APPENDIX W

AIR QUALITY REGULATORY GUIDANCE DOCUMENTS
CARB and CAT Early Action Measures and Strategy Reports
CLIMATE ACTION TEAM
PROPOSED EARLY ACTIONS TO
MITIGATE CLIMATE CHANGE
IN CALIFORNIA

Draft for Public Review
INTRODUCTION: Climate Action Team Early Actions

The California Air Resources Board, under the California Global Warming Solutions Act of 2006 (Section 38560.5 of the Health and Safety Code) has the primary responsibility for reducing Greenhouse Gas Emissions. However, actions by many other state agencies are essential to meeting the emission reduction requirements of the Act. A substantial portion of the GHG emission reductions proposed in the 2006 Climate Action Team Report to reach 1990 emission levels by 2020 are strategies to be taken by agencies other than CARB.

By July 1, 2007 the statute calls for ARB to submit a list of early action measures that can be adopted and implemented by January 1, 2010. This report supplements the ARB report on early actions and is a status report on early actions being taken by the participating departments and agencies of the Climate Action Team.

The Climate Action Team (CAT) was created and is chaired by the Secretary of the California Environmental Protection Agency. Members include: the California Environmental Protection Agency (Cal/EPA), Business Transportation and Housing Agency (BTH), California Department of Food and Agriculture (CDFA), State and Consumer Services Agency (SCSA), Air Resources Board, California Department of Forestry and Fire Protection (CalFire), California Energy Commission (CEC), Department of General Services (DGS), Department of Water Resources (DWR), Integrated Waste Management Board (IWMB) and the California Public Utilities Commission (CPUC).

All members of the CAT contributed to this report which describes ongoing and expected efforts to reduce and mitigate GHG emissions in the near term. In describing the items listed under Group 1 as "Discrete Early Actions", the CAT members considered the definition provided by the Global Warming Solutions Act of 2006. It should be noted however that only the ARB has a legal responsibility to enumerate early actions under this statute. The Group 1 items in this report are those where there is a reasonable belief that regulations would be in place by January 1, 2010. It should be noted that the Group 1 strategies of all CAT members except for ARB account for GHG emissions reductions of over 17 million metric tons of CO₂ equivalent by 2020 (emissions reductions for several strategies have not yet been determined).

Action items included in Group 2 are those for which a regulatory deadline of January 1, 2010 is not appropriate or achievable but where there are ongoing or expected efforts focused on GHG emissions reductions. Group 2 is titled: "Additional Early Action Measures to Reduce GHGs Already Underway or to be Initiated by CAT Members in 2007-2009". These items include many of the strategies outlined in the 2006 Climate Action Team report, additional strategies that have been formulated in the intervening months or strategies proposed by stakeholders in the development of the CARB's early action measures. The Group 2 strategies of all CAT members except for ARB account
for GHG emissions reductions of over 60 million metric tons of CO₂ equivalent by 2020 (emissions reductions for several strategies have not yet been determined).

There are several other items which comprise actions which, although not directly focused on GHG emission reductions, have significant co-benefits for climate change mitigation efforts. These Group 3 actions are described as: "Regulations for 2007-2009 Adoption with Potential GHG Reductions or Other Climate Co-Benefits".

**GROUP 1: Discrete Early Action Measures:**

In describing the items listed under Group 1 as "Discrete Early Actions", the CAT members have used the definition provided by the Global Warming Solutions Act of 2006. It should be noted however that only the ARB has a legal responsibility to enumerate early actions under this statute. The Group 1 items in this report are those where there is a reasonable belief that regulations would be in place by January 1, 2010 (although there is no requirement in the law that any CAT member other than the ARB adhere to this deadline).

**Business, Transportation, and Housing**

- **Cement Manufacture**: Caltrans has changed its cement specification to allow 2.5 percent interground limestone concrete mix in cement use. This will result in a GHG emissions reduction of <1 million metric tons of CO₂ equivalent (MMTCO₂E) per year, based on 2004 production levels. Investigations are being conducted to examine the use of concrete blends containing 5 percent interground limestone.

**California Department of Food & Agriculture**

- **Hydrogen Fuel Standards**: The CDFA Division of Measurement Standards, under SB 76 of 2005, is developing hydrogen fuel standards for use in combustion systems and fuel cells. These standards are to be completed by 2008.

**Air Resources Board**

- (for details see ARB report: "Early Actions for Climate Change Mitigation in California")

**California Energy Commission**

- **SB1368 (Regulation of greenhouse gases from load serving entities)**: In response to SB 1368, the CEC and the CPUC have been collaborating on utility procurement practices to address ways to transition away from carbon-intensive electricity sources. The CPUC adopted its regulations for the investor-owned utilities in January, 2007. The CEC intends to adopt regulations by June, 2007
requiring municipal utilities to transition away from carbon-intensive generation. These strategies implemented by the CEC and CPUC under SB1368 are expected to result in a combined GHG emissions reduction of over 15 MMTCO₂E by 2020.

- **Energy Efficient Building Standards:** The CEC has been actively engaged in its "Building Energy Efficiency Standards in Progress" effort. The next phase of the project is to conduct public workshops on mark-ups of the "Express Terms" of the Standards, plus the supporting technical rules for software developers and the extensive technical data appendices that are required for showing compliance. The CEC intends to adopt these regulations in 2008. The GHG emissions reductions from this strategy are still to be determined. (The GHG emissions reductions associated with ongoing energy efficient building standards are expected to be 3 MMTCO₂E by 2020.)

- **Energy Efficient Appliance Standards:** (Specific mention of lighting standards). CEC has the authority to regulate light bulb efficiency. The California Energy Commission is considering options for light bulb standards and anticipates adopting standards by January 1, 2010. The GHG emissions reductions from this strategy are still to be determined. (The GHG emissions reductions associated with other ongoing energy efficient appliance standards are expected to be 7 MMTCO₂E by 2020.)

- **Tire Efficiency:** Implementation of California’s tire efficiency law, Chapter 8.7 Division 15 of the Public Resources Code. The CEC, in consultation with the California Integrated Waste Management Board, will implement a replacement tire efficiency program of statewide applicability for replacement tires for passenger cars and light-duty trucks, to ensure that replacement tires sold in the state are at least as energy efficient, on average, as the tires sold in the state as original equipment on these vehicles. This strategy is expected to result in GHG emissions reduction of <1 MMTCO₂E by 2020.

- **New Solar Homes Partnership:** In late 2006, the Energy Commission approved implementation rules for new residential solar installations. Effective in January 2007, approved solar systems will receive incentive funds based on system performance above building standards. This program will result in 400 MW of new, emissions-free generating capacity. The GHG emissions reductions from this strategy are still to be determined.

**Department of Water Resources**

- **Water Use Efficiency:** DWR will adopt standards for projects and programs funded through water bonds that would require consideration of water use efficiency in construction and operation. This strategy is expected to result in GHG emissions reduction of 1 MMTCO₂E by 2020.

- **State Water Project:** DWR will evaluate the State Water Project (SWP) energy resources and include feasible and cost-effective renewable energy in the SWP’s portfolio. As DWR completes a GHG assessment through membership with the Climate Action Registry, and investigations of cleaner energy sources to replace reliance on the Reid Gardner power plant (see below), the SWP will be able to
significantly reduce its GHG emissions. The GHG emissions reductions from this strategy are still to be determined.

- **Cleaner Energy for Water Supply:** In renewing energy supply contracts for the State Water Project, it is DWR's goal not to renew contracts supplied by conventional coal power generation. One specific example of this is DWR's ownership interest in the Reid Gardner power plant near Las Vegas, Nevada. Upon expiration of the contract in 2013, DWR will not extend its ownership interest in the Reid Gardner plant. The GHG emissions reductions from this action are still to be determined.

**Integrated Waste Management Board**

- **Landfill Gas Recovery:** The IWMB is jointly developing a regulatory measure that will be implemented by ARB and will require landfill gas recovery systems on the few dozen small to medium landfills that do not have them and upgrade the requirements at landfills with existing systems to represent best capture and destruction efficiencies. Going forward this will be considered as an ARB measure. The GHG emissions reductions from these strategies are expected to be 2-4 MMTCO$_2$E by 2020.

**California Public Utilities Commission**

- **SB1368 (Regulation of greenhouse gases from load serving entities):** Please see this heading under CEC.
- **IOU Energy Efficiency Programs:** Planning has begun for 2009-2011 energy efficiency portfolios. In 2007, CPUC is evaluating the design of a risk/reward incentive mechanism for utilities to encourage additional investment in energy efficiency. Also in 2007, CPUC will develop new aggressive targets for efficiency between 2007 and 2020. In developing 2009-2011 portfolios, CPUC will evaluate new technologies and new measures that could deliver additional energy savings through these programs; new ideas include new options for encouraging compact fluorescent lighting in residential and commercial buildings. This strategy is expected to result in GHG emissions reduction of 4 MMTCO$_2$E by 2020.

**GROUP 2: Additional Early Action Measures To Reduce GHGs Already Underway or to be Initiated by CAT members in 2007-2009**

Action Items included in Group 2 are those for which a regulatory deadline of January 1, 2010 is not appropriate or achievable but where there are ongoing or expected efforts focused on GHG emissions reductions. Group 2 is titled: "Additional Early Action Measures To Reduce GHGs Already Underway or to be Initiated by CAT members in 2007-2009". These items include many of the strategies outline in the 2006 Climate
Action Team report as well as additional strategies that have been formulated in the intervening months.

Business, Transportation, and Housing (BTH)

- **Transportation Efficiency** (2006 CAT Report strategy): The Department of Transportation (Caltrans) will reduce congestion, improve travel time in congested corridors, and promote coordinated, integrated land use-transportation decisions through desired regional growth plans and smart land use measures. Caltrans will implement the Strategic Growth plan and infrastructure investment Plan, Regional Blueprint Planning, and the Caltrans Climate Action Program. This strategy is expected to result in GHG emissions reduction of 9 MMTCO₂E by 2020.

- **Smart Land Use and Intelligent Transportation** (2006 CAT Report strategy): Caltrans will integrate consideration of GHG reduction measures and energy efficiency factors into planning, project development, etc. Caltrans is developing a Director’s Policy on Climate Change and GHG emissions analysis will be integrated into transportation plans and projects. Caltrans will work with the California Transportation Commission (CTC) to include GHG emissions criteria into regional transportation planning guidelines. BTH intends to join the California Climate Action Registry which will complement efforts to determine GHG emissions from transportation. This strategy is expected to result in GHG emissions reduction of approximately 10 MMTCO₂E by 2020.

California Department of Food & Agriculture

- **Conservation Tillage and Enteric Fermentation** (2006 CAT Report strategy): With funding from ARB, CDFA will develop and implement actions to quantify and reduce enteric fermentation emissions from livestock and sequester soil carbon using cover crops and conservation tillage. This strategy is expected to result in GHG emissions reduction of 1 MMTCO₂E by 2020.

- **Dairy Digesters** (2006 CAT Report strategy): CDFA is participating in the CCAR process to develop a dairy digester protocol to document GHG emission reductions from these facilities. The GHG emissions reductions from this action are still to be determined.

State and Consumer Service Agency (Department of General Services)

**Green Building Initiative and Other Related Efforts** (2006 CAT Report strategy)

- Retro-commissioning: There are 27 retro-commissioning projects underway or completed that will yield an 8 percent to 10 percent reduction in energy usage and corresponding GHG emission reductions for each building. At least 21 more buildings will be retro-commissioned during calendar year 2007. DGS is putting substantial efforts into retro-commissioning state buildings owned and operated by DGS and other departments including: Corrections and Rehabilitation, Motor
Vehicles, Transportation, Developmental Services, Veterans Affairs, Technology Services, Parks and Recreation, Health Services, Food and Agriculture, the California Highway Patrol and the California State Lottery. This work is ongoing and will yield substantial energy savings and GHG emissions reductions in the next 18 months.

- Development of a Tool for Automating Data Collection of Energy Usage and GHG Emissions: The Department of General Services and the California Energy Commission have been working with US EPA Energy Star™ and the California Investor Owned Utilities to determine how to automate the uploading of utility generated energy usage data into the Energy Star™ Portfolio Manager benchmarking database. Most of the 1600 state owned buildings waiting benchmarking will have their energy usage data uploaded in this manner. Additional coordination with the Climate Action Registry will determine how to convert this information to GHG emission reductions.

- Solar Generation: Within the last year, the State has implemented over 3 megawatts of clean solar power generation, with another 1 megawatt coming on line this year. The second round of solar generation implementation is anticipated to total 10 additional megawatts and may include UC/CSU campuses and state fairgrounds.

- Energy Efficiency Benchmarking: The DGS has benchmarked its 52 state-owned buildings for energy efficiency and is leading an effort to support other state agencies in benchmarking the remainder of 1,600 state-owned facilities by June 1, 2007.

- Desktop Power Management: The DGS has implemented server-based desktop power management software that will reduce electricity use by desktop computers by up to 40 percent. The California Environmental Protection Agency, Department of Motor Vehicles and Department of Transportation are implementing the software as well.

- LEED Certification: The State now has 9 buildings that are certified by the Leadership in Energy and Environmental Design (LEED) program, totaling more than 2 million square feet. LEED buildings have lower energy usage and lower GHG emissions. LEED certification is being pursued on 85 additional new and renovated buildings totaling over 5.4 million square feet, as well as eight existing buildings totaling over 2.6 million square feet. Additionally, all smaller buildings less than 50,000 square feet in size are being designed and constructed to meet LEED standards.

- Hydrogen Fuel Cells: Initiatives are underway to incorporate clean hydrogen fuel cells in stationary applications at State facilities and as back-up generation for emergency services radics.

- High Performance Schools: The State has adopted new guidelines for energy and resource efficient schools and is currently processing the first applications for up to $100 million in bond money for construction of sustainable, high performance schools.

- Contracting for Environmentally Preferable Products: New State contracts have been or are being created for more energy and resource efficient IT goods, copiers, low mercury florescent lamps, the California Gold Carpet Standard, and
office furniture all of which lower GHG emissions due to environmentally preferable design and manufacturing standards. These combined strategies are expected to result in GHG emissions reduction of 2 MMTCO₂E by 2020.

**Transportation Policy Implementation (2006 CAT Report strategy)**

- **Ultra Low Emission Vehicles**: A new long-term commercial rental contract was released in March 2007 requiring a minimum Ultra Low Emission Vehicle (ULEV) standard for gasoline vehicles and require alternative fuel and hybrid-electric vehicles.
- **Flex Fuel Vehicles**: The DGS fleet purchased 1,134 flex-fuel, E-85 vehicles last year. DGS will replace 800 additional vehicles this year with new, more efficient vehicles, reducing GHG emissions by 370 metric tons of CO₂, .85 metric tons of Methane, and 1.14 metric tons of Nitrous Oxide. DGS has committed to purchasing at least 50 percent of new vehicles as flex-fuel vehicles by 2010.
- **Climate Registry**: The Department of General Services joined the Climate Registry on February 9, 2007. This includes the benchmarking and reduction of GHG emissions for 55 state-owned buildings totaling 15 million square feet, 100 leased buildings totaling 1 million square feet, and over 7,000 light duty vehicles. The GHG emissions reductions from these combined strategies are still to be determined.

**Air Resources Board**

- (for details see ARB report: "Early Actions for Climate Change Mitigation in California")

**California Department of Forestry & Fire Protection**

- **Urban Forestry (2006 CAT Report Strategy)**: CalFire is working with the U.S. Forest Service's Center for Urban Forestry Research (CUF), CCAR and others to develop a new forestry protocol for urban forestry. An initial draft protocol outline for measuring Urban Forestry emission reductions has been completed and is being reviewed by the task group assigned. Partnering with local government and private sector entities the objective of this strategy is to expand efforts with the end result of five million additional trees in urban areas by 2020. This strategy is expected to result in GHG emissions reduction of 1 MMTCO₂E by 2020.
- **Fuels Management/Biomass (2006 CAT Report Strategy)**: CalFire is working with the Tahoe Conservancy and the California Conservation Corps on the Lake Tahoe program. Placer County is also participating to provide biomass from forest fuel treatments to existing biomass utilization facilities. This strategy is expected to result in GHG emissions reduction of 3 MMTCO₂E by 2020.
- **Forest Conservation and Forest Management (2006 CAT Report Strategy)**: CalFire is participating with the Wildlife Conservation Board and stakeholders in
discussions that include looking at opportunities for carbon sequestration in the Prop 84 forest land conservation program to conserve and additional 75,000 acres of forest landscape by 2010. CalFire is working with the U.S. Forest Service on the Lake Tahoe program, and has met to discuss other opportunities for contributing to CAT forestry goals, particularly those related to fuels management and reforestation. These combined strategies are expected to result in GHG emissions reduction of 10 MMTCO₂E by 2020.

- **Afforestation/Reforestation** (2006 CAT Report Strategy): CalFire has met several times with the ARB to discuss carbon protocols for reforestation that have been approved by CCAR. PG&E has an accepted voluntary tariff to subsidize tree planting. Southern California Edison has contacted CalFire to discuss carbon sequestration opportunities through voluntary forest projects. This strategy is expected to result in GHG emissions reduction of 2 MMTCO₂E by 2020.

- **WESTCARB Activities**: CalFire is working with West Coast Regional Carbon Sequestration Partnership (WESTCARB) to evaluate fuels management and biomass use. CalFire continues to work with WESTCARB to evaluate terrestrial carbon sequestration opportunities by looking at reforestation and forest conservation management at its LaTour State Forest.

**California Energy Commission**

- **Municipal Utilities Electricity Sector Carbon Policy** (2006 CAT Report Strategy): The CPUC and the CEC have initiated a joint proceeding to provide a set of GHG emissions cap policy guidelines to the ARB for California’s electricity sector as a whole (IOUs and POUs). The ARB is actively involved in this proceeding. The GHG emissions reductions from this strategy are included in the numbers associated with the efforts on SB1368, enumerated in Group 1.

- **Appliance Energy Efficiency Standards in Place** (2006 CAT Report Strategy): The CEC will be updating its appliance regulations to re-institute appliance and equipment efficiency certification and data collection after successfully defending California’s right to require such data in federal appellate courts. This strategy is expected to result in GHG emissions reduction of 7 MMTCO₂E by 2020.

- **Alternative Fuels: Non-Petroleum Fuels** (2006 CAT Report Strategy): The CEC is will complete, by June 30, 2007, a state plan to increase the use of alternative fuels for transportation. The plan will also evaluate alternative fuels on a full fuel-cycle assessment, set goals for 2012, 2017, and 2022 for increased alternative fuel use, and recommend policies to ensure goals are attained. The GHG emissions reductions from this strategy are still to be determined.

- **Land Use/Smart Growth**: CEC will be leading the Land Use/Smart Growth subgroup of the CAT. This group will investigate potential strategies related to smart growth that will be included in the 2008 CAT report. This will include examining programs such as the California Regional Blueprint Program, the Local Development / Intergovernmental Review process and transportation planning grants. The GHG emissions reductions from this strategy are still to be
determined but some portion of the reduction will fall under the BTH Smart Land use strategy enumerated above.

Department of Water Resources

- **Water Delivery Planning**: DWR has begun a five year analysis and modeling effort to determine the impacts of climate change on California’s water systems. The GHG emissions reductions from this strategy are still to be determined.

- **Water-Energy Nexus**: DWR will consider options that would compel local agencies to incorporate climate change adaptation into regional water planning. Such options would ensure that local agencies consider water-energy nexus in Integrated Regional Water Management Plans and construction and operation of facilities. DWR expects to include consideration of GHG emissions as a part of the application criteria for future water management plan Proposal Solicitation Processes. The GHG emissions reductions from this strategy are still to be determined.

Integrated Waste Management Board

- **Zero Waste/High Recycling Strategy** (2006 CAT Report strategy): Building off of the successful 50% Statewide Recycling Goal, efforts to move toward zero waste through high level recycling and waste prevention are projected to provide an additional 3 MMTCO₂E by 2020. In January 2007, the IWMB approved a Scope of Work for a Lifecycle Assessment and Economic Analysis to help identify which materials to focus diversion efforts to achieve both maximum diversion and GHG reduction at the lowest possible cost. This strategy is expected to result in GHG emissions reduction of 5 MMTCO₂E by 2020.

- **Landfill Methane Capture Strategy** (2006 CAT Report strategy): The IWMB is analyzing increasing the efficiency of existing landfill methane systems and examining the implementation of earlier placement of final cover. The IWMB is collaborating with the CEC on a study to obtain field data and improve the estimates for the proposed strategy. The IWMB is conducting an emissions inventory that will be crucial in quantifying the GHG emissions reductions associated with this strategy. The GHG emissions reductions from this strategy are included in the Landfill Gas Recovery item enumerated above in Group 1.

- **Organic Materials Management**: IWMB will develop a market incentive program to encourage the organic materials management industry to increase organics diversion to the agricultural industry. The GHG emissions reductions from this strategy are still to be determined.

- **Landfill Gas Energy**: IWMB is providing funding for demonstration grants for Landfill Gas to Energy & LNG/biofuels projects. The GHG emissions reductions from this strategy are still to be determined.

- **Target Recycling**: IWMB is focusing on industry/public sectors with high GHG components to implement targeted commodity recycling programs. The GHG emissions reductions from this strategy are still to be determined.
California Public Utilities Commission

- **Accelerated Renewable Portfolio Standard (RPS)** (2006 CAT Report Strategy): In 2006, the PUC approved the IOUs' procurement and solicitation proposals, streamlined the market price benchmark calculation used to evaluate renewable projects, and adopted RPS participation criteria for non-utility load-serving entities. In 2007, the PUC will also examine RPS long-term planning as part of utility overall procurement planning, review and act on utility RPS contracts submitted for approval, and address the use of tradable renewable energy credits for RPS compliance. The GHG emissions reductions from this strategy are included in the efforts related to SB 1368 item enumerated above in Group 1.

- **California Solar Initiative**. (2006 CAT Report Strategy): In late 2006, the PUC finalized implementation rules. The Initiative is designed to deliver approximately 2,000 megawatts of clean, emissions-free energy to the California grid by 2016. Beginning in January 2007, solar systems will receive incentive funds based on system performance. This strategy is expected to result in GHG emissions reduction of 1 MMTCO₂E by 2020.

- **Transmission Infrastructure**: The PUC will consider approval of over $3 billion in utility transmission investment in 2007 that will help facilitate renewable goals. The Tehachapi Renewable Transmission Project is currently under review. The GHG emissions reductions from this strategy are still to be determined.

- **Water Energy Issues**: CPUC required energy utilities to file pilot program proposals in January 2007 to partner with water utilities to deliver energy efficiency programs. The CPUC is evaluating proposals now. New programs should encourage additional energy savings through augmentation of water conservation measures. CPUC is also considering adoption of a methodology to evaluate level of additional energy savings generated through water conservation measures. The GHG emissions reductions from this strategy are still to be determined.

- **Water Conservation**: CPUC adopted a Water Action Plan in December 2005. The Plan includes a number of initiatives to encourage water conservation, including: rate design reform, conservation program investment by water utilities, and partnering with energy utilities. CPUC is also acting as participating agency in the DWR Water Plan development. The GHG emissions reductions from this strategy are still to be determined.

- **Additional RPS**: The CPUC is evaluating options for RPS requirements beyond 20% (including 33%). CPUC is evaluating the use of renewable energy certificates (RECs) for RPS compliance. CPUC is evaluating interaction between RPS program requirements and greenhouse gas emissions cap. This is a strategy that may be amenable to a market based approach. This strategy is expected to result in GHG emissions reduction of 11 MMTCO₂E by 2020.

**GROUP 3: Regulations for 2007-2009 Adoption With Potential GHG Reductions or**
Other Climate Co-Benefits

There are several other action items noted which comprise actions which, although not directly focused on GHG emission reductions, have significant co-benefits for climate change mitigation efforts. These Group 3 actions are described as: "Regulations for 2007-2009 Adoption with Potential GHG Reductions or Other Climate Co-Benefits".

California Department of Food & Agriculture

- **Salt Recapture**: The Proposition 204, Drainage Water Source Reduction, Reuse and Salt Utilization Program, will improve water use efficiency, produce salt tolerant energy crops and recapture salt from drainage as a possible energy source. This program is funded through 2011 and is also pursuing options for growing salt tolerant bio-energy crops.
- **Rice Straw**: The Rice Straw Tax Credit Program provides $15 per ton of rice straw used off-field, reducing open-field burning of rice straw and methane emissions from rice straw decomposition in the field. This program is slated to sunset at the end of 2008 but CDFA is supporting current legislation to extend and expand this program.
- **Dairy Management Practices**: CDFA is leading the effort to develop a strategic plan for dairy research and demonstration for on-farm management practices that protect water quality and air quality. These practices go well beyond just digesters and will have ancillary global warming benefits.
- **Photovoltaic Installation**: The CDFA Division of Fairs and Expositions directly funds about 90% of the operating budget of the Joint Powers Authority (the Ca Construction Authority) that installs photovoltaic systems at county and agricultural fairgrounds. Over 5 MW has been installed in is operating to date, with another 3 MW that are in construction to be completed this summer.

California Energy Commission

- **Report to the Legislature on AB1007 (increased use of alternative fuels)**: The CEC will adopt policy recommendations based on the results of all technical analyses performed in response to AB 1007, and submit those adopted recommendations to the ARB for its use in fulfilling the requirements of AB 32. Expected reductions of GHG emissions resulting from these recommendations will be provided in the third quarter report for 2007.

California Department of Forestry & Fire Protection

- **Wildfire Control Program**: CalFire has developed a comprehensive program to control wildfires with the objective to control 95 percent of fires at ten acres or less through firefighting and forest management. It is estimated that every acre consumed by wildfire emits between 35 and 75 tons of carbon dioxide. Additional analysis will determine the full GHG emission reduction from this objective.
• **Biomass Energy**: CalFire promotes the use of wood to diversify energy supplies and is working with the CEC and CPUC on obtaining energy from forest residue (biomass). The Department is working toward the development of two small (1 megawatt) wood-to-electricity plants to demonstrate how renewable forest residue can generate energy.

**Department of Water Resources**

• **Urban Best Management Practices**: DWR will promote the implementation of Urban Best Management Practices that are locally cost-effective.

**Integrated Waste Management Board**

• **Commercial Recycling**: Focus local government efforts to require commercial recycling.
• **Multi-Family Recycling**: Focus local government efforts to require multi-family recycling.

**California Public Utilities Commission**

• **Carbon Capture and Sequestration**: Several proposals for power plants with integrated gasification combined cycle (IGCC) and/or carbon capture are expected in the next 18 months. If projects proposed to sell to California IOUs, CPUC would need to approve the contracts. This item falls under the auspices of SB1368. The project approval process will be handled on a case by case basis as it relates to reaching the GHG emissions goals of SB 1388.
EXPANDED LIST OF EARLY ACTION MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS IN CALIFORNIA RECOMMENDED FOR BOARD CONSIDERATION

Lyell Glacier, Yosemite National Park, California, USA circa 1903 (upper) and 2003 (lower)

SEPTEMBER 2007
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Comments on this report or its supporting appendices should be submitted to Michael Robert at (916) 327-0604, mrobert@arb.ca.gov and Dr. Tao Huali at (916) 324-2981, thuai@arb.ca.gov by September 24th, 2007.
The ARB staff is recommending that the Board expand the list of early action measures being pursued to reduce greenhouse gas emissions from 37 to 44 measures. Of these measures staff believes 9 merit consideration to be placed on the list of discrete early actions as defined by the California Global Warming Solutions Act of 2006 (AB 32), increasing the size of the current list of 3 by 6 items. Cumulatively, these 44 measures have the potential to deliver greenhouse gas emission reductions on the order of at least 42 million metric tons of CO$_2$-equivalents (MMTCO$_2$E) or a quarter of the 2020 emission reductions needed to meet AB 32 goal. Existing ARB regulations will contribute approximately an additional 30 MMTCO$_2$E reductions. The Climate Action Team has also identified measures (external to the ARB) that account for a cumulative reduction of approximately 88 MMTCO$_2$E. The remaining reductions to meet the 2020 target will be identified by the Scoping Plan due in late 2008. These additional early action recommendations will be presented at a September 17, 2007 public workshop and following consideration of public input will be brought before the Board at its October 25-26, 2007 hearing.

EXECUTIVE SUMMARY

In June 2007 the Air Resources Board (ARB) directed staff to pursue 37 early actions for reducing greenhouse gas (GHG) emissions under the California Global Warming Solutions Act of 2006 (AB 32). The broad spectrum of strategies to be developed — including a Low Carbon Fuel Standard, regulations for refrigerants with high global warming potentials, guidance and protocols for local governments to facilitate GHG reductions, and green ports — reflects that the serious threat of climate change requires action as soon as possible. Three of these 37 identified strategies were also identified as discrete early action measures. These are measures that could be fully adopted as regulations and made effective no later than January 1, 2010, the date established by the Health and Safety Code (HSC) Section 38560.5(b) that requires ARB to adopt discrete early actions.

In addition to approving the 37 GHG reduction strategies, the Board directed staff to further evaluate early action recommendations made at the June 2007 meeting by the AB 32 Environmental Justice Advisory Committee (EJAC), the California Air Pollution Control Officers Association (CAPCOA), and the South Coast Air Quality Management District (SCAQMD), and to report back to the Board within six months. The general sentiment of the Board suggested a desire to try to pursue greater GHG emissions reductions in California in the near-term. This revised early actions report provides staff's analyses of additional emission reduction strategies, and provides recommendations to significantly expand the list of early actions as well as discrete early action measures as identified by HSC Section 38560.5(a).
Since the June 2007 Board hearing, ARB staff has evaluated all 48 recommendations submitted by the EJAC, CAPCOA, and SCAQMD, as well as several other stakeholder suggestions and several internally-generated staff ideas. Each of these measures has been carefully considered with respect to potential emissions reductions, technological feasibility, estimated costs, and economic impacts. This document reports staff's findings and makes further recommendations for a revised list of early actions and, specifically, discrete early action measures (See insert in next page for definitions). The report also provides much greater detail on the evaluation of measures that staff has conducted since the previous April 2007 early actions report was released.

Based on its additional analysis, ARB staff is recommending the expansion of the early action list to a total of 44 measures. The additions to the list of the ARB's commitments also triple the number of measures that would be pursued on an accelerated timeline that meets the AB 32 timeframe for discrete early actions.

In total, as shown in Figure ES-1, the 44 recommended early actions have the potential to reduce GHG emissions by at least 42 million metric tons of carbon dioxide (CO$\text{2}$) equivalent (MMTCO$_2$E) emissions by 2020, representing about 25% of the estimated reductions needed by 2020. ARB staff is working on 1990 and 2020 GHG emission inventories in order to refine the projected reductions needed by 2020 and expects to present its recommendations to the Board by the end of 2007. The 2020 target reductions are currently estimated to be 174 MMTCO$_2$E.

Efforts to develop several of the strategies are already underway with workshops planned for fall 2007 and early 2008. Further, the Climate Action Team (CAT) member agencies are also moving forward with early actions with a targeted reduction of 68 MMTCO$_2$E by 2020. Both the ARB and CAT emission reduction projections are best estimates that are subject to revision as additional information on individual measures becomes available. The ARB staff will report on the early actions progress to its Board every six months. The CAT will also periodically update its efforts and progress on a similar schedule.

A list of all 44 early actions is presented in Table 1, with recommended additions as well as the discrete early action measures identified. In addition, the year and quarter in which the ARB Board hearing is anticipated is also indicated. Inclusion of a strategy, regardless of classification or whether it can be implemented before or after the January 1, 2010 enforceability date for discrete early action measures, represents a commitment by the Board to pursue and – for those strategies that meet all legal and technical requirements – bring the measure to the Board on the timeframe illustrated in the table.

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1 Available at www.arb.ca.gov/cc/042307workshop/early_action_report.pdf.
2 Includes the California Environmental Protection Agency, the Business, Transportation and Housing Agency, the Department of Food and Agriculture, the Resources Agency, the Air Resources Board, the Energy Commission, and the Public Utilities Commission.
3 Those actions are described by the CAT in its companion report on early actions which can be found at www.climatechange.ca.gov/climate_action_team/reports/2007-04-20_CAT_REPORT.
BACKGROUND

The California Global Warming Solutions Act of 2006 (AB 32) creates a comprehensive, multi-year program to reduce GHG emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020 (see Figure 1). AB 32 recognizes that such an ambitious effort requires careful planning and a comprehensive strategy. By January 1, 2009 the Board must design and adopt an overall Scoping Plan to identify how GHG emissions can be reduced back to 1990 levels by 2020. The Board has until January 1, 2011 to adopt the necessary regulations to implement that plan. Implementation begins no later than January 1, 2012 and the emissions reduction target is to be achieved by January 1, 2020. AB 32 also directs the Board to make recommendations on how to best achieve further reductions beyond 2020.

**Discrete Early Action** – Greenhouse gas reduction measure underway or to be initiated by ARB that meets the AB 32 legal definition as identified by the Health and Safety Code Section 38560.5. Discrete early actions are regulations to reduce greenhouse gas emissions adopted by the Board and enforceable by January 1, 2010.

**Early Action** – Greenhouse gas reduction measures underway or to be initiated by ARB in the 2007 – 2012 timeframe. These measures may be regulatory or non-regulatory in nature.
In April of 2007 ARB staff released a report entitled ‘Proposed Early Actions to Mitigate Climate Change in California.’ In that report staff proposed 37 early actions to reduce GHG emissions in California with a cumulative estimate in the range of 33-46 MMTCO₂E by 2020. Existing ARB regulations contributing an additional 30+ MMTCO₂E (principally the AB 1493 regulations on vehicle GHG emissions) were also discussed. Thus, ARB committed to pursue strategies with the potential to yield over 60 MMTCO₂E by 2020, representing an important down payment towards the estimated 2020 reduction target. In its April 2007 report staff recommended that three of these strategies be developed on a schedule that met the AB 32 legal requirement for discrete early action measures – the Low Carbon Fuel Standard (LCFS), reduction of refrigerant losses from motor vehicle air conditioning maintenance, and increased methane capture from landfills.

At its June hearing the Board adopted a resolution which listed three discrete early action measures recommended by the staff and also committed ARB to pursue a total of 37 early actions. The Board also directed the staff to further evaluate recommendations for early actions made by the EJAC, CAPCOA, and the SCAQMD, and to report back to the Board within six months. The general sentiment of the Board suggested a desire to try to accomplish greater GHG emissions reductions in California in the near-term. The staff has completed these additional analyses requested by the Board and staff’s conclusions and recommendations form the basis of this report. The updated recommendations documented herein will be presented at a September 17, 2007 public workshop at ARB headquarters in Sacramento, and following additional consideration of public input by the staff will be considered by the Board at its October 25-26, 2007 hearing.

Figure 1. Comprehensive Multiyear Program Established by AB 32
<table>
<thead>
<tr>
<th>EA ID</th>
<th>SECTOR</th>
<th>STRATEGY NAME</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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<td>Above ground storage tanks¹</td>
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<tr>
<td>3</td>
<td>Forestry</td>
<td>Forest management programs</td>
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<td>Transport</td>
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<td>7</td>
<td>Agriculture</td>
<td>Methane management (feedlot methane capture)²</td>
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<td>8</td>
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</tbody>
</table>

Additional measures are expected to meet the AB 32 definition of discrete early actions that they directly address GHG emissions, are regulatory, and are enforceable by January 1, 2010.

¹ Add 1-12 months to Board adoption date to determine the approximate date of Office of Administrative Law (OAL) approval. These measures are expected to meet the AB 32 definition of discrete early actions that they directly address GHG emissions, are regulatory, and are enforceable by January 1, 2010.

² There is a reasonable expectation that these measures will yield some reductions in emissions (e.g., diesel particulate matter, hydrocarbons), but they are not yet subject to the AB 32 definition of discrete early actions because they do not directly address greenhouse gases for which the science is most robust (e.g., CO₂, CH₄, N₂O, HFCs, PFCs), are non-regulatory, or are not enforceable by January 1, 2010.

³ These measures are expected to meet the AB 32 definition of discrete early actions that they directly address GHG emissions, are regulatory, and are enforceable by January 1, 2010.

⁴ New measures for HCVs and other classes not included in AB 1493 to be adopted in 2010. Additional requirements for LEVs to be adopted in conjunction with Assembly Bill 1493 (AB 1493).
The ARB is one of many state agencies pursuing early actions. The CAT has identified and is refining additional GHG reduction strategies that can be accomplished or initiated in the 2007-2009 period. The CAT process continues to evolve and grow and its early actions will be indispensable for meeting the 2020 target.

The ARB is also in the process of developing a comprehensive Scoping Plan, due in late 2008, which will outline a multifaceted approach to meeting the 2020 emissions reduction target defined in AB 32. The Scoping Plan will evaluate opportunities for sector-specific reductions, integrate synergistically all ARB and CAT early actions and additional GHG reduction measures by both entities, identify additional measures to be pursued as regulations, and define the role of any potential market mechanisms such as a cap-and-trade program. The analyses of many potential GHG emission reduction strategies that are not recommended as early actions are currently underway and will continue as part of the Scoping Plan development. Recommendations regarding the form of these additional GHG reduction measures (e.g., regulatory, non-regulatory, market-based) will be included in the Scoping Plan.

AB 32 requires that all GHG reduction regulations adopted and implemented by the Board be technologically feasible and cost-effective. The law also requires that GHG measures be structured to prevent negative impacts on emissions of criteria pollutants (e.g., hydrocarbons, particulate matter) and to avoid any disproportionate socioeconomic effects (among other criteria). These are critical considerations for each of the recommended early actions. Staff must address these factors fully as detailed proposals are developed. While staff has advanced its understanding with respect to key requirements that must be addressed for most of the proposed strategies, the analyses have not progressed to the point where all impacts (e.g., technical feasibility, cost-effectiveness) can be defined conclusively at this time. Staff plans to develop this information for each of the early actions brought before the Board. If additional information or analysis reveals that a particular measure cannot meet one or more of these requirements, it will not be put into effect. The actual design or features of each measure will be crafted through an open public process that includes interaction with interested stakeholders through various means including workshops.

**CONSIDERATION OF STAKEHOLDER INPUT**

**Sources of Additional Strategies**

As directed by the Board, ARB staff further evaluated early action recommendations from the EJAC, CAPCOA, and SCAQMD as presented at the June 2007 Board Meeting. The original submissions from these entities are included in Appendix A to this report. A brief summary of recommendations from these three sources is as follows:

- The EJAC submitted 34 recommendations for early actions. Of these, 21 were approved by the Board at its June 2007 hearing. Thirteen strategies were not on the list approved by the Board at its June hearing. These are evaluated in Appendix B.
• The CAPCOA submitted five broad suggestions regarding early actions. These and a sixth suggestion are also addressed in the strategy evaluations presented in Appendix B.

• The SCAQMD submitted eight suggestions pertaining to early actions, each of which was further evaluated by ARB staff as documented in Appendix B.

In addition to the items from these three sources, ARB staff has also evaluated additional potential early actions since the June 2007 Board meeting. These measures were either stakeholder suggestions or were items generated internally. There were also several measures approved by the Board at its June 2007 hearing that have direct climate benefits but were not addressed via the EJAC, CAPCOA, SCAQMD, or additional stakeholder suggestions summarized above that are further evaluated in this report. A list of all 63 items considered from these various sources may be found in Table 2 of this document. The results of the staff analysis for each of the strategies evaluated are included in Appendices B and C as indicated in the 'Summary Number' column of Table 2. For those items in Table 2 that are included in the list of previously approved or newly recommended early actions in Table 1, their Early Action ID number from Table 1 is also provided as a cross-reference.

There were several early actions approved by the Board at its June 2007 hearing which were not evaluated further by the ARB (as the rationale for them was documented in the April 2007 report). These include the three discrete early action measures – specifically the LCFS, reduction of refrigerant losses from motor vehicle air conditioning maintenance, and increased methane capture from landfills – currently approved by the Board. Additionally, some air pollution control measures that have been approved by the Board with potential GHG reductions or other climate co-benefits (e.g., diesel control measures and hydrocarbon emission standards) have not been further evaluated by staff as their primary rationale was already established.

Staff Analysis of Strategies

Based on the direction from the Board, significant staff effort was expended to increase the depth and breadth of the analysis afforded to the strategies suggested by stakeholders. For each candidate early action measure analyzed, staff’s recommendation concerning identification as an early action was based on a consideration of potential emissions reductions, estimated costs and economic impacts, the impacted sectors / entities, technological feasibility, and any additional information available. Completion of a full analysis for each of these factors was the goal for each strategy evaluated. However, as a comprehensive assessment will take at least several months for many strategies, much of the desired information is very preliminary or not currently available for a number of measures. Each staff evaluation sought to address:
<table>
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<th>SECTOR</th>
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<td>Manure digester protocol for calculating greenhouse gas mitigation</td>
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<td>EJAC</td>
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<td>Reduce methane venting/leaks from oil and gas systems</td>
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<td>Recycling of waste gases at oil production sites</td>
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<td>Transportation</td>
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<td>Truck stop electrification with incentives for truckers</td>
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<td>Electrification of construction equipment at urban sites</td>
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<td>Energy efficiency of California cement facilities</td>
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<td>Oil and Gas</td>
<td>Relatively inexpensive energy savings measures with short payback times for cement power plants built prior to 1980</td>
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<td>Oil and Gas</td>
<td>Identify and implement energy efficiency measures at refineries that include, but are not limited to, conducting an energy audit</td>
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<td>Evaluate enclosed dairy barns as an additional strategy for the capture and combustion of methane emissions at dairies</td>
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<td>Phase out pre-1980 power plants generating at least 100 MW and provide incentives to replace them with clean energy</td>
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<td>Accelerate introduction and deployment of light-duty vehicle (passenger) hybrid technology</td>
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<td>Alternative low-emission systems in fire protection systems</td>
<td>No Change in Classification</td>
</tr>
<tr>
<td>Appendix B46</td>
<td>3</td>
<td>ARB EA REPORT</td>
<td>Forestry</td>
<td>Forestry protocol endorsement</td>
<td>No Change in Classification</td>
</tr>
<tr>
<td>Appendix B47</td>
<td>29</td>
<td>ARB EA REPORT</td>
<td>Transportation</td>
<td>Enforcement of federal ban on HFC release during service/dismantling of MVACs</td>
<td>No Change in Classification</td>
</tr>
</tbody>
</table>
The potential emission reductions in 2010 (if any) and 2020 in terms of million metric tons of CO₂-equivalent per year, including any co-benefits (e.g., reduction in emissions of criteria pollutants) or disbenefits (e.g., fuel penalty).

The costs per MTCO₂E and the total cost of implementation in 2010 (if applicable) and 2020 and the sectors that will bear the costs including any potential disproportionate impacts on small businesses or environmental justice sectors of the community. This discussion includes businesses or individuals (e.g., environmental justice community) that may be adversely impacted by the proposed strategy.

The likely technical feasibility of the technology by describing the degree to which it or a similar technology has already been proven. If not applicable, the research/pilot studies that suggest the technological feasibility is likely to be within the next few years are cited.

Additional considerations that pertain to the measure, such as if any other jurisdiction (state, county) has taken the action, whether the item falls under ARB jurisdiction or is a CAT strategy, whether ARB has legal authority, whether the item would be regulatory, when the item could be taken before the Board, and coordination with affected entities, trade associations, and/or government agencies.

Current State of Understanding

Appendices B and C include a complete listing of staff's analysis for each of the 63 recommendations / potential early actions listed in Table 2, exclusive of the landfill methane capture suggestion by the EJAC, which is already a discrete early action. Each summary has a unique identification number that is also listed in Table 2 for each measure; note that multiple measures may be addressed by the same summary.

The summaries in Appendices B and C represent ARB staff's current understanding of the ideas evaluated. It is acknowledged that in many instances, additional time, effort, and information are still needed for a more thorough compilation of all relevant and necessary information to support development as a regulation or other approach such as guidance.

Based on its current state of understanding, staff has made one of six recommendations for each measure it evaluated which are described below. One of these six recommendations is indicated for each of the strategies evaluated (see disposition column in Table 2).

- **Previously Approved -- No Change** -- applies to measures which were approved by the Board as early actions at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this early action is recommended.
• **Previously Approved – Reclassify as a Discrete Early Action** – applies to measures which were approved by the Board as early actions at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this early action be reclassified as a discrete early action measure.

• **Proposed Measure – Add as a Discrete Early Action** – applies to measures which are recommended for addition to the list of discrete early action measures.

• **Proposed Measure – Add as an Early Action** – applies to measures which are recommended for addition to the list of early actions.

• **Proposed Measure – Continue to Evaluate in Scoping Plan** – applies to measures proposed at the June 2007 Board meeting which are recommended for further evaluation in the Scoping Plan. A draft Scoping Plan is expected by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering these recommendations.

• **Proposed Measure – Further Evaluation Needed** – applies to measures proposed that require further information and evaluation prior to recommending that they be pursued as early actions. As additional information becomes available staff will consider whether it supports recommending these strategies as additions to the Board’s list of commitments for reducing greenhouse gas emissions.

