P-03/001F. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=439797.

U.S. EPA. (2005b) Supplemental guidance for assessing susceptibility from early-life exposure to carcinogens. Risk Assessment Forum, Washington, DC; EPA/630/R-03/003F. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=439798.

U.S. EPA. (2005c) Aging and toxic response: issues relevant to risk assessment. Risk Assessment Forum, Washington, DC; EPA/600/P-03/004A. Available online at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=156648.

U.S. EPA. (2005d) Review of the national ambient air quality standards for particulate matter: policy assessment of scientific and technical information, OAQPS Staff Paper (EPA-452/R-05-005). Available online at http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_cr_sp.html.

U.S. EPA. (2005e) Guidance on selecting age groups for monitoring and assessing childhood exposures to environmental contaminants. Risk Assessment Forum, Washington, DC; EPA/630/P-03/003F. Available online at http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=146583.

U.S. EPA. (2005f) Air quality criteria for ozone and related photochemical oxidants (Second external review draft) (EPA/600/R-05/004aB). Available online at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=137307.

U.S. EPA. (2006a) Toxicological review of dibutyl phthalate(di-n-butyl phthalate) (CAS No. 84-74-2) (External peer review draft). Office of Research and Development, National Center for Environmental Assessment, Washington, DC; NCEA-S-1755. Available online at http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=457421.

U.S. EPA. (2006b) Approaches for the application of physiologically based pharmacokinetic (PBPK) models and supporting data in risk assessment. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. Available online at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=157668.

U.S. EPA. (2006c) Air quality criteria for lead (Second external review draft). Office of Research and Development, National Center for Environmental Assessment, Washington, DC; EPA/600/R-05/144aB-bB, 2006. Available online at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=154041.

U.S. EPA. (2006d) Harmonization in interspecies extrapolation: use of $BW^{3/4}$ as default method in derivation of the oral RfD (External Review Draft). Risk Assessment Forum, Washington, DC; EPA/630/R-06/001. Available online at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=148525.

U.S. FDA (Food and Drug Administration). (1978) Good laboratory practice for nonclinical laboratory studies. 21 CFR Part 58. Available online at http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=58.

U.S. FDA. (1997) Food and drug administration modernization act. PL 105-115. Available online at http://www.fda.gov/cder/guidance/105-115.htm.

U.S. FDA. (2002) Best pharmaceuticals for children act. PL 107-109. Available online at http://www.fda.gov/opacom/laws/pharmkids/contents.html.

U.S. FDA (2005) Draft Guidance for industry - how to comply with the pediatric research equity act. Available online at http://www.fda.gov/cder/guidance/6215dft.pdf.

U.S. FDA. (2006) Guidance for industry – nonclinical safety evaluation of pediatric drug products. U.S. Department of Health and Human Services. Food and Drug Administration. Center for Drug Evaluation and Research (CDER). Available online at http://www.fda.gov/cder/guidance/5671fnl.pdf.

Vineis, P; Kriebel, D. (2006) Causal models in epidemiology: Past inheritance and genetic future. Environ Health 5(1):21. [e-pub ahead of print] Available online at http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=16859537.

Walthall, K; Cappon, GD; Hurtt, ME; et al. (2005) Postnatal development of the gastrointestinal system: a species comparison. Birth Defects Res B Dev Reprod Toxicol 74(2):132-156. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=15834902&query_hl=45&itool=pubmed_docsum.

Weed, DL. (2005) Weight of evidence: a review of concept and methods. Risk Anal 25(6):1545-1557. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=AbstractPlus&list_uids=16506981&query_hl=5&itool=pubmed_docsum.

White, WJ; Lee, CS. (1998) The development and maintenance of the Crl:CD®(SD)IGS BR breeding system. Charles River Laboratories. Research Models. Available online at http://www.criver.com/flex_content_area/documents/rm_rm_a_igs_rat_breeding_system.pdf.

WHO (World Health Organization). (2006) Principles for evaluating health risks in children associated with exposure to chemicals (draft). International Programme on Chemical Safety (IPCS) Environmental Health Criteria document (EHC-237). Available online at http://www.who.int/ipcs/features/ehc/en/index.html.

Wood, SL; Beyer, BK; Cappon, GD. (2003) Species comparison of postnatal CNS development: functional measures. Birth Defects Res B Dev Reprod Toxicol 68(5):391-407. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14745989&query_hl=163.

Xu, Y; Little, JC. (2006) Predicting emissions of SVOCs from polymeric materials and their interaction with airborne particles. Environ Sci Technol 40(2):456-461. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=search&DB=pubmed.

Yelin, R; Schyr, RB; Kot, H; et al. (2005) Ethanol exposure affects gene expression in the embryonic organizer and reduces retinoic acid levels. Dev Biol 279(1):193-204. Available online at http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6WDG-4F7Y93H-2-1&_cdi=6766&_user=14684&_orig=search&_coverDate=03%2F01%2F2005&_qd=1&_sk=997209998&view=c&_alid=451515301&_rdoc=1&wchp=dGLbVlb-zSkWA&md5=e2a0a807b351ce612e88e5893d2f16cd&ie=/sdarticle.pdf.

Young, JG; Eskenazi, B; Gladstone, EA; et al. (2005) Association between in utero organophosphate pesticide exposure and abnormal reflexes in neonates. Neurotoxicology 26:199-209. Available online at http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6W81-4F7S0VD-1-1&_cdi=6641&_user=14684&_orig=search&_coverDate=03%2F01%2F2005&_qd=1&_sk=999739997&view=c&_alid=451507612&_rdoc=1&wchp=dGLbVtz-zSkzk&md5=b02f3248db13b6a40b8dd1ed9d003d3e&ie=/sdarticle.pdf.

Zoetis, T; Hurtt, ME. (2003a) Species comparison of anatomical and functional renal development. Birth Defects Res B Dev Reprod Toxicol 68(2):111-120. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12866702&query_hl=160.

Zoetis, T; Hurtt, ME. (2003b) Species comparison of lung development. Birth Defects Res B Dev Reprod Toxicol 68(2):121-124. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12866703&query_hl=158.

Zoetis, T; Walls, I. (ed.) (2003) Principles and practices for direct dosing of pre-weaning mammals in toxicity testing and research. Risk Science Institute, Washington, DC: ILSI Press. Available online at http://rsi.ilsi.org/Publications/directdosingpreweaning.htm.

Zoetis, T; Tassinari, MS; Bagi, C; et al. (2003) Species comparison of postnatal bone growth and development. Birth Defects Res B Dev Reprod Toxicol 68(2):86-110. Available online at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=search&DB=pubmed.

Executive Department

State of California

EXECUTIVE ORDER B-37-16
MAKING WATER CONSERVATION A CALIFORNIA WAY OF LIFE

WHEREAS California has suffered through a severe multi-year drought that has threatened the water supplies of communities and residents, devastated agricultural production in many areas, and harmed fish, animals and their environmental habitats; and

WHEREAS Californians responded to the drought by conserving water at unprecedented levels, reducing water use in communities by 23.9% between June 2015 and March 2016 and saving enough water during this period to provide 6.5 million Californians with water for one year; and

WHEREAS severe drought conditions persist in many areas of the state despite recent winter precipitation, with limited drinking water supplies in some communities, diminished water for agricultural production and environmental habitat, and severely-depleted groundwater basins; and

WHEREAS drought conditions may persist in some parts of the state into 2017 and beyond, as warmer winter temperatures driven by climate change reduce water supply held in mountain snowpack and result in drier soil conditions; and

WHEREAS these ongoing drought conditions and our changing climate require California to move beyond temporary emergency drought measures and adopt permanent changes to use water more wisely and to prepare for more frequent and persistent periods of limited water supply; and

WHEREAS increasing long-term water conservation among Californians, improving water use efficiency within the state's communities and agricultural production, and strengthening local and regional drought planning are critical to California's resilience to drought and climate change; and

WHEREAS these activities are prioritized in the California Water Action Plan, which calls for concrete, measurable actions that "Make Conservation a California Way of Life" and "Manage and Prepare for Dry Periods" in order to improve use of water in our state.

NOW, THEREFORE, I, EDMUND G. BROWN JR., Governor of the State of California, in accordance with the authority vested in me by the Constitution and statutes of the State of California, in particular California Government Code sections 8567 and 8571, do hereby issue this Executive Order, effective immediately.

IT IS HEREBY ORDERED THAT:

The orders and provisions contained in my January 17, 2014 Emergency Proclamation, my April 25, 2014 Emergency Proclamation, Executive Orders B-26-14, B-28-14, B-29-15, and B-36-15 remain in full force and in effect except as modified herein.

State agencies shall update temporary emergency water restrictions and transition to permanent, long-term improvements in water use by taking the following actions.

USE WATER MORE WISELY

1. The State Water Resources Control Board (Water Board) shall, as soon as practicable, adjust emergency water conservation regulations through the end of January 2017 in recognition of the differing water supply conditions across the state. To prepare for the possibility of another dry winter, the Water Board shall also develop, by January 2017, a proposal to achieve a mandatory reduction in potable urban water usage that builds off of the mandatory 25% reduction called for in Executive Order B-29-15 and lessons learned through 2016.

2. The Department of Water Resources (Department) shall work with the Water Board to develop new water use targets as part of a permanent framework for urban water agencies. These new water use targets shall build upon the existing state law requirements that the state achieve a 20% reduction in urban water usage by 2020. (Senate Bill No. 7 (7th Extraordinary Session, 2009-2010).) These water use targets shall be customized to the unique conditions of each water agency, shall generate more statewide water conservation than existing requirements, and shall be based on strengthened standards for:

    a. Indoor residential per capita water use;
    b. Outdoor irrigation, in a manner that incorporates landscape area, local climate, and new satellite imagery data;
    c. Commercial, industrial, and institutional water use; and
    d. Water lost through leaks.

    The Department and Water Board shall consult with urban water suppliers, local governments, environmental groups, and other partners to develop these water use targets and shall publicly issue a proposed draft framework by January 10, 2017.

3. The Department and the Water Board shall permanently require urban water suppliers to issue a monthly report on their water usage, amount of conservation achieved, and any enforcement efforts.

ELIMINATE WATER WASTE

4. The Water Board shall permanently prohibit practices that waste potable water, such as:

    - Hosing off sidewalks, driveways and other hardscapes;
    - Washing automobiles with hoses not equipped with a shut-off nozzle;
    - Using non-recirculated water in a fountain or other decorative water feature;
    - Watering lawns in a manner that causes runoff, or within 48 hours after measurable precipitation; and
    - Irrigating ornamental turf on public street medians.

5. The Water Board and the Department shall direct actions to minimize water system leaks that waste large amounts of water. The Water Board, after funding projects to address health and safety, shall use loans from the Drinking Water State Revolving Fund to prioritize local projects that reduce leaks and other water system losses.

6. The Water Board and the Department shall direct urban and agricultural water suppliers to accelerate their data collection, improve water system management, and prioritize capital projects to reduce water waste. The California Public Utilities Commission shall order investor-owned water utilities to accelerate work to minimize leaks.

7. The California Energy Commission shall certify innovative water conservation and water loss detection and control technologies that also increase energy efficiency.

STRENGTHEN LOCAL DROUGHT RESILIENCE

8. The Department shall strengthen requirements for urban Water Shortage Contingency Plans, which urban water agencies are required to maintain. These updated requirements shall include adequate actions to respond to droughts lasting at least five years, as well as more frequent and severe periods of drought. While remaining customized according to local conditions, the updated requirements shall also create common statewide standards so that these plans can be quickly utilized during this and any future droughts.

9. The Department shall consult with urban water suppliers, local governments, environmental groups, and other partners to update requirements for Water Shortage Contingency Plans. The updated draft requirements shall be publicly released by January 10, 2017.

10. For areas not covered by a Water Shortage Contingency Plan, the Department shall work with counties to facilitate improved drought planning for small water suppliers and rural communities.

IMPROVE AGRICULTURAL WATER USE EFFICIENCY AND DROUGHT PLANNING

11. The Department shall work with the California Department of Food and Agriculture to update existing requirements for Agricultural Water Management Plans to ensure that these plans identify and quantify measures to increase water efficiency in their service area and to adequately plan for periods of limited water supply.

12. The Department shall permanently require the completion of Agricultural Water Management Plans by water suppliers with over 10,000 irrigated acres of land.

13. The Department, together with the California Department of Food and Agriculture, shall consult with agricultural water suppliers, local governments, agricultural producers, environmental groups, and other partners to update requirements for Agricultural Water Management Plans. The updated draft requirements shall be publicly released by January 10, 2017.

The Department, Water Board and California Public Utilities Commission shall develop methods to ensure compliance with the provisions of this Executive Order, including technical and financial assistance, agency oversight, and, if necessary, enforcement action by the Water Board to address non-compliant water suppliers.

This Executive Order is not intended to, and does not, create any rights or benefits, substantive or procedural, enforceable at law or in equity, against the State of California, its agencies, departments, entities, officers, employees, or any other person.

I FURTHER DIRECT that as soon as hereafter possible, this order be filed in the Office of the Secretary of State and that widespread publicity and notice be given of this order.

IN WITNESS WHEREOF I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 9th day of May 2016.

EDMUND G. BROWN JR.
Governor of California

ATTEST:

ALEX PADILLA
Secretary of State

County of Riverside

Draft Climate Action Plan

Public Review Draft

RIVERSIDE COUNTY
PLANNING DEPARTMENT

February 2015

County of Riverside | Transportation and Land Management Agency | Planning Department
4080 Lemon Street, 12th Floor | Riverside, CA 92502-1409 | Phone: (951) 955-3200 | Fax: (951) 955-1811

This page intentionally left blank

ACKNOWLEDGEMENTS

This Riverside County Climate Action Plan is the outcome of work contributed by a number of individuals. We wish to thank all individuals who contributed to the success of this report, in particular:

- Riverside County, Economic Development Agency for administering the Energy Efficiency and Conservation Block Grant funding
- Riverside County, Planning Department, Adam Rush, Principal Planner
- Riverside County, Planning Department, Cindy Thielman-Braun, Urban Regional Planner IV
- Riverside County, Transportation and Land Management Agency, JiHong McDermott, GIS Supervisor Analyst/Demographics
- Riverside County, Transportation Department, Kevin Tsang, Associate Engineer
- Riverside County, Waste Management Department, Hans Kernkamp, General Manager/Chief Engineer
- Riverside County, Waste Management Department, Sung Key Ma, Planner IV
- Riverside County, Economic Development Agency – Aviation Division, Chad Davies, Senior Airport Development Specialist
- Riverside County, Economic Development Agency – Aviation Division, Marsha Dunlap, Fiscal Analyst
- Southern California Edison, Gerard Wilson, SCE Account Manager
- Southern California Gas Company, Environmental Policy and Affairs, Daniel McGivney, Environmental Affairs Program Manager
- Southern California Gas Company, Frank Spasaro
- Southern California Association of Governments, Arnold San Miguel
- Southern California Association of Governments, Ping Wang
- United States Department of Energy, Energy Efficiency and Conservation Block Grant

This page intentionally left blank

SEJA Comment Letter-Attachment C-Page 157

Table of Contents

Executive Summary

Chapter 1 Introduction 1-1

1.1 Purpose 1-3
1.2 Goals 1-3
1.3 Relationship to the County General Plan 1-4
1.4 Background 1-4
A. Greenhouse Gases 1-4
1.5 Regulatory Setting 1-5
A. International and Federal 1-6
B. State 1-7
C. Regional 1-12
D. Local 1-13

Chapter 2 Methodology 2-1

2.1 Overview 2-1
2.2 Calculation of GHGs 2-2
A. Energy 2-3
B. Water Supply 2-4
C. Wastewater Treatment 2-5
D. Solid Waste Management 2-5
E. Area Source Emissions 2-6
F. Transportation 2-7
G. Agriculture 2-7

Chapter 3 GHG Emissions Inventory 3-1

3.1 2008 Government Emissions Inventory 3-1
A. Data Inputs 3-1
B. Emissions Summary 3-2

C. 2008 Government Department Emissions and Costs 3-2
D. 2008 Total Government Cost Estimates 3-4
3.2 2008 Community-Wide Emissions Inventory 3-4
A. Data Inputs 3-4
B. Emissions by Source 3-5
3.3 2020 Business as Usual Community-Wide Emissions Inventory 3-6
A. Data Inputs 3-6
B. 2020 BAU Emissions by Source 3-7
3.4 2035 Business As Usual Community-Wide Emissions Inventory 3-8
A. Data Inputs 3-8
B. 2035 BAU Emissions by Source 3-8
3.5 2020 Reduction Target 3-9
3.6 Emissions Comparison by Year 3-10

Chapter 4 GHG Emissions Reduction Programs and Regulations 4-1

4.1 Existing Riverside County General Plan Policies Related to GHG 4-1
4.2 Transportation 4-3
A. R1 Transportation Measures 4-3
B. R2 Transportation Measures 4-4
C. R3 Transportation Measures 4-7
4.3 Energy 4-8
A. R1 Energy Measures 4-8
B. R2 Energy Measures 4-10
C. R3 Energy Measures 4-14
4.4 Area Source Emissions 4-16
A. R2 Area Source Measures 4-16
B. R3 Area Source Measures 4-16
4.5 Purchased Water 4-17
A. R1 Water Measures 4-17
B. R2 Water Measures 4-17
4.6 Solid Waste 4-18
A. R1 Solid Waste Measure 4-18
B. R2 Solid Waste Measures 4-19
C. R3 Solid Waste Measures 4-19

4.7 Agriculture 4-20
A. R1 Agriculture Measure 4-20
B. R2 Agriculture Measures 4-20
C. R3 Agriculture Measure 4-20
4.8 Industrial 4-21
A. R1 Industrial Measures 4-21
B. R2 Industrial Measures 4-21

Chapter 5 Total Estimated Reductions 5-1

5.1 Reductions from Statewide Measures 5-1
5.2 Reductions from Implementation Measures 5-3
5.3 Reduced 2020 Community-Wide Emissions Inventory 5-4
A. Emissions by Source 5-4
5.4 Reduced 2035 Community-Wide Emissions Inventory 5-5
A. Emissions by Source 5-6
5.5 Emissions Summary 5-7

Chapter 6 Conclusions 6-1

Chapter 7 Implementation 7-1

7.1 STEP 1 – Administration and Staffing 7-1
7.2 STEP 2 – Financing and Budgeting 7-1
A. Energy Efficiency and Renewable Energy Financing 7-2
B. Transportation Financing 7-4
C. Waste Reduction Financing 7-4
D. Water Conservation and Treatment Financing 7-5
7.3 STEP 3 – Timeline and Prioritization 7-5
7.4 STEP 4 – Public Participation 7-7
7.5 STEP 5 – Project Review 7-7
7.6 STEP 6 – Monitoring and Inventorying 7-8
7.7 STEP 7 – Beyond 2020 7-8

Chapter 8 References 8-1

List of Tables

Table ES-1 2008 and 2020 GHG Emissions Comparison ... 2
Table ES-2 Projected 2035 GHG Emissions Comparison ... 2
Table 2-1 Riverside County Landfills ... 2-5
Table 3-1 2008 Government Data Inputs ... 3-1
Table 3-3 2008 Government Emissions and Costs by Department ... 3-3
Table 3-4 Estimated Government Energy Costs ... 3-4
Table 3-5 2008 Community-Wide Data Inputs ... 3-4
Table 3-6 2008 Community-wide GHG Emissions by Source ... 3-5
Table 3-7 2020 BAU Community-Wide Data Inputs ... 3-6
Table 3-8 2020 GHG Emissions by Source ... 3-7
Table 3-9 2035 BAU Community-Wide Data Inputs ... 3-8
Table 3-10 2035 BAU GHG Emissions by Source ... 3-8
Table 3-11 2020 GHG Emissions Reduction Target ... 3-9
Table 3-12 GHG Emissions by Source ... 3-10
Table 3-13 2020 GHG Emissions Reduction Target ... 3-10
Table 4-1 General Plan Policies Related to Reducing GHG Emissions ... 4-2
Table 5-1 Statewide Measures and Associated Emissions Reduced from the 2020 Inventory ... 5-1
Table 5-2 Statewide Reduction Summary for 2020 Inventory ... 5-2
Table 5-3 Comparison to Reduction Target ... 5-2
Table 5-4 Percentage Reduction from 2020 Inventory ... 5-2
Table 5-5 R2 Measures and Associated Emissions Reduced from 2020 Inventory ... 5-3
Table 5-6 IM Reduction Summary for 2020 Inventory ... 5-4
Table 5-7 Reduced 2020 GHG Emissions by Source ... 5-4
Table 5-8 Reduced 2035 GHG Emissions by Source ... 5-6
Table 5-9 2020 GHG Emissions Comparison ... 5-7
Table 5-10 2035 GHG Emissions Comparison ... 5-8
Table 7-1 GHG Reduction Measure Timeline and Phasing Schedule ... 7-6
Table 7-2. Potential Reduction Measures to Reach a 2035 Goal of 2.3 $MMTCO_2e$ ... 7-10

List of Figures

Figure 3-1 2008 Government Emissions by Category (metric tons CO_2e) ... 3-2
Figure 3-2 2008 Government Emissions by Department (metric tons CO_2e) ... 3-3
Figure 3-3 2008 Emissions Generated by Emissions Category (metric tons CO_2e) ... 3-6
Figure 3-4 2020 BAU Emissions Generated by Source (metric tons CO_2e) ... 3-7
Figure 3-5 2035 BAU GHG Emissions by Source ... 3-9
Figure 5-1 Reduced 2020 GHG Emissions Generated by Source ... 5-5
Figure 5-3 Reduced 2035 GHG Emissions by Source ... 5-7
Figure 6-1 Riverside County GHG Emissions by Year ... 6-1

List of Appendices

Appendix A: The Greenhouse Effect, Greenhouse Gases and Climate Change Impacts
Appendix B: Modeling Coefficients and Data Assumptions
Appendix C: Data Inputs
Appendix D: GHG Inventory Calculations
Appendix E: Reduction Measures, Assumptions and Attributed Reductions
Appendix F: Screening Tables

ACRONYMS

AB 32	Assembly Bill 32, The California Global Warming Solutions Act of 2006
ARRA	American Recovery & Reinvestment Act
BAU	Business As Usual Scenario
BTU	British Thermal Unit
CARB	California Air Resources Board
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
Cal EPA	California Environmental Protection Agency
Cal Recycle	California Department of Resources Recycling and Recovery
CAS	California Climate Adaption Strategy
CCAT	California Climate Action Team
CCAR	California Climate Action Registry
CCR	California Code of Regulations
CCTP	Climate Change Technology Program
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFC	Chlorofluorocarbons
C_2F_6	Hexafluoroethane
CF_4	Carbon Tetrafluoride
CH_4	Methane
CIWMB	California Integrated Waste Management Board
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CSI	California Solar Initiative
CWSRF	Clean Water State Revolving Funds
DPM	Diesel Particulate Matter
EECGB	Energy Efficiency Community Block Grant
EMFAC2007	On-Road Emission Factors published by the CARB in 2007
GCC	Global Climate Change
GHG	Greenhouse Gas
GWh	Gigawatt Hours

GWP	Global Warming Potential
HFC	Hydrofluorocarbons
HFC-23	Trifluoromethane
HFC-134	Hydrofluorocarbon 134
HFC-152a	Difluoroethane
IPCC	Intergovernmental Panel on Climate Change
ITS	Intelligent Transportation Systems
LEED	Leadership in Energy and Environmental Design
MMT	Million Metric Tons
MT	Metric Tons
MWh	Megawatt Hours
N_2O	Nitrous Oxide
NSHP	New Solar Home Program
O_3	Ozone
RIP	Regional Improvement Program
RTIP	Regional Transportation Improvement Program
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SCG	Southern California Gas Company
SIP	State Implementation Plan
SF_6	Sulfur Hexafluoride
STIP	State Transportation Improvement Plan
URBEMIS 2007	Urban Emissions Model, version 9.2 published in June 2007
USEPA	United States Environmental Protection Agency
VMT	Vehicle miles traveled

SEJA Comment Letter-Attachment C-Page 163

Executive Summary

Riverside County is committed to providing a more livable, equitable, and economically vibrant community through the incorporation of sustainability features and reduction of greenhouse gas (GHG) emissions. By using energy more efficiently, harnessing renewable energy to power buildings, recycling waste, conserving and recycling water and enhancing access to sustainable transportation modes, Riverside will keep dollars in the local economy, create new green jobs and improve community quality of life. The efforts toward reducing GHG emissions described in this report would be done in coordination with Riverside County's land use decisions. The foundation of planning land use decisions is found in the General Plan policies and programs.

Through this Climate Action Plan (CAP), the County of Riverside has established goals and policies that incorporate environmental responsibility into its daily management of residential, commercial and industrial growth, education, energy and water use, air quality, transportation, waste reduction, economic development and open space and natural habitats to further their commitment.

The first step in completing the CAP was to complete a GHG emissions inventory. The CAP includes GHG inventories of community-wide and municipal sources based on the most recent data available for the year 2008. Sources of emissions include transportation, electricity and natural gas use, landscaping, water and wastewater pumping and treatment and treatment and decomposition of solid waste. Riverside County's 2008 inventory amounted to 7,012,938 MT CO_2e community-wide and 226,753 MT CO_2e from municipal operations.

Following the state's adopted AB 32 GHG reduction target, Riverside County has set a goal to reduce emissions back to 1990 levels by the year 2020. This target was calculated as a 15% decrease from 2008 levels, as recommended in the AB 32 Scoping Plan. The estimated community-wide emissions for the year 2020, based on population and housing growth projections associated with the assumptions used in the proposed General Plan Update, are 12,129,497 MT CO_2e. In order to reach the reduction target, Riverside County must offset this growth in emissions and reduce community-wide emissions to 5,960,998 MT CO_2e by the year 2020.

The development of this CAP coincides with Riverside County's General Plan Update. A community-wide emissions inventory is also calculated for the horizon year of 2035. The socioeconomic growth rates from the General Plan Update were used to estimate the 2035 emissions.

Various state policies have enacted programs that will also contribute to reduced GHG emissions in Riverside County by the year 2020. Some of these policies include updated building codes for energy efficiency, the low carbon fuel standard, Pavley vehicle emissions standards and the Renewables Portfolio Standard for utility companies. By supporting the state in the implementation of these measures, Riverside County will experience substantial GHG emissions reductions. These GHG reductions from the state measures are accounted for in the reduced inventories.

In order to reach the reduction target, the County of Riverside would also need to implement the additional local reduction measures described in this report. These measures encourage energy efficiency and renewable energy in buildings, transit oriented planning, water conservation and increase waste diversion. Table ES-1 (2008 and 2020 GHG Emissions Comparison), below, summarizes the community-wide emissions for 2008, 2020 and the reduced 2020 inventory with the inclusion of the proposed reduction measures.

Table ES-1 2008 and 2020 GHG Emissions Comparison

Source Category	Metric tons of CO_2e			
	2008	2020 BAU	Reduced 2020	% Reduced
Transportation	2,850,520	6,977,331	2,454,032	64.83%
Energy	1,577,667	2,830,246	1,141,380	59.67%
Area Sources	269,181	442,024	230,188	47.92%
Purchased Water	152,473	175,344	109,021	37.82%
Solid Waste	132,666	181,728	92,273	49.22%
Agriculture	2,030,431	1,522,823	1,507,220	1.02%
Total	**7,012,938**	**12,129,497**	**5,534,113**	**54.37%**
Emission Reduction Target [a]		**5,960,998**	**5,960,998**	

Note: Mass emissions of CO_2e shown in the table are rounded to the nearest whole number. Totals shown may not add up due to rounding.
a The reduction target for 2020 is based on a 15% decrease from Riverside County's 2008 emissions inventory.

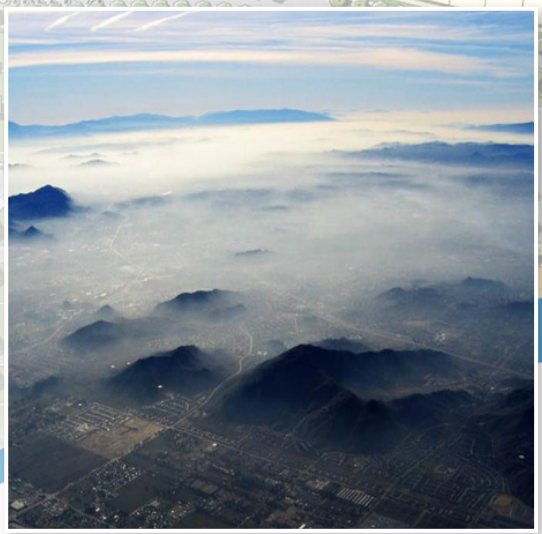
Table ES-2 (Projected 2035 GHG Emissions Comparison) summarizes the 2035 emissions for Riverside County based on the anticipated growth rates included in Riverside County's General Plan update. After 2020, GHG emissions would continue to grow; however, the growth in Riverside County's future emissions would be offset by the reductions from incorporation of the CAP measures. The reduction measures included in the CAP have been developed to meet the 2020 reduction target; however, the implementation of the CAP would require periodic updates to ensure that Riverside County is continually tracking GHG emissions and making adjustments as necessary to ensure that future targets are met. The 2035 reduced inventory represents the estimated GHG emissions from Riverside County with the continued implementation of the reduction measures outlined in the CAP as well as the assumption that the current statewide measures would be extended beyond 2020. This represents a strategy for Riverside County to continue to reduce emissions below the 2020 reduction target through to 2035 and beyond.

Table ES-2 Projected 2035 GHG Emissions Comparison

Source Category	Metric tons of CO_2e			
	2008	2035 BAU	Reduced 2035	% Reduced
Transportation	2,850,520	9,318,041	2,617,363	71.9%
Energy	1,577,677	3,610,701	1,323,685	63.3%
Area Sources	269,181	529,384	256,478	51.6%
Purchased Water	152,473	293,077	146,118	50.1%
Solid Waste	132,666	220,747	107,198	51.4%
Agriculture	2,030,431	1,522,823	1,486,815	2.4%
Total	**7,012,938**	**15,494,774**	**5,937,658**	**61.7%**
2020 Reduction Target [a]		**5,964,354**	**5,964,354**	

Note: Mass emissions of CO2e shown in the table are rounded to the nearest whole number. Totals shown may not add up due to rounding.
a The reduction target for 2020 is based on a 15% decrease from Riverside County's 2008 emissions inventory.

This CAP describes a baseline for Riverside County's GHG emissions, projects how these emissions will grow, and includes strategies to reduce emissions to a level consistent with California's emissions reduction target. These strategies complement Riverside County's General Plan policies and are consistent with Riverside County's vision for a more sustainable community.



Chapter 1
Introduction

This page intentionally left blank

Chapter 1 Introduction

NOTE TO THE READER:

The County of Riverside is recirculating Draft Environmental Impact Report No. 521 (DEIR No. 521) for public review from February 21, 2015 through April 6, 2015 in accordance with the California Environmental Quality Act, Section 15088.5. Correlative changes were made to Draft General Plan Amendment No. 960 (GPA No. 960) and the Draft Climate Action Plan. The revised GPA No. 960 and CAP documents are made available for public reference.

The documents were previously circulated from May 1, 2014, through June 30, 2014. The circulation garnered a substantial amount of comments from government and regulatory agencies, interest groups, and Riverside County citizens, which resulted in the aforementioned changes. Additionally, several changes to the documents occurred in order to more accurately reflect the existing conditions of the County, and to further analyze impacts associated with the GPA No. 960. The following is a summary of the changes that occurred to the documents:

Draft General Plan Amendment No. 960:

- *Data corrections to the Lakeview Nuevo Area Plan to reflect the removal of Specific Plan 342.*
- *Removal of the Lakeview Mountains Policy Area from the Lakeview Nuevo Area Plan.*
- *Addition of language clarifying the Wine Country Community Plan (GPA No. 1077) in relation to the Southwest Area Plan.*
- *Addition of language clarifying Airport Land Use consistency and Mixed Use Planning Areas.*
- *Addition of Policy S 1.4 requiring the County to implement the County of Riverside Multi-Jurisdictional Hazard Mitigation Plan.*
- *Addition of Policy OS 4.9 discouraging development within watercourses and areas within 100 feet of riparian vegetation.*
- *Minor modifications to text and policies as a result from comments received during the circulation of the draft document.*

Draft EIR No. 521:

- *The Draft EIR was updated to better reflect the existing conditions within the County.*
- *Several analysis sections of the Draft EIR were further refined in order to reflect changes associated with the updated background information. These sections included Air Quality, Greenhouse Gas, Biological Resources, Transportation and Circulation, Water Resources, and Cumulative Impacts.*
- *All analysis sections were updated where relevant to maintain consistency with any changes made in the Draft General Plan Update and Draft Climate Action Plan.*

Draft Climate Action Plan:

- *The Draft Climate Action Plan was updated with new implementation measures.*

The recirculated documents better account for the changing environment in Riverside County and more accurately address future conditions. Although comments submitted during the previous comment period do not require a written response, it should be noted that these comments are part of the administrative record and were taken into consideration while drafting the revised document. Any comments made during the May 2014 circulation of the documents will be included in the administrative record; however they will not be addressed in the Response to Comments. Per Section 15088.5(f)(1) of the CEQA Guidelines, only those comments submitted in response to the recirculated Environmental Impact Report will receive a formal written response in the Response to Comments as a part of the Final EIR.

In order to clearly display all of the changes that have been made during the General Plan Update Process, text has been formatted to show changes made in each step of the process. This includes:

- Black Text: General Plan text prior to GPA No. 960 is noted in black text.
- *Red Text: Textual changes proposed as part of the May 2014 previously circulated document are shown in red text.*
- *Blue Text: Textual changes made to the documents after the May 2014 circulation are shown in blue text.*

The color coding of the edits allows the reader to distinguish more clearly between the original General Plan text, the previously proposed May 2014 revisions (red) and the new February 2015 proposed revisions to GPA No. 960, EIR No. 521 and the Climate Action Plan.

1.1 Introduction

The County of Riverside is committed to reducing GHG emissions in an effort to provide a more livable, equitable, and economically vibrant community. By using energy more efficiently, harnessing renewable energy to power our buildings, enhancing access to sustainable transportation modes and recycling waste, dollars are kept in our local economy, new green jobs are created and community quality of life improves. These efforts toward reducing GHG emissions must be done in coordination with Riverside County's land use decisions. The foundation of planning land use decisions are the General Plan policies and programs. The policies and programs of the Riverside County General Plan are intended to underlie most land use decisions. Preparing, adopting, implementing and maintaining a general plan serves to:

- Define the community's environmental, social, and economic goals.
- Provide citizens with information about their community and with opportunities to participate in the planning and decision-making processes of their community.
- Coordinate the community and environmental protection activities among local, regional, state and federal agencies.
- Guide in the development of the community.

In order to achieve these goals and to provide a more livable, equitable and economically vibrant community, the County of Riverside has committed to prepare and implement the Riverside County Climate Action Plan (CAP) to help ensure that the impact of development on air quality is minimized, energy is conserved and land use

SEJA Comment Letter-Attachment C-Page 169

decisions made by Riverside County and all internal operations within Riverside County are consistent with adopted state legislation.

This section describes the purpose and goals of the CAP; describes the relationship of the CAP to the Riverside County General Plan, provides background information on GHG emissions; and summarizes the regulatory framework surrounding GHG emissions and climate change.

1.2 Purpose

The CAP was designed under the premise that the County of Riverside, and the community it represents, is uniquely capable of addressing emissions associated with sources under Riverside County's jurisdiction, and that Riverside County's emission reduction efforts should coordinate with the state strategies of reducing emissions in order to accomplish these reductions in an efficient and cost-effective manner. The County of Riverside developed this document with the following purposes in mind:

- Create a GHG emissions baseline from which to benchmark GHG reductions.
- Provide a plan that is consistent with and complementary to: the GHG emissions reduction efforts being conducted by the State of California through the Global Warming Solutions Act (AB 32), federal government through the actions of the Environmental Protection Agency (EPA), and the global community through the Kyoto Protocol.
- Guide the development, enhancement, and implementation of actions that reduce GHG emissions.
- Provide a policy document with specific implementation measures meant to be considered as part of the planning process for future development projects.

1.3 Goals

To fulfill the purposes of the CAP, the County of Riverside identified the following goals to be achieved:

- Provide a list of specific actions that will reduce GHG emissions, giving the highest priority to actions that provide the greatest reduction in GHG emissions and benefits to the community at the least cost.
- Reduce emissions attributable to Riverside County to levels consistent with the target reductions of AB 32.
- Establish a qualified reduction plan for which future development within Riverside County can tier and thereby streamline the environmental analysis necessary under the California Environmental Quality Act (CEQA).

1.4 Relationship to the County General Plan

The General Plan includes a series of linked documents including technical reports, and elements containing goals, policies and implementation programs that provide direction to the County of Riverside on managing its resources and how future development will occur.

The CAP is a separately bound document that will provide another implementation tool of the General Plan to guide development in Riverside County. The CAP focuses development on attaining the various goals and policies of the General Plan and all community plans relative to GHG emissions, and to achieve the goals outlined in Section 1.2 above.

1.5 Background

The CAP achieves the purpose and goals described above by providing:

- An analysis of GHG emissions and sources attributable to Riverside County.
- Estimates on how those emissions are expected to increase.
- Recommended policies and actions that can reduce GHG emissions to meet state, federal and international targets.
- A timeline of implementation.
- A defined tracking and reporting mechanism that will measure progress toward the goals.

In order to understand this process, the reader needs to know a few facts about GHG emissions, the climate change impacts anticipated within the County of Riverside and the international, federal, state and local regulatory framework designed to address climate change. The following information provides a brief background on these topics. A more complete description of the greenhouse effect, GHG emissions, and general climate change impacts can be found in Appendix A of this document.

A. Greenhouse Gases

Parts of the Earth's atmosphere act as an insulating "blanket" of just the right thickness, trapping sufficient solar energy to keep the global average temperature in a suitable range. This blanket is a collection of atmospheric gases called greenhouse gases, based on the idea that these gases also trap heat similar to the glass walls of a greenhouse. These gases, consisting mainly of water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and chlorofluorocarbons (CFC), all act as effective global insulators, reflecting back to earth infrared radiation. Human activities, such as producing electricity and driving internal combustion vehicles, emit these gases into the atmosphere.

Due to the successful global bans on chlorofluorocarbons (primarily used as refrigerants, aerosol propellants and cleaning solvents), Riverside County does not generate significant emissions of these GHGs. This also includes other synthesized gases such as hydrofluorocarbons (HFCs) and carbon tetrafluoride (CF_4) which have been banned and are no longer available on the market. Because of the ban, Riverside County will not generate emissions of these GHGs and therefore, they are not considered any further in this document. Sulfur

SEJA Comment Letter-Attachment C-Page 171

hexafluoride (SF_6) is another GHG with a high global warming potential; it is mainly used as a gaseous dielectric medium in electric switchgear of high voltage electric transmission lines and medical use in retinal detachment surgery and ultrasound imaging. In both uses, SF_6 is not released to the atmosphere and therefore, it is not considered further in this document.

Because GHGs have variable potencies, a common metric of carbon dioxide equivalents (CO_2e) is used to report the combined potency from all of the GHGs. The potency each GHG has in the atmosphere is measured as a combination of the volume of its emissions and its global warming potential,[1] and is expressed as a function of the potency with respect to the same mass of CO_2. Thus, by multiplying the individual gas by its global warming potential, the emissions of each individual gas can be measured in terms of metric tons of CO_2e (MT CO_2e).

This CAP contains two types of GHG inventories, one covering community-wide emissions and the other for Riverside County's municipal emissions. The community-wide inventory focuses on the sources and amounts of GHG emissions generated from activities associated with land uses within the unincorporated areas under the jurisdictional control of the County of Riverside, while the municipal inventory covers emissions solely from the buildings, facilities, and vehicles under the operational control of the local government. The purpose of the inventories is to create a clear picture of how the unincorporated communities within Riverside County and the government operations uses fossil fuels and other forms of energy, and to pinpoint the activities and sectors contributing the most GHGs.

1.6 Regulatory Setting

In an effort to stabilize GHG emissions and reduce impacts associated with climate change, international agreements as well as federal and state actions were implemented beginning as early as 1988. The international, federal, state, regional and local government agencies discussed below work jointly, as well as individually, to address GHG emissions through legislation, regulations, planning, policy-making, education and a variety of programs.

[1] The potential of a gas or aerosol to trap heat in the atmosphere.

A. International and Federal

Kyoto Protocol

The United States participates in the United Nations Framework Convention on Climate Change (UNFCCC) signed on March 21, 1994. Specifically, the Kyoto Protocol is a treaty made under the UNFCCC and was the first international agreement to regulate GHG emissions. It has been estimated that if the commitments outlined in the Kyoto Protocol are met, global GHG emissions could be reduced by an estimated 5% from 1990 levels during the first commitment period of 2008–2012 (UNFCCC 1997). It should be noted that although the United States is a signatory to the Kyoto Protocol, Congress has not ratified the Protocol and the United States is not bound by the Protocol's commitments.

In December 2009, representatives from 170 countries met in Copenhagen to ratify an updated UNFCCC agreement known as the "Copenhagen Accord." This accord is a voluntary agreement between the United States, China, India and Brazil that recognizes the need to keep global temperature rise to below 2°C and obliges signatories to establish measures to reduce greenhouse gas emissions and to prepare to provide help to poorer countries in adapting to climate change. The countries met again in Cancun in December 2010 and adopted the Cancun Agreements, which reinforce and build upon the Copenhagen Accord. The nations agreed to recognize country targets, develop low-carbon development plans and strategies and report inventories annually. In addition, agreements were made regarding financing for developing countries, as well as for technology support and coordination among all nations. The next conference of the parties is scheduled for December 2011 in South Africa.

Climate Change Technology Program

In lieu of the Kyoto Protocol's mandatory framework, the United States has opted for a voluntary and incentive-based approach toward emissions reductions. The Climate Change Technology Program (CCTP) is a multi-agency research and development coordination effort led by the Secretaries of Energy and Commerce and charged with carrying out the President's National Climate Change Technology Initiative.

U.S. Environmental Protection Agency

The United States Environmental Protection Agency (USEPA) is responsible for implementing federal policy to address global climate change. The federal government administers a wide array of public-private partnerships to reduce GHG emissions generated by the United States. These programs focus on energy efficiency, renewable energy, methane and other non-CO_2 gases, agricultural practices and implementation of technologies to achieve GHG reductions. The USEPA implements several voluntary programs that help substantially reduce GHG

SEJA Comment Letter-Attachment C-Page 173

emissions. These programs include: the State Climate and Energy Partner Network, which fosters the exchange of information between federal and state agencies regarding climate and energy; the Climate Leaders program for companies; the Energy Star® labeling system for energy-efficient products; and the Green Power Partnership for organizations interested in buying green power. All of these programs play a significant role in encouraging voluntary reductions from large corporations, consumers, industrial and commercial buildings, and many major industrial sectors.

It should be noted that in *Massachusetts v. Environmental Protection Agency* (Docket No. 05–1120), the U.S. Supreme Court held in April of 2007 that the USEPA has authority to regulate greenhouse gases and that the USEPA's reasons for not regulating this area did not fit the statutory requirements. As such, the Court ruled that the USEPA should be required to regulate CO_2 and other greenhouse gases as pollutants pursuant to Section 202(a)(1) of the federal Clean Air Act (CAA).

Towards this aim, in 2009 the USEPA issued a Final Rule for mandatory reporting of GHG emissions by fossil fuel suppliers, industrial gas suppliers, direct GHG emitters and manufacturers of heavy-duty and off-road vehicles and vehicle engines. It also requires annual reporting of emissions. The first annual reports required by the Rule were due in March 2011. This rule does not regulate the emission of GHGs; it only requires the monitoring and reporting of greenhouse gas emissions for those sources above certain thresholds (USEPA 2009). In addition, the USEPA adopted a Final Endangerment Finding for the six defined GHGs in December 2009. This Endangerment Finding is required for the USEPA to regulate GHG emissions under Section 202(a)(1) of the CAA.

On May 13, 2010, the USEPA issued a Final Rule that establishes a common sense approach to addressing greenhouse gas emissions from stationary sources under the CAA permitting programs. The rule is in its second phase, which continues through June 2013. In this phase, new construction projects that exceed a CO_2e threshold of 100,000 tons per year and modifications of existing facilities that increase CO_2e emissions by at least 75,000 tons per year are subject to permitting requirements. Additionally, operating facilities that emit at least 100,000 tons per year are subject to Title V permitting requirements for GHGs (USEPA 2010a). New and existing industrial facilities that meet or exceed that threshold require a permit under the New Source Review Prevention of Significant Deterioration (PSD) and Title V Operating Permit programs.

B. State

California Air Resources Board

The California Air Resources Board (CARB), a part of the California Environmental Protection Agency (CalEPA), is responsible for the coordination and administration of both federal and state air pollution control programs within California. In this capacity, CARB conducts research, sets the California Ambient Air Quality Standards (CAAQS), compiles air emission inventories, develops suggested control measures and provides oversight of local programs. CARB establishes emissions standards for motor vehicles sold in California, consumer products (such as hairspray, aerosol paints and barbecue lighter fluid) and various types of commercial equipment. It also sets fuel specifications to further reduce vehicular emissions. CARB has primary responsibility for the development of California's State Implementation Plan (SIP), for which it works closely with the federal government and the local air districts. The SIP is required for the State of California to take over implementation of the federal Clean Air Act in California and consists of rules and technical documentation to support the State of California's plan for reducing emissions of criteria pollutants in areas that exceed EPA standards and are designated non-attainment.

Executive Order S-20-04

Governor Arnold Schwarzenegger signed Executive Order S-20-04 regarding Green Buildings on December 14, 2004. It established California's priority for energy and resource-efficient high performance buildings. The Executive Order sets a goal of reducing energy use in state-owned buildings by 20 percent by 2015 (from a 2003 baseline) and encourages the private commercial sector to set the same goal. Executive Order S-20-04 also directs compliance with the Green Building Action Plan which details the measures the state will take to meet these goals. To summarize, Executive Order S-20-04 and the Green Building Action Plan assigned the California Energy Commission to develop the following measures to achieve the goals of Executive Order S-20-04:

- Building efficiency benchmarking system for all state-owned and private commercial buildings.
- Develop commissioning and retro commissioning guidelines for commercial buildings.
- Develop and refine (Title 24) building energy efficiency standards applicable to commercial buildings sector to result in 20% reduction in energy use by 2015 using standards adopted in 2003 as the baseline.
- Consult and collaborate with the Department of General Services, Department of Finance and California Public Utility Commission on retrofitting all state-owned buildings.

Executive Order S-3-05

California Governor Arnold Schwarzenegger announced on June 1, 2005, through Executive Order S-3-05, the following GHG emission reduction targets:

- By 2010, California shall reduce GHG emissions to 2000 levels.
- By 2020, California shall reduce GHG emissions to 1990 levels.
- By 2050, California shall reduce GHG emissions to 80% below 1990 levels.

The first California Climate Action Team (CCAT) Report to the Governor in 2006 contained recommendations and strategies to help meet the targets in Executive Order S 3-05. In April 2010, the Draft California Action Team (CAT) Biennial Report expanded on the policy-oriented 2006 assessment. The new information detailed in the CAT Assessment Report includes development of revised climate and sea-level projections using new information and tools that have become available in the last two years, and an evaluation of climate change within the context of broader social changes such as land-use changes and demographic shifts (CCAT 2010). Action items in the report focus on the preparation of the Climate Change Adaptation Strategy, required by Executive Order S-13-08, described later in this report.

Assembly Bill 1493, Clean Car Standards

AB 1493 (also known as the Pavley Bill, in reference to its author Fran Pavley) was enacted in 2002 and requires the "maximum feasible and cost effective reduction" of GHGs from automobiles and light-duty trucks. Subsequently, in 2004, CARB approved the "Pavley I" regulations limiting the amount of GHGs that may be released from new passenger automobiles beginning with model year 2009 through 2016; these regulations would reduce emissions from new passenger automobiles by 30% from 2002 levels by 2016. The second set of regulations ("Pavley II") is currently in development and will cover model years 2017 through 2025 in order to reduce emissions by 45% by the year 2020. The automotive industry legally challenged the bill claiming that the

SEJA Comment Letter-Attachment C-Page 175

federal gas mileage standards preempted these state regulations. In 2005, California filed a waiver request to the USEPA in order to implement the GHG standards (Pavley I and II) and in March of 2008, the USEPA denied the request. However, in June 2009, the decision was reversed and the USEPA granted California the authority to implement the GHG reduction standards for passenger cars, pickup trucks, and sport utility vehicles.

In September 2009, CARB adopted amendments to the "Pavley I" regulations that cemented California's enforcement of the Pavley rule starting in 2009 while providing vehicle manufacturers with new compliance flexibility. The amendments also coordinated California's rules with the federal rules for passenger vehicles.

Assembly Bill 32, The Global Warming Solutions Act of 2006

In 2006, the California State Legislature adopted AB 32, *the California Global Warming Solutions Act of 2006*, focusing on reducing GHG emissions in California. GHGs as defined under AB 32 include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride. AB 32 required CARB to adopt rules and regulations directing state actions that would reduce GHG emissions to 1990 statewide levels by 2020. CARB was also required to publish a list of "discrete early action" GHG emission reduction measures that would be made enforceable by 2010. The law further required that such measures achieve the maximum technologically feasible and cost-effective reductions in GHGs from sources or categories of sources to achieve the statewide greenhouse gas emissions limit for 2020.

Towards this aim, in October 2007, CARB published its Final Report for Proposed Early Actions to Mitigate Climate Change in California. This report described recommendations for discrete early action measures to reduce GHG emissions. Resulting from this were three new regulations including: a low carbon fuel standard, reduction of HFC-134a (a refrigerant chemical) emissions from non-professional servicing of motor vehicle air conditioning systems and improved landfill methane capture. CARB estimated that by 2020, reductions from these three measures would reduce emissions by approximately 13-26 million metric tons CO_2e.

In 2007, CARB released a report, *California 1990 GHG Emissions Level and 2020 Emissions Limit,* establishing that statewide levels of GHG emissions in 1990 were 427 MMT CO_2e. Additionally, in 2008, CARB adopted the *Climate Change Scoping Plan*, outlining the State of California's strategy to achieve the 2020 GHG limit. The Scoping Plan proposes a comprehensive set of actions designed to reduce overall GHG emissions in California, improve the environment, reduce dependence on oil, diversify energy sources, save energy, create new jobs and enhance public health. The plan emphasizes a cap-and-trade program, but also includes the discrete early actions previously mentioned.

Senate Bill 97

SB 97, enacted in 2007, amended CEQA to clearly establish that GHG emissions and the effects of GHG emissions are appropriate subjects for CEQA analysis. It directed the California Office of Planning and Research (OPR) to develop revisions to the *State CEQA Guidelines* "for the mitigation of GHG emissions or the effects of GHG emissions" and directed the Resources Agency to certify and adopt these revised *State CEQA Guidelines* by January 2010 (See PRC Section 21083.05). The revisions were codified into the California Code of Regulations and became fully effective by July 2010. These revisions provide regulatory guidance for the analysis and mitigation of the potential effects of GHG emissions.

Among the changes resulting from SB 97 was the addition of criteria for Climate Action Plans used in the tiering and streamlining of CEQA analysis of GHGs for subsequent development projects. Riverside County has updated the Air Quality Element of the General Plan to include specific policies to address GHG emissions. The implementation mechanisms for these GHG-related policies are the Screening Tables for New Development, included in Appendix N of the General Plan. The Screening Tables allow new development projects a streamlined option for complying with the CEQA requirements for addressing GHG emissions. Additionally, Riverside County's Climate Action Plan details policies to reduce emissions from municipal and community-wide sources including emissions from existing buildings and new development. The addition to the *State CEQA Guidelines* reads as follows:

15183.5. Tiering and Streamlining the Analysis of Greenhouse Gas Emissions.

(a) Lead agencies may analyze and mitigate the significant effects of greenhouse gas emissions at a programmatic level, such as in a general plan, a long range development plan, or a separate plan to reduce greenhouse gas emissions. Later project-specific environmental documents may tier from and/or incorporate by reference that existing programmatic review. Project-specific environmental documents may rely on an EIR containing a programmatic analysis of greenhouse gas emissions as provided in Section 15152 (tiering), 15167 (staged EIRs) 15168 (program EIRs), 15175-15179.5 (Master EIRs), 15182 (EIRs Prepared for Specific Plans), and 15183 (EIRs Prepared for General Plans, Community Plans, or Zoning).

(b) Plans for the Reduction of Greenhouse Gas Emissions. Public agencies may choose to analyze and mitigate significant greenhouse gas emissions in a plan for the reduction of greenhouse gas emissions or similar document. A plan to reduce greenhouse gas emissions may be used in a cumulative impacts analysis as set forth below. Pursuant to Sections 15064(h)(3) and 15130(d), a lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project complies with the requirements in a previously adopted plan or mitigation program under specified circumstances.

(1) Plan Elements. A plan for the reduction of greenhouse gas emissions should:

(A) Quantify greenhouse gas emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area;

(B) Establish a level, based on substantial evidence, below which the contribution to greenhouse gas emissions from activities covered by the plan would not be cumulatively considerable;

(C) Identify and analyze the greenhouse gas emissions resulting from specific actions or categories of actions anticipated within the geographic area;

(D) Specify measures or a group of measures, including performance standards, that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level;

(E) Establish a mechanism to monitor the plan's progress toward achieving the level and to require amendment if the plan is not achieving specified levels;

(F) Be adopted in a public process following environmental review.

(2) Use with Later Activities. A plan for the reduction of greenhouse gas emissions, once adopted following certification of an EIR or adoption of an environmental document, may be used in the cumulative impacts analysis

SEJA Comment Letter-Attachment C-Page 177

> *of later projects. An environmental document that relies on a greenhouse gas reduction plan for a cumulative impacts analysis must identify those requirements specified in the plan that apply to the project, and, if those requirements are not otherwise binding and enforceable, incorporate those requirements as mitigation measures applicable to the project. If there is substantial evidence that the effects of a particular project may be cumulatively considerable notwithstanding the project's compliance with the specified requirements in the plan for the reduction of greenhouse gas emissions, an EIR must be prepared for the project.*

One of the goals of the CAP is to allow programmatic level review and mitigation of GHG emissions that allows for streamlining of CEQA review for subsequent development projects. To accomplish this, the CAP framework is designed to fulfill the requirements identified in CEQA Guidelines Section 15183.5, above.

Senate Bill 375

SB 375 established mechanisms for the development of regional targets for reducing passenger vehicle greenhouse gas emissions and was adopted by the State of California in September 2008. In response, in 2010, CARB adopted vehicular GHG emissions reduction targets developed in consultation with the state's metropolitan planning organizations (MPOs), which included the Southern California Association of Governments (SCAG), to which Riverside County belongs. The targets require a 7-8% reduction by 2020 and 13-16% reduction by 2035 for each MPO. The objective of these targets is to induce cities and counties to change their land use patterns and improve their transportation alternatives. Through the SB 375 process, MPOs, such as SCAG, are to work with local jurisdictions in the development of "Sustainable Communities Strategies" (SCS) designed to integrate development patterns and the transportation network in a way that reduces greenhouse gas emissions while meeting housing needs and other regional planning objectives. In particular, SCAG's reduction target for per capita vehicular emissions is 8% by 2020 and 13% by 2035 (CARB 2010b). SCAG is in the process of preparing its SCS according to its 2012 regional transportation plan (RTP) update schedule. To date, no region has adopted an SCS; the earliest RTP updates with SCSs are expected in 2012.

Executive Order S-13-08

On November 14, 2008, Governor Schwarzenegger issued Executive Order S-13-08, the Climate Adaptation and Sea Level Rise Planning Directive, which provides clear direction for how the State of California should plan for future climate impacts. Executive Order S-13-08 calls for the implementation of four key actions to reduce the vulnerability of California to climate change:

- Initiate California's first statewide Climate Change Adaptation Strategy (CAS) that will assess the state's expected climate change impacts, identify where California is most vulnerable, and recommend climate adaptation policies.
- Request that the National Academy of Sciences establish an expert panel to report on sea level rise impacts in California in order to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea level rise in designated coastal and floodplain areas for new and existing projects.
- Initiate studies on critical infrastructure projects and land-use policies vulnerable to sea level rise.

The resultant 2009 CAS Report summarizes the best known science on climate change impacts in the state to assess vulnerability and outlines possible solutions that can be implemented within and across state agencies to

promote resiliency. This is the first step in an ongoing, evolving process to reduce California's vulnerability to climate impacts (California Natural Resources Agency 2009a).

California Code of Regulations (CCR) Title 24, Part 6

CCR Title 24, Part 6: *California's Energy Efficiency Standards for Residential and Nonresidential Buildings* (Title 24) were first established in 1978 in response to a legislative mandate to reduce California's energy consumption. The standards are updated periodically to allow consideration and possible incorporation of new energy efficiency technologies and methods. Electricity production by fossil fuels results in GHG emissions, and energy-efficient buildings require less electricity. Therefore, increased energy efficiency results in decreased GHG emissions.

The Energy Commission adopted the 2008 Standards on April 23, 2008, and the Building Standards Commission approved them for publication on September 11, 2008. These updates became effective on August 1, 2009. The Energy Commission adopted the 2008 changes to the Building Energy Efficiency Standards for several reasons:

- To provide California with an adequate, reasonably priced and environmentally sound supply of energy.
- To respond to AB 32, the Global Warming Solutions Act of 2006, which mandates that California must reduce its GHG emissions to 1990 levels by 2020.
- To pursue California energy policy, which states that energy efficiency is the resource of first choice for meeting California's energy needs.
- To act on the findings of California's Integrated Energy Policy Report (IEPR) that concludes that the Standards are the most cost-effective means to achieve energy efficiency, expects the Building Energy Efficiency Standards to continue to be upgraded over time to reduce electricity and peak demand and recognizes the role of the Standards in reducing energy related to meeting California's water needs and in reducing GHG emissions.
- To meet the West Coast Governors' Global Warming Initiative commitment to include aggressive energy efficiency measures into updates of state building codes.
- To meet the energy efficiency goals of Executive Order S-20-04 which established California's Green Building Initiative. The Executive Order seeks to improve the energy efficiency of nonresidential buildings through aggressive standards toward the target of a 20% reduction in building energy use from a 2003 baseline by the year 2015.

California Green Building Code

CCR Title 24, Part 11: California's Green Building Standard Code (CalGreen) was adopted in 2010 and went into effect January 1, 2011. CalGreen is the first statewide mandatory green building code and significantly raises the minimum environmental standards for construction of new buildings in California. The mandatory provisions in CalGreen will reduce the use of volatile organic compounds (VOC) emitting materials, strengthen water conservation, and require construction waste recycling.

C. Regional

Riverside County spans three different air basins: South Coast, Salton Sea, and Mojave Desert. The portions of Riverside County within the South Coast and Salton Sea Air Basins are regulated by the South Coast Air Quality

Management District (SCAQMD), which also governs Los Angeles and Orange Counties, plus a small portion of San Bernardino County. The easternmost third of Riverside County, that within the Mojave Desert Air Basin, is under the jurisdiction of the Mojave Desert Air Quality Management District (MDAQMD), which also governs most of San Bernardino County. The AQMDs are responsible for promoting and improving the air quality of their jurisdiction's basins. This is accomplished though air quality monitoring, evaluation, education, implementation of control measures to reduce emissions from stationary sources, permitting and inspection of pollution sources, enforcement of air quality regulations and by supporting and implementing measures to reduce emissions from motor vehicles. Both the SCAQMD and the MDAQMD have stationary, area and mobile source[2] control measures designed to bring the area into compliance with the state ozone standards.

After AB 32 was passed, SCAQMD formed the Climate Change Committee along with the Greenhouse Gases CEQA Significance Thresholds Working Group and the SoCal Climate Solutions Exchange Technical Advisory Group. On September 5, 2008, the SCAQMD Board approved the SCAQMD Climate Change Policy, which outlines actions SCAQMD will take to assist businesses and local governments in implementing climate change measures, decrease the agencies carbon emissions and provide information to the public regarding climate change. On December 5, 2008, the SCAQMD Board approved interim CEQA GHG significance thresholds for stationary sources, rules, and plans. SCAQMD adopted a tiered approach for determining significance; projects that are exempt from CEQA or consistent with a local GHG reduction plan are determined less than significant. Tier 3, the primary tier the board will use for determining significance, has a screening significance threshold using the 90th percentile of emissions capture rate approach.

D. Local

In light of state and regional efforts to reduce GHGs, there are several avenues of opportunity Riverside County faces. In preparing this CAP, the County of Riverside is able to streamline its CEQA review of individual projects. By having a GHG reduction plan that adequately addresses emissions at the plan level, the County of Riverside is able to determine that projects that are consistent with the plan will not have significant GHG-related impacts. Coordination with CARB, SCAQMD, and the State Attorney General's office ensures that the inventories and reduction strategies presented in this report adequately address the County of Riverside's emissions. The County of Riverside will use screening tables for new development (described in Section 4 of this report) in order to evaluate the consistency of individual projects with the goals and reduction measures outlined in this report.

The screening tables are setup similar to a checklist with points allocated to certain elements that reduce greenhouse gas emissions; if the project garners 100 points (by including enough GHG-reducing elements), then the project is consistent with Riverside County's plan for reducing emissions. This streamlined process relieves the Riverside County development projects from lengthy studies or uncertainties, particularly for small development proposals. The screening tables are set up in such a way that a new development project can earn points by reducing emissions from an existing source (by making an existing building more energy efficient, for example). This is particularly beneficial for jurisdictions, such as Riverside County, that have significant housing stock built prior to the 1974 inception of Title 24 energy efficiency standards and requirements. Thus, Riverside County is able to reduce emissions from both existing sources and future development.

[2] Stationary sources emit pollutants from a fixed location, for example industrial boilers. Mobile sources are motor vehicles and other transportation sources that generate pollution through the combustion of fossil fuels. Area sources are those associated with the activities of a given area, such as from fireplaces and lawnmowers in a residential area.