**RECOMMENDATIONS FOR ADDITIONAL EARLY ACTIONS**

The ARB staff is recommending that a total of 44 early actions be developed and brought to the Board for future consideration. These measures are recommended because staff’s evaluation concluded that they are expected to yield significant GHG emission reductions, are likely to be cost-effective and technologically feasible, and can be brought back to the Board as full proposals in the 2007-2012 timeframe. Specifically, staff is recommending that 6 more discrete early actions be added to the list previously approved by the Board, two of which are new recommendations to be added to the list of those actions meeting the narrow definition of discrete early actions in that they are regulatory and will be enforceable by January 1, 2010. Furthermore, staff is recommending that 4 previously adopted early actions be reclassified as discrete early action measures. Cumulatively, these 44 total recommendations are expected to yield at least 42 MMTCO₂E reductions by 2020, representing about 25% of the 2020 target.

**Summary of Items Reviewed**

Table 2 lists each of the items evaluated as potential early actions. It consists of the recommendations made by the EJAC, CAPCOA and the SCAQMD as well as additional strategies that were identified by stakeholders or ARB staff. Each of the strategies has been evaluated with the results of the evaluation presented in
Appendices B and C. The 'Summary ID' column of Table 2 cross-references each of these items to its summary in the appendices; the final disposition of each item is listed in the 'Disposition' column.

**Items Addressed by Recently Adopted Regulations**

The ARB recently adopted an off-road diesel rule\(^4\) at its July 2007 Board hearing. This regulatory measure was not listed as an early action in the April 2007 ARB staff report. The regulation requires a reduction in off-road diesel engine particulate matter emissions, and is applicable to off-road engines such as those used by urban construction equipment. A possible way to achieve such pollutant reductions is via the electrification of construction equipment at urban sites. This particular example was submitted by the EJAC [refer to summary number B17 in Appendix B]; this recommendation is therefore encapsulated within the intent of a recently adopted regulation and was not further evaluated as part of the early action effort.

**Measures Recommended as Additional Discrete Early Actions**

The ARB staff's recommendations concerning the addition of discrete early actions are summarized below. In addition to these measures staff closely evaluated many other measures as potential discrete early action measures. However, for reasons such as the non-regulatory nature of a measure, its implementation timeline, and others, they are not recommended for addition to the list of discrete early action measures. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

*SF\(_6\)* **Reductions in the Non-Electric Sector:** This measure is recommended as an additional discrete early action measure. The strategy involves the potential ban of SF\(_6\) in non-utility, non-semiconductor applications where safe, cost-effective alternatives are available. These applications may include magnesium production and casting operations, air quality tracer gas studies, and face velocity tests for laboratory hoods. The staff will investigate other possible uses of SF\(_6\) during the development of the regulations.

*Reduction of High GWP GHGs in Consumer Products:* This measure is recommended as an additional discrete early action measure. The strategy involves the reduction of high-GWP GHGs used as propellants in aerosol products, tire inflators, electronics cleaning, dust removal, hand held sirens, hobby guns (compressed gas), party products (foam string), and other formulated consumer products when viable alternatives are available. Some data regarding emissions of greenhouse gases are available from a recent survey of consumer products, which may represent possible reductions within the discrete early action timeframe. Manufacturers are also currently being surveyed to determine the extent of usage of high GWP gases in several more categories of consumer products. These future survey results may lead to additional strategies with

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emission reduction potential that can be pursued after the deadline for discrete early action items.

**Measures Recommended for Reclassification as Discrete Early Actions**

The ARB staff's recommendations concerning the reclassification of pre-existing early actions are summarized below. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

**SmartWay Truck Efficiency:** This measure is recommended to be re-classified as a discrete early action measure. The strategy involves requiring existing trucks/trailers to be retrofitted with the best available "SmartWay Transport" and/or ARB approved technology. Technologies that reduce GHG emissions from trucks may include devices that reduce aerodynamic drag and rolling resistance. Aerodynamic drag may be reduced using devices such as cab roof fairings, cab side gap fairings, cab side skirts, and on the trailer side, trailer side skirts, gap fairings, and trailer tail. Rolling resistance may be reduced using single wide tires or low-rolling resistance tires and automatic tire inflation systems on both the tractor and the trailer.

**Tire Inflation Program:** This measure is recommended to be re-classified as a discrete early action measure. The strategy involves actions to ensure that vehicle tire pressure is maintained to manufacturer specifications. Specifically, the strategy seeks to ensure that tire pressure in older vehicles is monitored by requiring that tires be checked and inflated at regular service intervals. One potential approach would be to require all vehicle service facilities, such as dealerships, maintenance garages, and smog check stations, to check and properly inflate tires. It is also anticipated that signage at fueling stations clearly indicate the availability of compressed air at no charge. Staff also recommends that the feasibility of conducting an extensive outreach program be investigated.

**Reduction of PFCs from the Semiconductor Industry:** This measure is recommended to be re-classified as a discrete early action measure. The strategy involves establishing a PFC emissions reduction goal and determining measures to achieve that goal. There are several approaches the industry has either employed or committed to continue evaluating to reduce PFC emissions from semiconductor production, including process optimization (optimizing the use of PFCs, such as in the chamber cleaning process), alternative chemistry

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5 The United States Environmental Protection Agency (U.S. EPA) in collaboration with the freight industry has developed a voluntary program designed to increase energy efficiency while significantly reducing greenhouse gases and criteria pollutants. The program, known as the SmartWay Transport Partnership (SmartWay Transport), encourages trucking companies to use technologies that improve efficiency and reduce emissions. The SmartWay Transport also designates highly efficient and emission reduction technology packages as SmartWay Upgrade Kits which can be purchased at various SmartWay partner centers, dealerships, and service centers. ([http://www.epa.gov/otaq/smartway/documents/420f07027.htm](http://www.epa.gov/otaq/smartway/documents/420f07027.htm))
development, emissions abatement; and recovery/recycling (separation of fluorinated compounds from other gases for further processing and reuse).

Green Ports: This measure is recommended as an additional discrete early action measure. The strategy involves providing an alternative source of power for ships while they are docked. For example, the ships can use cables to receive electricity from the shore, thereby allowing them to shut off their auxiliary engines, reducing emissions of air pollutants. Staff proposes to present the draft regulation to the Board as a measure to reduce nitrogen oxides (NOx) and diesel particular (PM) emissions and to quantify the associated (carbon dioxide) CO2 emission reductions. By focusing on NOx and PM reductions, staff will address the local and regional health impacts of ships docked in California’s ports, including any disproportionate impacts those emissions may have on surrounding communities.

Measures Recommended as Additional Early Actions

The ARB staff’s recommendations concerning the addition of early actions are summarized below. In addition to these recommendations staff closely evaluated many other measures such as a green ship incentive program, and refinery methane emission reductions. However, for reasons such as a substantial lack of available information, technological barriers, implementation timeline, and others, they are not recommended for addition to the list of early actions. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

Refrigerant Tracking, Reporting, and Recovery Program: This measure is recommended as an additional early action. The strategy involves the reduction of emissions of high GWP GHGs through establishing requirements for enhanced monitoring, enforcement, reporting, and recovery. It may be determined that more than one strategy is required to effectively address the sources of interest and that the strategy or strategies are likely to include both regulatory and non-regulatory elements. Such strategies could include:

- Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers: This consists of an assessment of the magnitude of the emissions from refrigerated shipping containers. Depending on results, the strategy may be similar to the one enforcing the federal ban on releasing refrigerants to the atmosphere from the servicing or dismantling of MVACS. After the recovery from a decommissioned container, it may be desirable to disable the refrigeration unit as well, which may require a regulation.

- Residential Refrigeration Program: This involves supporting existing voluntary programs to promote the upgrade of residential refrigeration equipment in need of repair, such as refrigerators and freezers. The program could potentially be expanded to include window unit air conditioners.
• **High-GWP Refrigerant Tracking, Reporting, and Deposit Program**: This strategy involves 1) expanding and enforcing the national ban on venting high-GWP GHGs (including fully emissive processes) during equipment/process lifetime; 2) requiring high-GWP GHG sales, use and energy use reporting as well as inspection and maintenance (I/M) and leak repair for equipment, cylinders, products, or systems with capacities above some CO$_2$E threshold; 3) requiring technician certification for sales, purchase, transport, recovery, reclamation, resale, I/M; and 4) establishing a high-GWP GHG deposit program and/or fines for emissive processes or leaky systems.

**Cement (A): Energy Efficiency of California Cement Facilities**: This measure is recommended as an additional early action. The strategy involves reducing CO$_2$ emissions from fuel combustion, calcination, and electricity use by converting to a low-carbon fuel-based production, decreasing fuel consumption, and improving energy efficiency practices and technologies in cement production.

**Cement (B): Blended Cements**: This measure is recommended as an additional early action. The strategy to reduce CO$_2$ emissions involves the addition of blending materials such as limestone, fly ash, natural pozzolan and/or slag to replace some of the clinker in the production of Portland Cement. Currently, ASTM cement specifications allow for replacement of up to 5% clinker with limestone. Most manufacturers could in fact replace up to 4% with limestone. Caltrans allows for 2.5% average limestone replacement until testing of the long term performance of the concrete is complete. Caltrans currently has over $1 million in task orders and is devoting considerable staff resources to the evaluation of limestone blending in cement. Caltrans also currently has standards for using flyash and slag in concrete. Other blending practices will be explored.

**Anti-idling Enforcement**: This measure is recommended as an additional early action. The strategy guarantees emission reductions as claimed by increasing compliance with anti-idling rules, thereby reducing the amount of fuel burned through unnecessary idling. Measures may include enhanced field enforcement of anti-idling regulations, increased penalties for violations of anti-idling regulations, and restriction on registrations of heavy-duty diesel vehicles with uncorrected idling violations.

**Collaborative research to understand how to reduce GHG emissions from nitrogen land application**: This measure is recommended as an additional early action. The strategy involves the identification of methodologies for better characterizing California’s nitrogen cycle. An important first step to better characterizing the relationship between nitrogen land application and nitrous oxide formation in California agriculture, landscaping and other uses as well as opportunities for emission reductions is a collaborative research effort with stakeholders. The research is expected to focus on identifying optimal ways to reduce nitrous oxide emissions while increasing soil retention of nitrogen for plant uptake. As part of
the research the ARB will collaborate with the California Department of Food and Agriculture, Department of Pesticide Regulation, commodity groups, and other stakeholders. The research is expected to ultimately support the development of guidance to improve the characterization of nitrous oxide emissions from nitrogen land applications as well as identify effective strategies for emission reductions.

Process Forward for Regulatory Items

All discrete early action measures and the majority of the other early actions will enter into the conventional regulatory development process. This process involves public workshops and the consideration of stakeholder input, followed by the formal regulation development, which includes a public hearing where the Board considers the staff recommendation. If the Board adopts the regulation or an amended regulation, then it must be reviewed and approved by the Office of Administrative Law (OAL) before becoming law. Though the non-regulatory strategies such as guidelines will not become binding mandates, they will go through a similar process of public participation. This open process ensures that the regulatory development of each strategy that the staff recommends to the Board is informed by the best and most up-to-date information.

ADDITIONAL CONSIDERATIONS / CAT STRATEGIES

ARB has or will be adopting several strategies not discussed explicitly in this report that will yield significant GHG reductions by 2020. Most notably, the regulation that the Board adopted in response to AB 1493, which mandated the reduction of greenhouse gas emissions from passenger vehicles, is expected to account for 30 MMTCO₂E by 2020. Other diesel PM, ozone-precursor, and State Implementation Plan (SIP) measures are also expected to have climate co-benefits whose magnitudes are yet to be determined.

In its April 2007 draft report entitled 'Climate Action Team Proposed Early Actions to Mitigate Climate Change in California', the CAT identified early actions external to the ARB that may yield up to 68 MMTCO₂E reductions by 2020. In addition to ARB, members of the CAT have begun work on implementing many of the strategies outlined in the April 2007 draft report. Although not under statutory mandate to do so, the other CAT members expect to have several items implemented through regulations by January 1, 2010; these 13 strategies are expected to result in emission reductions of approximately 7 MMTCO₂E with some reduction estimates still to be calculated. The same CAT members have also identified 41 additional measures for the post-2010 timeframe, which are expected to yield reductions in greenhouse gas emissions on the order of 61 MMTCO₂E by 2020.

The ARB is in the process of developing a comprehensive Scoping Plan, due in late 2008, which will outline the multifaceted approach to meeting the 2020 emissions reduction target required by AB 32. The Scoping Plan will evaluate opportunities for sector-specific reductions, integrate synergistically all ARB and CAT early actions and additional GHG reduction measures, and define the role of any potential market mechanisms. The analyses of many potential GHG emission reduction strategies that
are not recommended as early actions are currently underway and will continue as part of the Scoping Plan development. Recommendations regarding the form of these additional GHG reduction measures (e.g. regulatory, non-regulatory, market-based) will be included in the Scoping Plan.

CONCLUSIONS / RECOMMENDATIONS

At its June 2007 hearing, the Board asked staff to conduct additional analyses of stakeholder suggestions for early actions. Staff has completed this task as well as the further evaluation of additional potential early action measures, and recommends that the list of early action measures be expanded to 44. Nine of these strategies meet the AB 32 definition of discrete early action measures, which is three times the number of original discrete early action measures currently approved by the Board. The ARB recognizes that California must act quickly and decisively now to begin the long road to mitigating the most serious impacts of global warming, and is committed to pursuing the full list of 44 early actions.

The revised list of early actions as recommended by ARB staff is a more ambitious plan than originally proposed and is a complement to the actions of the Climate Action Team members and many other entities in California, the U.S., and the world who are acting now for climate protection. Discrete early action measures that will be in place and enforceable by 2010 include the original list of 3 strategies, plus an additional 6 measures in the transportation and commercial sectors. In addition, 5 new measures as suggested by stakeholders or staff analysis will also be pursued as early actions, but will be implemented post-2010 or are not necessarily regulatory in nature. Cumulatively, all 44 early actions have the potential for reductions of 42 MMTCO₂E by 2020.

The revised early action plan is a comprehensive framework of regulatory and non-regulatory elements that will result in significant and effective GHG emission reductions. The revised early action plan will receive public input at a September 17, 2007 workshop and will be considered by the Board at its October 25-26, 2007 hearing. If approved, each early action will be developed through an open public process.
GLOSSARY OF TERMS AND ACRONYMS

**AB 32** – Assembly Bill 32, the Global Warming Solutions Act of 2006

**ARB** – Air Resources Board

**CAPCOA** – California Air Pollution Control Officers Association

**CAT** – Climate Action Team, a committee of multiple state agencies led by the Secretary of Cal/EPA

**CO₂** – carbon dioxide; a byproduct of fossil fuel combustion, cement production, and other natural processes

**Discrete Early Actions** – Greenhouse gas reduction measure underway or to be initiated by ARB that meets the AB 32 legal definition as identified by the Health and Safety Code Section 38560.5. Discrete early actions are regulations to reduce greenhouse gas emissions adopted by the Board and enforceable by January 1, 2010.

**Early Actions** – Greenhouse gas reduction measures underway or to be initiated by ARB in the 2007 – 2012 timeframe. These measures may be regulatory or non-regulatory in nature.

**EJAC** – Environmental Justice Advisory Committee

**GHG** – greenhouse gas or gases; defined in AB 32 as including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride; also known as “the Kyoto six”

**GWP** – global warming potential, the relative warming of a greenhouse gas as compared to carbon dioxide which has a GWP of 1.0.

**HFCs** – Hydrofluorocarbons; a class of compounds whose molecules consist of carbon, hydrogen, and fluorine atoms typically used in air conditioning systems and as propellants

**HSC** – (the California) Health and Safety Code

**LCFS** – Low Carbon Fuel Standard

**MMTCO₂E** – million metric tons (of) carbon dioxide equivalent (gases)

**MVAC** – motor vehicle air conditioning (systems)

**OAL** – California Office of Administrative Law
OHRV – Off Highway Recreational Vehicle

PFCs – perfluorocarbons, a class of compounds derived from hydrocarbons by replacement of hydrogen atoms by fluorine atoms. PFCs are made up of atoms of carbon, fluorine, and/or sulfur, and are mostly used in the semi-conductor industry.

SCAQMD – South Coast Air Quality Management District

SF₆ – sulfur hexafluoride; a highly stable non-conducting chemical used for and emitted from various industrial processes and in the manufacturing of electrical circuitry.
APPENDIX A – EJAC, CAPCOA, and SCAQMD Recommendations
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Improved landfill methane capture</td>
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<tr>
<td>2</td>
<td>Require HFC-134a reductions through evaluation of refrigerants in decommissioned or stored cargo containers, commercial and residential HVAC system leakage, auto dismantling/crushing facilities (i.e., requiring HFCs be removed from cars prior to scrappage)</td>
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<tr>
<td>3</td>
<td>Manure management*</td>
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<tr>
<td>4</td>
<td>Reduce venting/leaks from oil and gas systems</td>
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<tr>
<td>5</td>
<td>Heavy-duty vehicle emissions, efficiency improvements*</td>
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<tr>
<td>6</td>
<td>Cool automobile paints*</td>
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<tr>
<td>7</td>
<td>Port electrification</td>
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<tr>
<td>8</td>
<td>Transportation refrigeration, electric standby</td>
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<tr>
<td>9</td>
<td>Truck stop electrification with Incentives for truckers</td>
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<tr>
<td>10</td>
<td>Tire inflation program</td>
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<tr>
<td>11</td>
<td>Require low GWP refrigerants for new MVACs*</td>
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<tr>
<td>12</td>
<td>Add AC leak tightness test and repair to Smog Check</td>
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<tr>
<td>13</td>
<td>Wafflemat system for concrete slab foundations</td>
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<tr>
<td>14</td>
<td>Demonstrate use of shore-side generators as bridge to electrical hook-up</td>
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<tr>
<td>15</td>
<td>Green ship incentive program</td>
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<tr>
<td>16</td>
<td>Anti-idling requirement for cargo handling equipment at ports</td>
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<tr>
<td>17</td>
<td>Require the electrification of airport ground support equipment</td>
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<tr>
<td>18</td>
<td>Require the electrification of construction equipment at urban sites</td>
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<tr>
<td>19</td>
<td>Adopt a regulation and/or incentive program to take advantage of emerging hybrid technology for medium duty delivery trucks</td>
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<tr>
<td>20</td>
<td>Relatively inexpensive energy savings measures with short pay back times for cement industry</td>
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<tr>
<td>21</td>
<td>Explore a greenhouse gas and mercury emission performance standard for cement facilities equivalent to the level achievable through conversion from coal to natural gas</td>
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<tr>
<td>22</td>
<td>Relatively inexpensive energy savings measures with short pay back times for fossil fuel power plants built prior to 1980*</td>
</tr>
<tr>
<td>23</td>
<td>Relatively inexpensive energy savings measures with short pay back times for refineries*</td>
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<tr>
<td>24</td>
<td>Accelerate the replacement of cargo handling equipment at ports*</td>
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<tr>
<td>25</td>
<td>Enclose dairy barns to capture methane*</td>
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<tr>
<td>26</td>
<td>Adopt South Coast and San Joaquin rules on enclosed composting facilities statewide*</td>
</tr>
<tr>
<td>27</td>
<td>Establish necessary rules and or emissions thresholds for transmission to local Air Districts for the phase out, by 2010, of power plants built prior to 1980 that generate over 100 MW of electricity and provide incentives for clean energy production in their place*</td>
</tr>
<tr>
<td>28</td>
<td>Prohibit fuel oil burning for base load generation of electricity in facilities 100 MW or greater and built prior 1980*</td>
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<tr>
<td>29</td>
<td>We recommend CARB undertake and adopt regulatory measures that require recycling of waste gases at refineries instead of dumping or incinerating them*</td>
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<tr>
<td>30</td>
<td>Adopt regulatory measures to eliminate the methane exemptions granted to refineries and require methane control measures at refineries*</td>
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</table>
| 31 | Identify and implement energy efficiency measures at refineries that include, but are not limited to, conducting an energy audit. This audit shall consider and address, at least:
  a) Use of clean, renewable energy for refinery electricity consumption
  b) The impact of heavier crude oil modifications on GHG emission
  c) Other energy efficiency measures

| 32 | We recommend CARB undertake and adopt regulatory measures that require recycling of waste gases at oil production sites instead of dumping or incinerating them

| 33 | Adopt regulatory measures to eliminate the methane exemptions granted to oil production sites and require methane control measures at oil production sites

| 34 | Identify and implement energy efficiency measures that include, but are not limited to, conducting an energy audit at oil production sites. This audit shall consider and address, at least:
  a) Use of clean, renewable energy for oil production site electricity consumption
  b) Other energy efficiency measures

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**Early Action Measures to be Forwarded by ARB to the CAT Team**

The Committee recommends that all CAT agencies with jurisdiction in the area of energy generation, procurement, siting, permitting, rate-setting and renewable energy deployment in both electricity and transportation sectors, conduct the following:

1) Quantify and publicly provide the air emission and cumulative impacts of new power plant construction in CA and report to CARB the implications for the achievement of the state's climate and air quality goals;

2) Require proponents of new power plant construction to conduct a thorough and robust renewable energy alternatives assessment. If a more carbon-beneficial combination of energy producing or saving sources is available, then the utility should be required to pursue that avenue. This process should begin with all currently approved and expected power plants;

3) Report to CARB on the progress of existing renewable energy deployment programs and identify obstacles to the achievement of the state's renewable energy goals;

4) Perform an audit of existing and planned low-income rate assistance, energy efficiency, solar, and green building programs and identify barriers that impede local community participation.

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*Note: The Committee supports electrification of engines when coupled with efforts to increase use of clean, renewable energy sources such as wind and solar.*

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*During the development of this measure ARB must identify methods that would eliminate the NOx emissions which result from this technology in order to comply with the prohibition in AB 22 against backsliding on criteria pollutants.*

*Particularly promising avenues include requiring or incentivizing: Use of oil base fluids, Use of automatic tire inflation systems, Use of low viscosity lubricants, Improving heavy logistics, and Pursuit of hybrid truck technology.*

*ARB should undertake a complete life cycle analysis before suggesting use of fuel additives.*

*Any regulation developed would have to ensure that the new paint formulations did not cause backsliding on criteria pollutants.*

*Any chosen replacement must first undergo a complete life cycle analysis and multi-media toxicity analysis.*
This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

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This measure had not been previously received by CARB and was added to the Early Action Measures list by the Committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

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May 14, 2007

Ms. Catherine Witherspoon
Executive Officer
California Air Resources Board
1001 I Street
P.O. Box 2815
Sacramento, CA 95812

Re: Proposed Early Action Measures Under AB 32

Dear Ms. Witherspoon,

The California Air Pollution Control Officers Association is writing to support your efforts to identify discrete early action measures to help secure the earliest possible reductions in greenhouse gas emissions, and to urge you to include additional measures and timeframes in your final proposal. We also would like to offer the support and resources of local air districts in developing and implementing early action measures.

Local air districts recognize the critical importance of early reductions to delay the approach of a climate change “tipping point” and to affect a meaningful slowing of the process of climate change. We also recognize the extraordinary resource demands facing the ARB as you implement the requirements of AB 32. We believe that by relying on local air districts for specific tasks, the ARB will be able to reserve crucial resources for those activities that should be developed and implemented centrally.

CAPCOA supports the inclusion of the measures listed in the ARB’s April 20, 2007 draft proposal. We believe additional measures can and should be identified as Group 1 measures. We also believe that more specific time frames should be included for measures in Group 2 and Group 3. Most importantly, we believe there are existing processes and programs that can be effectively leveraged for early reductions of greenhouse gases, and we urge you to include specific tasks and milestones for them in your final list of measures.

The local districts understand the difficulties identifying specific measures that can be adopted and implemented in the short time period called for in AB 32. We recommend actions in five key areas that ARB can take to secure these reductions quickly and without investing significant additional resources.
Recommendation 3: Prioritize SIP rulemaking. CAPCOA recommends that ARB review proposed SIP measures and rank them on the basis of criteria pollutant reductions, public health protection, and greenhouse gas reduction potential. Rules that rank high in all three areas should be given higher priority in the rulemaking calendar. This additional review will not add substantially to workload already planned, but will define GHG reductions that can be achieved in the near term without compromising progress towards clean air or undermining protection of public health.

Recommendation 4: Review Existing Rules. CAPCOA recommends that you perform a review of existing state and local rules, similar to an "All Feasible Measures" review that would identify existing rules that, whether expressly intended or not, result in significant reductions of GHGs. Rules that are so identified could be more quickly adopted for statewide implementation and adopted by the ARB. Some local districts have already adopted and implemented regulations intended to reduce GHG emissions; many others have regulations for criteria pollutants which, by virtue of the way the rules are structured, also secure significant collateral GHG reductions. We believe that with a modest investment of resources, perhaps relying on a contractor who could work with a CAPCOA committee, ARB could identify rules with potential for statewide GHG reductions. Because these rules have already been adopted and implemented, much of the preparatory work has been done and the feasibility and costs are well documented; this should shorten both the time and resources needed for state rulemaking. CAPCOA has already begun this review and we look to share initial results with you in the near future.

CAPCOA also recommends that ARB use a focused workgroup process (which you have already discussed with us) to tap district staff resources and expertise with specific source categories to identify discrete early reductions that could be achieved in each category. We believe this process could identify early reduction potential in the six categories ARB has identified for reporting and rulemaking, and could be used to accomplish some of the necessary steps to speed adoption by the ARB. The workgroup process could also be used to build on the review of local regulations (described above) and identify opportunities for additional reductions of greenhouse gases within the existing air pollution program framework. Some local districts have already begun this review and others plan to begin soon. CAPCOA believes such a coordinated workgroup process could identify potential GHG reductions and secure them in the near term through local rule amendments that implement a consistent statewide standard — similar to a suggested control measure. We recommend that this process be included in your final list, and would be happy to work with you in defining an appropriate schedule and associated emission reduction potential.

Recommendation 5: Minimize Impacts of New Stationary Sources. CAPCOA recommends that ARB work with the districts to develop a coordinated approach to reviewing greenhouse gas emissions from significant stationary sources in categories that also emit significant amounts of GHGs. As you know, the most environmentally effective and cost effective emission reductions are those implemented before a project is built. The challenge of reaching the 1990 baseline will be easier to meet if we ensure that economic growth occurs along the path of least climate impact. Local air districts already require permits and preconstruction review for such sources, which provides an efficient and effective platform to identify and address GHG emissions from new or modified sources in categories of concern. ARB should establish a general framework for including a review of GHG emissions in the local permitting process. The framework should also identify appropriate local, regional, or global mitigation strategies. This process would be analogous to the development of review programs for toxic air contaminants in the late 1980s and early 1990s. In fact, because of district obligations under CEQA, districts may be required to address GHG emissions associated with new permits regardless of any action by ARB. The outcome would be better coordinated with ARB participation at the outset to identify the scope of the review and the mitigations to be considered.
Recommendation 4: Leverage CEQA Mitigations. CAPCOA recommends that ARB work with local districts to coordinate approaches to the review of GHGs under CEQA and capture the reductions that result from mitigation. Local air districts routinely review the impacts of a variety of development projects under CEQA. Local governments are currently contacting air districts with questions about how to incorporate climate change and address GHG emissions of projects, and are seeking specific guidance on GHG significance thresholds for projects. CAPCOA’s Climate Protection Committee and Planning Managers Committee are working on this now, and we would like to include ARB staff in this effort. We believe that a focused effort to identify thresholds and mitigation measures could result in practical reductions in the near term through the CEQA process. We recommend that ARB include timelines and commitments to such a process on the early action measures list, and we would be happy to work with you on an appropriate schedule and associated emission reduction potential.

Recommendation 5: Capture Voluntary Reductions. CAPCOA recommends ARB work with local districts to establish mechanisms to promote, track, verify, and capture voluntary reductions in GHGs. As you are well aware, there is tremendous interest in voluntary reductions on the part of business, local government, and the general public. CAPCOA believes this interest should be aggressively pursued. Many local air districts are already working with local stakeholders to identify and organize voluntary reduction efforts. CAPCOA also has a Climate Protection Committee that is tasked, among other things, with compiling voluntary reduction strategies and other materials to support individual districts in this area. We suggest ARB work with us to compile information, and that ARB rely on local districts to help from your reporting, verification, and tracking structure for early reduction efforts. We believe ARB should include milestones for implementing this in your final list of measures, and will work with you to identify associated emission reduction targets.

Summary

In closing, CAPCOA applauds ARB’s efforts to identify and secure early reductions of greenhouse gases under AB 32. We urge you to include additional Group 1 early action measures on your final list, and to establish time frames for the measures in Group 2 and Group 3. We specifically recommend that ARB 1) prioritize SIP reductions to maximize collateral GHG reductions, 2) review existing local rules to identify potential statewide measures or local enhancements, and use district resources in workgroup efforts on-specific source categories with significant GHG emissions, 3) coordinate with districts on a strategy to use existing permit programs to review and mitigate greenhouse gases from significant stationary sources, 4) coordinate with districts on review and mitigation of GHGs under CEQA, and 5) rely on local air district resources to implement early reductions through coordinated voluntary programs.

Thank you for your consideration of our recommendations.

Sincerely,

Larry R. Allen
President
Via email

Mr. Bart Croes
Division Chief
California Air Resources Board
1001 I Street
Sacramento CA 95812

Re: Proposed Early Actions to Mitigate Climate Change in California

Dear Mr. Croes:

Thank you for the opportunity to comment on the State’s Proposed Early Actions to Mitigate Climate Change in California. This effort will contribute significantly to the overall strategy to reduce greenhouse gases in the state. The following comments are offered for your consideration.

The report includes 3 tables: Table 1, Group 1 - Early Action Measures; Table 2, Group 2 - Additional GHG Reduction Measures Underway or Initiated by ARB in 2007 - 2009 Period; and Table 3, Group 3 - ARB Air Pollution Controls for 2007 - 2009 Adoption with Potential GHG Reductions or Other Climate Co-Benefits. Relative to the measures in Group 1, which will be adopted and implemented by January 1, 2010, SCAQMD staff recommends including a measure to accelerate hybrid penetration, as this technology is already well developed and readily available. At a minimum, this measure should be added to Group 3 if it is not added to Group 1. In addition, the measure on Low Carbon Fuel Standard (1-1) needs to be evaluated in light of the recent Stanford study regarding potential negative implications of E-85.

For Group 2, it would be very helpful for CARB staff to identify years for adoption and implementation for each measure to enable a better sense of priority. Providing preliminary information for potential reductions would also help to understand these measures and their relative benefits. Measure 2-16, Port Electrification should be moved to Group 3 as part of the port measures. There are also several measures that SCAQMD staff would like to see adopted by 2009, not just underway or to be initiated. These are measures 2-9 - Energy Efficiency, 2-13 - Transportation (light-duty vehicle standards), and 2-14 - Transportation (heavy-duty vehicle emission reductions and efficiency improvements.

A-8
For Group 3, there are SIP measures in the SCAQMD 2007 Air Quality Management Plan that should be added:

- Evaporative Emission Standards for Recreational Boats and Off-Road Recreational Vehicles; and
- Auxiliary Ship Engine Cold Ironing.

In addition, CARB staff should consider adding one of the SCAQMD measures in the 2007 Air Quality Management Plan – Accelerated Use of Plug-In Hybrids for Light- and Medium-Duty Vehicles, if it is not added to Group 1.

The report also includes tables in Attachment A with the status of assignment to Groups 1, 2, or 3, or deferred to the Scoping Plan. Sixteen of the 24 items in the table are deferred to the Scoping Plan, which is not due for another 18 months. SCAQMD staff recommends that work on these concepts be initiated right away so emission reductions can be realized as soon as possible.

SCAQMD staff also concurs with comments made at the April 30th Environmental Justice Advisory Committee meeting that the report could be improved by adding information on the more than 70 proposals received and the reasons why many ideas were not included in this report.

Thank you again for the opportunity to contribute to this important policy document. If you have any questions or would like to discuss this further, please call me at (909) 396-3104 or Elaine Chang at (909) 396-3186.

Sincerely,

Jill Whynot
Planning and Rules Manager

cc: Alberto Ayala, CARB
    M. Robert, CARB
Via email

Mr. Bart Croes
Division Chief
California Air Resources Board
1001 I Street
Sacramento CA 95812

Re: Additional SCAQMD Comment - Proposed Early Actions to Mitigate Climate Change in California

Dear Mr. Croes:

South Coast Air Quality Management (SCAQMD) staff sent comments on May 7, 2007 regarding the Proposed Early Actions to Mitigate Climate Change in California. We have an additional comment that CARB staff should consider for inclusion.

An early action measure should be added to require that natural gas supplies for the state be at a Wobbe index of 1360 or lower. As you know, higher carbon content will result in increased carbon dioxide emissions. It is possible to achieve this level by securing natural gas sources with low Btu content, removing heavier hydrocarbon components by a condensing process, injection of inert gas such nitrogen, and blending high Btu gas with low Btu gas. This would have concurrent nitrogen oxides benefits, as well. Please see control measure #2007CMB-04 in the draft 2007 Air Quality Management Plan for additional information.

Thank you for considering this addition to the early action list. If you have any questions or would like to discuss this further, please call me at (909) 396-3104 or Elaine Chang at (909) 396-3186.

Sincerely,

Jill Whynot
Planning and Rules Manager

ECJW
CC: Alberto Ayala, CARB

Cleaning the air that we breathe.
Suggested Changes to Early Action Measures
by SCAQMD Staff
June 21, 2007

Add New Group 1 (Early Action Measures)

- Accelerate hybrid penetration
- Wobbe index ≤ 1360 for natural gas

Group 2 Measures (underway or to be started in 2007 – 2009)

- Add specific adoption and implementation dates
- 2-9 Energy Efficiency adopt by 2009
- 2-13 Transportation (LD) adopt by 2009
- 2-14 Transportation (HD) adopt by 2009
- 2-16 Port Electrification adopt by 2009

Add to Group 3 Measures (adopt 2007 – 2009)

- Evaporative Emission Standards for Recreational Boats and Off-Road Recreational Vehicles
- Auxiliary Ship Engine Cold Ironing
- Accelerated Use of Plug-In Hybrids (if not added to Group 1)

Consider Other Measures Suggested by CARB Environmental Justice Advisory Group
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1. Early Actions Strategy Name and Proponent

SUMMARY #: B01
ID NUMBER: N/A
TITLE: CAPCOA RECOMMENDATIONS
PROPOSER: CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION (CAPCOA)

2. Staff Recommendation

Work with CAPCOA to pursue its recommendations. The proposed CAPCOA working group can provide input into the development of the scoping plan for AB 32. Other recommendations could help in quantifying greenhouse gases reductions.

3. Action Description

CAPCOA makes five recommendations. These recommendations can support identification and quantification of greenhouse gas reductions as we proceed on AB 32 implementation.

**PRIORITY SIP RULEMAKING**

CAPCOA recommends that ARB's SIP rulemaking be ranked taking into consideration greenhouse gas emissions. The requirements of the federal Clean Air Act dictate that we proceed expeditiously with the measures needed to meet ozone and PM2.5 standards. The most critical near-term SIP rulemakings are already underway and all must be considered top priorities in order to meet federal deadlines. However, as we develop new longer-term SIP measures we will look for opportunities to reduce both criteria pollutants and greenhouse gases.

**REVIEW EXISTING RULES**

CAPCOA recommends a workgroup process that taps district resources and expertise to identify potential greenhouse gas reductions that could be achieved consistently statewide through local rulemaking. This would be similar to the "suggested control measure" approach that has been used for criteria pollutants. We propose to work with CAPCOA to initiate this process to support development of the AB 32 scoping plan.

**MINIMIZE GHG IMPACTS OF NEW STATIONARY SOURCES**

CAPCOA recommends that ARB work with local air districts to minimize impacts of new stationary sources. It suggests a coordinated approach to reviewing significant stationary sources in categories that also emit significant amounts of greenhouse gases.
The local permitting process and the environmental review (CEQA) process are suggested as possible mechanisms for achieving GHG emissions mitigation.

Staff suggests a joint effort to identify stationary source technologies for new sources that would reduce both criteria pollutant and greenhouse gases. This could include promoting development of new technologies that achieve multiple benefits.

**LEVERAGE CEQA MITIGATIONS AND CAPTURE VOLUNTARY REDUCTIONS**

CAPCOA recommends that ARB work with local air districts on approaches to the review of greenhouse gas impacts under the California Environmental Quality Act (CEQA) process, including GHG significance thresholds for projects, and to develop a process for the capturing of reductions that result from CEQA mitigations.

The Governor's Office of Planning and Research is charged with providing statewide guidance on CEQA implementation. With respect to quantifying any reductions that result from project level mitigation of greenhouse gas emissions, we would like to see air districts take a lead role in tracking such reductions in their regions.

4. **Potential Emission Reductions**

To be estimated during scoping plan development or rulemaking process.

5. **Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

To be assessed during scoping plan development or rulemaking process.

6. **Technical Feasibility**

To be assessed during scoping plan development or rulemaking process.

8. **Division:** Planning and Technical Support Division  
   **Staff Lead:** Jeff Weir  
   **Section Manager:** Ravi Ramalingam  
   **Branch Chief:** Kurt Karperos

9. **References:**

1. Early Actions Strategy Name and Proponent

SUMMARY #: B02  
ID NUMBER: NA  
TITLE: REFRIGERANT TRACKING, REPORTING AND RECOVERY PROGRAM (REFRIGERANT RECOVERY FROM DECOMMISSIONED REFRIGERATED SHIPPING CONTAINERS, RESIDENTIAL REFRIGERATION PROGRAM, HIGH-GWP TRACKING/REPORTING/REPAIR/DEPOSIT PROGRAM)  
PROPOINENT: STAKEHOLDER SUGGESTION- ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE, ARB STAFF

2. Staff Recommendation

This combination of measures is recommended for addition to the list of early actions. The Board date for consideration of these items is anticipated in 4th quarter of 2011. It is presented as one strategy given the interrelated objective, which is to reduce emissions of high-GWP GHGs through establishing requirements for enhanced monitoring, enforcement, reporting, and recovery. It may be determined that more than one strategy is required to effectively address the sources of interest and that the strategy or strategies are likely to include both regulatory and non-regulatory elements.

3. Early Action Description

Below is a brief description of potential approaches for addressing each of the source categories considered. Staff will explore the most efficient opportunities for achieving the largest reductions from the below categories which may translate into a single or multiple strategies.

Refrigerant Recovery from Decommissioned Shipping Containers: This action consists of an assessment of the magnitude of the emissions from refrigerated shipping containers. Depending on results, the strategy may be similar in scope to the measure aimed at enforcing the federal restrictions on refrigerant venting during servicing or dismantling of motor vehicle air conditioning systems (MVACS). After the recovery from a decommissioned container, it may be desirable to disable the refrigeration unit, which may require a regulation. Enforcement personnel and federal and local air management district assistance would be needed.

Residential Refrigeration Program: This involves supporting existing voluntary programs to promote the upgrade of pre-2000 residential refrigeration equipment in need of repair, such as refrigerators and freezers. The program could potentially be expanded to include window unit air conditioners (A/Cs); upgraded HVAC units are not
recommended, as the costs are likely significant and would disproportionately impact lower-income people.

A statewide effort to support programs for expanding the upgrading of old appliances to Energy Star efficiencies or better should be coordinated with various local utilities' voluntary programs and the US EPA's RAD program\(^\text{1}\). Given the utilities lead role in such programs, the ARB's role would be expected to consisting of enhancing its outreach efforts to underscore the benefits of participating in such programs. This program could also be coordinated with a foam recovery program, especially if automated recovery of refrigerant, foam, and scrap metal is implemented.

This program will likely result in an increased number of refrigerators entering the waste stream that will need to be properly recycled to achieve GHG emission avoidance. However, if all waste refrigerant, foam, and other materials are properly recycled/destroyed, direct GHG emissions avoidance benefits may be significant, as well as indirect GHG emissions avoidance benefits due to energy efficiency gains\(^\text{2}\).

Part of the residential refrigeration program includes a strategy to be developed in collaboration with the US EPA to enhance the enforcement of end-of-life (EOL) recovery of refrigerant\(^\text{3}\).

Insulation foam contained in residential appliances will be addressed in another strategy, but there may be some overlap between refrigerant and foam recovery for appliances if the entities involved in manual refrigerant removal (which requires US EPA technician certification) are also able/willing to perform manual foam removal on appliances at end-of-life (EOL).

The proposed measure will be voluntary, and ARB's role will be to promote replacement through coordination/outreach efforts with the utilities, the US EPA, and the California Energy Commission (CEC), which will enhance public awareness of energy savings and GHG benefits associated with the program.

For maximum effectiveness, this program will also have to be coordinated with ARB's planned end-of-life enforcement and foam recovery measures to ensure that old residential appliances are properly disposed of and high global warming potential (GWP) refrigerants/foams are properly recovered/recycled or destroyed.

**High-GWP Tracking/Reporting/Repair/Deposit Program:** This strategy involves the following: 1) expanding and enforcing the national ban on venting high-GWP GHGs (including fully emissive processes) during equipment/process lifetime; 2) requiring high-

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2. Dave Godwin, USEPA, personal communication, 7/06.
3. The CFC-12 refrigerant/CFC-11 foam blowing agent combination was used for many years in residential refrigerators and freezers, and phasewant of HCFC-141b from appliance foam has only been occurring in the past four years. New refrigerators and freezers generally contain HFC-134a as the refrigerant and HFC-245fa as the foam blowing agent. Currently, ODS recovery is mandated by federal law, and venting HFCs is forbidden, but enforcement is weak and venting is not well-defined. Additionally, EOL technician certification for recovery/reclamation is only required for ODSs and is subject to little oversight/enforcement; the EOL recovery regulation would extend the certification requirement to other high-GWP GHGs and would call for additional oversight/enforcement at transfer stations, landfills, and other disposal facilities.
GWP GHG sales, use and energy use reporting as well as inspection and maintenance (I/M) and leak repair for equipment, cylinders, products, or systems with capacities above some CO₂E threshold; 3) requiring technician certification for sales, purchase, transport, recovery, reclamation, resale, I/M; and 4) establishing a high-GWP GHG deposit program and/or fines for emissive processes or leaky systems.

Currently, Section 608 of the CAAA limits intentional venting of ODSs and HFCs, requires record keeping for systems employing more than 50 lbs of an ODS, and requires technician certification for ODS systems (I/M, repair, recovery, reclamation). High-GWP GHG sales are only restricted to ODSs in cylinders (not pre-charged equipment); the sales restriction does not apply to HFCs.

Reporting, in addition to record-keeping for ODS systems > 50 lbs, is required in SCAQMD (Rule 1415), and it is proposed that ARB implements a high-GWP GHG reporting requirement rather than record-keeping only. Reporting would be for any high-GWP GHG above a specified CO₂E threshold (extending beyond ODSs). The permanent reporting protocol could apply to any high-GWP GHG bought, sold, or used, by any manufacturer, retailer, distributor, repair person/technician, auditor, facility/corporate parent. Production plus imports into California (gas in cylinders or as an equipment charge) can be checked against use and exports out of California for mass balance purposes.

High-GWP GHG sales will be restricted to certified technicians (i.e., consumers cannot not buy cans or cylinders of high-GWP GHGs over some threshold value), which differs from current federal law which only limits sales of ODSs to certified technicians (except for ODS refrigerants contained in air conditioners and refrigerators).

The deposit program could apply to cylinders (raw chemical) or pre-charged equipment (such as refrigerators, A/Cs, vending machines, etc.)⁴. Furthermore, fines could be assessed based on annual use reporting and auditing for systems above some CO₂E threshold. Reporting will have little to no impact on leaking/emissive equipment if there are not financial disincentives in excess of refrigerant costs (i.e., the deposit or fine should cost more than refrigerant needed to recharge a leaky system, so that leaks are promptly fixed).

Deposit/return and/or fine programs would encourage leak-tightness and recovery of high GWP GHGs, as well as encourage upgrading of old, leaky equipment. A similar program has been adopted in Australia, and industry groups are voluntarily considering a deposit/return program in the US.

Adoption of this measure will require a blend of regulatory/non-regulatory approaches, as it will extend current regulations and also require a collaborative effort with the US EPA to enforce what is already established by law.

4. Potential Emission Reductions

⁴ Consumer goods would be more difficult to subject to deposit and return since they are intended to be fully emissive, but it is believed that purchases over a given CO2E limited to certified technicians will inhibit consumers from buying more than small numbers of product.
Refrigerant Recovery from Decommissioned Shipping Containers: There is insufficient data on the emissions from this source. For the decommissioned shipping containers, it is estimated that the HFC-134a refrigerant bank at end-of-life could be approximately 15,000 MTCO₂E per year in the area surrounding the Ports of Long Beach and Los Angeles. This is based on the estimated Los Angeles-Long Beach fraction of world shipping container activity of approximately 8 percent and 30 percent of the total container population consists of refrigerated shipping containers. The percent of refrigerated containers that a ship may carry varies between 10 to 50 percent of the total container capacity. The estimated Los Angeles-Long Beach fraction of world refrigerated shipping container activity applied to the estimated annual turnover rate of refrigerated shipping containers has been estimated to be 100,000. The refrigerant charge in modern shipping containers ranges from 13 to 16 pounds. If these containers are allowed to accumulate, the bank could become on the order of 0.1 MMTCO₂E in a 5 to 10 year period assuming a 10 pound refrigerant charge at decommissioning. Thus, the reduction potential of a mitigation strategy for this source would be less than 0.1 MMTCO₂E in 2020. In addition, given that these shipping containers may last from 20 to 30 years, there may be a significant number of older CFC-based systems. Finally, it is important to determine what happens to the shipping containers as they approach end-of-life.

Residential Refrigeration Program: Estimated annual emission reductions of 0.8 MMTCO₂E are possible for refrigerant recovery. Of the 0.8 MMTCO₂E of annual emissions avoided for refrigerant recovery, about 0.7 is due to recovery of R-12 refrigerant. This estimate does not include the benefits from deploying more efficient systems sooner (see energy efficiency calculations, below).

Although refrigerant recovery is currently supposed to occur at the time of disposal, destruction of refrigerant is not required, and it is generally assumed that recovered/reused refrigerant will eventually be emitted.

The CO₂E emissions avoidance was calculated for 2005, and only refrigerators and freezers going to landfills were considered; numbers of pre-2000 appliances in need of repair were not available. Inclusion of portable A/C units could increase emissions benefits, but numbers of portable units that are repaired or landfilled each year are unknown. Without knowledge of the numbers and age distributions of appliances in California, 2020 emissions reductions based on sector growth and transitional refrigerant/blowing agent use estimates were not possible. However, it is reasonable to assume that approximately 0.8 MMTCO₂E reductions will be possible every year until refrigerators and freezers containing R-12 are gone, which will happen in large part by 2020.

Energy efficiency emissions avoidance in 2020 resulting from appliance retirement could not be calculated due to lack of data regarding age distribution of California appliances.

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[5] The following assumptions were used: 1) 20 year lifetimes for refrigerators, 2) R-12 use in refrigerators stopped in 1995; from 1995 - 2005 HFC-134a was used, 3) in 2005, half of disposed refrigerators contain R-12 as the refrigerant and the other half contain HFC-134a as the refrigerant, 4) 13,000,000 refrigerator/freezers are disposed of annually in the US and 60% go to landfills or transfer stations, 5) the California population fraction was roughly 13% in 2005, 6) 100-year direct GWPs of 8100 and 1300 were used for R-12 and HFC-134a, respectively, 7) refrigerant masses of 0.23 kg/appliance and 0.16 kg/appliance for R-12 and HFC-134a, respectively, were obtained from USEPA (Dave Godwin, personal conversation, 2/07).
but again it is reasonable to assume that an additional 0.45 MMTCO₂ reduction is possible annually.⁶

To summarize, by 2020, annual emission reductions of roughly 1.25 MMTCO₂E are possible by recovering refrigerant from pre-2000 refrigerators and freezers, and by requiring upgrading to Energy Star or better appliances.

**High-GWP Tracking/Reporting/Repair/Deposit Program**: Staff believes that significant emission reductions may be realized through the proposed strategy; however, emission reductions cannot be estimated for this strategy, as there are no data to support emission avoidance calculations.

**Total Reductions**: The combined annual reductions possible with this group of strategies is 1.25 MMTCO₂E, which is a lower-bound estimate that does not include CFC-containing shipping containers, appliances that are upgraded rather than repaired, and the impacts of requiring reporting/repair/deposits for systems over a given CO₂E threshold.

5. **Estimated Costs/Economic Impacts and the Impacted Sectors/Entities**

**Refrigerant Recovery from Decommissioned Shipping Containers**: Very little specific information on costs and economic impacts is known today. Per the federal regulation (40 CFR 82), refrigerant cannot be released to the atmosphere. Specialized equipment and certified technicians are required to properly carry out this measure. Equipment to recover the refrigerant may cost $5,000. The training cost for servicing certification is minimal. Both the equipment and the certified technicians are something that businesses should already have if they are in compliance with the existing federal regulation. It is possible that existing businesses in the air conditioning and refrigeration servicing industry may be able to handle recovering the refrigerant from the decommissioned refrigerated shipping containers. There will also be a requirement to remove or disable the decommissioned refrigeration unit, which should be a minimal cost. It is believed that as these shipping containers age, they get sold to smaller shipping businesses and these may bear the brunt of the measure for decommissioned containers. In addition, some of these units may be sold to restaurants and other businesses for increased refrigeration capacity. If the federal regulation is applied to in-use containers, then all segments of the business would be affected.

**Residential Refrigeration Program**: The US EPA states that because of reduced energy demand, appliance incentive/disposal programs cost about $0.04 on average to reduce each kWh of demand. This translates into about $63/MTCO₂, which includes the incentives and credits given to upgrade older appliances.⁷

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⁶ USEPA estimates that 700 kWh/year savings are possible by replacement of a 20 yr old refrigerator with a current energy star appliance; an emission factor of approximately 1.4 lbs CO₂/kWh for gas-generated electricity was obtained from Carbon Dioxide Emissions from the Generation of Electric Power in the United States, DOE, 7/2000: http://www.eia.doe.gov/FTSROOT/environment/co2emiss00.pdf

⁷ See above footnote.

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The impacted sectors and entities would mostly be appliance salvagers/recyclers and individuals disposing pre-2000 appliances; however, with incentives and rebates, the cost associated with disposal and some of the cost of a new appliance is avoided.

The US EPA RAD program was started in 2006 and the success of the program has not been gauged yet, although it is anticipated that a mandatory program would be more effective.

**High-GWP Tracking/Reporting/Repair/Deposit Program:** Record-keeping, I/M and repair is already required for systems containing > 50 lbs of an ODS refrigerant; in SCAQMD, reporting is required for these systems in addition to record-keeping. Even those entities who are not yet keeping records for reporting purposes must still have some records of refrigerant/product purchases for resale and income tax purposes. Therefore, the costs associated with record-keeping and reporting are believed to be negligible.

I/M costs are not believed to be significant\(^8\), but leak repair and/or high GWP GHG recovery for some processes may be expensive. The costs associated with I/M and leak repair cannot be estimated due to the large variety in numbers and types of equipment covered by this strategy. Costs associated with a deposit and return program are unknown, but will presumably be passed on to the consumer at the time of purchase.

**6. Technical Feasibility**

The technology required to remove refrigerants from shipping containers and appliances is feasible and commercially available. Automated refrigerant and foam removal from appliances is also technically feasible, and can be performed during scrap metal processing and recovery\(^9\).

There are no anticipated technical feasibility issues for the tracking/reporting/repair/deposit program other than recovery of high-GWP GHGs for certain unknown, emissive processes.

**7. Additional Considerations**

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\(^8\) Presently, owners or operators of large RAC systems should maintain and repair their systems for optimal performance and reduced energy costs, so the incremental cost of the new rule is not expected to be significantly higher than current costs, unless leaks are going undetected and unrepaired. The costs to pay for yearly inspection and maintenance by certified technicians is not expected to be more than about $200 (based on one 8-hour workday by a HVAC technician at a rate of $22/hour in California; http://www.payscale.com/research/US/Job=HVAC_Service_Technician/Hourly_Rate/by_State).

The incremental costs per system associated with an owner, operator, or HVAC technician/auditor filling out several short reporting forms is also expected to be less than $200 (see above).

All Strategies: Ozone depleting substances (ODSs) were used in the past as refrigerants and foam-blowing agents; each of the strategies described above include ODSs as they exist in older refrigeration systems, appliances, and foams. Recovering and destroying ODSs from containers and appliances is a cost-effective way to reduce high-GWP gas emissions, and also reduces negative impacts on stratospheric ozone.

An enforcement component for the decommissioned container and tracking/reporting/repair/deposit measures is anticipated, since these are regulatory measures rather than voluntary measures.

Refrigerant Recovery from Shipping Containers: Staff will perform a needs assessment to improve the current understanding of overall refrigerant leakage emissions and refrigerant banks for both active and decommissioned refrigerated shipping containers. This is particularly important for the major port areas of Los Angeles, Long Beach, and Oakland. If mitigation action is supported by the analysis, the measure should involve a program enforcing the existing provisions of the existing federal regulation, 40 CFR 82. A basic inventory is needed to determine the extent that refrigerant emissions are unaccounted for. In addition, end-of-life accounting for these different types of refrigerated containers needs to be explored.

Residential Refrigeration Program: The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user.

California trade associations associated with Certified Appliance Recyclers and recyclers of scrap metals are unknown.

Coordination with the US EPA with respect to this regulation is ongoing. Further coordination with utilities participating in appliance trade-in programs is anticipated.

High-GWP Tracking/Reporting/Repair/Deposit Program: The affected entities will be owners/operators/purchasers/sellers of high-GWP GHGs and systems containing those chemicals, as well as contractors/technicians who install/repair such systems.

A partial list of trade associations possibly impacted, either positively or negatively, by the regulation follows: ARAP (described previously), the Air-Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), North American Technician Excellence (NATE), and many others unknown to staff (equipment trade associations, building trade associations, industrial chemical and consumer trade groups, semiconductor and other industrial process trade groups, etc.).

Coordination with the US EPA and SCAQMD with respect to this strategy would be ongoing.

8. Division: Research Division
Staff Lead: Whitney Leeman/Winston Potts
Section Manager: Michael Robert/Tao Huai
Branch Chief: Vacant/Alberto Ayala
9. References

American Association of Port Authorities (AAPA) web site: http://www.aapa-ports.org/home.cfm


David Hatch, Carrier Transcold, personal communication, 5/07.


Federal Register, Section 608 of the CAAA, and USEPA's related website: http://www.epa.gov/oar/caa/caa608.txt

Harrison, R., "The Potential Impacts of Megaship Operations on Gulf Port," Center for Transportation Research, University of Texas


USEPA, RAD program website: http://www.epa.gov/ozone/snap/emissions/radp.html

1. Early Actions Strategy Name and Proponent

SUMMARY #:  B03
ID NUMBER:  ARB 2-1 / EJAC-2
TITLE:  MANURE DIGESTER PROTOCOL FOR CALCULATING GREENHOUSE GAS MITIGATION
PROONENT:  ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 3rd quarter of 2008.

Specifically, staff recommends Board endorsement of the California Climate Action Registry (CCAR) manure digester protocol in order to promote voluntary greenhouse gas emissions reductions.

3. Early Action Description

Description of Protocol – The manure digester protocol provides methodologies for calculating reductions in the emissions of greenhouse gases resulting from the installation of a manure digester at an animal agricultural facility.

Technology Description – Manure digesters (also called biogas control systems) are systems which trap gaseous emissions from manure (primarily methane) and combust the gas. The trapping process is achieved by enclosing the manure, which often involves covering a manure lagoon with plastic or otherwise isolating the manure from the ambient environment. The combustion process occurs either by combusting the trapped methane biogas in an engine in order to generate electricity, or by venting and flaring the gases.

CCAR Protocol Development Process – CCAR began developing a protocol for calculating manure greenhouse gas emission back in April 2006. The protocol development process began with a first scoping meeting, included multiple working group meetings and document reviews, and included representatives from nearly every stakeholder group, including industry, government, academia, and the general public.

Need for Digester Protocol Endorsement – Although this protocol was adopted by CCAR, endorsement by the Board would send a clear signal that the ARB considers the protocols to be accurate and acceptable for voluntary GHG emissions reductions. To achieve this end, the ARB is initiating a process to continue discussions on the protocol by holding workshops to solicit comments on the protocol and to identify potential improvements. The ultimate goal is to present the protocol to our Board for endorsement as a voluntary greenhouse gas reduction measure.
Establishing a voluntary protocol can help incentivize the installation of manure digesters by legitimizing the technology and offering a pathway to quantify and verify the greenhouse gas benefits. Keeping this protocol a voluntary measure helps avoid premature technology mandates which could have significant cost and environmental drawbacks due to digesters currently being a costly, combustion-oriented technology.

4. Potential Emission Reductions

Digesters have the potential to provide a 50 percent reduction in GHG emissions resulting from manure storage (0.006 MMT CO2E per digester) as well provide electrical energy, offsetting the production of additional GHGs.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Cost per digester can range from the low hundreds of thousands of dollars to over a million dollars, depending on the digester type (covered lagoon, plug flow, etc.) and the amount of manure and biogas being processed. The captured biogas can be valuable if used for heating (water, animal housing) or combusted in an engine/ generator to produce electricity. Thus, the digester can reduce farm costs and may provide income if the gas or electricity is sold to other entities or back to the grid.

6. Technical Feasibility

Manure digesters are currently installed and operating at a limited number of farms in California.

7. Additional Considerations

Affected Entities: Farmers, energy companies, and any companies involved in the business of mitigating greenhouse gases (AgCert, CEERT, etc.)

Trade Associations: California Farm Bureau, Western United Dairymen, California Dairy Campaign.

Government Agencies Coordination: State Water Resources Control Board, local Air Pollution Control Districts, California Department of Food and Agriculture, California Climate Action Registry and others.

Proposed Board Hearing Date: September 2008

8. Division: Planning and Technical Support Division
   Staff Lead: Kevin Eslinger
   Section Manager: Dale Shimp
   Branch Chief: Richard Bode
1. Early Actions Strategy Name and Proponent

SUMMARY #: B04
ID NUMBER: EJAC-3/ARB 2-12
TITLE: REDUCE METHANE VENTING/LEAKS FROM OIL AND GAS SYSTEMS
PROPOSENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE AND CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

Staff recommends an evaluation of the effectiveness of the existing district rules. Most likely these rules can be amended and readily adopted by the ARB for statewide implementation. Staff also proposes to investigate the feasibility of deploying innovative technologies and to improve management practices, including the stakeholder's proposal to implement energy efficiency measures that will further promote recycling of otherwise vented gases. These combined actions could potentially reduce methane emissions from both gas and oil systems by approximately 1.0 MMTCO₂E in 2020.

3. Early Action Description

Emissions from natural gas systems are primarily methane gas. There are four major sources of methane emissions from the systems: production, processing, transmission, and distribution of natural gas. These emissions are process related, mostly stemming from normal operations, routine maintenance, and system upsets. Also, a relatively smaller amount of methane emissions results from oil systems.

Several air districts have adopted and implemented rules to reduce volatile organic compound (VOC) emissions from natural gas and crude oil production and processing facilities. These existing rules may also reduce methane emissions. In addition, there are several proven cost-effective technologies and management practices that would result in a significant reduction of methane emissions.

Staff will take the following approach to achieve the GHG reduction goal from oil and gas systems as stated in the 2006 CAT report:

- Amend existing rules
  - Form a working group that consists of ARB, district, and interested stakeholders to review the existing rules to identify potential methane emissions reduction measures.
• Improve management practices. Encourage districts with oil and gas systems under their jurisdiction to practice directed and more frequent inspections of compressor stations, gate stations, surface and storage facilities, transmission pipelines, and off-shore platforms.

• Require the installation of cost-effective technologies. Numerous technologies have been identified and proven in the U.S. EPA Natural Gas STAR program, a voluntary program partnership with the oil and natural gas industries, that will pay back investments in a short period of time through saleable gas savings. These technologies include replacement of high- with low-bleed pneumatic devices, installation of a flash tank on glycol dehydrators, retrofitting compressors to capture vented gas, and using an infrared aerial imaging camera to detect leaks, etc.

4. Potential Emission Reductions

Among the above identified strategies, staff estimated installation of new technologies will provide the greatest potential GHG emissions reduction, about 70 percent of the targeted goal of 1.0 MMTCO₂E in 2020, while the rest will come from the existing rule amendments (~10 percent) and enforcement (~20 percent). Collectively, these strategies will provide a medium potential of GHG emissions reduction. They will also provide further emissions reduction of VOCs and toxics, with no incurred fuel penalty.

5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

ARB will develop this measure in partnership with CAPCOA. ARB will need additional resources to develop and enforce the new rule. CAPCOA may also require additional resources for complementary rulemaking to ensure that the rules are consistent.

As for the oil and gas industries, investment in new technologies will likely pay for itself through net fuel savings to offset the costs. As a result, staff believes that none of the proposed strategies will cause any potential disproportionate economic impacts on small businesses or environmental justice communities from increased utility rates.

6. Technical Feasibility

Natural Gas STAR partner companies have implemented most of the new technologies identified through a voluntary program established by the U.S. EPA when the natural gas prices were relatively low. These technologies were proven to be reliable and cost-effective. With the higher gas prices today, these technologies are even more cost-effective and attractive to the industry.

7. Additional Considerations

Staff has reviewed several districts' rules, addressing VOC emissions, that may have reduced methane emissions, and will work together with the districts to identify if any oil and gas industries have implemented fuel saving technologies. The ARB has legal
authority to develop regulations and outreach programs to speed up the deployment of these technologies. However, staff believes a comprehensive and uniform regulation for this CAT strategy cannot be achieved in 18 months.

Affected Entities:

Oil and gas industries, pipeline operators, gas processing and storage facilities, utility companies

Trade Associations:

American Gas Association (AGA), Gas Processors Association (GPA), Interstate Natural Gas Association of America (INGAA), Kinder Morgan, Natural Gas Supply Association (NGSA), Pacific Gas and Electric Company (PG&E), Southern California Gas Company (SoCalGas), San Diego Gas & Electric (SDG&E), Western States Petroleum Association (WSPA)

Government Agencies to coordinate with:

Air Districts, California Air Pollution Control Officers Association (CAPCOA), California Energy Commission (CEC), California Public Utility Commission (CPUC), California State Land Commission (CSLC), Federal Energy Regulatory Commission (FERC), United States Environmental Protection Agency (U.S. EPA)

8. Division: Stationary Source Division
   Staff Lead: Win Setiawan
   Section Manager: Terrel Ferreira
   Branch Chief: Barbara Fry

9. References:

1California Climate Leadership: Strategies to Reduce Global Warming Emissions

2Stakeholders’ comments to the ARB Proposed Early Action Measures to Reduce Greenhouse Gases, June 2007 Board Hearing, Los Angeles:
   http://www.arb.ca.gov/lists/ab32eam07/ab32eam07-ws-5.pdf
   http://www.arb.ca.gov/cc/jeac/ghg_emns_finalcommitteeec.pdf
   http://www.arb.ca.gov/cc/jeac/ghg_emnscommitteelist.pdf

3Various Air Districts Rules.

4U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions,
   EPA 430-R-99-013, September 1999, U.S. EPA.

5The EPA Natural Gas STAR Program:
   http://www.epa.gov/gasstar/
1. Early Actions Strategy Name and Proponent

SUMMARY #: B05
ID NUMBER: EJAC-4/ARB 2-14
TITLE: SMARTWAY TRUCK EFFICIENCY
PROPOSENT: 2006 CAT REPORT AND STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 4th quarter of 2008.

The rationale for staff's recommendation is based on the commercial availability of a wide variety of technologies that improve fuel efficiency of heavy-duty vehicles that pay for themselves from fuel savings in a very short time. Although these technologies are commercially available, the trucking industry has been reluctant in using them due to the high initial capital investment and logistic issues related to using some of the technology at loading docks and other locations. However, staff believes these issues can be resolved. Therefore, staff recommends developing a regulatory program and evaluate whether financial assistance would be needed to help small businesses comply with the proposed regulation.

3. Early Action Description

The strategy would require existing trucks/trailers to be retrofitted with the best available fuel efficiency "SmartWay Transport" and/or ARB approved technology. Technologies that improve fuel efficiency of trucks may include devices that reduce aerodynamic drag and rolling resistance. Aerodynamic drag may be reduced using devices such as cab roof fairings, cab side gap fairings, cab side skirts, and on the trailer side, trailer side skirts, gap fairings, and trailer tail. Rolling resistance may be reduced using single wide tires or low-rolling resistance tires and automatic tire inflation systems on both the tractor and the trailer.

1 The United States Environmental Protection Agency (U.S. EPA) in collaboration with the freight industry has developed a voluntary program designed to increase energy efficiency while significantly reducing greenhouse gases and criteria pollutants. The program known as the SmartWay Transport Partnership (SmartWay Transport), encourages trucking companies to use technologies that improve fuel economy and reduce emissions. The SmartWay Transport also designates highly fuel efficient and emission reduction technology packages as SmartWay Upgrade Kits which can be purchased at various SmartWay partner centers, dealerships, and service centers. (http://www.epa.gov/otaq/smartway/documents/420f07027.htm)
The requirements would apply to California and out-of-state registered Class 8 trucks (gross vehicle weight rating greater than 33,000 pounds) that travel to California. Most of the newer Class 8 combination trucks are long haul trucks for which technologies that reduce both aerodynamic drag and rolling resistance would be appropriate. The older model combination trucks are typically considered short haul trucks and thus spend considerably less time at highway speeds, reducing significantly any benefits associated with aerodynamic improvements since drag varies with the square of the vehicle speed. Thus, it would be most appropriate to require only rolling resistance improvements for these trucks. Straight trucks (trucks with an integrated cargo area) would likely be required to be equipped with devices that reduce aerodynamic drag as well as rolling resistance.

Staff's preliminary thinking is that the rule could be implemented through a phase-in schedule with 10 percent of the trucks and trailers meeting the requirements in 2010, 25 percent in 2011, 60 percent in 2012, and 100 percent in 2013. This rule should also require that new 2010 and subsequent trucks and trailers that are sold in or service California be "SmartWay" certified tractors and trailers.

Although the cost of retrofitting the trucks and trailers would eventually be recovered through fuel savings, the upfront investment capital needed to comply with the requirements may become a financial burden to businesses, especially small businesses and those that own multiple trailers per tractor. Therefore, staff recommends that an evaluation be conducted to determine whether a financial assistance program would be needed to help small businesses comply with the requirements.

4. Potential Emission Reductions

Potential GHG emission reductions were estimated for calendar years 2010 and 2020. For 2010, the scenario assumes that 10 percent of the existing 2009 and older model year (MY) trucks and tractor-trailer combinations and all 2010 MY trucks and tractor trailer combinations comply with the requirements. MYs 2006 to 2010 trucks were assumed to be long haul, MYs 2000 to 2005 medium haul, and MYs 1990 to 1999 short haul. Based on these assumptions and considering the total vehicle miles traveled both inside and outside of California, in 2010, the estimated GHG reductions could be up to 6 MMTCO2E of which about 7% would occur within California. Similarly in 2020, MYs 2016 to 2020 were assumed to be long haul, MYs 2010 to 2015 medium haul and MYs 2000 to 2009 as short haul trucks. Thus, the 2020 estimated GHG reductions could be up to 20 MMTCO2E of which about 11% would occur within California. Requiring compliance by California registered trucks and trailers would significantly reduce the

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2 U.S. EPA Certified SmartWay tractors and trailers are long haul tractors and trailers equipped with components that significantly reduce fuel consumption and emissions. The specifications for a U.S. EPA Certified SmartWay tractor include a model year 2007 and later engine, integrated cab-high roof fairings, cab side fairing gap reducers, tractor fuel-tank side fairings, aerodynamic bumper and mirrors, options for reducing extended engine idling, and options for low-rolling resistance tires. The specifications for a U.S. EPA Certified SmartWay trailer are side skirts, weight-saving technologies, gap reducers on the front of the trailer or trailer tail, and options for low resistance tires. For further information refer to: http://www.epa.gov/smartway/documents/420f07033.htm.
GHG benefits of this rule to 0.2 and 1.3 MMT CO₂e in 2010 and 2020, respectively. The strategy is also expected to reduce emissions of criteria pollutants and especially emissions of oxides of nitrogen (NOx) since NOx is directly related to the tractive power requirements. Staff has not yet precisely quantified the reductions in emissions of criteria pollutants that may result from this strategy, but expect them to be on the order of 10 percent reduction for pollutants such as NOx, which are closely related to fuel use.

5. Estimated Costs/ Economic Impacts and the Impacted Sectors / Entities

Entities that may be affected by this strategy include the freight industry, trailer manufacturers, truck manufacturers, tire manufacturers, businesses that own trailers to haul their freight into and out of California, and cab and trailer aerodynamic device manufacturers. The strategy is expected to provide cost savings to trucking businesses over the useful life of the tractor trailer combination by reducing fuel consumption. Assuming that add-on devices result in 13.9 percent fuel economy gain, the savings are approximately $5,400 per year for a truck with a baseline fuel economy of 6.1 miles per gallon and an average mileage accrual rate of approximately 90,000 miles per year, and a fuel cost of $3.00 per gallon. The cost of the add-on devices for a tractor trailer combination, which staff estimates to be approximately $12,000, can therefore be recovered within 2 to 2.5 years for a trailer-to-tractor-ratio of 1 and within 8 to 10 years for a trailer-to-tractor ratio of three. Businesses that own only trailers and no tractors may not be able to recover the cost of retrofitting their trailers through fuel savings, and therefore, they may need to recover their investment either by paying less to haulers or by passing it to customers by increasing the cost of their merchandise.

6. Technical Feasibility

As indicated above, technologies that improve fuel economy of trucks are currently commercially available. Most of the tractors currently on the road are equipped with cab roof fairings and cab side fairing gap reducers. Trailer side skirts, trailer side fairing gap reducers, single wide tires and automatic tire inflation systems are also commercially available as SmartWay Upgrade Kits. However, there are some minor technical issues with these technologies that will need to be resolved. Retrofit of cab aerodynamics may or may not be possible depending on whether the tractor has factory installed reinforcements or not. Trailer side skirts may be problematic on some trailers where the side skirt interferes with access to equipment. Also, some fleets have expressed concern on trailer side skirts getting damaged when driving over road dips or bumps. The use of trailer tails is currently very limited due to functionality problems at loading docks. Currently, manufacturers of SmartWay devices are working on solutions to these problems and staff believes that these minor technical problems will be resolved by the time the rule is implemented or can be addressed in the development of this rule.

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3 The $12,000 estimate includes the cost for trailer aerodynamics (side skirts, gap fairings, and trailer tail), single wide tires and wheels for the tractor and trailer, automatic tire inflation system, and installation cost.

4 The industry average trailer-to-tractor ratio is not exactly known. However, the most commonly cited numbers range between 2 to 3 trailers-per-tractor. The higher the number of trailers per tractor, the longer it takes to recover the cost from fuel savings.
7. Additional Considerations

This regulatory strategy is motivated primarily by its potential to reduce GHGs. All portions of this strategy can be accomplished under the authority granted by the California Global Warming Solutions Act of 2006, Assembly Bill 32 (AB 32). AB 32 provides the Air Resources Board (Board) with the authority to regulate sources of GHGs to achieve the maximum and cost-effective GHG emission reductions from these sources. The item can be taken to the Board by the 4th quarter of 2008 but requires additional resources.

Affected Entities: Truck carriers, shipper carriers, trailer manufacturers, truck manufacturers, truck and trailer aerodynamic device manufacturers, tire manufacturers, businesses that own trailers to haul their freight into and out of California

Trade Associations: American Trucking Association, California Trucking Association, Truck Manufacturers Association, Truck Trailer Manufacturers Association, California Chamber of Commerce.

Government Agencies to coordinate with: None.

8. Division: Mobile Source Control Division
   Staff Lead: Daniel Hawelti
   Section Manager: Stephan Lemieux
   Branch Chief: Michael Carter
1. Early Actions Strategy Name and Proponent

**SUMMARY #**  
B06  
**ID NUMBER:**  
EA 2-15  
**TITLE:**  
COOL PAINTS FOR AUTOMOBILES  
**PROONENT:**  
EARLY ACTION REPORT OF APRIL 21, 2007 AND STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2009.

3. Early Action Description

Cool paints are highly solar energy reflective coatings formulated with pigments that have low absorption (high reflectance) of sunlight. White is considered to reflect more sunlight than any other color. But while white paints reflect the visible light, they may or may not reflect the balance of the sunlight. The majority of solar energy is not in the visible range, therefore careful formulation of pigments can allow the reflectance of near-infrared (NIR) sunlight which contains about 52 percent of the solar energy, while maintaining visible light reflectance (i.e., perceived color). For vehicles, the more solar energy is reflected, the less the vehicle’s interior will heat up when it is parked in the sun.

Cool paints have been demonstrated by the Society of Automotive Engineers as part of the Improved Mobile Air Conditioning Cooperative Research Program. They are technically feasible in the near-term for new vehicles. Researchers at Lawrence Berkeley National Laboratory (LBNL) tested various automotive paints formulated for use between 1992 and 2002. Using a solar spectrometer, they determined the reflectance of both visible and NIR light wavelengths. Table 1 presents the reflectance of light (higher reflectance equals cooler paint). As expected, the dark colors tended to reflect less light; more light energy is absorbed. The potential of cool paints can be readily seen when examining the results for red paints, shown in bold on the table. The red paints ranged from a reflectance of 0.13, not much better than the black paint tested, to a high of 0.37. While that does not approach the 0.70 seen for the white vehicle, it is nearly three times more reflective than the worst performing red paint.

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1 These paints were all tested with a white primer.
Table 1. Reflectance of Vehicle Paints

<table>
<thead>
<tr>
<th>Vehicle Paint Color</th>
<th>Visible light</th>
<th>NIR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black, 1998 Ford</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Dark Grey, 1998 Dodge Intrepid</td>
<td>0.06</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Grey Metallic, 1992 GM Buick</td>
<td>0.21</td>
<td>0.25</td>
<td>0.22</td>
</tr>
<tr>
<td>Silver, 1992 Ford Escort</td>
<td>0.49</td>
<td>0.54</td>
<td>0.50</td>
</tr>
<tr>
<td>Gold Metallic, 1998 Ford Taurus</td>
<td>0.46</td>
<td>0.56</td>
<td>0.49</td>
</tr>
<tr>
<td>Light Blue Metallic, 1994 Honda Accord</td>
<td>0.33</td>
<td>0.44</td>
<td>0.39</td>
</tr>
<tr>
<td>Blue Metallic, 2001 GM</td>
<td>0.06</td>
<td>0.13</td>
<td>0.10</td>
</tr>
<tr>
<td>Green, 1995 Chevy Camaro</td>
<td>0.07</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Red, Chevy</td>
<td>0.08</td>
<td>0.18</td>
<td>0.13</td>
</tr>
<tr>
<td>Red, 2000 Ford Escort</td>
<td>0.14</td>
<td>0.50</td>
<td>0.33</td>
</tr>
<tr>
<td>Red, 2002 Chevy Avalanche</td>
<td>0.15</td>
<td>0.35</td>
<td>0.25</td>
</tr>
<tr>
<td>Red, 1993 Chevy S10 Blazer</td>
<td>0.15</td>
<td>0.57</td>
<td>0.37</td>
</tr>
<tr>
<td>White, 1997 GM Park Avenue</td>
<td>0.70</td>
<td>0.77</td>
<td>0.70</td>
</tr>
</tbody>
</table>

4. Potential Emission Reductions

The concept behind this proposed action item is that the use of cool paints would reduce the solar heat gain in a vehicle parked in the sun. A cooler interior would provide drivers with less need to activate the air conditioner (A/C).

LBNL researchers have investigated the CO₂ reduction that would result from a 5°F reduction in vehicle temperature at start up.² LBNL's Dr. Hashem Akbari estimates that such a reduction in temperatures, applied to the light duty vehicle fleet in California, would reduce CO₂ emissions from A/C use by about 25 percent, reducing current CO₂ estimates of A/C related emissions of 10.2 million metric tons per year (Mt/yr) to 7.8 Mt/yr, a 2.4 Mt/yr reduction.³

Staff also requested input from Dr. John Rugh, National Renewable Energy Laboratory, on the probability of A/C use for a given reduction in temperatures. Dr. Rugh is currently involved in a global effort led by the Society of Automotive Engineers (SAE) to come up with an agreed upon method to determine life cycle climate performance. This effort is known as SAE's Improved Mobile Air Conditioning Cooperative Research Program. Dr. Rugh provided a draft analysis from Phoenix, showing the percent of time the A/C is in use for given ambient temperature ranges. As would be expected, at low ambient

² A 5°F reduction in interior temperature has been measured by Toyota when changing from a metallic blue paint with a solar reflectivity of 10 percent to one with a reflectivity of 20 percent. Table 1 shows NIR reflectivity of 0.77 for white paint. This could be applicable to all paints, and could probably be improved to reach values closer to 100 percent reflectivity. Therefore, even the metallic blue paint should be able to achieve a reflectivity of at least 50 percent. Thus, the anticipated CO₂ reduction should be conservative.

³ Literature on cool paints and window glazings typically model the potential for downsizing the A/C unit that exists due to measured reductions in soak temperature. Statements of the amount of downsizing feasible for equivalent cooling times are typically followed by an associated reduction in CO₂ emissions. Dr. Akbari presumes improvements in emissions would result whether the A/C unit was downsized or the existing unit was simply used less frequently.
temperatures, very little A/C is used: As temperatures increase to around 18°C, A/C use begins to increase. Use continues to increase steadily until the A/C is in use nearly 100 percent of the time, around 38°C. During the rising portion of the curve, A/C use increases about 5 percent per °C. If it is presumed that increased ambient temperatures are associated with increased soak temperatures, it would be logical to correlate a reduction in soak temperature in the midsection of the graph with a reduction in A/C use. Thus, a reduction in temperature of about 2.7°C (5°F), as seen in the Toyota test, would be expected to result in 14 percent less A/C use when ambient temperatures are in the rising portion of the curve. Staff applied that figure to the methodology developed by Dr. Akbari, and found a predicted reduction in CO₂ emission from a 2.7°C reduction in temperature of 2.1 MT/yr, which is comparable to the estimate presented by Dr. Akbari.

The following bullets summarize the issue:

➢ Slightly over half of all solar energy is in the form of NIR radiation, which is not visible to the naked eye. Cool paints use pigments that have low absorptance of NIR while maintaining a variety of visible colors.
➢ The benefits of cool paints include:
  • Lower external surface temperatures, reducing burn hazard and the transfer of heat to the interior of the vehicle.
  • Lower interior temperatures, resulting in greater driver comfort and potentially reduced A/C demand.
  • Potential to reduce size of air conditioner. According to LBNL staff, a vehicle’s A/C is currently designed to cool a black vehicle parked for 4 hours in the summer sun in Phoenix within a set time period. If that vehicle is painted with cool black paint, the soak temperature would be reduced and the A/C load reduced. Downsizing the A/C would allow it to operate at more efficient loads while maintaining desired interior temperatures.
  • Reduced use of and/or downsizing of an A/C would result in reduced GHG emissions. Analyses indicate a reduction of 2.1 to 2.4 MT/yr CO₂e could be achieved for the light duty fleet with a relatively small improvement in solar reflectivity. Additional reductions for the medium and heavy duty fleets would likely increase this figure.
  • Possible increased lifespan of exterior paint, interior plastics and other materials

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

There are few disbenefits to this technology beyond a slight increase in coating cost. This may be more than offset by reduced A/C use or A/C downsizing, if this occurs. Cool paints currently cost about $10 more per vehicle than traditional paints. Literature indicates these paints are applied with standard equipment and methods. The small increased cost could be more than offset by a downsized A/C unit, and would be offset by improvements in operational costs due to reduced A/C use. In addition, the increased comfort should be of value to many consumers.

These paints would have the most benefit if used in conjunction with other technologies (e.g., window glazing, passive ventilation) to reduce a vehicle’s interior temperatures. Therefore with the development of this rulemaking, staff will also evaluate other
technologies that will reduce the heat load on the vehicle’s A/C and determine if it would be appropriate to include these technologies in the “cool paints” proposal.

6. Other Considerations:

Cool paints can be formulated with existing paint formulations such that supply should not be an issue. BASF, DuPont, Sherwin Williams, many other paint manufacturers do have cool versions of at least some paints developed. Cool paints do not limit consumer choice of color. Cool paints use pigments that have low absorbance of the non-visible spectrum while maintaining the same variety of visible colors that consumers demand. Presently, cost and car maker acceptance appear to be the only show-stoppers for the use of cool paints and other complimentary cool car technologies.

An evaluation should be done to determine if the reformulated “cool paint” will result in an increased toxic exposure risk during the paint application process and disposal. Staff believes this exposure risk should be minimal due to the fact that research thus far, shows that “cool paints” can be formulated using existing pigments; however it is an issue that needs to addressed during the formal rulemaking process.

7. Division: Mobile Source Control Division
   Staff Lead: Marijke Bekken
   Section Manager: Sharon Lemieux
   Branch Chief: Michael Carter

8. References:

Akbari, Hashem, "Coatings for Cool Vehicles" Presentation, March 16, 2007


1. Early Actions Strategy Name and Proponent

SUMMARY #: B07
ID NUMBER: EJAC-14/SCAQMD-6/EA 2-16/ARB A-14
TITLE: GREEN PORTS
PROPOsENT: 2006 CAT REPORT AND STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 1st quarter of 2008.

Staff proposes to present the draft regulation to the Board as a measure to reduce nitrogen oxides (NOx) and diesel particulate (PM) emissions and to quantify the associated (carbon dioxide) CO2 emission reductions. By focusing on NOx and PM reductions, staff will address the local and regional health impacts of ships docked in California's ports, including any disproportionate impacts those emissions may have on surrounding communities.

3. Early Action Description

This early action allows docked ships to shut off their auxiliary engines by plugging into shoreside electrical outlets or other technologies. The Air Resources Board identified port electrification as a strategy to reduce the emissions of nitrogen oxides (NOx) and diesel particulate matter (PM) when the Board approved the Goods Movement Emission Reduction Plan in April 2006. Furthermore, the Climate Action Team (CAT) recommended port electrification as a greenhouse gas (GHG) emission reduction strategy in 2006.

While a ship is docked at a berth, or "hotelled," it continuously runs at least one auxiliary engine to power lighting, ventilation, pumps, communication, and other onboard equipment. Ships can hotel for several hours or several days.

Port electrification provides an alternative source of power for these ships while they are docked. The ships can use cables to receive electricity from the shore, thereby allowing them to shut off their auxiliary engines, reducing emissions of air pollutants. Although the generation of electricity creates emissions—typically from power plants located elsewhere—these emissions are much less than those from the auxiliary engines located on the ships. Port electrification of a ship can reduce its emissions of NOx and diesel PM by more than 90 percent. Greenhouse gas (GHG) emissions, as carbon dioxide (CO2), are also reduced, depending on the source of electricity provided to the berth.
To be an attractive candidate for shore electrification, a ship must visit a California port frequently, spend a sufficient number of hours in berth, and have an ample power demand while docked. The ship categories that typically meet these criteria are container ships, passenger ships, and refrigerated cargo ships. (Passenger ships, although in port for only about 10 hours, visit frequently and have tremendous power needs.) Ship categories that are not attractive candidates include bulk cargo ships, vehicle carriers, and most tankers. The ports that receive numerous calls by container ships, passenger ships, and refrigerated cargo ships—and therefore the ports most likely to employ port electrification—are Los Angeles, Long Beach, San Diego, Oakland, San Francisco, and Hueneme.

ARB staff is currently working with ports, ship operators, utility companies, local air districts, and other interested stakeholders to develop a regulation to reduce emissions from ships while docked. Although the proposed regulation will allow alternative technologies to reduce emissions, the key component of the regulation will be port electrification. Staff expects to take the proposed regulation to the Board for its consideration by the end of 2007.

4. Potential Emission Reductions

ARB staff is pursuing the port electrification strategy as a measure to reduce NOx and diesel PM emissions. This strategy was identified in the Goods Movement Emissions Reduction Plan (GMERP), approved by the Board in April 2006. The reduction of these pollutants is essential for protecting public health near California's ports and for the South Coast Air Basin to eventually achieve and maintain health-based ambient air quality standards for ozone and fine particulate matter. The reduction of CO2 is a co-benefit of the proposed at-berth emission reduction regulation.

Although the proposed regulation is not yet fully developed, staff estimates that the regulation may result in the following emission reductions:

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx (Tons)</td>
<td>15,000</td>
<td>19,000</td>
</tr>
<tr>
<td>Diesel PM (Tons)</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>CO2 (Million Metric Tons)</td>
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<td>0.5</td>
</tr>
</tbody>
</table>

Staff expects port electrification to achieve emission reductions in 2010—largely due to the commitments of the Port of Los Angeles and the Port of Long Beach through their Clean Air Action Plan—however, the emission reductions from the proposed regulation will not be substantial until after 2010.

The potential CO2 emission reductions of port electrification are dependent on the source of the electricity provided to the port. If the electricity portfolio of the utility company has a significant portion of renewable sources, such as wind, solar, or biomass, then the CO2 reductions may be substantial. Similarly, if the portfolio contains sources of electricity that generate considerable amounts of CO2—say, out-of-state coal-fired plants—then the potential CO2 emissions would be diminished.
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For the purpose of this analysis, ARB staff used a CO₂ emission factor of 0.25 MMT CO₂/MW-hr for the electrical grid and 0.69 MMT CO₂/MW-hr for the auxiliary engines. Staff will consider utility-specific CO₂ emissions and marginal electricity generation CO₂ emissions (typically combined-cycle gas turbines) as the development of the regulation proceeds.

As mentioned earlier, the proposed regulation will allow alternative technologies to achieve required emission reductions. These alternatives may include ship-side technologies, such as post-combustion devices, alternative fuels, or cleaner engines, or shore-side technologies, including distributed generation or emission-capture-and-treatment devices. These technologies will probably be less effective in reducing GHG emissions when compared to port electrification; however, their overall deployment and impact are uncertain.

As a GHG emission reduction strategy, port electrification has the potential to reduce CO₂ emissions on the order of 0.3 to 0.5 MMT CO₂ per year. This estimate does not consider the climate benefit associated with reduction of black carbon, a component of diesel PM.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Staff estimates that port electrification, as currently proposed, will cost more than $1.2 billion, roughly one-third of that cost borne by the ports and terminals, two-thirds by the ship operators.

The growth in port activity—especially the substantial increase in containers expected to be handled by the ports and the projected surge in cruise-ship vacations—will have a significant impact on the number of ships that must be built or retrofitted to accommodate port electrification. ARB staff estimates the number of ships to be affected by the proposed regulation as:

<table>
<thead>
<tr>
<th>Ships Affected</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container</td>
<td>500</td>
<td>1,200</td>
</tr>
<tr>
<td>Passenger</td>
<td>76</td>
<td>110</td>
</tr>
<tr>
<td>Refrigerated Cargo</td>
<td>10</td>
<td>25</td>
</tr>
</tbody>
</table>

In addition to the recovery of that capital expenditure, annual operating expenses will include labor costs necessary to connect and disconnect the ships to shore power and the cost of the electricity itself. Fuel savings realized by shutting down the auxiliary engines will help offset the electricity costs.

Staff estimates that the annual costs of port electrification are as follows:

<table>
<thead>
<tr>
<th>Annual Costs</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Costs</td>
<td>$148 million</td>
<td>$250 million</td>
</tr>
<tr>
<td>Operating Costs</td>
<td>$42 million</td>
<td>$75 million</td>
</tr>
<tr>
<td>Total</td>
<td>$190 million</td>
<td>$325 million</td>
</tr>
</tbody>
</table>
As mentioned above, port electrification is considered foremost a measure to reduce NOx and diesel PM emissions with GHG emission reductions being a co-benefit. The cost effectiveness of port electrification for 2020 is estimated at $17,000/ton for NOx or $640,000/ton for PM. These values represent the cost of the regulation completely allocated to either NOx or diesel PM; a sharing of the total costs between these two pollutants would further enhance their cost effectiveness.

If NOx and diesel PM emission reductions were not considered, and port electrification were considered solely as a GHG emission reduction measure, the cost effectiveness in 2020 would be $650/MT CO2.

Staff proposes to present the draft regulation to the Board as a measure to reduce NOx and diesel PM and to quantify the associated co-benefit of CO2 emission reductions. By focusing on NOx and PM reductions, staff will address the local and regional health impacts of ships docked in California’s ports, including any disproportionate impacts those emissions may have on surrounding communities.

6. Technical Feasibility

Port electrification is a proven technology. The U.S. Navy has been employing it worldwide for decades. Princess Cruise Lines currently uses port electrification in Juneau, AK and Seattle, WA, as does China Shipping at the Port of Los Angeles (POLA). The NYK Atlas has recently plugged in at POLA, and British Petroleum is expected to utilize port electrification by the end of the year at the Port of Long Beach for two of its diesel-electric tankers.

Although technically feasible, port electrification is not without its challenges, including the availability of electricity, the standardization of electrical hookups, and sufficient visits to electrified berths by retrofitted ships to make the emissions reductions cost-effective. Staff has been discussing the necessary electrical infrastructure and supply with the major ports and utility companies. The International Maritime Organization (IMO) is considering standard electrical connections for port electrification, and several California ports and other organizations are participating in that effort.

7. Additional Considerations

California will be the first state to require port electrification, or its equivalent, if the Board adopts a proposed regulation within the next six months. Current port electrification projects within California and the United States have been required on a case-by-case basis.

The requirement to reduce emissions from ships while docked at California ports is clearly within the jurisdiction of the Air Resources Board. Port electrification has been identified as a strategy to reduce NOx and diesel PM in the Goods Movement Emission Reduction Plan and as a GHG emission reduction strategy by the CAT. Staff will bring a proposed regulation to the Board within the next six months.