This page intentionally left blank

SEJA Comment Letter-Attachment C-Page 181

Chapter 2
Methodology

This page intentionally left blank

Chapter 2 Methodology

2.1 Overview

The first step in drafting this CAP is to prepare the GHG inventories for Riverside County. GHG inventories include all major sources of emissions attributable directly or indirectly to Riverside County's government operations or activities within the community the County of Riverside serves. GHG inventories are divided into two broad categories: government GHG inventories and community-wide GHG inventories. Government GHG inventories include emissions resulting from county government operations. Community-wide GHG inventories include a broader range of emissions associated with both the activities within the community Riverside County serves and the government operations. As such, the government GHG inventory is a subset of the larger community-wide GHG inventory. The methodology for preparing GHG inventories incorporates the protocols, methods, and emission factors found in the California Climate Action Registry (CCAR) *General Reporting Protocol* (version 3.1, January 2009), the *Local Government Operations Protocol* (LGOP) (version 1.1, May 2010), and the *Draft Community-wide GHG Emissions Protocol* under development by the Association of Environmental Professionals (AEP) and the International Council for Local Environmental Initiatives (ICLEI). The LGOP provides the guidance and protocols in the development of the government GHG inventory. Currently, there is not an adopted protocol for the development of community-wide GHG inventories. However, the AEP/ICLEI *Draft Community-wide GHG Emissions Protocol* provides draft guidance in the development of the community-wide inventory.

The LGOP and the draft AEP/ICLEI *Draft Community-wide GHG Emissions Protocol* categorize GHG emissions into three distinct "scopes" as a way of organizing GHG emissions, as follows:

- **Scope 1 Emissions** – All "direct" sources of community-wide GHG emissions from sources within the jurisdictional boundaries and unincorporated areas of Riverside County. This includes fuel burned onsite in buildings and equipment such as natural gas or diesel fuel; transportation fuels burned in motor vehicles; and wood-burning emissions from household hearths. For inventories of only government operations, these emissions are limited to activities under the operational control of the County of Riverside government.
- **Scope 2 Emissions** – Encompasses "indirect" sources of GHG emissions resulting from the consumption of purchased electricity, which is electricity used by the residents, businesses, and County of Riverside's facilities. An "indirect" source is one where the action that generates GHGs is separated from where the GHGs are actually emitted. For example, when a building uses electricity, it necessitates the burning of fossil fuels, such as coal or natural gas (and resultant release of GHGs) to generate electricity by a utility facility located elsewhere. Thus, they are distinguished from *direct* emissions (i.e., Scope 1 emissions) from electricity production, which are reported by the utility itself, in order to avoid double counting.

- **Scope 3 Emissions** – An optional reporting category that encompasses all other "indirect emissions" that are a consequence of activities of Riverside County's residents and businesses, but occur from sources out of the jurisdictional control of the local government. The key to this category of emissions is that they must be "indirect or embodied emissions over which the local government exerts significant control or influence" (CCAR 2010). For example, when considering GHG emissions from trucks hauling waste under a county contract, the County of Riverside does not own the waste hauling trucks, but does have significant control over how many pickups the trucks make.

Scope 1 emissions are characterized in this report as "direct emissions" While Scope 2 emissions are characterized as "indirect source emissions."

The analysis herein is tailored to include all existing and projected emission sources within the unincorporated areas of Riverside County to provide, to the fullest extent feasible, a comprehensive analysis of GHG reductions. The AB 32 Scoping Plan establishes a comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions of GHG emissions.

2.2 Calculation of GHGs

The first step in developing the CAP was to establish an existing inventory of Riverside County's GHG emissions. The purpose of this inventory is to create an existing inventory to align with the Riverside County General Plan Update. The CAP uses 2008 as the year on which to base the existing inventory; this is the most recent year for which reliable data concerning Riverside County's residential, commercial, and government operations are available. This inventory provides a framework on which to design programs and actions that specifically target reductions by emissions sources. Programs and actions already in place within Riverside County are described in Chapter 4. The 2008 inventory serves as a reference against which to measure Riverside County's progress towards reducing GHG emissions into the future, and also serves as documentation for potential emission trading opportunities.

The methodology used for the calculation of GHG emissions differs depending on the emission source, as described below. The emissions calculations follow the CCAR General Reporting Protocol, version 3.1; LGOP, version 1.1; and CARB's Mandatory GHG Reporting Regulations (Title 17, California Code of Regulations, Sections 95100 et seq.). These protocols are consistent with the methodology and emission factors endorsed by CARB and USEPA. In cases where these protocols do not contain specific source emission factors, current industry standards or the USEPA's *AP 42 Compilation of Air Pollution Emission Factors* were used.

In estimating Riverside County's total GHG emissions in 2008, many data sources were utilized. For community energy statistics, the following agencies and Riverside County departments were consulted: Riverside County Planning Department, Southern California Edison (SCE), Imperial Irrigation District (IID) and Southern California Gas Company (SCG). Transportation data sources included Riverside County Transportation Department, Riverside County Economic Development Agency, Southern California Association of Governments (SCAG) and California Department of Transportation (CalTrans). Agricultural data sources included Riverside County Agricultural Commissioner and SCAG. Water use data was gathered from Coachella Valley Water District, Desert Water Agency, Eastern Municipal Water District, Western Municipal Water District, Palo Verde Irrigation District, San Gorgonio Pass Water Agency and Metropolitan Water District of Southern California. Solid waste data was collected from Riverside County Waste Management Department, California Integrated Waste Board (CIWB) and California Department of Resources Recycling and Recovery (Cal Recycle). Appendix C includes a compilation of all data inputs. In cases where specific data for 2008 was not available,

SEJA Comment Letter-Attachment C-Page 185

estimates were made by extrapolating from existing data the County of Riverside had that was as close to 2008 as possible. Details on the data inputs and estimates made when 2008 data was not available can be found in Appendices B and C of this CAP. The data used in the calculations for each inventory are summarized in Chapter 3. All of the contributors to GHG emissions (kilowatt-hours (kWh) of electricity generated by fossil fuel combustion in power plants, natural gas in therms, vehicle travel in VMT, and solid waste in tons) are expressed in the common unit of MT of CO_2e released into the atmosphere in a given year.

In addition, the costs associated with the GHG emissions were calculated for each sector (based on availability of data). The costs were based on the consumer fees for each fuel type included in the inventory. By including the costs, the County of Riverside can assess where consumers are spending the most money and utilize the information in making decisions on reduction measures. Coefficients, modeling inputs, and other assumptions, used in the calculations of GHGs are included in the Appendix of this report.

GHG emissions are typically segregated into direct and indirect sources as discussed previously. However, direct and indirect sources are not completely independent of each other and are often combined into other more encompassing categories. For example, although natural gas combustion is a direct source and electricity generation is an indirect source, they both are typically discussed under a heading of "Energy" when policies are put in place to reduce emissions. Therefore, this CAP discusses emissions with respect to the general source categories of Transportation, Energy, Area Source, Water, Wastewater, and Solid Waste.

A. Energy

Electricity

Emissions of CO_2, CH_4, and N_2O within Riverside County result from the use of electricity. Annual electricity usage in 2008, obtained from SCE and IID, the two major commercial electricity providers serving Riverside County territory, was used in determining community-wide electricity consumption and generation emission estimates for the existing inventory. For the municipal inventory, electricity use in government facilities and streetlights was included and categorized by department. For 2020, emissions estimates were based on the anticipated growth in population, housing and employment for the County of Riverside. The 2020 growth projections were interpolated from the General Plan Update growth rates.

SCE and IID provide electricity generated via a variety of sources, including combustion of natural gas and coal, nuclear, large hydroelectric, and renewable sources (solar, wind, etc.). Each of these sources of electricity emits different amounts of GHGs. Therefore, emissions from electricity were determined by multiplying annual usage in megawatt hours per year (MWh/year) by the SCE emission factors appropriate to the inventory year for CO_2, CH_4, and N_2O obtained from USEPA's Emissions and Generation Resource Integrated Database (eGRID) (USEPA 2007).

Two gas-to-energy facilities are located in unincorporated Riverside County, one at the Badlands Landfill and one at the El Sobrante Landfill. These facilities take the methane collected from the decomposition of solid waste and convert it to electricity. The generation of electricity from these alternative generation sources results in emission reductions. Therefore, the operation of these facilities offset electrical consumption within the inventory by approximately 13,016 megawatt hours to account for the electricity generated by these facilities in 2008. Concerning the El Sobrante Landfill, the County of Riverside cannot claim all of the benefits associated with the gas-to-energy facility at the landfill. The El Sobrante landfill is privately owned and operated. The majority of the waste disposed of at the landfill is generated from outside of Riverside County boundaries. The County of Riverside collects fees and has indirect control over the waste collected from within Riverside County at the El

Sobrante Landfill; however, the County of Riverside does not have control over the landfill waste collected by the private operator from outside Riverside County boundaries. Therefore, the benefits from cogeneration are limited to the portion of methane associated with waste collected within Riverside County. As of the end of 2008, approximately 49 percent of the total waste deposited in the El Sobrante landfill originated within Riverside County with the remaining 51 percent originating outside of Riverside County. The 2008 baseline inventory calculates the benefit of the El Sobrante cogeneration based on the portion of waste collected within Riverside County. The contractual split of waste at El Sobrante Landfill was updated after 2008 such that 40 percent of the waste will come from within Riverside County with the remaining 60 percent coming from outside Riverside County. Cogeneration benefits at the El Sobrante Landfill for years 2020 and 2035 reflect the contractual split of waste.

Natural Gas Combustion

The residents and businesses of Riverside County emit GHGs from the combustion of natural gas, most often used for space heating. The annual natural gas usage for the unincorporated areas of Riverside County measured in million British Thermal Units (MMBTUs) was multiplied by the respective emissions factors for CO_2, CH_4, and N_2O to determine the emissions from natural gas combustion. Existing inventory consumption levels for municipal operations and the community as a whole were obtained from the Southern California Gas Company (SCG) and future community-wide consumption estimates were based on anticipated growth in Riverside County.

B. Water Supply

Water-related emissions included in this section are indirectly produced as a result of electrical consumption to pump and treat water imported from outside Riverside County. There are many water agencies that operate in Riverside County providing both potable and non-potable water to customers in the unincorporated areas. The six major water importers and wholesalers serving Riverside County are: Coachella Valley Water District (CVWD), Desert Water Agency (DWA), Eastern Municipal Water District (EMWD), Western Municipal Water District (WMWD), Palo Verde Irrigation District (PVID) and San Gorgonio Pass Water Agency (SGPWA). Serving EMWD and WMWD, the Metropolitan Water District of Southern California (MWD) holds the rights to a large portion of the State Water Project supply (the system of aqueducts and canals that distributes water from the Sacramento Bay-San Joaquin Delta across the state) and is the largest water wholesaler in California. The San Gorgonio Pass Water Agency also gets its water from the State Water Project. The water agencies in the eastern portion of Riverside County predominantly get their water from the Colorado River.

Each agency's water supply comes from a mixture of the following sources: the Bay-Delta via the State Water Project, the Colorado River, local groundwater, recycled water, and local surface water. The GHG emissions associated with water use come from the energy used to collect, treat, convey, and distribute the water. Water imported through the State Water Project and from the Colorado River have higher GHG emissions associated with them, when compared to local water sources, as these distant sources require energy intensive transport to reach Riverside County. This category, "Water Supply," addresses the GHG emissions resulting from energy used to pump/transport these imported sources of water from their sources to Riverside County. This separate category is necessary, as the energy used is accrued across a varied of providers and is not included in the data collected from SCE and IID. For local water sources, the data collected from SCE and IID include associated electricity usage and, hence GHG emissions are included under the "Electricity" category described above. Showing GHG emissions associated with local water sources in the "Electricity" category avoided double counting because the electricity used to pump local water supplies was embedded in the SCE reported electrical consumption data for unincorporated Riverside County.

SEJA Comment Letter-Attachment C-Page 187

C. Wastewater Treatment

As with the local water supply just mentioned, GHG emissions associated with wastewater (that is, sewage, urban runoff, and, in some cases, industrial or manufacturing runoff) are based on the electricity needed to pump and treat the wastewater. Again, since wastewater treatment occurs locally within Riverside County, these emissions are also accounted for under the "Electricity" section of the community-wide inventory to avoid double counting of GHG emissions identical to how locally pumped water were treated.

D. Solid Waste Management

Riverside County Waste Management Department is responsible for managing the County's landfills, including both active and closed landfills, with one exception – the El Sobrante landfill, which is privately owned and operated. Table 2-1 (Riverside County Landfills), below, provides information on the closure year (either past or planned), the year the landfill gas (LFG) system was installed, the in place tonnage at the end of 2008 and the amount of waste disposed at each landfill in 2008. As discussed under "Electricity," the County of Riverside collects fees and has control over the portion of the El Sobrante landfill waste collected from within Riverside County. Therefore, the emissions associated with solid waste within the inventory are limited to the portion of waste collected within Riverside County.

Riverside County's municipal inventory includes the emissions associated with the landfills that are owned and managed by the County of Riverside. This includes emissions from county-owned vehicles and equipment as well as fugitive methane emissions from open and closed landfills that are managed by the County of Riverside. Riverside County's emissions from vehicles and equipment associated with solid waste are included, respectively, in the vehicle fleet and off-road equipment sections of the municipal operations inventory.

Table 2-1 Riverside County Landfills

Landfill Name (closure year)	Year LFG System Installed	In-place Tonnage (end of 2008)	Waste Disposed in 2008
Badlands (2016)	2001	8,389,807	582,404.62
Blythe (2034)	1998	609,373	15,178.80
Coachella (1997)	2001	3,237,845	-
Corona (1986)	1988	3,200,000	-
Desert Center	-	40,425	15.25
Double Butte (1994)	1997	1,977,463	-
Edom Hill (1997)	2008	7,323,778	-
Elsinore (1965)	1993	1,140,000	-
El Sobrante (2045)*	1989	22,127,558	960,363.49
Highgrove (1998)	1998	3,496,425	-
Lamb Canyon (2021)	2001	6,376,349	688,142.35
Mead Valley (1997)	1995	2,312,837	-
Mecca II	-	228,088	8.86
Oasis	-	176,410	1,479.97
W. Riverside (1993)	1988	1,260,000	-

*El Sobrante is a privately operated landfill; all others are operated by Riverside County Waste Management. Waste Disposed in 2008 associated with the El Sobrante landfill represents only the in County portion (or approximately 49 percent) of the total waste disposed at this landfill.

Emissions from solid waste result from three different waste-related sources of emissions: transportation from its source to the landfill, operation of the equipment used at the landfill and the fugitive emissions from waste decomposition. Emissions from the transportation of solid waste are determined based on the average number of

miles traveled by each truck multiplied by the CO_2, CH_4, and N_2O emissions generated per mile traveled. These emissions are accounted for under the "Transportation," Section 2.3.4, of the inventory, described below. The emissions from landfill equipment are dependent upon the type of equipment, fuel use and duration of use. Emissions from waste decomposition at both active and inactive landfills located in the unincorporated areas of Riverside County are included in the inventory. The operational information used in this section was collected from the Riverside County Waste Management Department.

Emissions from the equipment used at the landfills were calculated from total fuel use by the equipment and the emission factors for CO_2, CH_4 and N_2O, as determined from CARB off-road mobile source emission factors. Fugitive methane emissions from the decomposition of solid waste (typically buried) are calculated based on the annual waste generation multiplied by the applicable emission factors for waste production for CH_4. Many landfills now have a methane capture system in place; depending on the type of system, not all of the methane generated from the decomposition is included in the inventory. In Riverside County, three of the existing seven active landfills and nine inactive landfills have such systems. Although CO_2 is also a by-product of organic waste decomposition, the USEPA considers these emissions to be natural and not anthropogenic. Therefore, they are not included in the emissions inventory. Nitrous oxide is not a by-product of decomposition and, therefore, no fugitive emissions of nitrous oxide are anticipated or calculated from solid waste sources.

E. Area Source Emissions

Landscaping Emissions

Emissions of CO_2, CH_4 and N_2O are generated by the use of landscape equipment that runs on gasoline. CO_2 emissions were determined directly through URBEMIS2007 for the existing (2008) and 2020 community-wide inventories. URBEMIS2007 is a computer software package that is used for modeling projected emissions of air quality pollutants including carbon dioxide. From the CO_2 emissions, the approximate number of gallons of gasoline consumed by landscape equipment use was calculated (CARB 2007e). This number was then multiplied by emission factors presented in the General Reporting Protocol, version 3.1 (CCAR 2010) to derive both CH_4 and N_2O emissions. Landscaping emissions in the municipal inventory were calculated based on Riverside County's inventory of equipment and fuel use along with the specific CO_2, CH_4 and N_2O emission factors for each equipment type.

Wood Burning Emissions

Direct CO_2 emissions are produced from the burning of wood in wood stoves and fireplaces. Natural gas-fired stoves, barbecues and other heating devices are not included in this subcategory; they have already been accounted for under "Energy." Carbon dioxide, CH_4 and N_2O emissions from wood stoves and fireplaces are calculated based on the percentage of residential units using each type of hearth and the California average amount of wood burned per unit provided by the EIA 2005 Residential Energy Consumption Survey (EIA 2005). The emission coefficients used are taken from the USEPA's AP-42 document (USEPA 1985).

SEJA Comment Letter-Attachment C-Page 189

F. Transportation

On-Road Vehicles

For Riverside's municipal inventory, CO_2, CH_4 and N_2O emissions from Riverside County's municipal fleet were calculated based on the fuel use and annual miles traveled by each vehicle. CO_2 emissions were calculated using the total fuel use multiplied by the emission factor for either gasoline or diesel fuel. CH_4 and N_2O emissions are based on the vehicle's age, model and miles traveled. The emissions were then organized by each department.

For the community-wide inventory, emissions from on-road vehicles include all generated from trips attributable to activities taking place in the unincorporated parts of Riverside County. Carbon dioxide emissions from vehicles were calculated utilizing EMFAC2007 emission factors for the existing and 2020 inventories. The Emission Factors (EMFAC) model was developed by the California Air Resources Board and is used to calculate CO_2 emission rates for on-road motor vehicles, from light-duty passenger vehicles to heavy-duty trucks that operate on highways, freeways, and local roads in California (CARB 2007b). Motor vehicle emissions of CH_4 and N_2O were calculated using USEPA emission factors for on-road vehicles based on the total annual mileage driven multiplied by their respective emission factors by year. Vehicle miles traveled (VMT) were provided by the Riverside County Transportation Department. VMT was derived from transportation modeling of the trips entering Riverside County, trips leaving Riverside County, and trips within Riverside County. Pass-through traffic (that is, trips beginning and ending outside of Riverside County) is not included in this analysis. Since trips entering and leaving Riverside County have only one end in Riverside County, only half of these miles were included in the emissions analysis, in order to reflect the split jurisdiction of these trips.

The transportation modeling (RIVTAM) assumed that all vehicles are either gasoline or diesel powered. The estimates therefore do not account for electrical, biodiesel (a blend of diesel and vegetable oil), or hydrogen powered systems. Any electrically powered vehicle which draws its power from a residential, commercial, or industrial land use within Riverside County will be accounted for under electrical usage, i.e., "Energy." Predicted 2020 BAU vehicle trips were estimated by using Riverside County General Plan buildout (approximately Year 2060) conditions and interpolating back to year 2020.

Aviation Emissions

Riverside County owns and operates five airports: Hemet-Ryan, French Valley, Chiriaco Summit, Desert Center and Jacqueline Cochran Regional Airport. The municipal inventory includes the emissions from the energy used to run the facilities and lights at the airports and the emissions from onsite equipment, while the community-wide inventory includes emissions from all aviation activities. The GHG emissions associated with aircraft trips within Riverside County were calculated based on annual fuel consumption (extrapolated from airport aviation fuel sales) and emission factors for jet fuel and aviation fuel for CO_2, CH_4 and N_2O. Fuel services are not provided at the Chiriaco Summit or Desert Center Airport, so all fuel consumption data was obtained from the three larger airports. March Air Reserve Base is not included here as it is not under the direct jurisdiction of the County of Riverside.

G. Agriculture

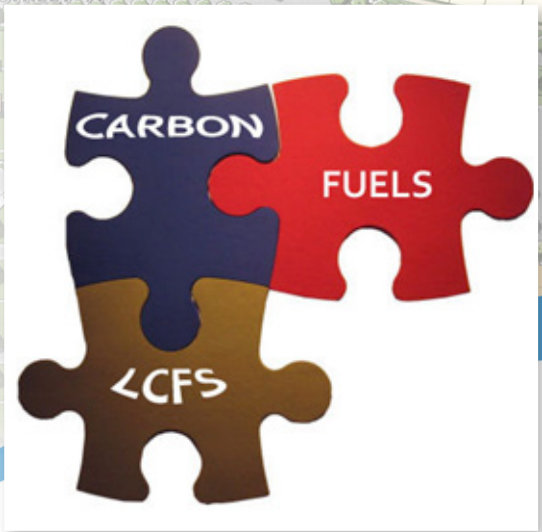
Riverside County has a large amount of agricultural land with a variety of cultivation uses. The most prominent uses are field and seed crops, including primarily alfalfa and wheat, as well as irrigated pasturelands and rangelands (for grazing). Other uses include fruit trees, vineyards, vegetables, and livestock. Agricultural practices contribute

directly to emissions of greenhouse gases through a variety of processes. Assessment of non-carbon-dioxide emissions are from the following source categories: enteric fermentation in domestic livestock, livestock manure management, crop cultivation and field burning of agricultural residues.

Livestock emissions are divided into two categories based on the emissions source: enteric fermentation and manure management. Enteric fermentation is defined as a fermentation process that takes place in the stomach of ruminant animals, such as cows, sheep and goats. This process produces methane that is released through belching and flatulence. Manure management is the process of gathering and disposing of manure generated by livestock. Management practices vary by type of livestock, but in the case of dairy cows, manure is often collected and stored in lagoons. As the manure breaks down, methane is released.

Methane and nitrous oxide is the primary greenhouse gases emitted from crop cultivation and associated activities. Rice cultivation and field burning of agricultural residues are contributing sources of CH_4 (USEPA 2009b). Agricultural-related emissions for 2008 were based on data from SCAG and the Riverside County Agricultural Commissioner.

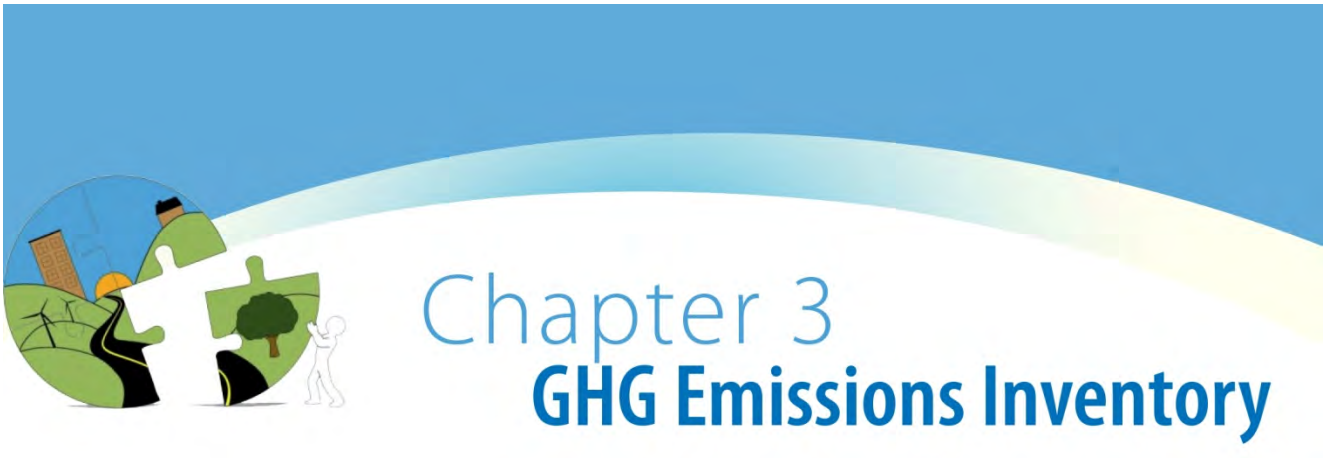
SEJA Comment Letter-Attachment C-Page 191



Chapter 3

GHG Emissions Inventory

This page intentionally left blank



Chapter 3 GHG Emissions Inventory

The following sections describe Riverside County's 2008 government operations and community-wide GHG emissions inventories. The government operations inventory includes sources and quantities of GHG emissions from government owned or rented buildings, facilities, vehicles, and equipment. The community-wide emissions inventory identifies and categorizes the major sources and quantities of GHG emissions produced by residents, businesses, and municipal operations in the unincorporated areas of Riverside County using the best available data. By having the government emissions separated from the community as a whole, the local government can implement reduction strategies where it has direct control, closely monitor the changes in emissions over time, and set an example for the rest of Riverside County.

3.1 2008 Government Emissions Inventory

A. Data Inputs

Data for the government inventory was gathered from various Riverside County departments. Table 3-1 (2008 Government Data Inputs), below, summarizes the data inputs and sources for each of the emission categories included in the inventory.

Table 3-1 2008 Government Data Inputs

Category	Data Input	Data Source
Electricity (kWh)		
Consumption	114,737,623	SCE
Generation*	13,015,642	Riverside County Waste management
Natural Gas (therms)	1,622,208	SCG
Vehicle Fleet		
Gasoline(gallons)	3,419,635	Riverside County Fleet Manager
Diesel (gallons)	469,649	
Off-Road Equipment		
Gasoline(gallons)	982	
Diesel (gallons)	1,031,016	
LNG (gallons)	368,838	Riverside County Fleet Manager
Propane (gallons)	3,607	
Jet Fuel (gallons)	1,832,210	
Aviation Fuel (gallons)	404,686	
Solid Waste Landfill Gas Collection (MMSCF)	2,406	Riverside County Waste Management

* El Sobrante is a privately operated landfill; all others are operated by Riverside County Waste Management Department. Electrical Generation for Riverside County reflects the Badlands facility and the portion of cogeneration at El Sobrante landfill associated with in-county disposal (or 49 percent) of the total generation at the El Sobrante facility.

Each data input was then multiplied by the associated emission factor to calculate the emissions inventory. Additionally, where possible, the emissions were categorized by county department.

B. Emissions Summary

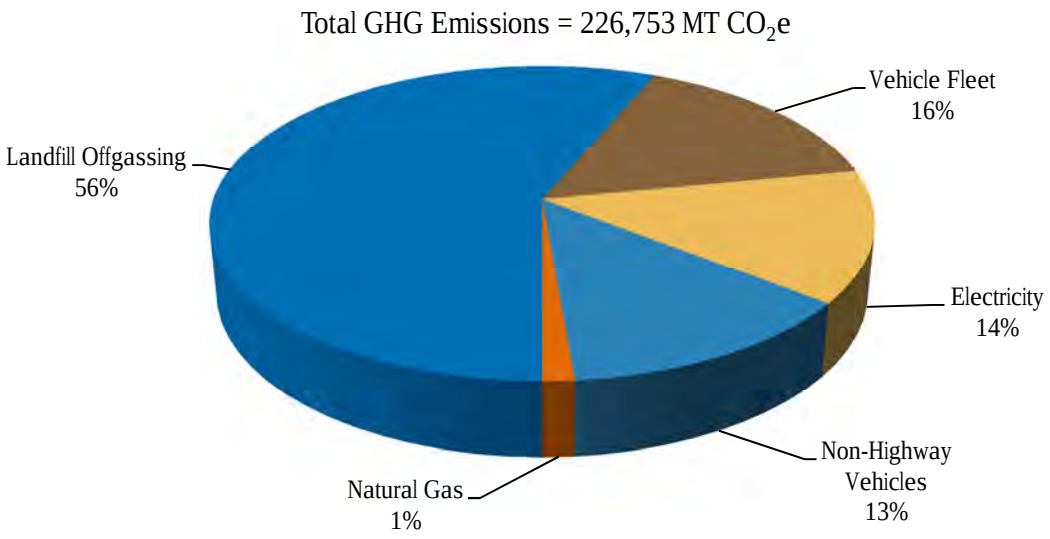
Riverside County emitted 226,753 MT CO_2e through its government operations in 2008. The emissions were calculated based on the vehicle and equipment fleet fuel use, energy accounts, and waste management. The largest portion of Riverside County's 2008 government emissions were from landfill emissions (56%), followed by emissions from the vehicle fleet (16%). Table 3-2 (2008 Total Government Emissions) summarizes Riverside County's 2008 emissions of CO_2e as broken down by emissions category. Figure 3-1 (2008 Government Emissions by Category) is a graphical representation of Table 3-2. A detailed breakdown of 2008 emissions by category is available in Appendix D of this CAP.

Table 3-2 2008 Total Government Emissions

Category	Metric tons of CO_2e
Landfill Offgassing	127,850
Vehicle Fleet	35,331
Electricity	30,859
Off-Road Equipment*	29,649
Natural Gas	3,065
Total	**226,753**

*Off-Road Equipment includes front end loaders, dozers, forklifts, etc.

Figure 3-1 2008 Government Emissions by Category (metric tons CO_2e)



C. 2008 Government Department Emissions and Costs

For the government operations inventory, it is helpful to see which departments are generating the most emissions. This helps to pinpoint where emissions are coming from and where the focus should be placed for targeting emissions reductions. Table 3-3 (2008 Government Emissions and Costs by Department) summarizes the solid waste, electricity, natural gas, and vehicle fleet emissions by department. Figure 3-2 (2008 Government Emissions by Department) is a graphical representation of Table 3-3.

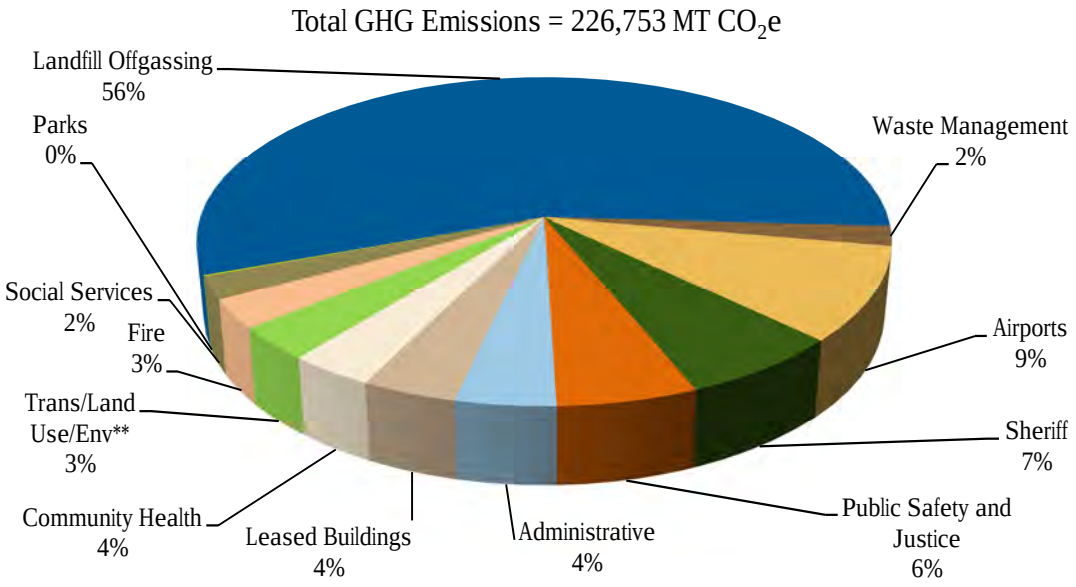
Landfill offgassing, while under the control of the waste management department, is listed as a separate category because the methane emitted from waste decomposition is the result of solid waste from the entire community, both unincorporated areas and municipal waste deposited in Riverside County Landfills. Separating out the emissions in this fashion gives a better comparison of the waste management department with other departments within the County of Riverside local government operations. Like the other departments, the waste management department emissions result from the utility consumption, mobile source emissions and waste generation associated with the everyday operations of the department. The sheriff's department accounts for the greatest energy costs primarily due to the numerous vehicles used by the sheriff's fleet.

Table 3-3 2008 Government Emissions and Costs by Department

Category	Metric Tons of CO_2e	Energy Cost ($)
Waste Management	4,421	$1,405,038
Landfill Offgassing	127,850	N/A
Airports	21,250	$ 253,676
Sheriff	15,039	$ 5,008,600
Public Safety and Justice	12,981	$ 4,223,789
Administrative	9,259	$ 3,033,217
Leased Buildings	8,753	$ 2,848,502
Community Health	7,780	$ 2,540,726
Transportation/Land Use/Environment	7,493	$ 2,201,486
Fire	6,541	$ 1,975,982
Social Services	5,206	$ 1,719,473
Parks	179	$ 59,011
Total	**226,753**	**$25,269,501**

Note: Emission sources include electricity, natural gas, vehicle fuels, and solid waste decomposition. Costs include electricity, natural gas, and transportation fuels.

Figure 3-2 2008 Government Emissions by Department (metric tons CO_2e)



D. 2008 Total Government Cost Estimates

The costs associated with the inventory represent the municipal energy and fuel use costs. These cost estimates give the County of Riverside a perspective on where Riverside County is spending the most money and help to prioritize reduction measures toward the sectors that have the potential to both reduce emissions and costs. Riverside County's fuel purchases for the vehicle fleet made up the largest cost in 2008, followed closely by electricity costs. Table 3-4 (Estimated Government Energy Costs), below, summarizes the cost estimates for 2008.

Table 3-4 Estimated Government Energy Costs

Source	Energy Cost
Vehicle Fleet	$ 11,433,028
Electricity	$10,033,552
Natural Gas	$ 989,547
Off-Road Vehicles	$2,813,374
Total	**$25,269,501**

3.2 2008 Community-Wide Emissions Inventory

The community-wide inventory represents all emissions from sources located with the unincorporated areas of Riverside County. Therefore, the government operations emissions described in the previous section are a subset of the community-wide inventories presented here. In 2008, Riverside County emitted a total of 7,012,938 MT CO_2e from the community as a whole. The following sections describe the data inputs, emissions by source and emissions by land use in 2008.

A. Data Inputs

Data for the community-wide inventory was gathered from various Riverside County departments, SCE, IID, SCG, and reports. Table 3-5 (2008 Community-Wide Data Inputs), below, summarizes the data inputs and sources for each of the emission categories included in the inventory. Each data input was then multiplied by the associated emission factor to calculate the emissions associated with each source.

Table 3-5 2008 Community-Wide Data Inputs

Category	Data Input	Data Source
Electricity		
SCE (kWh)	2,580,439,739	SCE
IID (kWh)	1,034,292,942	IID
Generation*	13,015,643	Riverside County Waste Management
Natural Gas (therms)	95,918,639	SCG
Transportation		
Annual VMT	5,161,531,679	Riverside County Traffic Modeling
Annual Trips	862,485,528	
Area Source (based on land use)		
SFR (units)	112,132	
MFR (units)	48,854	Riverside County Planning
Commercial (ksf)	169,585	
Industrial (ksf)	33,905	
Solid Waste Landfill Gas (SCFM) (In County)	4,910	Riverside County Waste Management

SEJA Comment Letter-Attachment C-Page 197

Category	Data Input	Data Source
Purchased Water (acre-feet)	193,802	Water Agency Reports
Agriculture (acres)		
Hay	29,648	Riverside County Agricultural Commissioner
Corn	497	
Oats	1,150	
Sorghum	3,197	
Wheat	14,817	
Cotton	6,901	SCAG
Vegetable & Fruit Trees	43,898	
Animals (head)		
Dairy Cow	43,773	
Poultry	5,260,914	
Sheep	12,700	

* El Sobrante is a privately operated landfill; all others are operated by Riverside County Waste Management Department. Electrical Generation for Riverside County reflects the Badlands facility and the portion of cogeneration at El Sobrante landfill associated with in-County disposal (or 49 percent) of the total generation at the El Sobrante facility.

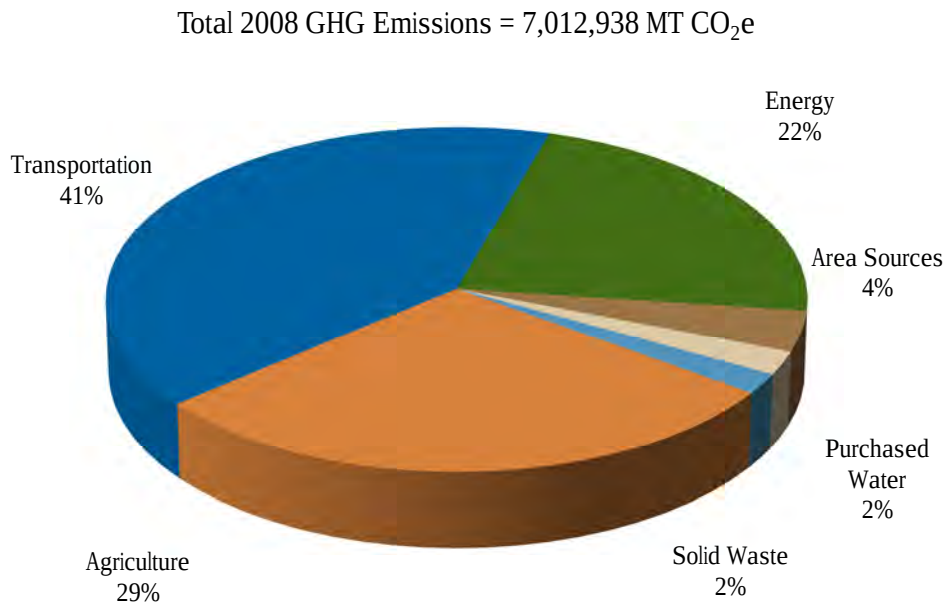
B. Emissions by Source

Table 3-6 (2008 Community-wide GHG Emissions by Source) summarizes net 2008 County emissions of CO_2e as broken down by emissions category. Riverside County as a whole emitted 7,012,938 MMT CO_2e in 2008. The largest portion of Riverside County's 2008 emissions were from transportation (41%), followed by agriculture (29%), and electricity and natural gas use in buildings (22%). Figure 3-3 (2008 Emissions Generated by Emissions Category) provides a comparison of GHG emissions by category.

Table 3-6 2008 Community-wide GHG Emissions by Source

Emissions Category	Metric tons of CO_2e
Transportation	2,850,520
Energy	1,577,667
Area Sources	269,181
Purchased Water	152,473
Solid Waste	132,666
Agriculture	2,030,431
Total	**7,012,938**

Figure 3-3 2008 Emissions Generated by Emissions Category (metric tons CO_2e)



3.3 2020 Business as Usual Community-Wide Emissions Inventory

In 2020, Riverside County is projected to emit a total of approximately 12.1 MMT CO_2e from BAU operations. BAU refers to continued operations and development of Riverside County according to 2008 policies, without the inclusion of proposed reduction or sustainability initiatives as part of this CAP. Reduction initiatives coming from the state or other agencies are not included in the BAU scenario; these reduction measures and their anticipated emission reductions in Riverside County are discussed in Chapter 4.

A. Data Inputs

Data for the 2020 BAU community-wide GHG inventory was estimated based on the General Plan growth rates for Riverside County. Table 3-7 (2020 BAU Community-Wide Data Inputs), below, summarizes Riverside County's socioeconomic growth rates.

Table 3-7 2020 BAU Community-Wide Data Inputs

Category	Data Input	Data Source
Growth Rates (based on General Plan Update) [a]		Riverside County TLMA/IT/GIS/ Demographics
Households	62.4%	
Employment	96.1%	

a Note: The growth rates represent the overall growth from 2008 to 2020 and are derived from the socioeconomic and land use factors used for the proposed General Plan Update.

The socioeconomic growth rates were used to estimate the emissions associated with transportation, electricity, natural gas, water, area source, and solid waste.

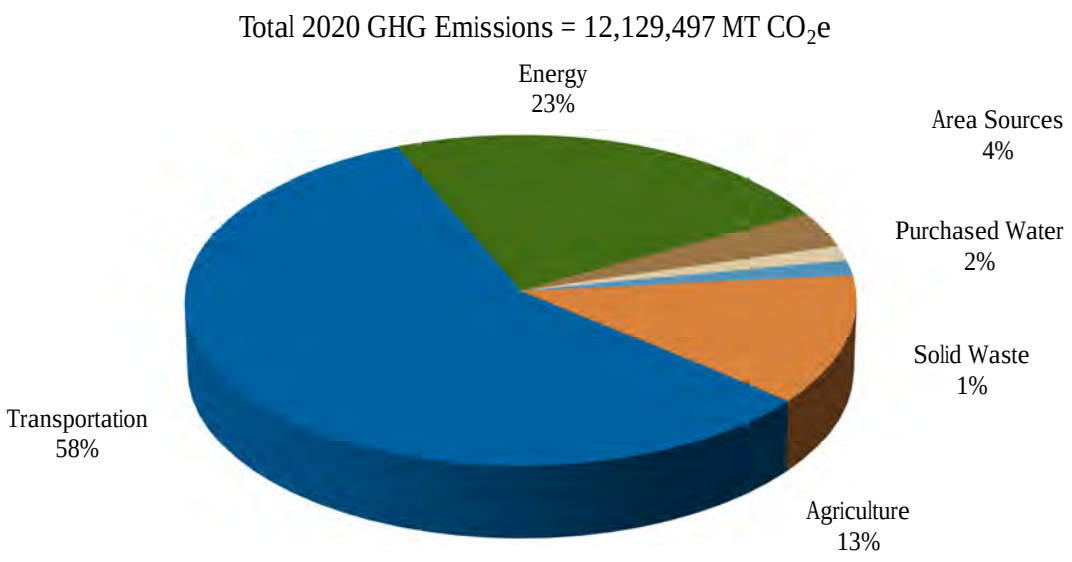
B. 2020 BAU Emissions by Source

The 2020 BAU emissions are estimated based on the projected growth in Riverside County from 2008 to 2020. These projections include a 62.4% increase in households and a 96.1% increase in employment; these growth rates were applied, respectively, to residential and non-residential 2008 emissions in order to estimate 2020 BAU emissions. Table 3-8 (2020 GHG Emissions by Source) summarizes the net 2020 County emissions of CO_2e as broken down by emissions category. Figure 3-4 (2020 BAU Emissions Generated by Source) is a graphical representation of Table 3-8. A detailed breakdown of 2020 emissions by category is available in Appendix D of this CAP.

Table 3-8 2020 GHG Emissions by Source

Emissions Category	Metric tons of CO_2e
Transportation	6,977,331
Energy	2,830,246
Area Sources	442,024
Purchased Water	175,344
Solid Waste	181,728
Agriculture	1,522,823
Total	**12,129,497**

Figure 3-4 2020 BAU Emissions Generated by Source (metric tons CO_2e)



3.4 2035 Business As Usual Community-Wide Emissions Inventory

In 2035, Riverside County is projected to emit a total of 15.5 MMT CO_2e based on the growth rates associated with the proposed General Plan Update and without the inclusion of the proposed reduction measures presented in this CAP.

A. Data Inputs

Data for the 2035 BAU community-wide GHG inventory was estimated based on the General Plan socioeconomic growth rates for the County. Table 3-9 (2035 BAU Community-Wide Data Inputs), below, summarizes Riverside County's growth rates.

Table 3-9 2035 BAU Community-Wide Data Inputs

Category	Data Input	Data Source
Growth Rates (based on General Plan Update) [a] Households Employment	 92.6% 165.1%	Riverside County TLMA/IT/GIS/ Demographics

a Note: The growth rates represent the overall growth from 2008 to 2035 and are derived from the socioeconomic and land use factors used for the proposed General Plan Update.

The socioeconomic growth rates were used to estimate the emissions associated with transportation, electricity, natural gas, water, area source, and solid waste.

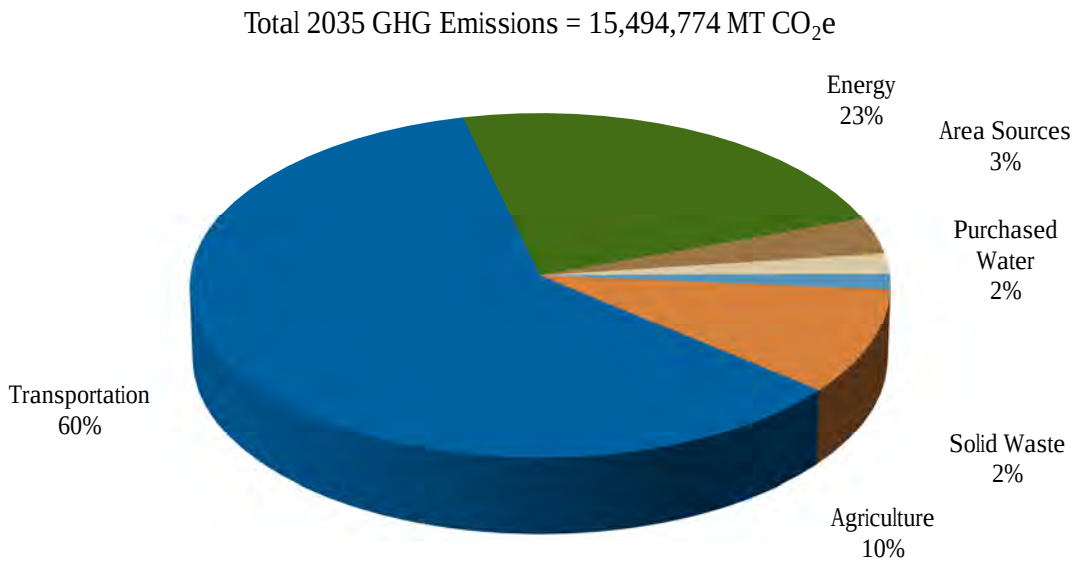
B. 2035 BAU Emissions by Source

The 2035 BAU emissions are estimated based on the projected growth in Riverside County from 2008 to 2035. These projections include a 92.6% increase in households and a 165.1% increase in employment; these growth rates were applied, respectively, to residential and non-residential 2008 emissions in order to estimate 2035 BSU emissions. Table 3-10 (2035 BAU GHG Emissions by Source) summarizes the net 2035 County emissions of CO_2e as broken down by emissions category. Figure 3-5 (2035 BAU GHG Emissions by Source) is a graphical representation of Table 3-10. A detailed breakdown of 2035 emissions by category is available in Appendix D of this CAP.

Table 3-10 2035 BAU GHG Emissions by Source

Category	Metric tons of CO_2e
Transportation	9,318,041
Energy	3,610,701
Areas	529,384
Purchased Water	293,077
Solid Waste	220,747
Agriculture	1,522,823
Total	**15,494,774**

Figure 3-5 2035 BAU GHG Emissions by Source



3.5 2020 Reduction Target

In order for California to meet the goals of AB 32, statewide GHG emissions will need to be reduced back to 1990 levels by 2020. To be consistent with the goals of AB 32, Riverside County would also need to achieve the same GHG emission reduction target. In the AB 32 Scoping Plan, CARB equated a return to 1990 levels to a 15% reduction from "current" levels. CARB states, "… ARB recommended a greenhouse gas reduction goal for local governments of 15 percent below today's levels by 2020 to ensure that their municipal and community-wide emissions match the state's reduction target" (CARB 2008). The reduction target calculated in the Scoping Plan was based on an inventory of the state's 2004 GHG emissions (then considered to be "current" levels); these emissions represent a high-point in the economy before the economic recession. Riverside County's reduction target is based on Riverside County's 2008 GHG emissions inventory.

Consistent with the State of California's adopted AB 32 GHG reduction target, Riverside County has set a goal to reduce GHG emissions back to 1990 levels by the year 2020. This target was calculated as a 15% decrease from 2008 levels, as recommended in the AB 32 Scoping Plan. The reduction target is displayed in Table 3-11 (2020 GHG Emissions Reduction Target). Having one overall reduction target, as opposed to targets for each sector, allows the County of Riverside the flexibility to reduce emissions from the sector with the most cost-effective reduction strategies (i.e., the greatest reduction in emissions at the least cost).

Table 3-11 2020 GHG Emissions Reduction Target

	Metric Tons CO_2e
2008 Emissions	7,012,938
% Reduction	15%
2020 Reduction Target	5,960,998

3.6 Emissions Comparison by Year

This report analyzes GHG emissions from the most current year with data available (2008) and estimates the future emissions for Riverside County in 2020 and 2035.

The 12.1 MMT CO_2e of GHG emissions for 2020 is an estimated increase of 5.1 MMT CO_2e above 2008 levels. The growth in emissions from 2008 to 2020 is a 73.0%. Table 3-12 (GHG Emissions by Source) shows a comparison of total emissions for 2008, 2020, and 2035 emissions.

Table 3-12 GHG Emissions by Source

Source	Metric Tons CO_2e		
	2008	2020 BAU	2035 BAU
Transportation	2,850,520	6,977,331	9,318,041
Energy	1,577,667	2,830,246	3,614,223
Area Sources	269,181	442,024	529,384
Purchased Water	152,473	175,344	293,077
Solid Waste	132,666	181,728	220,747
Agriculture*	2,030,431	1,522,823	1,522,823
Total	**7,012,938**	**12,129,497**	**15,494,774**

*Note that Agriculture is assumed to decline between 2008 and 2020 as development of the unincorporated Riverside County area continues and then remain the same between 2020 through 2035 as the County of Riverside increases density of developed areas in order to maintain the remaining open spaces and agricultural lands.

The AB 32 Scoping Plan suggests local governments estimate a reduction target for 2020 that is 15% below current emissions. Table 3-13 (2020 GHG Emissions Reduction Target) shows the 2020 reduction target for Riverside County's community-wide emissions, the 2020 emissions projected for Riverside County, and the difference between the two. This difference represents the total emissions that Riverside County will need to reduce in order to meet the target by 2020.

Table 3-13 2020 GHG Emissions Reduction Target

	Metric Tons CO_2e
2020 Emissions	12,129,497
2020 Reduction Target	5,960,998
Amount to Reduce by 2020	6,168,500

With the reduction target set at 5,960,998 MT CO_2e, the County of Riverside will need to reduce emissions by 6,168,500 MT CO_2e from the BAU 2020 emissions. Chapter 4 describes the efforts currently underway in Riverside County and the reduction strategies that would be implemented to reduce emissions in Riverside County in order to reach the 2020 reduction target.

SEJA Comment Letter-Attachment C-Page 203

Chapter 4

GHG Emissions Reduction Programs and Regulations

This page intentionally left blank

Chapter 4
GHG Emissions Reduction Programs and Regulations

The State of California has set specific targets for reducing GHG emissions from the burning of fossil fuels in both power plants and vehicles by adopting various regulations. In addition, state energy efficiency and renewable requirements provide another level of reductions. In order to provide credit to Riverside County for regulatory actions already taken or planned by the State of California, this CAP first evaluates the greenhouse gas reductions that will occur within Riverside County as a result of these actions. These will be identified in the CAP as R1 reduction measures. The R1 measures are included here to show all of the anticipated reduction strategies identified in the AB 32 Scoping Plan for implementation at the state level that will ultimately result in a reduction of GHG emissions at the county level. The R1 measures are not administered or enforced by Riverside County, but Riverside County - by describing them herein- substantiates the reductions applied in association with these statewide measures.

R2 and R3 reduction measures will be incorporated at the county level to provide additional reductions in GHG emissions. R2 measures are those measures that can be quantified to show the value of the reduction from the incorporation of those measures; the R2 measures correspond to the Implementation Measures (IM) included in Appendix N of the General Plan. R3 measures are measures that, although they provide a vehicle through which reductions in emissions will occur, cannot be quantified at this time. The R3 measures are supportive measures or methods of implementation for the R2 measures. A complete list of assumptions and reductions for each of the R1 and R2 measures is included in Appendix E of this CAP.

The following reduction measures are organized herein by source category (energy, solid waste, area source emissions, agriculture, transportation, and industrial) then by R1, R2, and R3 measure. The method to be used for numbering the mitigation measures will be to list the R designation (R1, R2, or R3) then an abbreviation of the source category, followed by the order number. So, R1-E1 is the first R1 measure within the energy category, R1-E2 is the second measure within the energy category, and so on. The source category abbreviations are as follows: T – transportation; E – energy; S – solid waste; L – area source (landscaping) emissions; W – purchased water; A – agriculture; and I – industrial.

4.1 Existing Riverside County General Plan Policies Related to GHG

Policies to reduce GHG emissions often overlap with policies addressing energy conservation, reduced automobile use, water conservation and many other issues. Riverside County has many General Plan policies that

help to reduce GHG emissions while targeting another policy applicable to Riverside County. Table 4-1 (General Plan Policies Related to Reducing GHG Emissions) below summarizes these General Plan policies.

Table 4-1 General Plan Policies Related to Reducing GHG Emissions

Sector	Element	Section	Policies
Energy Efficiency in Buildings	Land Use	Project Design	LU-4.1
	Multipurpose Open Space	Energy Conservation	OS-16.1 through OS-16.10
	Air Quality	Stationary Emissions	AQ-4.1, AQ-4.1, AQ-4.4
		Energy Efficiency and Conservation	AQ-5.1, AQ-5.2, AQ-5.4
Regional Agency Coordination	Land Use	Administration	LU-1.5
	Air Quality	Multi-Jurisdictional Cooperation	AQ-1.1 through AQ-1.4, AQ-1.7
Smart Growth	Land Use	Efficient Use of Land	LU-2.1
		Economic Development	LU-7.12
		Air Quality	LU-10.1
	Air Quality	Business Development	AQ-7.1, AQ-7.3
		Job-to-Housing Ratio	AQ-8.4 through AQ-8.9
Water Conservation	Land Use	Project Design	LU-4.1
	Circulation	Transportation System Landscaping	C-5.2
	Multipurpose Open Space	Water Conservation	OS-2.1 through OS-2.5
Reduce Automobile Use	Land Use	Efficient Use of Land	LU-2.1
		Project Design	LU-4.1
		Air Quality	LU-10.3, LU-10.4
		Circulation	LU-12.1, LU-12.3, LU-12.4
	Circulation	Planned Circulation Systems	C-1.2, C-1.7
		Pedestrian Facilities	C-4.1, C-4.9
		Transportation System Landscaping	C-5.2
		Public Transportation System	C-9.2
		Fixed Route Transit Service	C-11.2, C-11.4 through C-11.7
		Transit Oasis and Transit Centers	C-12.1 through C-12.3
		Passenger Rail	C-13.1 through C-13.3
		Bikeways	C-17.3, C-17.4
		Environmental Considerations	C-20.12
		Transportation Systems Management	C-21.1, C-21.9
	Multipurpose Open Space	Energy Conservation	OS-16.3, OS-16.8
	Air Quality	Mobile Pollution Sources	AQ-3.2, AQ-3.4
		Trip Reduction	AQ-10.1 through AQ-10.4
Renewable Energy/Alternative Fuel	Multipurpose Open Space	Renewable Energy	OS-10.1, OS-11.1 through OS-11.3, OS-12.1
	Air Quality	Transportation System Management Improvements	AQ-13.1
Reduce Waste	Air Quality	Energy Efficiency and Conservation	AQ-5.1

SEJA Comment Letter-Attachment C-Page 207

4.2 Transportation

A. R1 Transportation Measures

The following list of R1 transportation-related measures are those measures that California has identified in the AB 32 Scoping Plan that will result in emission reductions within Riverside County.

R1-T1: Assembly Bill 1493: Pavley I

Assembly Bill (AB) 1493 (Pavley) required CARB to adopt regulations that will reduce GHG from automobiles and light-duty trucks by 30% below 2002 levels by the year 2016, effective with 2009 models. By 2020, this requirement will reduce emissions in California by approximately 16.4 MMT of carbon dioxide equivalents ($MMTCO_2e$), representing 17.3% of emissions from passenger/light-duty vehicles in the State of California.

R1-T2: Assembly Bill 1493: Pavley II

California committed to further strengthening the AB1493 standards beginning in 2017 to obtain a 45% GHG reduction from 2020 model year vehicles. This requirement will reduce emissions in California by approximately 4.0 $MMTCO_2e$, representing 2.5% of emissions from passenger/light-duty vehicles in the State of California.

R1-T3: Executive Order S-1-07 (Low Carbon Fuel Standard)

The Low Carbon Fuel Standard (LCFS) will require a reduction of at least 10% in the carbon intensity of California's transportation fuels by 2020. By 2020, this requirement will reduce emissions in California by approximately 15 $MMTCO_2e$, representing 6.9% of emissions from passenger/light-duty vehicles in the State of California.

R1-T4: Tire Pressure Program

The AB32 early action measure involves actions to ensure that vehicle tire pressure is maintained to manufacturer specifications. By 2020, this requirement will reduce emissions in California by approximately 0.55 $MMTCO_2e$, representing 0.3% of emissions from passenger/light-duty vehicles in the State of California.

R1-T5: Low Rolling Resistance Tires

This AB32 early action measure would increase vehicle efficiency by creating an energy efficiency standard for automobile tires to reduce rolling resistance. By 2020, this requirement will reduce emissions in California by approximately 0.3 $MMTCO_2e$, representing 0.2% of emissions from passenger/light-duty vehicles in the State of California.

R1-T6: Low Friction Engine Oils

This AB32 early action measure would increase vehicle efficiency by mandating the use of engine oils that meet certain low friction specifications. By 2020, this requirement will reduce emissions in California by approximately 2.8 $MMTCO_2e$, representing 1.7% of emissions from passenger light-duty vehicles in the State of California.

R1-T7: Goods Movement Efficiency Measures

This AB32 early action measure targets system wide efficiency improvements in goods movement to achieve GHG reductions from reduced diesel combustion. By 2020, this requirement will reduce emissions in California by approximately 3.5 $MMTCO_2e$, representing 1.6% of emissions from all mobile sources (on-road and off-road) in the State of California.

R1-T8: Heavy-Duty Vehicle GHG Emission Reduction (Aerodynamic Efficiency)

This AB32 early action measure would increase heavy-duty vehicle (long-haul trucks) efficiency by requiring installation of best available technology and/or CARB approved technology to reduce aerodynamic drag and rolling resistance. By 2020, this requirement will reduce emissions in California by approximately 0.93 $MMTCO_2e$, representing 1.9% of emissions from heavy-duty vehicles in the State of California.

R1-T9: Medium and Heavy-Duty Vehicle Hybridization

The implementation approach for this AB 32 measure is to adopt a regulation and/or incentive program that reduces the GHG emissions of new trucks (parcel delivery trucks and vans, utility trucks, garbage trucks, transit buses, and other vocational work trucks) sold in California by replacing them with hybrids. By 2020, this requirement will reduce emissions in California by approximately 0.5 $MMTCO_2e$, representing 0.2% of emissions from all on-road mobile sources in the State of California. This reduction is also equivalent to a 1.0% reduction of emissions from all heavy-duty trucks in the State of California.

R1-T10: Regional SB 375 Targets

Regional transportation emission reduction targets have been established pursuant to SB 375. Statewide, this requirement is expected to reduce emissions by 5 $MMTCO_2e$, which is equivalent to 2% of emissions from all mobile emission sources. These emissions will be reduced through the implementation of Sustainable Community Strategies developed by the Metropolitan Planning Organizations (MPOs) throughout the state, SCAG for Riverside County. CARB, in conjunction with SCAG, has adopted a target of an 8% decrease in transportation emissions by 2020 for the region. The reductions from SB 375 overlap with many of the state transportation reduction measures described above. Therefore, this R1 measure is expected to reduce Riverside's transportation emissions by 6% (rather than the 8% target) beyond what the other state-level transportation measures will reduce.

B. R2 Transportation Measures

The following list of R2 measures are measures Riverside County can incorporate into the new development projects for the reduction of transportation-related emissions to achieve an AB 32 compliant reduction target.

SEJA Comment Letter-Attachment C-Page 209

R2-T1: Employment Based Trip and VMT Reduction

This R2 measure would implement General Plan Policies AQ 3.3, AQ 10.1, AQ 10.3, and AQ 10.4 through the adoption of a voluntary trip reduction program for new commercial and industrial development that promotes commuter choices, employer transportation management, guaranteed ride home programs and commuter assistance and outreach type programs intended to reduce commuter vehicle miles traveled. A guaranteed ride home program is a program that ensures employees that take advantage of carpooling opportunities are guaranteed a safe ride home should the employee miss the carpool pick-up time due to work-related activities. This could be as simple as the employer paying for taxi service for the employee. Surveys within California have shown that ridesharing increases by 5% when a guaranteed ride home program is available (FTA 2006). To gain points within the Screening Table, employers with more than 100 employees within unincorporated Riverside County would need to establish a trip reduction plan that would incorporate annual employee commute surveys, marketing of commute alternatives, ride matching assistance, and transit information at a minimum.

R2-T2: Increased Residential Density

Designing proposed projects with increased densities, where allowed by the General Plan and/or County zoning, could reduce GHG emissions associated with traffic in several ways. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. The reductions in GHG emissions are quantified based on reductions to VMT; the relationship between density and VMT is described by its elasticity. If a new development project demonstrates an increase is density (and hence a corresponding decrease VMT) beyond the average value for that particular land use type, then the project can garner points in the screening tables for new development. This strategy also provides a foundation for implementation of many other strategies which would benefit from increased densities. New development projects earn points for residential projects that increase housing density.

R2-T3: Mixed Use Development

Having different types of land uses near one another can decrease VMT since trips between land use types are shorter and may be accommodated by non-motorized methods of transportation. For example, when residential areas are in the same neighborhood as retail and office buildings, a resident does not need to travel outside of the neighborhood to meet his/her trips needs. A new development project will earn points in the screening tables by including diversity of land uses within a ¼ mile. Due to the variations available in implementing a mixed use project, the reductions, and applicable points associated, will be determined on a case-by-case basis.

R2-T4: Preferential Parking

This R2 measure would implement General Plan Policies AQ 3.3 and AQ 10.3 by encouraging proposed development projects to incorporate a comprehensive parking program for public and private parking lots to facilitate carpooling and alternate transportation. Incentives to encourage carpooling and the use of alternate transportation methods could include:

- Providing reserved preferential parking spaces for car-share, carpool, and ultra-low or zero emission vehicles;
- Provide larger parking spaces that can accommodate vans used for ride-sharing programs and reserve them for vanpools; and include adequate passenger waiting/loading areas;

- Restricting the number of parking spaces within the development by sharing parking among different land uses where feasible. For example, in areas where there are multiple land uses, provide resident restricted parking during nighttime hours (7pm to 7am) and open the parking lot for use by patrons of the surrounding commercial buildings during daytime hours; and
- Provide convenient pedestrian pathways through parking areas.