8. Division: Stationary Source Division
   Staff Lead: Grant Chin
9. References:

*Draft Evaluation of Cold-Ironing Ocean-Going Vessels at California Ports (ARB, March 2006)*

*Documentation to Climate Action Team, December 2006*
Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Action Strategy Name and Proponent

SUMMARY #: B08
ID NUMBER: EJAC-7/ARB 2-17
TITLE: TRANSPORT REFRIGERATION UNITS, ELECTRIC STANDBY
PROONENT: 2006 CAT REPORT AND ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This strategy was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this strategy is recommended. Costs for this strategy are high and new information indicates costs may be 30 to 50 percent higher than originally estimated. An extensive amount of coordination with industry remains to be completed before any regulatory action can proceed. This is due to a variety of factors, including the lack of industry standards for electric power use on transport refrigeration units (TRUs). For example, more than four optional voltages are used, along with both single phase and 3-phase frequencies, and many electric power plug configurations are in use (see Part 7 for more information). Therefore, a Board hearing date is not indicated.

3. Description

Transport refrigeration units are refrigeration systems powered by integral internal combustion engines designed to control the environment of temperature sensitive products that are transported in trucks, trailers, shipping containers, and railcars. In 2004, the TRU Airborne Toxic Control Measure (ATCM) was adopted to reduce diesel particulate matter (PM) emissions from TRU engines. ARB staff is currently implementing this ATCM. As conceived, this strategy would go beyond current ATCM requirements with a regulatory action to require that no TRU-equipped trucks, trailers, shipping containers, or railcars that are used at a large distribution center for outbound loads would be allowed to be powered by internal combustion engines for more than 30 minutes in a 24-hour period.

An optional component of this strategy would prohibit the use of internal-combustion engine-powered TRUs on trucks, trailers, shipping containers, and railcars from being used for extended cold storage at California distribution centers, grocery stores, and elsewhere. This practice occurs during the 4-to-6 week period before all of the major holidays because distribution center cold storage warehouse capacity is exceeded at about 30 percent of the distribution facilities and at an unknown number of grocery stores.
4. Potential Emission Reductions

For this strategy, staff estimates a reduction of 3.4 to 4.3 million gallons of diesel fuel used per year (with 51 to 64 GWh of new electricity use); the optional component (extended cold storage prohibition) would result in an additional reduction of 1.7 million gallons of diesel fuel used per year (with 26 GWh new electricity use). This strategy would also provide emission reduction co-benefits due to reduced diesel engine operating times; therefore, emissions of ozone precursors and diesel PM particulates would also be reduced. However, ARB staff estimates only about 0.04 million metric tons per year of CO₂ reductions could be achieved (0.45 million metric tons total by 2020).

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Capital costs are estimated to be $105 million for the first year and $3.1 to $3.6 million per year thereafter. The optional component would require an additional one-time capital cost of $44 million. New information indicates capital costs may be 30 to 50 percent higher than these early estimates. Without including these potential increases, inflation or discount factors, ARB staff estimates rough annual costs at $16.7 million per year (total accrued costs, with savings, would be approximately $167 million in 2020). Staff is still working on refining cost and is not able to provide a cost-effectiveness estimate at this time.

6. Technical Feasibility

Compliance is a critical issue which will most likely require the use of various technologies in order to ensure that adequate enforcement of the regulation occurs. Technologies exist that could be applied toward automated compliance assurance and reporting systems, but it may take several years to develop and test the reliability of such systems such that they could be used for this application. Additional regulatory action may also be necessary to ensure these compliance assurance systems provide an enforceable reporting mechanism.

7. Additional Considerations

Industry standards need to be developed and adopted to address compatibility issues, plug types, and configurations. Although electric standby (E/S) technology is available for some TRU models, less than one percent of trailer TRUs are currently equipped with E/S and retrofitting with E/S is extremely expensive and has never been attempted. Extensive design and development work is needed before E/S use could be required. Most existing TRU models will need to be redesigned to use smaller, more efficient refrigeration compressors or to use larger, more powerful electric motors to provide enough capacity for quick initial trailer cool-down prior to loading perishable goods. Current E/S designs use under-powered electric motors that are intended only to maintain a temperature set point after the diesel engine completes the initial chill down. Additionally, further investigation on the feasibility of prohibiting the use of diesel-powered TRUs for extended cold storage is needed as it may require a significant change in business practices and have unforeseen economic impacts.
8. Division: Stationary Source Division
   Staff Lead: Rod Hill
   Section Manager: Richard Boyd
   Branch Chief: Dan Donohoue
1. Early Actions Strategy Name and Proponent

SUMMARY #: B09  
ID NUMBER: EJAC-9/ARB 2-19  
TITLE: TRUCK STOP ELECTRIFICATION WITH INCENTIVES FOR TRUCKERS  
PROPOSENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is waiting to be determinate.

Staff recommends that ARB considers an incentive-based strategy to expedite a comprehensive deployment of on-shore electric power infrastructure to eliminate idling emissions from heavy-duty trucks. This incentive program must consider the existing requirements of the idling regulations in order to design an approach that would yield surplus emissions through the use of financial incentives. The incentives could be structured to pay a portion of the plug-in usage fee either to the truckers or to the technology vendors. The advantage of this strategy would be the elimination (exclusive of power plant emissions) of greenhouse gas and criteria pollutant emissions resulting from truck idling activities. This approach would also provide an alternative for the trucking industry to not just comply with the idling requirements, but would allow them to go beyond those requirements to achieve zero emission through the use of financial incentives. The disadvantage of this strategy would be the high costs to obtain relatively small incremental benefits since existing regulations have already established very low emission thresholds for this source category.

3. Early Action Description

This strategy would require truck stops to install electrical power infrastructure (i.e., on-shore electrical power) to reduce heavy-duty trucks idling emissions, perhaps through the use of financial incentives. On-shore electric power involves the electrification of truck parking spaces to provide power for heating, cooling and on-board truck accessories. Affected entities of this strategy include owners and/or operators of heavy-duty trucks, truck stops owners and technology vendors.

Heavy-duty trucks idle their engines an estimated 6 hours per day, resulting in emissions of criteria pollutants and greenhouse gases. These emissions could be eliminated with the proposed electrification strategy as a result of eliminating the combustion of diesel fuel from either the truck engine or the auxiliary power unit (APU) engine. The ARB has already adopted regulations limiting the idling time of heavy-duty trucks unless the truck
is installed with appropriate low-emission technology. Starting in 2008, all trucks must comply with a 5-minute idling limit unless it has a certified APU coupled with a PM trap. Engine manufacturers also have the option of certifying model year 2008 and newer main truck engines to a low idling NOx emission level of 30 grams per hour (ARB, 2005). Since the existing regulations have already set limits and requirements on truck idling activities, this proposed strategy would provide additional emission reductions beyond those regulations by eliminating the emissions resulting from operation of the APU, or from low-idling emission engines.

Currently, there are already two on-shore power technologies that have been commercially established and have been used to eliminate truck idling emissions. The two technologies are commonly referred to as on-board power infrastructure and off-board infrastructure technologies.

On-board power infrastructure provides trucks with 110-volt AC electrical power at truck stops to run the air conditioning, heating and on-board accessories. This would require truck stops to be equipped with electrical outlets throughout the parking spaces and trucks need to be equipped or retrofitted with inverter/chargers, electrical power connections and electrically driven heating and air conditioning units. The drawbacks of this approach include the high initial infrastructure cost, cost for equipment add-ons to trucks, and its availability, which is limited to where the infrastructure is installed. The aftermarket cost for add-ons and installation is about $4,000 per truck and power infrastructure installation is about $3,500 to $6,000 per truck parking space depending on the number of power pedestals installed (Perrot, et al, 2004).

Off-board power infrastructure provides 110-volt AC electrical power through an externally installed heating and air conditioning unit, as well as hook-ups for basic telephone, Internet and television services at each truck parking space. The unit is connected to the truck through a console installed to the truck window using a template insert. The console contains all the necessary connections and controls, including a card reader for the billing system. Currently the usage fee for basic services range from $1.25 to $1.50 per hour. The off-board power infrastructure installation cost is approximately $12,000 to $20,000 per parking space depending on the number of parking spaces installed (Antares, 2005). The advantage of this system is that the truck does not need to be modified with any alternative cab comfort technology, resulting in immediate benefits to the truck owner using the service through reduced fuel consumption and maintenance savings.

This strategy could be crafted as a regulation requiring all truck stops to install electric infrastructure that could be used by truckers to eliminate truck engine idling. To be effective, that regulation would also need to require the truckers to use the electric infrastructure for their idling needs instead of idling the truck engine or using the APU. However, since ARB already has existing idling regulations, one of which has already been implemented and the other will become effective in January 2008, it will be challenging to develop another regulation on top of the existing idling regulation. A less contentious approach would be through an incentive-based program to spur the installation of the appropriate electric infrastructure that would allow truckers the option to "plug in" when they park at these truck stops.

ARB has already had direct experience in implementing an incentive-based on-shore power infrastructure program. ARB executed a grant with IdleAire, a company that
developed an off-board power infrastructure technology, to assist in the installation and operation of off-board power infrastructure at various truck stops located in the San Joaquin Valley. The grant, totaling $1,334,536, was used to pay for usage ($1.50 per hour) of the IdleAire device at the 415 parking spaces at six truck stops that are spread throughout the San Joaquin Valley. The South Coast Air Quality Management District (SCAQMD) has also funded IdleAire projects in the South Coast with funding from the Carl Moyer Program and the U.S. EPA. In addition to paying for usage, at a rate of $3.94 per hour, the SCAQMD program also pays for a portion of the installation cost ($8,726 per unit) of the IdleAire power unit.

4. Potential Emission Reductions

The existing truck idling regulation limits idling time from heavy-duty trucks to 5 minutes unless the truck is equipped with an APU coupled with a particulate trap or, alternately, unless the truck is a 2008 and later model year that is certified to the low idling NOx emission standard of 30 grams per hour. Because of this requirement, the NOx idling emission rate of 30 grams per hour was used as the baseline emission level. Since existing idling regulations do not specify optional idling emission rates for pollutants other than NOx emissions, the truck baseline idling emission levels for other pollutants such as HC, PM, and CO2 were established using EMFAC2002 idling emission rates. The surplus emission reductions are calculated as going from these baseline levels to a zero emission level for each truck stop parking space that is electrified.

Based on data from Report to Congress of Adequacy of Parking Facilities, there is currently about 7,500 spaces at truck stops and 1,300 spaces in Caltrans public rest areas. Currently, about 900 parking spaces at truck stops are installed with electric power infrastructure, resulting in an estimated 2010 annual reduction of about 55,000 tons of CO2 per year (0.055 MMTCO2E). If the remaining truck stop parking spaces are electrified, an additional annual reduction of about 405,000 tons of CO2 (0.4 MMTCO2E) would result. Depending on the expected growth of available parking spaces at truck stops, the 2020 emission benefits could be adjusted accordingly. The expected CO2 emission reduction from this strategy, if fully implemented, could be on the order of 0.1 to 1.0 MMTCO2E. Emission reductions of criteria pollutants (HC, NOx, and PM) are estimated to be about 530, 1,300, and 120 tons per year, respectively, in 2010.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Given the cost of the existing on-shore electric power infrastructure technology and the expected baseline emission rates, it is estimated that the cost to reduce CO2 emissions to range from a low of about $135 per metric ton to a high of about $359 per metric ton. There are about 6,600 parking spaces at truck stops and about 1,300 parking spaces in Caltrans public rest areas that are currently do not have electric power infrastructure, for a total of about 7,900 truck non-electrified parking spaces. Assuming the cost of on-shore power infrastructure to range from $7,500 to $20,000, including the cost of on-truck equipment in the case of the on-board power infrastructure technology, the total cost to electrify all 6,600 parking spaces at truck stops would be about $49,500,000 to $132,000,000. If the 1,300 parking spaces at Caltrans public rest areas are also to be installed with on-shore electric power infrastructure, it would cost an additional $9,750,000 to $26,000,000.
A requirement for an on-shore electric power infrastructure would impact truck stop owners, truck drivers, and technology vendors. The economic burden on truck stop owners would depend on how they structured their approach towards establishing the required infrastructure. They could purchase the equipment and have it installed at their facilities, or they could opt to lease the parking spaces to technology vendors for them to install the equipment. The cost to truckers could range from the cost to install the necessary equipment on their trucks in the case of an on-board technology to simply just paying for the hourly cost of plugging in when they use the facility. The cost to technology vendors would be the cost to manufacture, install, and operate the power infrastructure.

6. Technical Feasibility

On-shore electric power infrastructure is an established, proven commercial technology. This technology is currently being deployed at various truck stops throughout the country. In California, approximately 900 truck stop parking spaces already have on-shore electric power infrastructure. The main obstacle to more widespread deployment of this technology appears to be the relatively high initial cost of installing the necessary infrastructure.

7. Additional Considerations

Additional analysis is needed before deciding on an implementation path. It is possible that other jurisdictions have taken this action as an incentive program. Also, this strategy clearly falls under ARB jurisdiction and authority as idling limits have been adopted. Although an incentive program appears to be the best option, a regulation could be developed in the next 18 months, making the strategy a discrete early action.

Affected Entities: Truck stop owners, truck drivers, technology vendors

Trade Associations: Trucking associations, utilities companies

Government Agencies to coordinate with: Local air districts, local governments regarding permitting requirements

8. Division: Mobile Source Control Division
   Staff Lead: Bob Nguyen
   Section Manager: John Kato
   Branch Chief: Jack Kitowski

9. References:

ARB, Notice of Public Hearing to Consider Requirements to Reduce Idling Emissions from New and In-Use Trucks, Beginning in 2008, Sacramento, September 1, 2005
Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #: B10
ID NUMBER: EA 2-20
TITLE: TIRE PRESSURE PROGRAM
PROONENT: AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 1st quarter of 2009.

Maintaining a vehicle’s tire pressure to the manufacturer’s recommended specifications is a practical strategy to achieving early greenhouse gas (GHG) emission reductions. Current Federal law requires auto manufacturers to install tire pressure monitoring systems in all new vehicles beginning September 1, 2007. Staff recommends that the ARB investigate strategies to ensure that the tire pressures in older vehicles are also monitored, as well as requiring the tires to be checked and inflated at regular service intervals. One potential strategy would be to require all vehicle service facilities, such as, dealerships, maintenance garages, and smog check stations, to check and inflate tires.

Staff also recommends that the feasibility of conducting an extensive outreach program be investigated. The outreach program could entail placards being placed above each fueling dispenser to encourage drivers to properly maintain their tires each month. The placards would highlight the amount of money consumers could save as a result of lower fuel consumption, as well as, how each consumer is doing their part to help prevent climate change.

3. Early Action Description

According to the National Highway Traffic Safety Administration (NHTSA), 74% of all vehicles have at least one significantly under inflated tire. The U.S. Department of Energy (DOE), California Energy Commission (CEC), and NHTSA, state that every 1 pound per square inch (PSI) drop in tire pressure equals an approximate 0.4% drop in a vehicle’s gas mileage. Establishing a program to monitor and correct vehicle tire pressure could save Californians a minimum of 61 million gallons of fuel, which equates to 0.54 MMT of CO₂ emissions in 2010 (first year of implementation) and 22.5 million gallons of fuel and 0.20 MMT of CO₂ emissions in 2020. Potential savings from a program that was 100 percent effective in ensuring proper tire inflation are on the order of 96 millions gallons of fuel saved in 2010.
4. Potential Emission Reductions

The GHG emission benefit of this program is associated with the reduction in gallons of fuel consumed by California drivers. The reduction in gallons of fuel consumed is based upon 10 million vehicles visiting a repair facility at least once a year and having their tires checked and inflated to the manufacturer’s recommended pressure. Approximately 74 percent of vehicles in California have under inflated tires, of which, 27 percent have at least one tire severely under inflated (25 percent or more of the manufacturer’s recommended pressure). On average, a vehicle tire loses approximately 1 PSI per month. For every loss of 1 PSI in tire pressure, a corresponding loss in fuel economy of 0.4% can be expected.

It is estimated that Californians will consume approximately 14.1 billion gallons of gasoline in 2010 and 16.2 billion gallons in 2020. In 2010 (first year of implementation), the predicted reduction in the consumption of fuel is 61 million gallons which equates to 0.54 MMT of CO₂. This is based on 27 percent of vehicles having at least one tire severely under-inflated, 47 percent having tires under inflated by 1 PSI, and 26 percent having the correct pressure. In 2020, emissions reductions are expected to be lower due to the recommended strategy and outreach programs and the federal requirement for tire pressure monitoring systems in all new vehicles. The reduction in gallons of fuel consumed will be approximately 22.5 million gallons which equals 0.20 MMT of CO₂.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Costs associated with this program include public outreach and education, equipment costs such as compressors and accessories, and labor. One study suggested the labor rate to check and inflate tires will be approximately $3.75 per vehicle. In addition, some vehicle repair facilities may be required to purchase an air compressor and accessories at an approximate cost of $500.

Retrofit technologies exist that can monitor tire pressure at costs ranging from $20 to $600 depending on the system and installation variables (i.e., make and model of vehicle, brakes, ABS, hourly installation rate, etc.). Additional staff work is needed to determine the feasibility and cost effectiveness of retrofits.

6. Technical Feasibility

There are no technology limitations for this strategy.

7. Additional Considerations

Several State and Federal agencies have public outreach websites that highlight the relationship between tire pressure and saving money (e.g., U.S. DOT – It All Adds Up, CEC – Fuel Efficient Tire Program, California’s Energy Efficiency Program – Flex Your Power, IWMB – National Tire Safety Week). Enforcement of this type of strategy will be extremely difficult.

Affected Entities: California’s vehicle repair facilities and refueling stations and vehicle owners.

Government Agencies to coordinate with: U.S. DOT, CEC, IWMB, and others as outreach information becomes available.
8. Division: Stationary Source Division
   Staff Lead: Theresa Anderson
   Wayne Sobieralski
   Section Manager: Mike Miguel
   Branch Chief: Mike Tollstrup

9. References:

1 U.S. Department of Transportation, NPRM on Tire Pressure Monitoring System FMVSS No. 138, 09/2004


4 Based on retail quotes obtained by the Air Resources Board, 07/2007
Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #: B11
ID NUMBER: EJAC-11/ARB 2-22
TITLE: REQUIRE LOW GWP REFRIGERANTS FOR NEW MACS
PROPOSENT: 2006 CAT REPORT AND ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

This strategy is also not a stand-alone measure. It is anticipated to be integrated into larger new measures focused on new vehicle GHG emission standards (e.g., Pavley II described as Summary # B33, page B-110 later in this appendix).

The central premise of the proposed strategy is the replacement of high global warming potential (GWP) refrigerants used in California's mobile air conditioning systems (MACS) with lower GWP alternatives that also represent better lifecycle climate performance (LCCP) than the current refrigerant. MACS in today's motor vehicles use nearly universally the refrigerant HFC-134a with a GWP of 1,300. A two-fold approach will be explored under the proposed new regulation. First, the core of the strategy would focus on developing new regulations requiring that new MACS use refrigerants with a lower GWP (e.g., 150 or less) in new vehicles currently not subject to the existing vehicle GHG emission standards (AB 1493). For vehicles subject to AB 1493, this strategy would explore further MACS improvements after the regulation is fully phased in 2015. Second, staff will explore the potential climate benefits from a universal phase out of HFC-134a (or other high GWP refrigerants) used in other remaining vehicle classes in the California fleet such as heavy-duty on- and off-road vehicles including new as well as in-use systems. Again, the identification of suitable alternatives would be based on lifecycle climate performance.

Alternative refrigerant development has been a highly contested arena in recent times. Driven primarily by Europe's landmark directive to phase out the use of HFC-134a in the MACSs of new vehicle types starting in 2011, several low GWP refrigerants are currently

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1 New alternative low GWP refrigerants in MACS are desired to the extent that these alternatives have lifecycle climate performance (LCCP) that exceeds the performance of the current refrigerant HFC-134a. Thus, new low GWP refrigerants are sought in systems that leak less and are more efficient than current systems.
under investigation and evaluation for toxicity, safety, energy efficiency, and technical feasibility by multiple industry entities. Identification of an eligible replacement for the European car market, the largest in the world, would boost efforts in California and could accelerate the implementation of new regulations mitigating the impact of refrigerants in MACS.

3. Early Action Description

This strategy explores the phase out of HFC-134a in all MACS in new vehicles certified for sale in California (heavy- and light-duty, on- and off-road) with the intent to reduce direct and indirect emission impacts and promote only the use of alternative refrigerants with superior lifecycle climate performance. Opportunities in the in-use fleet will also be evaluated.

Regulation of refrigerants is happening globally. The European Union (EU) is taking the lead. In 2006, the European Parliament and the Council decided that the dates for the phase-out of refrigerant HFC-134a in the European community shall be set at January 1, 2011 for new types of vehicles and January 1, 2017 for all new vehicles. The US EPA’s I-MAC Program has generated significant debate and progress regarding alternative refrigerants and the options for the US car MACS market with the best lifecycle climate performance. Extensive cooperation between government agencies, NGOs, and industry is needed to accomplish this strategy and fully realize its benefits.

4. Potential Emission Reductions

The proposed strategy was included in the Climate Action Team report of March 2006 and it emerged from ARB’s regulatory work for the motor vehicle greenhouse gas emissions regulation (AB1493). That work suggests that potential GHG emission reductions for a universal phase out of HFC-134a in new and in-used MACS in California are on the order of 2.5 MMTCO2E by 2020. However, the uncertainty with the estimate is on the order of 50%.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Preliminary cost estimates were developed for the revisions to the Climate Action Team Report of March 2006 that ARB and other agencies are undertaking. The numbers generated for that report are first-order estimates based on simple assumptions gleaned from the published literature about alternative MACS. Only estimated capital costs were considered. Additional staff analysis is needed to determine operating costs, cost savings, and economic impacts. The air conditioning system life is expected to be the same as current systems. Capital costs for the introduction of new refrigerants in the California fleet were estimated to be on the order of $150 million by 2020 based on assumptions that changes begin to phase in around 2013. This estimate is based on an incremental cost per vehicle of €20 to €25 per LDV in 2003 and is also applied to the other vehicle categories. For the HFC-152a alternative refrigerant, it is not expected that maintenance costs will change significantly or that there would be cost implications when converting an existing HFC-134a system design to use HFC-152a since development is fairly advanced. Selection of some other alternative refrigerants, for example CO2, could be significantly costlier. Incremental energy consumption estimates are not presented here. The reference below cites a potential 10% reduction in energy consumption for the
HFC-152a alternative for LDVs, but this will almost certainly vary significantly with vehicle category, engine type, operating cycle, extent of optimization achieved during system redesign, etc. Also, energy consumption for some other alternative refrigerant selections, for example CO₂-refrigerant systems, can actually show an increase under some operating conditions. Significant additional analysis is needed to enable and improve cost and performance estimates of the various alternative technologies.

6. Technical Feasibility

New HFC refrigerants with GWP values less than 150, such as those currently under development for the US market by Honeywell and DuPont, and existing alternative refrigerants such as HFC-152a (with GWP approximately 120°) or R744 (CO₂, GWP=1), are possible substitutes for HFC-134a in new vehicles. The feasibility of these low GWP refrigerants is being investigated and evaluated extensively by multiple entities. As suggested by the European directive, all indications are that a feasible refrigerant alternative to HFC-134a is eminent.

7. Additional Considerations

The EU regulation timeline calls for the phase out of HFC-134a beginning with new vehicles types in 2011. Thus, auto makers serving that market face at present time a critical go, no-go decision point regarding refrigerant selection for their systems.

The outcome of the AB1493 legal challenges, including the pending California waiver request to the US EPA, will impact significantly the form and function of the measure as proposed.

Each alternative new refrigerant will be evaluated from a lifecycle emissions standpoint to ensure that the net impact on greenhouse gas emissions is properly characterized and in order to promote improvements not only on refrigerant containment to minimize leakage, but also in system performance to reduce the parasitic impact of the MACS on the vehicle engine.

Affected Entities: Vehicle owners and operators, vehicle manufacturers, mobile air conditioning system repair facilities, mobile air conditioning system and component manufacturers, and air conditioning refrigerant manufacturers.


8. Division: Research Division
   Staff Lead: Pablo Cicero
   Section Manager: Tao Huai
   Branch Chief: Alberto Ayala

9. References:

2 The I-MAC Program is a consortium of government, industry, academia, and other stakeholders led by the US EPA with the objective to develop superior and improved HFC-134a mobile air conditioning technology with 50% lower leakage and 30% greater efficiency than current production-ready systems.


4 The GWP limit is intended to be that of HFC-152a, for which the IPCC 3rd Assessment Report suggested a 100-year forcing of 120. The more recent IPCC/TEAP Special Report on HFCs and PFCs suggests a direct forcing of 122.
1. Early Actions Strategy Name and Proponent

SUMMARY #: B12
ID NUMBER: EJAC-12/ARB 2-23
TITLE: ADDITION OF AC LEAK TEST AND REPAIR REQUIREMENTS TO SMOG CHECK
PROPOSENT: 2006 CAT REPORT AND ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 1st quarter of 2011.

The strategy proposes to explore the addition of a new motor vehicle air conditioning system (MVACS) leak test and repair requirements to the existing California Smog Check program for HFC-based MVACSs. To the extent that a cost-benefit analysis supports this measure, implementation will require the 1) identification, selection and verification of one or more reliable and low cost HFC refrigerant leak detectors to be used in the Smog Check setting; 2) development of a new Refrigerant Leak Check procedure and protocol; 3) new and additional training of the Smog Check technicians including achieving appropriate technician A/C repair certification; and 4) working with the Bureau of Automotive Repair (BAR) of the Department of Consumer Affairs (DCA) for mandating the new procedure to be integrated into the statewide Smog Check program. Research will be needed to evaluate the feasibility of the new test and extensive discussions among multiple stakeholders, including first and foremost BAR and legislature staff are anticipated. For this reason, this strategy cannot be developed before 2010 to meet the definition of a discrete early action.

3. Early Action Description

The proposed strategy will explore the addition of a refrigerant leak check to the “pass” criteria for the California vehicular inspection and maintenance (I/M) program, Smog Check, for all vehicles that undergo the test. As a result, all vehicles that pass Smog Check would have MACS that are either nearly leak-free or empty and excluded from further use of the AC system unless the leak is repaired. Vehicles that are determined to have unacceptable leak rates would be required to be repaired as a condition for registration. A similar requirement is already in place and enforced by some local air quality management districts. Thus, the proposed early action seeks to expand these local requirements statewide.
4. Potential Emission Reductions

The proposed strategy was included in the Climate Action Team report of March 2006 and it emerged from ARB's regulatory work for the motor vehicle greenhouse gas emissions regulation (AB1493). That work suggests that potential GHG emission reductions for a leak test and repair program in California are on the order of 0.45 MMTCO2E by 2020. However, the uncertainty with the estimate is on the order of 50%.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Some preliminary, but incomplete cost information exists. In 2005, BAR licensed approximately 9,700 Smog Check stations and almost 14,000 Smog Check technicians. Approximately 9.2 million Smog Check inspections were conducted at these Smog Check stations in 2005. Each Smog Check station would have additional one-time estimated expenditures of about $200-$300 for each hand-held HFC leak detector. Technician training for AC service certification would cost up to $280 per person. Based on above information, the total cost for equipment and training in California would be approximately $6M; $2M for equipment and $4M for training. In addition, the leak test would add time to the current Smog Check test, impacting the shop and the customer. Finally, in the case where a MVACS is found to require repairs, the customer would incur additional and potentially significant costs. Technology is also rapidly evolving and improving. Today’s MVACS are much tighter than older system and the industry, in response in part to regulatory interest, is proactively seeking refrigerant leak improvements in the system sold to car makers. These factors and many other economic impacts have not been thoroughly researched and additional time is needed to complete a full cost-benefit analysis of the proposed measure.

6. Technical Feasibility

There are several commercially available hand-held HFC leak detectors or “sniffers” on the market. These detectors are currently in use by the AC service and repair industry. The detectors would need to be demonstrated capable of reliable and accurate determination of refrigerant leaks in the Smog Check station setting at rates as determined in the proposed strategy. All MVACSs leak refrigerant naturally as the systems are not hermetic and deterioration is expected. A pass criterion based on a reasonable threshold leak rate requiring professional AC servicing or system disabling needs to be defined rigorously, perhaps as a fraction of the original system charge or other appropriate metric. The current commercially available sniffers can detect a concentration of refrigerant in a sample volume of some currently unknown combination of leakage and ambient air. Further investigation is needed to define the pass criterion for either a threshold concentration or leak rate.

Currently, the service industry standard established by the Society of Automotive Engineers, SAE J1628 Standard, requires charging the AC with sufficient refrigerant prior to conducting a leak check. This procedure might be not suitable for the implementation of this strategy because the leak check would be conducted at Smog Check Stations, which normally do not have AC charging equipment. A new leak check protocol would be necessary. The measure must also require professional AC servicing or system disabling when leakage is found. Other methods, such as injection of dye gases, are under investigation.
7. Additional Considerations

ARB and BAR would need to work closely as both agencies share responsibility for Smog Check. Roles and responsibilities for both agencies in the context of the proposed strategy should further analysis suggest to proceed to full development and implementation will need to be defined.

Affected Entities: The I/M program operators at the Smog Check stations, the owners of all vehicles required to undergo I/M, shops that repair vehicular AC systems, BAR, and DCA, The I/M operators would have to become certified for AC maintenance, purchase new instruments for detection of HFC emissions, and adopt the new protocols for including the new test into the Smog Check procedure. BAR and DCA would be expected to develop a new I/M procedure and protocol to accommodate the new HFC leak check. The agencies would be impacted with additional enforcement requirements for the proposed strategy.

8. Division: Research Division
   Staff Lead: Tao Zhan
   Section Manager: Tao Huai
   Branch Chief: Alberto Ayala

9. References:


1. Early Actions Strategy Name and Proponent

SUMMARY #      B13
ID NUMBER:     EA B-1, B-2
TITLE:         WAFFLEMAT SYSTEMS
PROPO NENT:    STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009.

3. Early Action Description

The WAFFLEMAT System (registered trademark) is a set of interconnected WAFFLEBOXES equally spaced within the area of a new foundation. Concrete is then poured over the WAFFLEBOXES to create a concrete slab, thereby decreasing the volume of concrete used on new foundations and indirectly reducing the amount of CO$_2$ emitted from the production and transportation of Portland cement. The WAFFLEMAT System is advertised by the manufacturer to reduce CO$_2$ emissions by 20% when used for new residential home concrete slab foundations built on "marginal" soils (e.g., expansive soil, rocky soil, and/or hydro-collapsible soil), where an increase in slab thickness is required. The 20% CO$_2$ emission reduction was calculated by comparing the WAFFLEMAT System to a 10 inch uniform thickness slab. The actual percentages of CO$_2$ emission reductions will vary depending on the type and thickness of the slab which the WAFFLEMATs are compared against.

4. Potential Emission Reductions

Based on information from the manufacturer, ARB staff estimated that utilization of the WAFFLEMAT System on new residential home construction may reduce 3.5 metric tons (MT) of CO$_2$ emissions per slab for a 2,000 square foot home. If one assumes that 200,000 new residential homes are built each year in California, 25% of those homes are located on marginal soils and all 25% of those homes utilize the WAFFLEMAT System, there may be an annual CO$_2$ emission reduction of 0.18 million MT. Using 2008 as the baseline year, by 2010 there will be a cumulative 0.35 million MT CO$_2$ emission reduction and by 2020 there will be a 2.1 million MT CO$_2$ emission reduction. The primary purpose of the WAFFLEMAT System is to displace the total amount of concrete needed in a residential foundation and still meet or exceed construction requirements. In theory, if less concrete is needed, less needs to be produced. Emission reductions of oxides of nitrogen (NO$_x$), particulate matter (PM), hydrocarbons, and carbon monoxide...
(CO) will also be achieved with the use of the WAFFLEMAT System if it is assumed that overall less concrete will have to be used.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The WAFFLEMAT System is estimated to cost $1.20 per square foot of foundation. When compared to the cost of concrete for a 10 inch uniform thickness slab foundation on a 2,000 square foot footprint, the WAFFLEMAT System and its reduced volume of concrete may increase the price of a foundation by $1,200. This equates to an approximate cost effectiveness of $340 per MTCO2E. Additionally, the WAFFLEMAT System is advertised to provide cost savings in labor and ground preparation. ARB staff does not have information to quantify labor and ground preparation cost savings at this time.

The use of the WAFFLEMAT System is limited to use with marginal soils that generally require thicker slab foundations. Use of the WAFFLEMAT System with good soils may result in an increased use of concrete.

6. Technical Feasibility

The WAFFLEMAT System was developed in 1995 and has had over 6.5 million square feet of concrete poured on it without one structural callback or failure. Pacific Housing Systems, Inc. (the distributor) and two engineering firms conducted studies to determine the design compliance and capability of the WAFFLEMAT System. Their results showed that the WAFFLEMAT System is technically feasible and has advantages over the traditional slab foundation in areas with marginal soils. Those advantages include, but are not limited to: the slab's ability to withstand larger cantilevers, reductions in labor costs, provides a more definite value for concrete costs, and reductions in overall installation time.

7. Additional Considerations

- The use of the WAFFLEMAT System does not ensure reduction in the production of cement. CO₂ emission reductions are achieved with the use of the WAFFLEMAT System if cement plant operators reduce the production of Portland cement.
- Currently, not every new single-family residence home is built on marginal soils. We are not certain what percentage of new homes is built on marginal soils versus good soils. This could impact the CO₂ emission reduction estimates.
- Geotechnical engineers should be employed to recommend which foundation is suited for a site's soil type.
- ARB will need to work with other state and local agencies to ensure that the use of the WAFFLEMAT System meets building codes.
- ARB staff needs to work closely with legal to determine scope of authority for requiring the use of WAFFLEMAT Systems on new construction.

8. Division: Stationary Source Division
   Staff Lead: Alicia Violet
   Section Manager: Todd Wong
   Branch Chief: Michael Tolsstrup
9. References:


1. Early Actions Strategy Name and Proponent

SUMMARY #: B14
ID NUMBER: EJAC-15/ARB A-15
TITLE: GREEN SHIP INCENTIVE PROGRAM
PROponent: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be
developed as a draft by mid-2008 and must be considered by the Board prior to January
1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for
fully considering the recommendation.

This measure is focused on reducing emissions of diesel particulate matter (PM) and
nitrogen oxides (NOx) by phasing in the installation of emission control devices on new
or existing vessels. While reductions in NOx and the elemental carbon portion of PM
may reduce global warming, other aspects of this measure may contribute to it. For
example, some of the emission control devices that can be used to significantly reduce
PM and NOx will have fuel penalties associated with them, resulting in higher carbon
dioxide (CO₂) emissions. Other control strategies may reduce fuel consumption and
CO₂ emissions. However, the overall effect of this measure on GHG emissions is
expected to be minimal.

We do intend to analyze the potential to modify this measure to also address GHG
emissions. However, for several reasons, this analysis cannot be conducted in a short
timeframe due to the complexity of the technical and jurisdictional issues. For example,
more advanced ship hull and propeller designs have been proposed as a way to reduce
fuel consumption and CO₂ emissions in some studies. However, it is uncertain whether
we can influence design changes on vessels built outside the United States. In addition,
it is expected that ship operators would already incorporate such changes to reduce their
operating expenses unless there are extremely high capital cost impacts or other
barriers. Furthermore, to fully address GHG emissions, a review of all the various
emissions from ships and their impact on global warming would need to be conducted.
The relevant emissions would include CO₂, methane, black carbon PM, sulfur oxides,
refrigerants, and NOx. Some of these emissions contribute to global warming, while
others have the opposite effect. In addition, some emissions effects may be localized
whereas others are not. Finally, the potential control strategies for each type of
emissions would need to be determined.

3. Early Action Description

This measure is included in the ARB’s Emission Reduction Plan for Ports and Goods
Movement. The measure, as currently proposed, seeks to reduce emissions of PM and

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NOx by phasing in the use of cleaner ships at California ports. There are two levels of clean ships: "30/30 vessels" that are 30 percent lower in NOx and PM than current vessels meeting International Maritime Organization (IMO) standards, and "60/90 ships" that are 60 percent lower in PM and 90 percent lower in NOx than IMO compliant vessels. By 2020, the goal is to have clean ships make 90 percent of all California port visits, with 30/30 vessels making 40 percent of ship visits, and 60/90 vessels making 50 percent of ship visits. The ship operator would be expected to choose the specific emission control devices. Examples of potential emission controls include selective catalytic reduction, more advanced fuel injectors, fuel/water emulsions, onboard water scrubbers, and cylinder lubricant control systems. This measure seeks to encourage or direct ship operators to either retrofit existing vessels or incorporate emission control devices into new build vessels. The measure could be an incentive program, a voluntary agreement, a regulation, or use some other mechanism.

Although this measure is currently designed to focus on PM and NOx emissions, it could be modified to also control GHG emissions. As a first step, the impact of the existing NOx and PM controls on GHG emissions should be evaluated. Next, additional opportunities to address GHG emissions would need to be investigated. Existing studies suggest a number of potential control measures that would reduce fuel consumption and therefore CO2 emissions (as well as other pollutants). These measures include the incorporation of optimized hull and propeller designs in new ship builds, operational changes focused on fuel efficiency, new methods of hull maintenance to reduce fouling, and the use of wind, solar power, and fuel cells.

4. Potential Emission Reductions

As mentioned above, this measure is not currently designed to reduce GHG emissions, and the potential impact on GHG emissions has not been quantified. Staff believes that the impact will range from a slight increase to a slight reduction in GHG emissions.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

TBD

6. Technical Feasibility

Improved engine design in new marine engine can improve combustion characteristics and reduce CO2 emissions. However the impact of control measures to reduce PM, NOx, and SOx may increase CO2 emissions.

7. Additional Considerations

See discussion under "Staff Recommendation."

8. Division: Stationary Source Division
   Staff Lead: Paul Milkey
   Section Manager: Peggy Taricco
   Branch Chief: Daniel Donohue
1. Early Actions Strategy Name and Proponent

SUMMARY #: B15
ID NUMBER: EJAC-16/ARB A-19
TITLE: ANTI-IDLING REQUIREMENT FOR CARGO HANDLING EQUIPMENT AT PORTS
PROONENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2009 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Staff believes significant informational gaps or constraints exist due to the dynamics of mobile cargo handling equipment operations, union labor contracts, and safety and security concerns, which prevent the implementation of an anti-idling requirement within the timeframe required for early action measures. The very nature of these operations makes it extremely difficult to determine what constitutes unnecessary idling. To illustrate, cargo handling equipment is often required to move rapidly from one location to another; and some equipment, such as rubber-tired gantry (RTG) cranes, have operator cabs approximately 50 feet above the ground, making it unsafe for the operator to exit the cab (i.e., idling limitations prevent air conditioner operation). It is inherently problematic and may complicate the development of idling restrictions at port terminals because they are generally larger than 200 acres and at any given time may have hundreds of pieces of equipment operating. All of these issues need further evaluation and many concerns need to be addressed.

In order to pursue this strategy, it would be necessary to collect complete equipment and facility specific operational data by facility type and/or operation. This data must be analyzed to identify similarities/dissimilarities in idling (equipment specific) at each facility and determine whether certain idling durations can be minimized and still not inhibit the functionality or efficiency of their operation. The next step would be to take this information and determine the extent to which cargo handling equipment engines idle, and what fraction of this total could be considered as unnecessary idling. Data logging would be the recommended method of collecting the various operational data needs. However, the variability in facility operations and the fact that the data must be equipment specific, taking into account the duty cycle of the engine, makes this a significant challenge, albeit achievable. While many data gaps prevent us from determining what is considered unnecessary idling at existing port or intermodal rail yard operations at this time, upcoming emission control retrofit demonstration programs for port equipment (such as top picks, side picks, RTG cranes, and reach stackers) include data logging components that will provide some data to help us evaluate this issue.
These efforts will be undertaken over the next two years and will help inform the decision on the appropriateness of pursuing an anti-idling measure.

3. Action Description

This early action strategy proposes to adopt a statewide regulation to limit or prohibit unnecessary idling of mobile cargo handling equipment that operates at California ports or intermodal rail yards. The limiting or prohibiting of unnecessary idling will result in reduced fuel usage, fuel cost savings, and environmental/health benefits. A reduction in fuel consumption should result in greenhouse gas emission reductions, as well as, reductions of criteria or toxic air contaminants. However, the magnitude of these reductions is unquantifiable at this time due to lack of operational data. In the event it is determined feasible to establish restrictions on idling, the proposed strategy could be considered as amendments to the existing regulation for cargo handling equipment at ports and intermodal rail yards.

4. Potential Emission Reductions

The potential greenhouse gas emission reduction potential of idling restrictions on cargo handling equipment cannot be quantified with any certainty at this time, but is anticipated to be low given the limited number of cargo handling equipment statewide.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Information is not available to estimate costs or economic impacts of this proposed Early Actions Strategy. However, the sectors that may incur costs from a restriction on idling include engine manufacturers, distributors, dealers, facility owners or operators, shipping lines, industries that contract with the ports or intermodal rail yards for movement of goods, and ultimately the end-user of the applicable consumer products.

6. Technical Feasibility

Limiting or prohibiting engine idling of mobile cargo handling equipment is likely to be technically feasible. However, the environmental benefits, cost effectiveness, emission reduction potential, and potential economic impacts on their operations can only be determined once more research and data collection has been completed and that data substantiates the extent to which unnecessary idling occurs. (See discussion under “Staff Recommendation.”)

7. Additional Considerations

See discussion under “Staff Recommendation.”

8. Division: Stationary Source Division
   Staff Lead: Lisa Williams
   Section Manager: Cherie Rainforth
   Branch Chief: Dan Donohoue
1. Early Actions Strategy Name and Proponent

SUMMARY #: B16
ID NUMBER: EJAC-28/ARB A-17
TITLE: ELECTRIFICATION OF AIRPORT GROUND SUPPORT EQUIPMENT
PROONENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering this recommendation.

Those categories of ground support equipment (GSE) most amenable to being electric powered already have a high percentage of zero emission vehicles (ZEV). There may be some other categories of GSE that could be candidates for either ZEV technology or hybrid electric vehicle technology. Assessing feasibility for the early action timeframe can be addressed over the next year. The potential greenhouse gas emission reductions from this discrete strategy appear to be negligibly small because the number of affected vehicles is small.

3. Action Description

This Early Action Strategy proposes to accelerate the replacement of airport GSE by specifying electrification. The proponents of this measure did not provide any details on the dates for the accelerated electrification, the categories of GSE units specifically targeted, or the percentage of electrification required.

This measure would overlap with the implementation of two recently-adopted ARB regulations for off-road equipment that include GSE - large spark ignited (LSI) engines and in-use diesel equipment. The LSI regulation, that became effective May 12, 2007, incorporates requirements of the recently-terminated Memorandum of Understanding (MOU) with the airline industry that calls for 30% electrification of the airline-owned GSE fleet in the South Coast Air Basin by 2010. The LSI regulation applies to gasoline and liquid natural gas-powered GSE. On July 27, 2007, ARB adopted an in-use diesel off-road equipment regulation that requires diesel equipment fleet owners to reduce their fleet-average emissions of NOx and PM in future years by turnover of a specified percentage of their fleet horsepower. Until staff sorts through how this measure would mesh with these regulations, it is unclear how or if there would be conflicts between the measure and the regulations.
In addition to these two ARB regulations, the South Coast Air Quality Management District (District) has proposed a statewide measure for emission reductions from GSE in the South Coast Air Basin by requiring accelerated zero emission vehicle penetration and more stringent fleet-average emission standards for GSE. The District's proposed measure would require airlines in the South Coast to increase the percentage of ZEVs in their GSE fleets from 30% to 45% by 2014, an increase of 15% additional ZEV penetration.

4. Potential Emission Reductions

If the measure were to achieve an additional 15% electrification of the GSE fleet by 2014 as suggested by the SCAQMD, this measure would represent about 1,200 additional electric GSE units. The most likely categories of GSE that might be amenable for electrification include push back tractors and cargo loaders for which we have estimated energy requirements, fuel use, and electricity use for replacement ZEV units. Assuming that each diesel unit on average uses 2,800 gallons of diesel fuel per year (about 3.5 gallons per hour), this represents an emission reduction of 0.036 million metric tons per year of CO2 emissions. Providing electricity from the California utility grid to recharge batteries for replacement ZEV units would require approximately 67 million kWh per year and would emit approximately 0.027 million metric tons of CO2 annually, assuming each kilowatt-hour would require on average about 400 grams of CO2 (Source: CEC). Thus, the net expected CO2 emission benefit from this proposed measure would be on the order of 0.007 MMTCO2E per year.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

If we assume that the Early Action Strategy would require an additional 15% ZEV vehicles in the GSE fleets, the airlines could incur significant costs, since the requirement would mandate the early replacement of nearly 1,200 units by 2014. Assuming average unit costs for ZEV GSE equal to $60,000, the total cost of the measure would be on the order of $70 million. For units that reach the end of their lifetime during this period, there would be no lost revenue from early replacement, but for units that have to be retired early, there would be a revenue impact on airlines.