R2-T5: Roadway Improvements including Signal Synchronization and Transportation Flow Management

This R2 measure would implement General Plan Policies AQ 12.1 and AQ 12.3. Proposed development projects that pay fare-share fees toward signal synchronization improvements or construct signalized intersections within a traffic signal synchronization system would gain points within the Screening Table through this R2 Measure. These modifications include, but are not limited to, synchronization of signals, improvement of traffic flow, the development of parallel roadways and support for the extension of freight rail into Riverside County's industrial areas. Even when required for other reasons, such as warranted by project traffic study results, such circulation improvements may still qualify for Screening Table points under this measure.

R2-T6: Provide a Comprehensive System of Facilities for Non-motorized Transportation

This measure emphasizes alternative non-motorized transportation hubs and encourages the creation of bike lanes and walking paths connecting to schools and other public facilities, provision of adequate bicycle parking; and encouragement of bicycle stations, attended parking, and other attended bicycle support facilities at intermodal hubs. Bicycle stations are full-service bicycle facilities that, in addition to providing secure, guarded bicycle parking, could include other amenities such as "valet" bicycle service, showers, bicycle rentals, or repair services. These types of facilities are intended for large residential and non-residential development as well as large employers (e.g., of 500 or more employees). In addition, the establishment of multi-use trails that promote off-street bicycle and pedestrian travel, as well as provision of secure bicycle racks, along these pathways would also promote their use.

R2-T7: Expand Renewable Fuel/Low-Emission Vehicle Use

Implementation of the following R2 measure would promote the expanded use of renewable fuel and low-emission vehicles within proposed projects. The project will earn points in the screening table by making low-emissions or electric vehicle use more accessible by including one or both of the following project components:

- Providing preferential parking for ultra-low emission, zero-emission, and alternative-fuel vehicles;
- Provide circuit and capacity in all garages of residential units and all new large-scale commercial buildings, over 162,000 square feet for installation of electric vehicle charging stations
  - Install electric vehicle charging stations in all the garages of residential units for new development projects
  - Install electric vehicle charging stations in garages or secure areas of parking for new large-scale commercial buildings over 162,000 square feet of floor space.

SEJA Comment Letter-Attachment C-Page 211

R2-T8: Anti-Idling Enforcement

This R2 measure involves the adoption and enforcement of an Anti-Idling Policy for heavy-duty diesel trucks, including local delivery trucks and long-haul truck transport within unincorporated Riverside County. This policy would prohibit idling of on- and off-road heavy duty diesel vehicles for more than five minutes. This policy would be implemented by new commercial and industrial projects with loading docks or delivery trucks. Such projects would be required to post signage at all loading docks and/or delivery areas directing drivers to shut down their trucks after five minutes of idle time. Also, employers who own and operate truck fleets would be required to inform their drivers of the anti-idling policy.

R2-T9: Increase Public Transit

New development projects will expand the local transit network by coordinating with regional transit authorities to include bus turnouts and other transit accommodations in design plans. This will encourage the use of transit and therefore reduce VMT. Unincorporated Riverside County hosts one Metrolink transit station; expanding connections to this station as well as other Metrolink stations in the neighboring cities will increase ridership and decrease VMT.

R2-T10: Employee Commute Alternative Schedule

Encouraging telecommuting and alternative work schedules reduces the number of commute trips and therefore VMT traveled by employees. Alternative work schedules could take the form of staggered starting times, flexible schedules, or compressed work weeks. Employers are encouraged to offer enough flexibility for employees to adopt these alternative schedules.

C. R3 Transportation Measures

The following R3 measure enhances and ensures the reductions accounted for within the R2 measures through education programs or are measures that will reduce emissions but cannot be quantified.

R3-T1: Regional Land Use & Transportation Coordination

This R3 measure promotes the development and use of transit between the incorporated and unincorporated portions of Riverside County as well as within unincorporated Riverside County. This reduction measure will also be enhanced by the implementation of SCAG's RTP and SCS.

R3-T2: Government Fleet Alternative Vehicles

Riverside County municipal fleet consists of vehicles ranging from small passenger cars to large trucks and fire engines. As older vehicles retire, the new replacement vehicles will continue to increase the fuel efficiency of Riverside County's fleet. Riverside County's use of fuel efficient and alternative fuel vehicles helps to promote their use by local residents.

4.3 Energy

A. R1 Energy Measures

The following list of R1 building energy efficiency related measures are those measures that California has identified in the AB 32 Scoping Plan that will result in emission reductions within Riverside County.

R1-E1: Renewable Portfolio Standard for Building Energy Use

Senate Bills (SBs) 1075 (2002) and 107 (2006) created the State's Renewable Portfolio Standard (RPS), with an initial goal of 20% renewable energy production by 2010. Executive Order (EO) S-14-08 establishes a RPS target of 33% by the year 2020 and requires state agencies to take all appropriate actions to ensure the target is met. The 33% RPS by 2020 goal is supported by CARB, though its feasibility is not certain due to current limitations in production and transmission of renewable energy.

R1-E2 and R1-E3: AB1109 Energy Efficiency Standards for Lighting (Residential and Commercial Indoor and Outdoor Lighting)

Assembly Bill (AB1109) mandated that the California Energy Commission (CEC) on or before December 31, 2008, adopt energy efficiency standards for general purpose lighting. These regulations, combined with other state efforts, shall be structured to reduce statewide electricity consumption in the following ways:

- R1-E2: At least 50% reduction from 2007 levels for indoor residential lighting by 2018; and
- R1-E3: At least 25% reduction from 2007 levels for indoor commercial and outdoor lighting by 2018.

R1-E4: Electricity Energy Efficiency (AB32)

This measure captures the emission reductions associated with electricity energy efficiency activities included in CARB's AB32 Scoping Plan that are not attributed to other R1 or R2 reductions as described in this report. This measure includes energy efficiency measures that CARB views as crucial to meeting the statewide 2020 target, and will result in additional emissions reductions beyond those already accounted for in California's Energy Efficiency Standards for Residential and Non-Residential Buildings (Title 24, Part 6 of the California Code of Regulations; hereinafter referred to as, "Title 24 Energy Efficiency Standards"), Riverside County's adopted Green Building ordinance (effective January 1, 2011), etc. By 2020, this requirement will reduce emissions in California by approximately 21.3 $MMTCO_2e$, representing 17.5% of emissions from all electricity in the State of California. This measure includes the following strategies:

- "Zero Net Energy" buildings (buildings that combine energy efficiency and renewable generation so that they, based on an annual average, extract no energy from the grid);
- Broader standards for new types of appliances and for water efficiency;

SEJA Comment Letter-Attachment C-Page 213

- Improved compliance and enforcement of existing standards;
- Voluntary efficiency and green building targets beyond mandatory codes;
- Voluntary and mandatory whole-building retrofits for existing buildings;
- Innovative financing to overcome first-cost and split incentives for energy efficiency, on-site renewables, and high efficiency distributed generation;
- More aggressive utility programs to achieve long-term savings;
- Water system and water use efficiency and conservation measures;
- Additional industrial and agricultural efficiency initiatives; and
- Providing real time energy information technologies to help consumers conserve and optimize energy performance.

R1-E5: Natural Gas Energy Efficiency (AB32)

This measure captures the emission reductions associated with natural gas energy efficiency activities included in CARB's AB32 Scoping Plan that are not attributed to other R1 or R2 reductions, as described in this report. This measure includes energy efficiency measures that CARB views as crucial to meeting the statewide 2020 target, and will result in additional emissions reductions beyond those already accounted for in California's Energy Efficiency Standards for Residential and Non-Residential Buildings (Title 24, Part 6 of the California Code of Regulations; hereinafter referred to as, "Title 24 Energy Efficiency Standards"), Riverside County's adopted Green Building ordinance (effective January 1, 2011), etc. By 2020, this requirement will reduce emissions in California by approximately 4.3 $MMTCO_2e$, representing 6.2% of emissions from all natural gas combustion in the State of California. This measure includes the following strategies:

- "Zero Net Energy" buildings (buildings that combine energy efficiency and renewable generation so that they, based on an annual average, extract no energy from the grid);
- Broader standards for new types of appliances and for water efficiency;
- Improved compliance and enforcement of existing standards;
- Voluntary efficiency and green building targets beyond mandatory codes;
- Voluntary and mandatory whole-building retrofits for existing buildings;
- Innovative financing to overcome first-cost and split incentives for energy efficiency, on-site renewables, and high efficiency distributed generation;
- More aggressive utility programs to achieve long-term savings;
- Water system and water use efficiency and conservation measures;
- Additional industrial and agricultural efficiency initiatives; and
- Providing real time energy information technologies to help consumers conserve and optimize energy performance.

R1-E6: Increased Combined Heat and Power (AB32)

This measure captures the reduction in building electricity emissions associated with the increase of combined heat and power activities, as outlined in CARB's AB32 Scoping Plan. The Scoping Plan suggests that increased combined heat and power systems, which capture "waste heat" produced during power generation for local use, will offset 30,000 GWh statewide in 2020. Approaches to lowering market barriers include utility-provided incentive payments, a possible combined heat and power portfolio standard, transmission and distribution support systems, or the use of feed-in tariffs. By 2020, this requirement will reduce emissions in California by approximately 6.7 $MMTCO_2e$, representing 7.6% of emissions from all electricity in the State of California.

R1-E7: Industrial Efficiency Measures (AB32)

This measure captures the reduction in industrial building energy emissions associated with the energy efficiency measures for industrial sources included in CARB's AB32 Scoping Plan. By 2020, this requirement will reduce emissions in California by approximately 1.0 $MMTCO_2e$, representing 3.9% of emissions from all industrial natural gas combustion in the State of California. CARB proposes the following possible statewide measures:

- Oil and gas extraction;
- GHG leak reduction from oil and gas transmission;
- Refinery flare recovery process improvements; and
- Removal of methane exemption from existing refinery regulations.

R1-E8: Renewable Portfolio Standard (33 percent by 2020) Related to Water Supply and Conveyance

This measure would increase electricity production from eligible renewable power sources to 33% by 2020. A reduction in GHG emissions results from replacing natural gas-fired electricity production with zero GHG-emitting renewable sources of power. By 2020, this requirement will reduce emissions from electricity used for water supply and conveyance in California by approximately 21.3 $MMTCO_2e$, representing 15.2% of emissions from electricity generation (in-state and imports).

B. R2 Energy Measures

The following list of R2 measures are measures related to building energy efficiency Riverside County can incorporate into the new development projects are to achieve an AB 32 compliant reduction target of 15% below existing emissions levels by the year 2020.

R2-E1: Residential Energy Efficiency Program

This R2 measure would implement General Plan Policies AQ 5.2, AQ 5.4, LU 4.1e, OS 16.1 and OS 16.9, and involves the adoption of a program that facilitates energy efficient design for new residential buildings such that the residential units are 5% to 20% more efficient than the current Title 24 Standards. The high end of this energy efficiency program is equal to that of the LEED for Homes and ENERGY STAR programs; aspects of these programs are included as options for new development in the screening table, but attaining LEED or

SEJA Comment Letter-Attachment C-Page 215

ENERGY STAR certification is not an explicit requirement. The County of Riverside energy efficiency program is a voluntary program with a flexible menu of options for compliance included in the screening table.

The 2008 Title 24 Energy Standards were adopted by the Energy Commission in April 2008 and compliance with the 2008 standards went into effect January 1, 2010. In an effort to meet the overall goal of the California Energy Efficiency Strategic Plan of reaching zero net energy for residential buildings by 2020, the stringency of the Title 24 Energy Standards as regulated and required by the State of California will continue to increase every three years. As energy efficiency standards increase, Riverside County may want to periodically re-evaluate their percentage beyond Title 24 goal to ensure it is still a feasibly achievable goal. Residential developments within the unincorporated portions of Riverside County are encouraged to participate in the volunteer Residential Energy Efficiency Program. This voluntary program would set a minimum goal of achieving energy efficiency of 5% greater than current Title 24 Standards. Incentives to participate in this volunteer program include prioritization and streamlining of the application process for residential projects that achieve the minimum goal. Towards this end, Riverside County's screening tables for new development include a menu of options with points assigned to each option. As long as the proposed project meets the required point allotment (100 points total) the project will be deemed consistent with the Riverside County plan for reducing GHG emissions. This system will assure flexibility in the implementation of this reduction measure. This reduction goal can be achieved through the incorporation of the strategies outlined in the bullet points below, although the list is not exclusive and other actions are also feasible:

- Install energy efficient appliances, including air conditioning and heating units, dishwashers, water heaters, etc.;
- Install solar water heaters;
- Install energy conserving windows and insulation;
- Install energy efficient lighting;
- Optimize conditions for natural heating, cooling and lighting by building siting and orientation;
- Use features that incorporate natural ventilation;
- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes; and
- Incorporate skylights; reflective surfaces and natural shading in building design and layouts.

R2-E2: Residential Renewable Energy Program

This R2 measure would implement General Plan Policies OS 10.1, OS 11.2, and OS 11.3, and facilitate the voluntary incorporation of renewable energy (such as photovoltaic panels) into new residential developments. For participating developments, the use of onsite renewable energy should be sufficient to reduce the new home's projected use of grid energy by 50%.

The California Energy Commissions' New Solar Homes Partnership is a component of the California Solar Initiative and provides rebates to developers of 6 or more units where 50% of the units include solar power. In addition, this measure would encourage that all residents be equipped with "solar ready" features where feasible, to encourage future installation of solar energy systems. Such features would include the proper solar orientation (south facing roof sloped at 20° to 55° from the horizontal), clear access on south-sloped roofs, electrical conduit installed for solar electric system wiring, plumbing installed for solar hot water systems and space provided for a

solar hot water tank. The incentive program should provide enough incentives to result in approximately 50% of new residential development participation in this program, thereby resulting in a 25% reduction in electrical consumption from new residential developments.

As an alternative to, or in support of, providing onsite renewable energy, the project proponent could also buy into a purchased energy offset program through the South Coast Air Quality Management District (SCAQMD), Southern California Edison (SCE), Mission Energy or others that will allow for the purchase of electricity generated from renewable energy resources offsite. Purchased energy offsets (or a combination of incorporated renewables and purchased offsets) must be equal to 25% of the total projected energy consumption for the development.

R2-E3: Residential Retrofit Implementation Program

This R2 measure would implement General Plan Policies OS 16.5, OS 16.7, and OS 16.9 and initiate a Riverside County program that facilitates the incorporation of energy reduction measures for residential buildings undergoing major renovations. AB 811 is a potential funding source to Riverside County for implementing incentive programs to encourage residences within Riverside County to undertake energy efficiency retrofitting and reducing energy consumption in retrofitted homes by a minimum of 15%. As with the new development, residential retrofits will comply with a menu of options of points assigned to them. As long as a developer meets the required total point allotment (100 points) the developer will meet the requirements to have the project deemed consistent with this plan. This system will be provided to assure flexibility in the implementation of all reduction measures. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following:

- Replace inefficient air conditioning and heating units with new energy efficient models
- Replace older, inefficient appliances with new energy efficient models
- Replace old windows and insulation with top quality windows and insulation
- Install solar water heaters
- Replace inefficient and incandescent lighting with energy efficient lighting
- Weatherize the existing building to increase energy efficiency

R2-E4: Residential Renewable Retrofit Program

This R2 measure would implement General Plan Policies OS 10.1, OS 11.2, and OS 11.3 and initiate an incentive program that encourages residents to retrofit their homes with photovoltaic panels such that 50% of all of the home's electrical usage is offset. The CEC's Solar Initiative has incentives available to homeowners.

R2-E5: Commercial Energy Efficiency Program

This R2 measure would implement General Plan Policies AQ 5.2, AQ 5.4, LU 4.1e, OS 16.1 and OS 16.9, and involves the adoption of a Riverside County Program that facilitates the energy efficient design for new commercial buildings so that new commercial buildings are 5% to 20% more efficient than the current Title 24 Standards. The high end of this voluntary energy efficiency program is 10% greater than the minimum requirements of the LEED and ENERGY STAR programs. As energy efficiency standards increase, Riverside

SEJA Comment Letter-Attachment C-Page 217

County may want to periodically re-evaluate their percentage beyond Title 24 goal to ensure it is still a feasibly achievable goal.

Commercial developments within the unincorporated portions of Riverside County are encouraged to participate in the voluntary Commercial Energy Efficiency Program. This voluntary program would set a minimum goal of achieving energy efficiency of 5% greater than current Title 24 Standards. Incentives to participate in this volunteer program would include prioritization and streamlining of the application process for commercial projects that achieve the minimum goal. As described in R2-E1 above, the Riverside County screening tables provide all developers with a list of potentially feasible GHG reduction measures that reflect the current state of the regulatory environment. The menu of options have points assigned to them and as long as the proposed project meets the required point allotment (100 points) it will be deemed to be consistent with Riverside County's GHG reduction plan. This system will provide flexibility in the implementation of all reduction measures. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following:

- Install energy efficient appliances, including air conditioning and heating units, dishwashers, water heaters, etc.;
- Install solar water heaters;
- Install top quality windows and insulation;
- Install energy efficient lighting;
- Optimize conditions for natural heating, cooling and lighting by building siting and orientation;
- Use features that incorporate natural ventilation;
- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes; and
- Incorporate skylights, reflective surfaces and natural shading in building design and layouts.

R2-E6: Commercial/Industrial Renewable Energy Program

This R2 measure would implement General Plan Policies OS 10.1, OS 11.2 and OS 11.3, and facilitate the voluntary incorporation of onsite renewable (solar or other renewable) energy generation into the design and construction of new commercial, office and industrial development. A project can earn points in the screening table for renewable energy generation if it is incorporated such that a minimum of 20% of the proposed project's total energy needs are offset. In addition this measure would encourage all facilities be equipped with "solar ready" features where feasible, to facilitate future installation of solar energy systems. These features should include the proper solar orientation (south-facing roof sloped at 20˚ to 55˚ from the horizontal), clear access on south sloped roofs, electrical conduit installed for solar electric system wiring, plumbing installed for solar hot water systems and space provided for a solar hot water tank.

As an alternative to, or in support of, providing onsite renewable energy, the project proponent could buy into a purchased energy offset program through the South Coast Air Quality Management District (SCAQMD), Southern California Edison (SCE) or others that will allow for the purchase of electricity generated from renewable energy resources offsite. Purchased energy offsets (or a combination of incorporated renewables and purchased offsets) should equal 20% of the total projected energy consumption for the development.

R2-E7: Commercial/Industrial Retrofit Program

This R2 measure would implement General Plan Policies AQ 5.2, AQ 5.4, OS 16.1, OS 16.7 and OS 16.9 and encourage all commercial or industrial buildings undergoing major renovations to reduce their energy consumption by a minimum of 20%. As with the new development, a menu of options will be provided to assure flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following energy efficiency and renewable energy technologies:

- Replace inefficient air conditioning and heating units with new energy efficient models
- Replace older, inefficient appliances with new energy efficient models
- Replace old windows and insulation with top-quality windows and insulation
- Install solar water heaters
- Replace inefficient and incandescent lighting with energy efficient lighting
- Weatherize the existing building to increase energy efficiency
- Install solar panels

R2-E8: Induction Streetlight Retrofits

New induction street lamps are estimated to last five times longer and consume 50% less energy than the traditional high pressure sodium (HPS) lamps. Changing out old lamps for new ones reduces electricity use and saves money in the long-run. Retrofitting streetlights shall be done in accordance with Riverside County's Mt. Palomar Lighting Ordinance, which requires use of low pressure sodium vapor (LPSV) street lighting within 15 miles of Mt. Palomar Observatory and Riverside County Ordinance No. 915 regulating light pollution countywide.

R2-E9: Increase Gas to Energy Production from Landfills

This R2 measure would implement General Plan Policies OS-10.1, OS-11.1 through OS-11.3 and OS-12 by increasing Riverside County's generation of electricity from waste-generated methane. Currently, the Badlands Landfill operates a 1.3 MW generation facility with a capacity for approximately 8,200 mWh annual generation. The El Sobrante Landfill currently operates a 3.8 MW generation facility with a capacity for generating 24,000 mWh annually. Under this measure, Riverside County will increase gas-to-energy generation by: (1) increasing the capacity at the Badlands to a 4 MW system and increasing operation to 90% by 2020; (2) increasing the El Sobrante's facility operation to 90%; and (3) installing a 1.3 MW system at the Lamb Canyon Landfill and having that facility in operation 90% of the year.

C. R3 Energy Measures

The following R3 measures enhance and/or ensure the reductions accounted for within the R2 measures through education programs or are measures that will reduce emissions but cannot be quantified.

R3-E1: Energy Efficient Development, and Renewable Energy Deployment Facilitation and Streamlining

This measure would encourage Riverside County to identify and remove regulatory and procedural barriers to the implementation of green building practices and the incorporation of renewable energy systems. This includes the General Plan Energy Element Policies. Implementation of the Energy Element Policies includes updating of codes and zoning requirements and guidelines among others to facilitate renewable energy deployment and streamlining. This measure could be further enhanced by providing incentives for energy efficient projects such as priority in the reviewing, permitting and inspection process. Additional incentives could include permit streamlining and CEQA streamlining in exchange for incorporating green building practices or renewable energy systems.

R3-E2: Energy Efficiency Training & Public Education

This measure would provide public education and publicity about energy efficiency measures and reduction programs available within Riverside County, including rebates and incentives available for residences and businesses. In addition, this measure would provide training in green building materials, techniques, and practices for all plan review and building inspection staff.

R3-E3: Energy Efficiency and Solar Energy Financing

This measure would facilitate the incorporation of innovative, grant funded or low-interest financing programs for energy efficiency and renewable energy projects for both existing and new developments. This would include financing for heating, ventilation, air conditioning, lighting, water heating equipment, insulation, weatherization and residential and commercial renewable energy. A few potential options for funding this measure include:

- Use the money from offset purchases to provide grants to allow for the offset of some of the cost to existing residents in making energy efficiency upgrades.
- Target local funds to assist affordable housing developers to incorporate renewable energy sources and energy efficiency design features into low-income housing during development or through retrofit programs.
- Establish a Finance District, approve a bond purchase, and administer agreements to allow property owners to implement energy efficiency retrofits or designs and/or install renewable systems. Under this provision, repayment could be incorporated as a special tax on the property owner's property tax bill.
- Funding of other incentives to encourage the use of renewable energy sources and energy efficient equipment and lighting.

R3-E4: Cross-Jurisdictional Coordination

Under this reduction measure, Riverside County would coordinate with other local governments, special districts, nonprofit, and other organizations in order to optimize energy efficiency and renewable resource development and usage throughout Riverside County. This would allow for economies of scale and shared resources to more effectively implement these environmental enhancements.

4.4 Area Source Emissions

Area source emissions make up a small portion of Riverside County's total emissions; however, the following reduction measures can contribute toward reducing emissions in order to meet the AB 32 2020 reduction target. No statewide measures are related to area source emissions; however, the R2 measures are from the SCAQMD.

A. R2 Area Source Measures

R2-L1: Electric Landscaping Equipment

This measure reduces GHG emissions by substituting electric landscaping equipment for the traditional gas-powered equipment. Electric lawn equipment including lawn mowers, leaf blowers and vacuums, shredders, trimmers, and chain saws are available. When electric landscaping equipment is used in place of conventional equipment, direct GHG emissions from natural gas combustion are replaced with indirect GHG emissions associated with the electricity used to power the equipment. In the Screening Tables for New Development, projects would be able to earn points for including accessible outdoor outlets in the project design.

R2-L2 & R2-L3: SCAQMD Healthy Hearths

AQMD's Rule 445-Wood Burning Devices, adopted on March 7, 2008, applies to residents in the South Coast Air Basin and includes the following key components:

- R2-L2: No permanently installed indoor or outdoor wood burning devices in new developments;
- R2-L3: Establishes a mandatory wood burning curtailment program on high pollution days during November through February, beginning November 1, 2011. Based on current air quality conditions, there may be 10 to 25 mandatory curtailment days in specific areas (AQMD 2008).

B. R3 Area Source Measures

The following R3 measures are related to landscape strategies that will help reduce GHG emissions and can be incorporated into development projects without additional cost. These measures strategically place trees and other landscape mechanisms that create shade to reduce the heat island effect within parking lots and adjacent to buildings, which in turn, reduces the temperature of buildings and cars during the summer.

R3-L1: Expand County Tree Planting

This program evaluates the feasibility of expanding tree planting within Riverside County. This includes the evaluation of potential carbon sequestration from different tree species, potential reductions of building energy use from shading and GHG emissions associated with pumping water used for irrigation. Commercial and retail development should be encouraged to exceed shading requirements by a minimum of 10% and to plant low emission trees. All future development would be encouraged to preserve native trees and vegetation to the furthest extent possible.

SEJA Comment Letter-Attachment C-Page 221

R3-L2: Heat Island Plan

The implementation of this measure would include promoting the use of cool roofs, cool pavements, and parking lot shading to the entire County of Riverside by increasing the number of strategically placed shade trees. Further, Riverside County Design Guidelines should be amended to include that all new developments and major renovations (additions of 25,000 square feet or more) would be encouraged to incorporate the following strategies such that heat gain would be reduced for 50% of the non-roof impervious site landscape (including parking, roads, sidewalks, courtyards and driveways). The strategies include:

- Strategically placed shade trees;
- Paving materials with a Solar Reflective Index (SRI) of at least 29;
- Open grid pavement system; or
- Covered parking (with shade or cover having an SRI of at least 29).

4.5 Purchased Water

The purchased water imported from the State Water Project or from the Colorado River uses a large amount of energy for transportation. The following measures help to reduce the need for imported water and, therefore, reduce GHG emissions from the energy associated with water.

A. R1 Water Measures

R1-W1: Renewable Portfolio Standard Related to Water Supply and Conveyance

This measure would increase electricity production from eligible renewable power sources to 33% by 2020. A reduction in GHG emissions results from replacing natural gas-fired electricity production with zero GHG-emitting renewable sources of power. By 2020, this requirement will reduce emissions from electricity used for water supply and conveyance in California by approximately 21.3 MMT CO_2e, representing 15.2% of emissions from electricity generation (in-state and imports).

B. R2 Water Measures

R2-W1: Water Use Reduction Initiative

This initiative would reduce emissions associated with electricity consumption for water treatment and transportation. This measure encourages Riverside County to adopt a per capita water use reduction goal in support of the Governor's Executive Order S-14-08 which mandates the reduction of water use of 20% per capita. Riverside County's adoption of a water use reduction goal would introduce requirements for new development and would provide cooperative support for water purveyors that are required to implement these reductions for existing developments. Riverside County would also provide internal reduction measures such that

County of Riverside facilities will support this reduction requirement. New development projects will be able to earn points in the Screening Tables for New Development by incorporating design features that reduce water use.

In addition, this R2 measure would implement General Plan Policies LU 4.1d and f, C 5.2 and OS 2.1 through OS 2.4 and provide incentives for all new proposed development projects to comply with the California Green Building Standards Code. Under the California Green Building Code, new developments are required to reduce indoor potable water use by 20% beyond the Energy Policy Act of 1992 fixture performance requirements, and to reduce outdoor potable water use by 50% from a mid-summer baseline average consumption through irrigation efficiency, native plant selection, the use of recycled water and/or captured rainwater, for example. The state is dependent upon local water purveyors and jurisdictions to implement these new requirements. This R2 measure is provided here to enable its implementation and ensure points are allocated from the Screening Tables in accordance with the resultant benefits.

R2-W2: Increase Reclaimed Water Use

California water supplies come from a variety of sources including groundwater, surface water and reservoirs. For Southern California in particular, much of the water is transported over long distances, which can require a substantial amount of electricity. Recycled, or reclaimed, water is water reused after wastewater treatment for non-potable uses instead of returning the water to the environment. Since less energy is required to provide reclaimed water, fewer GHG emissions are associated with reclaimed water use compared to the average California water supply use. The Screening Table would allow new development to achieve points by including the use of recycled water.

4.6 Solid Waste

A. R1 Solid Waste Measure

The following R1 solid waste related measure is a measure that California has identified in the AB 32 Scoping Plan that will result in emission reductions within Riverside County.

R1-S1: Solid Waste Measures

The CARB Scoping Plan recommends three measures for reducing emissions from Municipal Solid Waste at the state level, including: 1) landfill methane control; 2) increase the efficiency of landfill methane capture; and 3) high recycling/zero waste. CARB is in the process of developing a discrete early action program for methane recovery (1), which was adopted in early 2010. This measure is expected to result in a 1.0 MMT CO_2e reduction by 2020. Other measures proposed by CARB include increasing efficiency of landfill methane capture (2) and instituting high recycling/zero waste policies (3). Potential reductions associated with these measures are still to be determined. CARB estimates a preliminary one-time cost for adoption of these measures to be approximately $70 per ton of CO_2 reduced.

SEJA Comment Letter-Attachment C-Page 223

B. R2 Solid Waste Measures

The following list of R2 measures are candidate measures Riverside County can incorporate into the development review process related to solid waste to achieve an AB 32 compliant reduction target.

R2-S1: County Diversion Program

This R2 measure would implement General Plan Policy AQ 4.1 and AQ 5.1 through a countywide waste diversion plan to further exceed the state requirements by diverting 75% of all waste from landfills by 2020. The following is a potential list of waste reduction measures that can be incorporated into development projects that will further strengthen existing waste reduction/diversion programs:

- Encourage commercial, office, and industrial development to adopt a voluntary procurement standard and prioritize those products that have less packaging, are reusable, recyclable, or compostable;
- Include recycling and green waste collection infrastructure (assigned areas with separate designated bens for each type of recycled material) within residential, commercial, and industrial development;
- Require a minimum of 15% of materials used in construction be sourced locally, as feasible; and
- Encourage the use of recycled building materials and cement substitutes for new developments.

R2-S2: Construction Diversion Program

This R2 measure also implements General Plan Policies AQ 4.1 and AQ 5.1 by giving incentives through points within the Screening Table to new development projects that provide diversion of 60% of construction waste. This provides a 10% increase in diversion beyond the AB 2176, Section 42911, requirement that dictates that development projects provide adequate areas for collecting and loading recyclable materials and requires a 50% diversion rate prior to being issued a building permit.

C. R3 Solid Waste Measures

The following R3 measures enhance and/or ensure the reductions accounted for within the R2 measures through education programs that help participation and compliance of the R2 measures identified above.

R3-S1: Encourage Increased Efficiency of the Gas to Energy System at Landfills.

This R3 measure would encourage the landfills operated by Riverside County Waste Management to keep current with upgrades in efficiencies to landfill gas capture and gas to energy systems and to upgrade as feasible when significant increases in conversion efficiencies are available.

R3-S2: Waste Education Program

This R3 measure would provide countywide public education and increased publicity about commercial and residential recycling. This measure would educate the public about waste reduction options available at both

residential and commercial levels, including composting, grass recycling, waste prevention and available recycling services.

R3-S2: On-Site Diversion and Conversion at County Landfills

This R3 measure would upgrade existing active Riverside County landfills to an integrated waste management operation that includes onsite recycling and reuse, in-situ composting, alternative landfill technology, such as bioreactor, as well as, waste conversion technologies, such as Anaerobic Digestion, Gasification, Pyrolysis, Hydrolysis, etc. Besides the direct benefits of fugitive LFG emission reductions and energy conversion, this landfill-based integrated waste management approach will have the additional environmental benefits of reducing regional VMT from waste material hauling and using existing permitted solid waste facilities equipped with compliant environmental protection systems.

4.7 Agriculture

A. R1 Agriculture Measure

The following R1 agriculture-related measure is a measure that California has identified in the AB 32 Scoping Plan that will result in emission reductions within Riverside County.

R1-A1: Methane Capture at Large Dairies

This is an AB 32 voluntary measure to encourage the installation of methane digesters to capture methane emissions at large dairies. By 2020, this requirement will reduce emissions in California by approximately one MMT CO_2e, representing 7.8% of CH_4 and N_2O emissions from manure management and enteric fermentation at dairies in the State of California.

B. R2 Agriculture Measures

Agriculture is an important, but separate, economic sector from new development projects within Riverside County. Because of the difference between agricultural activities and new residential, commercial and industrial development within Riverside County, IMs for agricultural source emissions are not recommended at this time.

C. R3 Agriculture Measure

The following R3 measure enhances and/or insures the reductions accounted for within the R2 measures through education programs that help participation and compliance of the R2 measures identified above.

R3-A1: Promote Soil Management Practices

Under this reduction measure, Riverside County would promote soil management practices that reduce nitrogen dioxide emissions through strategies such as fertilizer management, nitrification inhibitors, water management, and efficient use of fossil fuels.

SEJA Comment Letter-Attachment C-Page 225

4.8 Industrial

The following list of R1 industrial related measures are those measures that CARB has identified in the AB 32 Scoping Plan that will result in emission reductions within Riverside County. This section describes GHG emission reductions for the existing and proposed national, state, or regional industrial fuel combustion measures that will result in future GHG reductions for the industrial sector and do not require significant county action.

A. R1 Industrial Measures

R1-I1: Oil and Gas Extraction Combustion Related GHG Emission Reduction

This AB 32 measure would reduce combustion emissions from oil and gas extraction. By 2020, this requirement will reduce emissions in California by approximately 1.8 MMT CO_2e, representing 13% of combustion emissions from oil and gas extraction in the State of California.

R1-I2: Stationary Internal Combustion Engine Electrification

This AB 32 measure would affect owners and operators of industrial and commercial engines over 50 horsepower used as primary power sources by replacing internal combustion engines with electric motors. By 2020, this requirement will reduce emissions in California by approximately 0.3 MMT CO_2e, representing 0.5% of combustion emissions from industrial sources (non-coal) in the State of California.

B. R2 Industrial Measures

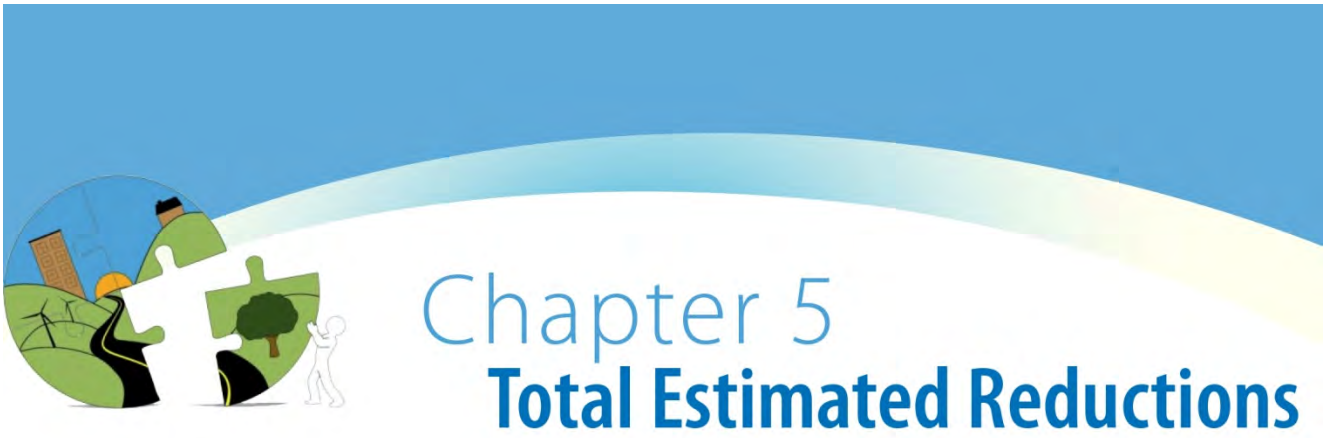
Industrial point source emitters of GHGs are required to comply with Title V Permits under the federal Clean Air Act. As such, these types of emissions are not under the jurisdiction of Riverside County and, hence, no IMs were developed or are proposed for point source emitters. Other types of industrial emissions (mobile source, energy, etc.) are reduced through R1 measures and the measures described throughout this document.

This page intentionally left blank.

Chapter 5

Total Estimated Reductions

This page intentionally left blank



Chapter 5
Total Estimated Reductions

In 2020, Riverside County is projected to emit a total of 12,129,497 MT CO_2e without the incorporation of reduction measures. With implementation of the reduction measures discussed in Chapter 4, Riverside County emissions for 2020 would be reduced to 5,534,113 MT CO_2e. The statewide reduction measures (the R1 Measures in Chapter 4) would reduce close to half of Riverside County's emissions and make a substantial contribution toward reaching the 2020 reduction target. However, Riverside County would need to supplement the state measures with the implementation of the local implementation measures (IM measures) discussed in Chapter 4.

5.1 Reductions from Statewide Measures

The following tables summarize the GHG reductions afforded to Riverside County from the implementation of the statewide R1 reduction measures. Table 5-1 (Statewide Measures and Associated Emissions Reduced from the 2020 Inventory) shows the annual MT CO_2e and the corresponding percent of emissions reduced for each of the R1 statewide measures described in Chapter 4 during the year 2020. Note that some R1 measures are not quantifiable and are not included in Table 5-1.

Table 5-1 Statewide Measures and Associated Emissions Reduced from the 2020 Inventory

Transportation	MT CO_2e Reduced	% of Transportation Emissions
R1-T1 & R1-T2: Pavley Vehicle Efficiency*	257,519	3.7%
R1-T3: Low Carbon Fuel Standard	188,757	2.7%
R1-T4: Tire Pressure	14,167	0.2%
R1-T5: Low Rolling Resistance Tires	9,417	0.1%
R1-T6: Low Friction Oils	80,248	1.2%
R1-T7: Goods Movement Efficiency	35,394	0.5%
R1-T8: Aerodynamic Efficiency	41,357	0.6%
R1-T9: Medium/Heavy Duty Hybridization	30,634	0.4%
R1-T10: Regional SB 375 Targets	404,697	5.8%
Transportation Total	**1,062,190**	15.2%
Energy	**MT CO_2e Reduced**	**% of Energy Emissions**
R1-E1: RPS – 33% Renewable by 2020	365,239	12.9%
R1-E2 & R1-E3: Lighting	161,400	5.7%
R1-E4: Electrical Energy Efficiency	127,288	4.5%
R1-E5: Natural Gas Energy Efficiency	24,631	0.9%
R1-E6: Increased Combined Heat and Power	96,397	3.4%
R1-E7: Industrial Efficiency	80,180	2.8%
Energy Total	**855,135**	**30.2%**
Purchased Water	**MT CO_2e Reduced**	**% of Water Emissions**
R1-W1: RPS – 33% Renewable by 2020	33,315	19.0%
Purchased Water Total	**33,315**	**19.0%**

Agriculture	MT CO_2e Reduced	% of Agriculture Emissions
R1-A1: Methane Capture at Dairies	15,604	1.0%
Agriculture Total	**15,604**	**1.0%**
Total Reductions	**1,966,245**	16.2%

* Because Pavely I and Pavely II work in tandem for total reductions and would not have equivalent reductions if implemented independently of one another, they are shown together in this table

Table 5-2 (Statewide Reduction Summary for 2020 Inventory) compares the 2020 inventory (without the incorporation of any reduction measures) to the community-wide emissions with the statewide reductions. As shown in the table, the statewide reduction measures would reduce 16.2% of Riverside County's total community wide annual emissions by the year 2020.

Table 5-2 Statewide Reduction Summary for 2020 Inventory

	2020 BAU MT CO_2e	State Reductions MT CO_2e	2020 Reduced MT CO_2e	% Reduction
Transportation	6,977,331	1,062,190	5,915,141	15.2%
Energy	2,830,246	855,135	1,975,111	30.2%
Area Sources	442,024	0	442,024	0.0%
Purchased Water	175,344	33,315	142,029	19.0%
Solid Waste	181,728	0	181,728	0.0%
Agriculture	1,522,823	15,604	1,507,220	1.0%
Total	12,129,497	**1,966,245**	**10,163,253**	16.2%

Although the statewide measures would significantly reduce Riverside County's emissions, they would not be enough to reach the established 2020 reduction target. Riverside County's reduction target was calculated as 15% below 2008 levels, which equates to 5,960,998 MT CO_2e. The statewide reduction measures would bring Riverside County down to 10,163,253 MT CO_2e, which leaves 4,202,255 MT CO_2e to be reduced by measures implemented at the community level, see Table 5-3 (Comparison to Reduction Target).

Table 5-3 Comparison to Reduction Target

	MT CO_2e
2020 with State Reductions	10,163,253
2020 Reduction Target	5,960,988
Amount left to Reduce	**4,202,255**

The measures described in Chapter 4 would be implemented to reduce the remaining 4,202,255 MT CO_2e in order to reach the 2020 reduction target for Riverside County. The 2020 Reduction Target is an estimated 50.9% below the 2020 inventory. The statewide reduction measures work to reduce Riverside County's emissions by 16.2% from the 2020 inventory, as shown in Table 5-4 (Percentage Reduction from 2020 Inventory).

Table 5-4 Percentage Reduction from 2020 Inventory

	% from 2020 Inventory
2020 Reduction Target	50.9%
State Reduction Measures	16.2%
Amount left to Reduce	**34.7%**

The remaining 34.7% of emissions would be reduced through the implementation of the measures described in Chapter 4. Measures include several categories of reductions: the energy-efficiency measures that Riverside County has incorporated since 2008; measures that implement policies included in the proposed General Plan Update; and additional measures that applicants could include as part of their project when filling out the Screening Tables.

5.2 Reductions from Implementation Measures

The IMs discussed in Chapter 4 would be implemented primarily through the Screening Tables for New Development and with General Plan policies. The measures go beyond the state measures to reduce GHG emissions in order to meet the 2020 reduction target. Table 5-5 (R2 Measures and Associated Emissions reduced from 2020 Inventory) summarizes the MT CO_2e and the corresponding percentage of emissions reduced for each of the R2 measures.

Table 5-5 R2 Measures and Associated Emissions Reduced from 2020 Inventory

Transportation	MT CO_2e Reduced	% of Transportation Emissions
R2-T1: Employment Based Trip and VMT Reduction	870,619	12.5%
R2-T2: Increased Residential Density	470,134	6.7%
R2-T3: Mixed Use Development	451,851	6.5%
R2-T4: Preferential Parking	15,293	0.2%
R2-T5: Roadway Improvements – Signals, Flow	304,019	4.4%
R2-T6: Non-Motorized Transportation Facilities	328,333	4.7%
R2-T7: Expand Alternative Fuel Vehicle Use	451,928	6.5%
R2-T8: Anti-Idling Enforcement	71,736	1.0%
R2-T9: Increase Public Transit	382,918	5.5%
R2-T10: Employee Commute Alternative Schedules	114,277	1.6%
Transportation Total	**3,461,109**	49.6%
Energy	**MT CO_2e Reduced**	**% of Energy Emissions**
R2-E1: Residential Energy Efficiency Program	72,480	2.6%
R2-E2: Residential Renewable Energy Program	108,728	3.8%
R2-E3: Residential Retrofit Implementation Program	70,365	2.5%
R2-E4: Residential Renewable Retrofit Program	83,026	2.9%
R2-E5: Commercial Energy Efficiency Program	182,796	6.4%
R2-E6: Commercial/Industrial Renewable Program	261,923	9.3%
R2-E7: Commercial/Industrial Retrofit Program	25,948	0.9%
R2-E8: Induction Streetlight Retrofits	12,793	0.5%
R2-E9: Increase Gas-To-Energy Production	15,672	0.6%
Energy Total	**833,731**	29.5%
Area Source	**MT CO_2e Reduced**	**% of Area Source Emissions**
R2-L1: Electric Landscape Equipment	123,959	28.0%
R2-L2: No New Wood-burning Devices	75,241	17.0%
R2-L3: Mandatory Curtailment Days	12,637	2.9%
Area Source Total	**211,837**	47.9%
Water	**MT CO_2e Reduced**	**% of Water Emissions**
R2-W1: Water Use Reduction Initiative	28,406	16.2%
R2-W2: Increase Reclaimed Water Use	4,602	2.6%
Water Total	**33,007**	**18.8%**
Solid Waste	**MT CO_2e Reduced**	**% of Solid Waste Emissions**
R2-W1: County Diversion Program	82,371	45.3%
R2-W2: Construction Diversion Program	7,058	3.9%
Solid Waste Total	**89,455**	49.2%
Total Reductions	**4,629,410**	38.2%

With the statewide reduction measures and the implementation of the IMs, Riverside County would reduce its community-wide emissions to a level below the established 2020 reduction target. Table 5-6 (IM Reduction Summary for 2020 Inventory) summarizes the 2020 inventory emissions, the GHG reductions associated with the statewide and IMs, and the reduced 2020 emissions.

Table 5-6 IM Reduction Summary for 2020 Inventory

	2020 MT CO_2e	State Reductions MT CO_2e	IM Reductions MT CO_2e	Reduced 2020 MT CO_2e	% Reduction
Transportation	6,977,331	1,062,190	3,461,109	2,454,032	64.8%
Energy	2,830,246	855,135	833,731	1,141,380	59.7%
Area Sources	442,024	0	211,837	230,188	47.9%
Purchased Water	175,344	33,315	33,007	109,021	37.8%
Solid Waste	181,728	0	89,455	92,273	49.2%
Agriculture	1,522,823	15,604	0	1,507,220	1.0%
TOTAL	**12,129,497**	**1,966,245**	**4,629,140**	**5,534,113**	**54.4%**

5.3 Reduced 2020 Community-Wide Emissions Inventory

With the implementation of GHG reduction measures, Riverside County is projected to reduce its emissions to a total of 5,534,113 MT CO_2e, which is 426,884 MT CO_2e below the 2020 reduction target. This is a decrease of 54.4% from Riverside County's 2020 BAU emissions inventory and 15% from the 2008 emissions. The reduction measures reduce GHG emissions from all sources of community-wide GHG emissions including transportation, energy, area sources, water, solid waste and agriculture. The following section describes the reduced emissions by source for the year 2020.

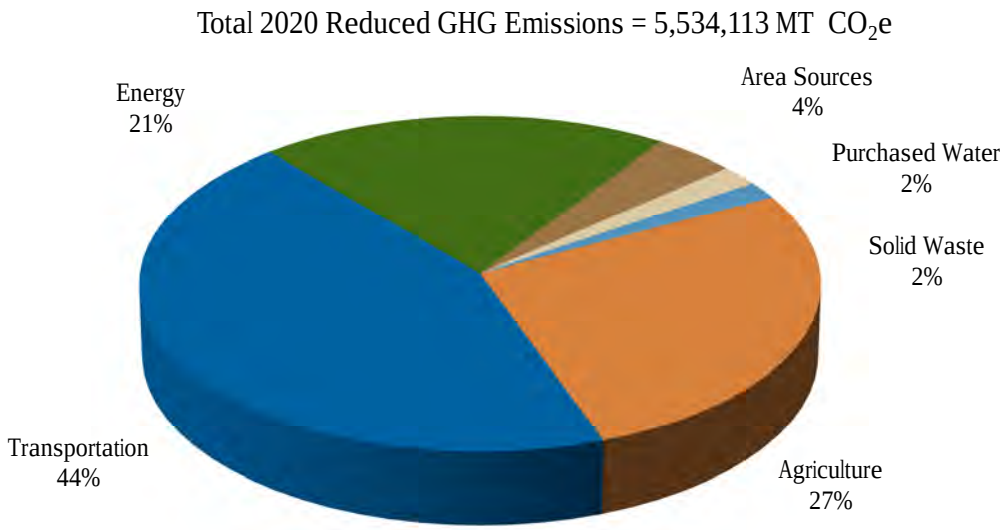
A. Emissions by Source

The emissions by source for the reduced 2020 inventory were calculated by applying a percent reduction to the 2020 emissions for each reduction measure. Table 5-7 (Reduced 2020 GHG Emissions by Source) summarizes the reduced 2020 County emissions of CO_2e as broken down by emissions category. Figure 5-1 (Reduced 2020 GHG Emissions Generated by Source) is a graphical representation of Table 5-7. A detailed breakdown of reduced 2020 emissions by category is available in Appendix D of this CAP.

Table 5-7 Reduced 2020 GHG Emissions by Source

Category	Metric tons of CO_2e
Transportation	2,454,032
Energy	1,141,380
Area Sources	230,188
Purchased Water	109,021
Solid Waste	92,273
Agriculture	1,507,220
Total	**5,534,113**

Figure 5-1 Reduced 2020 GHG Emissions Generated by Source



5.4 Reduced 2035 Community-Wide Emissions Inventory

Beyond 2035, Riverside County's GHG emissions would reduce with the continued implementation of the 2020 reduction strategies, expansion of the transit system according to the forthcoming SCAG RTP, and increased stringency of state reduction measures. In addition to the 2020 reduction measures, the following assumptions were included in the reduced 2035 GHG emissions:

- Pavley vehicle efficiency standards would continue beyond 2035 at a similar rate.
- The low carbon fuel standard would increase from 10% to 12%.
- Continued expansion of medium and heavy duty vehicle hybridization.
- Expanded SB 375 target with SCAG RTP/SCS implementation.
- 0.4% reduction in transportation emissions associated with CA High Speed Rail project.
- 30% increase in residential density post 2020.
- 10% increase in mixed use development post 2020.
- Expanded preferential parking programs.
- Expanded signal synchronization and traffic flow management programs.
- 60% increase in facilities for bicycle and pedestrian transportation post 2020.
- Double the number of electric vehicles post 2020.

- Expanded transportation network post 2020.
- Increased percent of RPS to 39% by 2035.
- Continued regulations for energy efficient lighting.
- Increased electrical and natural gas energy efficiency post 2020.
- Expanded combined heat and power systems.
- Increased industrial efficiency by 60% post 2020.
- New homes achieve energy efficiency 25% beyond current Title 24.
- 65% participation of new home with renewable energy systems.
- 50% of existing homes undergo energy efficiency and/or renewable energy retrofits.
- 25% of new commercial development installs renewable energy systems.
- 60% of existing commercial developments undergo energy efficiency retrofits.
- Water conservation expands to 30%.
- Reclaimed water use increases to 10%.
- Construction waste diversion doubles post 2020.
- Methane capture at dairies doubles post 2020.

With the continued implementation of the Screening Tables for New Development and predicted future developments at the state level, Riverside County's 2035 emissions would be reduced down to a total GHG emissions inventory of approximately 5,937,658 MT CO_2e, this represents a 61.7% decrease from the 2035 BAU emissions inventory and is below the 2020 reduction target. The assumptions described above represent one possible scenario for achieving reductions beyond 2020. Future inventory updates, monitoring of reduction measures, and updating policies will be necessary to create a successful post 2020 plan.

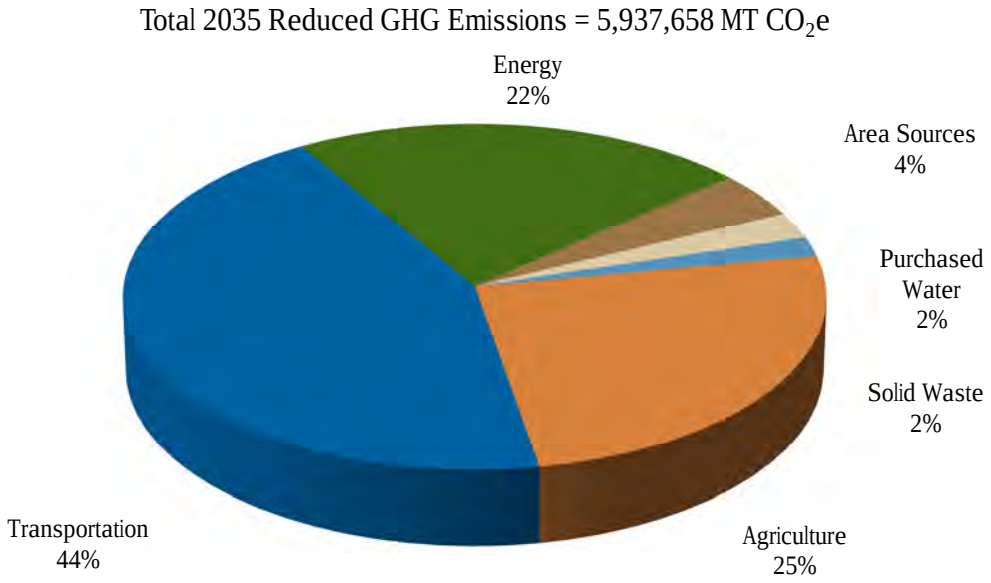
A. Emissions by Source

The emissions by source for the 2035 reduced inventory were calculated by applying a percent reduction to the 2035 emissions inventory for each reduction measure. Table 5-8 (Reduced 2035 GHG Emissions by Source) summarizes the 2035 County emissions of CO_2e as broken down by emissions category. Figure 5-3 (Reduced 2035 GHG Emissions by Source) is a graphical representation of Table 5-8. A detailed breakdown of the reduced 2035 emissions by category is available in Appendix D of this CAP.

Table 5-8 Reduced 2035 GHG Emissions by Source

Category	Metric tons of CO_2e
Transportation	2,617,363
Energy	1,323,685
Area Sources	256,478
Purchased Water	146,118
Solid Waste	107,198
Agriculture	1,485,815
Total	**5,937,658**

Figure 5-3 Reduced 2035 GHG Emissions by Source



5.5 Emissions Summary

With the implementation of the reduction measures outlined in Chapter 4, Riverside County would reduce its emissions to a level below the 2020 reduction target calculated in Chapter 3. This represents a 54.3% decrease from the 2020 BAU inventory and is consistent with the State of California's GHG reduction goals. Table 5-9 (2020 GHG Emissions Comparison) summarizes the existing 2008 emissions, the 2020 BAU emissions inventory, and the reduced 2020 emissions.

Table 5-9 2020 GHG Emissions Comparison

Source Category	Metric tons of CO_2e			
	2008	2020 BAU	Reduced 2020	% Reduced
Transportation	2,850,520	6,977,331	2,454,032	64.8%
Energy	1,577,667	2,830,246	1,141,380	59.7%
Area Sources	269,181	442,024	230,188	47.9%
Purchased Water	152,473	175,344	109,021	37.8%
Solid Waste	132,666	181,728	92,273	49.2%
Agriculture	2,030,431	1,522,823	1,507,220	1.0%
Total	**7,012,938**	**12,129,823**	**5,534,113**	**54.4%**
Emission Reduction Target		**5,960,998**	**5,960,998**	
Below Reduction Target?		**No**	**Yes**	

Note: Mass emissions of CO_2e shown in the table are rounded to the nearest whole number. Totals shown may not add up due to rounding.

Beyond 2020, these reduction measures would continue to reduce emissions particularly from new development projects and transportation. Without reduction measures, Riverside County's growth beyond 2020 would result in more GHG emissions; however, these emissions can be offset with the implementation of the Screening Tables for New Development and the General Plan's policies to reduce GHG emissions. Table 5-10 (2035 GHG

Emissions Comparison) summarizes Riverside County's existing 2008 emissions, anticipated 2035 emissions inventory, and reduced 2035 emissions.

Table 5-10 2035 GHG Emissions Comparison

Source Category	Metric tons of CO_2e			
	2008	BAU 2035	Reduced 2035	% Reduced
Transportation	2,850,520	9,318,041	2,617,363	71.9%
Energy	1,577,667	3,610,701	1,323,685	63. 3%
Area Sources	269,181	529,384	256,478	51.6%
Purchased Water	152,473	293,077	146,118	50.1%
Solid Waste	132,666	220,747	107,198	51.4%
Agriculture	2,030,431	1,522,823	1,486,815	2.4%
Total	**7,012,938**	**15,494,774**	**5,937,658**	**61.7%**
Emission Reduction Target		**5,960,998**	**5,960,998**	
Below Reduction Target?		**No**	**Yes**	

Note: Mass emissions of CO_2e shown in the table are rounded to the nearest whole number. Totals shown may not add up due to rounding.

Table 5-10 shows that the continued implementation of the reduction measures combined with the anticipated increased stringency of state reduction measures would reduce 2035 emissions by 61.7%, which is below the 2020 reduction target. The State of California's ambitious reduction target for the year 2050 is to reduce emissions 80% below 1990 emissions. In order to reach this target, technology must advance significantly and more stringent measures for building and vehicle efficiency must be implemented. While the measures included in this CAP would provide a plan for Riverside County to reduce emissions enough to meet the 2020 target and experience further reductions through to 2035, the CAP would need to be updated periodically in the future in order to update these measures.

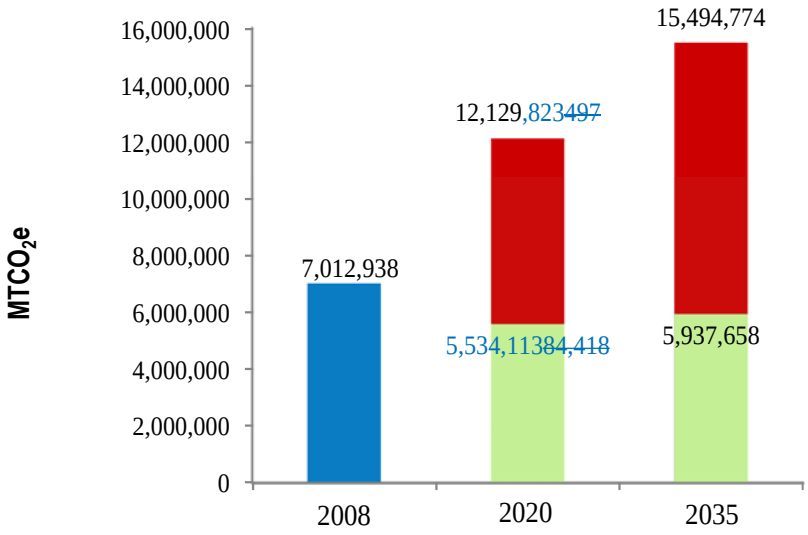
Chapter 6
Conclusions

This page intentionally left blank

Chapter 6 Conclusions

This CAP serves as a guide to help Riverside County implement the objectives of conserving resources and reducing GHG emissions. This document also serves as a technical resource for the proposed update of Riverside County's current General Plan and other land use related documents that may require evaluation and documentation of GHG emissions. Figure 6-1 (Riverside County GHG Emissions by Year) shows a comparison between the emission inventories, including the reduced 2020 BAU and 2035 BAU inventories. The blue bar represents the calculated GHG inventory for Riverside County for 2008. The red bars show the projected growth in GHG emissions in 2020 BAU and 2035 BAU based on the General Plan growth rates. The green bars demonstrate the reduced inventories after the implementation of the statewide and community reduction measures described in Chapter 4.

Figure 6-1 Riverside County GHG Emissions by Year



This CAP sets a target to reduce community-wide GHG emission emissions by 15% from 2008 levels by 2020 consistent with the state reduction goals in AB 32. The CARB Scoping Plan outlines the reduction strategies designed to meet the statewide reduction goal of AB 32. Riverside County has a reduction strategy as described in Chapter 4 that would meet the state reduction goal. Reduction measures provided herein would ensure that Riverside County meets the AB 32 reduction target of reducing to 15% below 2008 levels (reduce down to

5,964,354 MT CO_2e) by 2020. Such programs include strengthening Riverside County's existing programs as well as implementing the Screening Tables for New Development. In some cases, implementation will require the cooperation of other agencies, private businesses, and residents. The success of these measures will be tracked using indicators and targets such as those described in this CAP. Even with the anticipated growth, the modernization of vehicle fleets, combined with the continued implementation of the proposed measures, will reduce GHG emissions by approximately 6,595,384 MT CO_2e from 2020 levels. Therefore, the implementation of the state (R1) measures combined with Riverside County's R2 and R3 measures will reduce GHG emissions down to 5,534,113 MT CO_2e by year 2020, which is 426,884 MT CO_2e below the reduction target.

Beyond 2020, Riverside County would continue implementation of the Screening Tables. During this time, the reduction measures implemented through the Screening Tables would continue to reduce GHG emissions from new development. Additionally, it is assumed that the state measures would be reinforced post-2020 to further reduce emissions. With these assumptions, Riverside County's emissions would decrease to a level below the 2020 reduction target by 2035. Continued implementation of this CAP in post 2020 years is discussed in Chapter 7.

SEJA Comment Letter-Attachment C-Page 241

Chapter 7
Implementation

This page intentionally left blank

Chapter 7 Implementation

This section describes implementation steps for the CAP to support achievement of the GHG reduction goals for the community at large. Success in meeting Riverside County's GHG emission reduction goal will depend on cooperation, innovation and participation by Riverside County and residents, businesses, and government entities in Riverside County's land use jurisdiction with regards to implementing the CAP. This section outlines key steps that the County of Riverside will follow for the implementation of this CAP.

7.1 STEP 1 – Administration and Staffing

The County of Riverside will appoint an Implementation Coordinator to coordinate implementation of this CAP. The Implementation Coordinator will oversee and document implementation of the reduction measures and provide periodic monitoring of emissions.

The Implementation Coordinator will, at a minimum, include the following departments, but will be expanded as needed to ensure coordinated leadership in plan implementation:

- Riverside County Executive Office (EO) – the executive office can provide economic, financial and administrative guidance and support to the Implementation Coordinator.
- Transportation Land Management Agency (TLMA) – Riverside County's Land Use umbrella agency will provide coordination between the various land use divisions, including, but not limited to Building & Safety and Transportation and will assist in the implementation of New Development Implementation Measures.
- Riverside County Economic Development Agency-Facilities Management Division – this county division administers the energy efficiency improvements to Riverside County owned facilities being constructed as a result of the Energy Efficiency and Conservation Block Grant (EECBG) funding.
- Planning Division – Planning can provide expertise in the project entitlement process and provide long-term planning support.

7.2 STEP 2 – Financing and Budgeting

The Implementation of the CAP will require creative, continuing and committed financing in order to work. Local, regional, state and federal public sources of funding will be needed along with the substantial involvement of the private sector. The Riverside County Implementation Plan will take into account the costs and staff resources throughout implementation of the plan as well as the financial benefits and cost savings. The following different financing options will be explored by the County of Riverside:

- State and Federal Grants and Low-interest Loans – As described below, there are a variety of grant and loan programs that exist in various sectoral areas.
- Support from Local Businesses, Non-Profits, and Agencies – Opportunities for public/private partnerships (like the SCE partnerships) exist to provide cooperation on many aspects of the CAP including energy efficiency retrofits, waste minimization, transit promotion and education.
- Self-Funding and Revolving Fund Programs – Innovative programs to fund residential solar investments.
- Agreements with Private Investors – Energy service companies and other private companies can finance up-front investments in energy efficiency and then be reimbursed through revenues from energy savings.
- Taxes and Bonds – Various local governments have used targeted finance instruments for solar, transportation, vehicle improvements and landfill methane controls.