6. Technical Feasibility

Airlines have already undertaken substantial electrification of certain categories of the GSE fleet including baggage tractors and belt loaders representing an estimated 46% of the total statewide GSE fleet, mostly in the South Coast Air Basin and at Sacramento International Airport. Other categories of GSE that might be targets for electrification are pushback tractors and cargo loaders and cargo tractors, representing about 41% of the 200 GSE fleet. Pushback tractors represent almost 70% of the potential CO2 emissions, while cargo loading and tractor equipment represents about 30% of potential CO2 emissions. Electric pushback tractors are currently deployed in limited quantities in airline GSE fleets, while electric battery powered cargo loading equipment and cargo tractors have not yet been successfully demonstrated.

7. Additional Considerations

None.
8. Division: Planning and Technical Support Division  
Staff Lead: Jim Lemer  
Section Manager: Gary Honcoop  
Branch Chief: Kurt Karperos

9. References:

*New Emission Standards, Fleet Requirements, and Test Procedures for Forklifts and Other Industrial Equipment, ARB's LSI Regulation, effective May 12, 2007*

*Regulation for In-use Off-Road Diesel Vehicles, approved by ARB July 27, 2007*

*Final Air Quality Management Plan, approved by SCAQMD June, 2007, Off-Road Measure 04*

*California Electricity Consumption by County in 2005, CEC.*


B-57
1. Early Actions Strategy Name and Proponent

SUMMARY #:  B17  
ID NUMBER:  EJAC-18  
TITLE:  ELECTRIFICATION OF CONSTRUCTION EQUIPMENT AT URBAN SITES  
PROPOSENT:  ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

The ARB recently adopted an off-road diesel rule at its July 2007 Board hearing. This regulatory measure is believed to address the recommendations of the Environmental Justice Advisory Committee regarding the electrification of construction equipment at urban sites. That is because the measure requires or allows for the use of lower emission technologies including electrified equipment.
1. Early Actions Strategy Name and Proponent

SUMMARY #: B18
ID NUMBER: EJAC-19
TITLE: HYBRIDIZATION OF MEDIUM- AND HEAVY-DUTY VEHICLES
PROONENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 1st quarter of 2011.

ARB staff was asked to investigate the feasibility of "hybrid electric technology for medium- and heavy-duty trucks" as an early action item to address greenhouse gas (GHG) emission reductions mandated by Assembly Bill 32. Medium duty trucks are trucks with gross vehicle weight rating (GVWR) between 8,501 and 14,000 pounds and heavy-duty trucks are 14,001 pounds and greater. Staff's evaluation focuses on trucks with GVWR greater than 10,000 pounds, which hereinafter are referred to as heavy-duty trucks.

Despite the widespread presence of hybrid electric technology in the passenger car industry, heavy-duty hybrid technology for commercial trucks are still in the pre-production development stage. The major factors hindering a rapid introduction of cost-effective hybrid technology in the heavy-duty vehicle sector are the high incremental cost and risk aversion by both hybrid builders and buyers.

Many of the present prototype heavy-duty hybrid vehicles use off-the-shelf components that are not designed and optimized for on-road heavy-duty hybrid vehicles. Some hybrid components are not commercially available and must be custom designed for the application. These components significantly increase the cost of the hybrid system due to the low production volumes. Also, reliability and maintainability of hybrid trucks are still being tested and long term durability of hybrid trucks has not been demonstrated for most applications.

Staff anticipates that hybrid technology will become available in the next 5 or more years as a commercial product for applications on urban delivery, utility, and other specialty work trucks with a potential to provide significant greenhouse gas emission reductions by 2020.
3. Early Action Description

Adopt a regulation and/or incentive program to take advantage of emerging hybrid electric technology for heavy-duty trucks.

Hybrid electric technology offers the potential to significantly improve fuel efficiency and performance while reducing emissions. However, these benefits are highly dependent on the duty cycle of the truck application. Hybrid technology provides the greatest benefit when used in vocational applications that have significant urban, stop-and-go driving, idling, and power take-off operations in their duty cycle. Such applications include parcel delivery trucks and vans, utility trucks, garbage trucks, transit buses, and other vocational work trucks. Line haul trucks are typically operated for long periods of time at high speed and load cruise driving modes and therefore, hybrid technology may not be as beneficial for this type of truck.

Several governmental and non-governmental organizations have been sponsoring research and developing programs that will bring together hybrid developers, truck and engine manufacturers, and truck users in an effort to speed up the introduction of heavy-duty hybrid technology into the marketplace.

Among the governmental organizations, the United States Department of Energy (DOE) has initiated a cost shared research and development program for advanced heavy-duty hybrid propulsion systems that will focus on improving fuel efficiency of heavy duty trucks and buses. DOE is funding approximately $4 million per fiscal year of cost shared projects with the heavy-duty hybrid industry (50/50 cost share) on this program1.

The United States Department of Transportation (DOT) in partnership with the North American Bus Industries, invested over $50 million, in a program that demonstrated fuel efficiency improvements of a transit bus through hybrid propulsion and weight reduction using composite materials. In addition to investing in other hybrid and fuel cell demonstration programs, DOT also continues to fund the purchase of advanced hybrid electric transit buses2.

The United States Department of Defense is also a major sponsor in the development of heavy-duty hybrid technologies for combat vehicles and trucks.

The United States Environmental Protection Agency (U.S. EPA) has sponsored a program to develop and demonstrate the benefits of a hydraulic hybrid propulsion technology which is an alternative to hybrid electric propulsion. This system captures and stores a large portion of the braking energy by pumping hydraulic fluid into a high pressure hydraulic fluid accumulator and pressurizing an inert gas. The energy stored in the high pressure fluid is then used to help propel the vehicle during the next vehicle acceleration event2.

Among the non-governmental organizations are the WestStart-CALSTART operated Hybrid Truck Users Forum (HTUF) and the North West Hybrid Truck Consortium. HTUF assists truck users and hybrid truck makers to move to pre-production manufacturing levels and deployment and reduce overall costs by creating common fleet requirements and joint purchase commitments. Under the HTUF program, working groups that are currently active include the Parcel Delivery Working Group, the Utility Working Group, the Refuse Truck Working Group, and the Shuttle Bus Working Group3.
The Hybrid Parcel Delivery Truck Working Group focuses on Class 4 to 6 urban parcel delivery trucks and includes members from several major parcel delivery fleets in North America such as Federal Express (FedEx), United Parcel Service (UPS), Purolator Express, and the United States Postal Service (U.S. PS). FedEx was the first truck operator to test parcel hybrid electric trucks. It put 18 hybrid electric trucks on the road in 2005, 75 more in 2006 and is currently considering 75 more. Purolator Express has 10 hybrid electric parcel trucks and plans to add 115 trucks this year. UPS also plans to acquire 50 Eaton hydraulic hybrid trucks this year³.

The Hybrid Utility Working Group is made up of 14 fleets and focuses on Class 5 to 7 utility and specialty work trucks. The work group has deployed 24 utility trucks nationwide and preliminary results indicate fuel savings ranging between 10 to 50 percent³.

The Hybrid Refuse Working Group consists of 7 private and municipal refuse truck fleets. The purpose of this working group is to develop a common chassis and vehicle performance specifications in an effort to speed up the introduction of hybrid trucks for refuse fleet operations. In May 2007, the group released a request for proposals to purchase and deploy 8 preproduction hybrid refuse trucks for assessment⁴.

The Northwest Hybrid Truck Consortium is a coalition of several county and city governments, and utility companies located in the state of Washington. The group works together with HTUF to identify hybrid opportunities and raise regional and state funding for hybrid deployment. In 2006, the consortium acquired $250,000 in funding from the U.S. EPA's West Coast Collaborative project, to support early hybrid truck deployments by reducing the incremental cost of the purchased hybrid trucks⁴.

4. Potential Emission Reductions

To understand the potential of hybrid technology in reducing GHG emissions, staff estimated GHG emission reductions in 2020. Assuming that all new Class 3 to 5 (10,001 to 19,500 lbs) trucks sold in California beginning in 2015, use hybrid technology, the GHG emission reductions from these trucks are estimated to be 0.5 MMT of CO₂e in 2020. These hybrid trucks represent 20 percent of the total California fleet in the same class and their vehicle miles traveled represents 30 percent of the total California fleet of the same class. To put this in perspective, if 100 percent of the Class 3 to 5 trucks were hybrids in 2020, the potential GHG emission reduction could be up to 1.7 MMT of CO₂e.

<table>
<thead>
<tr>
<th></th>
<th>CY 2020 (MY 2015-2020)</th>
<th>CY 2020 (ALL MYS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles</td>
<td>53,421</td>
<td>273,739</td>
</tr>
<tr>
<td>(10,001 to 19,500 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily Vehicle Miles Travel</td>
<td>3,694,200</td>
<td>12,166,000</td>
</tr>
<tr>
<td>GHGs Reduced in 2020 in MMT of CO₂e</td>
<td>0.5</td>
<td>1.7</td>
</tr>
</tbody>
</table>

- Fuel economy improvement: 35%
- Base truck fuel economy: 7.2 mpg
5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Table 2 compares a base truck with a "replacement" hybrid truck. As shown in the comments column of the table, the data were obtained from different sources. Incremental cost and in-use performance data were obtained from a hybrid truck builder and DOE published reports for hybrid buses and CNG trucks.

<table>
<thead>
<tr>
<th></th>
<th>Base Diesel Truck</th>
<th>Parcel Hybrid Truck</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost ($)</td>
<td>$40,000</td>
<td>$70,000</td>
<td>- Cost of the base truck is from a truck dealership.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Incremental cost is from a hybrid builder:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$30,000 (75% above cost of base truck) for preproduction parcel trucks.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>($10,000, or 25% above cost of base truck for production volume of 10,000 trucks or more)</td>
</tr>
<tr>
<td>Fuel Economy (mpg)</td>
<td>7</td>
<td>9.5</td>
<td>Fuel economy improvement 35%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Base truck fuel economy is assumed to be 7 mpg.</td>
</tr>
<tr>
<td>Fuel Cost ($/gal)</td>
<td>$3.00</td>
<td>$3.00</td>
<td>In estimating fuel savings, the fuel price per gallon is assumed to remain constant during the 10 year lifetime period of the truck.</td>
</tr>
<tr>
<td>Annual VMT (miles)</td>
<td>22,000</td>
<td>22,000</td>
<td>Source: Parcel delivery truck feet operator</td>
</tr>
<tr>
<td>Life of the vehicle (years)</td>
<td>10</td>
<td>10</td>
<td>Source: Parcel delivery truck feet operator</td>
</tr>
<tr>
<td>Maintenance Cost</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Being pre-production vehicles, the parcel fleet operator has not realized maintenance savings because of problems in software, transmission, parking brake, etc.</td>
</tr>
<tr>
<td>Assumed maintenance costs: ($/mile)</td>
<td>$0.16</td>
<td>$0.15</td>
<td>Base truck maintenance $0.16/mile Hybrid truck maintenance cost is assumed 4% less — considers only labor and parts cost without battery replacement</td>
</tr>
</tbody>
</table>

Figure 1 shows the savings realized from fuel economy improvements and reduced maintenance needs for the 10-year life of the parcel delivery truck. Future year savings were converted into 2007 dollars using a 7 percent discount rate. Assuming a 75 percent incremental cost difference, the chart shows that the preproduction hybrid parcel truck never recovers the incremental cost from fuel and maintenance savings. If production volume increases and the incremental cost drops to 25 percent of the cost of the base truck, then the hybrid truck will recover the incremental cost within 4 to 5 years. Note that in Figure 1 the maintenance cost for the hybrid truck is assumed to be 4% less than the base truck and does not include battery replacement.
According to one hybrid truck builder, the hybrid parcel delivery truck equipped with nickel metal hydride (NIMH) will require a one-time battery replacement during its life. The replacement battery pack costs between $5,000 to $8,000. Adding this cost to the maintenance cost of the hybrid truck results in $0.18/mile which is 10 percent higher than that of the base truck. Figure 2, below, shows the savings and payback period for this truck. It can be seen that the payback period for the high volume production hybrid truck (incremental cost of 25 percent) becomes 6 years.
Figure 2

- Prototype Hybrid Parcel Truck
  Current Incremental Cost: 75%
- Incremental Cost: 40%
- Production Volume: 10,000
  Incremental Cost: 25%

6. Division: Mobile Source Control Division
   Staff Lead: Daniel Hawelti
   Section Manager: Stephan Lemieux
   Branch Chief: Michael Carter

7. References:


1. Early Actions Strategy Name and Proponent

SUMMARY #: B19
ID NUMBER: EA-B-1, B-2
TITLE: CEMENT (A): ENERGY EFFICIENCY OF CALIFORNIA CEMENT FACILITIES
PROponent: STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

Staff assessment indicates that significant near term carbon dioxide (CO₂) reductions might be obtained by implementing energy efficient practices and technologies at California's cement facilities.

A proposed measure to consider greater reduction from low-carbon fuels in the cement sector is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation, which could entail large cost impacts on cement production in California.

3. Early Action Description

California's eleven cement facilities manufacture between 10 to 15 percent of the United States cement production. Annually, these eleven facilities use large amounts of energy: 1440 gigawatt hours (GWh) of electricity (7.2% of total energy used), 17.6 million therms of natural gas (2.6%), 2.3 million tons of coal (87.9%), 0.25 tons of coke (<0.1%), and burns 5.9 million tires¹ (2.3%). The three sources that result in CO₂ emissions from cement facilities are: 1) direct emissions from fuel combustion, 2) direct emissions from limestone calcination, and 3) indirect emissions from electricity use. Reducing CO₂ emissions from fuel combustion, calcination, and electricity use requires facilities to convert to using a low-carbon fuel, decrease fuel consumption, and improve energy efficiency practices and technologies in cement production².

4. Potential Emission Reductions

In 2004, CO₂ emissions from fuel combustion, limestone calcination, and electricity use are estimated at 10.8 million metric tons of CO₂ equivalent per year (MMTCO₂E). Staff estimates that CO₂ emissions from fuel combustion are 4.1 MMTCO₂E, limestone calcination 5.9 MMTCO₂E, and electricity use at 0.8 MMTCO₂E.
Potential carbon dioxide reductions are estimated for all three of those categories listed below:

A. Fuel Combustion

Clinker production is the most energy-intensive stage in cement production, accounting for over 90% of total industry energy use\(^3\). The most prominent fuel source used for clinker production in California is coal. Coal accounts for over 95% of all CO\(_2\) emissions from fuel consumption. Coal emits over 210 pounds of CO\(_2\) per million Btu (MBtu) compared to 117 pounds of CO\(_2\) per MBtu of natural gas\(^4,5\). If a low-carbon fuel, such as natural gas, is substituted for coal, potential reductions could exceed 1 MMTCO\(_2\) reduction per year can be obtained. Further evaluation and information is needed to determine the feasibility of this proposed measure. Issues such as cost, infrastructure, plant modifications, and operational requirements need to be evaluated in more detail to determine if switching to low-carbon fuels can be recommended as a strategy for reducing greenhouse gas emissions.

B. Energy-efficiency Practices and Technologies

Energy-efficiency practices and technologies in cement production can be implemented to decrease CO\(_2\) emissions. Energy consumption in the cement plant sector consists of energy used for raw material preparation, clinker production and finish grinding\(^6\). Raw material preparation and finish grinding is an electricity-intensive (indirect emissions) production. However, electricity accounts for only 10% of the overall energy use at cement plants\(^7\).

1. Raw Materials Preparation

The standard raw materials used in California for cement production are limestone, chalk, and clay. These materials are usually extracted from a quarry close to the plant. Approximately 1.5 tons of raw materials are required to produce one ton of Portland cement. Raw materials preparation involves transport systems, blending, grinding mills, and classifiers (separators). Using the most highly efficient equipment in this category can save electricity and reduce indirect CO\(_2\) emissions by 0.2 MMTCO\(_2\)E at power plants.

2. Clinker Production

The heating of cement kilns to produce clinker is the largest user of energy at these facilities. To improve the energy-efficiency in clinker production, improved control systems, improved combustion system, reduction in kiln heat loss, grate coolers, preheater/precalciner type systems, newer mill drives, and use of secondary fuels can be utilized. Staff lacks sufficient data to estimate potential CO\(_2\) reductions from California facilities. Much of the information available is based on national averages of cement plant efficiencies. Using this data, potential energy efficiency improvements could result in up to 0.7 MMTCO\(_2\)E annually. Staff believes this estimate overstates the potential CO\(_2\) reductions because a study by Lawrence Berkeley National Lab\(^8\) found that California plants operate more efficiently than the national average. In order to more accurately assess potential reductions, staff needs to obtain plant specific information from each California facility.
3. Finish Grinding

To produce powdered cement, clinker is ground to the consistency of face powder. Finish grinding involves process control, grinding mills, and classifiers. Carbon dioxide emissions reduction of 0.1 MMTCO₂E can be accomplished with high-efficiency equipment.

5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The estimated cost impact to California’s cement industry to use cleaner fuels and more energy-efficient equipment/technologies is about one billion dollars annually. These costs are discussed below.

Coal is the major fuel used in California to heat the kiln used in clinker production. If coal was replaced by natural gas, total annual cost increase for California facilities would be estimated at $500 million. This equates to approximately $200 per metric ton of carbon dioxide equivalent (MTCO₂E) reduced per year. It should be noted that this number only reflects the difference in fuel costs. Additional work is needed to determine infrastructure and other costs that may significantly change the cost effectiveness.

Several technologies and practices exist that can reduce the energy intensity of various process stages of cement production. If each cement facility changed to higher energy-efficiency equipment for raw material preparation, the total cost is estimated at $256 million. This corresponds to approximately $1,300 per MTCO₂E reduced. The finish grinding process is estimated at $111 million if all cement facilities changed equipment for higher energy-efficiency. This equates to $1,100 per MTCO₂E reduced. Finally, improved energy-efficiency for clinker production involves many technical stages. Total cost for modification is estimated at $90 million. This corresponds to $125 per MTCO₂E reduced. Additional information is necessary to more accurately determine energy efficiency strategies.

6. Technical Feasibility

This measure is technically feasible by applying low-carbon fuels for heating cement kilns and using more efficient equipment at various process stages of cement production. However, staff lacks information regarding the actual benefits that would be achieved by replacing existing equipment with more energy efficient equipment used at each California cement facility. Administering these measures could be costly to industry.

7. Additional Considerations

- Applicability of technological changes will depend on the current and future situations regarding individual plants. Capital projects would be implemented only if the company has more than 50 years of limestone reserve remaining. Cement plants with a shorter supply would most likely implement minor upgrades and focus on energy management measures.
Mercury emissions from coal and raw materials needs to be evaluated. An assessment needs to be implemented concurrently with greenhouse gas reduction strategies to better understand impacts to industry.

8. Division: Stationary Source
Staff Lead: Jim Stebbins
Section Manager: Todd Wong
Branch Chief: Michael Tolstrup

9. References


1. Early Actions Strategy Name and Proponent

SUMMARY #:  B20
ID NUMBER:  EA B-1, B-2
TITLE:  CEMENT (B): BLENDED CEMENTS
PROPOSENT:  ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 2nd quarter of 2009.

3. Early Action Description

From cement plants, carbon dioxide (CO₂) emissions are released into the atmosphere during the calcination process and the burning of fuels to produce clinker, the main ingredient in Portland Cement. The calcination process involves the decomposition of calcium carbonate (limestone) to calcium oxide (clinker or lime), in which CO₂ is released. Calcination is carried out in furnaces or kilns under very high temperatures.

A strategy to reduce CO₂ emissions involves the addition of blending materials such as limestone, fly ash, natural Pozzolan and/or slag to replace some of the clinker in the production of Portland Cement. Currently, ASTM cement specifications allow for replacement of up to 5% clinker with limestone. Most manufacturers could in fact replace up to 4% with limestone. Caltrans allows for 2.5% average limestone replacement until testing of the long term performance of the concrete is complete. Caltrans currently has over $1 million in task orders and is devoting considerable staff resources to the evaluation of limestone blending in cement. Caltrans also currently has standards for using flyash and slag in concrete. Other blending practices will be explored.

Industrial wastes such as coal fly ash, blast furnace slag, and silica fume have cementitious properties and can be blended with clinker or added at the concrete mixing stage. The quality of these blended cements is comparable to Portland cement. The differences are lower initial strength, but higher final strength, and improved resistance to sulfates and seawater. In the United States, one study estimated that these blended cements account for about one percent of the domestic cement shipments. Limitations on further penetration of fly ash, slag, and silica fume into the concrete market depends on the availability, construction standards, transportation costs, and user preferences; however, the potential CO₂ emission reduction potential warrants further examination. Caltrans mandates 25% fly ash in almost all of its concrete and allows up to 35% fly ash replacement of cement. Caltrans also allows up to 60% slag replacement of cement in all concrete. Additional staff work is needed to determine other current blending practices in the State.
4. Potential Emission Reductions

In 2004, cement plants in California produced about 11.2 million metric (MM) tons of clinker, which corresponds to about 10.8 MM tons of CO₂ emitted from the production of clinker. Blending with 25% fly ash, slag, or silica fume has a potential to reduce CO₂ emissions by reducing the need to produce an equivalent amount of clinker. For each percent of cement replaced by these blending materials, CO₂ emissions may be reduced proportionally. At this time, ARB staff does not have information on how much of blended cements are used in California and further evaluations are needed to estimate the potential use of these blended cements to reduce CO₂ emissions. It should be noted that this strategy may not reduce CO₂ emissions in California, but is expected that cement imports would be reduced and thus result in reduced emissions elsewhere.

Fly ash that is typically blended is a by-product of coal combustion and may contain mercury. Mercury levels in fly ash need to be evaluated.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The production of clinker is an energy intensive process, which involves heating and maintaining high temperatures in the cement kilns and its associated equipment (pre-heaters/pre-calciners). This strategy may result in the production of less clinker per unit of cement produced. In blending with 5% limestone, it is estimated that clinker production could be reduced by 0.56 MM tons, resulting in a reduction in energy use of 2.14 x 10⁶ MMBtu. This is equivalent to not burning 75,000 tons of coal and saving plant operators in the State about $3 million. Due to the lack of information, the economic impacts of blending 25% fly ash or slag can not be determined at this time.

6. Technical Feasibility

The replacement of Portland Cement with limestone is technically feasible and may reduce CO₂ emissions per unit of cement produced. However, additional evaluations are warranted to assess the feasibility, availability, and cost of blended cements containing fly ash and slag.

7. Additional Considerations

- The cement plant industry and environmental groups support the use of blending cements.

- The production of clinker at cement plants is also a source of mercury emissions caused by naturally occurring mercury found in the raw materials and from the combustion of coal. ARB staff has begun its efforts to understand the processes involved with the production of Portland cement, gather information to assess the impacts of both CO₂ and mercury emissions, evaluate control options for all pollutants, and assess the economic impacts to the industry and the public. It is not yet fully understood the potential impacts of blending on mercury emissions from cement manufacturing facilities.

- Ongoing and future discussions with Caltrans and other agencies will ensure that
the addition of blended cements will meet their specifications and approval.

- Additional work is needed to determine the extent to which blending currently is being done and the technical feasibility of establishing limits for the blending of fly ash and slag as a strategy to reduce CO2 emissions.

8. **Division:** Stationary Source Division  
**Staff Lead:** Duc Tran  
**Section Manager:** Todd Wong  
**Branch Chief:** Michael Tollstrup

9. **References**


*Website: [http://www.ket.org/Trips/Coal/AGSM/agsmmtypess.htm](http://www.ket.org/Trips/Coal/AGSM/agsmmtypess.htm)*

*U.S Cement Plant Detail by State, PCA, December 31, 2004*

*Kamala R. Jayaraman and Joshua S. Smith, ICF Consulting*

*PCA, Cement Klin Dust Production Summary for California Portland Cement Plants.*

*Peter Hawkins, Paul Tennis, and Rachel Detwiler, The Use of Limestone in Portland Cement: A state-of-the-Art Review, PCA.*

*Climate Action Program at Caltrans, California Department of Transportation, December 2006.*


*Joe Seay, HeadWaters, Incorporated, August 2, 2007, Personal Communication.*

*Pam Herman Milmoe and Martin Ross, United States Environmental Protection Agency, Evaluation of the Environmental Impacts from APCA/CW Partnership, presented at the 1999 American Council for an Energy Efficient Economy (ACEEE)*
1. Early Actions Strategy Name and Proponent

SUMMARY #: B21
ID NUMBER: EJAC-22
TITLE: RELATIVELY INEXPENSIVE ENERGY SAVINGS MEASURES WITH SHORT PAY BACK TIMES FOR FOSSIL FUEL POWER PLANTS BUILT PRIOR TO 1980
PROONENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

In addition, the ARB staff recommends working with the local air districts to start a dialogue with power plant owners and operators to disseminate information on energy savings measures through an educational outreach program. For these measures, there is already inherent built-in advantages (cost savings and short payback times).

3. Early Action Description

This strategy proposes that the ARB implement relatively inexpensive energy savings measures with short payback times for fossil fuel-fired power plants constructed prior to 1980. The EJAC has identified these older electrical generating units as significant contributors to greenhouse gas emissions due to their lower thermoelectric efficiencies compared to new state-of-the-art combined-cycle power plants.

ARB staff determined that there are 59 fossil fuel-fired thermoelectric power plants within California that came online prior to 1980. In 2005, the CO₂ emissions from these facilities totaled 13.9 million metric tons of CO₂-equivalent per year (MMTCO2E) or about 25 percent of total CO₂ emissions from all power plants in California.

ARB staff has identified two potential measures that could generate energy savings with minimal investment. The U.S. Department of Energy's (DOE) Industrial Technologies Program helps industrial plants operate more efficiently and profitably by identifying ways to reduce energy use in key process systems. The program has identified that minimal improvements in burner efficiency can result in significant savings. The following case from the DOE website (www.eere.energy.gov/industry) provides an example of the potential savings:

Case: Consider a 50,000 lb/hr process boiler with a combustion efficiency of 79% (E1). The boiler annually consumes 500,000 million Btu (MMBtu) of natural gas. At a price of $8.00/MMBtu, the annual fuel cost is $4 million. The installed cost is
$75,000 for a new burner that provides an efficiency improvement of 2% (E2). The cost savings is:

\[
\text{Cost Savings} = \text{Fuel Consumption} \times \text{Fuel Price} \times (1 - E1/E2) \\
= 500,000 \text{ MMBtu/year} \times $8/\text{MMBtu} \times (1 - 0.79/0.81) \\
= $98,760/\text{year}
\]

The simple payback on investment is:
Simple Payback = $75,000 / $98,760/year = 0.76 year

The table below shows the annual dollar savings for 1% and 3% efficiency improvements.

<table>
<thead>
<tr>
<th>Burner Combustion Efficiency Improvement</th>
<th>Annual Energy Savings (MMBtu/year)</th>
<th>Annual Dollar Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>6,250</td>
<td>$50,000</td>
</tr>
<tr>
<td>2%</td>
<td>12,345</td>
<td>$98,760</td>
</tr>
<tr>
<td>3%</td>
<td>18,290</td>
<td>$146,320</td>
</tr>
</tbody>
</table>

The second measure is the use of newly-developed “automated migration tools,” which consist of control and process optimization software to enhance operations by automatically balancing the process for optimum results, coordinating boiler/turbine control, emissions monitoring, economic dispatch, and fleet management. (Westinghouse Process Control, Inc., a subsidiary of Emerson, is one such vendor of this technology.) Some of the benefits include lower maintenance and materials costs, improvements in heat rate, and reductions in unit startup time. The software allows power plants to modernize their operations for greater efficiency and output, while at the same time minimizing their generation downtime.

These efficiency-enhancing measures may be of particular interest to the coastal power plants that have once-through cooling. Once-through cooling is an effective and relatively inexpensive method for re-condensing super-heated steam after it has been used to generate power. Once-through cooling draws sea water into the plant, where it flows through a heat exchanger to cool the steam, and then subsequently returns the heated water back into the environment. Sea water is abundant and cold and represents an efficient means of handling waste heat. However, once-through cooling may have a deleterious environmental impact due to the entrainment and impingement of marine life; therefore, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for power plants that utilize once-through cooling. If a less-efficient cooling method is required by these power plants, they could suffer an energy penalty ranging from 1.7 to 8.6 percent. ARB staff has identified 17 pre-1980 plants that may need to be retrofitted to comply with proposed once-through cooling requirements. Measures to mitigate this loss in overall efficiency may be especially pertinent.

4. Potential Emission Reductions

For the example case above for a single boiler, the potential emission reductions range from 0.12 to 0.34 MMTCO₂E based on the fuel savings from the burner efficiency improvements. A plant-by-plant analysis is required to determine how many generating
units in the State have not already gone through similar modifications and could benefit from this measure. In addition, ARB staff was not able to obtain information on specific efficiency rates associated with the optimization software. Further investigation is required. Therefore, ARB staff cannot yet determine the total emission reduction potential of this strategy. However, depending on annual fuel consumption rates for the 59 pre-1980 power plants and opportunities for at least one percent efficiency improvements, there is a potential for significant emission reduction.

A potential co-benefit of efficiency improvements that lower overall fuel use is a concurrent reduction in criteria pollutant emissions.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The cost of burner improvements will be site-specific. Also, ARB staff was not able to obtain information on upgrade costs associated with the optimization software, and further research is required. Therefore, the total cost of implementation cannot yet be determined due to the need to assess each generating unit on a case-by-case basis. Costs will be borne by the power plants, but the payback in efficiency and reduced fuel consumption should provide a short payback time and would not be expected to translate into increased electricity rates for consumers.

6. Technical Feasibility

In 2006, the DOE’s Industrial Technologies Program completed 200 Energy Savings Assessments at U.S. industrial plants. Their website contains over 50 case studies for companies that have participated in past assessments and that are already saving energy and money. These studies describe demonstrated energy improvement projects, process improvement projects, and/or assessments at the plant level. These projects and accompanying savings can be replicated at similar plants.

With respect to optimization software, Westinghouse Process Control’s website (www.emersonprocess-powerwater.com/solutions/pwr-successstories.cfm) describes experience with over 30 power generation projects across the U.S. and internationally.

7. Additional Considerations

- This measure would complement other actions taken by State agencies. In September 2005, the California Public Utilities Commission (CPUC) launched an ambitious energy efficiency and conservation campaign by authorizing energy efficiency plans and $2 billion in funding for 2006-2008 for the State’s utilities.

- In addition, this item may be included under two CAT strategies to be implemented by the California Public Utilities Commission—specifically, “Investor Owned Utility Energy Efficiency Programs (including LSEs)” and “Investor-Owned Utility (IOU) Additional Energy Efficiency Programs/Demand Response.”

Before taking this item to the Board, ARB staff recommends conducting further research to identify any additional low-cost energy savings opportunities for power plants and to
obtain a more accurate quantification of the potential emission reductions based on a case-by-case analysis of options.

8. Division: Stationary Source Division
   Staff Lead: Chris Gallenstein
   Section Manager: Mike Waugh
   Branch Chief: Mike Tollstrup

9. References:

   California Air Resources Board, database on California power plants, based on air district permit information from 2001.

   California Air Resources Board, spreadsheet on greenhouse gas emissions from power plants for 2005, based on Energy Information Administration data.


   California Energy Commission, spreadsheet on pre-1990 generating unit ratings and status.


1. Early Actions Strategy Name and Proponent

SUMMARY #: B22
ID NUMBER: EJAC-23/EJAC-29/ EJAC-31
TITLE: IDENTIFY AND IMPLEMENT ENERGY EFFICIENCY MEASURES AT REFINERS THAT INCLUDE, BUT ARE NOT LIMITED TO, CONDUCTING AN ENERGY AUDIT
PROPOSENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Several of the measures that could be implemented to realize energy efficiency savings with potential greenhouse gas (GHG) benefits are listed in the section(s) below. Staff reviewed specifics of the necessary steps/processes necessary to implement such actions. This includes permitting and construction activities. Staff has concluded that all these measures could potentially provide moderate to significant GHG benefits. However, given the remaining uncertainties with identifying a viable strategy, staff does not recommend adding the suggested measures to the list of early actions. As part of its ongoing assessments, staff plans to:

   a) Perform an evaluation to determine refiner’s energy use and energy efficiency.
   
   b) Develop a detailed strategy to define a plan to monitor changes in refinery energy uses and efficiency over time.
   
   c) Define regulatory measures that could be implemented.

Each of these activities requires detailed analyses to ensure a comprehensive plan is adopted by each refinery before energy efficiency measures could be implemented.

3. Early Action Description

U.S. Department of Energy, the American Petroleum Institute, and large refinery facilities have completed a number of energy efficiency projects and demonstration studies in the last ten years. The results from these activities are the basis of the suggested measures for energy efficiency savings. The potential measures that could achieve modest to significant energy savings include: use of an energy management assessment system to continually optimize refinery processes, installation of new or expanding existing co-generating capacity, use of new (low-energy) technologies for desulfurization of fuels, incorporating low level heat streams back into refinery processes, reducing fouling and corrosion in cooling water streams, and treating and using low BTU refinery plant gas as an energy source. Some of these measures are currently under evaluation by refiners.
4. Potential Emission Reductions

Current ARB GHG combustion estimates suggest that California refineries emit 30 million metric ton equivalents of CO₂ annually. However, energy and GHG savings need to be determined for each refinery. Co-generation reduces CO₂ emissions by ~ 25% (not plant wide but just from this source of energy) compared to steam and electricity being delivered by an external utility. Savings are mainly derived by lower transmission losses, export of electricity and better heat management at the facility. The other measures when implemented could provide for marginal to moderate reductions (< 10%) reductions in energy needs for a given refinery with attendant GHG reductions.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

All the measures indicated above have moderate to significant costs associated with planning, design, permitting, construction and maintenance. Most if not all costs associated with implementation would be the responsibility of the refinery.

6. Technical Feasibility

Most of the proposed measures have been demonstrated to be feasible and cost effective by industry and government agency projects. However, refinery specific technical feasibility analyses need to be conducted to ensure that the specifics of each refinery are considered before adopting or mandating any energy efficiency measure.

7. Additional Considerations

Significant technical challenges exist to adapting findings from energy assessments of even a small refinery. Completing such assessments could take anywhere from 12-18 months before a report could be delivered. Based on the recommendation, construction, permitting, etc. may require additional time. Hence, adoption of measures to conduct such energy assessments is reasonable but not as discrete early action measures due to the time needed to conduct a complete assessment.

A study conducted by the California Energy Commission in participation with California refiners concluded that implementation would entail time frames of 3 or more years even for measures for which there was no significant technical, regulatory, enforcement, or other challenges. This conclusion is similar to staff's assessment of timelines necessary for adoption of any of the measures discussed above.

8. Division: Stationary Source
   Staff Lead: Reza Lorestany
   Section Manager: John Courtis
   Branch Chief: Dean Simeroth
1. Early Actions Strategy Name and Proponent

SUMMARY #:\hspace{1cm} B23
ID NUMBER: \hspace{1cm} EJAC-24
TITLE: \hspace{1cm} ACCELERATE THE REPLACEMENT OF CARGO HANDLING EQUIPMENT AT PORTS
PROONENT: \hspace{1cm} ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Accelerating the replacement of cargo handling equipment at ports and Intermodal rallyards beyond that required by the Air Resources Board’s (ARB) regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards (Cargo Handling Rule) could compromise the expected reductions in NO\textsubscript{x} and diesel PM from that rule and would have negligible impacts on greenhouse gas emissions. Accelerating the implementation dates for compliance could potentially jeopardize the overall benefits that can be realized from the Cargo Handling Rule. While there may be some near-term increase in emission reductions, a large portion of the overall benefits that are scheduled to be realized would be lost since operators would not be able to purchase the cleaner Tier 4 engines that will be available in the post 2011 timeframe. For example, for some larger equipment, such as rubber tire gantry cranes (RTG) that have long useful lives (up to 20 years or more), high horsepower ratings, and are costly (upwards of over 1 million dollars), the regulation was designed to accelerate the turnover of this equipment such that, in most cases, a new RTG would be purchased when the ultra-low emission Tier 4 engines would be available. Having this equipment replaced sooner, as proposed in this early action measure, would result in the loss of the significant emissions benefits from a Tier 4 engine since the operator would have to purchase either a Tier 2 or Tier 3 engine. Since this equipment has a long useful life, the benefits of a Tier 4 engine would be foregone for up to 20 years.

Furthermore, it is expected that the Cargo Handling Rule, or the acceleration of that rule, would result in a negligible effect on global warming. Because the Cargo Handling Rule requires operators to move from uncontrolled engines to cleaner engines with NO\textsubscript{x} and PM controls and in some cases to apply exhaust retrofits, there can be a fuel economy penalty as high as two to four percent. When more fuel is burned, more CO\textsubscript{2} is produced, and CO\textsubscript{2} is a greenhouse gas. However, the Cargo Handling Rule does result in the reduction of black carbon emissions which also contribute to global warming and this may offset the fuel penalty effects.
Accelerating the turnover would result in the loss of NOx and diesel PM emission reductions over the life of the equipment resulting in a loss of public health protection and without achieving any measurable greenhouse gas benefits.

3. Early Action Description

The Cargo Handling Rule became effective December 6, 2006, and established performance standards based on the best available control technology (BACT) for new and in-use cargo handling equipment operating at these facilities. Compliance with the regulation will be phased in beginning in 2007 based on the age of the engine, whether or not it is a yard truck or non-yard truck equipment, and the size of the fleets. The performance standards and compliance dates in the regulation were designed to maximize the public health benefits from the rule, taking into account the useful life of the equipment, the use and cost of new equipment, the horsepower of the engines, and when cleaner new engines, in particular the 2007 on-road engines and Tier 4 off-road engines, would be available.

This Early Action Strategy proposes to accelerate the replacement of cargo handling equipment at ports and intermodal rail yards earlier that the compliance schedules required by the existing statewide regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards. The proponents of this measure did not provide any details on the dates for acceleration or the equipment targeted.

4. Potential Emission Reductions

As discussed under “Staff Recommendation”, we do not expect any greenhouse gas emission benefits from this proposed early action measure.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The costs associated with accelerating the implementation dates in the Cargo Handling Rule could be significant. In most cases, the useful life of equipment would be decreased even more than required by the rule, resulting in increased costs to terminal operators, shippers, and consumers.

6. Technical Feasibility

It is technically feasible to require faster turnover of equipment at ports and intermodal rail yards. However, as discussed in “Staff Recommendation,” accelerating the turnover would decrease the expected emission reductions of NOx and diesel PM from the rule and have negligible impacts on greenhouse gas emissions.

7. Additional Considerations

8. Division: Stationary Source Division
   Staff Lead: Lisa Williams
   Section Manager: Cherie Rainforth
   Branch Chief: Dan Donohue
1. Early Actions Strategy Name and Proponent

SUMMARY #: B24
ID NUMBER: EJAC-25
TITLE: EVALUATE ENCLOSED DAIRY BARNS AS AN ADDITIONAL STRATEGY FOR THE CAPTURE AND COMBUSTION OF METHANE EMISSIONS AT DAIRIES
PROPOSED: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

In addition to this measure, ARB staff will be evaluating potential measures for modified feed management, manure removal frequency, covered and treated lagoons, and digesters as potential strategies for reducing methane emissions.

This evaluation will be undertaken as part of ARB's actions for reducing methane emissions at dairies. These actions are not appropriate for consideration as early action measures because the time-frame is not sufficient to conduct the required in-depth cost-effective analyses, develop consistent emissions testing methods, and evaluate emerging technologies or technology-transfers. These activities must be conducted in advance of proposing any measures for reducing GHG emissions from dairy operations. ARB Planning and Technical Support Division (PTSD) staff is currently developing a protocol for calculating changes in GHG gas emissions resulting from the voluntary installation of a manure digester at animal agricultural facilities. The development of this voluntary protocol has been proposed as an early action measure and is discussed in a separate white paper prepared by PTSD.

3. Early Action Description

This strategy proposes that the ARB develop a regulation to require that housing and milking barns at dairies be vented to an incinerator or biofilter/bioscrubber as a means of controlling methane emissions from enteric fermentation. This strategy consists of fully enclosing barns and exhausting the air to an incinerator or a biofilter/bioscrubber.

Incinerators can achieve a 90 percent or greater reduction in methane emissions. However, incinerators emit oxides of nitrogen, carbon dioxide, toxic air pollutants and require the use of a fuel to promote the destruction of compounds such as methane.
Biofilter/bioscrubber technology can achieve approximately 80 percent control of emissions of volatile organic compounds (VOCs), ammonia, and hydrogen sulfide. ARB staff was not able to confirm any control efficiencies for methane from biofilters/bioscrubbers. By-products of biofilters/bioscrubbers are water and carbon dioxide.

In their May 7, 2007 letter to the Chairman of the Air Resources Board, the Center on Race, Poverty & the Environment argues 1) that cow housing is where most enteric fermentation takes place, 2) biofilter systems are already in use for swine facilities and have been reported for dairies, and 3) have been proposed by industry in California. ARB staff has not been able to confirm the extent to which these statements are true. In addition, ARB staff is not aware of any information about the cost of these technologies or their ability to reduce GHG emissions at any enclosed animal facility.

4. Potential Emission Reductions
California’s dairy cow population produces about 4.7 MMTCO2E of methane from enteric fermentation. Although biofilters/bioscrubbers and incinerators can reduce methane emissions, the overall net GHG emissions (that would occur after discounting the GHG emissions emitted from electricity required to operate the technologies and as a by-product of the technologies themselves) have not been determined.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities
A detailed cost-effectiveness analysis of such systems needs to be performed prior to their application. In addition, the calculation of net reduction in GHGs must include the electricity used to move contaminated air from the barns to the filtration device or incinerator. The agriculture industry, particularly sectors involved in confined animal facilities, would be impacted by this proposal.

6. Technical Feasibility
These technologies could theoretically be transferred to dairies. However, the extent to which enclosed animal barns outfitted with these technologies could achieve a net reduction in GHG emissions, particularly carbon dioxide, has not been demonstrated.

7. Additional Considerations
This is an untested technology with likely high-energy requirements for airflow and high-water requirements for evaporative cooling. There may be some benefits in milk production by maintaining the proper temperatures inside the freestall barns. Manure handling in the confined spaces may be more difficult. An increased risk to animals will occur from overheating. Marketing campaigns based on “unconfined cows” might be compromised. Animal health and welfare issues may arise.
8. **Division:** Stationary Source Division  
   **Staff Lead:** Dan Weller  
   Regulatory Assistance Section  
   **Section Manager:** Kitty Howard  
   **Branch Chief:** Michael Tollstrup  
   **Staff Attorney:** George Poppic

9. **References:**


2. *Letter to Dr. Robert Sawyer, Chairman of the California Air Resources Board. Dated: May 7, 2007. Received from Avinash Kar (Center on Race, Poverty, & the Environment) and Tom Frantz (Global Warming Environmental Justice Advisory Committee)*

B-82
1. Strategy Name and Proponent

SUMMARY #: B25
ID NUMBER: EJAC-26
TITLE: COMPOSTING – ADOPT SOUTH COAST AND SAN JOAQUIN RULES STATEWIDE
PROONENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

3. Description

South Coast Air Quality Management District (SCAQMD) Rule 1133.2 and San Joaquin Valley Unified Air Pollution Control District (SJV) Rule 4565 were adopted for the purpose of controlling volatile organic compounds (VOC) and ammonia from co-composting facilities. This strategy would adopt SCAQMD and SJV rules for enclosed co-composting facilities statewide. Co-composting is the composting of a mixture of biosolids and manure with bulking agents to produce compost. Greenwaste facilities use green waste or food waste as the primary feedstock, and may add small amounts of manure or other biosolids as an amendment; chipping and grinding facilities reduce the size of greenwaste or wood waste to be used in composting, or as cover for landfills.

4. Potential Emission Reductions

This action is expected to have a low (0-0.1 million metric ton carbon equivalent) emissions reduction potential. The composting rules in SCAQMD and SJV were designed to reduce emissions of VOC and ammonia (as precursors to ozone and PM10). GHG emissions were not evaluated during the development of the district rules.

According to U.S. EPA, composting may result in emissions of methane from anaerobic decomposition, and non-biogenic emissions of carbon dioxide (CO₂) from the collection and transport of the organic materials to the composting site. U.S. EPA considers CO₂ emissions from aerobic decomposition to be "biogenic" and therefore does not include them in the Inventory of U.S. Greenhouse Gas Emissions and Sinks. Research indicates that efficient composting will not result in significant methane emissions, will have minimal CO₂ emissions from transportation and mechanical turning of compost piles, and can result in some carbon storage (sequestration) from the application of compost to soils. Methane emissions were estimated to be essentially zero and CO₂ emissions per ton of material composted was estimated to be 0.01 million ton carbon equivalent (MTCE) indirect CO₂. U.S. EPA estimated that centralized composting of organics
results in net GHG storage of 0.05 MTCE/wet ton of organic inputs composted and applied to agricultural soil.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

SCAQMD evaluated the cost effectiveness of Rule 1133.2 under several scenarios. Under the most likely scenario for an existing facility, with enclosures for all phases of the operation, and biofiltration, the cost was $8,700 to $10,000 per ton of VOC and ammonia reduced, depending on the type of enclosure selected. Costs for a new facility were between $11,000 and $12,000 per ton. Although greenwaste composting facilities have the largest throughput of any composting operation, they are exempt because the control options were determined to be cost-prohibitive.