Given that financing is vital to implementing many of the CAP measures, a review of current and potential funding sources was completed for the different sectors covered in this CAP and is presented below to help early phase implementation of the CAP. Whether at the federal, western regional or state level, it appears likely that there will be some form of a "cap and trade" system in place within several years. This system, depending on its particular character, is likely to influence energy prices (such as for electricity, natural gas, and vehicle fuels), and may make currently cost-ineffective measures more economically feasible in the medium term and allow the financing of a broader range of plan measures.

A. Energy Efficiency and Renewable Energy Financing

Federal Energy Efficiency Community Block Grants (EECBG). As part of the stimulus package (the "American Recovery and Reinvestment Act" or ARRA), signed into law by President Obama in spring 2009, block grants are available for energy efficiency planning and improvements in the building, transportation and other sectors. The purpose of the EECBG Program is to assist eligible jurisdictions in creating and implementing strategies to: reduce fossil fuel emissions in a manner that is environmentally sustainable and that maximizes, to the greatest extent practicable, benefits for local and regional communities; reduce the total energy use of the eligible entities; and improve energy efficiency in the building sector, the transportation sector and other appropriate sectors. Eligible activities include: development of an energy efficiency and conservation strategy; technical consultant services; residential and commercial building energy audits; financial incentive programs; energy efficiency retrofits; energy efficiency and conservation programs for buildings and facilities; development and implementation of certain transportation programs; building codes and inspections; certain distributed energy projects; material conservation programs; reduction and capture of methane and greenhouse gases from landfills and dairies; efficiency traffic signals and street lighting; renewable energy technologies on government buildings; and other appropriate activity.

Federal Tax Credits for Energy Efficiency. On October 3, 2008, President Bush signed into law the "Emergency Economic Stabilization Act of 2008." This bill extended tax credits for energy efficient home improvements (windows, doors, roofs, insulation, HVAC and non-solar water heaters). These residential products during 2008 were not eligible for a tax credit, as previous tax credits had expired at the end of 2007. The bill also extended tax credits for solar energy systems and fuel cells to 2016. New tax credits were established for small wind energy systems and plug-in hybrid electric vehicles. Tax credits for builders of new energy efficient homes and tax deductions for owners and designers of energy efficient commercial buildings were also extended.

See: http://www.energystar.gov/index.cfm?c=products.pr_tax_credits.

SEJA Comment Letter-Attachment C-Page 245

SCE Energy Efficiency / Renewable Energy Incentives

- Online or mail-in Home Energy Efficiency Survey. This 15-minute survey gives helpful energy-saving tips that will also help the environment. The questions and tips are tailored for residential energy usage.
- Rebate programs for residential use include lighting, appliances, heating and cooling, multifamily housing, pool, solar leadership and customer generation.
- Energy Centers provide free information, training and support to make important Energy Management and energy efficiency choices.
- SCE Energy Manager offers online access to usage information and detailed cost analyses business energy use.
- Financial Offerings include on-Bill Financing, Zero-interest financing towards the purchase and installation of qualifying energy efficient equipment for commercial, industrial and agricultural customers.
- Regulation & Compliance Support "The Cool Planet Project" assists customers with recent installations or efficiency projects resulting in excess of one million kWh of energy in joining the Climate Registry.
- Solar Leadership helps create a cleaner energy future with innovative solutions that make it possible for you to join the solar movement.
- Self-Generation provides financial incentives for installing self-generation equipment to meet all or a portion of facility's energy needs.
- Specialized Services for Facilities:
  - New Buildings – Receive technical assistance in the design and construction of new energy efficient buildings.
  - Savings by Design: New construction builders and buyers can receive design assistance, owner incentives, and design team incentives.
  - California Advanced Homes - Incentives, design assistance, and technical education and services to encourage home builders to build homes that exceed California's Title 24 code standards by at least 15%.
  - Full-service solutions are available to qualifying customers to receive assistance in identifying and evaluating energy efficiency opportunities within existing buildings.
  - Retro Commissioning - Receive assistance to improve the bottom line in existing building's operations through specialized services to detect inefficiencies in complex building systems, and to determine optimum operating conditions.
- Heating Ventilation & Air Conditioning - Lower operating costs and increase equipment life through proper HVAC installation and regular maintenance. Future programs will focus on two key components:
  - A/C Quality Maintenance, and
  - A/Q Quality Installation.

AB 811 Financing Districts. AB 811 permits the creation of assessment districts to finance installation of distributed generation renewable energy sources or energy efficiency improvements that are permanently fixed to residential, commercial, industrial, or other real property. Riverside County's partnership with WRCOG in creation of the Energy Efficiency and Water Conservation Program allows home and business owners to utilize

this type of financing program and avoid upfront costs associated with energy system installations. Financing is repaid through the property tax bill and repayment obligations remain with the property when it is sold to a new owner.

California Energy Commission (CEC) Energy Efficiency Financing. The CEC offers up to $3 million per application in energy efficiency financing and low interest loans to cities and counties for installing energy-saving projects. Examples of projects include: lighting systems, pumps and motors, streetlights and LED traffic signals, automated energy management systems/controls, building insulation, energy generation including renewable and combined heat and power projects, heating and air conditioning modifications and wastewater treatment equipment.

See http://www.energy.ca.gov/efficiency/financing/

California Energy Commission Bright Schools Program. This is a collaborative project of the CEC, California Conservation Corps, local utility companies and other qualifying energy service companies to assist schools in undertaking energy efficiency projects. Project staff will guide schools through identifying and determining a project's feasibility, securing financing for the project, and purchasing and installing the new energy efficient equipment.

See http://www.energy.ca.gov/efficiency/brightschools/index.html

B. Transportation Financing

Federal Energy Efficiency Community Block Grants (EECBG). As described above, eligible activities include development and implementation of certain transportation programs and efficient traffic signals and street lighting.

Regional Transportation Improvement Program (RTIP). The Regional Transportation Improvement Program (RTIP) is funded from 75% of the funds made available for transportation capital improvement projects under the State Transportation Improvement Program (STIP). This program targets urban projects that are needed to improve transportation within the region. The Southern California Association of Governments (SCAG) and RCTC recommends to the California Transportation Commission (CTC) the selection of these projects, which can include state highway improvements, local roads, public transit, intercity rail, grade separations, and more.

Interregional Improvement Program (IIP). The Interregional Improvement Program (IIP) is funded from 25% of the funds made available for transportation capital improvement projects under the STIP. This program targets projects that are needed to improve interregional movement of people and goods. Caltrans recommends to the CTC the selection of these projects, which can include state highway improvements, intercity passenger rail, mass transit guide ways, or grade separation projects.

C. Waste Reduction Financing

California Integrated Waste Management Board Grants and Loans. The CIWMB offers funding opportunities authorized by legislation to assist public and private entities in the safe and effective management of the waste stream. See http://www.ciwmb.ca.gov/grants/ for more details.

SEJA Comment Letter-Attachment C-Page 247

D. Water Conservation and Treatment Financing

Clean Water State Revolving Funds. CWSRFs fund water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management. CWSRFs have funded over $74 billion, providing over 24,688 low-interest loans to date.

See http://www.epa.gov/owm/cwfinance/cwsrf/index.htm for more details.

CWSRF's offer:

- Low Interest Rates, Flexible Terms – Nationally, interest rates for CWSRF loans average 2.3%, compared to market rates that average 5%. For a CWSRF program offering this rate, a CWSRF funded project would cost 22% less than projects funded at the market rate. CWSRFs can fund 100% of the project cost and provide flexible repayment terms up to 20 years.
- Funding for Nonpoint Source Pollution Control and Estuary Protection – CWSRFs provided more than $167 million in 2009 to control pollution from nonpoint sources and for estuary protection, more than $3 billion to date.
- Assistance to a Variety of Borrowers – The CWSRF program has assisted a range of borrowers including municipalities, communities of all sizes, farmers, homeowners, small businesses, and nonprofit organizations.
- Partnerships with Other Funding Sources – CWSRFs partner with banks, nonprofits, local governments, and other federal and state agencies to provide the best water quality financing source for their communities.

7.3 STEP 3 – Timeline and Prioritization

The County of Riverside will develop an implementation schedule based on the completion of the full cost effectiveness analysis. Prioritization will be based on the following factors:

- Cost effectiveness;
- GHG reduction efficiency;
- Availability of funding;
- Level of county control;
- Ease of implementation; and
- Time to implement.

In general consideration of these factors, the following is an outline of key priorities for three phases starting in 2012 through 2020.

- Phase 1 (2012-2014): Development of key ordinances, completion of key planning efforts, implementation of most cost-effective measures, and support of voluntary efforts.

- Phase 2 (2014–2017): Continued implementation of first tier measures, implementation of second tier measures, and implementation of key planning outcomes from Phase 1.
- Phase 3 (2017–2020): Continued implementation of first and second tier measures, implementation of third tier of measures.

Because the goals of this CAP are aggressive, success in meeting the CAP goals depend on some flexibility in the GHG reduction actions. The County of Riverside is committed to flexibility in implementing the reduction measures and meeting the goals of this CAP. Many of the reduction measures in this Plan may be implemented through a menu of options. The goals of each reduction measure can often be achieved through a variety of means, especially those related to building energy efficiency. For example, the County of Riverside will develop energy efficient design programs (measures R2-E3 and R2-E4). Compliance with the energy efficient design programs can be achieved through many combinations of actions including (but not limited to): installing energy efficient appliances, lighting, and HVAC systems; installing solar panels and solar water heaters; siting and orienting buildings to optimize conditions for natural heating, cooling, and lighting; installing top-quality windows and insulation; and incorporating natural shading, skylights, and reflective surfaces. Table 7-1 (GHG Reduction Measure Timeline and Phasing Schedule) presents the potential timeline and phasing schedule for the GHG reduction measures.

Table 7-1 GHG Reduction Measure Timeline and Phasing Schedule

Reduction Measure	Phase
Transportation	
R2-T1: Employment Based Trip and VMT Reduction	1, 2, 3
R2-T2: Increased Residential Density	1, 2, 3
R2-T3: Mixed Use Development	1, 2, 3
R2-T4: Preferential Parking	1, 2, 3
R2-T5: Roadway Improvements – Signals, Flow	1
R2-T6: Non-Motorized Transportation Facilities	1, 2, 3
R2-T7: Expand Alternative Fuel Vehicle Use	1, 2, 3
R2-T8: Anti-Idling Enforcement	2
R2-T9: Increase Public Transit	2
R2-T10: Employee Commute Alternative Schedules	1, 2, 3
Energy	
R2-E1: Residential Energy Efficiency Program	1
R2-E2: Residential Renewable Energy Program	1
R2-E3: Residential Retrofit Implementation Program	2
R2-E4: Residential Renewable Retrofit Program	2
R2-E5: Commercial Energy Efficiency Program	1
R2-E6: Commercial/Industrial Renewable Program	1
R2-E7: Commercial/Industrial Retrofit Program	2
R2-E8: Induction Streetlight Retrofits	1
Area Source	
R2-L1: Electric Landscape Equipment	1
R2-L2: No New Wood-burning Devices	1
R2-L3: Mandatory Curtailment Days	1
Water	
R2-W1: Water Use Reduction Initiative	1
R2-W2: Increase Reclaimed Water Use	2, 3

SEJA Comment Letter-Attachment C-Page 249

Reduction Measure	Phase
Solid Waste	
R2-W1: County Diversion Program	2
R2-W2: Construction Diversion Program	2

7.4 STEP 4 – Public Participation

The citizens and businesses in Riverside County are integral to the success of GHG reduction efforts. Their involvement is essential in order to reach the reduction goals because this CAP depends on a combination of state and local government efforts, public and private sources of finance and the voluntary commitment, creativity, and participation of the community at large. The County of Riverside must strike a balance between development and environmental stewardship to keep the economy strong and, at the same time, protect the environment. The County of Riverside will educate stakeholders such as businesses, business groups, residents, developers, and property owners about the CAP and encourage participation in efforts to reduce GHG emissions in all possible sectors.

7.5 STEP 5 – Project Review

The CEQA guidelines support projects that lower the carbon footprint of new development, and encourage programmatic mitigation strategies that may include reliance on adopted regional blueprint plans, CAPs and general plans that meet regional and local GHG emissions targets and that have also undergone CEQA review. The criteria needed to use adopted plans in evaluating impacts of GHG emissions from subsequent development projects is found in CEQA Guidelines Section 15183.5. Once adopted, this CAP fulfills these requirements. The County of Riverside is responsible for ensuring that new projects conform to these guidelines and meet the goals and requirements outlined in this CAP.

The County of Riverside will implement the reduction measures for new development during the CEQA review, through the use of a Riverside County GHG Screening Table document based upon the CAP. The Riverside County GHG Screening Table document will provide guidance for the analysis of development projects and divide projects into two broad categories based upon the CEQA review they are going through. The screening table will provide a menu of reduction options. If a project can obtain 100 points from the screening table, the mitigated project will implement pertinent reduction measures such that it meets the reduction goals of the CAP and a less than significant finding can be made for the project. The menu of options in the screening table is tied to the R2 Measures in the CAP and the IMs in the General Plan such that 100 points will meet the emission reductions associated with the R2 Measures and IMs. This menu allows for maximum flexibility for projects to meet its reduction allocation.

The methodology discussed above is described in more detail in the Riverside County GHG Screening Table document, presented in Appendix N of the General Plan and is consistent with the analysis and quantification methodology used in the CAP.

The Screening Tables also serve to document the implementation of reduction measures. Using the screening tables as a reduction measure monitoring tool is described in more detail in Section 7.6 below.

7.6 STEP 6 – Monitoring and Inventorying

The County of Riverside will create a system for monitoring the implementation of this CAP and adjusting the plan as opportunities arise. As the plan is implemented and as technology changes, the CAP should be revised to take advantage of new and emerging technology. If promising new strategies emerge, the County of Riverside will evaluate how to incorporate these strategies into the CAP. Further, state and federal action will also result in changes which will influence the level of Riverside County emissions.

Screening tables completed during project review, as described in Section 7.5 above, will serve as documentation of the implementation of reduction measures. The County of Riverside shall retain the completed screening tables in order to maintain a record of the types and levels of implementation of each of the R2 measures. The point values in the completed screening tables also document the estimated levels of emission reductions anticipated during implementation. By maintaining these records, the County of Riverside can monitor the CAP reduction measure implementation and compare the anticipated emission reductions with the goals for the CAP over time.

The GHG inventory will be periodically updated in coordination with the three phases noted above: 2013 (to update with the Regional Transportation Plan outputs and Phase 1 progress); 2017 (to review Phase 2 progress, allow for course corrections to keep progress on target for 2020, and to develop post-2020 forecasts for use in planning for after 2020); and 2020 (to establish baseline for post-2020 GHG reduction planning). The County of Riverside will also implement a monitoring and reporting program to evaluate the effectiveness of reduction measures with regards to progress towards meeting the goals of the CAP.

To provide periodic updates to the CAP inventory of GHG emissions, Riverside County will use a Microsoft (MS) Excel format emissions inventory tool developed by the CAP consultant. This tool will include all the emission factors and emission sources specific to Riverside County. The tool will be designed such that Riverside County staff can input VMT, water use, solid waste and energy consumption data and the tool will quantify emissions for the unincorporated areas.

The CAP Implementation Coordinator shall be responsible for maintaining records of reduction measure implementation and insuring that the periodic updates to the emissions inventory are completed using the MS Excel based emission inventory tool.

7.7 STEP 7 – Beyond 2020

As described above under the discussion of Reduction Goals, 2020 is only a milestone in GHG reduction planning. Executive Order S-03-05 calls for a reduction of GHG emissions to a level 80 percent below 1990 levels by 2050, and this level is consistent with the estimated reductions needed to stabilize atmospheric levels of CO2 at 450 parts per million (ppm). Thus, there will be a need to start planning ahead for the post-2020 period. The County of Riverside will commence planning for the post-2020 period starting in 2017, at the approximate midway point between plan implementation and the reduction target and after development of key ordinances and implementation of cost-effective measures. At that point, Riverside County will have implemented the first two phases of this CAP and will have a better understanding of the effectiveness and efficiency of different reduction strategies and approaches. Further, the state's regulations under AB 32 would have been fully in force since 2012; federal programs and policies for the near term are likely to be well underway; market mechanisms like a cap and trade system are likely to be in force and will be influencing energy and fuel prices; and continuing technological change in the fields of energy efficiency, alternative energy generation, vehicles, fuels, methane

SEJA Comment Letter-Attachment C-Page 251

capture and other areas will have occurred. Riverside County will then be able to take the local, regional, state and federal context into account. Further, starting in 2017 will allow for development of the post-2020 plan so that it can be ready for full implementation, including potential new policies, revisions to the General Plan (as necessary), programs, ordinances, and financing by 2020. The new plan will include a specific target for GHG reductions for 2035 and 2050. The targets will be consistent with broader state and federal reduction targets and with the scientific understanding of the needed reductions by 2050. The County of Riverside will adopt the new plan by January 1, 2020.

The new CAP adopted on or before January 1, 2020 will keep on track through 2035 to meet the 2050 goal by implementing the following.

- Increase energy efficiency and green building efforts (for County municipal facilities as well as private buildings within the unincorporated areas) so that the savings achieved in the 2020 to2035 timeframe are approximately 69% those accomplished in 2020.
- Continue to implement land use and transportation measures to lower VMT and shift travel modes (assumed improvement of 8% compared to the unmitigated condition, which is within SCAG's assumed range of 8% to 12% of GHG reductions for 2035).
- Capture more methane from landfills receiving regional waste, move beyond 75% local waste diversion goal for 2020, and utilize landfill gas further as an energy source.
- Continue to improve local water efficiency and conservation.
- Continue to support and leverage incentive and rebate and other financing programs for residential and commercial energy efficiency and renewable energy installations to shorten payback period and costs and to develop programs that encourage increased use of small-scale renewable power as it becomes more economically feasible.

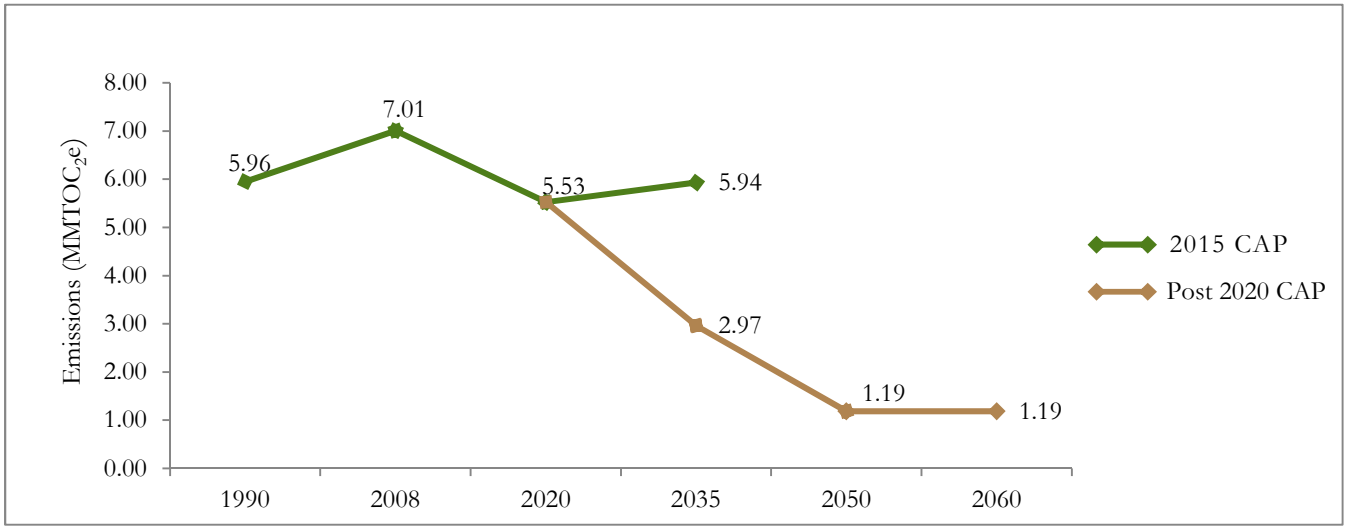
The conceptual effects of these strategies are presented in Table 7-2 and would represent an approximate doubling of effort from that planned at the state and County level for 2020. In total, the measures described above would produce reductions to bring the region's GHG emissions to an estimated 3 MMTCO2e by 2035. While the potential mix of future GHG reduction measures presented in this section is preliminary, it serves to demonstrate that the current measures in the CARB Scoping Plan and the County's CAP can not only move the region to its 2020 goal, but can also provide an expandable framework for much greater long-term greenhouse gas emissions reductions toward the ultimate 2050 goal.

Table 7-2. Potential Reduction Measures to Reach a 2035 Goal of 2.3 $MMTCO_2e$

	Reductions by 2035 in CAP				Scenario for Additional Reductions by 2035		
	State	County	TOTAL	% BAU Reduction	Additional Reductions 2020–2035	Effort Relative to this CAP	
	$MTCO_2e$	$MTCO_2e$	$MTCO_2e$	%	$MTCO_2e$	%	Notes
Building Energy (Residential, Commercial, Industrial)	855,135	1,431,881	2,287,016	63.3%	1,486,205	65%	CARB Scoping Plan calls for doubling of energy efficiency reductions between 2020 and 2030 (i.e., 100% effort relative to the period 2008–2020). The County would have to do 5% more in this sector to be on target. Additional GHG reductions during this period will come from a continued de-carbonization of electricity at the public utility level, more aggressive retrofitting of existing buildings and greatly increased use of small scale renewables.
Transportation	1,062,190	5,638,488	6,700,678	71.9%	1,713,327	25.6%	CARB Scoping Plan calls for a doubling of GHG reductions from vehicle fleet by 2030 compared to 2020 and more than doubling reduction of carbon intensity of transportation fuels (i.e., 100% effort relative to the period 2008–2020). The region would need to do about 8% more in this sector to stay on target. SCAG assumes between 8% and 12% in GHG reductions after 2020 for 2035 for VMT reduction. This analysis assumes 8% for local reductions.
Solid Waste Management	0	113,549	113,549	51.4%	23,733	20.9%	Assumed the County continue further efforts at methane control, waste diversion, and potential waste to energy projects to result in modest further reductions in sector (7%). Once capture technology is installed, additional reductions in this sector are somewhat limited.
Agriculture	36,008	0	36,008	2.4%	0	0%	No assumed change.
Wastewater Treatment	0	0	0	NA	8,132	100%	Assumed additional 3% in reduction in sector due to installation of fugitive emission capture technology and additional water conservation.
Purchased Water	33,315	113,644	146,959	50.1%	12,023	8.1%	Assumed additional 5% in reduction in sector due to continued effort to conserve water at a similar rate as 2008-2020.
TOTAL			**9,284,210**		**3,243,420**		

Figure 7-1 below shows the trajectory of emissions within this Draft 2015 CAP that achieves an AB 32 compliant reduction target of 5.96 million metric tons (MMT) CO_2e and the conceptual 2035 and 2050 reductions in a post 2020 CAP needed to reduce emissions down to 80% below 1990 levels by 2050 outlined in Executive Order S-3-05. Riverside County will develop the post-2020 CAP so that it can be ready for full implementation, including potential new policies, revisions to the General Plan (as necessary), programs, ordinances, and financing by 2020. The Post 2020 CAP will include a specific target for GHG reductions for 2035 and 2050. The targets will be consistent with broader state and federal reduction targets including Executive Order S-3-05 and with the scientific understanding of the needed reductions by 2050. The County of Riverside will adopt the new Post 2020 CAP by January 1, 2020.

Figure 7-1 Riverside County GHG Emissions by Year



This page intentionally left blank.

SEJA Comment Letter-Attachment C-Page 255

Chapter 8
References

This page intentionally left blank

Chapter 8
References

Association of Environmental Professionals (AEP) White Paper: Alternative Approaches to Analyzing Greenhouse Gases and Global Climate Change Impacts in CEQA Documents, June 2007.

Association of Environmental Professionals (AEP) White Paper: Community-wide Greenhouse Gas Emission Protocols, March 2011.

Association of Environmental Professionals (AEP) White Paper: Forecasting Community-wide Greenhouse Gas Emissions and Target Setting, May 2012.

California Air Pollution Control Officers Association (CAPCOA), Quantifying Greenhouse Gas Mitigation Measures, August 2010.

California Air Pollution Control Officers Association (CAPCOA), White Paper: CEQA and Climate Change, January 2008.

California Air Resources Board (CARB), Climate Change Scoping Plan, December 2008.

California Air Resources Board (CARB), EMFAC2007, 2007. [2007b]

California Air Resources Board (CARB), Mandatory Reporting of Greenhouse Gas Emissions, December 6, 2007. [2007c]

California Air Resources Board (CARB), Proposed Early Actions to Mitigate Climate Change in California December 20, 2007. [2007d]

California Air Resources Board (CARB), Proposed SB 375 Greenhouse Gas Targets: Documentation of the Resulting Emission Reductions based on MPO Data, August 9, 2010. [2010a]

California Air Resources Board, Regional Greenhouse Gas Emission Reduction Targets for Automobiles and Light Trucks Pursuant to Senate Bill 375, September 23, 2010. [2010b]

California Air Resources Board, URBEMIS2007 for Windows Version 9.2.4, 2007. [2007e]

California Building Standards Commission (CBSC), 2010 California Green Building Standards Code, January 2010.

California Climate Action Team (CCAT), Climate Action Biannual Report, April 2010.

California Climate Action Team (CCAT), California Climate Action Team's Final Report to the Governor and Legislature, March 2006.

California Climate Action Registry (CCAR), General Reporting Protocol, Version 3.1, January 2009.

California Climate Action Registry (CCAR), Local Government Protocol, Version 1.1, May 2010.

California Department of Finance, E-4 Population Estimates, http://www.dof.ca.gov/research/demographic/reports/estimates/e-4_2001-07/, accessed August 2010.

California Energy Commission (CEC), Refining Estimates of Water Related Energy Use in California: CEC-500-2006-118, December 2006. [2006a]

California Energy Commission (CEC), California's Energy Efficiency Standards for Residential and Nonresidential Buildings, Title 24, Part 6, of the California Code of Regulations, 2008 Standards, April 23, 2008.California Health and Safety Code Section 38505 (g), Greenhouse Gas Definitions, http://law.onecle.com/california/health/38505.html, accessed February 11 2011.

California Natural Resources Agency, 2009 California Climate Adaptation Strategy, December 2, 2009. [2009a]

California Natural Resources Agency, CEQA Guidelines Amendments, December 30, 2009. [2009b]

Energy Information Administration (EIA), 2005 Residential Energy Consumption Survey, 2005.

Federal Transit Administration (FTA), Guaranteed Ride Home Programs, A Study of Program Characteristics, Utilization, and Costs. May 16, 2006.

Intergovernmental Panel on Climate Change (IPCC), Climate Change 2001: The Scientific Basis, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate, 2001.

South Coast Air Quality Management District (SCAQMD), Greenhouse Gas CEQA Significance Thresholds, December 5, 2008.

United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, December 11, 1997.

U.S. Environmental Protection Agency (USEPA), AP-42, Compilation of Air Pollutant Emission Factors, Fourth Edition, September 1985.

U.S. Environmental Protection Agency (USEPA), Emissions and Generation Resource Integrated Database (eGRID2007), version 1.1, December 31 2007.

U.S. Environmental Protection Agency, Final GHG Tailoring Rule, 40 CFR Parts 51, 52, 70, et al., May 2010. [2010a]

U.S. Environmental Protection Agency, Mandatory Reporting of Greenhouse Gases Rule, 40 CFR Part 98, October 2009.

U.S. Environmental Protection Agency, Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, Third Edition, September 2006.

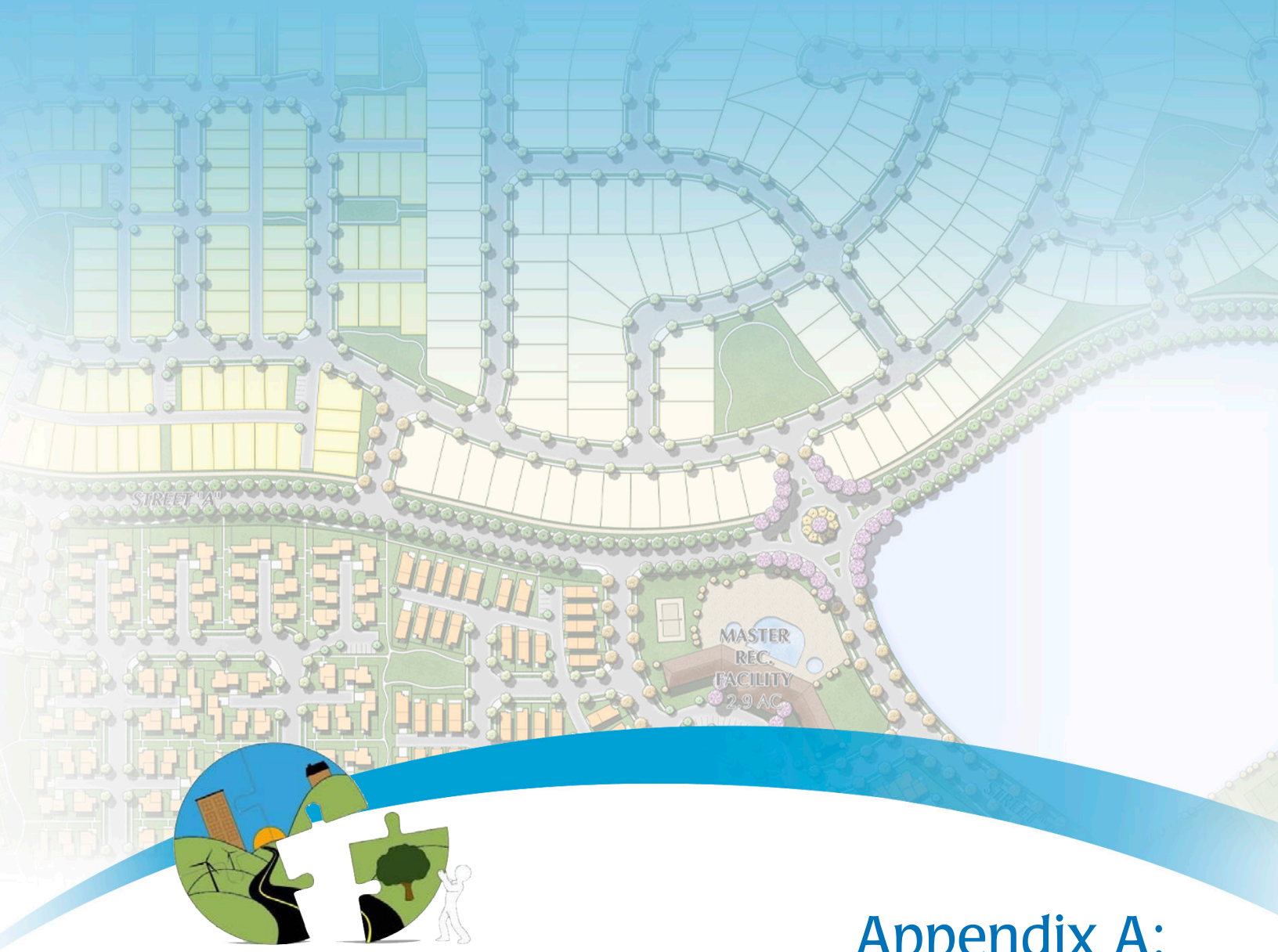
SEJA Comment Letter-Attachment C-Page 259

U.S. Environmental Protection Agency, U.S. Greenhouse Gas Inventory Report, Section 6 Agriculture, http://www.epa.gov/climatechange/emissions/downloads09/Agriculture.pdf, accessed February 2010. [2010b]

U.S. Supreme Court, Massachusetts et al. v. Environmental Protection Agency et al., No. 05-1120, Decided April 2, 2007.

This page intentionally left blank

SEJA Comment Letter-Attachment C-Page 261



Appendix A:

The Greenhouse Effect, Greenhouse Gases, and Climate Change Impacts

This page intentionally left blank

GLOBAL CLIMATE CHANGE

Parts of the Earth's atmosphere act as an insulating blanket of just the right thickness, trapping sufficient solar energy to keep the global average temperature in a suitable range. The 'blanket' is a collection of atmospheric gases called 'greenhouse gases' (GHGs) based on the idea that the gases also 'trap' heat like the glass walls of a greenhouse. These gases, mainly water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, and chloroflurocarbons (CFCs) all act as effective global insulators, reflecting back to earth visible light and infrared radiation. Human activities such as producing electricity and driving vehicles have contributed to the elevated concentration of these gases in the atmosphere. This in turn, is causing the Earth's temperature to rise. A warmer Earth may lead to changes in rainfall patterns, much smaller polar ice caps, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans.

Leading scientists around the world agree that Global Warming Potential is a reality and that human activities are disrupting the earth's climate by intensifying the greenhouse effect.

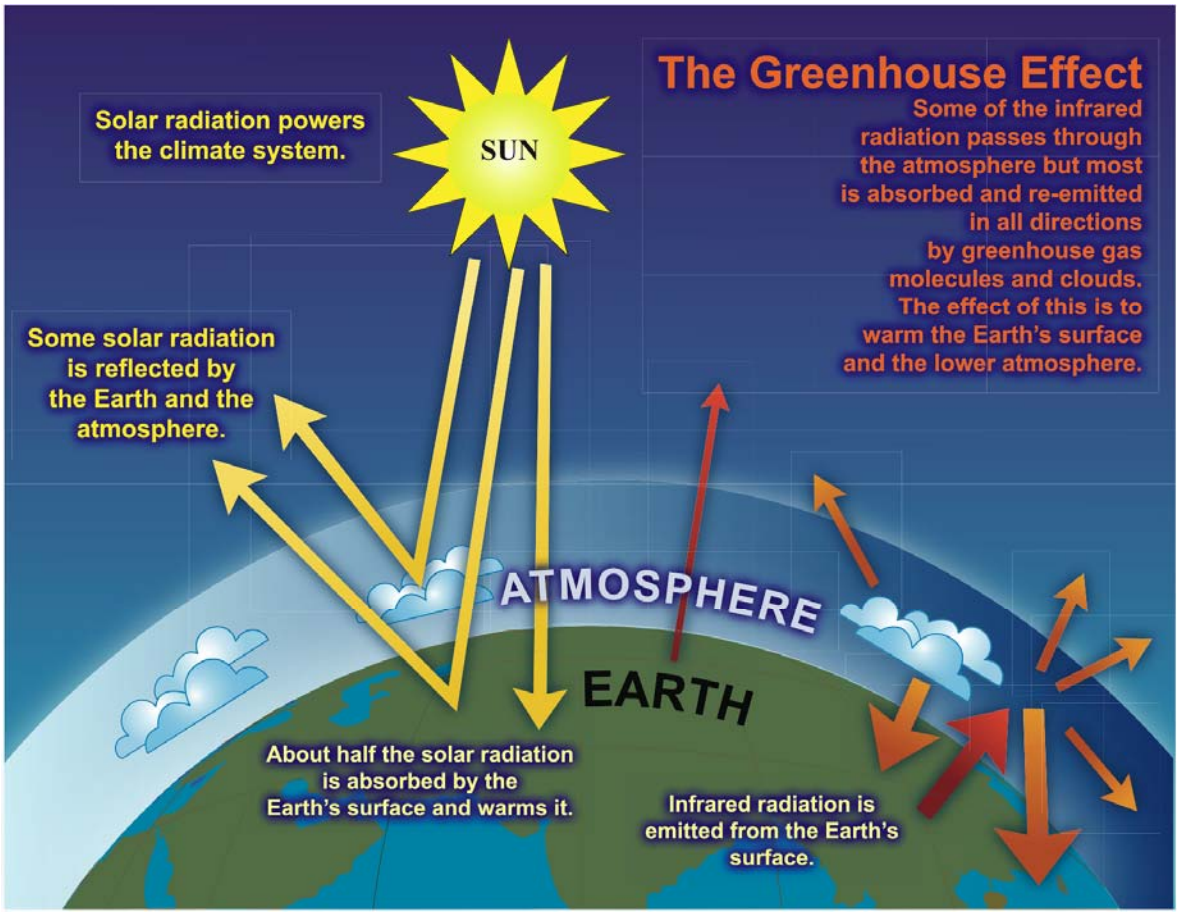
1. THE GREENHOUSE EFFECT

A balance of naturally occurring gases dispersed in the atmosphere determines the Earth's climate by trapping solar heat. This phenomenon is known as the greenhouse effect. As sunlight passes through our atmosphere, the incoming solar radiation is eradiated from the earth's surface as heat energy. Greenhouse gases like carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and water vapor trap some of this reradiated energy. This trapped heat warms the earth, much as the glass of a greenhouse traps reradiated energy from sunlight and thereby warms the interior of the structure. Figure 1-1 illustrates the Greenhouse Gas Effect.

2. GLOBAL WARMING

The natural "greenhouse effect" allows the earth to remain warm and sustain life. Greenhouse gases trap the sun's heat in the atmosphere, like a blanket, and help determine the existing climate. The increased consumption of fossil fuels (wood, coal, gasoline, etc.) has substantially increased atmospheric levels of greenhouse gases. As atmospheric concentrations of greenhouse gases rise, so do temperatures. Over time this rise in temperatures would result in climate change. Theories concerning climate change and global warming existed as early as the late 1800s. By the late 1900s the understanding of the earth's atmosphere had advanced to the point where many climate scientists began to accept that the earth's climate is changing. Today, many climate scientists agree that some warming has occurred over the past century and will continue through this century.

Figure A.1 - The Greenhouse Gas Effect



Source: IPPC, 2008

The United Nations Intergovernmental Panel on Climate Change predicts that changes in the earth's climate will continue through the 21st century and that the rate of change may increase significantly in the future because of human activity. Many researchers studying California's climate believe that changes in the earth's climate have already affected California and will continue to do so in the future.

3. GREENHOUSE GASES

Parts of the Earth's atmosphere act as an insulating blanket of just the right thickness, trapping sufficient solar energy to keep the global average temperature in a suitable range. The 'blanket' is a collection of atmospheric gases called 'greenhouse gases' (GHGs) based on the idea that the gases also 'trap' heat like the glass walls of a greenhouse. These gases, mainly water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, ozone, and aerosols all act as effective global insulators, reflecting back to earth visible light and infrared radiation.

The accumulation of GHGs in the atmosphere regulates the earth's temperature. Without the natural heat trapping effect of GHGs, the earth's surface would be about 34 degrees Centigrade (°C) cooler (CAT 2006). However, it is believed that emissions from human activities have elevated the concentration of these gases in the atmosphere beyond the level of naturally occurring concentrations. This in turn is causing the Earth's temperature to rise. A warmer Earth may lead to changes in rainfall patterns, much smaller polar ice caps, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans.

Individual GHGs have varying global warming potential (GWP) and atmospheric lifetimes. The reference gas for GWP is carbon dioxide; carbon dioxide has a GWP of one. Compared to methane's GWP of 21 it is clear that methane has a greater global warming effect than carbon dioxide on a molecule per molecule basis (EPA 2006b). As shown below in Table 1.1 GWP ranges from 1 (carbon dioxide) to 23,900 (sulfur hexafluoride).

Atmospheric lifetimes vary from 1.5 (HFC-152a) to 50,000 years (tetrafluoromethane). One teragram (equal to one million metric tons) of carbon dioxide equivalent (Tg CO_2 Eq.) is the mass emissions of an individual GHG multiplied by its GWP. The atmospheric lifetime and GWP of selected greenhouse gases are also summarized in Table 1.1.

Table A.1 Global Warming Potentials and Atmospheric Lifetimes

Gas	Atmospheric Lifetime (years)	Global Warming Potential (100 year time horizon)
Carbon Dioxide	50 - 200	1
Methane	12 ± 3	21
Nitrous Oxide	120	310
HFC-23 264		11,700
HFC-134a 14.6		1,300
HFC-152a 1.5		140
PFC: Tetrafluoromethane (CF4)	50,000	6,500
PFC: Hexafluoroethane (C2F6)	10,000	9,200
Sulfur Hexafluoride (SF6)	3,200	23,900
Source: U.S. Environmental Protection Agency, 2006.		

Of all greenhouse gases in the atmosphere, water vapor is the most abundant, important, and variable. It is not considered a pollutant; in the atmosphere it maintains a climate necessary for life. The main source of water vapor is evaporation from the oceans (approximately 85 percent). Other sources include evaporation from other water bodies, sublimation (change from solid to gas) from ice and snow, and transpiration from plant leaves.

Ozone is also a greenhouse gas; however, unlike other GHGs, ozone in the troposphere is relatively short-lived and therefore is not global in nature. It is difficult to make an accurate determination of the contribution of ozone precursors (nitrogen oxides and volatile organic compounds) to global climate change (GCC) (CARB 2004b).

Aerosols are suspensions of particulate matter in a gas emitted into the air through burning biomass (plant material) and fossil fuels. Aerosols can warm the atmosphere by absorbing and emitting heat and can cool the atmosphere by reflecting light. Cloud formation can also be affected by aerosols. Sulfate aerosols are emitted when fuel containing sulfur is burned. Black carbon (or soot) is emitted during biomass burning and incomplete combustion of fossil fuels. Particulate matter regulation has been lowering aerosol concentrations in the United States; however, global concentrations are likely increasing.

Carbon Dioxide

The natural production and absorption of carbon dioxide (CO_2) is achieved through the terrestrial biosphere and the ocean. However, humankind has contributed to the alteration of the natural carbon cycle by burning coal, oil, natural gas, and wood. Since the industrial revolution began in the mid 1700s, each of these human-caused activities has increased in scale and distribution. Carbon dioxide was the first GHG demonstrated to be increasing in atmospheric concentration with the first conclusive measurements being made in the last half of the 20th century. Prior to the industrial revolution, concentrations were fairly stable at 280 ppm. Today, they are around 370 ppm, an increase of well over 30 percent (EPA 2006). Left unchecked, the concentration of carbon dioxide in the atmosphere is projected to increase to a minimum of 540 ppm by 2100 as a direct result of anthropogenic sources (IPCC 2001). This will result in an average global temperature rise of at least two degrees Celsius (3.6 ^{O}F) (IPPCC 2001).

Carbon dioxide emissions are directly generated primarily in the form of vehicle exhaust and in the consumption of natural gas for heating. Carbon dioxide emissions are also generated from natural gas combustion and indirectly through the use of electricity. Other indirect sources of carbon dioxide include the use of potable water and generation of wastewater (potable water and wastewater treatment generates greenhouse gases), and the generation of solid waste.

Methane

Methane (CH_4) is an extremely effective absorber of radiation, though its atmospheric concentration is less than carbon dioxide and its lifetime in the atmosphere is brief (10-12 years), compared to some other GHGs (such as carbon dioxide, nitrous oxide, and CFCs). Methane has both natural and anthropogenic (human) sources. It is released as part of the biological processes in low oxygen environments, such as in swamplands or in rice production (at the roots of the plants). Over the last 50 years, human activities such as growing rice, raising cattle, using

natural gas and mining coal have added to the atmospheric concentration of methane (EPA 2006b).

Nitrous Oxide

Concentrations of nitrous oxide (N_2O) also began to rise at the beginning of the industrial revolution. Microbial processes in soil and water, including those reactions that occur in fertilizer containing nitrogen, produce nitrous oxide. The use of fertilizers has increased over the last century. Global concentration for nitrous oxide in 1998 was 314 ppb, and in addition to agricultural sources for the gas, some industrial processes (fossil fuel-fired power plants, nylon production, nitric acid production, and vehicle emissions) also contribute to its atmospheric load (EPA 2006b).

Chlorofluorocarbons

Chlorofluorocarbons (CFCs) have no natural source, but were synthesized for use as refrigerants, aerosol propellants and cleaning solvents. Since their creation in 1928, concentrations of CFCs in the atmosphere have been rising. Due to the discovery that they are able to destroy stratospheric ozone, a global effort to halt their production was undertaken and was extremely successful, so much so that levels of the major CFCs in the atmosphere are now remaining static or declining. However, their long atmospheric lifetimes mean that some of the CFCs will remain in the atmosphere for over 100 years. Since they are also a GHG, along with such other long-lived synthesized gases as CF_4 (carbontatrafuoride) and SF_6 (sulfurhexafluoride), they are of concern. Another set of synthesized compounds called HFCs (hydrofluorcarbons) are also considered GHGs, though they are less stable in the atmosphere and therefore have a shorter lifetime and less of an impact (EPA 2006b). CFCs, CF_4, SF_6 and HFCs have been banned and are no longer available on the market.

4. Human and Cultural Causes of Climate Change

Like all other animals, humans participate in the natural carbon cycle, but there are important differences between human and animal activities. By burning coal, oil, and natural gas, humans are adding carbon dioxide (CO_2) to the atmosphere much faster than the carbon in rocks is released through natural processes. Clearing and burning forests to create agricultural land converts organic carbon to carbon dioxide gas. The oceans and land plants are absorbing a portion, but not nearly all of the CO_2 added to the atmosphere by human activities. Human climate drivers include heat-trapping emissions from cars and power plants, aerosols from pollution, and soot particles.

5. IMPACTS FROM GREENHOUSE GAS EMISSIONS

Global Impacts

While in some cases global climate change may temporarily improve certain aspects of a region, such as lengthening the growing season, it is estimated that the ecology of the natural world will not be able to adjust quickly enough to prevent widespread environmental degradation (IPCC, 2001). In California, it is likely that warmer temperatures will result in frequent and longer periods of drought (UCS 1999). The majority of the scientific community has stated that beyond doubt, global climate change will be one of the most significant challenges the globe will face in the twenty-first century, and will impact almost every system we depend upon for survival.

Just as humans are affected by climate change, so too are plants and animals. Animals must breathe the same air and are subject to the same types of negative health effects as humans. Certain plants and trees may absorb air pollutants that can stunt their development or cause premature death.

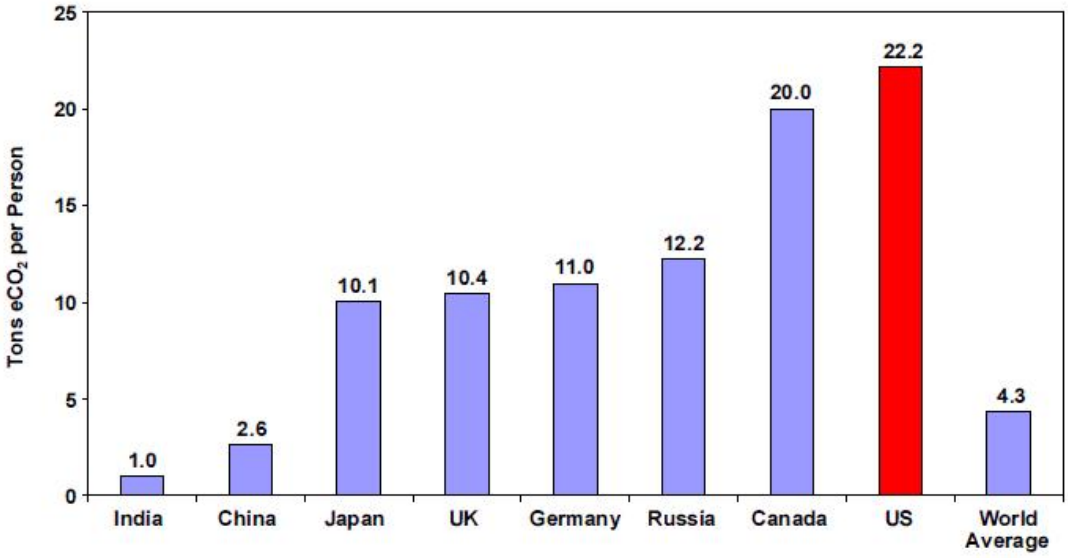
There are also numerous impacts to the human economy including lost workdays due to illness, a desire on the part of business to locate in areas with a healthy environment, and increased expenses from medical costs. Pollutants may also lower visibility and cause damage to property. Certain air pollutants are responsible for discoloring painted surfaces, eating away at stones used in buildings, dissolving the mortar that holds bricks together, and cracking tires and other items made from rubber.

The United States has the highest per capita emissions of GHGs in the world, 22 tons of CO_2 per person per year (see figure 1-2). With only five percent of the world's population, the United States is responsible for 24 percent of the world's CO_2 emissions. California, despite its strong environmental regulations, is the second largest greenhouse gas polluting state in the nation, and emits 2% of global human-generated emissions. Its largest contribution of CO_2 is from vehicle emissions.

According to the International Panel on Climate Change (IPCC), the following are current worldwide statistics for CO_2 concentrations (IPCC, 2008):

- The atmospheric concentration of carbon dioxide (CO_2) during the last two decades has increased at the rate of 0.4% every year.
- Current CO_2 concentrations are higher than they have been in the last 420,000 years, and according to some research, the last 20 million years.
- About three-quarters of the CO_2 emissions produced by human activity during the past 20 years are due to the burning of fossil fuels.

Figure A-2 – Per Capita CO_2 Emissions from 2001



Source: Energy Information Administration, 2001.

Human Health

According to the Pew Center's report on Human Health and Climate Change, health threats may depend on surpassing a threshold level of a climate factor such as significant change in temperature, precipitation, or storm frequency. Once that threshold has passed, the incidence of disease may drastically increase.

Environmental factors play a significant role in some diseases carried by insects. Warming could make tick-borne Lyme disease more prevalent. Mosquito-borne diseases such as West Nile virus, Dengue Fever, and Malaria could acquire new ranges and access to previously unexposed populations (IPCC, 2001). For example, the temperature range at which the malaria-carrying mosquito lives is sensitive to a mere one-degree in temperature change; thus an overall increase in global temperatures will increase the land areas where it may spread disease. These temperature changes affect not only the mosquitoes, but also disturb and in some cases decrease the habitats of its natural predators (Rogers, 2002).

Ecosystems

Scientists predict serious consequences of global warming. The rapid, unprecedented increase in temperatures accelerates the water cycle, which then increases the occurrence, variability, and severity of storms and drought (IPCC, 2008). Such extreme climate events will potentially disrupt ecosystems and damage food and water supplies. In addition, increased temperatures cause thermo-expansion of the oceans and accelerate the melting of the icecaps, thereby raising the overall level of the oceans. The sea-level rise may have multiple outcomes, including significant

environmental disturbances, coastline destruction, major population displacement and economic disruption.

While there is some degree of uncertainty, scientists are able to predict many of the challenges that climate change presents to ecosystems. Warmer temperatures may force some species to higher altitudes or more northern latitudes. This migration may be prevented by human developments that literally block the path as well as non-native species that can out-compete native plants and animals in new locations or make those areas uninhabitable. For example, there is evidence that certain butterflies, often a species that is used to indicate the health of an ecosystem, are moving further north, and are seldom seen in the southern reaches of their range. In addition, warmer temperatures have enabled the Jeffrey pine beetle to have more than one birth cycle per season, lengthening the amount of time this pest is able to damage trees (USC, 200 Pg 1-6). Furthermore, human impact other than greenhouse gas emissions will exacerbate challenges to ecosystems attempting to reestablish at higher elevations or new locations. According to the UCS report, “In many parts of California, fragmentation of the landscape by human developments, invasions by nonnative species, and air pollution may limit the reestablishment of native ecosystems.” (UCS, 200 Pg 1-6).

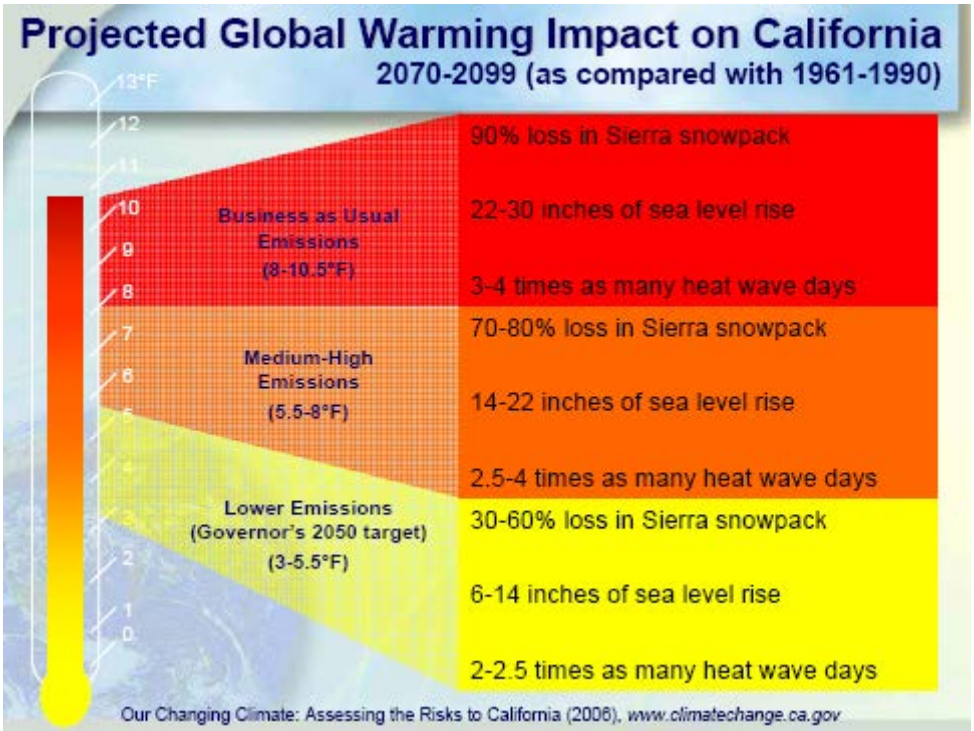
Impacts to California

While it is a global problem, influenced by an array of interrelated factors, climate change is also a regional and local problem, with serious impacts foreseen for California, the Southern California Area.

The impacts of climate change will be variable and widespread. Global and local climate change will impact weather, sea-level rise, water resources, ecosystems, human health, economy, and infrastructure.

Projected future climate change may affect California in a variety of ways. Public health can suffer due to greater temperature extremes and more frequent extreme weather events, increases in transmission of infectious disease, and increases in air pollution. Agriculture is especially vulnerable to altered temperature and rainfall patterns, and new pest problems. Forest ecosystems would face increased fire hazards and would be more susceptible to pests and diseases. The Sierra snowpack that functions as the state's largest reservoir could shrink by one third by 2060, and to half its historic size by 2090. Run off that fills reservoirs will start in midwinter, not spring, and rain falling on snow will trigger more flooding. The California coast is likely to face a rise in sea level that could threaten its shorelines. Sea level rise and storm surges could lead to flooding of low-lying property, loss of coastal wetlands, erosion of cliffs and beaches, saltwater contamination of drinking water, and damage to roads, causeways, and bridges. Figure 1-3 illustrates potential impacts from global warming on California (2070-2099).

Figure A- 3 – Projected Global Warming Impacts on California (2070-2099)



Ultimately, in the next few decades, the impacts of climate change on weather in California will see warmer overall temperatures and an increase in precipitation events, with an increase of intensity and frequency of rainstorms.

Climate and Weather

There is a key difference between climate and weather. According to the National Science Foundation report on climate change in California, "Weather is the day-to-day phenomena we experience—sun, rain, fog, warm, cold, wind—that vary greatly. Climate is long term statistical patterns of weather…and is reflected in average temperatures, rainfall, and other weather events at a given location, and climate change is signaled by long-term changes in those averages" (CRA, 2002).

In 1999, the Union of Concerned Scientists and the Ecological Society of America published a report called *Confronting Climate Change in California*, which describes the predicted impacts of climate change in California. According to this report, California has had a 2 °F increase in temperature over the past 100 years, and annual precipitation has decreased by 10-25% in some regions The report also noted that most climate change models predict a temperature increase of 4° F in California in the next 20 to 40 years. These models also projected a decrease in the

number of long dry spells, and an annual precipitation increase of 20-30% (with a range of 10-50%) in spring and fall, with somewhat larger increases in winter. One model reveals a large increase in precipitation over California, particularly in the form of rain, but with dry areas to the east of the Sierra. This regional model projects that winter precipitation over the coastal areas and the Sierra will increase by 25% or more, with an associated risk of increases in winter mud slides and flooding (UCS, 1999).

Much of the anticipated changes in climate will depend on the frequency and strength of the El Niño-Southern Oscillation phenomenon (ENSO). Most global climate change models indicate the possibility of more frequent ENSO events. El Niño historically happens every two to seven years off the west coast of South America, as a result of changes in ocean currents and prevailing winds over the Pacific Ocean. These changes bring warm water from the western oceans, displacing the nutrient-rich cold water that normally wells up on the western coasts of the Americas from deep in the ocean. These changes bring more frequent and extreme weather anomalies, including severe droughts and floods, hurricanes and winter storms. According to the National Science Foundation, "the invasion of warm water disrupts both the marine food chain and the economies of coastal communities that are based on fishing and related industries" (CAR, 2002). The effects of El Niño in California vary across the state, but in the past have included abnormally frequent winter rains and storms, and abnormally dry summers and associated wildfires (UCS, 1999). The 1982-83 El Niño, the strongest event in recorded history, brought $8 billion in economic impacts and $100 million in California alone (CAR, 2002).

Water Resources

Climate change impacts will bring an additional burden to California's already over-taxed water supply system. According to the IPCC there will be an increase in the number of intense precipitation days and flood frequencies in basins driven by snowmelt, such as California's Central Valley (IPCC, 2001). For this type of basin, the accumulation of snow in winter is the essential "water tower" that stores water until the spring's warmer temperatures begins to melt the snow, forming the streams and rivers that supply the entire watershed with water for the duration of the summer.

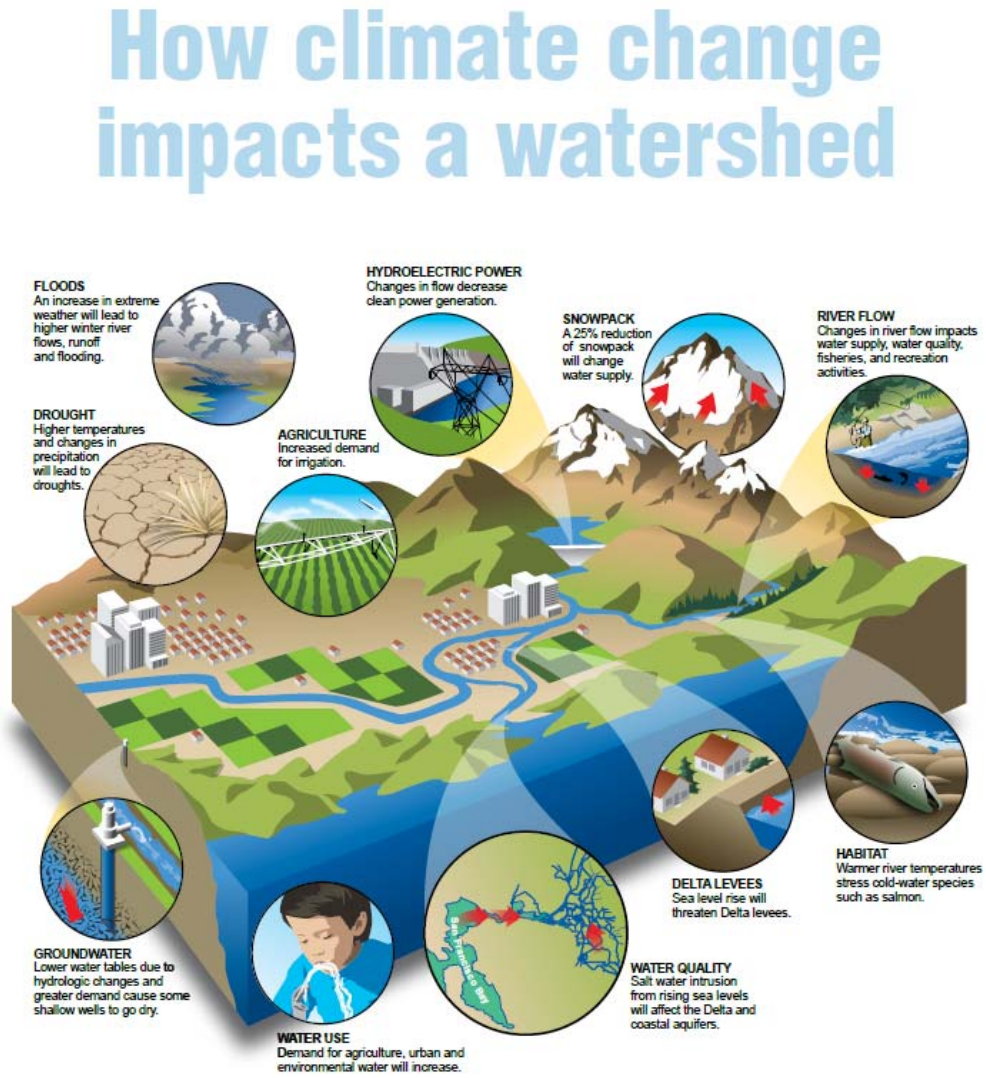
Even under normal climatic conditions, 80% of California's annual rainfall occurs in the winter and is stored in the snowpacks of the various mountain ranges (UCS, 2005). The warmer temperatures associated with climate change will increase rainstorms and decrease snowstorms, shorten the overall snowfall season, and accelerate the rate of spring snowmelt, ultimately leading to more rapid, earlier, and greater spring runoff (Frederick, 1999). The anticipated early spring floods are likely to be followed by excessively dry summers.

California's water supply is already under stress. According to the National Science Foundation report on climate change in California, "Every major water supply source in California is [decreasing in capacity and] currently over-allocated (CRA, 200 Pg 1-5). A combination of natural and human activities is causing this depletion of California water supplies as well as water intrusion and chemical contamination. According to the Union of Concerned Scientists (UCS), 95% of the state's wetlands have already been destroyed.

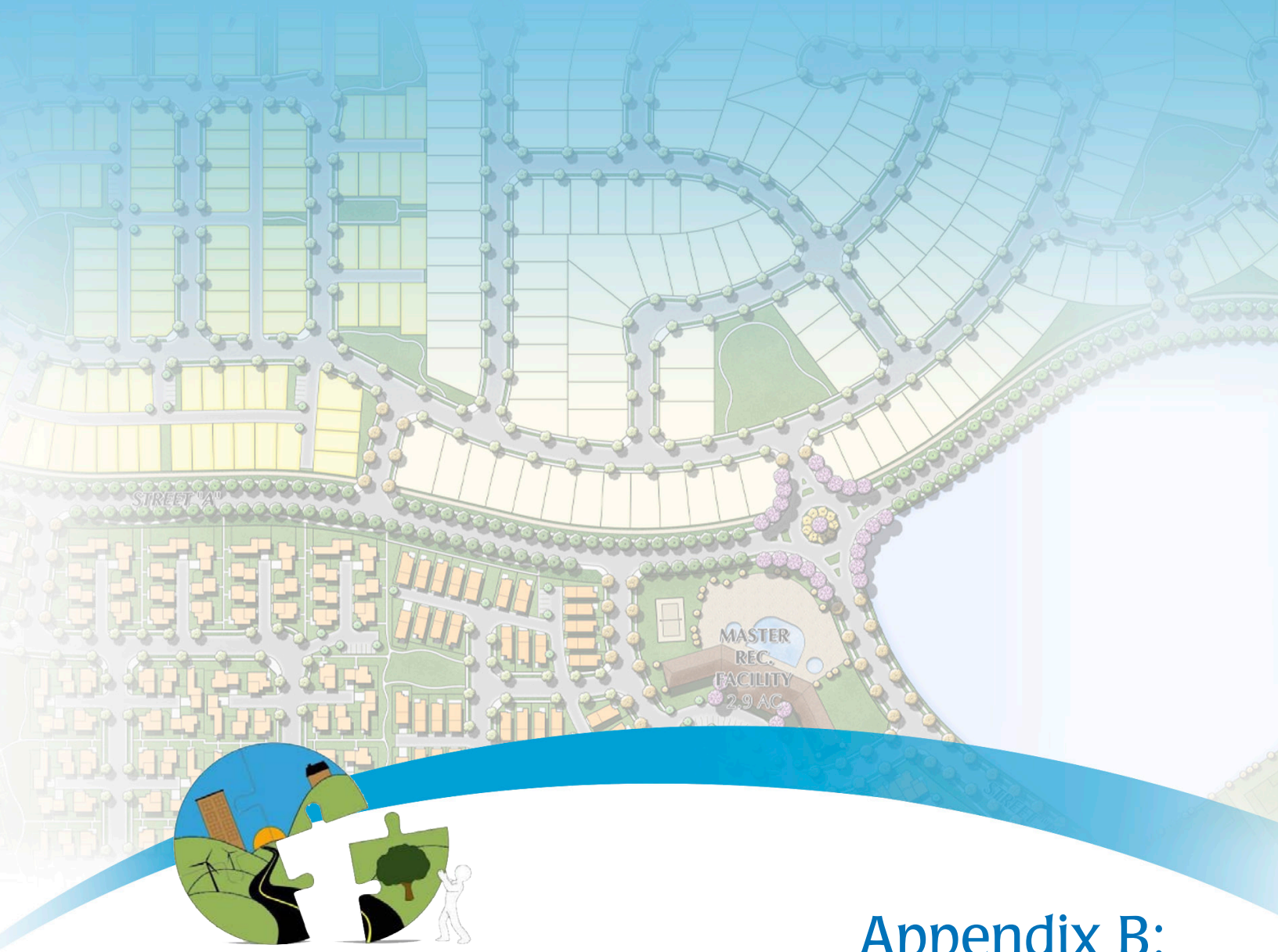
In the past, California Water Resources on a statewide basis has allowed California to meet most of its agricultural and urban water management objectives and flood management objectives in most years. Generally, during a single dry year or two, surface and groundwater storage can maintain most water deliveries, but can result in critically low water reserves. Longer droughts can create numerous problems, including extreme fire danger, economic harm to urban and rural communities, loss of crops, and the potential for species collapse and degraded water quality in some regions. Water demand in California is already increasing because of population expansion. In addition, demand for water for irrigation rises with warmer temperatures. Summers with higher temperatures and even less rainfall and runoff than usual will exacerbate demands for water in California.

Climate change magnifies the problems that exist with an aging water infrastructure and growing population. While recent bond measures have provided a down payment for improving California's water and flood systems, climate change presents an ongoing risk that requires a long-term commitment of funding that is properly matched to anticipated expenditures, beneficiaries and responsible parties.

Figure A-4 – How Climate Change Impacts a Watershed



Source: California Department of Water Resources 2008



Appendix B:
Modeling Coefficients and Data Assumptions

This page intentionally left blank

RIVERSIDE COUNTY
Greenhouse Gas Emissions Inventory
Modeling Assumptions

Assumptions

[1] Electricity providers for Riverside County unincorporated are Southern California Edison and Imperial Irrigation Distrtict. Both companies provided electricity usage organized by rate code for accounts within the unincorporated areas.

[2] Natural gas is serviced to Riverside County by the Southern California Gas Company. The Gas Company provided annual totals of residential, commercial, and industial natural gas use for the unincorporated areas of Riverside County for the year 2008.

[3-11] Riverside County receives water from a number of agencies and water districts, however, all of the water comes from either local sources (groundwater, surface water, or recycled water) or imported sources (The State Water Project or Colorado River Water). The energy associated with local sources is already included in the electricity data provided by the utilities. Imported water data was collected from Coachella Valley Water District, Desert Water Agency, Eastern Municipal Water District, Western Municipal Water District, Rancho California Water District, Palo Verde Irrigation District, Elsinore Valley Municipal Water Distrcit, and San Gorgonio Pass Water Agency.

[12] Riverside County Waste Management operates six active landfills: Badlands, Blythe, Desert Center, Lamb Canyon, Mecca II, and Oasis. El Sobrante Landfill is privately operated in the County. There are also closed landfills that continue to off gas methane as the waste decomposes. Waste Management provided fugitive methane emissions and onsite equipment fuel usage data for each active and closed landfill.

[13] Annual VMT for Riverside County accounts for miles traveled on trips with at least one end point in the unincorporated areas of the County. For this analysis, the total miles traveled for trips with both end points in the County was added to half of the miles traveled for trips with one end point in the County since those miles are shared with another jurisdiction.

[14] Emissions from aviation activities were based on aviation and jet fuel consumption from airport fueling stations in the unincorporated areas of Riverside County.

[15] Population, housing, and land use data was used to estimate landscaping and woodburning emissions, project future business as usual emissions, and categorize emissions as residential vs. non-residential.

[16] Emissions from agricultural activities vary depending on the type of crop or animal managed on the land. Southern California Association of Governments prepared CA GIS data detailing the acreage of each type of agricultural land use for the unincorporated areas of Riverside County.

Data Sources

[1] *Source: Southern California Edison, Electricity Use Report for the Unincorporated Area of Riverside County, July 2009-June 2010.*
[2] *Source: Imperial Irrigation District, kWh Billing Summary, 2008.*
[3] *Source: Southern California Gas Company, Riverside County Summary Data, 2008.*
[4] *Source: Coachella Valley Water District, Urban Water Management Plan, 2005 (Appendix E).*
[5] *Source: Desert Water Agency, Urban Water Management Plan, 2005.*
[6] *Source: Eastern Municipal Water District, Urban Water Management Plan, 2005.*
[7] *Source: Western Municipal Water District, Integrated Regional Water Management Plan, May 2008 (Section 4.1.2.2).*
[8] *Source: Western Municipal Water District, Comprehensive Annual Financial Report,2009.*
[9] *Source: Western Municipal Water District, Urban Water Management Plan, 2005.*
[10] *Source: Rancho California Water District, Urban Water Management Plan, 2005.*
[11] *Source: Elsinore Valley Municipal Water District, Financial Report 2007-2008.*
[12] *Source: San Gorgonio Pass Water Agency, Supplemental Water Supply Planning Study, October 2009.*
[13] *Source:* Riverside County Waste Management, 2008.
[14] *Source:* Riverside County Transportation and Land Management Agency, RivTAM Base Year Model for 2007 Socio-Economic Data.
[15] *Source:* Riverside County Economic Development Agency, airport fuel records, 2008.
[16] *Source:* CA Department of Finance, Population and Housing Estimates, 2008.
[17] *Source:* CA Department of Conservation, Division of Land Resource Protection, 2008 farmland GIS data. Prepared by Southern California Association of Governments (SCAG).

RIVERSIDE COUNTY
Greenhouse Gas Emissions Inventory
Modeling Assumptions

Mobile Source Emissions

	CO_2	CH_4	N_2O	Not Gas Dependent
Onroad Emission Factors (g/mile)				
Non Cat passenger Car [18]	469.64	-	-	
Cat passenger Car [18]	340.71	-	-	
Diesel Passenger Car [18]	359.47	-	-	
Non cat light-duty truck [18]	470.04	-	-	
Cat light duty truck [18]	424.04	-	-	
Diesel Light duty Truck [18]	346.44	-	-	
Non Cat light-duty truck 2 [18]	470.42	-	-	
Cat light duty truck 2 [18]	424.09	-	-	
Diesel Light duty truck 2 [18]	351.88	-	-	
Non Cat Medium duty Truck [18]	580.07	-	-	
Cat med duty truck [18]	580.46	-	-	
Diesel Med duty truck [18]	346.44	-	-	
Non Cat lite-heavy duty truck [18]	567.9	-	-	
Cat Light-heavy duty truck [18]	567.9	-	-	
Diesel Lite-heavy duty truck [18]	519.7	-	-	
Non Cat lite-heavy duty truck 2 [18]	567.9	-	-	
Cat Light-heavy duty truck 2 [18]	567.9	-	-	
Diesel Lite-heavy duty truck 2 [18]	528.63	-	-	
Non Cat med-heavy duty truck [18]	567.9	-	-	
Cat med-heavy duty truck [18]	567.9	-	-	
Diesel med-heavy duty truck [18]	1505	-	-	
Non cat Heavy Duty truck [18]	567.9	-	-	
Cat heavy duty truck [18]	567.9	-	-	
Diesel heavy duty truck [18]	1924.2	-	-	
Non Cat Other Bus [18]	567.9	-	-	
Cat other bus [18]	567.9	-	-	
Diesel Other Bus [18]	1505	-	-	
Non Cat Urban Bus [18]	567.9	-	-	
Cat Urban Bus [18]	567.9	-	-	
Diesel Urban Bus [18]	2779.2	-	-	
Non cat motorcycle [18]	121.23	-	-	
Cat motorcycle [18]	138.33	-	-	
Diesel Motorcycle [18]	0	-	-	
Non Cat School Bus [18]	567.9	-	-	
Cat School Bus [18]	567.9	-	-	
Diesel School Bus [18]	1505	-	-	
Non Cat Motor home [18]	567.9	-	-	
Cat Motor home [18]	567.9	-	-	
Diesel Motor home [18]	1505	-	-	
CO2 to CO2e multiplier [19]	-	-	-	1.0526
Aviation Gasoline (kg/gal) [20]	8.32	-	-	
Aviation Gasoline (gr/gal) [21]	-	7.04	0.11	
Jet Fuel (kg/gal)	9.57			
Jet Fuel (gr/gal)		0.27	0.31	

[18] *Source: Emissions Factors Software (EMFAC2007), California Air Resources Board, Version 2.3, November 2006.*

[19] *Source: Bay Area Air Quality Management District Greenhouse Gas Model (BGM) version 1.1.9 Beta. April 29, 2010.*

[20] *Source: California Climate Action Registry General Reporting Protocol, Version 3.1 January 2009 (Table C.3)*

[21] *Source: California Climate Action Registry General Reporting Protocol, Version 3.1 January 2009 (Table C.6)*

RIVERSIDE COUNTY
Greenhouse Gas Emissions Inventory
Modeling Assumptions

Landscape and Wood Burning Hearth Emissions

	CO_2	CH_4	N_2O	Not Gas Dependent
Mutifamily acres/property [22]				24.55
Multifamily landscaping tons/property/day [22]	0.25			
Multifamily average units/acre [22]				24.44
Single family tons/acre/day [22]	0.0193			
Single family average units/acre [22]				3.00
Non-Residential acres-to-building sq ft ratio [22]				1/2
Non-Residential tons/acre/day [22]	0.0102			
Woodburning emissions (lbs/ton of wood) [23]	3400			
Woodburning emissions (g/MMBTU) [23]		316.000	4.2000	
lbs/cord of wood [23]				2458
Energy Intensity of wood (MMBTU/ton) [23]				15.38

[22] *Source: URBEMIS2007 Emissions Estimation for Land Use Development Projects, Version 9.2*

[23] *Source: EPA AP-42 Emission Coefficients, Fifth Edition, Volume I October 1996 (Section 1.10)*

Natural Gas

	CO_2	CH_4	N_2O
Natural Gas Emissions (kg/MMBtu) [24]	53.06	0.005	0.0001

[24] *Source: California Climate Action Registry General Reporting Protocol, Version 3.1 January 2009 (Table C.7) - Kg/MMBtu*

Electricity

	CO_2	CH_4	N_2O
Southern California Edison 2005 (lbs/MWh) [25]	665.26	0.0076	0.0113
California Average 2005 (lbs/MWh) [25]	724.12	0.003	0.0081
Imperial Irrigation District 2005 (lbs/MWh) [25]	612.12	0.0314	0.0064

[25] *Source: Source: EPA Emission & Generation Resource Integrated Database (eGRID) Version 1.1*

Solid Waste

	CO_2	CH_4	N_2O
Density (g/cubic meter) [26]		662	

[26] *Source: USEPA (2007). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. United States Environmental Protection Agency. EPA 430-R-07-002. and Annex 3.10: Methodology for Estimating CH4 and N2O Emissions from Manure Management. April 15, 2007. Washington DC. http://www.epa.gov/climatechange/emissions/usgginv_archive.html*

RIVERSIDE COUNTY
Greenhouse Gas Emissions Inventory
Modeling Assumptions

Imported Water

	CO_2	CH_4	N_2O	Not Gas Dependent
Energy Intensity of Water Use (kWh/MG)				
Water Treatment [27]				111
Water Distribution [27]				1272
Wastewater Treatment [27]				1911
CA State Water Project Supply and Conveyance [27]				8325
Colorado River Water Supply and Conveyance [27]				6140

[27] *Source: CAPCOA Quantifying Greenhouse Gas Emissions, August 2010. Energy Intensity of Water Use to LA Basin (TableWSW-3.1)*

Standard Conversion Rates

	CO_2	CH_4	N_2O	Not Gas Dependent
gr/lb [28]				453.59291
lbs/short ton [28]				2000
metric tons/short ton [28]				0.907185
kg/ short ton [28]				907.18474
kg/metric ton [28]				1000
g/metric ton [28]				1,000,000
lbs/metric ton [28]				2204.62
therms per MMBTU [28]				0.10
kWh/MWh [28]				1000
kWh/GWh [28]				1,000,000
scf/Mcf [28]				1,000
Mcf/MMBTU [28]				0.9649
Gallons/Acre foot [29]				325,851.43
Gallons/ccf [29]				748.00

[28] *Source: California Climate Action Registry General Reporting Protocol, Version 3.1 January 2009 (Appendix B)*

[29] *Source:* http://onlineconversion.com/volume.htm

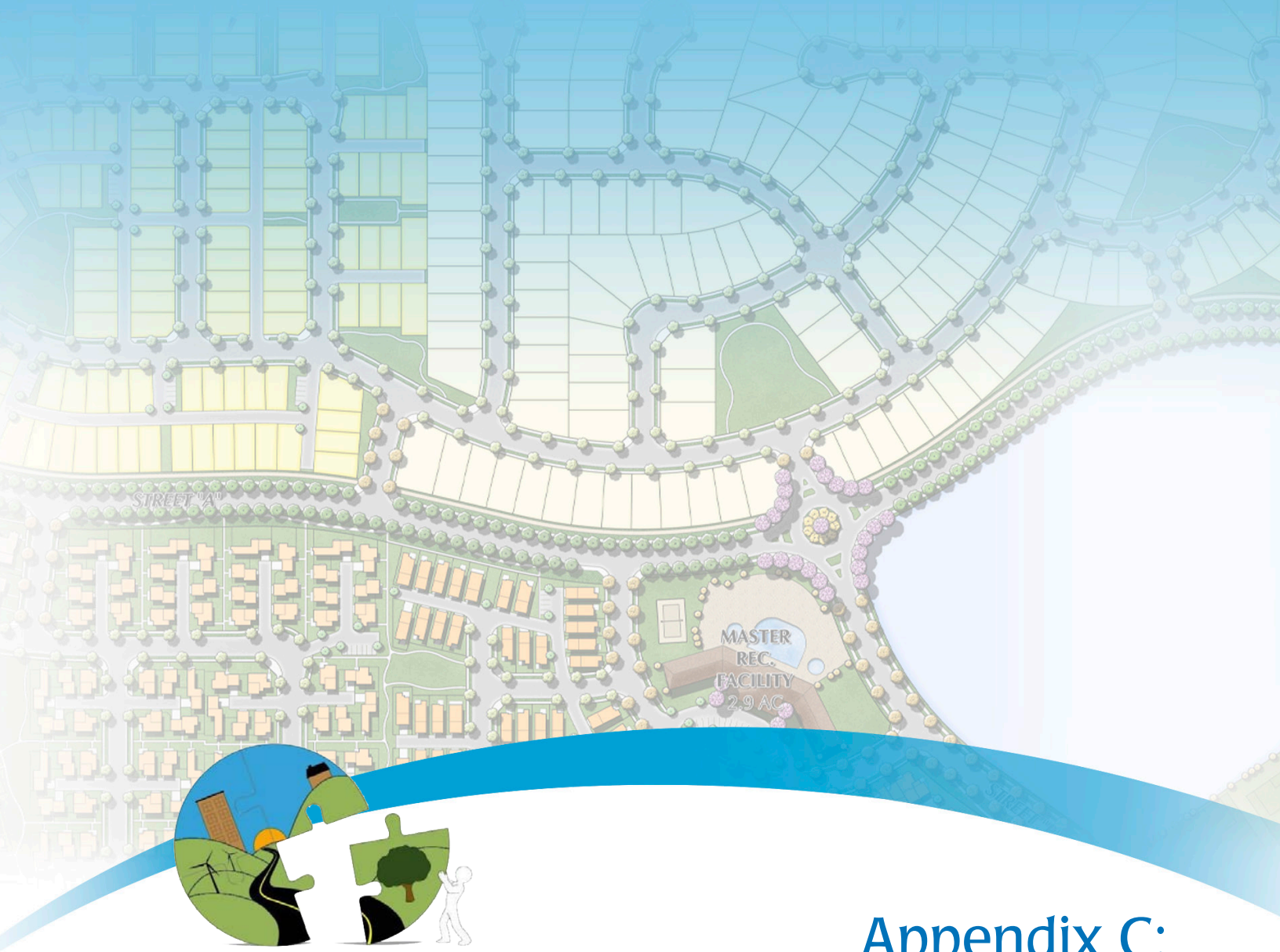
RIVERSIDE COUNTY
Greenhouse Gas Emissions Inventory
Modeling Assumptions

Agricultural

	CO_2	CH_4	N_2O	Not Gas Dependent	
# of hectares/acre [30]				0.4046945	
Ratio CH_4-C [30]				0.005	
Conversion CH_4-C to Full Mol. Wt. [30]				1.33	
Emission factor for liquid systems (kg N_2O-N/kg N) [30]				0.001	
Emission factor for solid systems (kg N_2O-N/kg N) [30]				0.02	
Ratio N_2O:N_2 [C_{10}] [30]				1.5714286	
Volitazition percent for all non-PRP ag soils [30]				0.2	
Volitazition percent for manure management [30]				0	
Rate NH_3-NO_X [30]				0.01	
Emission Factor for pastures, ranges, and paddocks [30]				0.02	
Emission factor for ground application [30]				0.0125	
Cwt (hundred weight) [30]				100	lbs
Volitazition of synthetic fertilizers [30]				0.1	
Volitazition of organic fertilizers [30]				0.2	
% leached from soils [30]				0.3	
Leaching Factor (kg N_2O-N / kg N) [30]				0.025	
Nitrogen Content of Non-manure Organics [30]				0.041	
Emission factor for soils (kg N2O-N/kgN) [30]				0.01	
N2O Emissions from Volitazition [30]				0.01	
N content of aboveground biomass for N-fixing crop production [30]				0.03	
Emission Factor for Temperate zone Histols (kg N2O-N / ha_yr) [30]				8	
Emission Factor for Subtropic zone Histols (kg N_2O-N / ha_yr) [30]				12	
N_2O-N Emissions Ratio [R_{N20_N}] [30]				0.007	
% of target year applied [30]				0.65	
% of following year applied [30]				0.35	

[30] *Source:* EPA State Inventory Tool for Agriculture, July 2008.

This page intentionally left blank



Appendix C:
Data Inputs

This page intentionally left blank

RIVERSIDE COUNTY
Greenhouse Gas Emission Inventory
Annual Usage and Generation

Inventory Year: 2008

Growth Rates	to 2020	to 2035
Residential	62.41%	92.55%
Non-Residential	96.10%	165.12%

Transportation

On-road Transportation

Annual Vehicle Miles Traveled	5,161,531,679
Annual Residential Trips	590,542,591
Annual Non-Residential Trips	271,942,936
Average $/gallon Gasoline:	$3.56
Average $/gallon Diesel:	$3.93

Aviation

	Annual Gallons	$/gallon
Jet Fuel	1,832,210	$0.10
Aviation Fuel	404,676	$0.10

Electricity and Natural Gas

Electricity

Socal Edison Electricity

Rate Code	Annual kWh	$/kWh	$
AG TOU	112,208,191	$0.09875	$11,080,513.98
Domestic	1,256,041,296	$0.11795	$148,144,544.28
GS-1	82,884,759	$0.17841	$14,787,469.85
GS-2	262,676,044	$0.08121	$21,332,341.81
PA-1	16,947,950	$0.13312	$2,256,145.00
PA-2	12,945,067	$0.11644	$1,507,266.64
Street Lighting	98,026,610	$0.07921	$7,764,923.04
TOU-8	596,794,701	$0.08680	$51,800,825.18
TOU-GS	154,930,764	$0.18348	$28,426,510.66
TOTAL	**2,593,455,382**		**$287,100,540.45**

SoCal Edison Emission Factors	
Default (2005)	Units
665.2607	lbs CO_2/MWh
7.5986	lbs CH_4/GWh
11.3094	lbs N_2O/GWh

2005 California Emission Factors	
Default (2005)	Units
724.12	lbs CO_2/MWh
30.24	lbs CH_4/GWh
8.08	lbs N_2O/GWh

Imperial Irrigation District

Rate Code	Annual kWh	$/kWh	$
Residential	450,673,960	$0.0784	$35,332,838.46
Energy Assistance	41,236,677	$0.0549	$2,263,068.83
Mobile Home	37,606,910	$0.0676	$2,542,227.12
Agricultural	62,987,028	$0.0618	$3,892,598.33
Small Commercial	101,736,856	$0.0820	$8,342,422.19
Large Commercial	321,462,730	$0.0659	$21,184,393.91
Industrial	266,000	$0.0628	$16,704.80
Street Lights	4,298,352		$0.00
Area Lighting	83,496		$0.00
Public Authority	12,398,373	$0.0732	$907,560.90
Interdepartmental	1,542,560		$0.00
TOTAL	**1,034,292,942**		**$74,481,814.55**

Imperial Irrigation District Emission Factors	
Default (2005)	Units
612.12	lbs CO_2/MWh
31.41	lbs CH_4/GWh
6.37	lbs N_2O/GWh

Cogeneration

	Annual mWh
Badlands	5,351.15
El Sorbante	15,641.82

Natural Gas

	therms	$/therms
Residential	52,372,096	$0.80
Commercial/Industrial	43,546,543	$0.61
TOTAL	**95,918,639**	**$68,461,068.03**

Area Source Emissions: Landscaping and Woodburning Emissions

Landscaping Emissions

Land use:

Single Family Residential Units:	112,132	units
Multi-family Residential Units:	48,854	units
Commercial Building Space:	169,585	1000 square feet
Industrial Building Space:	33,905	1000 square feet

Woodburning Emissions

Homes with wood stoves:	35%	% of residential homes
Amount of wood burned:	0.80	cords/unit
Homes with fireplaces:	10%	% of residential homes
Price of wood:	$3.50	$/cord of wood

Water

Imported Water

	Treated (acre-feet)		Untreated (acre-feet)	
	State Water Project	**Colorado River Water**	**State Water Project**	**Colorado River Water**
Coachella Valley Water District		14,338.01		
Desert Water Agency		18,347.58		
Eastern Municipal Water District	38,396.92	33,412.70	313.27	272.60
Elisinore Valley Municipal Water District	7,055.06	6,139.26		
Rancho California Water District	12,311.55	10,713.41	6,484.35	5,642.63
San Gorgonio Water Agency	2,175.10			
Western Municipal Water District	28,650.00	9,550.00		
Total Imported Water	**88,588.63**	**92,500.96**	**6,797.62**	**5,915.24**

Solid Waste

Onsite Equipment

Total Diesel Use (gal)	487,768
Total LNG Use (gal)	368,838

Waste Sources

% Residential	35%
% Non-Residential	65%

Fugitive Methane Emissions

	Measured LFG Flow (SCFM)	% LFG as CH_4	Destruction Efficiency	Methane Capture in 1990?
BADLANDS (flare alone)	639	43.7%	99.999629%	
BADLANDS (flare w/engine)	189	43.7%	99.999629%	
BADLANDS (engine)	450	44.0%	99.700000%	
BLYTHE	20	8.0%	0.000000%	
COACHELLA (1997)	346	36.8%	99.999644%	
CORONA (1986)	225	37.6%	99.900000%	Y
DOUBLE BUTTE (1994)	190	31.8%	99.999708%	
EDOM HILL (1997)	700	49.7%	99.999785%	
ELSINORE (1965)	70	19.3%	99.900060%	
EL SOBRANTE (Total)	3014	45.0%	99.900000%	Y
HIGHGROVE (1998)	310	46.7%	99.999781%	
LAMB CANYON	642	37.8%	99.999697%	
MEAD VALLEY (1997)	225	28.7%	99.999513%	
W. RIVERSIDE (1993)	66	26.2%	99.999149%	Y

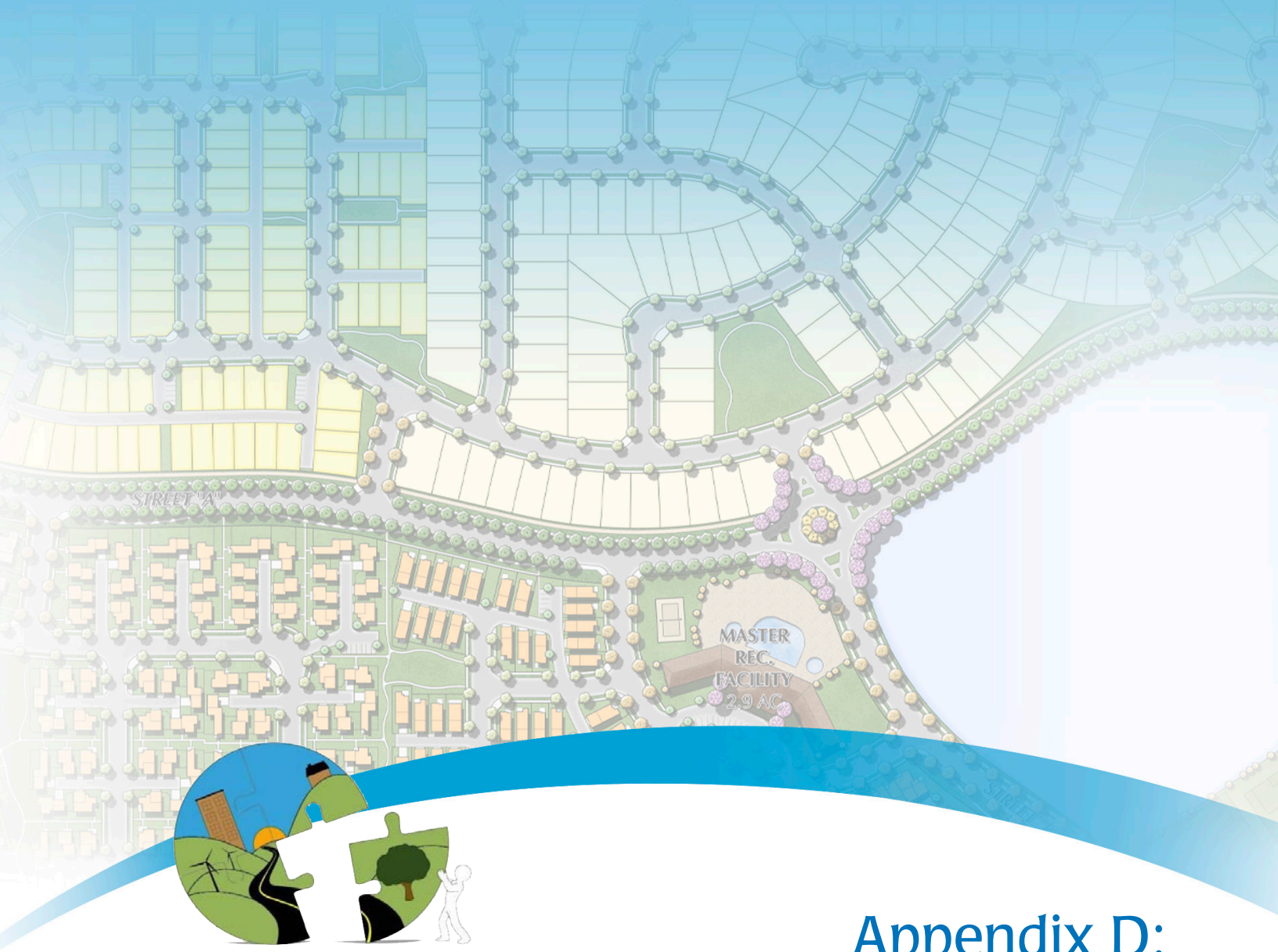
Agriculture

Annual Crop Growth

	Acres Harvested	Annual Yield (tons)
Hay (including Alfalfa)	29648	257608
Corn	497	24827
Oats	1150	3329
Sorghum	3197	22942
Wheat	14817	55589
Cotton	6901	7073
Vegetable Crops & Fruit Trees	43898	289710

Annual Animal head

	#
Dairy Cow	43,773
Poultry	5,260,914
Sheep	12,700



Appendix D:
GHG Inventory Calculations

This page intentionally left blank

RIVERSIDE COUNTY
Greenhouse Gas Emission Inventory
Climate Action Plan Comparison Summary

	2008	1990	2020	Reduced 2020
Transportation				
Mobile Source Emissions	2,829,359	2,404,955	6,956,170	2,432,871
Jet Fuel	17,721	15,063	17,721	17,721
Aviation Fuel	3,441	2,924	3,441	3,441
Sub Total	***2,850,520***	***2,422,942***	***6,977,331***	***2,454,032***
Energy				
Electrical Consumption	1,068,946	908,604	1,924,185	638,235
Natural Gas	510,249	433,711	906,738	504,737
Sub Total	***1,579,195***	***1,342,316***	***2,830,923***	***1,142,973***
Area Sources				
Landscaping	150,639	128,043	250,422	126,463
Woodburning	118,543	100,761	191,603	103,725
Sub Total	***269,181***	***228,804***	***442,024***	***230,188***
Water and Wastewater				
Water consumption	152,473	129,602	175,344	109,021
Sub Total	***152,473***	***129,602***	***175,344***	***109,021***
Solid Waste				
Landfill Offgasing	170,929	145,290	269,993	133,217
Onsite Equipment	6,755	5,741	7,768	7,768
Sub Total	***177,684***	***151,031***	***277,761***	***140,985***
Agriculture				
Enteric Fermentation	115,584	98,246	86,688	80,051
Manure Management	199,873	169,892	149,905	140,938
Rice Cultivation	0	0	0	0
Agriculture ResidueBurning	166	141	124	124
Annimals and Runoff	235,565	200,230	176,674	176,674
Fertilizer Use	246,162	209,237	184,621	184,621
Crop Growth	1,233,081	1,048,119	924,811	924,811
Sub Total	***2,030,431***	***1,725,866***	***1,522,823***	***1,507,220***
TOTAL	**7,059,485**	**6,000,562**	**12,226,206**	**5,584,418**

Source	2008	1990	2020	Reduced 2020
Transportation	2,850,520	2,422,942	6,977,331	2,454,032
Energy	1,579,195	1,342,316	2,830,923	1,142,973
Area Sources	269,181	228,804	442,024	230,188
Water and Wastewater	152,473	129,602	175,344	109,021
Solid Waste	177,684	151,031	277,761	140,985
Agriculture	2,030,431	1,725,866	1,522,823	1,507,220
Total	7,059,485	6,000,562	12,226,206	5,584,418
2020 Reduction Target	11,268,449	9,578,182	6,036,971	6,036,971

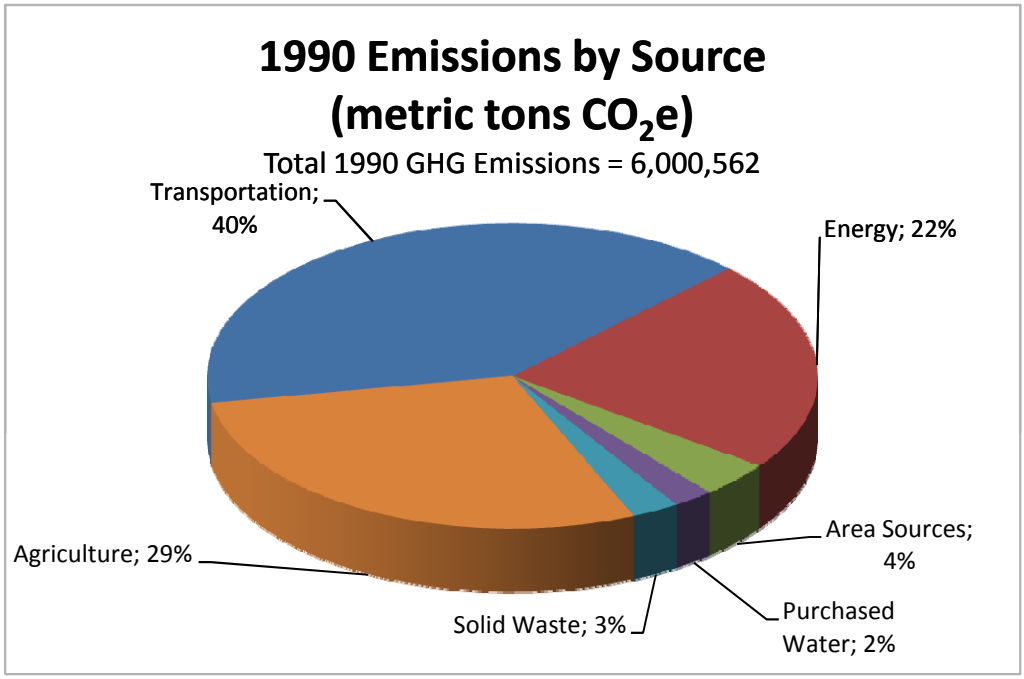
RIVERSIDE COUNTY
Greenhouse Gas Emission Inventory
2008 Emission Inventory

	CO_2	CH_4	N_2O	Total MT CO_2e	Annual Cost
Transportation					
Mobile Source Emissions	2,687,891	18,391	113,174	2,819,456	$1,291,364,434
HFC's from mobile sources	-	-	-	9,903	
Jet Fuel	17,534	10	176	17,721	$183,221
Aviation Fuel	3,367	60	14	3,441	$40,468
Sub Total	*2,708,792*	*18,461*	*113,364*	***2,850,520***	***$1,291,547,655***
Energy					
Electrical Consumption	1,063,434	496	5,017	1,068,946	$287,100,540
Electrical Generation					$35,332,838
Natural Gas	508,944	1,007	297	510,249	$68,461,068
Sub Total	*1,572,378*	*1,503*	*5,315*	***1,579,195***	***$390,894,447***
Area Sources					
Landscaping	150,639	-	-	128,043	
Woodburning	109,847	7,270	1,426	118,543	$202,842
Sub Total	*260,485*	*7,270*	*1,426*	***269,181***	***$202,842***
Water					
Water consumption	151,815	133	525	152,473	
Sub Total	*151,815*	*133*	*525*	***152,473***	
Solid Waste					
Landfill Offgasing	-	170,929	-	170,929	
Onsite Equipment	6,596	5	154	6,755	
Sub Total	*6,596*	*170,934*	*154*	***177,684***	
Agriculture					
Enteric Fermentation	-	115,584	-	115,584	
Manure Management	-	169,058	30,815	199,873	
Agriculture ResidueBurning	-	124	42	166	
Annimals and Runoff	-	-	235,565	235,565	
Fertilizer Use	-	-	246,162	246,162	
Crop Growth	-	-	1,233,081	1,233,081	
Sub Total	*0*	*284,766*	*1,745,665*	***2,030,431***	
Total	**4,700,066**	**483,067**	**1,866,449**	**7,059,485**	**$1,682,644,944**

ATTACHMENT C-2

1990

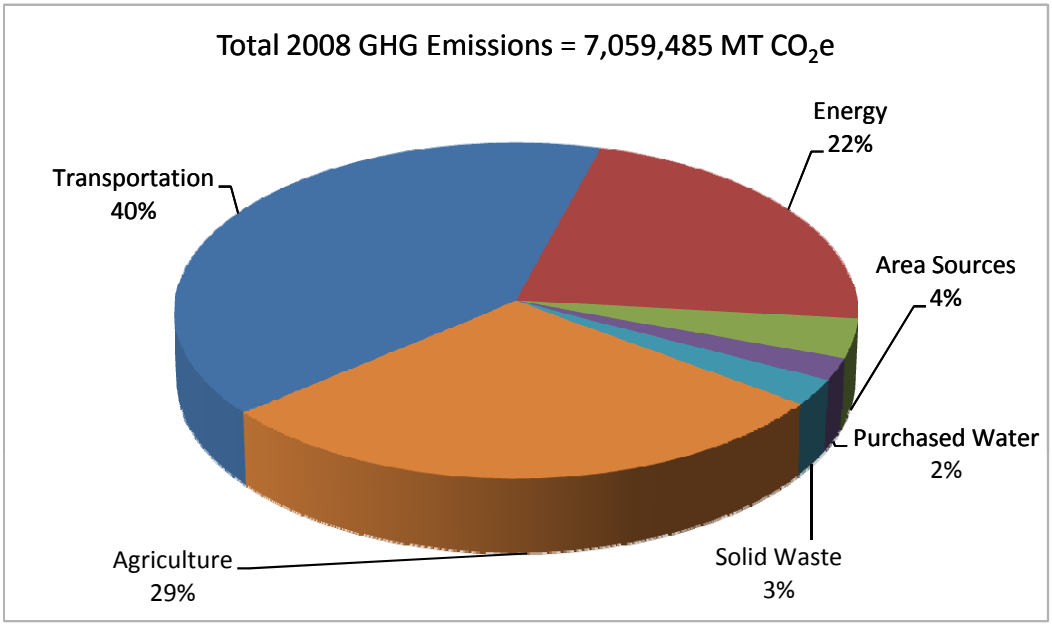
Net Total Emissions	
Category	**Metric tons of CO_2e**
Transportation	2,422,942
Energy	1,342,316
Area Sources	228,804
Purchased Water	129,602
Solid Waste	151,031
Agriculture	1,725,866
Total	6,000,562



ATTACHMENT C-2

2008

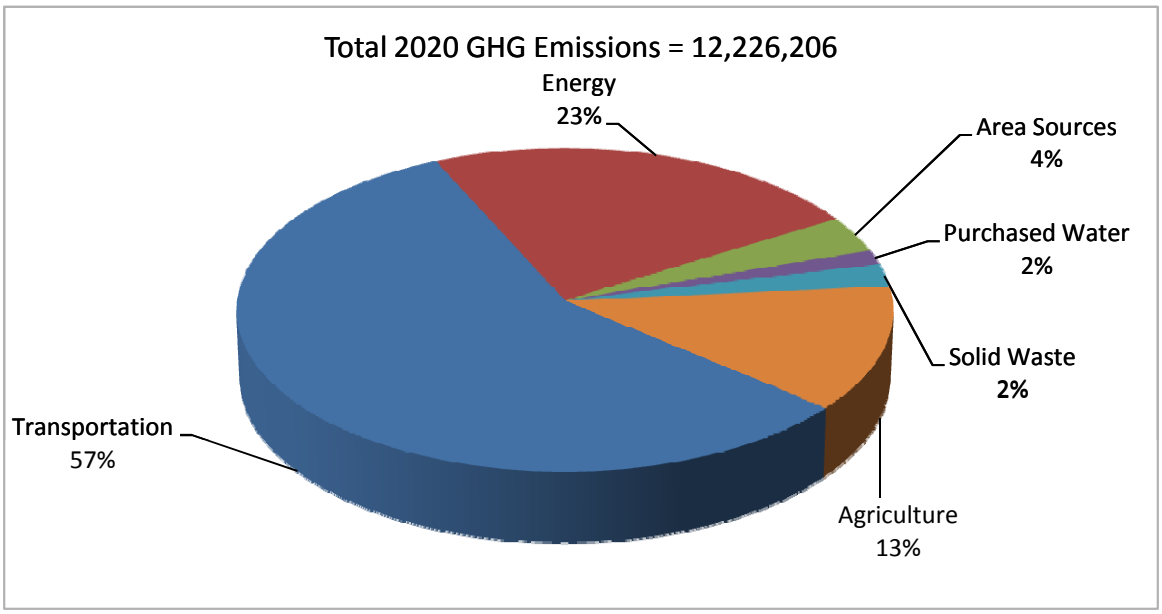
Net Total Emissions	
Category	**Metric tons of CO_2e**
Transportation	2,850,520
Energy	1,579,195
Area Sources	269,181
Purchased Water	152,473
Solid Waste	177,684
Agriculture	2,030,431
Total	7,059,485



ATTACHMENT C-2

2020 BAU

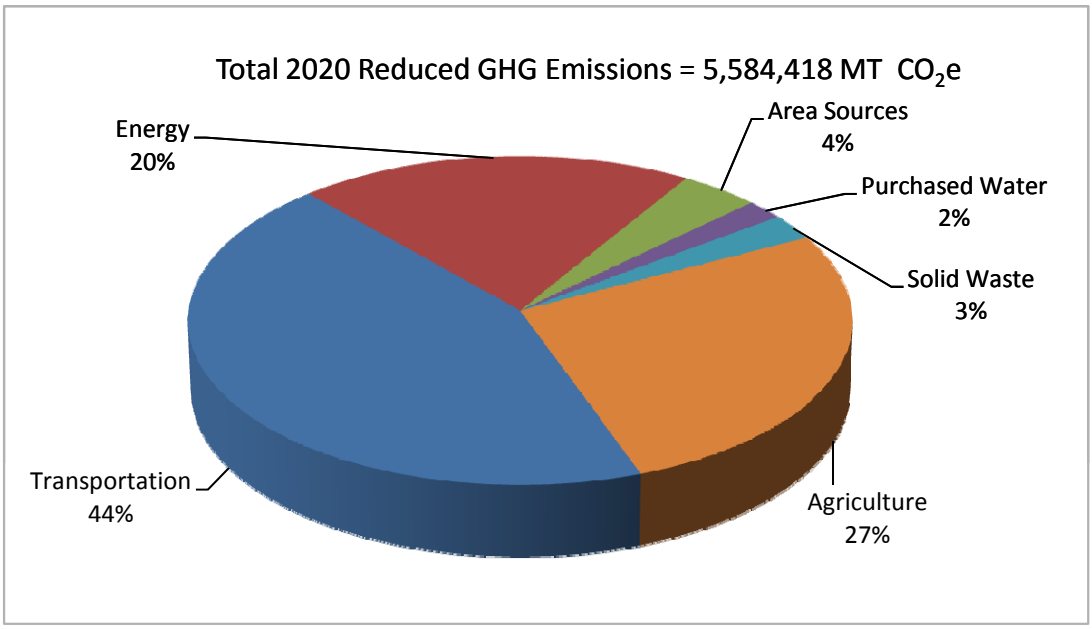
Net Total Emissions	
Category	**Metric tons of CO_2e**
Transportation	6,977,331
Energy	2,830,923
Area Sources	442,024
Purchased Water	175,344
Solid Waste	277,761
Agriculture	1,522,823
Total	12,226,206



ATTACHMENT C-2

2020 Reduced

Net Total Emissions	
Category	**Metric tons of CO_2e**
Transportation	2,454,032
Energy	1,142,973
Area Sources	230,188
Purchased water	109,021
Solid Waste	140,985
Agriculture	1,507,220
Total	5,584,418



RIVERSIDE COUNTY
Greenhouse Gas Emission Inventory
Annual Usage and Generation

Inventory Year: 2008

Growth Rates	to 2020	to 2035
Residential	62.41%	92.55%
Non-Residential	96.10%	165.12%

Transportation

On-road Transportation

Annual Vehicle Miles Traveled	5,161,531,679
Annual Residential Trips	590,542,591
Annual Non-Residential Trips	271,942,936
Average $/gallon Gasoline:	$3.56
Average $/gallon Diesel:	$3.93

Aviation

	Annual Gallons	$/gallon
Jet Fuel	1,832,210	$0.10
Aviation Fuel	404,676	$0.10

Electricity and Natural Gas

Electricity

Socal Edison Electricity

Rate Code	Annual kWh	$/kWh	$
AG TOU	112,208,191	$0.09875	$11,080,513.98
Domestic	1,256,041,296	$0.11795	$148,144,544.28
GS-1	82,884,759	$0.17841	$14,787,469.85
GS-2	262,676,044	$0.08121	$21,332,341.81
PA-1	16,947,950	$0.13312	$2,256,145.00
PA-2	12,945,067	$0.11644	$1,507,266.64
Street Lighting	98,026,610	$0.07921	$7,764,923.04
TOU-8	596,794,701	$0.08680	$51,800,825.18
TOU-GS	154,930,764	$0.18348	$28,426,510.66
TOTAL	**2,593,455,382**		**$287,100,540.45**

SoCal Edison Emission Factors	
Default (2005)	Units
665.2607	lbs CO_2/MWh
7.5986	lbs CH_4/GWh
11.3094	lbs N_2O/GWh

2005 California Emission Factors	
Default (2005)	Units
724.12	lbs CO_2/MWh
30.24	lbs CH_4/GWh
8.08	lbs N_2O/GWh

Imperial Irrigation District

Rate Code	Annual kWh	$/kWh	$
Residential	450,673,960	$0.0784	$35,332,838.46
Energy Assistance	41,236,677	$0.0549	$2,263,068.83
Mobile Home	37,606,910	$0.0676	$2,542,227.12
Agricultural	62,987,028	$0.0618	$3,892,598.33
Small Commercial	101,736,856	$0.0820	$8,342,422.19
Large Commercial	321,462,730	$0.0659	$21,184,393.91
Industrial	266,000	$0.0628	$16,704.80
Street Lights	4,298,352		$0.00
Area Lighting	83,496		$0.00
Public Authority	12,398,373	$0.0732	$907,560.90
Interdepartmental	1,542,560		$0.00
TOTAL	**1,034,292,942**		**$74,481,814.55**

Imperial Irrigation District Emission Factors	
Default (2005)	Units
612.12	lbs CO_2/MWh
31.41	lbs CH_4/GWh
6.37	lbs N_2O/GWh

Cogeneration

	Annual mWh
Badlands	5,351.15
El Sorbante	15,641.82

Natural Gas

	therms	$/therms
Residential	52,372,096	$0.80
Commercial/Industrial	43,546,543	$0.61
TOTAL	**95,918,639**	**$68,461,068.03**

Area Source Emissions: Landscaping and Woodburning Emissions

Landscaping Emissions

Land use:

Single Family Residential Units:	112,132	units
Multi-family Residential Units:	48,854	units
Commercial Building Space:	169,585	1000 square feet
Industrial Building Space:	33,905	1000 square feet

Woodburning Emissions

Homes with wood stoves:	35%	% of residential homes
Amount of wood burned:	0.80	cords/unit
Homes with fireplaces:	10%	% of residential homes
Price of wood:	$3.50	$/cord of wood

Water

Imported Water

	Treated (acre-feet)		Untreated (acre-feet)	
	State Water Project	**Colorado River Water**	**State Water Project**	**Colorado River Water**
Coachella Valley Water District		14,338.01		
Desert Water Agency		18,347.58		
Eastern Municipal Water District	38,396.92	33,412.70	313.27	272.60
Elisinore Valley Municipal Water District	7,055.06	6,139.26		
Rancho California Water District	12,311.55	10,713.41	6,484.35	5,642.63
San Gorgonio Water Agency	2,175.10			
Western Municipal Water District	28,650.00	9,550.00		
Total Imported Water	**88,588.63**	**92,500.96**	**6,797.62**	**5,915.24**

Solid Waste

Onsite Equipment

Total Diesel Use (gal)	487,768
Total LNG Use (gal)	368,838

Waste Sources

% Residential	35%
% Non-Residential	65%

Fugitive Methane Emissions

	Measured LFG Flow (SCFM)	% LFG as CH_4	Destruction Efficiency	Methane Capture in 1990?
BADLANDS (flare alone)	639	43.7%	99.999629%	
BADLANDS (flare w/engine)	189	43.7%	99.999629%	
BADLANDS (engine)	450	44.0%	99.700000%	
BLYTHE	20	8.0%	0.000000%	
COACHELLA (1997)	346	36.8%	99.999644%	
CORONA (1986)	225	37.6%	99.900000%	Y
DOUBLE BUTTE (1994)	190	31.8%	99.999708%	
EDOM HILL (1997)	700	49.7%	99.999785%	
ELSINORE (1965)	70	19.3%	99.900060%	
EL SOBRANTE (Total)	3014	45.0%	99.900000%	Y
HIGHGROVE (1998)	310	46.7%	99.999781%	
LAMB CANYON	642	37.8%	99.999697%	
MEAD VALLEY (1997)	225	28.7%	99.999513%	
W. RIVERSIDE (1993)	66	26.2%	99.999149%	Y

Agriculture

Annual Crop Growth

	Acres Harvested	Annual Yield (tons)
Hay (including Alfalfa)	29648	257608
Corn	497	24827
Oats	1150	3329
Sorghum	3197	22942
Wheat	14817	55589
Cotton	6901	7073
Vegetable Crops & Fruit Trees	43898	289710

Annual Animal head

	#
Dairy Cow	43,773
Poultry	5,260,914
Sheep	12,700

RIVERSIDE COUNTY
Greenhouse Gas Emission Inventory
Climate Action Plan Comparison Summary

	2008	2035	Reduced 2035
Transportation			
Mobile Source Emissions	2,829,359	9,296,880	2,596,201
Jet Fuel	17,721	17,721	17,721
Aviation Fuel	3,441	3,441	3,441
Sub Total	***2,850,520***	***9,318,041***	***2,617,363***
Energy			
Electrical Consumption	1,068,946	2,460,785	679,976
Natural Gas	510,249	1,150,593	644,658
Sub Total	***1,579,195***	***3,611,378***	***1,324,634***
Area Sources			
Landscaping	150,639	302,483	152,754
Woodburning	118,543	226,902	103,725
Sub Total	***269,181***	***529,384***	***256,478***
Water and Wastewater			
Water consumption	152,473	293,077	146,118
Sub Total	***152,473***	***293,077***	***146,118***
Solid Waste			
Landfill Offgasing	170,929	335,104	157,155
Onsite Equipment	6,755	11,595	11,595
Sub Total	***177,684***	***346,699***	***168,750***
Agriculture			
Enteric Fermentation	115,584	86,688	71,372
Manure Management	199,873	149,905	129,213
Rice Cultivation	0	0	0
Agriculture ResidueBurning	166	124	124
Annimals and Runoff	235,565	176,674	176,674
Fertilizer Use	246,162	184,621	184,621
Crop Growth	1,233,081	924,811	924,811
Sub Total	***2,030,431***	***1,522,823***	***1,486,815***
TOTAL	**7,059,485**	**15,621,403**	**6,000,158**

Source	2008	2035	Reduced 2035
Transportation	2,850,520	9,318,041	2,617,363
Energy	1,579,195	3,611,378	1,324,634
Area Sources	269,181	529,384	256,478
Water and Wastewater	152,473	293,077	146,118
Solid Waste	177,684	346,699	168,750
Agriculture	2,030,431	1,522,823	1,486,815
Total	7,059,485	15,621,403	6,000,158
2020 Reduction Target	6,000,562	6,000,562	6,000,562

Municipal GHG Inventory

Municipality: Riverside County
Inventory Year: 2008

Departmental Breakdown of Emissions

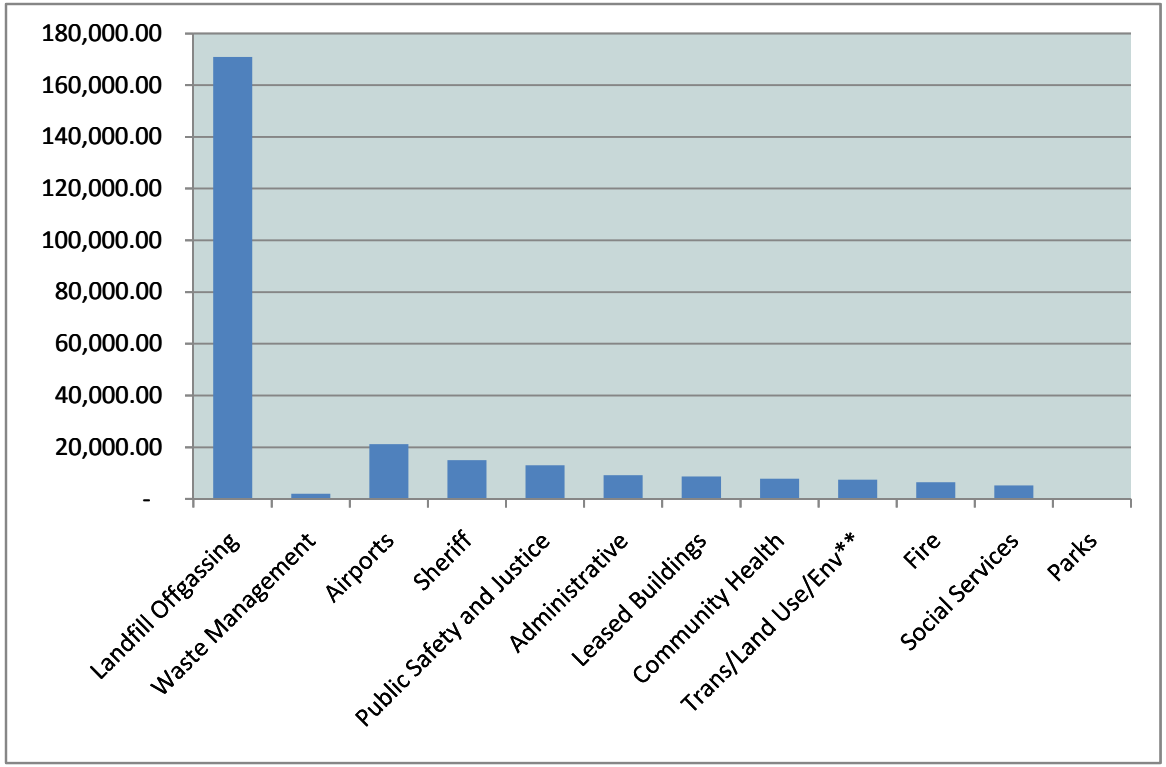
	Electricity		Natural Gas		Vehicle Fleet		Non-Highway Vehicles		TOTAL	
Government Department	MT CO_2e	$	MT CO_2e	$	MT CO_2e	$	MT CO_2e	$	MT CO_2e	$
Administrative	4,799.01	$ 1,561,862	178.04	$ 57,489	4,282.00	$ 1,413,845	0.07	$ 22	9,259.11	$ 3,033,217
Health Care	4,500.68	$ 1,464,769	393.03	$ 126,912	2,886.70	$ 949,046	-	$ -	7,780.41	$ 2,540,726
Public Safety and Justice	10,244.05	$ 3,333,978	1,946.92	$ 628,672	790.17	$ 261,140	-	$ -	12,981.15	$ 4,223,789
Social Services	1,952.45	$ 635,436	102.21	$ 33,005	3,151.04	$ 1,050,915	0.41	$ 117	5,206.12	$ 1,719,473
Parks	-	$ -	-	$ -	178.82	$ 59,011	-	$ -	178.82	$ 59,011
Waste Management	(6,031.26)	($1,962,903)	0.87	$ 282	1,303.98	$ 421,657	6,726.83	$ 2,158,244	2,000.43	$ 617,280
Sheriff	1,781.17	$ 579,692	160.69	$ 51,888	13,093.63	$ 4,376,235	3.18	$ 785	15,038.67	$ 5,008,600
Airports	-	$ -	-	$ -	88.69	$ 29,987	21,161.33	$ 223,689	21,250.02	$ 253,676
*Trans/Land Use/Env***	1,139.91	$ 370,990	-	$ -	4,596.25	$ 1,399,979	1,756.80	$ 430,517	7,492.96	$ 2,201,486
Leased Buildings	8,628.63	$ 2,808,230	124.72	$ 40,272	-	$ -	-	$ -	8,753.35	$ 2,848,502
Fire	1,423.53	$ 453,740	158.03	$ 51,028	4,959.76	$ 1,471,214	-	$ -	6,541.32	$ 1,975,982
Department 12	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Department 13	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Department 14	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Department 15	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Department 16	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Department 17	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Department TOTAL	**28,438.19**	**$ 9,245,794**	**3,064.51**	**$ 989,547**	**35,331.05**	**$ 11,433,028**	**29,648.61**	**$ 2,813,374**	**96,482**	**$ 24,481,743**
Solid Waste									170,929	
Grand TOTAL									**267,412**	

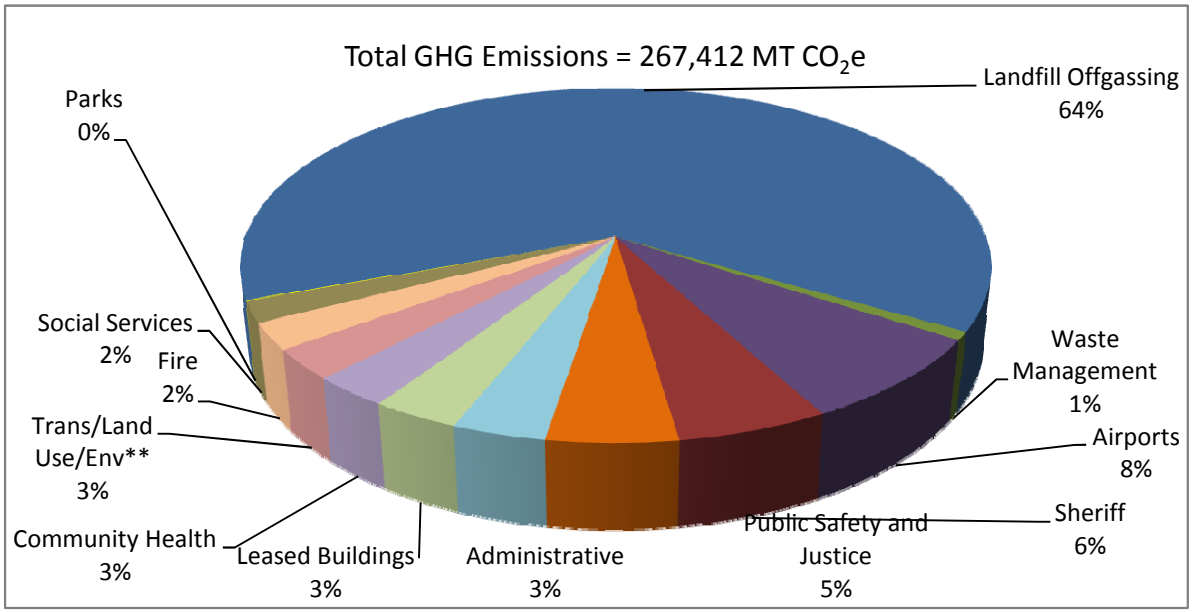
**Electricity is all streetlights

Other Sources

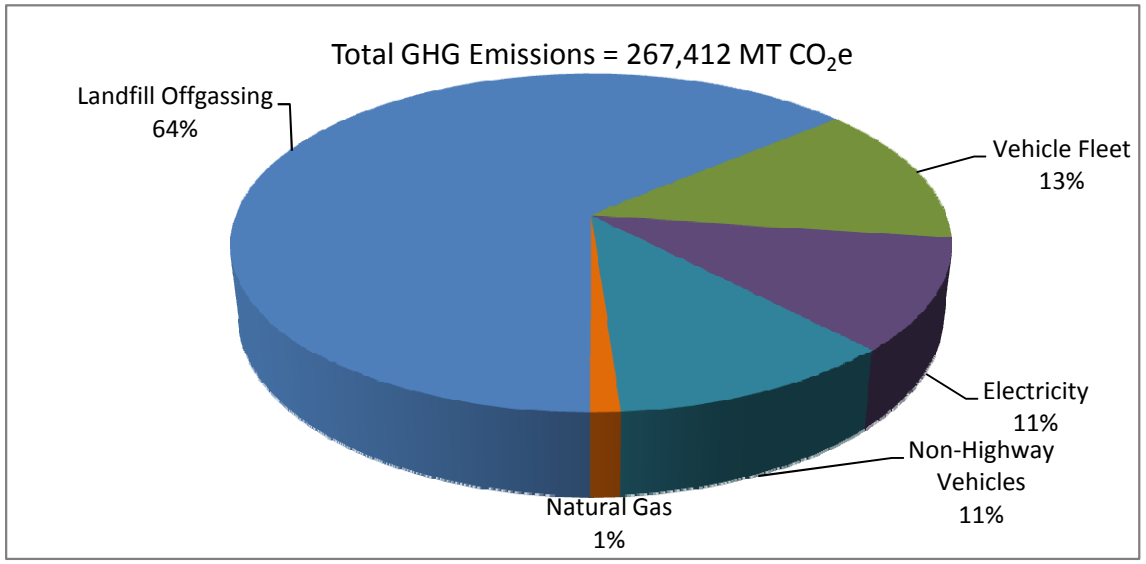
Solid Waste	CH_4 (MT)	CO_2e (MT)
Generated	0	0
Owned Landfills	8,139.50	170,929.49
TOTAL	8,139.50	170,929.49

Department	Total CO2e
Landfill Offgassing	170,929.49
Waste Management	2,000.43
Airports	21,250.02
Sheriff	15,038.67
Public Safety and Justice	12,981.15
Administrative	9,259.11
Leased Buildings	8,753.35
Community Health	7,780.41
Trans/Land Use/Env**	7,492.96
Fire	6,541.32
Social Services	5,206.12
Parks	178.82
TOTAL	**267,411.85**





Emissions Source	MT CO2e
Landfill Offgassing	170,929.49
Vehicle Fleet	35,331.05
Electricity	28,438.19
Non-Highway Vehicles	29,648.61
Natural Gas	3,064.51
TOTAL	**267,411.85**



Electricity

Instructions: Insert electricity use data for all facilities, streetlights, buildings, and other electric accounts owned/operated by the local government for each department. Also enter the emissions factors for CO^2, CH_4, and N_2O obtained from EPA eGrid or directly from the utility provider. Entering the rate code and associated cost per kWh of gas will allow the calculation of the total cost for each department's electricity use.