6. Technical Feasibility

It would be technically feasible to have all large composting facilities in the State comply with a statewide control measure similar to the SCAQMD or SJV rules. However, it is unclear at this time if the control measure would reduce GHG emissions.

7. Additional Considerations

While implementation of this strategy would certainly result in additional statewide VOC and ammonia benefits statewide, GHG reduction benefits are currently unclear. An analysis is needed to determine whether the controls (enclosure and biofilters) will reduce GHG emissions. Additionally, the Market Advisory Committee report on the establishment of a Cap and Trade Program reported that composting does not produce net greenhouse gas emissions. Furthermore, U.S. EPA has estimated that there is a net GHG storage of 0.05 MTCE/wet ton of organic inputs composted, once they are applied to agricultural soil. Data on GHG emissions from composting operations in the SCAQMD and SJV, as well as other areas of the State, need to be obtained and analyzed in order to determine if this strategy has the potential to result in GHG emission reductions.

With low-to-zero anthropogenic GHG emissions, regulating composting facilities for their GHG emissions alone may be cost prohibitive. The Market Advisory Committee noted that local governments have created incentives for increased composting based on the need to reduce the amount of material sent to landfills. Cities and counties were mandated to achieve a 50 percent source reduction by the year 2000, compared to a 1990 baseline. The current statewide diversion rate is 42 percent. If new regulations are imposed on these facilities, it could hinder further progress towards this goal. Composting, alternatively, may be considered a method of carbon sequestration and therefore a potential offset measure (for example, United States Department of Agriculture research indicates that compost usage can reduce fertilizer requirements by at least 20 percent thereby significantly reducing net GHG emissions), which would enhance the economic viability of composting. These issues need to be carefully considered and analyzed prior to proceeding with this strategy.

8. Division: Stationary Source Division
   Staff Lead: Kate MacGregor
   Section Manager: Richard Boyd
   Branch Chief: Dan Donohoue
1. Early Actions Strategy Name and Proponent

SUMMARY #: B26
ID NUMBER: EJAC-27
TITLE: PHASE OUT PRE-1980 POWER PLANTS GENERATING AT LEAST 100 MW AND PROVIDE INCENTIVES TO REPLACE THEM WITH CLEAN ENERGY
PROPOSENENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

ARB staff determined that the greenhouse gas reduction potential of this strategy appears to range from low (actually an increase in emissions) to large, depending on what assumptions are used. ARB staff recommends working with the local air districts to analyze the best options for each generating unit. This work would include determining to what extent natural phase-out is occurring and at what pace; considering how the existing power plants operate versus how the replacement plants will operate (combined-cycle generation is designed for baseload operation and using it as peaking capacity could result in higher emissions due to frequent startup and shutdowns where combustion systems and controls are not optimized); analyzing how planned transmission upgrades will affect the need for Reliability Must Run (RMR) units; and looking at whether new proposed power plant projects will replace the need for old generating units.

3. Early Action Description

This strategy proposes that the ARB develop a permitting system to phase out, by 2010, fossil fuel-burning thermoelectric power plants that generate at least 100 MW and were built prior to 1980. The EJAC argues that these represent the oldest, most inefficient units. The mechanism for this phase out would be through a scaled and planned annual reduction in CO₂ emissions between 2007 and 2010. The 2010 end-goal would be an emission standard equivalent to the 2007 cleanest combined-cycle plant operating at a heat rate of 6,500 Btu/kWh. Generating units that cannot meet the emission standard would be required to shut down. The proposed phase-out would occur according to the following increments of progress:
<table>
<thead>
<tr>
<th>Year</th>
<th>Allowable CO₂ Emission Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>equivalent to 2006 emissions</td>
</tr>
<tr>
<td>2008</td>
<td>at least 1/2 less than the difference between 2007 emissions and the 2010 standard</td>
</tr>
<tr>
<td>2009</td>
<td>at least 2/3 less than the difference between 2007 emissions and the 2010 standard</td>
</tr>
<tr>
<td>2010</td>
<td>equivalent to California's most efficient plants built in 2007 rated at 100 MW and 6,500 Btu/kwh</td>
</tr>
</tbody>
</table>

EJAC also suggests that ARB prohibit an RMR designation by the California Independent System Operator (CAISO) as a means to allow a unit that does not meet the emission levels to operate.

ARB staff assumes that the power plants in question will be replaced by modern combined-cycle power plants consisting of natural gas-fired combustion turbine generators where heat is recovered from the gas turbine exhaust gases to heat water and generate steam, which is sent through a steam turbine to produce additional electricity. Therefore, the amount of fossil fuel burned to generate electricity is less than older units with no heat recovery. For example, the typical electric generation efficiency of a combined-cycle plant is estimated from 40-58 percent, while a utility boiler is estimated from 25-40 percent.

ARB staff assumes that the power plants in question will be replaced by modern combined-cycle power plants consisting of natural gas-fired combustion turbine generators where heat is recovered from the gas turbine exhaust gases to heat water and generate steam, which is sent through a steam turbine to produce additional electricity. Therefore, the amount of fossil fuel burned to generate electricity is less than older units with no heat recovery. For example, the typical electric generation efficiency of a combined-cycle plant is estimated from 40-58 percent, while a utility boiler is estimated from 25-40 percent.

ARB staff determined there are 59 fossil fuel-fired thermoelectric power plants within California that came online prior to 1980. In 2005, the CO₂ emissions from these facilities totaled 13.9 million metric tons of CO₂-equivalent per year (MMTCO2E) or about 25 percent of total CO₂ emissions from all power plants in California. Of these, 30 power plants are also rated at 100 MW or more. The 30 plants represent three percent of the number of power plants statewide, yet contribute approximately 21 percent of the total MW plant capacity in the State. If all 30 plants are phased out by 2010, the State would need to secure about 20,000 MW of capacity. The facilities are located within the jurisdiction of the following air districts: Bay Area, South Coast, Mojave Desert, San Diego, San Luis Obispo, North Coast, and Ventura. The generating units consist of natural gas-fired utility boilers and combustion turbines, with the exception of one facility that uses jet fuel.

Of these 30 power plants, high heat rates and future longevity may soon be less of an issue due to several factors. First, ARB staff has determined that 18 plants have either replaced all or a portion of their generating units or the old generating units are retired or soon to be retired. Secondly, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for cooling water intake structures related to the mitigation of entrainment and impingement.
of marine life at power plants that utilize once-through cooling. ARB staff has identified 17 plants (14,479 MW) that may need to be retrofitted to comply with proposed once-through cooling requirements. These plants may be retired due to the cost to retrofit or may suffer an energy penalty ranging from 1.7 to 8.6 percent (at 67 percent load) to install wet or dry cooling.

Regarding reliance on RMR units, one of the ways to reduce the need to sign RMR contracts is to invest in transmission upgrades. Upgrades that increase the ability to import energy from neighboring states and Mexico, and increase the amount of energy that can be delivered to the major load centers in California, minimize the need to sign RMR contracts with aging facilities in these areas for local reliability purposes. Two major upgrades are scheduled to operating by 2008 and will increase the transmission networks import capability into Southern California by as much as 1,150 MW. The Miguel-Mission 230 kV line #2 will increase the import capability into San Diego by 560 MW and is expected to be operating by June of 2006. The short-term Southwest Transmission Expansion Plan upgrades will increase the import capability into the Los Angeles Basin by approximately 500 MW. There are no other major projects planned to increase the transmission capacity into California before 2009.

As a companion to the phase out of older, higher-emitting plants, this strategy proposes that incentives be provided to encourage clean energy substitutions. Identifying available incentive programs would be included as part of the evaluation for the Scoping Plan. However, there is a potential incentive in Assembly Bill 32 (AB 32) for facilities that implement voluntary reduction measures. AB 32 requires that adopted regulations ensure entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of these regulations receive appropriate credit for early voluntary reductions (Health and Safety Code Section 38582 (d)(3)). To support these reductions, ARB is required to adopt methodologies for the quantification of voluntary greenhouse gas emission reductions, and adopt regulations to verify and enforce any voluntary reductions that are authorized for use to comply with emission limits established by ARB (Health and Safety Code Section 38571).

4. Potential Emission Reductions

In 2005, the 59 pre-1980 power plants produced 13.9 million metric tons of CO₂-equivalent per year (MMTCO2E), which is equivalent to 24 percent of the CO₂ produced by power plants. Although available data were incomplete, plant numbers indicate capacity factors¹ ranging from 1.3 to 36.1 percent (average 13.2 percent). While recent data shows these plants operate infrequently, replacing them with new natural gas combined-cycle units would mean that the new plants will operate more because they are designed for baseload generation. Combined-cycle plants tend to have capacity factors around 85 percent². Based on these assumptions, ARB staff estimates the potential emissions impact due to shut down of pre-1980 power plants and replacement with combined-cycle generation in 2010 ranging from a 2.4 MMTCO2E reduction (at

¹ A percentage that tells how much of a power plant's capacity is used over time. It is the ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.
² Assumed CO₂ emission factor for combined-cycle generation is 1,100 lb CO₂/MWh, as proposed in SB 1368 regulations.
13.2 percent capacity factor) to a 60.4 MMTCO2E increase (at 85 percent capacity factor). Therefore, the emission reduction potential of this strategy is considered from low to large.

Depending on how well-controlled the existing plants are, there is the potential for criteria pollutant reductions from combined cycle. At the same time, depending on how the new facilities are operated, there is the potential for an overall increase in emissions due to frequent startups and shutdowns or higher capacity factors.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

ARB staff estimates that the cost to implement this strategy is simply the cost of replacing the old power plants with new combined-cycle power plants of identical capacity. As mentioned above, the potential replacement capacity is 20,000 MW. To replace this capacity with equivalent combined cycle generation is estimated to range from $1.4 to 8.7 billion (using a levelized cost for combined cycle of 5.85 cents/kWh²) based on capacity factors from 13.2 to 85 percent. If there is a reduction in emissions, the cost effectiveness is $564 per-MTTCO2E. The bulk of the costs will be borne by the electric utility industry. In turn, this could impact consumers in the form of increased electricity rates.

6. Technical Feasibility

The siting of large natural gas-fired combined-cycle plants in California started in 1997, coinciding with the passage of legislation in 1996 deregulating the California electric utility industry. Since then, 19 of these plants, totaling over 10,000 MW, are currently operating throughout the State. Therefore, the technology is proven and well-established.

7. Additional Considerations

Rules of the Oregon Energy Facility Siting Council set CO2 emission standards for new energy facilities. The standards apply to baseload gas plants, non-baseload power plants, and non-generating energy facilities that emit CO2. For baseload gas plants and non-baseload plants, the standard sets the net emissions rate at 0.675 pounds CO2/kWh (675 pounds CO2/MWh).

On October 30, 2006, the California Energy Commission (CEC) instituted a proceeding to establish a greenhouse gas emission performance standard to implement Senate Bill 1368 (Stats. 2000, Ch. 598). The bill directs the CEC, in consultation with the California Public Utilities Commission and the California Air Resources Board, to establish a greenhouse gas emission performance standard for all baseload⁴ generation of local publicly owned electric utilities at a rate no higher than the rate of emissions for natural gas-fired combined-cycle baseload generation. The proposed standard was set at 1,100 pounds of CO2/MWh, based on evaluating the performance of existing

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³ Represents an average of several cost estimates.
⁴ ARB staff is awaiting interpretation from the CEC and California Public Utilities Commission regarding whether plants currently operating with low capacity factors (but which were originally designed and intended for baseload operation) are subject to SB 1368 regulations.
combined-cycle natural gas baseload plants throughout the west, with special attention paid to the performance of units in California.

The CEC adopted the regulations pursuant to SB 1368 on May 28, 2007. The final rulemaking package was submitted to the Office of Administrative Law on June 1, 2007. On June 29, 2007, OAL issued a decision disapproving the action. The CEC is currently working on addressing the decision and determining what changes should be made to the proposed regulations to address OAL’s concerns.

8. Division: Stationary Source Division
   Staff Lead: Chris Gallenstein
   Section Manager: Mike Waugh
   Branch Chief: Mike Tollstrup

9. References:

1 California Air Resources Board, database on California power plants, based on air district permit information from 2001.

2 California Air Resources Board, spreadsheet on greenhouse gas emissions from power plants for 2006, based on Energy Information Administration data.

3 California Energy Commission, "Comparative Cost of California Central Station Electricity Generation Technologies," Staff Report, publication #100-03-001, August 2003.


7 California Energy Commission, Power Plant Licensing Cases, Status of All Projects, last updated 7/25/07: http://www.energy.ca.gov/stirlingcases/all_projects.html


11 California Energy Commission, spreadsheet on pre-1980 generating unit ratings and status.


14 Julie Gill, CAISO, personal communication, 7/24/07.

15 Oregon’s Power Plant Offset Program: http://www.climatetrust.org/programs_powerplant.php


1. Early Actions Strategy Name and Proponent

SUMMARY #: B27
ID NUMBER: EJAC-28
TITLE: PROHIBIT FUEL OIL BURNING IN PRE-1980 POWER PLANTS GENERATING AT LEAST 100 MW
PROPOSENENT: ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

ARB staff determined that the greenhouse gas reduction potential of this strategy is low. All power plants in California built prior to 1980 and rated at 100 MW or more with oil-firing capability utilize fuel oil only for backup purposes. There is one small plant on Catalina Island rated at 9.3 MW that uses diesel as the primary fuel.

3. Early Action Description

This strategy proposes that the ARB develop a regulation to prohibit the burning of fuel oil at power plants that generate at least 100 MW and were built prior to 1980. ARB staff determined there are no power plants of 100 MW or more in California that were constructed before 1980 and that burn fuel oil as the primary fuel. There are, however, 11 plants rated greater than 100 MW that are permitted to burn fuel oil as backup. They are located within the jurisdiction of the following air districts: Imperial, San Diego, South Coast, North Coast, and Bay Area. During 2005, four of these 11 plants used fuel oil for some portion of the year. The combined diesel and residual fuel oil consumption during 2005 emitted an estimated 0.068 million metric tons of CO₂-equivalent (MMTCO2E), or only 0.12 percent of the total CO₂ emissions from all California power plants.

In addition, there are five power plants rated less than 100 MW that utilize fuel oil as the primary fuel. They are located in South Coast, Placer County, and Northern Sierra air districts. Generating units at four of the five plants have been retired; only the Pebble Beach Generating Station on Catalina Island remains operational.

The longevity of four of the 11 power plants may be affected by proposed State Water Resources Board policy pertaining to coastal power plants that have once-through cooling. Once-through cooling draws sea water into the plant, where it flows through a heat exchanger to cool the steam, and then subsequently returns the heated water back to the source. Sea water is abundant and cold and represents an efficient means of handling plant waste heat. However, once-through cooling may have a deleterious
environmental impact due to the entrainment and impingement of marine life; therefore, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for power plants that utilize once-through cooling. The policy may require retrofit with an alternative cooling system such as wet or dry cooling. These plants may be retired due to the cost to retrofit.

4. Potential Emission Reductions

To determine potential emission reductions, ARB staff looked at the difference in emissions due to use of alternative fossil fuels with a lower carbon profile using 2005 as the baseline and assuming 2010 consumption data will be similar. As stated above, diesel and fuel oil burning in 2005 produced 0.068 MMTCO2E. Replacing fuel oil with liquefied petroleum gas (LPG) would result in a 14 percent reduction (0.010 MMTCO2E) in 2010. To replace with natural gas would result in a 25 percent reduction (0.017 MMTCO2E). Therefore, the emission reduction potential of this strategy is considered to be low.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The primary cost associated with this strategy is expected to consist of either the cost of lost power when it is needed (i.e., during a gas curtailment) or the price and cost of an alternative fuel, such as LPG, and its associated infrastructure. It is also possible that some of the generating units (e.g., burners) may need to be retrofitted to accommodate a different fuel.

The costs to businesses and consumers for lost power requires more in-depth research and was not determined for purposes of this analysis; however, it is expected to be significant, particularly depending on the frequency, timing, and duration of these events.

With respect to the use of alternative fuels, the cost of an equivalent amount of LPG is less than the combined diesel and fuel oil consumption for 2005. However, without specific plant information, ARB staff cannot determine any additional costs associated with infrastructure and equipment retrofits at this time.

6. Technical Feasibility

Power generating boilers, combustion turbines, and reciprocating engines that operate on a variety of fossil fuels are not new technologies. Some of the generating units in question may already have dual-fuel firing capability and thus the conversion from oil burning to a lower carbon fuel is not expected to require any equipment retrofits. Other units will have to be looked at on a case-by-case basis to determine the feasibility of retrofits such as replacement of burner orifices to accommodate various fuels.

Another factor to consider with respect to feasibility is that facilities may be limited by geography in terms of fuel supply choices. For example, the Pebble Beach Generating Station is located on Catalina Island just off the coast from Los Angeles and utilizes diesel fuel in their reciprocating engine generators. In addition, some regions have the need for dual-fuel capability due to natural gas curtailments. Adverse weather conditions, particularly in Northern California, during which commercial and industrial
space heating loads are high, can result in natural gas curtailments and spur the need for dual-fuel capability to meet power requirements.

7. Additional Considerations

Some California local air districts have prohibitory rules that apply to power generating units that directly prohibit oil burning after a certain date. Other district rules may indirectly result in the phase out of oil burning through average emission standards that apply to multiple generating units. In order to maximize operation, these power plants would be motivated to switch to cleaner-burning fuels, install emission control technologies, or a combination of both.

8. Division: Stationary Source Division
   Staff Lead: Chris Gailenstein
   Section Manager: Mike Waugh
   Branch Chief: Mike Tolistrup

9. References:

   California Air Resources Board, database on California power plants, based on air district permit information from 2001.

   2 California Air Resources Board, District Rules Database, main page last updated 3/24/05: http://www.arb.ca.gov/drdp/drdp.htm

   3 California Air Resources Board, spreadsheet on greenhouse gas emissions from power plants for 2005, based on Energy Information Administration data.


   8 California Energy Commission, spreadsheet on pre-1980 generating unit ratings and status.

   9 Energy Information Administration, Spot Prices for Crude Oil and Petroleum Products, last updated 7/25/07: http://tonto.eia.doe.gov/dnav/pet/pet_pri_spst_d.htm

   10 Energy Information Administration, Spot Prices for Crude Oil and Petroleum Products, last updated 7/25/07: http://tonto.eia.doe.gov/dnav/pet/petPri_and_dcus_nus_w.htm

   11 Energy Information Administration, Weekly Heating Oil and Propane Prices, last updated 4/19/07: http://tonto.eia.doe.gov/dnav/pet/pet_pri_wfr_dcus_nus_w.htm
1. Early Actions Strategy Name and Proponent

SUMMARY #: B28
ID NUMBER: EJAC-30/ARB 1
TITLE: REFINERY METHANE EMISSIONS
PROPOSER: 2006 CAT REPORT and STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be
developed as a draft by mid-2008 and must be considered by the Board prior to
January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective
approach for fully considering the recommendation.

Currently, there is no reporting system that identifies the sources and quantity of
methane emissions from refineries. However, the draft 2004 California GHG inventory
lists California petroleum refinery emissions as 30 million metric tons of CO₂ equivalents.
Using Air Resources Board (ARB) Emission Inventory Data¹ and ARB refinery speciation
profiles it is estimated that refinery methane emissions are 1.4 million metric tons of CO₂
equivalents. Recent refinery studies² suggest that the majority of the methane
emissions come from crude oil transfer operations, fugitive losses (valves and fittings),
flares, cooling towers, and wastewater treatment.

Staff proposes to:

(a) Perform an evaluation to determine sources and magnitude of refinery
methane emissions; and

(b) Develop a detailed strategy to define regulatory measures for monitoring
and control of methane exemptions granted to refineries. This will include
methane control measures for refinery processes currently controlled
under non-methane volatile organic compounds emission limits, and for
some sources with limited control requirements, e.g., cooling towers,
wastewater treatment, and ponds.

3. Early Action Description

Methane is emitted from many refining operations. The major sources of methane
emissions are vapor displacement from crude tanks from marine off-loading and refinery
desalter emissions. During the refining processes, methane is separated from the crude
oil through vacuum or atmospheric distillation. Methane emissions occur when gaseous
streams are transported at various points in the refinery. The primary method for

¹ ARB Almanac database
² Telephone communication with Don Robinson, ICF Consulting, 7/20/2007. ICF Consulting is
performing a methane study for the American Petroleum Institute. The study will determine the
GHG emissions for refineries. This analysis will determine CO₂, methane, and N₂O for all U.S.
refineries. Email Communication: Don Robinson DRobinson@icf.com
controlling methane emissions is the use of combustion devices, i.e., flare. If one excludes marine off-loading and refinery desalter emissions, most if not all refinery methane sources are low energy, i.e., low heating value, vapor streams\(^3\) that cannot be economically recovered.

4. Potential Emission Reductions

The potential emission reductions from this measure are unknown.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

There is no accurate estimate of the costs or the economic impacts. It is expected that the costs, depending on the source, could range from low to high. For new or exempt sources the costs may be high. In contrast, existing non-methane hydrocarbon control systems already control methane emissions by default. The major impact on existing control systems would be to require that methane be included in emission capture or destruction efficiencies.

6. Technical Feasibility

Monitoring and implementation of methane emission control measures is technically feasible. However, many California refineries do not use Best Available Control Technology (BACT) for known methane sources. Use of methane BACT may require additional work for design, local planning approval, and installation. Technology that meets refinery methane BACT has been installed in some California refineries. Use of a catalytic combustion device at the Shell Martinez marine loading terminal is a good example of a methane BACT installation. Mandatory use of BACT for all crude transfer operations and refinery desalter emissions will control most methane emissions by default.

7. Additional Considerations

None

8. Division: Stationary Source Division
   Staff Lead: Tim Dunn
   Section Manager: John Courtis
   Branch Chief: Dean Sirmeroth

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\(^3\) Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, *Profile of the Petroleum Refining Industry of California* (March 2004). The report was supported by the California Energy Commission through the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

B-95
1. Early Actions Strategy Name and Proponent

SUMMARY# B29
ID NUMBER: EJAC 2/CAPCOA-6/ARB 2-3
TITLE: SPECIFICATIONS FOR COMMERCIAL REFRIGERATION
PROPOSER: 2006 CAT REPORT, ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE, AND CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

This timing will allow staff the time necessary to complete inventory research\(^1\), interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

3. Early Action Description

This early action strategy was extracted from the updated Climate Action Team (CAT) work plan entitled “Reducing Direct and Indirect Greenhouse Gas (GHG) Emissions from Stationary Refrigeration and Air Conditioning (RAC) Sources\(^2\).”

The strategy involves regulatory measures to require supermarket leak tightness and advanced design requirements for new systems as well as energy efficiency measures for new and existing systems. Direct and indirect emissions need to be considered together over the lifetime of the RAC equipment, so that choices made to reduce direct emissions (e.g., low-GWP refrigerants or standalone systems) do not adversely impact energy consumption and vice versa.

Based on current technologies, commercially available solutions for leak reduction in retail food systems (which contain more piping, fittings, and valves than other types of systems), can support establishing a 5 percent maximum annual leak rate for new

\(^1\) Inventory work in this area is expected to be complete by late 2008.
\(^2\) Direct GHG emissions refer to the high global warming potential (GWP) emissions of CFCs, HCFCs, and HFCs used as working fluids in RAC systems. Indirect GHG emissions refer to CO\(_2\) emissions associated with electricity required to operate the RAC equipment.
systems in 2011 and 2 percent for new systems by 2016\(^3\). Currently it is estimated that the average leak rate for new systems is approximately 15 percent minimum. The 5 percent maximum annual leak rate by 2011 is based on industry estimates for controlling leaks in centralized direct expansion (DX) systems, which are the predominant systems currently being installed in retail food stores\(^4\). To reach the proposed 2020 limit of 2 percent for the maximum annual leak rate, it is expected that indirect supermarket refrigeration systems will have to be adopted rather than low-leak or low-charge DX designs or distributed systems.

Additionally, based on commercially available technologies, the following energy efficiency improvements to reduce energy consumption in existing and new retail food stores are proposed: 10 percent reduction in energy usage from the current baseline in 2011 and 30 percent in 2016\(^5\). These measures will be pursued in coordination with the California Energy Commission (CEC).

The technologies required for leak reduction in retail food systems include the following: sensitive leak detection equipment, fixed leak detection methods, utilizing brazed (welded) joints instead of flanged or threaded (mechanical) joints, compressor vibration reduction, and improved or reduced numbers of Schrader valves. Additionally, owners and operators of retail food systems would be required to adopt general policies to have full accessibility to all refrigerant pipe work.

Technologies involved in advanced-design retail food refrigeration systems include reduced charge DX systems, distributed systems, secondary loop (indirect) systems, and CO\(_2\) systems (indirect, cascade, and trans-critical systems). Advanced retail food refrigeration designs serve to reduce refrigerant charge (which is important in case of ruptures) as well as reducing leaks through shorter lines that employ fewer fittings.

The improvement of energy efficiency of retail food systems includes the following technologies: evaporative condensers, high efficiency compressor designs, floating head pressure controls, heat recovery, ambient or mechanical sub-cooling, variable speed fans/motors, improved heat exchangers, hot gas defrost, adding doors or night curtains to display cases, energy-efficient reach-ins, anti-sweat heater controls, indirect or energy-efficient case lighting.

4. Potential Emission Reductions

Estimated emission reductions of 4.7 MMTCO\(_2\)E in 2020 are possible based on a growth rate of 2 percent for new retail food systems in California (from the updated CAT Work Plan); this number only includes reduced leak rate designs for new systems and energy efficiency improvements for new and existing supermarket systems. If closed cases or night curtains are required, further CO\(_2\) reductions are possible.

\(^3\) This strategy, which could be applied to all RAC systems over a given capacity, basically applies to retail food systems since other "large" systems currently have much lower leak rates than retail food systems, which have baseline leak rates of 15%.

\(^4\) Industry estimates of improvements and target dates were obtained from European studies, and were presented by The Alliance for Responsible Atmospheric Policy (ARAP) in a meeting with ARB on 10/10/08.

\(^5\) Adding doors or night covers to display cases is not included in the energy reduction estimate, and is expected to result in even greater energy benefits if utilized.
The US EPA has indicated that statewide reductions of approximately 6.8 MMTCO₂E in 2020 are possible for various RAC strategies ranging from leak reduction and refrigerant recovery to indirect retail food ammonia systems. Their estimate includes measures, such as mandatory leak repair for existing systems, which ARB is considering separately. Furthermore, the estimate of 4.7 MMTCO₂E is a lower bound, as other measures such as mandatory reporting/repair/refrigerant deposit and return, are expected to increase the turnover rate of old systems and lead to further GHG reductions.

5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The estimated cost of the strategies discussed in this evaluation are expected to be on the order of $10-$20/MMTCO₂E in 2020. Estimates by the US EPA range from a savings of $3/MMTCO₂E (for enhanced leak repair and refrigerant recovery) to costs of $10/MMTCO₂E (for installation of an ammonia-based indirect supermarket system). Costs in the updated CAT report were estimated to be $14/MMTCO₂E, based on incremental cost differences of 20% between indirect systems and traditional DX systems.

Cost-effectiveness will improve as contractors gain comfort with installation of indirect systems and energy saving devices, and as prices for such devices/system components drop with increased production.

6. Technical Feasibility

Leak reduction technologies were obtained from industry estimates of possible leak tightness improvements. Performance of advanced systems designs has been documented in US EPA, California Energy Commission (CEC), and Oak Ridge National Lab (ORNL) reports.

Information on energy saving technologies were obtained from US Department of Energy (DOE), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and US EPA reports, and from presentations given by Charles Zimmerman (Wal-Mart), and Denis Clicic (ARMINES) at ARB's International Symposium On Near-Term Solutions for Climate Change Mitigation in California on March 6, 2007.

All leak reduction and energy efficiency improvement technologies appear to be proven commercially-available technologies; ARAP presented leak reduction technology to ARB based on European experiences with retail food systems, and Wal-Mart has employed advanced design refrigeration systems (secondary loop with heat reclaim) as well as other energy saving measures (LED lighting, closed cases, motion detection for lighting, machine room improvements) with aggressive energy efficiency goals of 25-30 percent reductions in 4 years.

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6 Obtained from subtracting out motor vehicle A/C reductions and distributing the national reductions to California using the 2005 population fraction of approximately 12.2%.
7. Additional Considerations

Given the necessary inventory research, technical complexity and stakeholder input process, staff believes this item could be developed into a regulatory proposal to be considered by the Board by the fourth quarter of 2010.

The affected entities will be owners and operators of retail food (or similar built-up) refrigeration systems, as well as contractors/technicians who install/repair such systems and manufacturers of system components.

A partial list of trade associations possibly impacted, either positively or negatively, by the regulation follows: ARAP (described previously), the Air-Conditioning and Refrigeration Institute (ARI), ASHRAE, North American Technician Excellence (NATE), California Grocers Associations.

Coordination with the US EPA and CEC with respect to developing the regulation is ongoing.

8. Division: Research Division
   Staff Lead: Whitney Leeman
   Section Manager: Michael Robert
   Branch Chief: Richard Corey

9. References

Alliance for Responsible Atmospheric Policy (ARAP)/CARB workshop, 10/06.


California EPA, Climate Action Team Report to Governor Schwarzenegger and the Legislature, 4/3/06.


Solvay Fluor, Advances in Supermarket Refrigeration Leak Reduction, Product Bulletin No. C/07.05/23/E


Van D. Baxter, Advances In Supermarket Refrigeration Systems, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6070

1. Early Actions Strategy Name and Proponent

SUMMARY #: B30  
ID NUMBER: SCAQMD-1  
TITLE: ACCELERATE INTRODUCTION AND DEPLOYMENT OF LIGHT-DUTY VEHICLE (PASSENGER) HYBRID TECHNOLOGY  
PROPOSER: SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

2. Staff Recommendation

Hybrid technology is an element anticipated to be embedded in additional regulatory measures aimed at further reducing greenhouse gas emissions from new motor vehicles. Thus, this measure is recommended to be considered as part of the analysis for the strategy to strengthen light-duty vehicle standards (B33).

During ARB development of the GHG regulation in response to AB 1493, staff carefully considered the strong benefits of hybrids in reducing CO\textsubscript{2} emissions. One of the hurdles identified to accelerating the introduction of light-duty vehicle hybrid-technology is that hybrid electric powertrains, which include an electric motor, battery pack, power controller and other components are relatively expensive. Accordingly, staff needed to consider the degree of hybridization appropriate and cost effective for the 2009-2016 timeframe. Staff concluded implementation of full hybrid electric vehicles would be premature prior to 2016 but believed that much could be done to prepare the vehicle fleet for incorporation of full hybrids in the meantime.

Accordingly, staff included Integrated starter/generator (ISG) components in nearly half of the vehicle technology package combinations that were modeled and subsequently utilized to set the adopted GHG emission standards. This provides the incentive and foundation for vehicle manufacturers to include ISG components into high volume applications, thereby driving down costs of these hybrid systems. Staff concluded that once ISG components were integrated across most of the vehicle fleet, it would be further cost-effective to increase the capability and size of these components to permit cost-effective full hybrids to be developed for deployment in the post 2016 timeframe, i.e., ones that could operate on all electric power and provide plug-In capability, assuming battery development in the meantime progresses favorably to reduce their size and cost and to improve performance and durability.

Staff also identified another hurdle - lead time for incorporating major powertrain changes throughout vehicle manufacturers' product lines. Generally powertrain changes require fairly long lead times due to the need to first develop the new components, integrate them seamlessly into the powertrain, and then test and refine them for optimum performance, reliability and durability. In addition, new machinery for producing such powertrains requires considerable planning, lead time and investment. As a result, staff provided long lead times to enable major powertrain upgrades such as incorporating...
hybrid systems into vehicles when manufacturers would be doing major revisions anyway as part of their normal vehicle powertrain life cycle process. This was done to avoid the excessive costs that accompany premature tear up of existing powertrains before their cycle life has expired.

3. Early Action Description

Modify the existing light-duty motor vehicle GHG emissions standards to require greater reductions, thereby forcing vehicle manufacturers to accelerate the introduction and deployment of hybrid technology.

4. Potential Emission Reductions

The currently adopted standards call for about a 30 percent reduction by 2016. Assuming that the new standards would call for about a 50 percent reduction, phased-in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet – staff estimates a 2030 reduction of about 27 MMT.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Since the technology is at an early stage of development, it is premature to estimate costs and economic impacts.

6. Technical Feasibility

While this measure is technically feasible, for the reasons stated above staff does not believe it would be cost-effective prior to 2017.

7. Additional Considerations

Hybrid technology needs further development and cost reduction if it is to be accepted by large numbers of consumers.

8. Division: Mobile Source Control Division
   Staff Lead: TBD
   Section Manager: Tony Andreoni
   Branch Chief: Analisa Bevan

9. References:

   Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles.
1. Early Actions Strategy Name and Proponent

SUMMARY #: B31
ID NUMBER: SCAQMD-2
TITLE: NATURAL GAS REQUIREMENT OF 1360 WOBBE INDEX
PROPOSANT: SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

2. Staff Recommendation

Staff is aware that there are several outstanding issues related to establishing a statewide Wobbe Index standard and the relationship of Wobbe Index and GHG emissions. Thus, staff recommends that ARB continue to coordinate with the SCAQMD to further evaluate the appropriateness of a statewide natural gas Wobbe Index specification.

3. Early Action Description

Establishing a statewide natural gas specification of 1360 Wobbe Index would ensure that California’s historical average Wobbe Index level would be maintained. California imports about 85 percent of its natural gas supplies via the Interstate pipeline; this gas historically meets a 1360 Wobbe Index. However, sources of high Wobbe Index gas, which includes California gas production and potential imported gas derived from liquefied natural gas (LNG), could significantly increase the Wobbe Index of natural gas in Southern California.

Preliminary information indicates that, in general, natural gas inherently meeting a Wobbe Index of 1360 at production has a lower GHG emissions potential than natural gas inherently meeting a Wobbe Index greater than 1360. This is also true for natural gas that has been processed for natural gas liquids (NGLs) extraction to reduce the level of a high Wobbe Index gas to a lower level. In these cases, the methane content (higher hydrogen to carbon ratio) is greater in natural gas natural gas meeting a lower Wobbe Index than natural gas meeting a higher Wobbe Index. However, reducing the Wobbe Index of natural gas by Inerts injection (e.g. nitrogen), would likely result in no or minimal GHG benefits since the dilution effect does not change the GHG potential on an energy (BTU) basis.

Recent action by the California State Lands Commission on the North Baja Pipeline Expansion project recognized the significance of introducing high Wobbe Index gas into California. Although the Commission approved the project, the Commission conditioned the approval by requiring the project proponent to monitor the Wobbe Index level of the gas being brought into California from the project and to mitigate possible NOx increases that could result from the use of that gas.
By establishing a natural gas specification of 1360 Wobbe Index, all gas would have to meet this standard, therefore maintaining the historical average Wobbe Index level. However, depending on the strategies used to meet this specification, GHG emission reductions may or may not be significant.

This strategy would be regulatory and affect the natural gas production and supply sectors.

4. Potential Emission Reductions

The GHG emissions benefit of this strategy is associated with the potential to avoid GHG emissions that may result from increasing the natural gas Wobbe Index above historical average levels. As discussed, the GHG emissions benefit associated with this strategy is highly dependent on the strategies used to meet a 1360 Wobbe Index specification. If natural gas liquids extraction is applied to natural gas to reduce the level of Wobbe Index to meet proposed specification, then there is a likely GHG benefit of about 1.5 percent going from a Wobbe Index of 1385 to 1360. If inerts injection were used, there would be zero to minimal GHG emissions benefit.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The cost of this strategy has not been specifically evaluated. However, rough estimates may be applicable from prior evaluations of natural gas treatment options which include NGLs extraction and inerts (e.g. nitrogen) injection. NGLs extraction can range as low as $0.04 per million BTU of gas processed and ranges from $0.24 to $0.42 per million BTU of gas processed when considering added storage and distribution infrastructure. Also, when considering inerts injection, this option ranges from $0.05 to $0.10 per million BTU of gas processed.

The natural gas industry and rate payers would be affected.

6. Technical Feasibility

Establishing a natural gas specification of 1360 Wobbe Index is technically feasible. Technology to treat natural gas to reduce the Wobbe Index is well proven but the degree of treatment is economically driven depending on the source of natural gas production and the market where the natural gas is to be sold.

7. Additional Considerations

The California Public Utilities Commission (CPUC) previously held rulemaking to establish a natural gas pipeline specification for Wobbe Index. After considering comments including a recommendation to establish a Wobbe Index of 1360, the CPUC approved a natural gas specification of 1385 Wobbe to ensure adequate supplies of natural gas. The CPUC at that time did not consider the impact of GHG emissions in their decision.

As mentioned, the jurisdiction of establishing a statewide natural gas pipeline specification for Wobbe Index needs to be clarified. Obviously, the CPUC has historical authority to regulate natural gas quality. However, under AB32, the authority to regulate
natural from a GHG perspective suggests that other agencies such as ARB now have some aspects of regulatory authority.

Currently, proposed SCAQMD-2 is not a Climate Action Team strategy.

Proposed SCAQMD-2 would be a regulatory item. Given the regulatory and technical issues that need to be addressed, development of this strategy would exceed 18 months. Further complications in developing this strategy are tied to efforts to address natural gas interchangeability. There are ongoing interchangeability test programs being sponsored by the California Energy Commission that are evaluating the effects of natural gas variability on the performance, durability, and emissions of stationary and mobile combustion equipment. Limited data indicates that certain combustion equipment can be adversely impacted as the Wobbe Index of natural gas increases resulting in increased criteria pollutants. These test programs will provide the technical basis for establishing a statewide natural gas interchangeability specification. These programs are scheduled to be completed within the next 12 to 18 months.

8. Division: Stationary Source Division
   Staff Lead: Jim Guthrie
   Section Manager: Gary Yee
   Branch Chief: Dean Simeroth

9. References:
   • CPUC Order to Institute Rulemaking R.04-01-025
   • CEC Public Interest Energy Research (PIER) program on natural gas interchangeability

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1. Early Actions Strategy Name and Proponent

SUMMARY #: B32
ID NUMBER: SCAQMD-3/ARB 2-9
TITLE: LIGHT COLORED PAVING, COOL ROOFS, AND SHADE TREES
PROPOONENT: SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure remain as an early action item. The Board date for consideration of this item is anticipated in 3rd quarter of 2008.

A non-regulatory strategy (guidance) for further action by businesses, developers, and/or individuals to reduce GHG emissions remains an early action as approved by the Board at its June 2007 hearing. In coordination with the California Energy Commission and the Lawrence Berkeley National Lab (LBNL), staff will develop research and real-world experience-based guidelines on actions that could be taken, documenting options, costs, and benefits. We would draw from local, national, and international experience. The guidelines would be neither a complete nor a necessarily suitable recommendation for every community, but rather a foundation or menu of options applicable to a broad range of communities. The development of the guidance may reveal the need for supplemental tools (e.g., calculators, sector targeted guidelines). Guidelines will be developed in close collaboration with business, community, and environmental stakeholders to ensure that the approach is as effective as possible.

3. Early Action Description

We recommend a non-regulatory voluntary program with a set of guidelines to be adopted to foster the establishment or transition to cool communities in California. The affected economic sector is the construction industry. Many of the technologies are already well established. Below is a brief description of the strategies expected to be addressed in the guidelines.

Cool Roofs
Cool roof programs as part of the Building Energy Efficiency standards (Title 24) which can save as much as 15 percent of cooling energy use during hot months of the year. Such a program has already been proposed (Hebert, 2005). Confining to a residential cool community program, the per-house cost premium is estimated at about $500 (Professor Akbari).

Cool Pavements
Pomerantz (1999) suggests that for the urban area of Los Angeles (10,000 km² and 1,250 km² paved), a change to cool pavements can result in reduction of ambient
temperature by 0.6°C (1°F). This reduction is estimated to result in ozone avoidance benefits of $75 million ($228 million extrapolated to California) and energy conservation benefits of $15 million per year. In 1990, California had 410,000 km² in total area with 28 urbanized areas with a total of 15,624 km² (5,091 km² in Los Angeles). By 1999, the urban area of the state may have reached 30,689 km² and the total paved area may have been 3,836 km² (3800 km² available for cool pavement retrofit).

It is estimated that a cool pavements program would require a premium price of $0.5 per square yard as there are additional costs associated with painting the surfaces. Manville and Shoup (2005) identified the fraction of paved area devoted to parking as 24% for the Los Angeles business district, leaving 76% of paved area for the cool pavement program; this is to keep separate the cool pavement and the parking shade program.

Shade Trees and Urban Forest
The Tree Benefit Estimator reports that a mature tree system would save about 700 kWh of energy (1,100 kg of CO₂ per household) (http://www.appanet.org/treeben/calculate.asp). Mature trees can cost as much as $300 per tree or $1200 for 4 trees surrounding a residence.

Taha et al. (2000) reported ("Three Cities," an ambient temperature reduction of 1.2K to 1.6K for a heavily vegetated scenario; Scott et al. (1999) reported increased parking lot shade reductions of 5°C to 7°C (2,592 m² shaded area covered by 23 mature trees) while the City of Sacramento guidelines recommend 22 trees providing 776 m² of shade. Manville and Shoup (2005) identified 24 percent of the paved area of Los Angeles central business district (LACBD) devoted to parking. Following that same logic and using Scott et al. nearly 8 million mature trees would be needed to offer complete shade to every parking lot in California. For Sacramento, 486 mW peak power (and 92,000 MTCO₂ emissions) may be avoided (Taha et al.).

4. Potential Emission Reductions

As the proposed strategy consists of voluntary guidance, estimating the emission reductions is a function of the actual strategies employed as well as the magnitude of adoption. As such, potential emission reduction estimates are to be determined as part of the development of the guidelines.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Developing effective guidelines will also increase energy independence, reduce peak energy that is quite often highly polluting, have air pollution benefits through reductions in precursors to ozone and particulate matter, and offer impetus to gentrification and increases in real estate values (Thériault et al. (2005)). Application of the guidance would likely increase construction costs in California. Rise of a new California-specific construction sector would however be a significant boon to our economy. Small businesses have the flexibility of becoming a part of this new expertise construction sector. Environmental justice communities would benefit from gentrification and increases in real estate value. Significant funding from point sources, local and state governments, and the public sector could be expected.
6. Technical Feasibility

Cool roofs are already a part of Title 24, and urban forestry has long been recognized a key to energy conservation and urban gentrification, thus, these technologies are feasible and proven.

7. Additional Considerations

Affected Entities: Construction permit jurisdictions, state and local governments, construction industry

Trade Associations: Construction industry associations

Government Agencies to coordinate with: California Energy Commission & LBNL

8. Division: Research Division
Staff Lead: Ash Lashgari
Section Manager: Eileen McCauley
Branch Chief: TBD

9. References

Akbari, Hashem, Professor at Lawrence Berkeley National Lab, Personal Communication, July 30, 2007


City of Sacramento’s parking lot shading design and maintenance guidelines http://www.cityofsacramento.org/parksandrecreation/ppdd/pdf/SHADING_GUIDELINES_06-05-03.pdf


USCB (United States Census Bureau) (2005), "Table 3, California: Selected Economic Characteristics, 2003" last revised, June 28, 2005.
Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #: B33
ID NUMBER: SCAQMD-4
TITLE: STRENGTHEN LIGHT-DUTY VEHICLE STANDARDS
PROPOSENT: SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2012.

In September 2004 the California Air Resources Board approved regulations to reduce greenhouse gas emissions from new motor vehicles. The regulations apply to new passenger vehicles and light duty trucks beginning with the 2009 model year. The standards adopted by the Board phase in during the 2009 through 2016 model years. When fully phased in, the near term (2009-2012) standards will result in about a 22 percent reduction as compared to the 2002 fleet, and the mid-term (2013-2016) standards will result in about a 30 percent reduction.

The proposed strategy is the second phase of the 2004 regulation. This timing of 2012 will allow staff the time necessary to complete inventory research, interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

3. Early Action Description

Adopt new standards to phase in beginning in the 2017 model year (following up on the existing mid-term standards that reach maximum stringency in 2016). The technologies that might be employed include highly efficient hybrid vehicles, use of lightweight materials to reduce vehicle mass, and reductions in air conditioning related emissions through the use of cool paints, low-GWP refrigerants, or other approaches.

4. Potential Emission Reductions

The currently adopted standards call for about a 30 percent reduction of GHGs by 2016. Assuming that the new standards call for about a 50 percent reduction, phased in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet—staff estimates a 2030 reduction of about 27 MMT.
5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities
Not yet determined.