Utility Provider: Southern California Edison

Emissions Coefficients

CO_2	0.000301758	metric tons/kWh
CH_4	3.44667E-09	metric tons/kWh
N_2O	5.12986E-09	metric tons/kWh

GWP

CH_4	21
N_2O	310

				Metric Tons				
Department	Annual kWh	Rate Code	$/kWh	CO_2	CH_4	N_2O	CO_2e	$
Administrative	15,816,385	AG TOU	$ 0.10	4,772.71	0.05	0.08	4,799.01	$ 1,561,862
Health Care	14,833,161	AG TOU	$ 0.10	4,476.02	0.05	0.08	4,500.68	$ 1,464,769
Public Safety and Justice	33,761,938	AG TOU	$ 0.10	10,187.92	0.12	0.17	10,244.05	$ 3,333,978
Social Services	6,434,821	AG TOU	$ 0.10	1,941.76	0.02	0.03	1,952.45	$ 635,436
Parks		AG TOU	$ 0.10	-	-	-	-	$ -
Waste Management	1,115,393	AG TOU	$ 0.10	336.58	0.00	0.01	338.43	$ 110,145
Waste Management (Cogen)	-20,992,973		$ 0.10	(6,334.79)	(0.07)	(0.11)	(6,369.69)	$ (2,073,048)
Sheriff	5,870,325	AG TOU	$ 0.10	1,771.41	0.02	0.03	1,781.17	$ 579,692
Airports		AG TOU	$ 0.10	-	-	-	-	$ -
Trans/Land Use/Env**	3,756,877	AG TOU	$ 0.10	1,133.67	0.01	0.02	1,139.91	$ 370,990
Leased Buildings	28,437,889	AG TOU	$ 0.10	8,581.35	0.10	0.15	8,628.63	$ 2,808,230
Fire	4,710,834	see below		1,416.25	0.03	0.02	1,423.53	$ 453,740
TOTAL	**93,744,650**			**28282.8796**	**0.33259**	**0.47846**	**28,438.19**	**$ 9,245,794**
	114,737,623							

**Electricity is all streetlights

Notes: Used average rate of $0.10/kWh. Taken from community inventory spreadsheet. Fire Department received electricity from SCE, Imperial Irrigation District, and Anza Electric Cooperative.

Cogen is listed as a Negative value because they are generating the electricity and not consuming it.

	Annual KWh	$/kWh	Metric Tons CO_2	CH_4	N_2O	CO_2e	$
Fire (SCE)	3752160.5	0.09875	1132.24271	0.01293	0.01925	1138.48119	370524.3485
Fire (IID)	819644.8087	0.0732	227.577079	0.01168	0.00237	228.556476	59998
Fire (Anza)	139028.503	0.167	56.4348188	0.00111	0.00011	56.4923468	23217.76
Total	**4710833.812**		**1416.25461**	**0.02572**	**0.02173**	**1423.53002**	**453740.1085**

IID

612.12	lbs CO_2/MWh	0.000277653
31.41	lbs CH_4/GWh	1.42474E-08
6.37	lbs N_2O/GWh	2.88939E-09

Anza

894.9052	lbs CO_2/MWh	0.000405923
17.5432	lbs CH_4/GWh	7.95747E-09
1.7543	lbs N_2O/GWh	7.95738E-10

Natural Gas

Instructions: Insert natural gas use data for all facilities, buildings, and other accounts owned/operated by the local government for each department. Entering the rate code and associated cost per therm of gas will allow the calculation of the total cost for each department's natural gas use.

Utility Provider: Southern California Gas Company

Emissions Coefficients

CO2	52.91	g/MMBTU	0.0005291	metric tons/therm		GWP	
CH4	5	g/MMBTU	0.00005	metric tons/therm	CH4	21	
N2O	0.1	g/MMBTU	0.000001	metric tons/therm	N2O	310	

				Metric Tons				
Department	Annual therms	Rate Code	$/therm	CO_2	CH_4	N_2O	CO_2e	$
Administrative	94243.91	Commercial	$ 0.61	49.86	4.71	0.09	178.04	$ 57,488.79
Health Care	208052.55	Commercial	$ 0.61	110.08	10.40	0.21	393.03	$ 126,912.06
Public Safety and Justice	1030609.33	Commercial	$ 0.61	545.30	51.53	1.03	1,946.92	$ 628,671.69
Social Services	54107.13	Commercial	$ 0.61	28.63	2.71	0.05	102.21	$ 33,005.35
Parks		Commercial	$ 0.61	-	-	-	-	$ -
Waste Management	462.13	Commercial	$ 0.61	0.24	0.02	0.00	0.87	$ 281.90
Sheriff	85061.57	Commercial	$ 0.61	45.01	4.25	0.09	160.69	$ 51,887.56
Airports		Commercial	$ 0.61	-	-	-	-	$ -
Trans/Land Use/Env**		Commercial	$ 0.61	-	-	-	-	$ -
Leased Buildings	66019	Commercial	$ 0.61	34.93	3.30	0.07	124.72	$ 40,271.59
Fire	83652.48	Commercial	$ 0.61	44.26	4.18	0.08	158.03	$ 51,028.01
Department 12				-	-	-	-	$ -
Department 13				-	-	-	-	$ -
Department 14				-	-	-	-	$ -
Department 15				-	-	-	-	$ -
Department 16				-	-	-	-	$ -
Department 17				-	-	-	-	$ -
TOTAL	**1,622,208**			**858.3103**	**81.1104**	**1.622208**	**3,064.51**	**$ 989,546.94**

Notes: Used average commerical rate for cost estimate.

Vehicle Fleet

Instructions: For each department, choose a vehicle type from the drop down menu and enter the total fuel used by that vehicle. For multiple vehicles of the same type in one department, total the fuel use for all like vehicles. If specifc MPG is known, override the default value. For the Fire Department, miles driven by vehicle was unknown, emissions calculated are from total fuel use.

Emissions Coefficients	$/gal					
Gasoline	$ 3.00	8.81	kg CO_2/gallon	0.00881	metric tons CO_2/gallon	
Diesel	$ 2.50	10.15	kg CO_2/gallon	0.01015	metric tons CO_2/gallon	
E85		6.05	kg CO_2/gallon	0.00605	metric tons CO_2/gallon	
CNG		6.84	kg CO_2/GGE	0.00684	metric tons CO_2/GGE	GGE=Gallon of Gasoline Equivalent
LPG (Propane)		5.74	kg CO_2/gallon	0.00574	metric tons CO_2/gallon	

	GWP
CH4	21
N2O	310

	Metric Tons				Fuel Use (gal)		
Department	**CO_2**	**CH_4**	**N_2O**	**CO_2e**	**Diesel**	**Gasoline**	$
Administrative	4,221.95	0.20	0.18	4,282.00	9,338.82	463,499	1,413,845
Health Care	2,849.22	0.13	0.11	2,886.70	17,683.55	301,612	949,046
Public Safety and Justice	780.57	0.03	0.03	790.17	517.65	86,615	261,140
Social Services	3,113.00	0.12	0.11	3,151.04	5,859.20	345,422	1,050,915
Parks	174.75	0.01	0.01	178.82	516.30	19,240	59,011
Waste Management	1,284.33	0.05	0.06	1,303.98	16,403.85	126,882	421,657
Sheriff	12,975.19	0.48	0.35	13,093.63	30,775.69	1,433,099	4,376,235
Airports	88.06	0.00	0.00	88.69		9,996	29,987
Trans/Land Use/Env**	4,564.74	0.10	0.09	4,596.25	160,912.06	332,566	1,399,979
Leased Buildings				-			-
Fire	4,959.76			4,959.76	227,642.00	300,703	1,471,214
TOTAL	**35,011.57**	**1.13**	**0.95**	**35,331.05**	**469,649**	**3,419,635**	**11,433,028**

Administrative

				Emission Factors			Total Emissions (metric tons)		
Vehicle	Number of Vehicles	Fuel Use (gal)	MPG	CO_2 (MT/gal)	CH_4 (g/mile)	N_2O (g/mile)	CO_2	CH_4	N_2O
Diesel Heavy Duty	3	3706.65	5.8	0.01015	0.0051	0.0048	37.62	0.00	0.00
Diesel Light Trucks 1983-1995	1	302.75	17	0.01015	0.0009	0.0014	3.07	0.00	0.00
Diesel Light Trucks 1996-Present	1	5143.22	19.1	0.01015	0.001	0.0015	52.20	0.00	0.00
Diesel Passenger Cars 1983-Pres	1	186.2	25.8	0.01015	0.0005	0.001	1.89	0.00	0.00
Gasoline Heavy Duty 2005	3	336.957	8	0.00881	0.0326	0.0177	2.97	0.00	0.00
Gasoline Light Trucks 1993	23	6183.8	17.5	0.00881	0.0813	0.1035	54.48	0.01	0.01
Gasoline Light Trucks 1994	8	2638.37	17.2	0.00881	0.0646	0.0982	23.24	0.00	0.00
Gasoline Light Trucks 1995	8	2039.675	17	0.00881	0.0517	0.0908	17.97	0.00	0.00
Gasoline Light Trucks 1996	1	467.2	17.2	0.00881	0.0452	0.0871	4.12	0.00	0.00
Gasoline Light Trucks 1997	6	3018.05	17	0.00881	0.0452	0.0871	26.59	0.00	0.00
Gasoline Light Trucks 1998	8	4276.59	17.1	0.00881	0.0391	0.0728	37.68	0.00	0.01
Gasoline Light Trucks 1999	41	21742.12	16.7	0.00881	0.0321	0.0564	191.55	0.01	0.02
Gasoline Light Trucks 2000	30	18726.595	16.9	0.00881	0.0346	0.0621	164.98	0.01	0.02
Gasoline Light Trucks 2001	27	15351.155	16.7	0.00881	0.0151	0.0164	135.24	0.00	0.00
Gasoline Light Trucks 2002	26	15359.792	16.7	0.00881	0.0178	0.0228	135.32	0.00	0.01
Gasoline Light Trucks 2003	18	14934.15	16.9	0.00881	0.0155	0.0114	131.57	0.00	0.00
Gasoline Light Trucks 2004	2	2196.85	16.7	0.00881	0.0152	0.0132	19.35	0.00	0.00
Gasoline Light Trucks 2005	12	12710.46	17.2	0.00881	0.0157	0.0101	111.98	0.00	0.00
Gasoline Light Trucks 2006	24	24737.697	17.5	0.00881	0.0157	0.0101	217.94	0.01	0.00
Gasoline Light Trucks 2007	53	36405.385	17.7	0.00881	0.0157	0.0101	320.73	0.01	0.01
Gasoline Light Trucks 2008	54	38500.309	18.2	0.00881	0.0157	0.0101	339.19	0.01	0.01
Gasoline Light Trucks 2009	10	490.22	19	0.00881	0.0157	0.0101	4.32	0.00	0.00
Gasoline Passenger Cars 1993	1	29.5	23.5	0.00881	0.0704	0.0647	0.26	0.00	0.00
Gasoline Passenger Cars 1994	4	422.4	23.3	0.00881	0.0531	0.056	3.72	0.00	0.00
Gasoline Passenger Cars 1995	2	316.44	23.4	0.00881	0.0358	0.0473	2.79	0.00	0.00
Gasoline Passenger Cars 1996	5	1446.75	23.3	0.00881	0.0272	0.0426	12.75	0.00	0.00
Gasoline Passenger Cars 1997	4	1057.22	23.4	0.00881	0.0268	0.0422	9.31	0.00	0.00
Gasoline Passenger Cars 1998	9	2297.993	23.4	0.00881	0.0249	0.0393	20.25	0.00	0.00
Gasoline Passenger Cars 1999	47	15458.149	23	0.00881	0.0216	0.0337	136.19	0.01	0.01
Gasoline Passenger Cars 2000	35	13466.965	22.9	0.00881	0.0178	0.0273	118.64	0.01	0.01
Gasoline Passenger Cars 2001	34	12413.825	23	0.00881	0.011	0.0158	109.37	0.00	0.00
Gasoline Passenger Cars 2002	25	12990.27	23.1	0.00881	0.0107	0.0153	114.44	0.00	0.00
Gasoline Passenger Cars 2003	19	6869.815	23.3	0.00881	0.0114	0.0135	60.52	0.00	0.00
Gasoline Passenger Cars 2004	14	8463.706	23.1	0.00881	0.0145	0.0083	74.57	0.00	0.00
Gasoline Passenger Cars 2005	60	37523.12	23.5	0.00881	0.0147	0.0079	330.58	0.01	0.01
Gasoline Passenger Cars 2006	86	53586.75	23.3	0.00881	0.0147	0.0079	472.10	0.02	0.01
Gasoline Passenger Cars 2007	101	50217.165	24.1	0.00881	0.0147	0.0079	442.41	0.02	0.01
Gasoline Passenger Cars 2008	56	26100.52	24.3	0.00881	0.0147	0.0079	229.95	0.01	0.01
Gasoline Passenger Cars 2009	7	723.22	25.4	0.00881	0.0147	0.0079	6.37	0.00	0.00
E85 Light Duty	27	5073.52	12.75	0.0065	0.055	0.067	32.98	0.00	0.00
CNG Light Duty	7	1573.01	23	0.00684	0.737	0.05	10.76	0.03	0.00
TOTAL	**903**	**479,485**					**4,221.95**	**0.20**	**0.18**

Health Care

Vehicle	Number of Vehicles	Fuel Use (gal)	MPG	Emission Factors CO_2 (MT/gal)	Emission Factors CH_4 (g/mile)	Emission Factors N_2O (g/mile)	Total Emissions (metric tons) CO_2	Total Emissions (metric tons) CH_4	Total Emissions (metric tons) N_2O
Diesel Light Trucks 1983-1995	1	59.1	17	0.01015	0.0009	0.0014	0.60	0.00	0.00
Diesel Light Trucks 1996-Present	14	17624.45	19.1	0.01015	0.001	0.0015	178.89	0.00	0.00
Gasoline Heavy Duty 2005	1	1118.8	8	0.00881	0.0326	0.0177	9.86	0.00	0.00
Gasoline Light Trucks 1993	7	1752.6	17.5	0.00881	0.0813	0.1035	15.44	0.00	0.00
Gasoline Light Trucks 1994	3	673.775	17.2	0.00881	0.0646	0.0982	5.94	0.00	0.00
Gasoline Light Trucks 1995	5	1633.9	17	0.00881	0.0517	0.0908	14.39	0.00	0.00
Gasoline Light Trucks 1996	1	141.715	17.2	0.00881	0.0452	0.0871	1.25	0.00	0.00
Gasoline Light Trucks 1997	6	3187.55	17	0.00881	0.0452	0.0871	28.08	0.00	0.00
Gasoline Light Trucks 1998	1	77.5	17.1	0.00881	0.0391	0.0728	0.68	0.00	0.00
Gasoline Light Trucks 1999	20	10490.08	16.7	0.00881	0.0321	0.0564	92.42	0.01	0.01
Gasoline Light Trucks 2000	14	6948.375	16.9	0.00881	0.0346	0.0621	61.22	0.00	0.01
Gasoline Light Trucks 2001	19	25976.95	16.7	0.00881	0.0151	0.0164	228.86	0.01	0.01
Gasoline Light Trucks 2002	47	44278.225	16.7	0.00881	0.0178	0.0228	390.09	0.01	0.02
Gasoline Light Trucks 2003	14	13477.49	16.9	0.00881	0.0155	0.0114	118.74	0.00	0.00
Gasoline Light Trucks 2004	5	5671.11	16.7	0.00881	0.0152	0.0132	49.96	0.00	0.00
Gasoline Light Trucks 2005	12	7426.73	17.2	0.00881	0.0157	0.0101	65.43	0.00	0.00
Gasoline Light Trucks 2006	14	19643.11	17.5	0.00881	0.0157	0.0101	173.06	0.01	0.00
Gasoline Light Trucks 2007	15	17689.15	17.7	0.00881	0.0157	0.0101	155.84	0.00	0.00
Gasoline Light Trucks 2008	60	52392.86	18.2	0.00881	0.0157	0.0101	461.58	0.01	0.01
Gasoline Light Trucks 2009	2	177.13	19	0.00881	0.0157	0.0101	1.56	0.00	0.00
Gasoline Passenger Cars 1993	2	296.4	23.5	0.00881	0.0704	0.0647	2.61	0.00	0.00
Gasoline Passenger Cars 1994	4	499.25	23.3	0.00881	0.0531	0.056	4.40	0.00	0.00
Gasoline Passenger Cars 1995	8	838.475	23.4	0.00881	0.0358	0.0473	7.39	0.00	0.00
Gasoline Passenger Cars 1997	1	445.125	23.4	0.00881	0.0268	0.0422	3.92	0.00	0.00
Gasoline Passenger Cars 1998	3	759.265	23.4	0.00881	0.0249	0.0393	6.69	0.00	0.00
Gasoline Passenger Cars 1999	47	15611.219	23	0.00881	0.0216	0.0337	137.53	0.01	0.01
Gasoline Passenger Cars 2000	27	9668.965	22.9	0.00881	0.0178	0.0273	85.18	0.00	0.01
Gasoline Passenger Cars 2001	9	2243.51	23	0.00881	0.011	0.0158	19.77	0.00	0.00
Gasoline Passenger Cars 2002	15	6281.285	23.1	0.00881	0.0107	0.0153	55.34	0.00	0.00
Gasoline Passenger Cars 2003	10	4338.16	23.3	0.00881	0.0114	0.0135	38.22	0.00	0.00
Gasoline Passenger Cars 2004	5	1532.2	23.1	0.00881	0.0145	0.0083	13.50	0.00	0.00
Gasoline Passenger Cars 2005	23	15786.69	23.5	0.00881	0.0147	0.0079	139.08	0.01	0.00
Gasoline Passenger Cars 2006	19	6232.13	23.3	0.00881	0.0147	0.0079	54.91	0.00	0.00
Gasoline Passenger Cars 2007	17	6802.625	24.1	0.00881	0.0147	0.0079	59.93	0.00	0.00
Gasoline Passenger Cars 2008	52	16696.955	24.3	0.00881	0.0147	0.0079	147.10	0.01	0.00
Gasoline Passenger Cars 2009	5	822.95	25.4	0.00881	0.0147	0.0079	7.25	0.00	0.00
E85 Light Duty	4	148.73	12.75	0.0065	0.055	0.067	0.97	0.00	0.00
CNG Light Duty	6	1689.75	23	0.00684	0.737	0.05	11.56	0.03	0.00
TOTAL	**518**	**321,134**					**2,849.22**	**0.13**	**0.11**

Public Safety and Justice

Vehicle	Number of Vehicles	Fuel Use (gal)	MPG	Emission Factors CO_2 (MT/gal)	CH_4 (g/mile)	N_2O (g/mile)	Total Emissions (metric tons) CO_2	CH_4	N_2O
Diesel Heavy Duty	1	374.75	5.8	0.01015	0.0051	0.0048	3.80	0.00	0.00
Diesel Light Trucks 1983-1995	1	142.9	17	0.01015	0.0009	0.0014	1.45	0.00	0.00
Gasoline Light Trucks 1993	2	287.55	17.5	0.00881	0.0813	0.1035	2.53	0.00	0.00
Gasoline Light Trucks 1995	1	67.95	17	0.00881	0.0517	0.0908	0.60	0.00	0.00
Gasoline Light Trucks 1999	1	479.11	16.7	0.00881	0.0321	0.0564	4.22	0.00	0.00
Gasoline Light Trucks 2000	1	31.4	16.9	0.00881	0.0346	0.0621	0.28	0.00	0.00
Gasoline Light Trucks 2001	8	4558.9	16.7	0.00881	0.0151	0.0164	40.16	0.00	0.00
Gasoline Light Trucks 2002	5	2749.03	16.7	0.00881	0.0178	0.0228	24.22	0.00	0.00
Gasoline Light Trucks 2005	2	737	17.2	0.00881	0.0157	0.0101	6.49	0.00	0.00
Gasoline Light Trucks 2006	4	6448.95	17.5	0.00881	0.0157	0.0101	56.82	0.00	0.00
Gasoline Light Trucks 2007	7	1966	17.7	0.00881	0.0157	0.0101	17.32	0.00	0.00
Gasoline Light Trucks 2008	8	1590.2	18.2	0.00881	0.0157	0.0101	14.01	0.00	0.00
Gasoline Passenger Cars 1993	3	61.2	23.5	0.00881	0.0704	0.0647	0.54	0.00	0.00
Gasoline Passenger Cars 1994	1	159.975	23.3	0.00881	0.0531	0.056	1.41	0.00	0.00
Gasoline Passenger Cars 1995	9	648.975	23.4	0.00881	0.0358	0.0473	5.72	0.00	0.00
Gasoline Passenger Cars 1998	5	919.4	23.4	0.00881	0.0249	0.0393	8.10	0.00	0.00
Gasoline Passenger Cars 1999	26	3713.014	23	0.00881	0.0216	0.0337	32.71	0.00	0.00
Gasoline Passenger Cars 2000	23	6376.325	22.9	0.00881	0.0178	0.0273	56.18	0.00	0.00
Gasoline Passenger Cars 2001	25	9272.27	23	0.00881	0.011	0.0158	81.69	0.00	0.00
Gasoline Passenger Cars 2002	16	5382.61	23.1	0.00881	0.0107	0.0153	47.42	0.00	0.00
Gasoline Passenger Cars 2003	4	1584.5	23.3	0.00881	0.0114	0.0135	13.96	0.00	0.00
Gasoline Passenger Cars 2004	3	528.8	23.1	0.00881	0.0145	0.0083	4.66	0.00	0.00
Gasoline Passenger Cars 2005	10	3528.725	23.5	0.00881	0.0147	0.0079	31.09	0.00	0.00
Gasoline Passenger Cars 2006	37	15541.785	23.3	0.00881	0.0147	0.0079	136.92	0.01	0.00
Gasoline Passenger Cars 2007	14	6261.12	24.1	0.00881	0.0147	0.0079	55.16	0.00	0.00
Gasoline Passenger Cars 2008	57	13720.35	24.3	0.00881	0.0147	0.0079	120.88	0.00	0.00
E85 Light Duty	7	1882.48	12.75	0.0065	0.055	0.067	12.24	0.00	0.00
Choose Vehicle Type			0	0	0	0	-	-	-
TOTAL	**281**	**89,015**					**780.57**	**0.03**	**0.03**

Social Services

Vehicle	Number of Vehicles	Fuel Use (gal)	MPG	Emission Factors CO_2 (MT/gal)	CH_4 (g/mile)	N_2O (g/mile)	Total Emissions (metric tons) CO_2	CH_4	N_2O
Diesel Heavy Duty	3	3465.6	5.8	0.01015	0.0051	0.0048	35.18	0.00	0.00
Diesel Light Trucks 1996-Present	4	2393.595	19.1	0.01015	0.001	0.0015	24.29	0.00	0.00
Gasoline Heavy Duty 2005	1	726.3	8	0.00881	0.0326	0.0177	6.40	0.00	0.00
Gasoline Light Trucks 1993	1	37.35	17.5	0.00881	0.0813	0.1035	0.33	0.00	0.00
Gasoline Light Trucks 1995	1	238.9	17	0.00881	0.0517	0.0908	2.10	0.00	0.00
Gasoline Light Trucks 1998	1	401.825	17.1	0.00881	0.0391	0.0728	3.54	0.00	0.00
Gasoline Light Trucks 1999	22	8218.94	16.7	0.00881	0.0321	0.0564	72.41	0.00	0.01
Gasoline Light Trucks 2000	14	5756.212	16.9	0.00881	0.0346	0.0621	50.71	0.00	0.01
Gasoline Light Trucks 2001	9	5633.04	16.7	0.00881	0.0151	0.0164	49.63	0.00	0.00
Gasoline Light Trucks 2002	14	6315.055	16.7	0.00881	0.0178	0.0228	55.64	0.00	0.00
Gasoline Light Trucks 2004	2	1055.775	16.7	0.00881	0.0152	0.0132	9.30	0.00	0.00
Gasoline Light Trucks 2003	1	853.725	16.9	0.00881	0.0155	0.0114	7.52	0.00	0.00
Gasoline Light Trucks 2006	13	19054.885	17.5	0.00881	0.0157	0.0101	167.87	0.01	0.00
Gasoline Light Trucks 2007	67	56986.43	17.7	0.00881	0.0157	0.0101	502.05	0.02	0.01
Gasoline Light Trucks 2008	54	34936.285	18.2	0.00881	0.0157	0.0101	307.79	0.01	0.01
Gasoline Passenger Cars 1995	3	532.2	23.4	0.00881	0.0358	0.0473	4.69	0.00	0.00
Gasoline Passenger Cars 1997	3	356.9	23.4	0.00881	0.0268	0.0422	3.14	0.00	0.00
Gasoline Passenger Cars 1998	39	6260.945	23.4	0.00881	0.0249	0.0393	55.16	0.00	0.01
Gasoline Passenger Cars 1999	84	19297.875	23	0.00881	0.0216	0.0337	170.01	0.01	0.01
Gasoline Passenger Cars 2000	96	31237.881	22.9	0.00881	0.0178	0.0273	275.21	0.01	0.02
Gasoline Passenger Cars 2001	24	6841.985	23	0.00881	0.011	0.0158	60.28	0.00	0.00
Gasoline Passenger Cars 2002	38	13410.27	23.1	0.00881	0.0107	0.0153	118.14	0.00	0.00
Gasoline Passenger Cars 2003	25	10871.68	23.3	0.00881	0.0114	0.0135	95.78	0.00	0.00
Gasoline Passenger Cars 2004	8	2002.94	23.1	0.00881	0.0145	0.0083	17.65	0.00	0.00
Gasoline Passenger Cars 2005	48	22912.04	23.5	0.00881	0.0147	0.0079	201.86	0.01	0.00
Gasoline Passenger Cars 2006	14	6032.49	23.3	0.00881	0.0147	0.0079	53.15	0.00	0.00
Gasoline Passenger Cars 2007	118	64996.06	24.1	0.00881	0.0147	0.0079	572.62	0.02	0.01
Gasoline Passenger Cars 2008	38	20432.275	24.3	0.00881	0.0147	0.0079	180.01	0.01	0.00
Gasoline Passenger Cars 2009	1	22.15	25.4	0.00881	0.0147	0.0079	0.20	0.00	0.00
E85 Light Duty	6	1557.74	12.75	0.0065	0.055	0.067	10.13	0.00	0.00
Propane Light Duty	1	40.4	23	0.00574	0.037	0.067	0.23	0.00	0.00
TOTAL	**753**	**352,880**					**3,113.00**	**0.12**	**0.11**

Parks

				Emission Factors			Total Emissions (metric tons)		
Vehicle	**Number of Vehicles**	**Fuel Use (gal)**	**MPG**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Diesel Heavy Duty	1	68.3	5.8	0.01015	0.0051	0.0048	0.69	0.00	0.00
Diesel Light Trucks 1996-Present	1	448	19.1	0.01015	0.001	0.0015	4.55	0.00	0.00
Gasoline Light Trucks 1993	3	1087.8	17.5	0.00881	0.0813	0.1035	9.58	0.00	0.00
Gasoline Light Trucks 1995	3	1165.925	17	0.00881	0.0517	0.0908	10.27	0.00	0.00
Gasoline Light Trucks 1998	1	279.73	17.1	0.00881	0.0391	0.0728	2.46	0.00	0.00
Gasoline Light Trucks 1999	7	3390.715	16.7	0.00881	0.0321	0.0564	29.87	0.00	0.00
Gasoline Light Trucks 2000	3	1594.58	16.9	0.00881	0.0346	0.0621	14.05	0.00	0.00
Gasoline Light Trucks 2001	2	551.17	16.7	0.00881	0.0151	0.0164	4.86	0.00	0.00
Gasoline Light Trucks 2002	7	6349.955	16.7	0.00881	0.0178	0.0228	55.94	0.00	0.00
Gasoline Light Trucks 2003	3	3208.75	16.9	0.00881	0.0155	0.0114	28.27	0.00	0.00
Gasoline Light Trucks 2005	2	749.79	17.2	0.00881	0.0157	0.0101	6.61	0.00	0.00
Gasoline Light Trucks 2008	1	654.55	18.2	0.00881	0.0157	0.0101	5.77	0.00	0.00
Gasoline Passenger Cars 1999	1	90.775	23	0.00881	0.0216	0.0337	0.80	0.00	0.00
Gasoline Passenger Cars 2002	1	116.29	23.1	0.00881	0.0107	0.0153	1.02	0.00	0.00
TOTAL	**36**	**19,756**					**174.75**	**0.01**	**0.01**

Waste Management

Vehicle	Number of Vehicles	Fuel Use (gal)	MPG	Emission Factors CO_2 (MT/gal)	CH_4 (g/mile)	N_2O (g/mile)	Total Emissions (metric tons) CO_2	CH_4	N_2O
Diesel Heavy Duty	12	10331.5	5.8	0.01015	0.0051	0.0048	104.86	0.00	0.00
Diesel Light Trucks 1983-1995	2	197.7	17	0.01015	0.0009	0.0014	2.01	0.00	0.00
Diesel Light Trucks 1996-Present	7	5874.65	19.1	0.01015	0.001	0.0015	59.63	0.00	0.00
Gasoline Light Trucks 1993	4	1634.9	17.5	0.00881	0.0813	0.1035	14.40	0.00	0.00
Gasoline Light Trucks 1994	4	2230.2	17.2	0.00881	0.0646	0.0982	19.65	0.00	0.00
Gasoline Light Trucks 1995	2	784.55	17	0.00881	0.0517	0.0908	6.91	0.00	0.00
Gasoline Light Trucks 1996	6	1977.05	17.2	0.00881	0.0452	0.0871	17.42	0.00	0.00
Gasoline Light Trucks 1997	5	3698.45	17	0.00881	0.0452	0.0871	32.58	0.00	0.01
Gasoline Light Trucks 1998	7	3344.69	17.1	0.00881	0.0391	0.0728	29.47	0.00	0.00
Gasoline Light Trucks 1999	9	8762.695	16.7	0.00881	0.0321	0.0564	77.20	0.00	0.01
Gasoline Light Trucks 2000	7	8248.3	16.9	0.00881	0.0346	0.0621	72.67	0.00	0.01
Gasoline Light Trucks 2001	10	10934.975	16.7	0.00881	0.0151	0.0164	96.34	0.00	0.00
Gasoline Light Trucks 2002	7	7148.4	16.7	0.00881	0.0178	0.0228	62.98	0.00	0.00
Gasoline Light Trucks 2003	15	11309.71	16.9	0.00881	0.0155	0.0114	99.64	0.00	0.00
Gasoline Light Trucks 2004	11	19253.71	16.7	0.00881	0.0152	0.0132	169.63	0.00	0.00
Gasoline Light Trucks 2005	12	17132.28	17.2	0.00881	0.0157	0.0101	150.94	0.00	0.00
Gasoline Light Trucks 2006	4	3911.8	17.5	0.00881	0.0157	0.0101	34.46	0.00	0.00
Gasoline Light Trucks 2007	5	8133.005	17.7	0.00881	0.0157	0.0101	71.65	0.00	0.00
Gasoline Light Trucks 2008	12	14687.97	18.2	0.00881	0.0157	0.0101	129.40	0.00	0.00
Gasoline Light Trucks 2009	2	554.7	19	0.00881	0.0157	0.0101	4.89	0.00	0.00
Gasoline Passenger Cars 1993	2	707	23.5	0.00881	0.0704	0.0647	6.23	0.00	0.00
Gasoline Passenger Cars 1995	1	322	23.4	0.00881	0.0358	0.0473	2.84	0.00	0.00
Gasoline Passenger Cars 2001	1	606.4	23	0.00881	0.011	0.0158	5.34	0.00	0.00
Gasoline Passenger Cars 2002	1	789.22	23.1	0.00881	0.0107	0.0153	6.95	0.00	0.00
Gasoline Passenger Cars 2007	1	517.675	24.1	0.00881	0.0147	0.0079	4.56	0.00	0.00
Gasoline Passenger Cars 2009	2	127.1	25.4	0.00881	0.0147	0.0079	1.12	0.00	0.00
Gasoline Heavy Duty 2005	1	65.7	8	0.00881	0.0326	0.0177	0.58	0.00	0.00
TOTAL	**152**	**143,286**					**1,284.33**	**0.05**	**0.06**

Sheriff

Vehicle	Number of Vehicles	Fuel Use (gal)	MPG	Emission Factors CO_2 (MT/gal)	CH_4 (g/mile)	N_2O (g/mile)	Total Emissions (metric tons) CO_2	CH_4	N_2O
Diesel Heavy Duty	22	17264.2	5.8	0.01015	0.0051	0.0048	175.23	0.00	0.00
Diesel Light Trucks 1983-1995	2	50.2	17	0.01015	0.0009	0.0014	0.51	0.00	0.00
Diesel Light Trucks 1996-Present	9	13461.29	19.1	0.01015	0.001	0.0015	136.63	0.00	0.00
Gasoline Heavy Duty 2003	1	613.94	8	0.00881	0.0533	0.124	5.41	0.00	0.00
Gasoline Heavy Duty 2005	5	1169.15	8	0.00881	0.0326	0.0177	10.30	0.00	0.00
Gasoline Light Trucks 1993	19	2066.76	17.5	0.00881	0.0813	0.1035	18.21	0.00	0.00
Gasoline Light Trucks 1994	3	1995.916	17.2	0.00881	0.0646	0.0982	17.58	0.00	0.00
Gasoline Light Trucks 1995	1	155.75	17	0.00881	0.0517	0.0908	1.37	0.00	0.00
Gasoline Light Trucks 1996	3	585.55	17.2	0.00881	0.0452	0.0871	5.16	0.00	0.00
Gasoline Light Trucks 1997	8	2732.932	17	0.00881	0.0452	0.0871	24.08	0.00	0.00
Gasoline Light Trucks 1998	1	190	17.1	0.00881	0.0391	0.0728	1.67	0.00	0.00
Gasoline Light Trucks 1999	26	7032.431	16.7	0.00881	0.0321	0.0564	61.96	0.00	0.01
Gasoline Light Trucks 2000	25	7664.229	16.9	0.00881	0.0346	0.0621	67.52	0.00	0.01
Gasoline Light Trucks 2001	23	10092.503	16.7	0.00881	0.0151	0.0164	88.91	0.00	0.00
Gasoline Light Trucks 2002	8	3757.447	16.7	0.00881	0.0178	0.0228	33.10	0.00	0.00
Gasoline Light Trucks 2003	43	22577.96	16.9	0.00881	0.0155	0.0114	198.91	0.01	0.00
Gasoline Light Trucks 2004	15	18023.01	16.7	0.00881	0.0152	0.0132	158.78	0.00	0.00
Gasoline Light Trucks 2005	29	26041.216	17.2	0.00881	0.0157	0.0101	229.42	0.01	0.00
Gasoline Light Trucks 2006	52	72035.312	17.5	0.00881	0.0157	0.0101	634.63	0.02	0.01
Gasoline Light Trucks 2007	48	53307.399	17.7	0.00881	0.0157	0.0101	469.64	0.01	0.01
Gasoline Light Trucks 2008	56	33794.918	18.2	0.00881	0.0157	0.0101	297.73	0.01	0.01
Gasoline Light Trucks 2009	2	177.55	19	0.00881	0.0157	0.0101	1.56	0.00	0.00
Gasoline Passenger Cars 1993	1	328.75	23.5	0.00881	0.0704	0.0647	2.90	0.00	0.00
Gasoline Passenger Cars 1994	1	101.75	23.3	0.00881	0.0531	0.056	0.90	0.00	0.00
Gasoline Passenger Cars 1995	5	701	23.4	0.00881	0.0358	0.0473	6.18	0.00	0.00
Gasoline Passenger Cars 1996	5	415.77	23.3	0.00881	0.0272	0.0426	3.66	0.00	0.00
Gasoline Passenger Cars 1997	4	1138.695	23.4	0.00881	0.0268	0.0422	10.03	0.00	0.00
Gasoline Passenger Cars 1998	29	4084.669	23.4	0.00881	0.0249	0.0393	35.99	0.00	0.00
Gasoline Passenger Cars 1999	49	7922.365	23	0.00881	0.0216	0.0337	69.80	0.00	0.01
Gasoline Passenger Cars 2000	105	27456.141	22.9	0.00881	0.0178	0.0273	241.89	0.01	0.02
Gasoline Passenger Cars 2001	108	29501.911	23	0.00881	0.011	0.0158	259.91	0.01	0.01
Gasoline Passenger Cars 2002	95	32172.648	23.1	0.00881	0.0107	0.0153	283.44	0.01	0.01
Gasoline Passenger Cars 2003	218	145632.65	23.3	0.00881	0.0114	0.0135	1,283.02	0.04	0.05
Gasoline Passenger Cars 2004	25	17308.032	23.1	0.00881	0.0145	0.0083	152.48	0.01	0.00
Gasoline Passenger Cars 2005	173	162424.492	23.5	0.00881	0.0147	0.0079	1,430.96	0.06	0.03
Gasoline Passenger Cars 2006	392	376236.371	23.3	0.00881	0.0147	0.0079	3,314.64	0.13	0.07
Gasoline Passenger Cars 2007	221	178615.23	24.1	0.00881	0.0147	0.0079	1,573.60	0.06	0.03
Gasoline Passenger Cars 2008	413	179598.692	24.3	0.00881	0.0147	0.0079	1,582.26	0.06	0.03
Gasoline Passenger Cars 2009	91	5445.501	25.4	0.00881	0.0147	0.0079	47.97	0.00	0.00
E85 Light Duty	85	5726.06	12.75	0.0065	0.055	0.067	37.22	0.00	0.00
TOTAL	**2421**	**1,469,600**					**12,975.19**	**0.48**	**0.35**

Airports

				Emission Factors			Total Emissions (metric tons)		
Vehicle	**Number of Vehicles**	**Fuel Use (gal)**	**MPG**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Gasoline Light Trucks 1996	1	28.66	17.2	0.00881	0.0452	0.0871	0.25	0.00	0.00
Gasoline Light Trucks 2005	1	658.27	17.2	0.00881	0.0157	0.0101	5.80	0.00	0.00
Gasoline Light Trucks 2006	2	4382.27	17.5	0.00881	0.0157	0.0101	38.61	0.00	0.00
Gasoline Light Trucks 2007	1	1608.95	17.7	0.00881	0.0157	0.0101	14.17	0.00	0.00
Gasoline Light Trucks 2008	2	2822.05	18.2	0.00881	0.0157	0.0101	24.86	0.00	0.00
Gasoline Passenger Cars 2009	2	495.51	25.4	0.00881	0.0147	0.0079	4.37	0.00	0.00
TOTAL	**9**	**9,996**					**88.06**	**0.00**	**0.00**

Trans/Land Use/Env**

Vehicle	Number of Vehicles	Fuel Use (gal)	MPG	Emission Factors CO_2 (MT/gal)	CH_4 (g/mile)	N_2O (g/mile)	Total Emissions (metric tons) CO_2	CH_4	N_2O
Diesel Heavy Duty	84	116489	5.8	0.01015	0.0051	0.0048	1,182.36	0.00	0.00
Diesel Light Trucks 1983-1995	8	3888.195	17	0.01015	0.0009	0.0014	39.47	0.00	0.00
Diesel Light Trucks 1996-Present	50	40223.67	19.1	0.01015	0.001	0.0015	408.27	0.00	0.00
Diesel Passenger Cars 1983-Pres	1	311.19	25.8	0.01015	0.0005	0.001	3.16	0.00	0.00
Gasoline Heavy Duty 2005	5	4978.85	8	0.00881	0.0326	0.0177	43.86	0.00	0.00
Gasoline Light Trucks 1993	1	472.53	17.5	0.00881	0.0813	0.1035	4.16	0.00	0.00
Gasoline Light Trucks 1995	3	1359.95	17	0.00881	0.0517	0.0908	11.98	0.00	0.00
Gasoline Light Trucks 1996	1	610.125	17.2	0.00881	0.0452	0.0871	5.38	0.00	0.00
Gasoline Light Trucks 1998	4	1961.45	17.1	0.00881	0.0391	0.0728	17.28	0.00	0.00
Gasoline Light Trucks 1999	15	8949.08	16.7	0.00881	0.0321	0.0564	78.84	0.00	0.01
Gasoline Light Trucks 2000	17	7857.143	16.9	0.00881	0.0346	0.0621	69.22	0.00	0.01
Gasoline Light Trucks 2001	12	6840.765	16.7	0.00881	0.0151	0.0164	60.27	0.00	0.00
Gasoline Light Trucks 2002	55	34442.42	16.7	0.00881	0.0178	0.0228	303.44	0.01	0.01
Gasoline Light Trucks 2003	28	25617.69	16.9	0.00881	0.0155	0.0114	225.69	0.01	0.00
Gasoline Light Trucks 2004	16	20259.35	16.7	0.00881	0.0152	0.0132	178.48	0.01	0.00
Gasoline Light Trucks 2005	24	32439.475	17.2	0.00881	0.0157	0.0101	285.79	0.01	0.01
Gasoline Light Trucks 2006	39	46012.685	17.5	0.00881	0.0157	0.0101	405.37	0.01	0.01
Gasoline Light Trucks 2007	92	88267.13	17.7	0.00881	0.0157	0.0101	777.63	0.02	0.02
Gasoline Light Trucks 2008	38	32924.03	18.2	0.00881	0.0157	0.0101	290.06	0.01	0.01
Gasoline Passenger Cars 1993	1	13.594	23.5	0.00881	0.0704	0.0647	0.12	0.00	0.00
Gasoline Passenger Cars 1995	1	13.754	23.4	0.00881	0.0358	0.0473	0.12	0.00	0.00
Gasoline Passenger Cars 1998	2	96.95	23.4	0.00881	0.0249	0.0393	0.85	0.00	0.00
Gasoline Passenger Cars 1999	8	1054.216	23	0.00881	0.0216	0.0337	9.29	0.00	0.00
Gasoline Passenger Cars 2000	10	2628.35	22.9	0.00881	0.0178	0.0273	23.16	0.00	0.00
Gasoline Passenger Cars 2001	2	676.05	23	0.00881	0.011	0.0158	5.96	0.00	0.00
Gasoline Passenger Cars 2002	2	1494.75	23.1	0.00881	0.0107	0.0153	13.17	0.00	0.00
Gasoline Passenger Cars 2003	4	796.07	23.3	0.00881	0.0114	0.0135	7.01	0.00	0.00
Gasoline Passenger Cars 2005	3	1887.25	23.5	0.00881	0.0147	0.0079	16.63	0.00	0.00
Gasoline Passenger Cars 2006	15	5100.095	23.3	0.00881	0.0147	0.0079	44.93	0.00	0.00
Gasoline Passenger Cars 2007	9	4303.315	24.1	0.00881	0.0147	0.0079	37.91	0.00	0.00
Gasoline Passenger Cars 2008	5	1509.125	24.3	0.00881	0.0147	0.0079	13.30	0.00	0.00
E85 Light Duty	2	74.83	12.75	0.0065	0.055	0.067	0.49	0.00	0.00
Propane Light Duty	1	51.65	23	0.00574	0.037	0.067	0.30	0.00	0.00
Propane Heavy Duty	3	138.15	8	0.00574	0.197	0.175	0.79	0.00	0.00
TOTAL	**561**	**493,743**					**4,564.74**	**0.10**	**0.09**

Fire

	Total Use (gal)	CO_2 (MT)
Gasoline	300,703	2649.19
Diesel	227,642	2310.57
		4959.76

Non-Highway Vehicles and Equipment

Instructions: For each department, choose an equipment type from the drop down menu and enter the total fuel used by that piece of equipment. For multiple vehicles of the same type in one department, total the fuel use for all like pieces of equipment.

Emissions Coefficients	$/gal					
Gasoline	$ 3.00	8.81	kg CO_2/gallon	0.00881	metric tons CO_2/gallon
Diesel	$ 2.50	10.15	kg CO_2/gallon	0.01015	metric tons CO_2/gallon
Propane	$ 2.55			0.00574	metric tons CO_2/gallon

	GWP
CH_4	21
N_2O	310

	Metric Tons				Fuel Use (gal)			
Department	**CO_2**	**CH_4**	**N_2O**	**CO_2e**	**Diesel**	**Gasoline**	**Propane**	$
Administrative	0.06	0.00	0.00	0.07		7.35		$ 22
Health Care	-	-	-	-				$ -
Public Safety and Justice	-	-	-	-				$ -
Social Services	0.40	0.00	0.00	0.41	21.2	21.20		$ 117
Parks	-	-	-	-				$ -
Waste Management	6,646.60	0.50	0.22	6,726.83	859425.8	160.65	3606.95	$ 2,158,244
Sheriff	3.15	0.00	0.00	3.18	299.09	12.45		$ 785
Airports	20,901.24	3.34	0.61	21,161.33				$ 223,689
Trans/Land Use/Env**	1,740.36	0.12	0.04	1,756.80	171270.17	780.56		$ 430,517
Leased Buildings				-				$ -
Fire				-				$ -
TOTAL	**29,291.81**	**3.97**	**0.88**	**29,648.61**	**1,031,016**	**982.21**		**$ 2,813,374**

Administrative

		Emission Factors			Total Emissions (metric tons)		
Vehicle	**Fuel Use (gal)**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Other Large Utility (Gasoline)	7.35	0.00881	0.5	0.22	0.0647535	3.68E-06	1.62E-06
Choose Equipment		0	0	0	0	0	0
Choose Equipment		0	0	0	0	0	0
Choose Equipment		0	0	0	0	0	0
Choose Equipment		0	0	0	0	0	0
TOTAL	**7.35**				**0.0647535**	**3.68E-06**	**1.62E-06**

Social Services

		Emission Factors			Total Emissions (metric tons)		
Vehicle	**Fuel Use (gal)**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Other Large Utility (Gasoline)	21.2	0.00881	0.5	0.22	0.186772	1.06E-05	4.66E-06
Other Large Utility (Diesel)	21.2	0.01015	0.58	0.26	0.21518	1.23E-05	5.51E-06
TOTAL	**42.4**				**0.401952**	**2.29E-05**	**1.02E-05**

Waste Management

		Emission Factors			Total Emissions (metric tons)		
Vehicle	**Fuel Use (gal)**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Agricultural Equipment Diesel Fue	889.95	0.01015	1.44	0.26	9.0329925	0.001282	0.000231
Construction Diesel	487768	0.01015	0.58	0.26	4950.8452	0.282905	0.12682
Construction LNG	368838	0.00446	0.58	0.26	1645.01748	0.213926	0.095898
Other Large Utility (Diesel)	1929.85	0.01015	0.58	0.26	19.5879775	0.001119	0.000502
Other Small Utility (Gasoline)	157.2	0.00881	0.5	0.22	1.384932	7.86E-05	3.46E-05
Propane (all)	3606.95	0.00574	0.09	0.41	20.703893	0.000325	0.001479
Agricultural Equipment Gasoline	3.45	0.00881	1.26	0.22	0.0303945	4.35E-06	7.59E-07
Choose Equipment		0	0	0	0	0	0
TOTAL	**863193.4**				**6646.60287**	**0.49964**	**0.224965**

*With the inclusion of equipment from the El Sobrante Landfill, total construction fuel usage (Diesel and LNG) is 856,606 gallons.

Sheriff

		Emission Factors			Total Emissions (metric tons)		
Vehicle	**Fuel Use (gal)**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Agricultural Equipment Diesel Fue	51	0.01015	1.44	0.26	0.51765	7.34E-05	1.33E-05
Other Large Utility (Diesel)	248.09	0.01015	0.58	0.26	2.5181135	0.000144	6.45E-05
Other Small Utility (Gasoline)	12.45	0.00881	0.5	0.22	0.1096845	6.23E-06	2.74E-06
Choose Equipment		0	0	0	0	0	0
Choose Equipment		0	0	0	0	0	0
TOTAL	**311.54**				**3.145448**	**0.000224**	**8.05E-05**

Airports

		Emission Factors			Total Emissions (metric tons)		
Vehicle	**Fuel Use (gal)**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Jet Fuel	1832210	0.00957	0.27	0.31	17534.2497	0.494697	0.567985
Aviation Gasoline	404686	0.00832	7.04	0.11	3366.98752	2.848989	0.044515
Choose Equipment		0	0	0	0	0	0
Choose Equipment		0	0	0	0	0	0
Choose Equipment		0	0	0	0	0	0
TOTAL	**2,236,896**				**20901.23722**	**3.343686**	**0.612501**

Trans/Land Use/Env**

		Emission Factors			Total Emissions (metric tons)		
Vehicle	**Fuel Use (gal)**	**CO_2 (MT/gal)**	**CH_4 (g/mile)**	**N_2O (g/mile)**	**CO_2**	**CH_4**	**N_2O**
Agricultural Equipment Diesel Fue	29503.07	0.01015	1.44	0.26	299.4561605	0.042484	0.007671
Construction Diesel	77280.89	0.01015	0.58	0.26	784.4010335	0.044823	0.020093
Other Large Utility (Diesel)	64486.21	0.01015	0.58	0.26	654.5350315	0.037402	0.016766
Other Large Utility (Gasoline)	22.94	0.00881	0.5	0.22	0.2021014	1.15E-05	5.05E-06
Other Small Utility (Gasoline)	557.32						
Agricultural Equipment Gasoline	200.295	0.00881	1.26	0.22	1.76459895	0.000252	4.41E-05
TOTAL	**172,051**				**1740.358926**	**0.124973**	**0.044579**

Solid Waste

Instructions: Emissions from solid waste come from two sources: the waste generated by the government and the emissions from landfills owned/operated by the government. For generated solid waste, enter the landfill name where the waste is deposited, the total annual tons of waste, and select the landfill's methane recovery system. For the landfills, enter the name and the annual LFG gas collected, then override the default values related to the LFG system if specifc values are known.

Owned/Operated Landfills

Landfill Name	Annual LFG Gas Collected (MMSCF)	Fraction of CH_4 in LFG (%)	CH_4 Destruction Efficiency (%)	Collection Efficiency (%)	Oxidation Factor	CH4 Emitted (metric tons)	Total CO2e (metric tons)
BADLANDS (flare alone)	447.8112	44%	99.99963%	75%	0.1	1,122.81	23,578.91
BADLANDS (flare w/engine)	132.4512	44%	99.99963%	75%	0.1	332.10	6,974.04
BADLANDS (engine)	315.36	44%	99.70000%	75%	0.1	804.09	16,885.84
BLYTHE	14.016	8%	0.00000%	75%	0.1	27.88	585.43
COACHELLA (1997)	242.4768	37%	99.99964%	75%	0.1	511.97	10,751.40
CORONA (1986)	157.68	38%	99.90000%	75%	0.1	341.30	7,167.24
DOUBLE BUTTE (1994)	133.152	32%	99.99971%	75%	0.1	242.94	5,101.77
EDOM HILL (1997)	490.56	50%	99.99979%	75%	0.1	1,398.86	29,376.07
ELSINORE (1965)	49.056	19%	99.90006%	75%	0.1	54.50	1,144.55
HIGHGROVE (1998)	217.248	47%	99.99978%	75%	0.1	582.10	12,224.13
LAMB CANYON	449.9136	38%	99.99970%	75%	0.1	975.77	20,491.20
MEAD VALLEY (1997)	157.68	29%	99.99951%	75%	0.1	259.65	5,452.65
W. RIVERSIDE (1993)	46.2528	26%	99.99915%	75%	0.1	69.53	1,460.14
		50%	99%	75%	0.1	-	-
		50%	99%	75%	0.1	-	-
		50%	99%	75%	0.1	-	-
TOTAL	**2405.8464**					**5,600.69**	**117,614.46**

Notes:

MMSCF = Million Standard Cubic Feet

Average values for Fraction of CH_4 in LFG, CH_4 Destruction Efficiency, Collection Efficiency, and Oxidation Factor are present. Numbers should be changed if facility-specific factors exist.

Emissions from on-site equipment and hauling trucks are included in mobile emissions sources

	Measured LFG Flow (SCFM)	% LFG as CH_4	Destruction Efficiency	Estimated Fugitive CH_4 (SCFM)	Estimated Fugitive CH_4 (MT/yr)	Methane Capture in 1990?
BADLANDS (flare w/engine)	189	43.7%	99.9996%	24.78	244.13	
BADLANDS (engine)	450	44.0%	99.7000%	59.99	591.10	
BLYTHE	20	8.0%	0.0000%	2.08	20.49	
COACHELLA (1997)	346	36.8%	99.9996%	38.20	376.36	
CORONA (1986)	225	37.6%	99.9000%	25.46	250.89	Y
DOUBLE BUTTE (1994)	190	31.8%	99.9997%	18.13	178.59	
EDOM HILL (1997)	700	49.7%	99.9998%	104.37	1028.33	
ELSINORE (1965)	70	19.3%	99.9001%	4.07	40.07	
EL SOBRANTE (Total)	3014	45.0%	99.9000%	408.25	4022.32	Y
HIGHGROVE (1998)	310	46.7%	99.9998%	43.43	427.91	
LAMB CANYON	642	37.8%	99.9997%	72.80	717.31	
MEAD VALLEY (1997)	225	28.7%	99.9995%	19.37	190.87	
W. RIVERSIDE (1993)	66	26.2%	99.9991%	5.19	51.11	Y
					8,139.50	
					170,929.49	

Waste data provided by Riverside County Waste Management

35.315 cubic feet/cubic meter

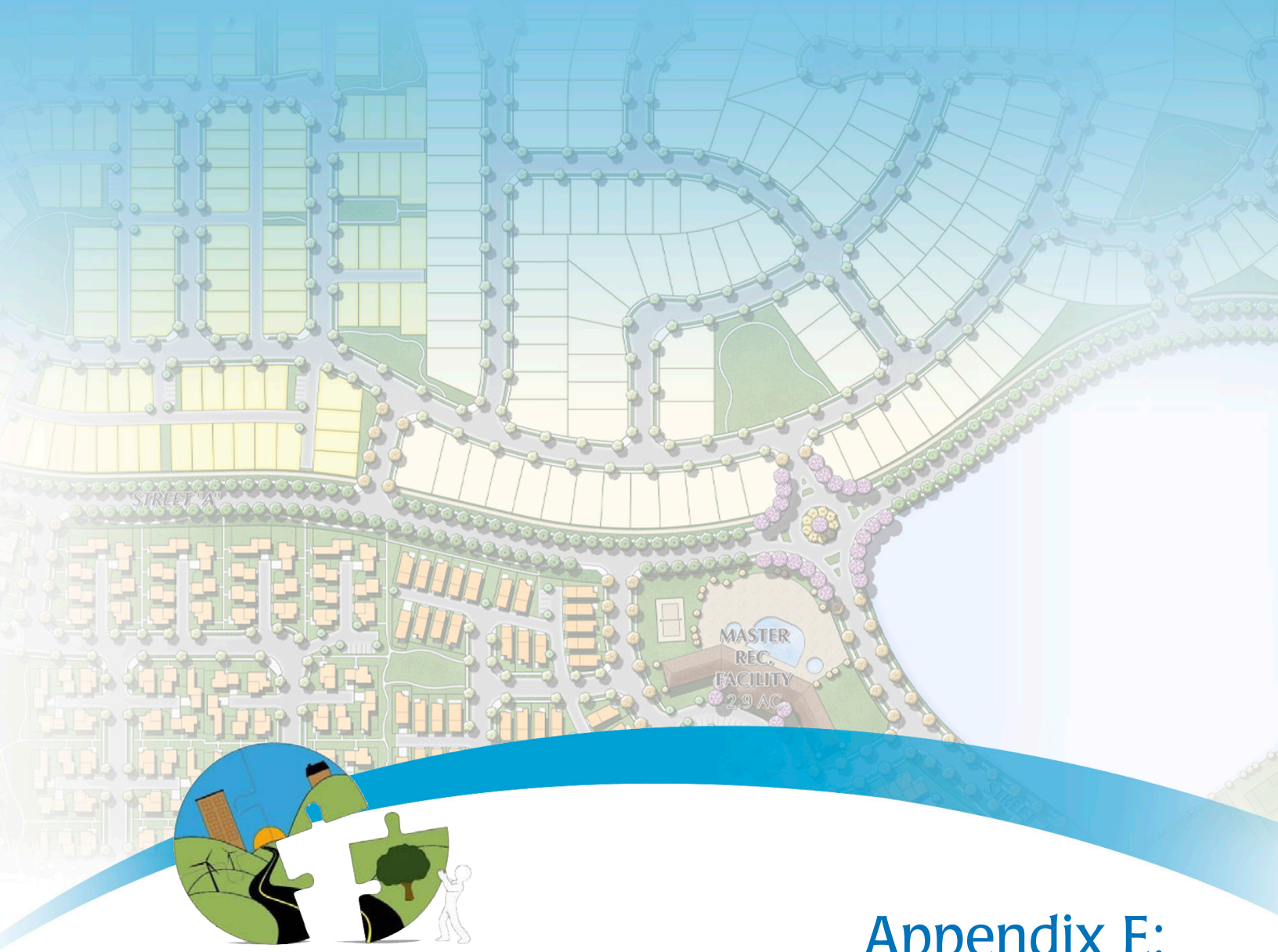
1000000 g/metric ton

Methane density

662 g/m^3

USEPA (2007). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005. United States Environmental Protection Agency. EPA 430-R-07-002. and Annex 3.10: Methodology for Estimating CH4 and N2O Emissions from Manure Management. April 15, 2007. Washington DC.

525,600 minutes per year



Appendix E:
Reduction Measures, Assumptions and Attributed Reductions

This page intentionally left blank

APPENDIX E1: 2020

Transportation Reduction Measures 2020

Pavley I and II and Low Carbon Fuel Standard Calculated on Transportation Tab

R1-T 4 Tire Pressure Program

The AB32 early action measure involves actions to ensure that vehicle tire pressure is maintained to manufacturer specifications. By 2020, this requirement will reduce emissions in California by approximately 0.55 $MMTCO_2e$, representing 0.3 percent of emissions from passenger/light-duty vehicles in the State.

Reduction to automobiles & light duty Trucks	=	0.30%

R1-T 5 Low Rolling Resistance Tires

This AB32 early action measure would increase vehicle efficiency by creating an energy efficiency standard for automobile tires to reduce rolling resistance. By 2020, this requirement will reduce emissions in California by approximately 0.3 $MMTCO_2e$, representing 0.2 percent of emissions from passenger/light-duty vehicles in the State.

Reduction to automobiles & light duty Trucks	=	0.20%

R1-T 6 Low Friction Engine Oils

This AB32 early action measure would increase vehicle efficiency by mandating the use of engine oils that meet certain low friction specifications. By 2020, this requirement will reduce emissions in California by approximately 2.8 $MMTCO_2e$, representing 1.7 percent of emissions from passenger light-duty vehicles in the State.

Reduction to automobiles & light duty Trucks	=	1.70%

R1-T 7 Goods Movement Efficiency Measures

This AB32 early action measure targets system wide efficiency improvements in goods movement to achieve GHG reductions from reduced diesel combustion. By 2020, this requirement will reduce emissions in California by approximately 3.5 $MMTCO_2e$, representing 1.6 Percent of emissions from all mobile sources (on-road and off-road) in the State.

Reduction afforded to Medium and Heavy Duty Vehicle emissions	=	1.60%

R1-T 8 Heavy-Duty Vehicle GHG Emission Reduction (Aerodynamic Efficiency)

This AB32 early action measure would increase heavy-duty vehicle (long-haul trucks) efficiency by requiring installation of best available technology and/or CARB approved technology to reduce aerodynamic drag and rolling resistance. By 2020, this requirement will reduce emissions in California by approximately 0.93 $MMTCO_2e$, representing 1.9 percent of emissions from heavy-duty vehicles in the State.

Reduction afforded to Heavy Duty Vehicles emissions	=	1.90%

R1-T 9 Medium and Heavy Duty Vehicle Hybridization

The implementation approach for this AB 32 measure is to adopt a regulation and/or incentive program that reduce the GHG emissions of new trucks (parcel delivery trucks and vans, utility trucks, garbage trucks, transit buses, and other vocational work trucks) sold in California by replacing them with hybrids. By 2020, this requirement will reduce emissions in California by approximately 0.5 $MMTCO_2e$, representing 0.2 percent of emissions from all on-road mobile sources in the State. This reduction is also equivalent to a 1.0 percent reduction of emissions from all heavy-duty trucks in the State.

Reduction afforded to passenger cars	=	0.20%
Reduction afforded to heavy duty trucks	=	1.00%

R1-T 10 Regional SB 375 Targets

Regional transportation emission reduction targets have been established. Statewide, this requirement is expected to reduce emissions by 5 MMTCO2e, which is equivalent to 2 percent of emissions from all mobile emission sources. ARB, in conjunction with SCAG, has adopted a target of an 8% decrease in transportation emissions by 2020 for the region. Many of the other reduction strategies included will work toward acheiving this target.