6. Technical Feasibility
The technologies involved in this strategy are either being proved or showing promising technical feasible. For example, available technologies that could be widely used on light-duty vehicles by 2012 include:
- Variable valve timing & lift
- Cylinder de-activation
- Gasoline direct injection - stoichiometric
- Turbocharging or cylinder deactivation
- 6-speed automatic and automated manual transmission
- Electric power steering
- Improved alternator
- More efficient, low-leak air conditioning
- Improved aerodynamics
- E85 vehicles

Additional technologies that could be widely used by 2016
- Extensive use of E85 vehicles
- Homogenous Combustion Compression Ignition (HCCI)
- Integrated Starter Generators (ISG)
- Camless Valve Actuation (CVA)
- Diesels
- Hybrids

7. Additional Considerations
In the near term, staff will continue to evaluate emerging technologies that have the potential to provide additional greenhouse gas reductions. Some technologies discussed under this subject can be implemented via separated early actions. Please refer to this report for detailed discussion.

8. Division: Mobile Source Control Division
   Staff Lead: TBD
   Section Manager: TBD
   Branch Chief: TBD

9. References:

   Work Plan for Potential GHG Reduction Measure, Air Resources Board 2-1.
1. Early Actions Strategy Name and Proponent

SUMMARY #: B34
ID NUMBER: SCAQMD-5
TITLE: OFF HIGHWAY RECREATIONAL VEHICLE (OHRV) EVAPORATIVE EMISSIONS CONTROL
PROPOSENT: 2007 STATE IMPLEMENTATION PLAN AND SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

2. Staff Recommendation

Staff recommends that this measure not be listed as an early action. Staff is aware of the potential climate benefit from hydrocarbon emission reductions, but additional developments are needed to address remaining scientific uncertainties regarding their climate impacts. Staff recommends that ARB continue to track the subject and further evaluation be conducted as appropriate. The strategy will remain on track for its air quality benefits.

3. Early Action Description

The OHRV category includes off highway motorcycles, ATVs, sand cars, and specialty vehicles. The OHRV evaporative emissions regulation will control primarily hydrocarbon emissions. Hydrocarbons are ozone precursors and ozone is a greenhouse gas. OHRVs will use proven automotive control technology including:

- Low Permeation Fuel Lines
- Low Permeation Fuel Tanks
- Carbon Canisters
- Fuel Injection

Additionally ARB will evaluate two implementation approaches:
1. A performance standard that will require equipment to be tested and meet a certain emission standard.
2. A design standard that will require equipment to use certified components. Each component must be tested and meet a certain emission standard.

4. Potential Emission Reduction

The OHRV regulation is expected to be implemented in 2012. When fully implemented in 2020, hydrocarbons are projected to be reduced by 11.3 TPD\textsuperscript{12}. A reduction of hydrocarbon emissions will lead to a reduction in ozone. However, currently there is no model that projects the CO\textsubscript{2}-equivalent warming impact for hydrocarbon emissions.
5. Estimated Cost / Economic Impacts and Impacted Sectors / Entities

An initial staff estimate of the increased cost to consumers to purchase an OHRV with evaporative controls is $350. It is expected that OHRV manufacturers will pass the cost of the regulation onto the OHRV consumer. When fully implemented in 2020 the total cost will be $588 million\(^3\). OHRV dealers may be adversely affected by an increase in equipment price of OHRVs.

6. Technical Feasibility

Potential technology that will control hydrocarbon emissions from OHRVs includes low permeation fuel tanks, low permeation fuel lines, carbon canisters, and fuel injection. These types of control technology have been proven on on-road vehicles for over 25 years. Recently evaporative controls have also been required on off-road categories such as land and garden equipment.

7. Additional Considerations

Currently ARB has aligned its regulatory approach with a U.S. EPA regulation that sets permeation standards for fuel tanks and fuel lines. However, ARB's OHRV regulatory initiative will evaluate the stringency of those standards to see if they can be tightened. ARB will also seek emission reductions from other sources within the category such as carburetors and running losses.

8. Division: Monitoring and Laboratory Division
   Staff Lead: Pippin Mader
   Section Manager: James Watson
   Branch Chief: Manjit Ahuja

9. References

1. Full implementation assumed at 95%
2. All emission calculations based on ARB's Off-road 2007 Model and 75% control
3. Controlled population of~1.68 million in 2020 times $350
2. Early Actions Strategy Name and Proponent

SUMMARY # B35
ID NUMBER: SCAQMD-5
TITLE: DETERMINATION OF EVAPORATIVE EMISSIONS FROM PLEASURE CRAFT
PROPOSENENT: 2007 STATE IMPLEMENTATION PLAN AND SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

2. Staff Recommendation

Staff recommends that this measure not be listed as an early action. Staff is aware of the potential climate benefit from hydrocarbon emission reductions, but additional developments are needed to address remaining scientific uncertainties regarding their climate impacts. Staff recommends that ARB continue to track the subject and further evaluation be conducted as appropriate. The strategy will remain on track for its air quality benefits.

3. Early Action Description.

The Pleasure Craft category includes inboard, outboard, sterndrive, and personal watercraft. The Pleasure Craft evaporative emissions control regulation will reduce hydrocarbon emissions. Hydrocarbons are ozone precursors and ozone is a greenhouse gas. Pleasure Craft will use proven automotive control technology including:

- Low Permeation Fuel Lines
- Low Permeation Fuel Tanks
- Carbon Canisters
- Fuel Injection

4. Potential Emission Reduction

The Pleasure Craft regulation is expected to be implemented in 2012. Hydrocarbon emissions are projected to be reduced by 16 TPD in 2012. When fully implemented in 2035\textsuperscript{1,2}, hydrocarbons are projected to be reduced by 53 TPD. However, currently there is no model that projects the CO\textsubscript{2}-equivalent warming impact for hydrocarbon emissions.

5. Estimated Cost / Economic Impacts and Impacted Sectors / Entities

An initial staff estimate of the increased cost to consumers to purchase a boat with an evaporative control system is $350\textsuperscript{3}. The estimated increased cost is minimal when
compared to the current cost of a new boat. When partially implemented in 2020, the cost to consumers is projected to be $310 million. When fully implemented in 2035 the total cost to consumers is estimated at $1.13 billion. There is no foreseeable adverse impact on any businesses or individuals.

6. Technical Feasibility

Potential control technology that will reduce hydrocarbon emissions from Pleasure Craft includes low permeation fuel tanks, low permeation fuel lines, carbon canisters, and fuel injection. These types of control technology have been proven on on-road vehicles for over 25 years. Recently evaporative controls have also been required on off-road categories such as land and garden equipment. Furthermore, a 2005 in-use study of Pleasure Craft retrofitted with carbon canisters conducted by the National Marine Manufacturers Association demonstrated technical feasibility for marine applications and lessened boat manufacturer concerns.

7. Additional Considerations

The proposal being developed does not seek to retrofit existing boats with control technology due to cost and safety issues. Because of their lengthy useful life, it may take up to three decades for the inventory of Pleasure Craft to become fully compliant subsequent to implementation of the regulation 2012.

8. Division: Monitoring and Laboratory Division
   Staff Lead: Fredrick Burrielli
   Section Manager: James Watson
   Branch Chief: Manjit Ahuja

9. References

1 Full implementation assumed at 95%
2 All emission calculations based on ARB's Off-road 2007 Model and 70% control reduction
3 Cost estimates based on a per vehicle control technology cost of $350
4 Controlled population of ~3.22 million in 2035 times $350.
1. Early Actions Strategy Name and Proponent

SUMMARY #: B36
ID NUMBER: EA 3-3
TITLE: VESSEL SPEED REDUCTION
PROONENT: AIR RESOURCES BOARD

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. At this time, staff is evaluating whether this is most appropriately managed as a regulatory item or a voluntary measure.

The staff recommends retaining the vessel speed reduction (VSR) measure as an early action for the following reasons:

- the need to gather additional information on the scope, emissions impact, cost, and environmental impacts of the measure; and
- the need for stakeholder input on whether a voluntary or regulatory approach should be taken.

Based on preliminary emissions estimates, the overall weight of evidence suggests that this measure would fall under the medium category for regulatory action (see subsection 4 for emission benefits).

3. Action Description

As part of our efforts under the Diesel Risk Reduction Plan, Goods Movement Emissions Reduction Plan, and Assembly Bill 32 - Greenhouse Gas Initiative, the Air Resources Board (ARB) staff is evaluating the need to develop an ocean-going VSR program. Ocean-going VSR is primarily a measure designed to reduce oxides of nitrogen (NOx) emissions, but also provides reductions in diesel PM emissions, oxides of sulfur (SOx) emissions, and carbon dioxide (CO2) emissions.

Over the past six years, a VSR program has been in place at the Port of Los Angeles and Port of Long Beach (POLA/POLB). The program requests that vessels reduce their speed to 12 knots beginning 20 nautical miles (nm) off shore from the POLA/POLB. Currently, the POLB maintains a Green Flag Program which is an incentive program that offers reduced dockage fees for those vessels in compliance with VSR. The compliance rate for the POLB Green Flag Program is about 80 percent.

ARB staff has begun a technical assessment of the impacts associated with VSR for ocean-going vessels. As part of the technical assessment, staff will be evaluating
emission reduction benefits of a VSR measure in and out of California ports and along the California coast within 24 nm, 40 nm, and 100 nm.

The staff assessment is in its very early stages. ARB staff held its first VSR workshop on July 12, 2007. At this workshop, ARB staff presented an overview of their activities related to the VSR assessment and shared some key elements needing industry's assistance. To conduct a full evaluation, ARB staff is in need of additional data to refine our emissions inventory, such as emission factors, speed data from ports other than POLA/POLB, as well as, an understanding of the operating cost impacts to the industry. ARB staff expects to release a draft technical assessment report with the results of their evaluation by the end of 2007. The evaluation in this report will be key to determining the need and best approach to implement a regulatory or a voluntary VSR measure.

4. Potential Emission Reductions

VSR is primarily a measure designed to reduce NOx emissions, but also provides reductions in diesel PM emissions, SOx emissions, and CO2 emissions. ARB staff has estimated the potential emissions reductions as a result of implementing a statewide VSR program within 24 nm and 100 nm of the California coastline. This preliminary assessment is based on the emissions benefits estimated using emissions factors from the use of low sulfur (0.1%) marine distillate in marine main and auxiliary engines and 2006 port call data from the California State Lands Commission. Our preliminary assessment suggests that the implementation of VSR reduces pollutants such as NOx, diesel PM, and SOx by an average of 30 percent within 24 nm of the California coast. In addition to these criteria pollutant emission reduction benefits, if a VSR program is implemented at 24 nm, the potential CO2 emission reductions in 2010 are estimated to be 0.62 million metric tons of CO2 (MMTCO2) and increasing to 0.97 MMTCO2 by 2020. If a VSR measure was implemented at a distance of 100 nm, then the additional CO2 emission reductions in 2010 are estimated to be approximately 0.5 MMTCO2 and in 2020 approximately 0.83 MMTCO2. These estimates exclude the emissions benefits already achieved by the POLA/POLB at a compliance rate of about 80 percent.

A VSR program at other ports, such as San Diego and Hueneme, may also provide emissions benefits, and to a lesser extent, San Francisco Bay Area ports. It is questionable whether a coastline VSR measure will achieve significant emission benefits.

The CO2 emission reduction potential rating for a VSR measure within 24 nm of the California coast is estimated to be in the medium (>0.1 to 1.0 MMTCO2) category.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The estimated costs and economic impacts of a regulatory or voluntary VSR measure have not been evaluated. A cost impact analysis for either a regulatory or voluntary VSR measure would need to include an estimate of the increase in the cost of operation to shipping companies due to reducing speeds in and out of California ports and along the coastline, increase cost of fuel used in auxiliary engines due to increased time traveling to port versus the fuel savings due to decreased ship engine power requirements, costs borne by the industries/terminals affected by a VSR measure, costs to ports in developing infrastructure improvements (i.e., radar equipment), and costs needed for enforcing any speed reduction measure. In addition to the POLA/POLB, staff is currently evaluating other major ports such as those in the Bay Area, San Diego, and

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Hueneme. Staff is also looking at the impact to the industry if VSR was implemented while transiting along the California coastline within 24 nm and 100 nm.

Voluntary measures, such as seen in the POLB Green Flag Incentive Program, may require port and terminal-specific costs. Some of the incentives of this program include reduced dock fees for those complying with the VSR program and tariff reduction incentives. The San Pedro Bay Clean Air Action Plan adopted in 2006 for the POLA/POLB, have estimated the costs of controls for the voluntary VSR measure to be approximately 4.4 million dollars for 2010. The POLA/POLB has already committed to fund a maximum of 11.3 million dollars through 2010/2011 for each port to implement the port's Clean Air Action Plan.

6. Technical Feasibility

A voluntary VSR program has been in place at the POLA/POLB over the past six years. The POLA/POLB accounts for over half of the port calls statewide. This VSR program requested ships to voluntarily reduce their speed to 12 knots at a distance of 20 nm from the California coast. Currently, the POLB maintains the Green Flag Incentive Program which offers reduced docking fees and environmental awards for vessels that voluntarily reduce their speeds in and out of the POLB. This program has been very successful as shown by its current 80 percent compliance rate. A VSR program is clearly technologically feasible. However, reducing speeds for an extended period of time transiting along the coast has not been evaluated. There is some information that maintaining a slower speed for extended distances may cause adverse mechanical effects on a vessel’s main engine. This analysis will need further evaluation.

7. Additional Considerations

- With the exception of the voluntary programs at the POLA/POLB, no federal or other state VSR regulations are currently in place.
- VSR activity falls under ARB jurisdiction and legal authority. ARB’s authority to regulate emissions beyond 3 nm is being challenged in court. Significant legal challenges are likely if the ARB elects to implement a VSR regulation beyond 24 nm.
- At this time, we are evaluating the feasibility of both regulatory and voluntary measures. Both approaches will consider speed reductions from direct travel in and out of major ports and evaluate the inclusion of transiting up and down the California coast. Voluntary approaches can include agreements or incentive programs between port and terminal operators, vessel owners and operators, and government agencies. Regulatory measures would take the form of an airborne toxic control measure.

8. Division: Stationary Source Division  
   Staff Lead: Hafizur Chowdhury  
   Section Manager: Robert Krieger  
   Branch Chief: Dan Donohoe
Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # B37  
ID NUMBER: ENVIRO-2  
TITLE: ANTI-IDLING ENFORCEMENT  
PROONENT: ENVIRONMENTAL STAKEHOLDERS

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this non-regulatory item would be the 4th quarter of 2008.

This strategy will ensure that climate change benefits are realized from an existing anti-idling rule. It is believed that the 0.7 million metric tons per year CO2 reduction listed in the 2005 staff report for the anti-idling rule have not yet been claimed.

Summary: Restricting vehicle idling (in this case, heavy-duty commercial diesel vehicles) reduces the amount of fuel burned which in turn, causes fewer emissions of greenhouse gases. Staff recommends that this measure become an early action item for the following reasons:

1) An anti-idling regulation is currently in place;

2) An enhanced version of the current anti-idling regulation is slated to commence enforcement on January 1, 2008; and

3) Proposed legislation (Assembly Bill [AB] 233, Jones), if adopted, would authorize and require ARB to further enhance its enforcement of the anti-idling regulation. This bill calls for an enhanced enforcement plan to be adopted by the Board by January 1, 2009.

If this bill is not enacted, staff could include enforcement enhancements through a Board action directed at reviewing and amending the current anti-idling regulation (with Board hearing no sooner than 2011).

3. Early Action Description

The burning of diesel fuel contributes to greenhouse gas emissions. This strategy will reduce greenhouse gases by reducing the amount of fuel burned through unnecessary idling. AB 233 calls for adoption of an enhanced enforcement plan that would be heard by the Board as a non-regulatory item.

1) ARB adopted a diesel particulate air toxic control measure (Title 13 of the California Code of Regulations, Section 2485) in June 2004 to control idling of diesel-fueled commercial motor vehicles. Enforcement commenced the following year. This rule prohibits, with some exceptions, the idling of diesel-fueled commercial motor vehicles for more than five minutes, and applies to both trucks and buses greater than 10,000 lbs. gross vehicle weight. The measure also
prohibits operation of a diesel-fueled auxiliary power system for more than five minutes within 100 feet of individual or multi-family housing units. The penalty for violating the idling regulation is currently a minimum of $100.

2) In October 2005, the Board approved an additional regulatory measure that eliminated the exemption for new and in-use trucks with sleeper berths starting in January 2008, thus requiring sleeper berth trucks to shut down and use alternative cab climate control technologies. In addition, the Board approved an amendment requiring that all new California-certified 2008 and subsequent model year heavy duty diesel engines be equipped with a non-programmable engine shutdown system that automatically turns off the engine after five minutes of idling. Enforcement of these provisions will begin in 2008.

3) AB 233, Jones, currently pending approval by the California Legislature, calls for:
   a) Enhanced field enforcement of anti-idling and other ARB regulations. AB 233 would require ARB to review existing enforcement regulations and adopt a plan for enhanced and coordinated enforcement of these regulations by January 1, 2009. Implementation of the plan would address staffing needs, goals for inspection efforts, education and training. Increases in field enforcement would flush out additional violators and give them fewer opportunities to disobey the regulation.
   b) Increased penalties for violations of anti-idling regulations. It is assumed that increasing the penalty from $100 to $300 per violation will increase the deterrent effect, resulting in improved compliance.
   c) Restriction on registrations of heavy-duty diesel vehicles with uncorrected idling violations. This would serve as an additional enforcement tool to encourage compliance.

4. Potential Emission Reductions

The emission numbers in the tables below do not represent an additional benefit due to enhanced enforcement. Rather, the numbers show the benefits of 100% compliance with the existing anti-idling rule. Enhanced enforcement is necessary in order to achieve a high compliance rate.

The elimination of non-essential diesel fueled vehicle idling reduces greenhouse gases as reported in ARB’s anti-idling program staff reports. According to ARB’s Initial Statement of Reasons for Proposed Rulemaking dated September 2005, the proposed sleeper berth anti-idling regulation amendments alone will reduce CO₂ emissions by nearly 1,751 metric tons per day (MTPD) and 0.6 million metric tons per year (MTPY) in 2010, and 2,068 MTPD and 0.7 million MTPY in 2020. (See www.arb.ca.gov/regact/hdv/dle/isor.pdf, page 46). Enhanced enforcement of these anti-idling regulations will reduce greenhouse gas emissions by ensuring that the intended benefit of 0.7 million MTPY is fully realized by 2020.

The tables below provide the estimated statewide emissions benefits projected in metric tons per year for the currently enforced anti-idling regulation and the sleeper berth exemption amendments to these regulations. However, these benefits assume 100% compliance. History has shown that no program achieves 100% compliance and that enhanced enforcement does lead to higher compliance rates. Based on a relatively small
sample of idling inspections, the current program’s rate of compliance is approximately 95%. However, given the limited number of idling inspections (due to resource constraints), it is assumed that this is not representative of statewide compliance rates.

**Estimated Statewide Idling Emission Benefits - Non-Sleeper Trucks (Metric Tons/Year) — Beginning In 2005**

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<thead>
<tr>
<th></th>
<th>PM</th>
<th>NO&lt;sub&gt;x&lt;/sub&gt;</th>
<th>HC</th>
<th>CO</th>
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<td>CA Registered</td>
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**2010 Estimated Statewide Idling Emission Benefits – Sleeper Trucks Only**

**Baseline Emissions (Metric Tons/Year) — Calendar Year 2010**

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<tr>
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<th>PM</th>
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<tr>
<td>CA Registered Sleeper Trucks</td>
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<td>Total Baseline</td>
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**Emission Reductions (Metric Tons/Year) — Calendar Year 2010**

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<th>PM</th>
<th>CO&lt;sub&gt;2&lt;/sub&gt;</th>
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**2020 Estimated Statewide Idling Emission Benefits – Sleeper Trucks Only**

**Baseline Emissions (Metric Tons/Year) — Calendar Year 2020**

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<tbody>
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**Emission Reductions (Metric Tons/Year) — Calendar Year 2020**

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<thead>
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<th>PM</th>
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<td>18,815</td>
<td>1460</td>
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<td>754,820</td>
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Source: ARB’s Initial Statement of Reasons for Proposed Rulemaking, September 1, 2006
5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The current anti-idling regulations provide for savings of approximately $100 million per year in reduced fuel and maintenance costs. The sleeper berth exemption amendments to these regulations provide an additional annual savings of approximately $20 million per year in reduced fuel and maintenance costs. The sleeper berth exemption also is projected to save approximately 70 million gallons of diesel fuel per year.

To comply with the sleeper berth exemption amendments, vehicle owners may spend between $1,000 and $10,500 depending on the type of alternative power selected and the application needed. However, it is expected that vehicle owners will recover their initial investments over time through the fuel and maintenance savings discussed above. Although ARB estimates cost recovery times to range between 8 months and 3 years, actual recovery times will solely depend on the alternative(s) selected and the amount of time spent at idle. Financial incentives may be available for qualified zero-emissions technologies through the Carl Moyer Program.

Costs to State – If enhanced enforcement is to be achieved, additional resources will be necessary to increase enforcement presence.

6. Technical Feasibility

Technologies that will allow vehicle operators to maintain cab comfort while not running the vehicle’s main engine are currently available. Some of these technologies are diesel-fueled auxiliary power systems, fuel-fired heaters, battery-electric auxiliary power systems, vehicle-battery-powered systems, truck stop electrification (on-board and off-board power infrastructure), and thermal energy storage systems.

7. Additional Considerations

A number of states have similar laws and some are more stringent than California’s current law. However in 2008, California’s law will no longer exempt idling of a vehicle’s main engine while the operator sleeps in a sleeper berth.

This existing rule can be enforced by ARB staff, as well as by peace officers and air district personnel. This strategy is not a regulatory item. If AB 233 is approved, it calls for ARB to adopt a comprehensive enforcement plan by January 1, 2009.

AB 233 has not yet been approved (as of August 15, 2007).

8. Division: Enforcement Division
   Staff Lead: Nancy O’Connor
   Section Manager: Judy Lewis
   Branch Chief: Paul E. Jacobs

9. References:

Assembly Bill 233 of 2007, Jones.
Senate Transportation & Housing Committee Analysis of AB 233, June 1, 2007.
ARB webpage: http://www.arb.ca.gov/msprog/truck-idling/truck-idling.htm
ARB webpage: http://www.arb.ca.gov/regact/hdvidle/isor.pdf
1. Early Actions Strategy Name and Proponent

SUMMARY #: B38
ID NUMBER: ARB 4-4
TITLE: \textit{SF}_6 \textit{REDUCTIONS FROM THE NON-ELECTRIC SECTOR}
PROPOSER: STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure is recommended for addition to the list of discrete early actions. The Board date for consideration of this item is anticipated in 1\textsuperscript{st} quarter of 2009.

The staff recommends developing regulations that ban the use of sulfur hexafluoride (\textit{SF}_6) for non-electricity sector/semiconductor applications where technologically feasible and cost-effective alternatives are available. As part of the assessment, strategies for achieving voluntary reductions will also be evaluated.

3. Early Action Description

This strategy applies to uses of \textit{SF}_6 other than the electrical utility industry and the semiconductor industry, which will be evaluated under separate strategies. The largest non-utility industry, non-semiconductor industry uses of \textit{SF}_6 identified by the staff to date include the magnesium manufacturing and casting operations, air quality tracer studies, and a gas for testing laboratory hoods to ensure worker safety and that Cal-OSHA ventilation requirements are met. Other uses cited include accelerators, leak detection, optical fiber production, glazing, medical, and refining, but the extent of these uses in California is currently unknown. The staff plans to identify all of the uses of \textit{SF}_6 in California, and the amount used, as part of its evaluation. As part of the regulatory development process, the staff will assess other uses of \textit{SF}_6, the associated emissions, mitigation options as well as cost to determine whether action is warranted. The U.S. EPA has formed a "Magnesium Industry Partnership" to voluntarily phase-out the use of \textit{SF}_6 in the magnesium industry by the end of 2010, so a regulation of this industry may be unnecessary. Nationwide, emissions from the magnesium industry are about 2.7 MMT\textit{CO}_2E per year. There are currently only three companies in California that have magnesium production and casting operations and that are members of the EPA partnership. The \textit{SF}_6 emissions from these companies are currently unknown. But scaling the nationwide estimated of 2.7 MMT\textit{CO}_2E per year to California by the number of production facilities gives a California number of about 0.09 MMT\textit{CO}_2E per year.

The staff envisions banning the use of \textit{SF}_6 in non-utility, non-semiconductor applications where safe, cost-effective alternatives are available. These applications may include magnesium production and casting operations, air quality tracer gas studies, and ventilation tests for laboratory hoods. The staff will investigate other possible uses of
SF₆ during the development of the regulations. It is important that all uses of SF₆ be investigated and considered given its high GWP, particularly if the application is one in which the compound is deliberately emitted, such as tracer gas applications. One pound of SF₆ emitted is equivalent to about 10 metric tons of carbon dioxide, from a global warming perspective.

4. Potential Emission Reductions
Statewide Emission Inventory

2020 GHG Emission Inventory: It is estimated that, nationwide, about 10 percent of the total SF6 is used in applications other than the utility and semiconductor industries. It is also estimated that about half of this 10 percent is used in the magnesium industry. The most recent estimate of emissions in California from both electric utilities and semiconductor manufacturing operations is about 1.6 MMTCO2E per year (CEC, 2006). Assuming that the proportion of SF6 emitted to the amount of SF6 used in other applications is the same as that for the utility and semiconductor applications, emissions from the other applications would be about 0.18 MMTCO2E per year in California. Nationwide, SF6 emissions from the magnesium industry are currently about 2.7 MMTCO2E per year. Scaling this number down to the number of production facilities in California gives a California emission estimate of about 0.09 MMTCO2E per year. However, if the U.S. EPA Magnesium Industry Partnership is successful in phasing out the use of SF6 by the end of 2010, the emissions from the magnesium industry will be zero in 2020. This leaves at least 0.09 MMTCO2E per year from other applications such as tracer studies and laboratory hood tests. However, it is likely that emissions from these other applications are somewhat higher than 0.09 MMTCO2E per year due to the fact that the ratio of amount of gas emitted to amount used in these applications is higher than that for utilities. In the utilities, the gas is emitted gradually as it escapes from enclosed systems, while in tracer studies and hood tests it is emitted instantaneously.

Anticipated 2020 Reductions: It is anticipated that all, or nearly all, of the emissions from non-utility, non-semiconductor use would be eliminated under the staff proposal. Therefore, the reductions are estimated to be on the order of 0.1-0.2 MMTCO2E per year.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Alternative gases have been identified for magnesium production and casting operations, and for laboratory hood tests performed to ensure adequate ventilation rates. The cost and economic impacts of using these gases will be evaluated during the regulatory development process, but the difference in cost would be expected to be modest.

6. Technical Feasibility

As part of the U.S. EPA's Magnesium Industry Partnership, magnesium production and casting operations have been developing the use of gases other than SF₆ to provide the
cover gas protection provided by SF₆. The partnership is attempting to meet the goal of phasing out SF₆ by 2010.

The staff will investigate both the technical and economic feasibility of using alternative gases in air quality tracer studies and laboratory hood tests done to comply with Cal-OSHA ventilation standards. The technical and economic feasibility of using alternative gases will also be evaluated for any other use of SF₆ identified by the staff.

7. Additional Considerations

Some of the factors that will need to be carefully evaluated include determining if there are alternative gases as safe and effective as SF₆ with lower lifecycle GHG emissions. To the extent that alternatives are available, staff would also investigate whether a voluntary measure such as a voluntary phase-out program would be as effective as a regulatory approach.

Affected Entities: Companies that produce magnesium or magnesium castings, air pollution and air quality researchers, universities, industries, and other institutions that have laboratory hoods that are subject to Cal-OSHA standards.

Trade Associations: North American Die Casting Association (DADCA), Compressed Gas Association, Associations which include industrial hygienists. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

Government Agencies to coordinate with: U.S. EPA, Cal-OSHA

Proposed Board Hearing Date: January, 2009

8. Division: Research Division
Staff Lead: Kevin Cleary
Greenhouse Gas Technology and Field Testing
Section Manager: Mike FitzGibbon
Branch Chief: TBD

9. References:


Communications with Cal-OSHA staff (Mike Horowitz)

1. Early Actions Strategy Name and Proponent

SUMMARY #: B39  
ID NUMBER: N/A  
TITLE: REDUCTION OF HIGH GWP GHGs USED IN CONSUMER PRODUCTS  
PROONENT: AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This measure is recommended for addition to the list of discrete early actions. The Board date for consideration of this item is anticipated in 4th quarter of 2008.

Some data regarding emissions of greenhouse gases is available from a recent survey of consumer products, which may represent possible reductions within the discrete early action timeframe. Manufacturers are also currently being surveyed to determine the extent of usage of high global warming potential (GWP) gases in several more categories of consumer products. These future survey results may lead to additional strategies with emission reduction potential that can be pursued after the deadline for discrete early action items.

3. Early Action Description

Consumer product formulations may be modified to reduce or eliminate the use of greenhouse gases with high GWP. Gases of interest include HFCs, HCFCs, HFEs, carbon dioxide, and nitrogen oxides, which are used as propellants in tire inflators, electronics cleaners, dust removal products, hand held sirens, hobby guns (compressed gas), party products (foam string), and other formulated consumer products. The objective of this discrete early action strategy would be to reduce the impact of high GWP GHGs used in these products when alternative formulations are available. For example, one possible form of the strategy would be to require switching when feasible from using a high GWP GHG such as HFC-134a (GWP=1300) to a GHG with a lower GWP such as HFC-152a (GWP=120). The Consumer Products Program is implemented through regulations and this proposed new discrete early action strategy would occur as part of that regulatory process.

4. Potential Emission Reductions

ARB staff estimate a potential emissions reduction of up to 0.25 MMTCO2E from consumer products. ARB is currently surveying consumer product manufacturers for specific information on product ingredients. Categories listed above that may contain high GWP GHGs are included in the survey. The required submission date for the survey is November 21, 2007. Analysis of survey data will provide an accurate estimate of potential emission reductions.
In 2002, A. D. Little reported that the annual North American consumption and emissions of HFCs in consumer products was 10 MMTCO2E with the two highest-use products being dust removal products and tire inflators at 4.7 and 3 MMTCO2E, respectively. California’s population is about eight percent of the North American population. Assuming product usage is similar across North America and scaling with population, HFC emissions from consumer products in California are about 0.8 MMTCO2E. This value seems to be confirmed by initial results from ARB’s 2003 Consumer and Commercial Products Survey.

5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

Costs per MTCO2E are not available at this time. However, other regulations in the Consumer Products Program have been implemented in a cost effective manner. The manufacturers would bear the cost of formulation changes, then presumably pass the cost on to the consumer. Each product category would be fully evaluated for estimated costs as regulations are implemented. Any potential disproportionate impacts would depend on the individual product and whether it is used to a greater extent by any given sector of the population.

6. Technical Feasibility

The ARB staff believes technology is available to make changes in some consumer product categories to decrease the use of high GWP GHGs without increasing other emissions. ARB has not previously worked with representatives of certain segments of the industry, such as manufacturers of hobby guns that use compressed gas, so determination of the technical feasibility of GHG reductions in some applications cannot be made at this time.

7. Additional Considerations

Consumer Products are under ARB jurisdiction with legal authority for regulation. New regulations are scheduled to be heard by the Board in 2008. These regulations may address the use of high GWP GHGs in several product categories. An initial public meeting for the development of this regulation is scheduled for August 29, 2007. These regulations, already under development, will meet the statutory deadline for discrete early actions. Development of regulations for other categories of consumer products would fall under the Scoping Plan of The California Global Warming Solutions Act of 2009.

8. Division: Stationary Source Division
   Staff Lead: Jessica Dean
   Section Manager: David Mallory
   Branch Chief: Janette Brooks

9. References:

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #: B40
ID NUMBER: N/A
TITLE: COLLABORATIVE RESEARCH TO UNDERSTAND HOW TO REDUCE GREENHOUSE GAS EMISSIONS FROM NITROGEN LAND APPLICATION
PROPOSENT: STAKEHOLDERS SUGGESTIONS

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

3. Early Action Description

Staff analysis suggests that nitrogen land application may be a significant source of nitrous oxide, which is a potent greenhouse gas. In order to reduce greenhouse gases while benefitting agricultural systems, landscaping and other uses, staff needs to identify methodologies for better characterizing California’s nitrogen cycle.

An important first step to better characterizing the relationship between nitrogen land application and nitrous oxide formation in California agriculture, landscaping and other uses as well as opportunities for emission reductions is a collaborative research effort with stakeholders. The research is expected to focus on identifying optimal ways to reduce nitrous oxide emissions while increasing soil retention of nitrogen for plant uptake. Factors such as the total acreage of crop field, the annual amount and type of nitrogen applied, the method of application, soil properties, the irrigation regime, and drainage conditions can all play a role in characterizing nitrous oxide formation and would therefore be expected to be studied as part of the work. As part of the research the ARB will collaborate with the California Department of Food and Agriculture, Department of Pesticide Regulation, commodity groups, and other stakeholders. The research is expected to ultimately support the development of guidance to improve the characterization of nitrous oxide emissions from nitrogen land applications as well as identify effective strategies for emission reductions.

4. Potential Emission Reductions

The potential benefit of nitrous oxide emission reductions following from the research effort requires further assessment and is therefore to be determined. However, given the current nitrogen fertilizer use efficiency and portfolio, possible reductions from guidance that builds on the research may be on the order of 1 MMTCO₂E.
5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

Entities expected to participate in the collaborative research effort as well as the subsequent development of guidance includes farm owners and operators, nitrogen fertilizer manufacturers and distributors, the California Department of Food and Agriculture, Department of Pesticide Regulation, Regional Water Boards, commodity groups, and other stakeholders. The estimated costs of the research are to be determined as are any costs or savings associated with implementing subsequent guidance.

6. Technical Feasibility

The ARB has an established track record of collaborating with stakeholders to ensure that high quality research is conducted and that the research facilitates the identification of effective mitigation strategies. It is anticipated that the necessary expertise to conduct the research can be secured via a contract with in-state experts.

7. Additional Considerations

The ARB will coordinate with the California Department of Food and Agriculture, Regional Water Control Boards, and local air quality management districts in their efforts related to Nutrient Management Plans.

8. Division: Planning and Technical Support Division/Research Division
   Staff Lead: TBD
   Section Manager: TBD
   Branch Chief: TBD

9. References:


APPENDIX C – Staff Evaluation of Remaining Previously Approved Early Actions
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<th>SUMMARY TITLE</th>
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<td>Stationary agricultural engine electrification</td>
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<td>Reduction of perfluorocarbons (PFCs) from the semiconductor industry</td>
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<td>Guidance and protocols for local governments to facilitate GHG emission reductions</td>
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<td>Guidance/protocols for businesses to facilitate GHG emission reductions</td>
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<td>Reduce sulfur hexafluoride (SF6) from electrical generation</td>
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1. Early Actions Strategy Name and Proponent

SUMMARY #       C01
ID NUMBER:      ARB 2.2
TITLE:          STATIONARY AGRICULTURAL ENGINE ELECTRIFICATION
PROONENT:       AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This strategy was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this strategy is recommended.

However, given that electrification of stationary agricultural diesel engines must be considered on a case-by-case basis due to operational and cost issues, a control measure to require the electrification of these engines is impractical and cost-prohibitive for many growers (see Parts 5 and 7 for additional information). Accordingly, the approach currently being implemented is an outreach effort and therefore a Board hearing is not anticipated.

3. Early Action Description

As part of the outreach being conducted for the amendments to the airborne toxic control measure (ATCM) for Stationary Compression-Ignition Engines, ARB staff is working with the local air districts to encourage replacement of diesel engines with electric motors and to take advantage of incentive funding opportunities. Outreach materials and workshops will provide information regarding ATCM compliance options, including electrification. ARB staff is encouraging growers to consider switching to electric motors, especially in those cases where irrigation pumps are located in close proximity to residential areas, schools, and hospitals.

4. Potential Emission Reductions

This effort is expected to have a low emission reduction potential. Based on discussions with the agricultural community and electric utilities, up to 20 percent of existing stationary diesel agricultural irrigation pump engines are expected to be replaced with electric motors by 2020. This would result in a 2020 reduction of approximately 0.1 million metric tons of carbon dioxide. Given the compliance schedule in the ATCM and uncertainty regarding some incentive programs, staff is unable to estimate reductions for 2010 at this time.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

ARB staff estimates the cost to electrify stationary agricultural engines at about $26 million (8,000 pump engines x 20 percent x $15,000 (average capital cost of an electric motor)). This estimate does not account for possible additional line extension and/or electrical hook-up charges (highly variable for agricultural electric customers depending on location, crop,
well-depth, and other variables), which are likely to be cost prohibitive for many growers in remote areas. The estimate also does not account for any potential incentive funds that may be available to switch from diesel- to electric-powered agricultural irrigation pumps as these funds are limited and available on a first-come, first-served basis.

6. Technical Feasibility

Outreach efforts will encourage the use of electric motors, which are established and proven in agricultural operations. Approximately 82 percent of all stationary agricultural irrigation pumps in California are currently powered by electric motors, 15 percent are diesel-powered, and three percent are powered by other means (e.g., natural gas, liquefied petroleum gas, propane, butane, or gasoline).

7. Additional Considerations

The Board approved the amendments to the ATCM for Stationary Compression-Ignition Engines at the November 2006 public hearing. The amendments contain emission performance standards for agricultural engines but do not mandate electrification or any other specific compliance option. As explained in the September 2006 staff report for the ATCM, the Board had previously directed ARB staff to investigate the opportunities and challenges associated with replacing California’s existing population of stationary diesel agricultural engines with electric motors. During the investigation, ARB staff identified many variables associated with farm and ranch electrical power use in California. These variables include irrigation method and schedule, availability of surface water, well pumping depth, quantity of water needed, fuel costs, electricity costs, and electrical infrastructure proximity and adequacy. Because of these variables, ARB staff concluded that any decision about the desirability or difficulty of converting stationary diesel agricultural engines to electric motors must be made on a site-by-site basis. Nonetheless, ARB staff believes that most engines will be replaced with new cleaner certified diesel engines or with electric motors. Retrofit and alternative fuels are other potential means of compliance. Staff is unable to predict which compliance option farmers will choose.

8. Division: Stationary Source Division
   Staff Lead: Jon Manji
   Section Manager: Richard Boyd
   Branch Chief: Dan Donohue
1. Early Actions Strategy Name and Proponent

SUMMARY #: C02
ID NUMBER: ARB 2-4
TITLE: REDUCTION OF PERFLUOROCARBONS (PFCs) FROM THE SEMICONDUCTOR INDUSTRY
PROONENT: AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 4th quarter of 2008.

3. Early Action Description

The semiconductor industry uses PFCs primarily for etching circuits in silicon wafers and cleaning chemical vapor deposition tool chambers where thin films of chemicals are laid down onto silicon wafers. During these processes, a portion of the PFC gases used is released to the atmosphere. There are four technologies industry has either employed or considered to reduce PFC emissions from semiconductor production:

- Process Optimization (optimizing the use of PFCs, such as in the chamber cleaning process);
- Alternative Chemistry Development;
- Emission Abatement; and
- Recovery/Recycling (separation of fluorinated compounds from other gases for further processing and reuse).

This discrete early action item will consider mandating the process optimization and alternative chemistry development technologies currently in use by some manufacturers. ARB would also evaluate the technical and economic feasibility of requiring emissions abatement and recovery/recycling strategies that may further reduce PFC emissions.

A few California manufacturers currently participate in voluntary national efforts to reduce PFC emissions to 10 percent below 1995 levels by 2010. A 2001 Memorandum of Understanding (MOU) agreement with the U.S. EPA provides details of these efforts. Only three of 93 California manufacturers (about 15 percent of California production) participate in the MOU agreement. Manufacturers and the U.S. EPA reached the agreement well before the adoption of Assembly Bill 32. Consequently, the State and federal courses of action have different goals and timeframes and information on any actions being taken by the remaining California companies to reduce PFC emissions is limited. A survey of the industry will be necessary to improve the accuracy of the emissions data.
4. Potential Emission Reductions

ARB staff proposed a GHG reduction goal of 0.5 MMTCO₂ equivalent in 2020 for the semiconductor industry in the April 2007 early actions report. This goal will be further evaluated based on survey results from the industry and other data that become available over the next few months.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The complete cost of this regulation has not been determined at this time. For process optimization, higher costs could be incurred by older fabrication facilities as process parameters such as chamber pressure, temperature, cleaning gas flow rates and gas mixture ratios are changed to reduce gas use. Alternative chemistry development is expected to result in minor cost impacts as the cost of alternative gases would be about the same as PFC gases. The manufacturers could pass on any additional costs to the consumers through higher product prices. The significance of this impact is not known.

6. Technical Feasibility

The technical feasibility of two of the four technology options for reducing PFC emissions within the semiconductor industry is fairly well known at this time. Two technologies currently used by manufacturers are:

- Process optimization
  This technology reduces the amount of PFCs used and has been primarily applied to the chamber cleaning process because of high use of PFC gases for cleaning.

- Alternative Chemistry Development
  Nitrogen trifluoride (NF₃) has been used as a substitute for hexafluoroethane (C₂F₆) in the chamber cleaning process to reduce PFC emissions since NF₃ is more effectively destroyed in the process.

Two technologies that would be further evaluated are:

- Emissions abatement
  Commercially available technologies can be applied to the chamber cleaning or the etching process to reduce emissions. High temperature and catalytic oxidation and plasma destruction are the most common technologies used to abate PFCs, but little is currently known about the extent of use by California manufacturers. Furthermore, the performance of abatement systems can vary greatly depending on the abatement device and process parameters, such as temperature and PFC gas flow rates.

- Recovery/Recycling
  These technologies have not achieved as much success as others as they are more costly or require more maintenance. The recovered compounds that are separated from other gases contain more impurities than virgin chemicals and are less likely to be used by the industry.

C-6
7. Additional Considerations

Additional considerations that pertain to the measure include:

This item is regulatory and falls under ARB jurisdiction. ARB has the legal authority to pursue this discrete early action item and the Climate Action Team supports further PFC reductions by the semiconductor industry. Staff recommends that this item be presented to the Board within 18 months.

Leakage Considerations: The movement of semiconductor production facilities and older equipment from California to regions beyond California may result in leakage effects. The Semiconductor Industry Association (SIA) has indicated that California semiconductor manufacturing has been in decline over the last decade. The reasons vary from high capital costs, to tax advantages offered by other state and foreign governments, to lower financial risks associated with overseas foundry manufacturing compared to self-manufacture. The illustration provided by SIA is that from 1995 to 2008, three of the six MOU California companies ceased manufacturing operations. The corresponding decline in emissions was that California went from representing nearly 8 percent of U.S. emissions to just 3 percent. Staff needs to determine if the decline in California's emissions represents a shift of PFC emissions to other countries such as China. If so, we will need to determine if those manufacturers are using older equipment sold by California firms which may result in high emissions.

Affected Entities
Industry:
- Semiconductor fabrication industry
- Semiconductor Industry Association

Government:
- Local air pollution control districts
- California Energy Commission
- U.S. EPA

8. Division: Stationary Source Division
Staff Lead: Dale Trenschel
Section Manager: Terrel Ferreira
Branch Chief: Barbara Fry

9. References:


1. Early Actions Strategy Name and Proponent

SUMMARY #: C03  
ID NUMBER: ARB 2-5  
TITLE: FOAM RECOVERY/DESTRUCTION PROGRAM  
PROONENT: AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2011.

This timing will allow staff the time to complete inventory research\(^1\), interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

An alternative or complimentary approach may include establishing a voluntary agreement for recovery and destruction for certain foams, if the agreement can be implemented more cost-effectively and can be expected to yield similar CO\(_2\)E benefits as mandatory compliance.

3. Early Action Description

This strategy involves a regulatory measure(s) to implement a program to recover and destroy high-GWP insulating foams from buildings, other construction/demolition (C/D) waste, and appliances at end-of-life (EOL). The appliance foam recovery would be coordinated with the US EPA, as they have implemented a similar, voluntary program with some utility providers\(^2\).

Many foams contain high-GWP GHG blowing agents, especially older insulating foams used in appliances and buildings, that contain chlorofluorocarbon (CFC) blowing agents such as CFC-11 (100-year direct GWP of 4,600).

Currently, foams are either broken (building panels) or shredded (appliances) and landfilled; at this time, no federal or state laws require that foams containing ozone depleting substance (ODS) or other high-GWP blowing agents in the foam be removed and destroyed\(^3\).

Foam recovery from appliances may either be done manually, or as part of a fully automated recovery system in which appliance refrigerant is removed/de-gassed, the appliance is

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\(^1\) Inventory work in this area is expected to be complete by late 2009.

\(^2\) Responsible Appliance Disposal program, or RAD: [http://www.epa.gov/ozone/snap/emissions/radp.html](http://www.epa.gov/ozone/snap/emissions/radp.html)

\(^3\) Although refrigerant removal is required at appliance EOL under federal and state law, it is unknown at this time whether foam and refrigerant recovery would be performed by the same people at the same time; the process and technician certification requirements are expected to differ.
shredded, with the refrigerant in the foam collected from the gaseous and solid phases and subsequently destroyed.