Reduction afforded to mobile emission sources = 6.00%

R1-T 11 CA High Speed Rail

California's planned high speed rail system is anticipated to reduce transportation emissions by 1 MMTCO2e. This amounts to 0.4% of the State's transportation emissions. There are stations planned in or near Riverside County, so the County will experience a similar reduction in emissions.

Reduction afforded to mobile emission sources = 0.00%

IM-T 1 Employment Based Trip and VMT Reduction

Implementation of this measure would require adopting a voluntary trip reduction ordinance that promotes commuter-choice programs, employer transportation management, guaranteed ride home programs and commuter assistance and outreach type programs intended to reduce commuter vehicle miles traveled. A guaranteed ride home program is a program that ensures employees that take advantage of carpooling opportunities are guaranteed a safe ride home should the employee miss the carpool pick-up time due to work related activities. This could be as simple as the employer paying for taxi service for the employee. This measure would require employers with more than 100 employees within the unincorporated County to establish a trip reduction plan that would incorporate annual employee commute surveys, marketing of commute alternatives, ride matching assistance, and transit information at a minimum. This reduction measure adds to and enhances Mobility Policies 2.G-2 and 2.G-3.

Assumptions:

* By 2020, this measure results in a 0.2% reduction in passenger/light-duty VMT in the County.
  The percentage reduction reflects growing decentralized & geographically extensive transportation network in the County.
* Measures R1-T1 through R1-T7 are implemented

IM-T1 Reductions:

Reduction afforded to passenger/light duty VMT in county	=	25.00%	
% Eligible Employees	=	80.00%	(CAPCOA estimate)
% Reduction Afforded	=	20.00%	

IM-T 2 Increased Residential Density

Designing the Project with increased densities, where allowed by the General Plan and/or Zoning Ordinance reduces GHG emissions associated with traffic in several ways. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. This strategy also provides a foundation for implementation of many other strategies which would benefit from increased densities

From CAPCOA: % VMT reduction = A * B where: A is the % increase in housing density and B is the elasticity of VMT to housing density.

Assumptions:

* Assume housing density increases by 150%
* Elasticity of VMT w.r.t. housing density is 0.07
* Measures R2-T2, R2-T3, R2-T5, R2-T6, R2-T8, and R3-T1 are implemented.

Reductions:

Reduction afforded to passenger/light duty VMT in county	=	13.50%

IM-T 3 Mixed Use Development

The demand for transportation is influenced by the density and geographic distribution of people and places. Whether neighborhoods have sidewalks or bike paths, whether homes are within walking distance of shops or transit stops will influence the type and amount of transportation that is utilized. By changing the focus of land use from automobile centered transportation, a reduction in vehicle miles traveled will occur. Implementation of Policies LU1.2 (Balanced Land Use Pattern), LU1.3 (Adequate Land Use Supply), LU 3.5 (Infill Development), LU 3.9 (Rural Hubs), LU 3.12 (Mixed Use); Mobility Policies M 3.1 (Transit Service for Residents), M 3.2 (Transit in New Development), M 3.3 (Transit Integration); and Agricultural Policies AG 4.4 (Farm worker Housing), AG 4.6 (Local Processing), AG 4.7 (Local Purchasing), and AG 4.12 (Support Uses) will all work together to provide a reduction in VMT for the County, by changing the

focus of land use away from vehicle centered transportation to the increased densities and lay-outs that foster the implementation and use of alternate modes of transportation.

Assumptions:

* Assumes low range VMT reduction of 9%.
* Measures R2-T2, R2-T3, R2-T5, R2-T6, R2-T8, and R3-T1 are implemented.

Reductions:

Reduction afforded to passenger/light duty VMT in county	=	15.00%

IM-T 4 Preferential Parking

Implementation of this reduction measure would encourage the County to adopt a comprehensive parking program for public and private parking lots that facilitate carpooling and alternate transportation. Incentives to encourage carpooling and the use of alternate transportation methods could include:

- Providing reserved preferential parking spaces for car-share, carpool, and ultra-low or zero emission vehicles;
- Provide larger parking spaces that can accommodate vans used for ride-sharing programs and reserve them for vanpools; and include adequate passenger waiting/loading areas;
- Consider restricting the number of parking spaces within the County by sharing parking among different land uses where feasible. For example in areas where there are multiple land uses provide resident restricted parking during nighttime hours (7pm to 7am) and open the parking lot for use by patrons of the surrounding commercial buildings during daytime hours; and
- Provide convenient pedestrian pathways through parking areas.

Assumptions:

* The percentage reduction reflects growing decentralized & geographically extensive transportation network in the County.
* Measures R1-T1 through R1-T7 and R2-T1 - R2-T2 are implemented
* Reduction is equal to 0.6% from all vehicle miles traveled by passenger and light duty vehicles in the County.

Reductions:

Reduction afforded to passenger/light duty

VMT in county = 0.60%

IM-T 5

Roadway Improvements Including Signal Synchronization and Transportation Flow Management

A study examined traffic conditions in Southern California using energy and emissions modeling and calculated the impacts of 1) congestion mitigation strategies to smooth traffic flow, 2) speed management techniques to reduce high free-flow speeds, and 3) suppression techniques to eliminate acceleration/deceleration associated with stop-and-go traffic. Using typical conditions on Southern California freeways, the strategies could reduce emissions by 7 to 12 percent. (from CAPCOA) Emissions reductions are highly dependent on current level of congestion on roadways.

Assumptions:

* Results in a 7-12% reduction in emissions (From CAPCOA)
* 12% reduction in emissions used as a conservative estimate
* Measures R1-T1 through R1-T7 and R2-T1 - R2-T3 are implemented

Reductions:

Reduction afforded to passenger/light duty VMT in county = 12.00%

IM-T 6 **Provide a Comprehensive System of Facilities for Non-motorized Transportation**

Mobility Goal M 5, and land use policies LU 1.10 (Efficient Land Use Patterns) and LU 4.8 (Quality New Development) require the County to address bicycle and pedestrian facilities. These goals and policies should: encourage the creation of bike lanes and walking paths directed to the location of schools, provide adequate bicycle parking; and encourage the development of bicycle stations, attended parking, and other attended bicycle support facilities at intermodal hubs. Bicycle stations are full-service bicycle facilities that in addition to providing secure, guarded bicycle parking could include other amenities such as “valet” bicycle service, showers, bicycle rentals, or repair services. These types of requirements are intended for large residential and non-residential development as well as large employers (500 or more employees). In addition, the establishment of multi-use trails that promote off-street bicycle and pedestrian travel as well as secure bicycle racks along these pathways will encourage their use.

- Proximity to bike lanes;
- Elimination of impediments to bicycle and pedestrian circulation;
- Secure bicycle storage;
- Bicycle and pedestrian incentive programs; and
- Showers and lockers.

Assumptions:

* The percentage reduction reflects growing decentralized & geographically extensive transportation network in the County.

* Measures R1-T1 through R1-T7 and R2-T1 - R2-T5 are implemented are implemented
* Results in a 0.65% reduction in vehicle miles traveled by passenger cars and light duty trucks

Reductions:

Reduction afforded to passenger/light duty VMT County from bike facilities at non-residential	=	0.65%
% Reduction from pedestrian facilities	=	14.00%

IM-T 7 Expand Renewable Fuel/Low-Emission Vehicle Use

Implementation of the following would promote the expanded use of renewable fuel and low-emission vehicles:

- Collaboration between local and regional governments and business to foster the increased use of renewable fuels. This can be accomplished by coordinating the siting of new alternative fueling/recharging locations for example.
- Providing preferential parking for ultra low-, zero- emission, and alternative fuel vehicles;
- Collaboration with energy providers to ensure the availability of necessary facilities and infrastructure to encourage the use of privately owned zero emission vehicles. This can be accomplished by having conveniently located charging and fueling stations for these vehicles.

- Provide incentives for taxicabs to use gas-electric hybrid vehicles or, at a minimum, smaller more fuel-efficient vehicles.

Assumptions:

* Each passenger vehicle (27.5 mpg avg) is replaced with similar electric vehicle
* 95% decrease in emissions is afforded for each vehicle
* Measures R1-T1 through R1-T7 and R2-T1 - R2-T6 are implemented are implemented

Reductions:

Emissions Reduction from each vehicle exchanged for electric vehicle	=	95.0%
% of electric vehicles in 2020	=	25.00%
Reduction afforded to passenger/light duty VMT (	=	23.75%

IM-T 8 Anti-Idling Enforcement

This measure involves the adoption and enforcement of an Anti-Idling Policy for heavy-duty diesel trucks, including local delivery trucks and long-haul truck transport within the County. This policy would prohibit idling of on and off-road heavy duty diesel vehicles for more than 5 minutes. This policy would be implemented by requiring signage at all loading docks and along truck routes informing drivers of the requirement to shut down their trucks after five minutes of idle time at loading docks and parking areas. By 2020 a 100% compliance with the anti-idling rules will reduce emissions in California by approximately 0.7 $MMTCO_2e$, representing 1.9 percent of emissions from heavy-duty diesel vehicles.

Assumptions:

* By 2020, this measure results in a 1.9% reduction in VMT from Medium Duty Vehicles in the County.
* By 2020, this measure results in a 1.9% reduction in VMT from Heavy Duty Vehicles in the County.
* Measures R1-T1 through R1-T7 are implemented

Reductions:

Reduction afforded to Medium and Heavy Duty Vehicle Emissions	=	3.61%

IM-T 9 Increase Public Transit

Assumes an increase in pulic transit coverage to expand upon Riverside County's one exisitng metrolink station.
Estimated increase of 15 percent

Assumptions:

* All default values fro CAPCOA
*
* Measures R1-T1 through R1-T7 are implemented

Reductions:

% increase in transit coverage	=	30.00%
city or transit ridership with respect to service coverage	=	1.01
Existing transit mode share (default for suburban area)	=	1.30%
Adjustments from transit ridership increase to VMT	=	0.67
Total Reductions afforded to passenger vehicles	=	26.391%

IM-T 10 Employee Commute Alternative Schedule

Assumes 30% of employees are eligible.
The 30% are evenly split between 9/80 schedule, 4 day-40 hour work week, and 1.5 days of telecommuting
Numbers from CAPCOA

10% 9/80: 0.7% VMT reduction
10% 4day: 1.5% VMT reduction
10% 1.5 day tele commute: 2.2% VMT reduction

Total reduction afforded to passenger vehicles: = 10.7%

Energy Reduction Measures 2020

R1-E 1 Renewable Portfolio Standard for Building Energy Use

Senate Bills (SBs) 1075 (2002) and 107 (2006) created the State's Renewable Portfolio Standard (RPS), with an initial goal of 20 percent renewable energy production by 2010. Executive Order (EO) S-14-08 establishes a RPS target of 33 percent by the year 2020 and requires State agencies to take all appropriate actions to ensure the target is met. The 33 percent RPS by 2020 goal is supported by the California Air Resources Board (CARB), though its feasibility is not certain due to current limitations in production and transmission of renewable energy.

Assumptions:

* Southern California Edison reaches its 33% goal for 2020.
* Assumes that in 2008 SCE's renewable portfolio was at 14% with respect to California's RPS.
* Assumes a 19% reduction in emissions from existing kWHs used.
* Assumes R1-E2 through R1-E6 have been implemented.

Reductions:

% Reduction Afforded = 19.00%

R1-E 2 & 3 AB1109 Energy Efficiency Standard for Lighting

Assembly Bill (AB1109) mandated that the California Energy Commission (CEC) on or before December 31, 2008, adopt energy efficiency standards for general purpose lighting. These regulations, combined with other State efforts, shall be structured to reduce State-wide electricity consumption in the following ways:

- R1-E2: At least 50 percent reduction from 2007 levels for indoor residential lighting by 2018; and
- R1-E3: At least 25 percent reduction from 2007 levels for indoor commercial and outdoor lighting by 2018.

Assumptions:

* Assumes 20% of residential electrical use is from lighting.
* Assumes 37.14% of commercial/industrial electrical usage is from lighting.
* Assumes 5.5% of commercial electrical usage is from outdoor streetlights and area lights.

Reductions:

% reduction from residential electrical use = 10.00%

% reduction from commercial/industrial electrical use = 10.66%

R1-E 4 Electrical Energy Efficiency

This measure captures the emission reductions associated with electricity energy efficiency activities included in CARB's AB32 Scoping Plan that are not attributed to other R1 or R2 reductions, as described in this report. This measure includes energy efficiency measures that CARB views as crucial to meeting the State-wide 2020 target, and will result in additional emissions reductions beyond those already accounted for in California's Energy Efficiency Standards for Residential and Non-Residential Buildings (Title 24, Part 6 of the California Code of Regulations; hereinafter referred to as, "Title 24 Energy Efficiency Standards"), the County's adopted Green Building ordinance (effective January 1, 2011), etc. By 2020, this requirement will reduce emissions in California by approximately 21.3 $MMTCO_2e$, representing 17.5 percent of emissions from all electricity in the State. This measure includes the following strategies:

- "Zero Net Energy" buildings (buildings that combine energy efficiency and renewable generation so that they, based on an annual average, extract no energy from the grid);
- Broader standards for new types of appliances and for water efficiency;
- Improved compliance and enforcement of existing standards;
- Voluntary efficiency and green building targets beyond mandatory codes;
- Voluntary and mandatory whole-building retrofits for existing buildings;
- Innovative financing to overcome first-cost and split incentives for energy efficiency, on-site renewables, and high efficiency distributed generation;
- More aggressive utility programs to achieve long-term savings;
- Water system and water use efficiency and conservation measures;
- Additional industrial and agricultural efficiency initiatives; and
- Providing real time energy information technologies to help consumers conserve and optimize energy performance.

Assumptions:

* The percent reduction from California's emissions from various energy efficiency measures is equal to the County's emissions from this measures or 17.5%.
* Assumes application only to New development

Reductions:

% reduction afforded	=	17.50%
% New Residential	=	38.43%
% New Commercial	=	62.98%
% reduction applied to residential	=	6.72%
% reduction applied to commercial	=	11.02%

R1-E 5 Natural Gas Energy Efficiency

This measure captures the emission reductions associated with natural gas energy efficiency activities included in CARB's AB32 Scoping Plan that are not attributed to other R1 or R2 reductions, as described in this report. This measure includes energy efficiency measures that CARB views as crucial to meeting the State-wide 2020 target, and will result in additional emissions reductions beyond those already accounted for in California's Energy Efficiency Standards for Residential and Non-Residential Buildings (Title 24, Part 6 of the California Code of Regulations; hereinafter referred to as, "Title 24 Energy Efficiency Standards"), the County's adopted Green Building ordinance(effective January 1, 2011), etc. By 2020, this requirement will reduce emissions in California by approximately 4.3 $MMTCO_2e$, representing 6.2 percent of emissions from all natural gas combustion in the State. This measure includes the following strategies:

- "Zero Net Energy" buildings (buildings that combine energy efficiency and renewable generation so that they, based on an annual average, extract no energy from the grid);
- Broader standards for new types of appliances and for water efficiency;
- Improved compliance and enforcement of existing standards;
- Voluntary efficiency and green building targets beyond mandatory codes;
- Voluntary and mandatory whole-building retrofits for existing buildings;
- Innovative financing to overcome first-cost and split incentives for energy efficiency, on-site renewables, and high efficiency distributed generation;
- More aggressive utility programs to achieve long-term savings;
- Water system and water use efficiency and conservation measures;
- Additional industrial and agricultural efficiency initiatives; and
- Providing real time energy information technologies to help consumers conserve and optimize energy performance.

Assumptions:

* The percent reduction from California's emissions from various energy efficiency measures is equal to the County's emissions from this measures or 6.2%.
* Assumes application only to New development

Reductions:

% reduction afforded	=	6.20%
% New Residential	=	38.43%
% New Commercial	=	49.01%
% reduction applied to residential	=	2.38%
% reduction applied to commercial	=	3.04%

R1-E 6 Increased Combined Heat and Power

This measure captures the reduction in building electricity emissions associated with the increase of combined heat and power activities, as outlined in CARB's AB32 Scoping Plan. The Scoping Plan suggests that increased combined heat and power systems, which capture "waste heat" produced during power generation for local use, will offset 30,000 GWh State-wide in 2020. Approaches to lowering market barriers include utility-provided incentive payments, a possible CHP portfolio standard, transmission and distribution support systems, or the use of feed-in tariffs. By 2020, this requirement will reduce emissions in California by approximately 6.7 $MMTCO_2e$, representing 7.6 percent of emissions from all electricity in the State.

Assumptions:

* The percent reduction from California's emissions is equal to the County's emissions from this measures or 7.6%.

Reductions:

% reduction afforded = 7.60%

R1-E 7 Industrial Efficiency Measures

This measure captures the reduction in industrial building energy emissions associated with the energy efficiency measures for industrial sources included in CARB's AB32 Scoping Plan. By 2020, this requirement will reduce emissions in California by approximately 1.0 $MMTCO_2e$, representing 3.9 percent of emissions from all industrial natural gas combustion in the State. CARB proposes the following possible State-wide measures:

- Oil and gas extraction;
- GHG leak reduction from oil and gas transmission;
- Refinery flare recovery process improvements; and
- Removal of methane exemption from existing refinery regulations.

Assumptions:

* The percent reduction from California's emissions is equal to the County's emissions from this measures or 3.9%.
* Assumes applies to all residential, commercial, and industrial land uses.

Reductions:

% reduction afforded = 3.90%

R2-E 1 Residential Energy Efficiency Program

This measure involves the adoption of a program that facilitates energy efficient design for all new residential buildings to be 20% beyond the current Title 24 Standards . This energy efficiency requirement is equal to that of the LEED for Homes and ENERGY STAR programs.

The 2008 Title 24 Energy Standards were adopted by the Energy Commission on April 23, 2008, with the 2008 Residential Compliance Manual adopted by the Commission on December 17, 2008. Compliance with the 2008 standards went into effect January 1, 2010. In an effort to meet the overall goal of the California Energy Efficiency Strategic Plan of reaching zero net energy for residential buildings by 2020, the stringency of the Title 24 Energy Standards as regulated and required by the State will continue to increase every three years. As energy efficiency standards increase the County may want to periodically re-evaluate their percentage beyond Title 24 goal to ensure it is still a feasibly achievable goal.

- Install energy efficient appliances, including air conditioning and heating units, dishwashers, water heaters, etc.;
- Install solar water heaters;
- Install top quality windows and insulation;
- Install energy efficient lighting;
- Optimize conditions for natural heating, cooling and lighting by building siting and orientation.
- Use features that incorporate natural ventilation;
- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes; and
- Incorporate skylights; reflective surfaces, and natural shading in buildings design and layouts.

The County will develop a menu of options with points assigned to them. As long as a developer meets the required point allotment (33 points) the developer will meet the requirements of this measure. This system will assure flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the strategies outlined in the bullet points above.

Assumptions:

* Applies to new development only.
* Assumes new development to be 20% beyond current Title 24.

Reductions:

% of new residential development	=	38.43%
% reduction afforded	=	20.00%
Total % reduction	=	7.69%

R2-E 2 Residential Renewable Energy Program

This measure facilitates the voluntary incorporation of renewable energy (such as photovoltaic panels) into new residential developments. For participating developments, renewable energy application should be such that the new home's projected energy use from the grid is reduced by 50%. The California Energy Commissions' New Solar Homes Partnership is a component of the California Solar Initiative and provides rebates to developers of 6 or more units where 50% of the units include solar power. In addition this measure would encourage that all residents be equipped with "solar ready" features where feasible, to encourage future installation of solar energy systems. These features should include the proper solar orientation (south facing roof sloped at 20° to 55° from the horizontal), clear access on south sloped roofs, electrical conduit installed for solar electric system wiring, plumbing installed for solar hot water systems, and space provided for a solar hot water tank. The incentive program should provide enough funding and other incentives as shown in the R3 measures to result in approximately fifty percent of new residential development participation in this program, thereby resulting in a 25% reduction in electrical consumption from new residential developments.

As an alternative to, or in support of, providing onsite renewable energy, the project proponent can buy into a purchased energy offset program that will allow for the purchase of electricity generated from renewable energy resources offsite. Purchased energy offsets (or a combination of incorporated renewables and purchased offsets) must be equal to 25% of the total projected energy consumption for the development. See R3-E3 for further details on the financing program.

Assumptions:

* Applies to new development only.
* Assumes that 50% of new development will participate.
* Assumes that those developments participating will reduce electrical use by 50%.

Reductions:

% of residential that is new	=	38.43%
% reduction from energy use	=	65.00%
% participating	=	50.00%
Total % reduction	=	12.49%

R2-E 3 Residential Retrofit Implementation Program

This measure would initiate a County program that facilitates the incorporation of energy reduction measures for residential buildings undergoing major renovations. AB 811 is a potential funding source to the County for implementing incentive programs to encourage residences within the County to undertake energy efficiency retrofitting and reducing energy consumption in retrofitted homes by a minimum of 15%. As with the new development, the County will develop a menu of options with points assigned to them. As long as a developer meets the required point allotment (100 points) the developer will meet the requirements of this measure. This system will be provided to assure flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following:

- Replace inefficient air conditioning and heating units with new energy efficient models;
- Replace older, inefficient appliances with new energy efficient models;
- Replace old windows and insulation with top-quality windows and insulation;
- Install solar water heaters;
- Replace inefficient and incandescent lighting with energy efficient lighting; and
- Weatherize the existing building to increase energy efficiency.

Assumptions:

- Applies to existing development only.
- Assumes that30% of existing development will participate.
- Assumes that those developments participating will increase efficiency by 20%.
- Assumes reduction from electrical and natural gas.

Reductions:

% of 2020 that is existing residential development	=	61.57%
% reduction applied	=	50.00%
% existing homes participating	=	30.00%
Total % reduction	=	9.24%

R2-E 4 Residential Renewable Retrofit Program

This measure will initiate an incentive program that encourages residents to retrofit their homes with photovoltaic panels such that 50% of all of the home's electrical usage is offset. The California Energy Commission's Solar Initiative has incentives available to home owners.

Assumptions:

* Applies to existing development only.
* Assumes that 25% of existing development will participate.
* Assumes that those developments participating will reduce emissions from electricity by60%.
* Assumes reduction from electricity.

Reductions:

% of 2020 that is existing residential development	=	61.57%
% reduction applied	=	65.00%
% existing homes participating	=	30.00%
Total % reduction	=	12.01%

R2-E 5 Commercial Energy Efficiency Program

This measure involves the adoption of a County Program that facilitates the energy efficient design for all new commercial buildings within Sutter Pointe to be 20% beyond the current Title 24 Standards which expands the new development requirements set forth in the Sutter Pointe Specific Plan EIR. This voluntary energy efficiency requirement is 10% greater than the minimum requirements of the LEED and ENERGY STAR programs. As energy efficiency standards increase the County may want to periodically re-evaluate their percentage beyond Title 24 goal to ensure it is still a feasibly achievable goal.

As described in R2-E1 above, the County could provide all developers with a list of potentially feasible GHG reduction measures that reflect the current state of the regulatory environment. The County will develop a menu of options with points assigned to them. As long as a developer meets the required point allotment (100 points) the developer will meet the requirements of this measure. This system will provide flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following:

- Install energy efficient appliances, including air conditioning and heating units, dishwashers, water heaters, etc.;
- Install solar water heaters;
- Install top quality windows and insulation;
- Install energy efficient lighting;
- Optimize conditions for natural heating, cooling and lighting by building siting and orientation.
- Use features that incorporate natural ventilation;
- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes; and

- Incorporate skylights; reflective surfaces, and natural shading in buildings design and layouts.

Assumptions:

* Applies to new development only.
* Assumes new development to be 28% beyond current Title 24.

Reductions:

% new com/ind that is new	=	62.98%
% reduction afforded	=	28.00%
Total % reduction	=	17.63%

R2-E 6 Commercial/Industrial Renewable Energy Program

This measure would facilitate the voluntary incorporation of renewable (solar or other renewable) energy generation into the design and construction of new commercial, office, and industrial developments. Renewable energy generation shall be incorporated such that a minimum of 20% of the project's total energy needs are offset. In addition this measure would encourage all facilities be equipped with "solar ready" features where feasible, to facilitate future installation of solar energy systems. These features should include the proper solar orientation (south facing roof sloped at 20° to 55° from the horizontal), clear access on south sloped roofs, electrical conduit installed for solar electric system wiring, plumbing installed for solar hot water systems, and space provided for a solar hot water tank.

As an alternative to, or in support of, providing onsite renewable energy, the project proponent can buy into an offset program that will allow for the purchase of renewable energy resources offsite. Purchased energy offsets (or a combination of incorporated renewables and purchased offsets) must be equal 20% of the total projected energy consumption for the development. See R3-E3 for further details on the financing program.

Assumptions:

* Applies to new development only.
* Assumes that 75% of new development will participate.
* Assumes that those developments participating will reduce electrical use by 65%.

Reductions:

% of com/ind development from growth	=	62.98%
% reduction from program	=	65.00%
% of participation	=	75.00%
Total % reduction	=	30.70%

R2-E 7 Commercial/Industrial Retrofit Program

This measure encourages all commercial or industrial buildings undergoing major renovations to reduce their energy consumption by a minimum of 20%. As with the new development, a menu of options will be provided to assure flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following: (Includes both energy efficiency and renewable energy technologies)

- Replace inefficient air conditioning and heating units with new energy efficient models;
- Replace older, inefficient appliances with new energy efficient models;
- Replace old windows and insulation with top-quality windows and insulation;
- Install solar water heaters;
- Replace inefficient and incandescent lighting with energy efficient lighting; and
- Weatherize the existing building to increase energy efficiency.

Assumptions:

* Applies to existing development only.
* Assumes that 25% of existing development will participate.
* Assumes that those developments participating will increase efficiency by 25%.
* Assumes reduction from electrical and natural gas.

Reductions:

% from existing com/ind development	=	37.02%
% reduction applied	=	40.00%
% of participation	=	30.00%
Total % reduction	=	4.44%

R2-E 8 **Induction Streetlight Retrofits**

The new lamps are estimated to last 5 times longer and consume 50% less energy than the HPS lamps.

Assumptions:

* Applies to streetlight electricity consumption
* Assumes 20% of lamps will be retrofitted
* Retrofitted lamps will use 50% less energy

Reductions:

% reduction applied	=	50.00%
% streetlights retrofitted	=	100.00%
% 2020 comm electricity use from streetlights	=	7.65%
Total % reduction	=	3.83%

Area Source Reduction Measures 2020

R2-L1 Electric Landscaping Equipment

49.5% % reduction *CAPCOA report*

SCAQMD Healthy Hearths Program

R2-L2 No new wood burning devices in homes

R2-L3 10 to 25 Mandatory Curtailment days

Total Heating Days	120	(November-February)
% Reduction	0.125	

Purchased Water Reduction Measures 2020

R1-W 1 Renewable Portfolio Standard (33% by 2020) Related to Water Supply and Conveyance

This measure would increase electricity production from eligible renewable power sources to 33 percent by 2020. A reduction in GHG emissions results from replacing natural gas-fired electricity production with zero GHG-emitting renewable sources of power. By 2020, this requirement will reduce emissions from electricity used for water supply and conveyance in California by approximately 21.3 $MMTCO_2e$, representing 15.2 percent of emissions from electricity generation (in-State and imports).

Assumptions:

* The percent reduction from California's emissions is equal to the County's emissions from electricity used for water supply and conveyance or 21%.
* Assumes applies to all residential, commercial, and industrial land uses.

Reductions:

% reduction afforded = 19.00%

R2-W 1 Water Use Reduction Initiative

This initiative would reduce emissions associated with electricity consumption for water treatment and reduction and therefore are included with the energy reductions. This measure encourages the County to adopt a per capita water use reduction goal in support of the Governors Executive Order S-14-08 which mandates the reduction of water use of 20 percent per capita. The County's adoption of a water use reduction goal would introduce requirements for new development and would provide cooperative support for water purveyors that are required to implement these reductions for existing developments. The County would also provide internal reduction measures such that County facilities will support this reduction requirement. The following represent potential programs that can be implemented to attain this reduction goal.

Water Conservation Program:

Under this program the excessive watering of landscaping, excessive fountain operation, watering during peak daylight hours, water of non-permeable surfaces, excessive water use for noncommercial washing, and water use resulting in flooding or runoff would be prohibited. In addition the program

would encourage efficient water use for construction activities, the installation of low-flow toilets and showerheads for all new developments, use of drought-tolerant plants with efficient landscape watering systems for all new developments, recycling of water used for cooling systems, use of pool covers, and the posting of water conservation signage at all hotels.

New Development Incentives:

Provide incentives for developers to comply with the California Green Building Standards Code as requirements for all new development. Under this Code new developments are required to reduce indoor potable water use by 20% beyond the Energy Policy Act of 1992 fixture performance requirements, and to reduce outdoor potable water use by 50% from a mid-summer baseline average consumption through irrigation efficiency, native plant selection, the use of recycled water and/or captured rainwater for example.

Water Meter Program:

Encourage water providers to install water meters for all County homes not using wells. This would provide for a better accounting of County water usage and provide potential costing per usage to help offset costs of the implementation of water conservation programs.

Water Efficiency Pricing Program

Under this program, the County would encourage water suppliers to adopt a water conservation pricing schedule (i.e. tiered rate) to encourage efficient water use. Notices could be provided in each billing showing water use budgets and the relationship between the budget and the actual usage.

Water Efficiency Retrofit Program:

This program would encourage upgrades in water efficiency for renovations or additions of residential, commercial, office, and industrial properties equivalent to that of new developments. The County would work with local water purveyors to achieve consistent standards, and to develop, approve, and review procedures for implementation.

Water Efficiency Training and Education:

Under this measure the County, in coordination with local water purveyors would implement a public information and education program that promotes water conservation. The program could include certification programs for irrigation designers, installers, and managers, as well as classes to promote the use of drought tolerant, native species and xeriscaping.

R2-W 1 Water Use Reduction Initiative

Increased Recycled Water Use:

Promote the use of municipal wastewater and graywater for agricultural, industrial and irrigation purposes. This measure would be subject to approval of the State Health Department and compliance with Title 22 provisions. This measure would facilitate the following:

- Inventory of non-potable water uses that could be substituted with recycled or graywater;
- Determination of the feasibility of producing and distributing recycled water for groundwater replenishment;
- Determine the associated energy/GHG tradeoffs for treatment/use vs. out of basin water supply usage; and
- Cooperation and coordination with responsible agencies to encourage the use of recycled water where energy tradeoffs are favorable.

Assumptions:

* Applies to all land uses (existing and new development)
* Assumes emission reduction of 20%.
* Assumes reduction to electricity used to treat and convey water and wastewater.
* Assumes that approximately 14% of the electricity usage is used to pump water from wells.

Reductions:

% reduction applied to water usage directly = 20.00%

IM-W 1 Increase Reclaimed Water Use

This measure would increase electricity production from eligible renewable power sources to 33 percent by 2020. A reduction in GHG emissions results from replacing natural gas-fired electricity production with zero GHG-emitting renewable sources of power. By 2020, this requirement will reduce emissions from electricity used for water supply and conveyance in California by approximately 21.3 $MMTCO_2e$, representing 15.2 percent of emissions from electricity generation (in-State and imports).

Assumptions:

* Percent of total water use coming from reclaimed is 5%
* Percentage reduction GHG by using reclaimed rather than potable water is 81%

Reductions:

% reduction afforded = 4.05%

IM-W 1 **County Diversion Program**

This measure would implement a County wide waste diversion plan to further the goal of diverting 75% of all waste from landfills by 2020. The following is a potential list of waste reduction measures that will further strengthen existing waste reduction/diversion programs.

- Provide outreach and education programs for residential, commercial, and industrial land uses in order to further promote existing County diversion programs;
- Increase disposal fees and/or reduce residential pick-up frequency;
- Encourage businesses to adopt a voluntary procurement standard and prioritize those products that have less packaging, are reusable, recyclable, or compostable;
- Support State level policies that provide incentives for efficient and reduced packaging waste for commercial products;

- Expand list of recyclable materials;
- Work with Recology to develop and provide waste audits;
- Make recycling and composting opportunities mandatory at all public events;
- Establish an appliance end-of-life requirement;
- For new developments, require the use of recycled-content materials, or recycled materials;
- Require a minimum of 15% of materials used in construction be sourced locally, as feasible; and
- Encourage the use of recycled building materials and cement substitutes for new developments.

Assumptions:

* Assumes an existing diversion rate of 53%
* Assumes 2020 goal of 80% diversion rate.
* Does not apply to construction activities
* % reduction applied is equivalent to: (80-53)/47

Reductions:

% reduction applied	=	57.45%
% not from construction activities	=	81.20%
% reduction applied	=	46.65%

IM-W 2 Construction Diversion Program

This IM also implements General Plan Policies AQ 4.1 and AQ 5.1 by giving incentives through points within the Screening Table to new development that provided diversion of 70% of construction waste. This provides a 20% increase in diversion beyond AB2176, § 42911, that requires development projects to provide adequate areas for collecting and loading recyclable materials and ensures a 50% diversion rate prior to being issued a building permit.

% reduction applied is equivalent to: 20/50

Reductions:

% reduction applied	=	40%
% from construction activities	=	18.80%
% reduction applied	=	7.52%

APPENDIX E2: 2035

Transportation Reduction Measures 2035

Pavley I and II and Low Carbon Fuel Standard Calculated on Transportation Tab

R1-T 4 Tire Pressure Program

The AB32 early action measure involves actions to ensure that vehicle tire pressure is maintained to manufacturer specifications. By 2020, this requirement will reduce emissions in California by approximately 0.55 $MMTCO_2e$, representing 0.3 percent of emissions from passenger/light-duty vehicles in the State.

Reduction to automobiles & light duty Trucks = 0.30%

R1-T 5 Low Rolling Resistance Tires

This AB32 early action measure would increase vehicle efficiency by creating an energy efficiency standard for automobile tires to reduce rolling resistance. By 2020, this requirement will reduce emissions in California by approximately 0.3 $MMTCO_2e$, representing 0.2 percent of emissions from passenger/light-duty vehicles in the State.

Reduction to automobiles & light duty Trucks = 0.20%

R1-T 6 Low Friction Engine Oils

This AB32 early action measure would increase vehicle efficiency by mandating the use of engine oils that meet certain low friction specifications. By 2020, this requirement will reduce emissions in California by approximately 2.8 $MMTCO_2e$, representing 1.7 percent of emissions from passenger light-duty vehicles in the State.

Reduction to automobiles & light duty Trucks = 1.70%

R1-T 7 Goods Movement Efficiency Measures

This AB32 early action measure targets system wide efficiency improvements in goods movement to achieve GHG reductions from reduced diesel combustion. By 2020, this requirement will reduce emissions in California by approximately 3.5 $MMTCO_2e$, representing 1.6 Percent of emissions from all mobile sources (on-road and off-road) in the State.

Reduction afforded to Medium and Heavy Duty Vehicle emissions	=	1.60%

R1-T 8 Heavy-Duty Vehicle GHG Emission Reduction (Aerodynamic Efficiency)

This AB32 early action measure would increase heavy-duty vehicle (long-haul trucks) efficiency by requiring installation of best available technology and/or CARB approved technology to reduce aerodynamic drag and rolling resistance. By 2020, this requirement will reduce emissions in California by approximately 0.93 $MMTCO_2e$, representing 1.9 percent of emissions from heavy-duty vehicles in the State.

Reduction afforded to Heavy Duty Vehicles emissions	=	1.90%

R1-T 9 Medium and Heavy Duty Vehicle Hybridization

The implementation approach for this AB 32 measure is to adopt a regulation and/or incentive program that reduce the GHG emissions of new trucks (parcel delivery trucks and vans, utility trucks, garbage trucks, transit buses, and other vocational work trucks) sold in California by replacing them with hybrids. By 2020, this requirement will reduce emissions in California by approximately 0.5 $MMTCO_2e$, representing 0.2 percent of emissions from all on-road mobile sources in the State. This reduction is also equivalent to a 1.0 percent reduction of emissions from all heavy-duty trucks in the State.

Reduction afforded to passenger cars	=	1.00%
Reduction afforded to heavy duty trucks	=	2.00%

R1-T 10 Regional SB 375 Targets

Regional transportation emission reduction targets have been established. Statewide, this requirement is expected to reduce emissions by 5 MMTCO2e, which is equivalent to 2 percent of emissions from all mobile emission sources. ARB, in conjunction with SCAG, has adopted a target of an 8% decrease in transportation emissions by 2020 for the region. Many of the other reduction strategies included will work toward acheiving this target.

Reduction afforded to mobile emission sources = 8.00%

R1-T 11 CA High Speed Rail

California's planned high speed rail system is anticipated to reduce transportation emissions by 1 MMTCO2e. This amounts to 0.4% of the State's transportation emissions. There are stations planned in or near Riverside County, so the County will experience a similar reduction in emissions.

Reduction afforded to mobile emission sources = 0.00%

IM-T 1 Employment Based Trip and VMT Reduction

Implementation of this measure would require adopting a voluntary trip reduction ordinance that promotes commuter-choice programs, employer transportation management, guaranteed ride home programs and commuter assistance and outreach type programs intended to reduce commuter vehicle miles traveled. A guaranteed ride home program is a program that ensures employees that take advantage of carpooling opportunities are guaranteed a safe ride home should the employee miss the carpool pick-up time due to work related activities. This could be as simple as the employer paying for taxi service for the employee. This measure would require employers with more than 100 employees within the unincorporated County to establish a trip reduction plan that would incorporate annual employee commute surveys, marketing of commute alternatives, ride matching assistance, and transit information at a minimum. This reduction measure adds to and enhances Mobility Policies 2.G-2 and 2.G-3.

Assumptions:

* By 2035, this measure results in a 25% reduction in passenger/light-duty VMT in the County. The percentage reduction reflects a growing decentralized and geographically extensive transportation network in the County.
* Measures R1-T1 through R1-T7 are implemented

Reductions:

Reduction afforded to passenger/light duty VMT in county	=	25.00%
% Eligible Employees	=	80.00%
% Reduction Afforded	=	20.00%

IM-T 2 Increased Residential Density

Designing the Project with increased densities, where allowed by the General Plan and/or Zoning Ordinance reduces GHG emissions associated with traffic in several ways. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. This strategy also provides a foundation for implementation of many other strategies which would benefit from increased densities

From CAPCOA: % VMT reduction = A * B where: A is the % increase in housing density and B is the elasticity of VMT with respect to housing density.

Assumptions:

* Assume housing density increases by 150%
* Elasticity of VMT w.r.t. housing density is 0.07
* Measures R2-T2, R2-T3, R2-T5, R2-T6, R2-T8, and R3-T1 are implemented.

Reductions:

Reduction afforded to passenger/light duty VMT in county	=	17.50%

IM-T 3 Mixed Use Development

The demand for transportation is influenced by the density and geographic distribution of people and places. Whether neighborhoods have sidewalks or bike paths, whether homes are within walking distance of shops or transit stops will influence the type and amount of transportation that is utilized. By changing the focus of land use from automobile centered transportation, a reduction in vehicle miles traveled will occur. Implementation of Policies LU1.2 (Balanced Land Use Pattern), LU1.3 (Adequate Land Use Supply), LU 3.5 (Infill Development), LU 3.9 (Rural Hubs), LU 3.12 (Mixed Use); Mobility Policies M 3.1 (Transit Service for Residents), M 3.2 (Transit in New Development), M 3.3 (Transit Integration); and Agricultural Policies AG 4.4 (Farm worker Housing), AG 4.6 (Local Processing), AG 4.7 (Local Purchasing), and AG 4.12 (Support Uses) will all work together to provide a reduction in VMT for the County, by changing the focus of land use away from vehicle centered transportation to the increased densities and lay-outs that foster the implementation and use of alternate modes of transportation.

Assumptions:

* Assumes low range VMT reduction of 9%.
* Measures R2-T2, R2-T3, R2-T5, R2-T6, R2-T8, and R3-T1 are implemented.

Reductions:

Reduction afforded to passenger/light duty VMT in county	=	12.00%

IM-T 4 Preferential Parking

Implementation of this reduction measure would encourage the County to adopt a comprehensive parking program for public and private parking lots that facilitate carpooling and alternate transportation. Incentives to encourage carpooling and the use of alternate transportation methods could include:

- Providing reserved preferential parking spaces for car-share, carpool, and ultra-low or zero emission vehicles;
- Provide larger parking spaces that can accommodate vans used for ride-sharing programs and reserve them for vanpools; and include adequate passenger waiting/loading areas;
- Consider restricting the number of parking spaces within the County by sharing parking among different land uses where feasible. For example in areas where there are multiple land uses provide resident restricted parking during nighttime hours (7pm to 7am) and open the parking lot for use by patrons of the surrounding commercial buildings during daytime hours; and

- Provide convenient pedestrian pathways through parking areas.

Assumptions:

* 0
* Measures R1-T1 through R1-T7 and R2-T1 - R2-T2 are implemented
* Reduction is equal to 0.1% from all vehicle miles traveled by passenger and light duty vehicles in the County.

Reductions:

Reduction afforded to passenger/light duty VMT in county	=	1.00%

IM-T 5

Roadway Improvements Including Signal Synchronization and Transportation Flow Management

A study examined traffic conditions in Southern California using energy and emissions modeling and calculated the impacts of 1) congestion mitigation strategies to smooth traffic flow, 2) speed management techniques to reduce high free-flow speeds, and 3) suppression techniques to eliminate acceleration/deceleration associated with stop-and-go traffic. Using typical conditions on Southern California freeways, the strategies could reduce emissions by 7 to 12 percent. (from CAPCOA) Emissions reductions are highly dependent on current level of congestion on roadways.

Assumptions:

* Results in a 7-12% reduction in emissions (From CAPCOA)
* 12% reduction in emissions used as a conservative estimate
* Measures R1-T1 through R1-T7 and R2-T1 - R2-T3 are implemented

Reductions:

Reduction afforded to passenger/light duty VMT in county	=	12.00%

IM-T 6 Provide a Comprehensive System of Facilities for Non-motorized Transportation

Mobility Goal M 5, and land use policies LU 1.10 (Efficient Land Use Patterns) and LU 4.8 (Quality New Development) require the County to address bicycle and pedestrian facilities. These goals and policies should: encourage the creation of bike lanes and walking paths directed to the location of schools, provide adequate bicycle parking; and encourage the development of bicycle stations, attended parking, and other attended bicycle support facilities at intermodal hubs. Bicycle stations are full-service bicycle facilities that in addition to providing secure, guarded bicycle parking could include other amenities such as "valet" bicycle service, showers, bicycle rentals, or repair services. These types of requirements are intended for large residential and non-residential development as well as large employers (500 or more employees). In addition, the establishment of multi-use trails that promote off-street bicycle and pedestrian travel as well as secure bicycle racks along these pathways will encourage their use.

- Proximity to bike lanes;
- Elimination of impediments to bicycle and pedestrian circulation;
- Secure bicycle storage;
- Bicycle and pedestrian incentive programs; and
- Showers and lockers.

Assumptions:

* 0

* Measures R1-T1 through R1-T7 and R2-T1 - R2-T5 are implemented are implemented
* Results in a 0.65% reduction in vehicle miles traveled by passenger cars and light duty trucks

Reductions:

Reduction afforded to passenger/light duty VMT County from bike facilities at non-residential	=	6.00%
% Reduction from pedestrian facilities	=	4.50%

IM-T 7 Expand Renewable Fuel/Low-Emission Vehicle Use

Implementation of the following would promote the expanded use of renewable fuel and low-emission vehicles:

- Collaboration between local and regional governments and business to foster the increased use of renewable fuels. This can be accomplished by coordinating the siting of new alternative fueling/recharging locations for example.
- Providing preferential parking for ultra low-, zero- emission, and alternative fuel vehicles;
- Collaboration with energy providers to ensure the availability of necessary facilities and infrastructure to encourage the use of privately owned zero emission vehicles. This can be accomplished by having conveniently located charging and fueling stations for these vehicles.
- Provide incentives for taxicabs to use gas-electric hybrid vehicles or, at a minimum, smaller more fuel-efficient vehicles.

Assumptions:

* Each passenger vehicle (27.5 mpg avg) is replaced with similar electric vehicle
* 79% decrease in emissions is afforded for each vehicle
* Measures R1-T1 through R1-T7 and R2-T1 - R2-T6 are implemented

Reductions:

Emissions Reduction from each vehicle exchanged for electric vehicle	=	98.0%
% of electric vehicles in 2035	=	69.00%
Reduction afforded to passenger/light duty VMT Coun	=	67.62%

IM-T 8 Anti-Idling Enforcement

This measure involves the adoption and enforcement of an Anti-Idling Policy for heavy-duty diesel trucks, including local delivery trucks and long-haul truck transport within the County. This policy would prohibit idling of on and off-road heavy duty diesel vehicles for more than 5 minutes. This policy would be implemented by requiring signage at all loading docks and along truck routes informing drivers of the requirement to shut down their trucks after five minutes of idle time at loading docks and parking areas. By 2020 a 100% compliance with the anti-idling rules will reduce emissions in California by approximately 0.7 $MMTCO_2e$, representing 1.9 percent of emissions from heavy-duty diesel vehicles.

Assumptions:

* By 2020, this measure results in a 1.9% reduction in VMT from Medium Duty Vehicles in the County.
* By 2020, this measure results in a 1.9% reduction in VMT from Heavy Duty Vehicles in the County.
* Measures R1-T1 through R1-T7 are implemented

Reductions:

Reduction afforded to Medium and Heavy Duty Vehicle Emissions	=	2.66%

IM-T 9 Increase Public Transit

Assumes an increase in pulic transit coverage to expand upon Riverside County's one exisitng metrolink station. Estimated increase of 15 percent

Assumptions:

* All default values fro CAPCOA
*
* Measures R1-T1 through R1-T7 are implemented

Reductions:

% increase in transit coverage	=	30.00%
Elasticity or transit ridership with respect to service coverage	=	1.01
Existing transit mode share (default for suburban area)	=	1.30%
Adjustments from transit ridership increase to VMT	=	0.67
Total Reductions afforded to passenger vehicles	=	26.391%

IM-T **10 Employee Commute Alternative Schedule**

Assumes 30% of employees are eligible.

The 30% are evenly split between 9/80 schedule, 4 day-40 hour work week, and 1.5 days of telecommuting

Numbers from CAPCOA

10% 9/80: 0.7% VMT reduction

10% 4day: 1.5% VMT reduction

10% 1.5 day tele commute: 2.2% VMT reduction

Total reduction afforded to passenger vehicles: = 4.4%

R1-E 1 Renewable Portfolio Standard for Building Energy Use

Senate Bills (SBs) 1075 (2002) and 107 (2006) created the State's Renewable Portfolio Standard (RPS), with an initial goal of 20 percent renewable energy production by 2010. Executive Order (EO) S-14-08 establishes a RPS target of 33 percent by the year 2020 and requires State agencies to take all appropriate actions to ensure the target is met. The 33 percent RPS by 2020 goal is supported by the California Air Resources Board (CARB), though its feasibility is not certain due to current limitations in production and transmission of renewable energy.

Assumptions:

* Southern California Edison reaches its 33% goal for 2020.
* Assumes that in 2008 SCE's renewable portfolio was at 14% with respect to California's RPS.
* Assumes a 19% reduction in emissions from existing kWHs used.
* Assumes R1-E2 through R1-E6 have been implemented.

Reductions:

% Reduction Afforded = 25.00%

R1-E 2 & 3 AB1109 Energy Efficiency Standard for Lighting

Assembly Bill (AB1109) mandated that the California Energy Commission (CEC) on or before December 31, 2008, adopt energy efficiency standards for general purpose lighting. These regulations, combined with other State efforts, shall be structured to reduce State-wide electricity consumption in the following ways:

- R1-E2: At least 50 percent reduction from 2007 levels for indoor residential lighting by 2018; and
- R1-E3: At least 25 percent reduction from 2007 levels for indoor commercial and outdoor lighting by 2018.

Assumptions:

* Assumes 20% of residential electrical use is from lighting.
* Assumes 37.14% of commercial/industrial electrical usage is from lighting.
* Assumes 5.5% of commercial electrical usage is from outdoor streetlights and area lights.

Reductions:

% reduction from residential electrical use	=	15.00%
% reduction from commercial/industrial electrical use	=	21.32%

R1-E 4 Electrical Energy Efficiency

This measure captures the emission reductions associated with electricity energy efficiency activities included in CARB's AB32 Scoping Plan that are not attributed to other R1 or R2 reductions, as described in this report. This measure includes energy efficiency measures that CARB views as crucial to meeting the State-wide 2020 target, and will result in additional emissions reductions beyond those already accounted for in California's Energy Efficiency Standards for Residential and Non-Residential Buildings (Title 24, Part 6 of the California Code of Regulations; hereinafter referred to as, "Title 24 Energy Efficiency Standards"), the County's adopted Green Building ordinance (effective January 1, 2011), etc. By 2020, this requirement will reduce emissions in California by approximately 21.3 $MMTCO_2e$, representing 17.5 percent of emissions from all electricity in the State. This measure includes the following strategies:

- "Zero Net Energy" buildings (buildings that combine energy efficiency and renewable generation so that they, based on an annual average, extract no energy from the grid);
- Broader standards for new types of appliances and for water efficiency;
- Improved compliance and enforcement of existing standards;
- Voluntary efficiency and green building targets beyond mandatory codes;
- Voluntary and mandatory whole-building retrofits for existing buildings;
- Innovative financing to overcome first-cost and split incentives for energy efficiency, on-site renewables, and high efficiency distributed generation;
- More aggressive utility programs to achieve long-term savings;
- Water system and water use efficiency and conservation measures;
- Additional industrial and agricultural efficiency initiatives; and
- Providing real time energy information technologies to help consumers conserve and optimize energy performance.

Assumptions:

* The percent reduction from California's emissions from various energy efficiency measures is equal to the County's emissions from this measures or 17.5%.
* Assumes application only to New development

Reductions:

% reduction afforded	=	20.00%
% New Residential	=	48.07%
% New Commercial	=	72.62%
% reduction applied to residential	=	9.61%
% reduction applied to commercial	=	14.52%

R1-E 5 Natural Gas Energy Efficiency

This measure captures the emission reductions associated with natural gas energy efficiency activities included in CARB's AB32 Scoping Plan that are not attributed to other R1 or R2 reductions, as described in this report. This measure includes energy efficiency measures that CARB views as crucial to meeting the State-wide 2020 target, and will result in additional emissions reductions beyond those already accounted for in California's Energy Efficiency Standards for Residential and Non-Residential Buildings (Title 24, Part 6 of the California Code of Regulations; hereinafter referred to as, "Title 24 Energy Efficiency Standards"), the County's adopted Green Building ordinance(effective January 1, 2011), etc. By 2020, this requirement will reduce emissions in California by approximately 4.3 $MMTCO_2e$, representing 6.2 percent of emissions from all natural gas combustion in the State. This measure includes the following strategies:

- "Zero Net Energy" buildings (buildings that combine energy efficiency and renewable generation so that they, based on an annual average, extract no energy from the grid);
- Broader standards for new types of appliances and for water efficiency;
- Improved compliance and enforcement of existing standards;
- Voluntary efficiency and green building targets beyond mandatory codes;
- Voluntary and mandatory whole-building retrofits for existing buildings;
- Innovative financing to overcome first-cost and split incentives for energy efficiency, on-site renewables, and high efficiency distributed generation;
- More aggressive utility programs to achieve long-term savings;
- Water system and water use efficiency and conservation measures;
- Additional industrial and agricultural efficiency initiatives; and
- Providing real time energy information technologies to help consumers conserve and optimize energy performance.

Assumptions:

* The percent reduction from California's emissions from various energy efficiency measures is equal to the County's emissions from this measures or 6.2%.
* Assumes application only to New development

Reductions:

% reduction afforded	=	8.00%
% New Residential	=	48.07%
% New Commercial	=	62.28%
% reduction applied to residential	=	3.85%
% reduction applied to commercial	=	4.98%

R1-E 6 Increased Combined Heat and Power

This measure captures the reduction in building electricity emissions associated with the increase of combined heat and power activities, as outlined in CARB's AB32 Scoping Plan. The Scoping Plan suggests that increased combined heat and power systems, which capture "waste heat" produced during power generation for local use, will offset 30,000 GWh State-wide in 2020. Approaches to lowering market barriers include utility-provided incentive payments, a possible CHP portfolio standard, transmission and distribution support systems, or the use of feed-in tariffs. By 2020, this requirement will reduce emissions in California by approximately 6.7 $MMTCO_2e$, representing 7.6 percent of emissions from all electricity in the State.

Assumptions:

* The percent reduction from California's emissions is equal to the County's emissions from this measures or 7.6%.

Reductions:

% reduction afforded	=	10.00%

R1-E 7 Industrial Efficiency Measures

This measure captures the reduction in industrial building energy emissions associated with the energy efficiency measures for industrial sources included in CARB's AB32 Scoping Plan. By 2020, this requirement will reduce emissions in California by approximately 1.0 $MMTCO_2e$, representing 3.9 percent of emissions from all industrial natural gas combustion in the State. CARB proposes the following possible State-wide measures:

- Oil and gas extraction;
- GHG leak reduction from oil and gas transmission;
- Refinery flare recovery process improvements; and
- Removal of methane exemption from existing refinery regulations.

Assumptions:

* The percent reduction from California's emissions is equal to the County's emissions from this measures or 3.9%.
* Assumes applies to all residential, commercial, and industrial land uses.

Reductions:

% reduction afforded = 5.00%

R2-E 1 Residential Energy Efficiency Program

This measure involves the adoption of a program that facilitates energy efficient design for all new residential buildings to be 20% beyond the current Title 24 Standards . This energy efficiency requirement is equal to that of the LEED for Homes and ENERGY STAR programs.

The 2008 Title 24 Energy Standards were adopted by the Energy Commission on April 23, 2008, with the 2008 Residential Compliance Manual adopted by the Commission on December 17, 2008. Compliance with the 2008 standards went into effect January 1, 2010. In an effort to meet the overall goal of the California Energy Efficiency Strategic Plan of reaching zero net energy for residential buildings by 2020, the stringency of the Title 24 Energy Standards as regulated and required by the State will continue to increase every three years. As energy efficiency standards increase the County may want to periodically re-evaluate their percentage beyond Title 24 goal to ensure it is still a feasibly achievable goal.

- Install energy efficient appliances, including air conditioning and heating units, dishwashers, water heaters, etc.;
- Install solar water heaters;
- Install top quality windows and insulation;
- Install energy efficient lighting;
- Optimize conditions for natural heating, cooling and lighting by building siting and orientation.
- Use features that incorporate natural ventilation;
- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes; and
- Incorporate skylights; reflective surfaces, and natural shading in buildings design and layouts.

The County will develop a menu of options with points assigned to them. As long as a developer meets the required point allotment (33 points) the developer will meet the requirements of this measure. This system will assure flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the strategies outlined in the bullet points above.

Assumptions:

* Applies to new development only.
* Assumes new development to be 20% beyond current Title 24.

Reductions:

% of new residential development	=	48.07%
% reduction afforded	=	25.00%
Total % reduction	=	12.02%

R2-E 2 Residential Renewable Energy Program

This measure facilitates the voluntary incorporation of renewable energy (such as photovoltaic panels) into new residential developments. For participating developments, renewable energy application should be such that the new home's projected energy use from the grid is reduced by 50%. The California Energy Commissions' New Solar Homes Partnership is a component of the California Solar Initiative and provides rebates to developers of 6 or more units where 50% of the units include solar power. In addition this measure would encourage that all residents be equipped with "solar ready" features where feasible, to encourage future installation of solar energy systems. These features should include the proper solar orientation (south facing roof sloped at 20° to 55° from the horizontal), clear access on south sloped roofs, electrical conduit installed for solar electric system wiring, plumbing installed for solar hot water systems, and space provided for a solar hot water tank. The incentive program should provide enough funding and other incentives as shown in the R3 measures to result in approximately fifty percent of new residential development participation in this program, thereby resulting in a 25% reduction in electrical consumption from new residential developments.

As an alternative to, or in support of, providing onsite renewable energy, the project proponent can buy into a purchased energy offset program that will allow for the purchase of electricity generated from renewable energy resources offsite. Purchased energy offsets (or a combination of incorporated renewables and purchased offsets) must be equal to 25% of the total projected energy consumption for the development. See R3-E3 for further details on the financing program.

Assumptions:

* Applies to new development only.
* Assumes that 50% of new development will participate.
* Assumes that those developments participating will reduce electrical use by 50%.

Reductions:

% of residential that is new	=	48.07%
% reduction from energy use	=	50.00%
% participating	=	65.00%
Total % reduction	=	15.62%

R2-E 3 Residential Retrofit Implementation Program

This measure would initiate a County program that facilitates the incorporation of energy reduction measures for residential buildings undergoing major renovations. AB 811 is a potential funding source to the County for implementing incentive programs to encourage residences within the County to undertake energy efficiency retrofitting and reducing energy consumption in retrofitted homes by a minimum of 15%. As with the new development, the County will develop a menu of options with points assigned to them. As long as a developer meets the required point allotment (100 points) the developer will meet the requirements of this measure. This system will be provided to assure flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following:

- Replace inefficient air conditioning and heating units with new energy efficient models;
- Replace older, inefficient appliances with new energy efficient models;
- Replace old windows and insulation with top-quality windows and insulation;
- Install solar water heaters;
- Replace inefficient and incandescent lighting with energy efficient lighting; and
- Weatherize the existing building to increase energy efficiency.

Assumptions:

* Applies to existing development only.
* Assumes that 25% of existing development will participate.
* Assumes that those developments participating will increase efficiency by 20%.

* Assumes reduction from electrical and natural gas.

Reductions:

% of 2020 that is existing residential development	=	51.93%
% reduction applied	=	40.00%
% existing homes participating	=	50.00%
Total % reduction	=	10.39%

R2-E 4 Residential Renewable Retrofit Program

This measure will initiate an incentive program that encourages residents to retrofit their homes with photovoltaic panels such that 50% of all of the home's electrical usage is offset. The California Energy Commission's Solar Initiative has incentives available to home owners.

Assumptions:

* Applies to existing development only.
* Assumes that 25% of existing development will participate.
* Assumes that those developments participating will reduce emissions from electricity by 50%.
* Assumes reduction from electricity.

Reductions:

% of 2020 that is existing residential development	=	51.93%
% reduction applied	=	50.00%
% existing homes participating	=	50.00%
Total % reduction	=	12.98%

R2-E 5 Commercial Energy Efficiency Program

This measure involves the adoption of a County Program that facilitates the energy efficient design for all new commercial buildings within Sutter Pointe to be 20% beyond the current Title 24 Standards which expands the new development requirements set forth in the Sutter Pointe Specific Plan EIR. This voluntary energy efficiency requirement is 10% greater than the minimum requirements of the LEED and ENERGY STAR programs. As energy efficiency standards increase the County may want to periodically re-evaluate their percentage beyond Title 24 goal to ensure it is still a feasibly achievable goal.

As described in R2-E1 above, the County could provide all developers with a list of potentially feasible GHG reduction measures that reflect the current state of the regulatory environment. The County will develop a menu of options with points assigned to them. As long as a developer meets the required point allotment (100 points) the developer will meet the requirements of this measure. This system will provide flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following:

- Install energy efficient appliances, including air conditioning and heating units, dishwashers, water heaters, etc.;
- Install solar water heaters;
- Install top quality windows and insulation;
- Install energy efficient lighting;
- Optimize conditions for natural heating, cooling and lighting by building siting and orientation.
- Use features that incorporate natural ventilation;
- Install light-colored "cool" pavements, and strategically located shade trees along all bicycle and pedestrian routes; and
- Incorporate skylights; reflective surfaces, and natural shading in buildings design and layouts.

Assumptions:

* Applies to new development only.
* Assumes new development to be 20% beyond current Title 24.

Reductions:

% new com/ind that is new	=	72.62%
% reduction afforded	=	30.00%
Total % reduction	=	21.78%

R2-E 6 Commercial/Industrial Renewable Energy Program

This measure would facilitate the voluntary incorporation of renewable (solar or other renewable) energy generation into the design and construction of new commercial, office, and industrial developments. Renewable energy generation shall be incorporated such that a minimum of 20% of the project's total energy needs are offset. In addition this measure would encourage all facilities be equipped with "solar ready" features where feasible, to facilitate future installation of solar energy systems. These features should include the proper solar orientation (south facing roof sloped at 20° to 55° from the horizontal), clear access on south sloped roofs, electrical conduit installed for solar electric system wiring, plumbing installed for solar hot water systems, and space provided for a solar hot water tank.

As an alternative to, or in support of, providing onsite renewable energy, the project proponent can buy into an offset program that will allow for the purchase of renewable energy resources offsite. Purchased energy offsets (or a combination of incorporated renewables and purchased offsets) must be equal 20% of the total projected energy consumption for the development. See R3-E3 for further details on the financing program.

Assumptions:

* Applies to new development only.
* Assumes that 25% of new development will participate.
* Assumes that those developments participating will reduce electrical use by 25%.

Reductions:

% of com/ind development from growth	=	72.62%
% reduction from program	=	25.00%
% of participation	=	60.00%
Total % reduction	=	10.89%

R2-E 7 Commercial/Industrial Retrofit Program

This measure encourages all commercial or industrial buildings undergoing major renovations to reduce their energy consumption by a minimum of 20%. As with the new development, a menu of options will be provided to assure flexibility in the implementation of this reduction measure. Although not limited to these actions, this reduction goal can be achieved through the incorporation of the following: (Includes both energy efficiency and renewable energy technologies)

- Replace inefficient air conditioning and heating units with new energy efficient models;
- Replace older, inefficient appliances with new energy efficient models;
- Replace old windows and insulation with top-quality windows and insulation;
- Install solar water heaters;
- Replace inefficient and incandescent lighting with energy efficient lighting; and
- Weatherize the existing building to increase energy efficiency.

Assumptions:

* Applies to existing development only.
* Assumes that 25% of existing development will participate.
* Assumes that those developments participating will increase efficiency by 25%.
* Assumes reduction from electrical and natural gas.

Reductions:

% from existing com/ind development	=	27.38%
% reduction applied	=	40.00%
% of participation	=	60.00%
Total % reduction	=	6.57%

R2-E 8 Induction Streetlight Retrofits

The new lamps are estimated to last 5 times longer and consume 50% less energy than the HPS lamps.

Assumptions:

* Applies to streetlight electricity consumption
* Assumes 20% of lamps will be retrofitted
* Retrofitted lamps will use 50% less energy

Reductions:

% reduction applied	=	50.00%
% streetlights retrofitted	=	100.00%
% 2020 comm electricity use from streetlights	=	7.65%
Total % reduction	=	3.83%

Area Source Reduction Measures 2035

R2-L1 Prohibit Gas Powered Landscape Equipment

49.5% % reduction *CAPCOA report*

SCAQMD Healthy Hearths Program

R2-L2 No new wood burning devices in homes

R2-L3 10 to 25 Mandatory Curtailment days

Total Heating Days	120	(November-February)
% Reduction	0.125	

Purchased Water Reduction Measures 2035

R1-W 1 Renewable Portfolio Standard (33% by 2020) Related to Water Supply and Conveyance

This measure would increase electricity production from eligible renewable power sources to 33 percent by 2020. A reduction in GHG emissions results from replacing natural gas-fired electricity production with zero GHG-emitting renewable sources of power. By 2020, this requirement will reduce emissions from electricity used for water supply and conveyance in California by approximately 21.3 $MMTCO_2e$, representing 15.2 percent of emissions from electricity generation (in-State and imports).

Assumptions:

* The percent reduction from California's emissions is equal to the County's emissions from electricity used for water supply and conveyance or 21%.
* Assumes applies to all residential, commercial, and industrial land uses.

Reductions:

% reduction afforded = 21.00%

R2-W 1 Water Use Reduction Initiative

This initiative would reduce emissions associated with electricity consumption for water treatment and reduction and therefore are included with the energy reductions. This measure encourages the County to adopt a per capita water use reduction goal in support of the Governors Executive Order S-14-08 which mandates the reduction of water use of 20 percent per capita. The County's adoption of a water use reduction goal would introduce requirements for new development and would provide cooperative support for water purveyors that are required to implement these reductions for existing developments. The County would also provide internal reduction measures such that County facilities will support this reduction requirement. The following represent potential programs that can be implemented to attain this reduction goal.

Water Conservation Program:

Under this program the excessive watering of landscaping, excessive fountain operation, watering during peak daylight hours, water of non-permeable surfaces, excessive water use for noncommercial washing, and water use resulting in flooding or runoff would be prohibited. In addition the program would encourage efficient water use for construction activities, the installation of low-flow toilets and showerheads for all new developments, use of drought-tolerant plants with efficient landscape watering systems for all new developments, recycling of water used for cooling systems, use of pool covers, and the posting of water conservation signage at all hotels.

New Development Incentives:

Provide incentives for developers to comply with the California Green Building Standards Code as requirements for all new development. Under this Code new developments are required to reduce indoor potable water use by 20% beyond the Energy Policy Act of 1992 fixture performance requirements, and to reduce outdoor potable water use by 50% from a mid-summer baseline average consumption through irrigation efficiency, native plant selection, the use of recycled water and/or captured rainwater for example.

Water Meter Program:

Encourage water providers to install water meters for all County homes not using wells. This would provide for a better accounting of County water usage and provide potential costing per usage to help offset costs of the implementation of water conservation programs.

Water Efficiency Pricing Program

Under this program, the County would encourage water suppliers to adopt a water conservation pricing schedule (i.e. tiered rate) to encourage efficient water use. Notices could be provided in each billing showing water use budgets and the relationship between the budget and the actual usage.

Water Efficiency Retrofit Program:

This program would encourage upgrades in water efficiency for renovations or additions of residential, commercial, office, and industrial properties equivalent to that of new developments. The County would work with local water purveyors to achieve consistent standards, and to develop, approve, and review procedures for implementation.

Water Efficiency Training and Education:

Under this measure the County, in coordination with local water purveyors would implement a public information and education program that promotes water conservation. The program could include certification programs for irrigation designers, installers, and managers, as well as classes to promote the use of drought tolerant, native species and xeriscaping.

Increased Recycled Water Use:

Promote the use of municipal wastewater and graywater for agricultural, industrial and irrigation purposes. This measure would be subject to approval of the State Health Department and compliance with Title 22 provisions. This measure would facilitate the following:

- Inventory of non-potable water uses that could be substituted with recycled or graywater;
- Determination of the feasibility of producing and distributing recycled water for groundwater

replenishment;

- Determine the associated energy/GHG tradeoffs for treatment/use vs. out of basin water supply usage; and
- Cooperation and coordination with responsible agencies to encourage the use of recycled water where energy tradeoffs are favorable.

Assumptions:

* Applies to all land uses (existing and new development)
* Assumes emission reduction of 20%.
* Assumes reduction to electricity used to treat and convey water and wastewater.
* Assumes that approximately 14% of the electricity usage is used to pump water from wells.

Reductions:

% reduction applied to water usage directly = 30.00%

IM-W 1 Increase Reclaimed Water Use

This measure would increase electricity production from eligible renewable power sources to 33 percent by 2020. A reduction in GHG emissions results from replacing natural gas-fired electricity production with zero GHG-emitting renewable sources of power. By 2020, this requirement will reduce emissions from electricity used for water supply and conveyance in California by approximately 21.3 $MMTCO_2e$, representing 15.2 percent of emissions from electricity generation (in-State and imports).

Assumptions:

* Percent of total water use coming from reclaimed is 5%
* Percentage reduction GHG by using reclaimed rather than potable water is 81%

Reductions:

% reduction afforded = 10.00%

IM-W 1 County Diversion Program

This measure would implement a County wide waste diversion plan to further the goal of diverting 75% of all waste from landfills by 2020. The following is a potential list of waste reduction measures that will further strengthen existing waste reduction/diversion programs.

- Provide outreach and education programs for residential, commercial, and industrial land uses in order to further promote existing County diversion programs;
- Increase disposal fees and/or reduce residential pick-up frequency;
- Encourage businesses to adopt a voluntary procurement standard and prioritize those products that have less packaging, are reusable, recyclable, or compostable;
- Support State level policies that provide incentives for efficient and reduced packaging waste for commercial products;
- Expand list of recyclable materials;
- Work with Recology to develop and provide waste audits;
- Make recycling and composting opportunities mandatory at all public events;
- Establish an appliance end-of-life requirement;
- For new developments, require the use of recycled-content materials, or recycled materials;
- Require a minimum of 15% of materials used in construction be sourced locally, as feasible; and
- Encourage the use of recycled building materials and cement substitutes for new developments.

Assumptions:

* Assumes an existing diversion rate of 53%
* Assumes 2020 goal of 80% diversion rate.
* Does not apply to construction activities
* % reduction applied is equivalent to: (80-53)/47

Reductions:

% reduction applied	=	57.45%
% not from construction activities	=	81.20%
% reduction applied	=	46.65%

IM-W 2 Construction Diversion Program

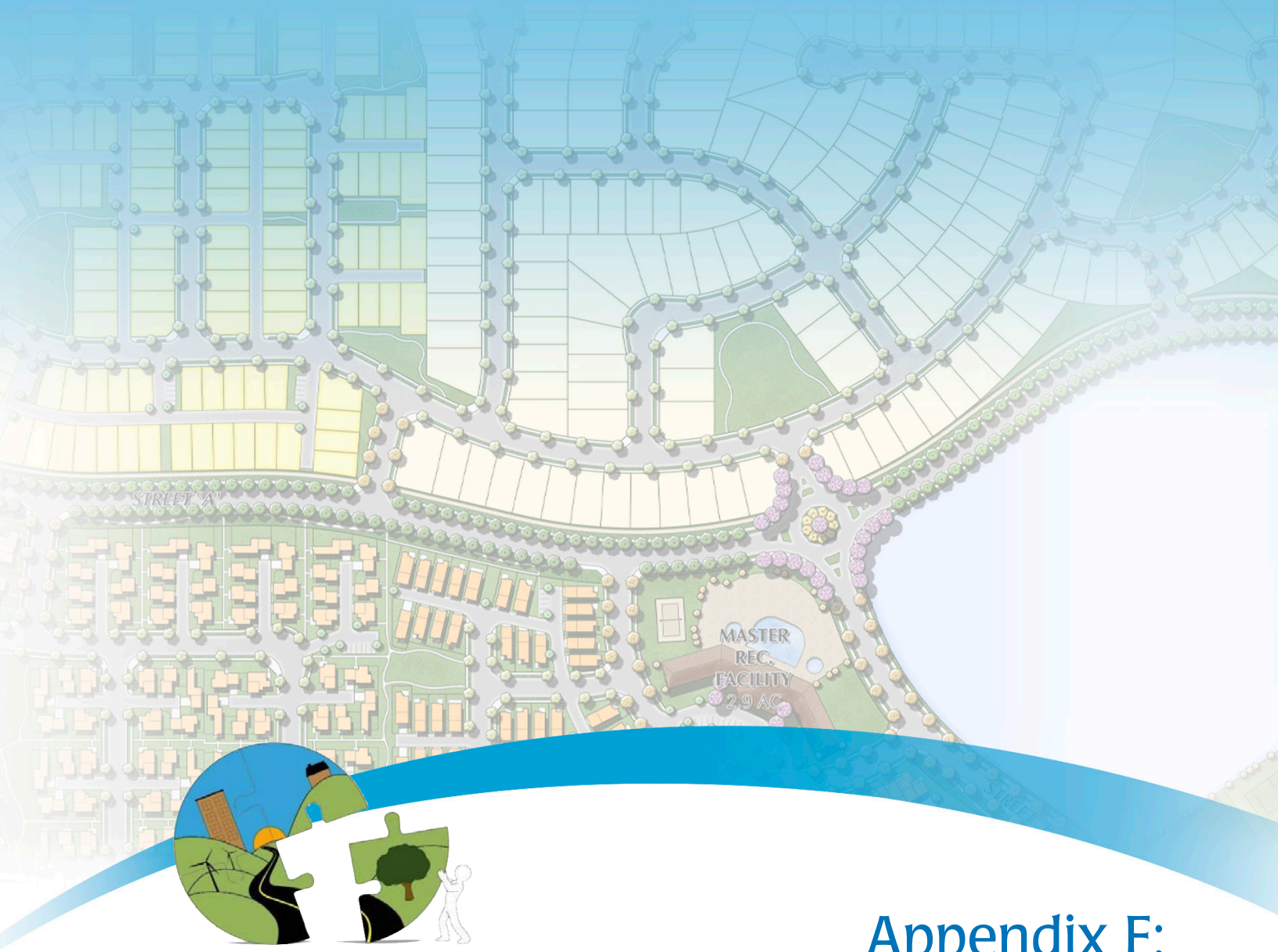
This IM also implements General Plan Policies AQ 4.1 and AQ 5.1 by giving incentives through points within the Screening Table to new development that provided diversion of 70% of construction waste. This provides a 20% increase in diversion beyond AB2176, § 42911, that requires development projects to provide adequate areas for collecting and loading recyclable materials and ensures a 50% diversion rate prior to being issued a building permit.

% reduction applied is equivalent to: 20/50

Reductions:

% reduction applied	=	80%
% from construction activities	=	18.80%
% reduction applied	=	15.04%

This page intentionally left blank



Appendix F:
Screening Tables

This page intentionally left blank

GREENHOUSE GAS EMISSIONS

Screening Tables
County of Riverside, California

May 2011

Prepared for:

COUNTY OF RIVERSIDE
4080 Lemon Street
Riverside, California 92501

Prepared by:

ATKINS

650 East Hospitality Lane, Suite 450
San Bernardino, California 92408

CONTENTS

Introduction **1**

California Environmental Quality Act **1**

CEQA Mandates for Analysis of Impacts 1

Greenhouse Gas Impact Determination **2**

Statewide or Regional Thresholds of Significance 2

Quantitative Analysis Relative to the Riverside GHG Technical Report 2

Methodology Overview 2

Methodology for the Calculation of GHG Emissions 4

Screening Tables **4**

Instructions for Residential, Commercial, or Industrial Projects **5**

Instructions for Mixed Use Projects ..... Error! Bookmark not defined.

References **22**

METHODS SUMMARY **24**

DEVELOPMENT OF THE POINT VALUES **25**

APPENDIX A – Methodology for the development and application of the Screening Table

TABLES

Table 1: Screening Table for GHG Implementation Measures for Residental Development 6

Table 2: Screening Table for GHG Implementation Measures for Commercial Development 13

Introduction

The California Environmental Quality Act ("CEQA") requires assessment of the environmental impacts of proposed projects including the impacts of greenhouse gas emissions. The purpose of this document is to provide guidance on how to analyze greenhouse gas (GHG) emissions and determine the significance of those emissions during CEQA review of proposed development projects within the County of Riverside. The analysis, methodology, and significance determination (thresholds) are based upon the Riverside County GHG Technical Report, the GHG emission inventories within the Technical Report, and the GHG implementation measures that reduce emissions to the AB-32 compliant reduction target of the Technical Report. The screening tables can be used by the County of Riverside Planning Department for review of development projects in order to insure that the specific implementation measures in the Technical Report are applied as part of the CEQA process for development projects. The screening tables provide a menu of options that both insures implementation of the measures and flexibility on how development projects will implement the measures to achieve an overall reduction of emissions, consistent with the reduction target of the Technical Report.

California Environmental Quality Act

CEQA MANDATES FOR ANALYSIS OF IMPACTS

CEQA requires that Lead Agencies inform decision makers and the public regarding the following: potential significant environmental effects of proposed projects; feasible ways that environmental damage can be avoided or reduced through the use of feasible mitigation measures and/or project alternatives; and the reasons why the Lead Agency approved a project if significant environmental effects are involved (CEQA Guidelines §15002). CEQA also requires Lead Agencies to evaluate potential environmental effects based to the fullest extent possible on scientific and factual data (CEQA Guidelines §15064[b]). A determination of whether or not a particular environmental impact will be significant must be based on substantial evidence, which includes facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts (CEQA Guidelines §15064f[5]).

The recently amended CEQA Guidelines (CEQA Guidelines §15064.4[a] [b]) explicitly require Lead Agencies to evaluate GHG emissions during CEQA review of potential environmental impacts generated by a proposed project. To assist in this effort, two questions were added to Appendix G of the CEQA Guidelines:

- Would the Project generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment?

- Would the Project conflict with any applicable plan, policy or regulation adopted for the purpose of reducing the emissions of GHGs?

Finally, under the "rule of reason," an EIR is required to evaluate impacts to the extent that is reasonably feasible ([CEQA Guideline § 15151; *San Francisco Ecology Center v. City and County of San Francisco* (1975) 48 Cal.App.3rd 584]). While CEQA does require Lead Agencies to make a good faith effort to disclose what they reasonably can, CEQA does not demand what is not realistically possible ([*Residents at Hawks Stadium Committee v. Board of Trustees* (1979) 89 Cal.App.3rd 274, 286]).

Greenhouse Gas Impact Determination

STATEWIDE OR REGIONAL THRESHOLDS OF SIGNIFICANCE

There are currently no published statewide or regional thresholds of significance for measuring the impact of GHG emissions generated by a proposed project. CEQA Guidelines §15064.7 indicates only that, "each public agency is encouraged to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects."

QUANTITATIVE ANALYSIS RELATIVE TO THE RIVERSIDE GHG TECHNICAL REPORT

METHODOLOGY OVERVIEW

An individual project cannot generate enough GHG emissions to influence global climate change. The project participates in this potential impact by its incremental contribution combined with the cumulative increase of all other sources of GHGs, which when taken together may have a significant impact on global climate change. To address the State's requirement to reduce GHG emissions, the County prepared the Technical Report with the target of reducing GHG emissions within the unincorporated County by 15% below 2008 levels by the year 2020. The County's target is consistent with the AB 32 target and ensures that the County is providing GHG reductions locally that will complement the State and international efforts of stabilizing climate change.

Because the County's Technical Report addresses GHG emissions reduction, the Report is in concert with AB 32 and international efforts to address global climate change. The Technical Report includes specific local requirements that will substantially lessen the cumulative contribution attributed to activities under the County's land use control. Compliance with the Report fulfills the approach found in CEQA Guidelines §15130(a)(3) for determining whether a project's contribution is cumulatively considerable.

Because GHG emissions are only important in the context of cumulative emissions, the focus of the analysis is on answering the question of whether incremental contributions of GHGs are a cumulatively considerable contribution to climate change impacts. The GHG Technical Report, in determining if the Project's effects will result in significant impacts, includes a set of implementation measures designed to substantially lessen cumulative impacts associated with GHG emissions as described in CEQA Guidelines §15130(a)(3). The Technical Report has the following components that fulfill mitigation for cumulative GHG emissions:

- The Report provides a countywide GHG emissions reduction target that will substantially lessen the cumulative problem;
- The Report provides Implementation Measures that new development projects must follow to meet the County's reduction target and substantially lessen the cumulative impact; and
- The Report provides a set of GHG emission inventories that provides quantitative facts and analysis of how the County implementation measures combined with the State reduction strategies reduce emissions to the reduction target that substantially lessens the cumulative impact.

The Technical Report satisfies the first condition because it includes a reduction target of reducing GHG emissions down to 15% below existing levels within the unincorporated County by 2020. This reduction target is compliant with AB 32. The AB 32 Climate Change Scoping Plan states: "In recognition of the critical role local governments will play in the successful implementation of AB 32, ARB recommended a greenhouse gas reduction goal for local governments of 15 percent below today's levels by 2020 to ensure that their municipal and community-wide emissions match the State's reduction target" (Scoping Plan page ES-5, CARB, December 2008). The County's Plan matches the State's reduction target, which also coincides with the reduction targets of the Kyoto Protocol. In this way, the County is teaming with the State and international efforts to reduce GHG emissions globally and substantially lessen the cumulative problem.

The Technical Report satisfies the second condition through the implementation measures for new development. This document supplies the specific criteria for new development to follow to insure that the implementation measures associated with new development are applied and the reduction target is met.

The Technical Report satisfies the third criteria by providing a set of countywide GHG emissions inventories for existing conditions, for future 2020 GHG emissions that are anticipated without the reduction measures (Business As Usual; BAU), and reduced levels of 2020 GHG emissions that will result from the implementation of the reduction measures. Finally, the reduced 2020 GHG emissions inventory quantitatively demonstrates that implementation of the reduction measures achieves the

reduction target (15% below existing GHG emission levels by 2020). These Countywide GHG emission inventories are found in Appendix A of the Technical Report.

METHODOLOGY FOR THE CALCULATION OF GHG EMISSIONS

Analysis of development projects can either be done through emissions calculations or by using the screening tables beginning on Page 6.

Total GHG emissions are the sum of emissions from both direct and indirect sources. Direct sources include mobile sources such as construction equipment, motor vehicles, landscape equipment; and stationary sources such as cooling and heating equipment. Indirect sources are comprised of electrical and potable water use, and the generation of solid waste and waste water.

Direct GHG emissions from mobile and stationary sources are determined as the sum of the annual GHG emissions from construction equipment, motor vehicles, landscape equipment, and heating and cooling equipment.

Indirect sources are determined based on source as follows. Electrical usage is reported as annual emissions from electrical usage. Potable water usage is reported as the annual emissions from electricity used for potable water treatment and transportation. Solid waste is reported as the sum of annual emissions from solid waste disposal treatment, transportation, and fugitive emissions of methane at the solid waste facilities. Wastewater usage is reported as the annual emissions from wastewater transport and treatment.

Analysis of development projects not using the screening tables should use the emission factors found in the latest version of the California Climate Action Registry (CCAR) General Reporting Protocol. Quantification of emissions from electricity used for potable water treatment and transportation as well as wastewater transport and treatment can be found in the California Energy Commission (CEC) document titled "Refining Estimates of Water-Related Energy Use in California (CEC December 2006).
For analysis of development projects using the screening tables, please refer to the process described on page 6.

Screening Tables

The purpose of the Screening Tables is to provide guidance in measuring the reduction of greenhouse gas emissions attributable to certain design and construction measures incorporated into development projects. The analysis, methodology, and significance determination (thresholds) are based upon the Riverside County GHG Technical Report, which includes GHG emission inventories, a year 2020 emission reduction target, and the goals and policies to reach the target. The methodology for the development and application of the Screening Table is set forth in Appendix A, attached hereto.

Instructions for Application to Projects

The Screening Table assigns points for each option incorporated into a project as mitigation or a project design feature (collectively referred to as "feature"). The point values correspond to the minimum emissions reduction expected from each feature. The menu of features allows maximum flexibility and options for how development projects can implement the GHG reduction measures. Projects that garner at least 100 points will be consistent with the reduction quantities anticipated in the County's GHG Technical Report. As such, those projects that garner a total of 100 points or greater would not require quantification of project specific GHG emissions. Consistent with CEQA Guidelines, such projects would be determined to have a less than significant individual and cumulative impact for GHG emissions.

Those Projects that do not garnish 100 points using the screening tables will need to provide additional analysis to determine the significance of GHG emissions. Nothing in this guidance shall be construed as limiting the County's authority to adopt a statement of overriding consideration for projects with requiring the preparation of an EIR due to a project's significant GHG impacts. The following tables provide a menu of performance standards/options related to GHG mitigation measures and design features that can be used to demonstrate consistency with the implementation measures and GHG reduction quantities in the GHG Technical Report.

Mixed use projects provide additional opportunities to reduce emissions by combining complimentary land uses in a manner that can reduce vehicle trips. Mixed use projects also have the potential to complement energy efficient infrastructure in a way that reduces emissions. For mixed use projects fill out both Screening Table 1 and Table 2, but proportion the points identical to the proportioning of the mix of uses. As an example, a mixed use project that is 50% commercial uses and 50% residential uses will show ½ point for each assigned point value in Table 1 and Table 2. Add the points from both tables. Mixed use projects that garner at least 100 points will be consistent with the reduction quantities in the County's GHG Plan and are considered less than significant for GHG emissions.

Table 1: Screening Table for GHG Implementation Measures for Residental Development

Feature	Description	Assigned Point Values	Project Points
Implementation Measure IM RE1: Energy Efficiency for New Residential			
E1.A Building Envelope			
E1.A.1 Insulation	Title 24 standard (required)	0 points	
	Modestly Enhanced Insulation (5% > Title 24)	1 point	
	Enhanced Insulation (15%> Title 24)	3 points	
	Greatly Enhanced Insulation (20%> Title 24)	5 points	
E1.A.2 Windows	Title 24 standard (required)	0 points	
	Modestly Enhanced Window Insulation (5% > Title 24)	1 point	
	Enhanced Window Insulation (15%> Title 24)	3 points	
	Greatly Enhanced Window Insulation (20%> Title 24)	5 points	
E1.A.3 Doors	Title 24 standard (required)	0 points	
	Modestly Enhanced Insulation (5% > Title 24)	1 point	
	Enhanced Insulation (15%> Title 24)	3 points	
	Greatly Enhanced Insulation (20%> Title 24)	5 points	
E1.A.4 Air Infiltration	Minimizing leaks in the building envelope is as important as the insulation properties of the building. Insulation does not work effectively if there is excess air leakage.		
	Title 24 standard (required)	0 points	
	Modest Building Envelope Leakage (5% > Title 24)	1 point	
	Reduced Building Envelope Leakage (15%> Title 24)	3 points	
	Minimum Building Envelope Leakage (20% > Title 24)	5 points	
E1.A.5 Thermal Storage of Building	Thermal storage is a design characteristic that helps keep a constant temperature in the building. Common thermal storage devices include strategically placed water filled columns, water storage tanks, and thick masonry walls.		
	Thermal storage designed to reduce heating/cooling by 5°F within the building	3 points	
	Thermal storage to reduce heating/cooling by 10°F within the building	6 points	
	Note: Engineering details must be provided to substantiate the efficiency of the thermal storage device.		

Feature	Description	Assigned Point Values	Project Points
E1.B Indoor Space Efficiencies			
E1.B.1 Heating/ Cooling Distribution System	Title 24 standard (required)	0 points	
	Modest Distribution Losses (5% > Title 24)	1 point	
	Reduced Distribution Losses (15%> Title 24)	3 points	
	Greatly Reduced Distribution Losses (15%> Title 24)	5 points	
E1.B.2 Space Heating/ Cooling Equipment	Title 24 standard (required)	0 points	
	Efficiency HVAC (5% > Title 24)	1 point	
	High Efficiency HBAC (15%> Title 24)	3 points	
	Very High Efficiency HBAC (20%> Title 24)	5 points	
E1.B.3 Water Heaters	Title 24 standard (required)	0 points	
	Efficiency Water Heater (Energy Star conventional that is 5% > Title 24)	1 point	
	High Efficiency Water Heater (Conventional water heater that is 15%> Title 24)	3 points	
	High Efficiency Water Heater (Conventional water heater that is 20%> Title 24)	5 points	
	Solar Water Heating System	7 points	
E1.B.4 Daylighting	Daylighting is the ability of each room within the building to provide outside light during the day reducing the need for artificial lighting during daylight hours.		
	All peripheral rooms within the living space have at least one window (required)	0 points	
	All rooms within the living space have daylight (through use of windows, solar tubes, skylights, etc.) such that each room has at least 800 lumens of light during a sunny day	1 points	
	All rooms daylighted to at least 1,000 lumens	3 points	
E1.B.5 Artificial Lighting	Title 24 standard (required)	0 points	
	Efficient Lights (5% > Title 24)	1 point	
	High Efficiency Lights (LED, etc. 15%> Title 24)	3 points	
	Very High Efficiency Lights (LED, etc. 20%> Title 24)	5 points	
E1.B.6 Appliances	Title 24 standard (required)	0 points	
	Efficient Appliances (5% > Title 24)	1 point	
	High Efficiency Energy Star Appliances (15%> Title 24)	3 points	
	Very High Efficiency Appliances (20%> Title 24)	5 points	

Feature	Description	Assigned Point Values	Project Points
E1.C Miscellaneous Residential Building Efficiencies			
E1.C.1 Building Placement	North/South alignment of building or other building placement such that the orientation of the buildings optimizes natural heating, cooling, and lighting.	3 points	
E1.C.2 Independent Energy Efficiency Calculations	Provide point values based upon energy efficiency modeling of the Project. Note that engineering data will be required documenting the energy efficiency and point values based upon the proven efficiency beyond Title 24 Energy Efficiency Standards.	TBD	
E1.C.3 Other	This allows innovation by the applicant to provide design features that increases the energy efficiency of the project not provided in the table. Note that engineering data will be required documenting the energy efficiency of innovative designs and point values given based upon the proven efficiency beyond Title 24 Energy Efficiency Standards.	TBD	
E1.C.4 Existing Residential Retrofits	The applicant may wish to provide energy efficiency retrofit projects to existing residential dwelling units to further the point value of their project. Retrofitting existing residential dwelling units within the unincorporated County is a key reduction measure that is needed to reach the reduction goal. The potential for an applicant to take advantage of this program will be decided on a case by case basis and must have the approval of the Riverside County Planning Department. The decision to allow applicants to ability to participate in this program will be evaluated based upon, but not limited to the following; Will the energy efficiency retrofit project benefit low income or disadvantaged residents? Does the energy efficiency retrofit project provide co-benefits important to the County? Point value will be determined based upon engineering and design criteria of the energy efficiency retrofit project.	TBD	
Implementation Measure IM E2: New Home Renewable Energy			
E2.A.1 Photovoltaic	Solar Photovoltaic panels installed on individual homes or in collective neighborhood arrangements such that the total power provided augments:		
	Solar Ready Homes (sturdy roof and electric hookups)	2 points	
	10 percent of the power needs of the project	4 points	
	20 percent of the power needs of the project	6 points	
	30 percent of the power needs of the project	8 points	
	40 percent of the power needs of the project	10 points	
	50 percent of the power needs of the project	12 points	
	60 percent of the power needs of the project	14 points	
	70 percent of the power needs of the project	16 points	
	80 percent of the power needs of the project	18 points	
	90 percent of the power needs of the project	20 points	
	100 percent of the power needs of the project	22 points	

Feature	Description	Assigned Point Values	Project Points
E2.A.2 Wind turbines	Some areas of the County lend themselves to wind turbine applications. Analysis of the areas capability to support wind turbines should be evaluated prior to choosing this feature. Individual wind turbines at homes or collective neighborhood arrangements of wind turbines such that the total power provided augments:		
	10 percent of the power needs of the project	4 points	
	20 percent of the power needs of the project	6 points	
	30 percent of the power needs of the project	8 points	
	40 percent of the power needs of the project	10 points	
	50 percent of the power needs of the project	12 points	
	60 percent of the power needs of the project	14 points	
	70 percent of the power needs of the project	16 points	
	80 percent of the power needs of the project	18 points	
	90 percent of the power needs of the project	20 points	
	100 percent of the power needs of the project	22 points	
E2.A.3 Off-site renewable energy project	The applicant may submit a proposal to supply an off-site renewable energy project such as renewable energy retrofits of existing homes. These off-site renewable energy retrofit project proposals will be determined on a case by case basis and must be accompanied by a detailed plan that documents the quantity of renewable energy the proposal will generate. Point values will be determined based upon the energy generated by the proposal.	TBD	
E2.A.4 Other Renewable Energy Generation	The applicant may have innovative designs or unique site circumstances (such as geothermal) that allow the project to generate electricity from renewable energy not provided in the table. The ability to supply other renewable energy and the point values allowed will be decided based upon engineering data documenting the ability to generate electricity.	TBD	
Implementation Measure IM W1: Water Use Reduction Initiative			
W1.A Residential Irrigation and Landscaping			
W1.A.1 Water Efficient Landscaping	Limit conventional turf to < 20% of each lot (required)	0 points	
	Eliminate conventional turf from landscaping	3 points	
	Eliminate turf and only provide drought tolerant plants	4 points	
	Xeroscaping that requires no irrigation	6 points	
W1.A.2 Water Efficient irrigation systems	Drip irrigation	1 point	
	Smart irrigation control systems combined with drip irrigation (demonstrate 20 reduced water use)	3 points	

Feature	Description	Assigned Point Values	Project Points
W1.A.3 Storm water Reuse Systems	Innovative on-site stormwater collection, filtration and reuse systems are being developed that provide supplemental irrigation water and provide vector control. These systems can greatly reduce the irrigation needs of a project. Point values for these types of systems will be determined based upon design and engineering data documenting the water savings.	TBD	
W1.A.4 Recycled grey water	Grey water (purple pipe) irrigation system on site	5 points	
W1.B Residential Potable Water			
W1.B.1 Showers	Title 24 standard (required) EPA High Efficiency Showerheads (15% > Title 24)	0 points 1 points	
W1.B.2 Toilets	Title 24 standard (required) EPA High Efficiency Toilets (15% > Title 24)	0 points 1 points	
W1.B.3 Faucets	Title 24 standard (required) EPA High Efficiency faucets (15% > Title 24)	0 points 1 points	
Implementation Measure IM W2: Increase Reclaimed Water Use			
W2.A.1 Recycled Water	5% of the total project's water use comes from recycled/reclaimed water	5 points	
Implementation Measure IM T2: Increase Residential Density			
T2.A.1 Residential Density	Designing the Project with increased densities, where allowed by the General Plan and/or Zoning Ordinance reduces GHG emissions associated with traffic in several ways. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. This strategy also provides a foundation for implementation of many other strategies which would benefit from increased densities. 1 point is allowed for each 10% increase in density beyond 7 units/acre, up to 500% (50 points)	1-50 points	
Implementation Measure IM T3: Mixed Use Development			
T3.A.1 Mixed Use	Mixes of land uses that complement one another in a way that reduces the need for vehicle trips can greatly reduce GHG emissions. The point value of mixed use projects will be determined based upon a Transportation Impact Analysis (TIA) demonstrating trip reductions and/or reductions in vehicle miles traveled. Suggested ranges: Diversity of land uses complementing each other (2-28 points) Increased destination accessibility other than transit (1-18 points) Infill location that reduces vehicle trips or VMT beyond the measures	TBD	

Feature	Description	Assigned Point Values	Project Points
	described above (points TBD based on traffic data).		
T3.A.2 Residential Near Local Retail (Residential only Projects)	Having residential developments within walking and biking distance of local retail helps to reduce vehicle trips and/or vehicle miles traveled. The point value of residential projects in close proximity to local retail will be determined based upon traffic studies that demonstrate trip reductions and/or reductions in vehicle miles traveled (VMT) The suburban project will have at least three of the following on site and/or offsite within ¼-mile: Residential Development, Retail Development, Park, Open Space, or Office. The mixed-use development should encourage walking and other non-auto modes of transport from residential to office/commercial locations (and vice versa). The project should minimize the need for external trips by including services/facilities for day care, banking/ATM, restaurants, vehicle refueling, and shopping.	1-16 points	
Implementation Measure IM T5: Traffic Flow Management Improvements			
T5.A.1 Signal Synchronization	Techniques for improving traffic flow include: traffic signal coordination to reduce delay, incident management to increase response time to breakdowns and collisions, Intelligent Transportation Systems (ITS) to provide real-time information regarding road conditions and directions, and speed management to reduce high free-flow speeds. Signal synchronization Traffic signals connected to existing ITS	1 point/signal 3 points/signal	
Implementation Measure IM T6: Bicycle/Pedestrian Infrastructure			
T6.A.1 Sidewalks	Provide sidewalks on one side of the street (required) Provide sidewalks on both sides of the street Provide pedestrian linkage between residential and commercial uses within 1 mile	0 points 1 point 3 points	
T6.A.2 Bicycle paths	Provide bicycle paths within project boundaries Provide bicycle path linkages between residential and other land uses Provide bicycle path linkages between residential and transit	TBD 2 points 5 points	
Implementation Measure IM T7: Electric Vehicle Use			
T7.A.1 Electric Vehicle Recharging	Provide circuit and capacity in garages of residential units for installation of electric vehicle charging stations Install electric vehicle charging stations in the garages of residential units	1 point 8 points	

Feature	Description	Assigned Point Values	Project Points
Implementation Measure IM T9: Increase Public Transit			
T9.A.1 Public Transit Access	The point value of a projects ability to increase public transit use will be determined based upon a Transportation Impact Analysis (TIA) demonstrating decreased use of private vehicles and increased use of public transportation. Increased transit accessibility (1-15 points)	TBD	
Implementation Measure IM L1: SCAQMD No New Wood Burning Stoves			
L1.A.1 Wood Burning	As part of Rule 445 and the Healthy Hearths™ initiative, the South Coast Air Quality Management District adopted a rule for no permanently installed indoor or outdoor wood burning devices in new development. Project contains no wood burning stoves or fireplaces	10 points	
Implementation Measure IM L2: Prohibit Gas-Powered Equipment			
L2.A.1 Landscape Equipment	Electric lawn equipment including lawn mowers, leaf blowers and vacuums, shredders, trimmers, and chain saws are available. When electric landscape equipment is used in place of conventional gas-powered equipment, direct GHG emissions from natural gas combustion are replaced with indirect GHG emissions associated with the electricity used to power the equipment. Project provides electrical outlets on the exterior of all building walls so that electric landscaping equipment is compatible with all built facilities.	8 points	
Implementation Measure IM SW1: 80 Percent Solid Waste Diversion Program			
SW1.A.1 Recycling	County initiated recycling program diverting 80% of waste requires coordination in neighborhoods to realize this goal. The following recycling features will help the County fulfill this goal: Provide green waste composing bins at each residential unit Multi-family residential projects that provide dedicated recycling bins separated by types of recyclables combined with instructions/education program explaining how to use the bins and the importance or recycling.	4 points 3 points	
Implementation Measure IM SW2: Construction and Demolition Debris Diversion Program			
SW2.A.1 Recycling of Construction/ Demolition Debris	50% of construction waste recycled (required) Recycle 55% of debris Recycle 60% of debris Recycle 65% of debris Recycle 70% of debris Recycle 75% of debris	0 points 2 points 3 points 4 points 5 points 6 points	
Total Points Earned by Residential Project:			

Table 2: Screening Table for GHG Implementation Measures for Commercial Development and Public Facilities

Feature	Description	Assigned Point Values	Project Points
Implementation Measure IM E5: Energy Efficiency for Commercial/Public Development			
E5.A Building Envelope			
E5.A.1 Insulation	Title 24 standard (required)	0 points	
	Modestly Enhanced Insulation (5% > Title 24)	4 points	
	Enhanced Insulation (15%> Title 24)	8 points	
	Greatly Enhanced Insulation (20%> Title 24)	12 points	
E5.A.2 Windows	Title 24 standard (required)	0 points	
	Modestly Enhanced Window Insulation (5% > Title 24)	4 points	
	Enhanced Window Insulation (15%> Title 24)	8 points	
	Greatly Enhanced Window Insulation (20%> Title 24)	12 points	
E5.A.3 Doors	Title 24 standard (required)	0 points	
	Modestly Enhanced Insulation (5% > Title 24)	4 points	
	Enhanced Insulation (15%> Title 24)	8 points	
	Greatly Enhanced Insulation (20%> Title 24)	12 points	
E5.A.4 Air Infiltration	Minimizing leaks in the building envelope is as important as the insulation properties of the building. Insulation does not work effectively if there is excess air leakage.		
	Title 24 standard (required)	0 points	
	Modest Building Envelope Leakage (5% > Title 24)	4 points	
	Reduced Building Envelope Leakage (15%> Title 24)	8 points	
	Minimum Building Envelope Leakage (20% > Title 24)	12 points	
E5.A.5 Thermal Storage of Building	Thermal storage is a design characteristic that helps keep a constant temperature in the building. Common thermal storage devices include strategically placed water filled columns, water storage tanks, and thick masonry walls.		
	Thermal storage designed to reduce heating/cooling by 5°F within the building	6 points	
	Thermal storage to reduce heating/cooling by 10°F within the building	12 points	
	Note: Engineering details must be provided to substantiate the efficiency of the thermal storage device.		

Feature	Description	Assigned Point Values	Project Points
E5.B Indoor Space Efficiencies			
E5.B.1 Heating/ Cooling Distribution System	Title 24 standard (required)	0 points	
	Modest Distribution Losses (5% > Title 24)	4 points	
	Reduced Distribution Losses (15%> Title 24)	8 points	
	Greatly Reduced Distribution Losses (15%> Title 24)	12 points	
E5.B.2 Space Heating/ Cooling Equipment	Title 24 standard (required)	0 points	
	Efficiency HVAC (5% > Title 24)	4 points	
	High Efficiency HVAC (15%> Title 24)	8 points	
	Very High Efficiency HVAC (20%> Title 24)	12 points	
E5.B.3 Commercial Heat Recovery Systems	Heat recovery strategies employed with commercial laundry, cooking equipment, and other commercial heat sources for reuse in HVAC air intake or other appropriate heat recovery technology. Point values for these types of systems will be determined based upon design and engineering data documenting the energy savings.	TBD	
E5.B.4 Water Heaters	Title 24 standard (required)	0 points	
	Efficiency Water Heater (Energy Star conventional that is 5% > Title 24)	4 points	
	High Efficiency Water Heater (Conventional water heater that is 15%> Title 24)	8 points	
	High Efficiency Water Heater (Conventional water heater that is 20%> Title 24)	12 points	
	Solar Water Heating System	14 points	
E5.B.5 Daylighting	Daylighting is the ability of each room within the building to provide outside light during the day reducing the need for artificial lighting during daylight hours.		
	All peripheral rooms within building have at least one window or skylight	1 point	
	All rooms within building have daylight (through use of windows, solar tubes, skylights, etc.) such that each room has at least 800 lumens of light during a sunny day	5 points	
	All rooms daylighted to at least 1,000 lumens	7 points	
E5.B.6 Artificial Lighting	Title 24 standard (required)	0 points	
	Efficient Lights (5% > Title 24)	4 points	
	High Efficiency Lights (LED, etc. 15%> Title 24)	6 points	
	Very High Efficiency Lights (LED, etc. 20%> Title 24)	8 points	

Feature	Description	Assigned Point Values	Project Points
E5.B.7 Appliances	Title 24 standard (required)	0 points	
	Efficient Appliances (5% > Title 24)	4 points	
	High Efficiency Energy Star Appliances (15%> Title 24)	8 points	
	Very High Efficiency Appliances (20%> Title 24)	12 points	
E5.C Miscellaneous Commercial Building Efficiencies			
E5.C.1 Building Placement	North/South alignment of building or other building placement such that the orientation of the buildings optimizes conditions for natural heating, cooling, and lighting.	4 points	
E5.C.2 Other	This allows innovation by the applicant to provide design features that increases the energy efficiency of the project not provided in the table. Note that engineering data will be required documenting the energy efficiency of innovative designs and point values given based upon the proven efficiency beyond Title 24 Energy Efficiency Standards.	TBD	
E5.C.3 Existing Commercial building Retrofits	The applicant may wish to provide energy efficiency retrofit projects to existing residential dwelling units to further the point value of their project. Retrofitting existing commercial buildings within the unincorporated County is a key reduction measure that is needed to reach the reduction goal. The potential for an applicant to take advantage of this program will be decided on a case by case basis and must have the approval of the Riverside County Planning Department. The decision to allow applicants to participate in this program will be evaluated based upon, but not limited to the following: Will the energy efficiency retrofit project benefit low income or disadvantaged communities? Does the energy efficiency retrofit project provide co-benefits important to the County? Point value will be determined based upon engineering and design criteria of the energy efficiency retrofit project.	TBD	
Implementation Measure IM E6: New Commercial/Industrial Renewable Energy			
E6.A.1 Photovoltaic	Solar Photovoltaic panels installed on commercial buildings or in collective arrangements within a commercial development such that the total power provided augments:		
	Solar Ready Roofs (sturdy roof and electric hookups)	2 points	
	10 percent of the power needs of the project	8 points	
	20 percent of the power needs of the project	14 points	
	30 percent of the power needs of the project	20 points	
	40 percent of the power needs of the project	26 points	
	50 percent of the power needs of the project	32 points	
	60 percent of the power needs of the project	38 points	

Feature	Description	Assigned Point Values	Project Points
	70 percent of the power needs of the project	44 points	
	80 percent of the power needs of the project	50 points	
	90 percent of the power needs of the project	56 points	
	100 percent of the power needs of the project	62 points	
E6.A.2 Wind turbines	Some areas of the County lend themselves to wind turbine applications. Analysis of the areas capability to support wind turbines should be evaluated prior to choosing this feature.		
	Wind turbines as part of the commercial development such that the total power provided augments:		
	10 percent of the power needs of the project	8 points	
	20 percent of the power needs of the project	14 points	
	30 percent of the power needs of the project	20 points	
	40 percent of the power needs of the project	26 points	
	50 percent of the power needs of the project	32 points	
	60 percent of the power needs of the project	38 points	
	70 percent of the power needs of the project	44 points	
	80 percent of the power needs of the project	50 points	
	90 percent of the power needs of the project	56 points	
	100 percent of the power needs of the project	62 points	
E6.A.3 Off-site renewable energy project	The applicant may submit a proposal to supply an off-site renewable energy project such as renewable energy retrofits of existing residential or existing commercial/industrial. These off-site renewable energy retrofit project proposals will be determined on a case by case basis accompanied by a detailed plan documenting the quantity of renewable energy the proposal will generate. Point values will be based upon the energy generated by the proposal.	TBD	
E6.A.4 Other Renewable Energy Generation	The applicant may have innovative designs or unique site circumstances (such as geothermal) that allow the project to generate electricity from renewable energy not provided in the table. The ability to supply other renewable energy and the point values allowed will be decided based upon engineering data documenting the ability to generate electricity.	TBD	
Implementation Measure IM W1: Water Use Reduction Initiative			
W1.C Irrigation and Landscaping			
W1.C.1 Water Efficient Landscaping	Limit conventional turf to < 20% of each lot (required)	0 points	
	Eliminate conventional turf from landscaping	3 points	
	Eliminate turf and only provide drought tolerant plants	4 points	
	Xeroscaping that requires no irrigation	6 points	

Feature	Description	Assigned Point Values	Project Points
W1.C.2 Water Efficient irrigation systems	Drip irrigation Smart irrigation control systems combined with drip irrigation (demonstrate 20 reduced water use)	1 point 5 points	
W1.C.3 Storm water Reuse Systems	Innovative on-site stormwater collection, filtration and reuse systems are being developed that provide supplemental irrigation water and provide vector control. These systems can greatly reduce the irrigation needs of a project. Point values for these types of systems will be determined based upon design and engineering data documenting the water savings.	TBD	
W1.D Potable Water			
W1.D.1 Showers	Title 24 standard (required) EPA High Efficiency Showerheads (15% > Title 24)	0 points 3 points	
W1.D.2 Toilets	Title 24 standard (required) EPA High Efficiency Toilets/Urinals (15% > Title 24) Waterless Urinals (note that commercial buildings having both waterless urinals and high efficiency toilets will have a combined point value of 6 points)	0 points 3 points 3 points	
W1.D.3 Faucets	Title 24 standard (required) EPA High Efficiency faucets (15% > Title 24)	0 points 3 points	
W1.D.4 Commercial Dishwashers	Title 24 standard (required) EPA High Efficiency dishwashers (20% water savings)	0 points 4 points	
W1.D.5 Commercial Laundry Washers	Title 24 standard (required) EPA High Efficiency laundry (15% water savings) EPA High Efficiency laundry Equipment that captures and reuses rinse water (30% water savings)	0 points 3 points 6 points	
W1.D.6 Commercial Water Operations Program	Establish an operational program to reduce water loss from pools, water features, etc., by covering pools, adjusting fountain operational hours, and using water treatment to reduce draw down and replacement of water. Point values for these types of plans will be determined based upon design and engineering data documenting the water savings.	TBD	
Implementation Measure IM W2: Increase Reclaimed Water Use			
W2.A.1 Recycled Water	Graywater (purple pipe) irrigation system on site	5 points	

Feature	Description	Assigned Point Values	Project Points
Implementation Measure IM T1: Employment Based Trip and VMT Reduction Policy			
T1.A.1 Alternative Scheduling	Encouraging telecommuting and alternative work schedules reduces the number of commute trips and therefore VMT traveled by employees. Alternative work schedules could take the form of staggered starting times, flexible schedules, or compressed work weeks. Provide flexibility in scheduling such that at least 30% of employees participate in 9/80 work week, 4-day/40-hour work week, or telecommuting 1.5 days/week.	5 points	
T1.A.2 Car/Vanpools	Car/vanpool program Car/vanpool program with preferred parking Car/vanpool with guaranteed ride home program Subsidized employee incentive car/vanpool program Combination of all the above	1 point 2 points 3 points 5 points 6 points	
T1.A.3 Employee Bicycle/ Pedestrian Programs	Complete sidewalk to residential within ½ mile Complete bike path to residential within 3 miles Bike lockers and secure racks Showers and changing facilities Subsidized employee walk/bike program Note: combine all applicable points for total value	1 point 1 point 1 point 2 points 3 points	
T1.A.4 Shuttle/Transit Programs	Local transit within ¼ mile Light rail transit within ½ mile Shuttle service to light rail transit station Guaranteed ride home program Subsidized Transit passes Note: combine all applicable points for total value	1 point 3 points 5 points 1 points 2 points	
T1.A.5 CTR	Employer based Commute Trip Reduction (CTR). CTRs apply to commercial, offices, or industrial projects that include a reduction of vehicle trip or VMT goal using a variety of employee commutes trip reduction methods. The point value will be determined based upon a TIA that demonstrates the trip/VMT reductions. Suggested point ranges: Incentive based CTR Programs (1-8 points) Mandatory CTR programs (5-20 points)	TBD	
T1.A.6 Other Trip Reduction Measures	Point values for other trip or VMT reduction measures not listed above may be calculated based on a TIA and/or other traffic data supporting the trip and/or VMT reductions.	TBD	

Feature	Description	Assigned Point Values	Project Points
Implementation Measure IM T3: Mixed Use Development			
T3.B.1 Mixed Use	Mixes of land uses that complement one another in a way that reduces the need for vehicle trips can greatly reduce GHG emissions. The point value of mixed use projects will be determined based upon traffic studies that demonstrate trip reductions and/or reductions in vehicle miles traveled	TBD	
T3.B.2 Local Retail Near Residential (Commercial only Projects)	Having residential developments within walking and biking distance of local retail helps to reduce vehicle trips and/or vehicle miles traveled. The point value of residential projects in close proximity to local retail will be determined based upon traffic studies that demonstrate trip reductions and/or reductions in vehicle miles traveled.	TBD	
Implementation Measure IM T4: Preferential Parking			
T4.A.1 Parking	Provide reserved preferential parking spaces for car-share, carpool, and ultra-low or zero emission vehicles. Provide larger parking spaces that can accommodate vans used for ride-sharing programs and reserve them for vanpools and include adequate passenger waiting/loading areas.	1 point 1 point	
Implementation Measure IM T5: Signal Synchronization and Intelligent Traffic Systems			
T5.B.1 Signal improvements	Techniques for improving traffic flow include: traffic signal coordination to reduce delay, incident management to increase response time to breakdowns and collisions, Intelligent Transportation Systems (ITS) to provide real-time information regarding road conditions and directions, and speed management to reduce high free-flow speeds. Synchronize signals along arterials used by project. Connect signals along arterials to existing ITS.	1 point/signal 3 points/ signal	
Implementation Measure IM T6: Bicycle and Pedestrian Infrastructure			
T6.B.1 Sidewalks	Provide sidewalks on one side of the street (required) Provide sidewalks on both sides of the street Provide pedestrian linkage between commercial and residential land uses within 1 mile	0 points 1 point 3 points	
T6.B.2 Bicycle paths	Provide bicycle paths within project boundaries Provide bicycle path linkages between commercial and other land uses Provide bicycle path linkages between commercial and transit	TBD 2 points 5 points	

Feature	Description	Assigned Point Values	Project Points
Implementation Measure IM T7: Electric Vehicle Use			
T7.B.1 Electric Vehicle Recharging	Provide circuit and capacity in garages/parking areas for installation of electric vehicle charging stations. Install electric vehicle charging stations in garages/parking areas	2 points/area 8 pts/station	
Implementation Measure IM T8: Anti-Idling Enforcement			
T8.A.1 Commercial Vehicle Idling Restriction	All commercial vehicles are restricted to 5-minutes or less per trip on site and at loading docks.	2 points Required of all Commercial	
Implementation Measure IM T9: Increase Public Transit			
T9.B.1 Public Transit	The point value of a projects ability to increase public transit use will be determined based upon a Transportation Impact Analysis (TIA) demonstrating decreased use of private vehicles and increased use of public transportation. Increased transit accessibility (1-15 points)	TBD	
Implementation Measure IM L2: Prohibit Gas-Powered Landscaping Equipment			
L2.B.1 Landscaping Equipment	Electric lawn equipment including lawn mowers, leaf blowers and vacuums, shredders, trimmers, and chain saws are available. When electric landscape equipment is used in place of conventional gas-powered equipment, direct GHG emissions from natural gas combustion are replaced with indirect GHG emissions associated with the electricity used to power the equipment. Project provides electrical outlets on the exterior of all buildings so that electric landscaping equipment is compatible with all built facilities.	2 points	
Implementation Measure IM SW1: 80 Percent Solid Waste Diversion Program			
SW1.B.1 Recycling	County initiated recycling program diverting 80% of waste requires coordination with commercial development to realize this goal. The following recycling features will help the County fulfill this goal: Provide separated recycling bins within each commercial building/floor and provide large external recycling collection bins at central location for collection truck pick-up Provide commercial/industrial recycling programs that fulfills an on-site goal of 80% diversion of solid waste	2 points 5 points	

Feature	Description	Assigned Point Values	Project Points
Implementation Measure IM SW2: Construction and Demolition Debris Diversion Program			
SW2.B.1 Recycling of Construction/ Demolition Debris	Recycle 2% of debris (required)	0 points	
	Recycle 5% of debris	1 point	
	Recycle 8 % of debris	2 points	
	Recycle 10% of debris	3 points	
	Recycle 12% of debris	4 points	
	Recycle 15% of debris	5 points	
	Recycle 20% of debris	6 points	
Total Points Earned by Commercial/Industrial Project:			

References

Association of Environmental Professionals (AEP) White Paper: Alternative Approaches to Analyzing Greenhouse Gases and Global Climate Change Impacts in CEQA Documents, June 2007.

Association of Environmental Professionals (AEP) White Paper: Community-wide Greenhouse Gas Emission Inventory Protocols, September 2010.

Association of Environmental Professionals (AEP) California Environmental Quality Act 2010 Statute & Guidelines, March 2010.

California Air Pollution Control Officers Association (CAPCOA), White Paper: CEQA and Climate Change, January 2008

California Air Pollution Control Officers Association (CAPCOA), Quantifying Greenhouse Gas Mitigation Measures, August 2010

California Air Resources Board, AB 32 Scoping Plan, December 2009

California Climate Action Team's Final Report to the Governor and Legislature, March 2007

California Climate Action Registry, General Reporting Protocol, Version 2.2, March 2007

Riverside County, Draft Greenhouse Gas Technical Report, November 2010

South Coast Air Quality Management District, Rules and Regulations, 2010

U.S. Environmental Protection Agency, AP-42, Compilation of Air Pollutant Emission Factors, Fifth Edition, September 1995

U.S. Environmental Protection Agency, AP-42, Final Rule on Update to the Compilation of Air Pollutant Emission Factors, October 2009

APPENDIX A: METHDOLOLGY FOR THE DEVELOPMENT AND APPLICATION OF THE SCREENING TABLES

METHODS SUMMARY

The point values in the Screening Tables were derived from the projected emissions reductions that each of the Implementation Measures (IM) within the Riverside County GHG Technical Report would achieve. The total emission reductions offered by each measure is based on both changes in existing land use activities as well as how new development is designed and built. In order to correctly allocate the emission reductions within the Screening Table, the amount of emission reductions afforded new development had to be segregated out of the aggregate total in a manner that is described below. Once the process of segregating new development out of the aggregate reduction totals was completed, the points were then proportioned by residential unit or square feet of commercial/industrial uses. This was accomplished by taking the predicted growth in households and commercial/industrial uses by the year 2020 and proportioning the appropriate IM reduction quantities for new development to the residential and commercial/industrial land use sectors within the Screening Table. These calculations result in point values that are allocated by residential unit or commercial/industrial square footage (measured in 1000 sq.ft.). Because of this, the size of the project is not relevant to the Screening Table. Regardless of size, each project needs to garnish 100 points to demonstrate consistency with the Technical Report. Efficiency, not size of the Project is critical. The following emission factor can be used in determining the amount of emissions reduced per point in the Screening Table:

The respective calculated emission values are in metric tons of carbon dioxide equivalents (MTCO2e)

For Residential Projects:

0.069 MTCO2e per Point per Residential Unit

For Commercial and Industrial Projects:

0.031 MTCO2e per Point per 1,000 Square Feet of gross Commercial/Industrial building area

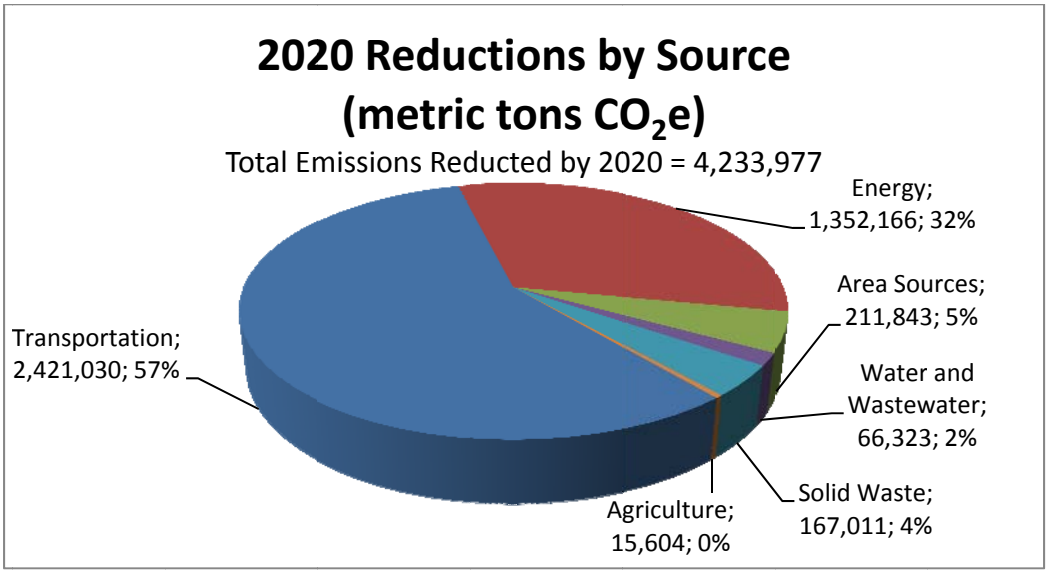
Note that the Screening Table and point values are best used for typical development projects processed by the County. Examples of typical development projects include residential subdivisions, multi-family residential apartments, condominiums and townhouses, retail commercial, big box retail, office buildings, business parks, and typical warehousing. Mixed use projects can use the Screening Tables following the instructions. Transit oriented development (TOD), and infill projects are able to use the Screening Tables, but the Screening Table points are likely to underestimate total emission reductions afforded these types of projects. Note that the Screening Tables include the opportunity to custom develop points (using the formula above) in order to account for the predicted reductions in vehicle trips and vehicle miles traveled within a project specific traffic study and GHG analysis. TOD and infill projects can be more accurately assessed and allocated points using this method.

However, more unusual types of industrial projects such as cement manufacturing, metal foundries, refrigerant manufacturing, electric generating stations, and oil refineries cannot use the Screening Tables because the emission sources for those types of uses were not contemplated in the table.

DEVELOPMENT OF THE POINT VALUES

The first step in developing the point system was the need to determine the total reductions afforded the GHG Plan. Figure 1 below shows the total emission reductions achieved by the GHG Plan. In total 4,288,863 MTCO2e will be reduced as a result of the GHG Plan.

Figure 1



The next step in developing the point system is to segregate out the State efforts in reducing GHG emissions within the County. Table 1 shows the reductions allocated to State measures and County strategies.

Table 1

Sector	2020 Reduction ($MTCO_2e$) State Strategies	County Strategies	Total
Transportation and Land Use	914,490	1,506,540	2,421,030
Building Energy -Energy Efficiency and Alternative Energy	860,205	491,962	1,352,166
Area Sources	0	211,843	211,843
Water Conservation	33,172	33,151	66,323
Solid Waste/Landfills	0	167,011	167,011
Agriculture	0	15,573	15,573
Total	**1,807,866**	**2,426,111**	**4,233,977**

As shown in Table 1, 2,426,111 MTCO2e are reduced by the County's Implementation Measure. This amount includes reductions afforded existing building retrofits, other changes to activities associated with existing land uses, as well as reductions associated with new development.

The next step is to segregate out of the County strategies total the amount of emissions that will be reduced within new development.

Table 2 on the next page summarizes the reduction in emissions afforded new development from the Implementation measures. Table 2 shows 2,228,440 MTCO2e being reduced from new development as a result of the County strategies. Within the 1,302,569 MTCO2e of new development reductions afforded County strategies, 619,336 MTCO2e of emissions reduced is accomplished through new Commercial and Industrial Projects, and 683,233 MTCO2e of emissions reduced is accomplished through new residential projects.

The next step in allocating point values is to determine the number of new homes and commercial buildings that are anticipated by year 2020. The County predicts that 100,477 new residential units will be needed by 2020 to accommodate the population growth by 2020. A total of approximately 195,547,000 square feet of new commercial and industrial buildings within the unincorporated County area is needed to accommodate anticipated job growth. This estimate is based on the relationship between past growth in employment to the average growth in commercial/industrial building area for Riverside County.

Dividing the 683,233 MTCO2e reductions of emissions afforded the Implementation Measures for new residential development by the anticipated 100,477 new residential units that will be built yields 6.80 MTCO2e per residential unit that needs to be reduced to fulfill the anticipated reductions of the GHG Technical Report. That amount equals 100 points, producing the following for the point values:
0.0680 MTCO2e per Point per Residential Unit

A similar process was used to derive the point value for new commercial/Industrial development. Because commercial/industrial land uses are typically described in thousand square feet of building space, the point value was calculated as follows: **0.031 MTCO2e per 1,000 Sq. Ft. of gross Commercial/Industrial building area.**

The final step was to allocate points to each of the reduction measures in order to provide the menu of point values. The spreadsheet on the next page shows emission reductions afforded each measure. Note that emissions associated with new development are reduced by the State's measures, as well as the County's Implementation measures. The Screening Tables focus on those measures the County is implementing associated with new development within the unincorporated County area. For this reason, the menu of options pertains to all of the Implementation Measures pertaining to new development.

Table 2

Reduction Number	Reduced Emissions($MTCO_2e$) Reduction Measure Name	Commercial/Industrial	Residential
IM-E1	New Residential Energy Efficiency		72,228.9
IM-E2	New Residential Renewable Energy		83,347.0
IM-E5	New Commercial Energy Efficiency	126,589.3	
IM-E6	New Commercial/Industrial Renewable Energy	34,576.5	
IM-T1	Employer VMT Reduction	150,960.2	
IM-T2	Increased Residential Density		109,947.0
IM-T3	Mixed Use Development	108,134.7	108,134.7
IM-T4	Preferential Parking	848.9	
IM-T5	Road Imp/Sig.Sync/TFM	18,718.0	40,647.4
IM-T6	Bicycle/Ped Infrastructure	4,123.5	8,954.5
IM-T7	Electric Vehicle Use	8,537.0	18,538.7
IM-T8	Anti-Idling Enforcement	14,552.0	
IM-T9	Increase Public Transit	31,147.2	67,638.3
IM-T10	Employee Commute Alt. Schedule	28,592.8	
IM-L1	SCAQMD No New Woodburning Stoves		68,559.3
IM-L2	Prohibit Gas-Powered Equipment	6,483.1	41,861.6
IM-W1	Water Use Reduction Initiative	6,118.6	4,911.8
IM-W2	Increase Reclaimed Water Use	991.2	795.7
IM-SW1	County Diversion Program	46,140.0	24,844.6
IM-SW2	Construction Diversion Program	32,823.3	32,823.3
Total IM Reductions for New Development		**619,336.4**	**683.233.0**