4. Potential Emission Reductions

Estimated annual emission reductions of 0.9 MMTCO$_2$E are currently possible for residential refrigerator and freezer foam recovery.$^4$ This number may be offset somewhat by CO$_2$ emissions associated with foam destruction.$^5$ Of the 0.9 MMTCO$_2$E, 0.8 MMTCO$_2$E is due to recovery of foam containing R-11.

The CO$_2$E emission reductions are calculated for 2005 with only refrigerators and freezers considered since quantities of insulating foams recovered from A/Cs and building wastes annually in California are unknown. Without knowledge of the numbers and age distributions of appliances in California, 2020 emissions reductions based on sector growth and transitional blowing agent use estimates were not possible. However, it is reasonable to assume that approximately 0.9 MMTCO$_2$E reductions will be possible every year until refrigerators and freezers containing R-11 are gone.

To summarize, by about 2012 annual emissions reductions of 0.9 MMTCO$_2$E may be possible by recovering foams banked in old refrigerators and freezers that would otherwise go to landfills. Emissions benefits associated with foam recovery from building and additional C/D wastes could not be estimated.

5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The US EPA estimates that automated foam recovery at appliance EOL costs approximately $6.5/TCO$_2$E, while manual foam recovery at appliance EOL costs approximately $48/TCO$_2$E. The US EPA states that foam recovery from steel faced building panels is cost effective where large volumes of panels are in one place.$^6$

The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user. Recovery of foam from buildings is not currently performed.

$^4$ The following assumptions were used: 1) 20 year lifetimes for refrigerators, 2) R-11 use in refrigerators stopped in 1995; from 1995 – 2005 HCFC-141b was used, 3) in 2005, half of disposed refrigerators contain R-11 as the foam blowing agent and the other half contain 141b, 4) 25% of the foam blowing agent is lost into the cabinet and is released into the atmosphere and that the remaining 75% is recoverable, 5) 13,000,000 refrigerator/freezers are disposed of annually in the US and 60% go to landfills or transfer stations 6) the California population fraction was roughly 13% in 2005, 7) 100-year direct GWPs of 4800 and 700 were used for R-11 and HCFC-141b, respectively, 8) blowing agent masses of 0.45 kg/appliance and 0.38 kg/appliance for R-11 and HCFC-141b, respectively, were obtained from USEPA (Dave Godwin, personal conversation, 2/07).

$^5$ An additional 0.8 MMT CO2E should be avoided at appliance EOL, as refrigerant recovery is mandated by federal and state law; this is discussed in the following strategy, ARB 4-2. Foaming destruction would require a large amount of additional analysis; currently, USEPA is developing a plan to destroy ODSs at RCRA facilities, and the operating assumption is that the CO2 emissions associated with relatively small amounts of foams and refrigerants are small compared to the hazardous waste destruction throughput of a typical RCRA facility, but this supposition is subject to further analysis and change.

A foam recovery program for appliances is currently operating as an incentive program between the US EPA and utility companies, some of which are located in California (Responsible Appliance Disposal program, or RAD, see following strategy, ARB 4-2). The program was started in 2006 and the success of the program has not been gauged yet, although it is anticipated that a mandatory program would be more effective.

6. Technical Feasibility

The technology required to remove foam blowing agents from appliances and other construction and demolition wastes is feasible, but labor intensive if manual removal is employed. Automated foam removal from appliances is technically feasible, and can be performed during scrap metal processing and recovery.

7. Additional Considerations

Ozone depleting substances (ODSs) were used in the past as foam blowing agents; CFC-11 (100-year direct GWP of 4,600) was used for many years, and phaseout of its replacement, HCFC-141b (100-year direct GWP of 700), from appliance foam has only been occurring in the past four years. Recovering and destroying ODSs may be a cost-effective way to reduce high-GWP gas emissions, and also reduces negative impacts on stratospheric ozone.

It is also possible that special facilities will need to be constructed if automated foam removal is deemed more economically feasible than manual foam removal and would therefore need to be considered in any estimates of cost-effectiveness.

The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user. California trade associations associated with recycling of scrap metals are unknown. Coordination with the US EPA with respect to this regulation is ongoing.

8. Division: Research Division
   Staff Lead: Whitney Leeman
   Section Manager: Vacant
   Branch Chief: Richard Corey

9. References


USEPA, RAD program website: http://www.epa.gov/ozone/snap/emissions/radp.html
Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #: C04
ID NUMBER: ARB 2-6
TITLE: GUIDANCE AND PROTOCOLS FOR LOCAL GOVERNMENTS TO FACILITATE GHG EMISSION REDUCTIONS
PROPOSER: AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 3rd quarter of 2008.

Local governments have the power to affect the main sources of pollution directly linked to climate change through infrastructure investments, land use decisions, building codes, and municipal service management. While a handful of local governments in California have already started to plan and implement local GHG reduction measures, development of a State guidance document and local government protocols is needed to encourage and support greater and coordinated local action statewide. Furthermore, development of these items will help ensure consistency and coordination between the multiple state agencies involved with Implementing AB 32, with regard to supporting and advising Local Government actions for GHG reductions.

Staff recommend developing guidance documents for Local Governments that outline GHG reduction opportunities, as well as protocols for emission reduction accounting.

3. Early Action Description

The first step of this strategy will be to coordinate with the Climate Action Team, local governments, the California Climate Action Registry, and local government support organizations like ICLEI (Local Governments for Sustainability). The guidance document will address: 1) best practices for local governments to reduce GHG emissions; 2) categorization and prioritization of strategies by applicability to community types (i.e., urban, suburban, rural), cost-effectiveness, time needed to achieve reductions, etc.; 3) local government protocols for emission reduction accounting; and 4) appropriate modeling tools to support emission quantification at the local level.

Specific recommendations could include: implementing green building standards, stronger recycling programs, energy conservation, changing municipal fleets to cleaner alternatives (gas-electric hybrids, natural gas fueled vehicles, etc.), promoting sustainable communities and smart growth; encouraging LED street and traffic lights; promoting alternative energy (e.g. solar).
These are effective actions that local governments can implement to reduce carbon emissions, which not only help the environment but could be cost effective. Guidance documents and protocols from this strategy will be voluntary not regulatory and will be developed in close coordination with stakeholders representing state, local, regional and industry perspectives. A strong long-term local level education program will be necessary for successful implementation.

Groups to work with include:

Trade Associations: California Building Industry Association (CBIA), League of California Cities, California State Association of Counties (CSAC), California Association of Councils of Governments (CALCOG).

Government Agencies: Governor’s Office of Planning and Research, California Air Pollution Control Officers Association (CAPCOA), and Local Air Pollution Control Districts, local government agencies, Cal/EPA’s Climate Action Team and its Land Use/Smart Growth Subgroup, Department of Community and Housing Development, Department of Transportation, California Energy Commission, Integrated Waste Management Board.

4. Potential Emission Reductions

Potential emission reduction impacts are difficult to predict with current knowledge.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Estimated costs and economic impacts are difficult to determine and this time.

6. Technical Feasibility

With regard to developing a best practices document for Local Government, many other cities, states, and private organizations have acknowledged the need to reduce global warming pollution and have taken steps to coordinate concerted efforts. Below is a list of just a few national and international programs that staff will consider closely:

- U.S. Mayors for Climate Protection - promote actions that city governments can do to profitably and reduce carbon emissions.
- The Clinton Climate Initiative - works with C40 Large Cities Climate Leadership Group, an association of large cities dedicated to tackling climate change—to develop and implement a range of actions that will accelerate greenhouse gas emissions reductions.
- ICLEI’s Cities for Climate Protection™ (CCP) Campaign - assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. More than 800 local governments participate in the CCP, integrating climate change mitigation into their decision-making processes.

As for protocols for emission reduction accounting, the California Climate Action Registry (CCAR) is currently under contract with the ARB to develop a suite of protocols for reporting and certifying GHG emission reductions for Local Governments. As part of this effort, CCAR will be preparing a scoping document that describes the full scope of local government activities and operations to which quantification protocols can be applied. Data and analysis from this work will support development of a Local Government guidance document.
7. Additional Considerations

Many of the actions that may be recommended fall under the jurisdiction of other state and local agencies therefore this strategy will provide advice and support action, rather than mandate.

An important aspect of this strategy will be verification of the emission reductions and the value associated with it. Future efforts will focus on how local governments can take credit for net reductions and best uses for those credits.

Proposed Board Hearing Date: July 2008

8. Division: Office of Climate Change
   Staff Lead: James Goldstene
Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #: C05
ID NUMBER: 2-7
TITLE: GUIDANCE/PROTOCOLS FOR BUSINESSES TO FACILITATE GHG EMISSION REDUCTIONS
PROPONET: AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2008.

Currently, California businesses' energy consumption contributes approximately 12 MMTCO2E GHG emissions per year. Through strategies such as efficient building practices, motor vehicle fleet changes, operational changes, fossil fuel switching, and recycling, local businesses can reduce cost effectively their carbon footprint. These emission reductions range from quite minor to very significant and all reductions will assist the State in meeting its targets under AB32.

Greenhouse gas emission reduction guidance and suggested strategies for local businesses will be presented to the Board in July 2008. At present, it is anticipated that implementation of local business reduction measures will be strongly encouraged, but strictly on a voluntary basis with a dedicated and aggressive educational outreach effort. It is also anticipated that initially, guidance will be broad and, hence applicable to a broad spectrum of businesses. In time, the guidance will evolve into focused, sector-specific recommendations. To the extent possible, a robust emission verification element will be integrated into the guidance so that reductions can be quantified.

3. Early Action Description

This strategy will provide guidance and informational resources to local businesses on best practices, emission calculation and verification methods, case studies, cost-effectiveness information, and other tools to assist in reducing greenhouse gas emissions. The guidance will seek to distill and translate the vast amount of information already existing into tangible and concrete steps that local business can implement. Staff's efforts will be focused on reaching out to small/mid-size businesses to engage them in the development of actions, to offer guidance for estimating emissions, identifying and quantifying reductions, and facilitating actions to reduce carbon footprints. Information on relevant options, particularly those that have been implemented successfully by others at a local or national level will be highlighted.

This strategy will focus on businesses ranging from a small office to mid-size corporations and will address the climate benefits of both operational and behavioral changes. Operational changes could include the use of Energy Star equipment, compact fluorescent light bulbs, water conservation, recycling, and motor vehicle fleet changes. In addition to physical changes to the
operation of the business (e.g., new construction, retrofits to existing buildings), the guidance will address the benefits of behavioral changes such as incentives for carpooling/walking/bicycling to the workplace, facilitate employees walking to lunch, procuring "green" products, incentives for reducing waste/electricity consumption, Governor's Awards program to recognize green business leaders, etc. Businesses that choose to pledge to participate in the effort for climate protection will be encouraged and assisted to inventory and report their emissions via recognized channels such as the California Climate Action Registry.

To be successful, this strategy must convince businesses to embrace new projects and initiatives from both environmental and economic perspectives. Thus, a key element of success in the strategy will be to determine how enhancements of operational efficiencies can result in increased profits for a participating business via savings in energy consumption. In addition to working with established organizations that represent or have strong ties with the targeted audience (small and medium business owners/managers), emphasis will be placed on implementation through a variety of means (e.g., information in association newsletters, presentations at trade meeting, web-based tools, etc.). ARB staff will monitor the effectiveness of and response to efforts in order and make necessary adjustments as needed to strengthen the program into the future.

4. Potential Emission Reductions

Energy efficiency measures associated with green buildings address lighting, heating and cooling, water conservation, refrigeration, and recycling and often lead to a large decrease in GHG emissions. The US Department of Energy states that new energy-efficient design can cut energy usage by 50%; renovation of existing buildings can yield savings of up to 30%. Governor Schwarzenegger signed Executive Order S-20-04 in 2004, which sets a goal of reducing energy use in State-owned buildings 20% by 2015 (from a 2003 baseline). The private commercial sector is encouraged to do the same. The California Energy Commission estimated 2004 GHG emissions in the commercial sector to be approximately 12 MMTCO2E. Thus, achieving a 20% reduction in GHG emissions as called for in the Executive Order could potentially realize a reduction of more than 2 MMTCO2E in the commercial sector.

5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

Cost information will vary widely depending on the specific action implemented by a local business. Thus, it is premature to report this information at this time. However, information coming from existing examples that have successfully achieved improvements indicates that the return on investment for energy efficiency measures is often recovered in three to five years, resulting in long term cost savings due to lower utility bills. Measures that could be implemented pursuant to this proposed early action are quite varied and potentially include installation of LED exit signs, efficient refrigeration systems, improved building insulation, purchase of Energy Star appliances and office equipment, and implementation of recycling programs. Improvements that are scalable to square footage of operations will be pursued so that the emission reduction benefits can be pursued across all sizes of businesses.

6. Technical Feasibility

The proposed strategy benefits from the successful experience from several local businesses and other entities that have already set targets and developed climate action plans. The mitigation strategies will likely be a suite of best practices already in use and proven to be
feasible and effective. Staff will work with the business community to ensure that this strategy focuses on activities and provide information that will promote real, quantifiable, and sustainable reductions. We will also focus on the most effective ways to target the information at decision makers. Hurdles may include developing and implementing guidance that is sufficiently specific and documented.

7. Additional Considerations

ARB will work in consultation with several agencies including: 1) California Energy Commission, 2) Business Associations 3) California Climate Action Registry 4) California Chamber of Commerce, 5) Utility providers, as well as many others.

8. Division: Research Division/Planning and Technical Support Division/Office of Climate Change

   Staff Lead: TBD
   Section Manager: Annmarie Mora
   Branch Chief: Alberto Ayala

9. References:


1. Early Actions Strategy Name and Proponent

SUMMARY #: C06
ID NUMBER: ARB 2-8
TITLE: REDUCE SULFUR HEXAFLUORIDE (SF₆) FROM ELECTRICAL GENERATION
PROONENT: AIR RESOURCES BOARD STAFF

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2011.

3. Early Action Description

This strategy proposes that the ARB develop a measure to reduce sulfur hexafluoride (SF₆) emissions from the electric power industry, which is the primary user of SF₆. SF₆ is a synthetic gas used as an insulating medium. The most common use for SF₆ is as an electrical insulator in high-voltage equipment that transmits and distributes electricity. Since the 1950's, the U.S. electric power industry has used SF₆ widely in circuit breakers, gas-insulated substations, and other switchgear used in the transmission system to manage the high voltages carried between generation stations and customer load centers. Fugitive emissions of SF₆ can escape from gas-insulated substations and switchgear through seals. It can also be released during equipment installation and when equipment is opened for servicing. Several factors affect SF₆ emissions from electric power systems, such as the type and age of the equipment (e.g., older circuit breakers can contain up to 2,000 pounds of SF₆, while modern breakers usually contain less than 100 pounds), and the handling and maintenance procedures practiced by the utilities.

SF₆ is a highly potent greenhouse gas. Over a 100-year period, SF₆ is 23,900 times more effective at trapping infrared radiation than an equivalent amount of carbon dioxide. SF₆ is also a very stable chemical, with an atmospheric lifetime of 3,200 years. Consequently, it will accumulate in the atmosphere.

The U.S. Environmental Protection Agency (U.S. EPA) reports that the most promising and cost-effective options to reduce SF₆ emissions are leak detection and repair, use of recycling equipment, and employee education and training.

4. Potential Emission Reductions

U.S. EPA estimates that the SF₆ emissions from electric power systems in the U.S. in 2005 were 4.9 million metric tons of CO₂-equivalent (MMTCO2E). The Cal/EPA Climate Action Team
Report states that hydrofluorocarbons, perfluorocarbons, and SF$_6$ accounted for about 3.5 percent of gross 2002 greenhouse gas emissions in California (CO$_2$-equivalent). USEPA reports that use of recycling equipment can reduce SF$_6$ emissions by about 10 percent, and leak detection and repair can reduce SF$_6$ emissions by 20 percent.

Further investigation is required to determine the portion of SF$_6$ emissions attributed to the California electric power industry and the most appropriate and effective emission reduction equipment and practices. Therefore, ARB staff cannot yet determine the total emission reduction potential of this strategy.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

U.S. EPA reports that cost-effective operational improvements and equipment upgrades can be accomplished at an average cost of $9.00 per pound. The cost impacts of this strategy specific to the California power sector cannot be determined at this time as further investigation is required. ARB staff assumes that costs will be borne by the power companies and could translate into increased electricity rates for consumers.

6. Technical Feasibility

The most cost-effective SF$_6$ emission reduction options reported by USEPA focus on maintenance and education, and therefore do not appear to have any associated major technical issues. However, to the extent that repair and replacement activities are used to reduce emissions, scheduling to minimize electrical system disruption could be an issue.

7. Additional Considerations

8. Division: Stationary Source Division
   Staff Lead: Chris Gallenstein
   Section Manager: Mike Waugh
   Branch Chief: Mike Tollstrup

9. References:


Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #: C07
ID NUMBER: ARB 2-10
TITLE: ALTERNATIVE SUPPRESSANTS IN FIRE PROTECTION SYSTEMS
PROONENT: STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2011.

Staff recommends developing a proposal for the use of lower GWP substances in fire protection systems to the extent that safe, technically feasible, and cost-effective alternatives are available. These systems, called total flooding systems, are typically used to protect large computer data management areas in commercial buildings, clean room manufacturing facilities, telecommunications equipment, museums and archives. If further evaluation supports the use of this measure as a early action, the proposal will be considered by the Board by December 2011.

One possible approach (for illustrative purposes only): By 2012, require that all new total flooding fire suppressant systems use fire suppressants with a GWP below a specified threshold. The analysis may also explore requiring, providing the options are technologically feasible and cost-effective, that existing total flooding fire suppressant systems enhance inspections of or replace systems using substances with a GWP above a specified threshold, which may or may not be different than the above-mentioned threshold.

3. Early Action Description

Use lower global warming potential (GWP) gases in new fire protection systems to the extent that safe, technically feasible, and cost-effective alternatives are available.

4. Potential Emission Reductions

Statewide Emission Inventory¹
2005 GHG Emission Inventory: 0.05 MTCO₂
2020 Projected GHG Emissions: 0.23 MTCO₂
Anticipated 2020 Reductions: <0.1 MMT CO₂E which assumes 43 percent control

¹ All emissions estimates based on USEPA Vintaging Model scaled to California based on population assuming only HFC 227 since HFC 23 is only 1%; Halon emission data are not available at this time. Reduction estimates based on technical feasibility from EPA 2006 for new systems. Including reductions from replacement of systems with Halons or HFCs would increase the reduction potential.
Prior to the 1990s, most total flooding fire suppression systems used Halon 1301, however, it is an ozone depleting substance and, based on the Montreal Protocol on Substances that Deplete the Ozone Layer, its production in the US was completely phased out by the mid-1990s. Due to this fact, new systems have moved to Halon replacements, however, with the exception of the US Department of Defense, there has been no concerted effort to remove existing Halon 1301 systems and recycled Halon 1301 is inexpensive and widely available for recharge needs (Wickham 2002). The lifetime of a system ranges from 10 to 35 years.

There are several Halon alternatives being used in fire suppression systems. The US EPA estimates that HFC 227ea covers approximately 16 percent of the total new flooding fire protection systems with HFC 23 (<1%), inert gas (10%) and not-in-kind alternatives (NiK) such as powdered aerosols, water sprinklers and mist systems making up the remainder of the market (74%) (US EPA, 2006). Although these Halon alternatives are not ozone depleters, HFC 227ea and HFC 23 do have significant global warming potentials (GWP) of 2990 for HFC 227ea and 11700 for HFC 23 (IPCC, 1996). In comparison, Halon 1301 has a GWP of 7030, much higher than the common alternative of HFC 227ea (WMO, 2002).

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The US EPA estimates that the least cost alternative would be approximately $40/tonne CO$_2$E (US EPA, 2006) in the US for new systems. The estimate reflects the relative cost of alternative formulations, space costs, and costs associated with installing a new, and sometimes weightier, type of system. The costs may need to be updated and revised to reflect the situation in California. For example labor costs and heating and cooling costs differ from the average for the US. This analysis did not consider costs for replacement systems.

Total flooding systems are used by a wide variety of sectors with uses varying from data processing centers to the oil and gas industry to military weapons systems. Any requirements effecting new systems will be fairly evenly distributed among the sectors. Systems with low expected lifetimes (10-15 years) will be impacted most in the short-term as systems need to be replaced sooner. Any requirements to replace existing systems may have a larger impact on sectors with systems that have long expected lifetimes (35 years). These sectors were expecting the system to last up to 35 years but may have to upgrade the system much sooner.

6. Technical Feasibility

There are a number of low GWP alternatives to Halons and HFCs for use in total flooding fire suppression systems, however, they need to be analyzed for effectiveness, space constraints, safety concerns, and other issues. Not every alternative will work in every situation and technical feasibility will be vary based on space needs, human exposure potential for asphyxiates, and other constraints.

7. Additional Considerations

Some factors that need to be considered as part of the evaluation include whether the alternatives are as effective, do the alternatives have increased toxicity, are there any multi-media environmental impacts and whether the strategy would apply to only new installations or would existing installations need to be retrofitted? Other questions that need to be considered include what happens to the HFCs and Halons from any systems that are phased out, and will other agencies and insurance companies allow their use? Another fundamental
question concerns whether another agency would be more appropriate to adopt the strategy as well as determining if a voluntary measure be just as effective?

**Affected Entities:** Commercial building owners and property management companies, fire suppressant manufacturers (e.g., 3M, Great Lakes Chemical, Brownell, DuPont, Stat-X) and system manufacturers/suppliers (Sea fire, Nautical, Many suppliers - CA based include CalProtection, Chemetron, Diversified Protection, Facilities Protection Inc., Intelligent Technologies and Systems, and RFI Communications & Security).

**Trade Associations:** Building Industry Association, Chemical Manufacturers Association, Building Insurance, Fire Suppression Systems Association, Fire Equipment Manufacturers Association and others.

**Government Agencies to coordinate with:** California Department of Fire Protection, State Fire Marshall's Office, Department of General Services, OEHHA, DHS, Cal-OSHA, and others.

**Proposed Board Hearing Date:** December 2011

8. **Division:** Research Division  
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9. **References:**


1. Early Actions Strategy Name and Proponent

SUMMARY # C08
ID NUMBER: ARB 2-11
TITLE: FORESTRY PROTOCOL ENDORSEMENT
PROPOSENT: STAKEHOLDER SUGGESTION

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in the 4th quarter of 2007.

Staff recommends this strategy remain on the list as an early action by Board endorsement of the California Climate Action Registry (CCAR) forestry protocols for immediate use to enhance voluntary greenhouse gas emissions reductions. Staff recommends a two-phase process that allows early action by bringing existing sector, project, and certification protocols, developed by CCAR, to the Board for approval in October 2007 and also allows for longer term consideration and review of additional forestry protocol development as determined in the initial public workshop process. Endorsement of sector and project forest protocols would be non-regulatory, because their use would be voluntary.

3. Early Action Description

Forestry is the only sector that actively removes greenhouse gases from the atmosphere. The CCAR forestry protocols represent the work of leading experts in the field of forestry and in protocol development, the input of stakeholders and the public over a 4-year public process, and the review by 50 external experts, representing the forest industry, policy and academia. The protocols have been approved by the Board of Forestry (2004) and the CCAR Board (2005). The three protocols together – the sector, project, and certification protocols – are a cohesive and comprehensive set of methodologies for forest carbon accounting, and contain the elements necessary to generate high quality, conservative carbon credits. The first step to effective carbon reduction is accurate carbon accounting.

Unlike other sectors, immediate action in the forest sector does not result in instantaneous greenhouse gas reduction, because forests need time to grow to realize reduction benefits. Therefore, the sooner these voluntary protocols are endorsed, the faster forest projects can be put in place, to establish future reductions. The three carbon reduction project types – reforestation, conservation forest management, and avoided development – provide an accounting framework for maximizing carbon sequestration and minimizing carbon loss without compromising the other ecosystem functions forest provide (habitat, structure, nutrient cycling), as well as the suite of other benefits humans depend on from the forests (water storage, soil stability, temperature modification, air and water purification, wood products, recreation). As such, they are ready for use in voluntary measures to reduce carbon emissions in California.
4. Potential Emission Reductions

Because they are critical to accurate carbon accounting, the forestry protocols are required in several of the forest-related Climate Action Team (CAT) strategy implementation plans. A third of carbon reductions through the forest CAT plan depend on application of these forest protocols which equates to a cumulative sequestration of roughly 10 MMTCO2eq between now and 2020. The CAT-strategy reforestation projects in the year 2020 are expected to result in GHG emissions reduction of 2 MMTCO2eq (CAT, 2007). While there is already interest in the protocols from the private forest sector, the potential emissions reduction from the voluntary use of the protocols could vary depending on a variety of factors, including management activity, site fertility, and available funding. One unpublished industry study suggests a potential increase of 2½-fold in the pine zone (Steve Brink, California Forestry Association, pers. comm.). Nationally, an additional 100 to 200 Tg C/yr of forest carbon sequestration is achievable, but would require investment in inventory and monitoring, development of technology and practices, and assistance for land managers (Birdsey et al. 2006).

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Currently, the methodologies for carbon stock assessment require intensive sampling programs to meet the required confidence levels for verification. This is labor and time intensive, and therefore costly. There is currently no better technology/methodology to measure carbon if a high degree of certainty is required in carbon stock assessment. Carbon stock certainty should meet the criteria of other carbon emission estimates in the state (20% of the mean estimate). Smaller landowners may find the cost to implement the sampling and subsequent verification too burdensome to participate. The larger industrial landowners (>30,000 acres) should be able to use forest stocking data from sustained-yield management plans which they are required to submit to California Department of Fire and Forest Protection (CalFire). Data for inventorying large land areas may be accessible from CalFire plot data and USFS Forest Inventory and Analysis plot data.

6. Technical Feasibility

The carbon accounting techniques used in the forest protocols are standard forest measurement techniques.

7. Additional Considerations

The forestry protocols are designed for small to mid-sized private forest ownerships. There is a need for continued development of forest accounting methodologies to address outstanding issues for: 1) public forest ownerships and for 2) industrial forest private land ownerships. These issues can be addressed within the framework of the existing protocols by defining additional project types beyond the three project types (reforestation, conservation forest management, and avoided deforestation) in the current protocols. For public landowners, issues to resolve include legality of permanent easement transfer, baseline/additionality definition, and carbon offset ownership. By recognizing the need for additional project types in the future, the existing forestry protocols can be moved forward through the public process, endorsed and implementation immediately while the new project types are developed through a longer term public process. This will expedite the availability of the forest protocols for immediate use, while still allowing due consideration to the different needs of the industrial and public forest sector.
Affected Entities: Any forest ownership in California could participate in all forest project types, including state and federal public forests, and private forests. Many non-forest entities might participate in reforestation activities, including local governments, utilities, others.

Trade Associations: California Forestry Association.

Government Agencies Coordination: California Department of Forest and Fire Protection, Board of Forestry, United States Forest Service.

8. Division: Planning and Technical Support Division
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The protocols can be found in their entirety on the California Climate Action Registry website at: http://www.climateregistry.org/PROTOCOLS/FP/


Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #  C09
ID NUMBER:  ARB 2-18 / EJAC-2
TITLE:  ENFORCEMENT OF FEDERAL BAN ON HFC RELEASE DURING SERVICE/DISMANTLING OF MVACS
PROPOSENENT:  2006 CAT REPORT

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2010.

This non-regulatory strategy is expected to be developed in close collaboration with the United States Environmental Protection Agency (US EPA). The strategy is not a stand-alone measure. Rather, it is designed to be implemented in concert with a number of other strategies that staff has identified for mitigating the climate impact of HFCs.

3. Early Action Description

The goal of this non-regulatory strategy is improved compliance with a regulation of US EPA (40 CFR 82.154) that prohibits the venting of certain types of refrigerant, including HFCs, to the atmosphere when MVACS equipment is serviced or dismantled. Venting is avoided by recovering refrigerants with specialized equipment. The recovered refrigerant can be re-used by the owner or transferred to re-processors approved by US EPA.

The main focus of the proposed strategy would be the climate impact abatement of HFCs used in the air-conditioning (A/C) systems of vehicles that are to be dismantled. The current degree of compliance with 40 CFR 82.154 is poorly documented but under review. Per this strategy, better compliance by dismantlers would be obtained via a cooperative program that would be created among ARB’s Enforcement Division, appropriate offices in the US EPA, and the environmental protection offices of the counties where dismantling activity is taking place. The specific form of the program has not been determined yet, pending quantification of the avoidable emissions of HFCs. However, the anticipated approach would emphasize enhanced enforcement of existing federal requirements for recovery via audits of activities and documentation.

4. Potential Emission Reductions

Potential emission reductions from dismantling have been estimated to be in the range of 0.1 to 0.6 MMTCCO2E in 2010 and 0.1 MMTCO2E in 2020. The potential reductions are lower in the year 2020 because it is assumed that half of the cars going to the dismantlers will have new low-GWP refrigerant in the A/C system instead of HFC-134a as called for in other companion...
HFC reduction strategies. Preliminary estimates suggest that the refrigerant bank in EOL vehicles could be as high as 0.5 MMTCO\textsubscript{2}E per year. Estimates of annual A/C servicing emissions ranges from 0.3 to 0.6 MMTCO\textsubscript{2}E. The ARB staff has initiated extramural research to estimate the annual amount of HFC that is available for recovery from vehicle at end-of-life and we will continue to work with the USEPA to develop improved estimates of the portion of the available amount that is being recovered and other parameters.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Some dismantlers may not have the latest compliant hardware for recovering refrigerants or any equipment at all. Each such dismantler who would be prompted to purchase the equipment would have to spend in the neighborhood of $3000 to $4000 per unit. The number of units needed would depend on the size of the operation (vehicle throughput). However, this would be an expense that the dismantler has so far avoided only through failure to comply with the existing federal regulation. Thus, this is not a cost burden associated with the proposed strategy.

The same statements apply to obtaining certification for technicians who use the recovery equipment, but with minimal anticipated costs. Training for the US EPA’s certification program is offered by various commercial schools. In addition, the Mobile Air Conditioning Society offers free training (a downloadable pamphlet) and a nominal exam fee, so the necessary expense for operator certification should be minimal.

6. Technical Feasibility

This measure is technically feasible because it is the current federal law, which has been in existence for some time. As such, the equipment exists to recover the refrigerant from automobile A/C systems whether they are being serviced or dismantled. The rigorous enforcement of the federal regulation in California is meant to force vehicle dismantlers to universally use refrigerant-recovery equipment as required by law. The same is true for garages and auto service centers that service MVACS; however, the fraction of such shops that do not have the requisite equipment may be small. It should be noted that recovery procedures and equipment are being revised by industry standard setting bodies to make the process more effective with a higher recovery rates of the refrigerant.

7. Additional Considerations

This strategy involves the enforcement of an existing federal regulation (U.S. EPA- 40 CFR 82.154) that prohibits the venting of refrigerants to the atmosphere when the MVACS is being serviced or dismantled. Some local air districts adopt the federal regulation by reference and others have their own regulation which prohibits the release of refrigerants into the atmosphere. Originally, this item was a strategy in the Climate Action Team Report of March 2006 that ARB intends to pursue as one of suite of measures designed for reducing HFC refrigerant impacts. This strategy involves the creation of a cooperative program among ARB’s Enforcement Division, appropriate offices in the U.S. EPA, and local air districts in California. U.S. EPA is currently working on a regulatory impacts assessment that will estimate the emission reductions and costs associated with this type of measure. That work and other on-going activities are expected to yield the necessary additional information for strategy development such as the number of non-compliant dismantlers and shops that perform MVACS servicing in California.
8. Division: Research Division
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9. References:


2 Air Resources Board, HFC-134a as an Automotive Refrigerant - Background, Emissions and Effects of Potential Controls, August 6, 2004 (www.arb.ca.gov/cc/cc.htm)

3 Karen Thundiyil, USEPA, personal communication, 7/26/07.

4 Improved Mobile Air Conditioning Program (IMAC), "Reducing Refrigerant Emissions at Service and Vehicle End of Life," June 30, 2007
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INTRODUCTION

California has a long history of environmental leadership. Motivated by the stunning natural beauty of our coastline, inland valleys, forests and mountains, as well as by the public health and environmental challenges brought on by increasing levels of pollution, California's citizens have repeatedly called for and supported measures to protect California's environmental heritage. Our political leadership and governmental institutions have responded with a variety of initiatives that restore, protect, and enhance the environment to ensure public health, environmental quality, and economic vitality. Often these California initiatives have provided a benchmark and template for further action both nationally and internationally.

This tradition of environmental leadership continues to this day. In 2005, recognizing that global warming will impose compelling and extraordinary impacts on California, the Governor signed Executive Order S-3-05 which established climate change emission reduction targets for the state and set in motion a process to ensure the targets are met. This Executive Order also recognized the importance of preparedness in that it directed the Secretary of the California Environmental Protection Agency (Cal/EPA) to lead an effort to evaluate the impacts of climate change on California and to examine adaptation measures that would best prepare the state to respond to the adverse consequences of climate change.

1.1 Organization of the Report

The report begins (Section 2) with an overview of the scientific evidence regarding climate change and its potential effects in California. Section 3 outlines the long history of previous actions that California has taken to understand and address the threat of climate change. Section 4 provides an overview of the scenario analysis that was done to evaluate the impacts of climate change on California, potential adaptation measures that can be taken to best respond to those impacts, and an economic assessment of the impacts. Section 5 presents the Climate Action Team recommendations regarding strategies the state should pursue to reduce climate change emissions.

Section 6 outlines market-based options for the state and includes a discussion of design choices that need to be further evaluated prior to adoption of a market-based program for the state. Section 7 discusses all possible emission reduction implementation options that were considered by the Climate Action Team, including market-based options. Section 8 covers a broad assessment of the economic implications of state actions to reduce climate change emissions. Section 9 looks specifically at potential impacts on minority and low-income communities. Section 10 contains the Climate Action Team's recommendations to the Governor and the Legislature.
2 CLIMATE CHANGE OVERVIEW

The Earth’s climate has always evolved—the extremes of the 100,000-year ice-age cycles in both climate and climate change emissions over the last half million years are well documented. The period of the last 10,000 years has been warm and stable, and the last millennium, over which current societies have developed, has been one of the most stable climates observed. Yet, during the 20th century, we have observed a rapid change in the climate and climate change pollutants that is attributable to human activities.

These recent changes in climate change pollutants far exceed the extremes of the ice ages, and the global mean temperature is warming at a rate that cannot be explained by natural causes alone. Human activities are directly altering the chemical composition of the atmosphere through the buildup of climate change pollutants.

It is true that levels of natural climate change pollutants have fluctuated in the past. However, there are several reasons for attributing the rise in climate change pollutants to anthropogenic, rather than natural emissions. The first indicator comes from comparing the current increase with changes that have occurred in the past.

At the end of the last ice age, the concentration of CO₂ increased by around 100 ppm (parts per million) over about 8,000 years, or approximately 1.25 ppm per century. Since the start of the industrial revolution, the rate of increase has accelerated markedly. The rate of CO₂ accumulation currently stands at around 150 ppm/century—more than 200 times faster than the background rate for the past 15,000 years.

The heat-trapping property of climate change pollutants is undisputed. Although there is uncertainty about exactly how and when the Earth’s climate will respond to increasing concentrations of climate change pollutants, combining observations with climate models indicates that detectable changes are underway. There most likely are and will continue to be changes beyond global mean warming, such as changes in regional temperature extremes, precipitation, soil moisture, and sea level, all of which could have significant adverse effects on many ecological systems, as well as on human health and the economy.

This section first presents the causes and projections for climate change, then discusses climate change pollutants. It includes a definition of global warming potentials and climate change pollutants. The section concludes with a brief discussion of abrupt climate change.

2.1 Climate Change Causes and Projections

Climate change is a shift in the "average weather" that a given region experiences. This is measured by changes in the features that we associate with weather, such as temperature, wind patterns, precipitation, and storms. Global climate change means change in the climate of the Earth as a whole. The Earth’s natural climate has always been, and still is, constantly changing. The
climate change we are seeing today, however, differs from previous climate change in both its rate and its magnitude.

The temperature on Earth is regulated by a system commonly known as the "greenhouse effect." Naturally occurring climate change pollutants, primarily water vapor, CO$_2$, CH$_4$, and N$_2$O, absorb heat radiated from the Earth's surface. As the atmosphere warms, it in turn radiates heat back to the surface to create the greenhouse effect. The Earth's surface temperature would be about 34°C (61°F) colder than it is now if it were not for the natural heat trapping effect of climate change pollutants like CO$_2$, CH$_4$, N$_2$O, and water vapor.

Human activities are exerting a major and growing influence on some of the key factors that govern climate by changing the composition of the atmosphere and by modifying the land surface. The concentration of CO$_2$ in the atmosphere has risen about 30 percent since the late 1800s (National Assessment Synthesis Team [NAST], 2001). This increase has resulted from the burning of coal, oil, and natural gas, and the destruction of forests around the world to provide space for agriculture and other human activities.

Global projections of population growth and assumptions about energy use indicate that the CO$_2$ concentration will continue to rise, likely reaching between two and three times its late-19th-century level by 2100. Figure 2-1 shows the atmospheric CO$_2$ concentration from year 1000 to year 2000 from ice core data and from direct atmospheric measurements during the past few decades. Projections of CO$_2$ concentrations for the period 2000 to 2100 are based on model predictions.
Figure 2-2 shows variations of the Earth's surface temperature for years 1000 to 2100. From year 1000 to year 1860 variations in average surface temperature of the Northern Hemisphere are reconstructed from proxy data (tree rings, corals, ice cores, and historical records). The line shows the 50-year average; the gray region, the 95 percent confidence limit in the annual data.

For the period 1860 to 2000, the figure shows variations in observations of globally and annually averaged surface temperature from the instrumental record; the line shows the decadal average. For 2000 to 2100, projections of globally averaged surface temperature are shown for several model scenarios using a global climate model.

The Third Assessment Report of the International Panel on Climate Change (IPCC, Synthesis Report, 2001) and the National Research Council of the National Academies (NRC, 2001) conclude that the global climate is changing at a rate unmatched in the past 1,000 years. The IPCC assessment cites new and stronger evidence that most of the global warming observed over the last 50 years is attributable to human activities and that anthropogenic climate change will persist for many centuries.
Many sources of data indicate that the Earth is warming faster than at any time in the previous 1,000 years. The global mean surface temperature has increased by 1.1°F since the 19th century (IPCC Synthesis report, 2001). The 10 warmest years of the last century all occurred within the last 15 years.

For example, 2002 and 2003 are tied as the second warmest years on record, according to a year-end review of climate data by the National Oceanic and Atmospheric Administration. Both the IPCC (2001) and the NAST (2001) reports project that warming in the 21st century will be significantly larger than in the 20th century. Scenarios examined in these assessments indicate that temperatures in the U.S. will rise by about 5° to 9°F (3° to 5°C) on average in the next 100 years.

2.2 Climate Change Emission Sources and Pollutants

As shown in Figure 2-3, fossil fuel consumption in the transportation sector was the single largest source of California's climate change emissions in 2002, with the industrial sector as the second-largest source. Electricity production, from both in-state and out-of-state sources, was the third-largest source. Agriculture, forestry, commercial, and residential activities comprised the balance of California's climate change emissions (CEC, 2005).
As previously indicated, human activities are altering the chemical composition of the Earth's atmosphere through the release and build-up of climate change emissions. However, climate change pollutants such as water vapor, CO2, CH4, N2O, and O3 can also be associated with natural sources. Conversely, several classes of halogenated substances that contain fluorine, chlorine, or bromine are also climate change emissions, but they are, for the most part, solely a product of industrial activities.

Figure 2-4 provides a distribution of California anthropogenic climate change pollutants by gas in 2002, expressed in terms of CO2 equivalence. In addition, there are a number of other pollutants such as carbon monoxide, nitrogen oxides, and aerosols that have direct or indirect effects on terrestrial or solar radiation absorption. Individual climate change species are briefly discussed in the following section.
Carbon Dioxide (CO₂)
In the atmosphere, carbon generally exists in its oxidized form, as CO₂. Increased CO₂ concentrations in the atmosphere have been primarily linked to increased combustion of fossil fuels. Fossil fuel combustion accounted for 98 percent of gross California CO₂ emissions. California's total CO₂ emissions from fossil fuel combustion in 2002 were 360 million metric tons CO₂, which accounts for approximately 7 percent of the U.S. emissions from this source. The transportation sector accounted for the largest portion of CO₂ emissions with gasoline consumption accounting for the greatest portion of emissions.

Methane (CH₄)
Methane accounted for approximately 6 percent of gross 2002 climate change emissions in California (CO₂ equivalent). Methane is produced during anaerobic decomposition of organic matter in biological systems. Decomposition occurring in landfills accounts for the majority of anthropogenic CH₄ emissions in California and in the United States as a whole. Agricultural processes such as enteric fermentation, manure management, and rice cultivation are also significant sources of CH₄ in California.

Nitrous Oxide (N₂O)
Nitrous oxide emissions accounted for nearly 7 percent of climate change emissions (CO₂ equivalent) in California in 2002. The primary sources of anthropogenic N₂O emissions in California are agricultural soil management and fossil fuel combustion in mobile sources.
Nitrous oxide is a product of the reaction that occurs between nitrogen and oxygen during fuel combustion. Both mobile and stationary combustion emit N₂O, and the quantity emitted varies according to the type of fuel, technology, and pollution control device used, as well as maintenance and operating practices. U.S.EPA estimates from 2003 suggest that in 2001, N₂O emissions from mobile combustion were 13 percent of U.S. N₂O emissions, while stationary combustion accounted for 3 percent.

**Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulfur Hexafluoride (SF₆)**

HFCs, PFCs and SF₆ accounted for about 3.5 percent of gross 2002 climate change emissions in California (CO₂ equivalent). HFCs are primarily used as substitutes for ozone-depleting substances (ODS) regulated under the Montreal Protocol. PFCs and SF₆ are generally emitted from various industrial processes including aluminum smelting, semiconductor manufacturing, electric power transmission and distribution, and magnesium casting. There is no aluminum or magnesium production in California; however, the rapid growth in the semiconductor industry leads to greater use of PFCs.

**Other Radiatively Important Gases**

In addition, there are a number of man-made pollutants, emitted primarily as by-products of combustion (both of fossil fuels and of biomass), that have indirect effects on terrestrial or solar radiation absorption by influencing the formation or destruction of other climate change emissions. These include carbon monoxide (CO), nitrogen oxides (NOₓ), nonmethane volatile organic compounds (NMVOCs), and sulfur dioxide (SO₂).

These compounds, regulated in the U.S. and California pursuant to the Clean Air Act, are often referred to as "criteria pollutants." The criteria pollutants are reactive compounds, and they tend to remain in the atmosphere for a much shorter time (typically hours to months) than the previously discussed gases. As shown in Table 2-1, CO₂, N₂O, CH₄, and HFC-134a have atmospheric lifetimes ranging from a century to 10 years.

The sequence of reactions that removes CO, NOₓ, and NMVOCs from the atmosphere, however, tends to promote the formation of tropospheric O₃ which is also a potent climate change emission. At present, there is large scientific uncertainty in estimating the radiative forcing effects of criteria pollutants.

**Aerosols**

Aerosols are extremely small particles or liquid droplets found in the atmosphere. Various categories of aerosols include naturally produced aerosols (e.g., soil dust, sea salt, biogenic aerosols, and volcanic aerosols), and anthropogenic aerosols (e.g., sulfates, ammonium nitrate, industrial dust, and carbonaceous aerosols including black carbon and organic carbon). Anthropogenic aerosols are derived directly or indirectly from transportation, coal combustion, cement manufacturing, waste incineration, and biomass burning.
Aerosols affect radiative forcing in both direct and indirect ways: directly by scattering and absorbing solar and thermal infrared radiation; and indirectly by altering the cloud properties and atmospheric heating rates that in turn modify the formation, precipitation efficiency, and radiative properties of clouds. The effect of aerosols on regional and global climate is complex: in general, sulfate aerosols enhance the reflection of sunlight and cool the Earth, while black carbon aerosols enhance the absorption of sunlight and warm the Earth.

Understanding the role of aerosols in climate change requires inclusion of realistic representations of aerosols and their radiative forcings in climate models. However, uncertainty in aerosol radiative forcing arises because neither emissions, atmospheric abundance, optical properties, nor indirect effects are well characterized. The IPCC (2001) and the NACIP (2002) have identified the total (direct and indirect) radiative forcing due to aerosols, and in particular light absorbing aerosols, as one of the most uncertain components of climate change models.

**Water Vapor**

It should be noted that just because water vapor is the most important contributor to the natural greenhouse effect does not mean that human-made climate change emissions are unimportant. However, human activities do not seem to be appreciably changing the atmospheric concentration of water vapor in any direct way on the global average.

A simple comparison of the relative greenhouse efficiencies of water vapor and \( \text{CO}_2 \) quickly becomes problematic because water vapor enters the climate system mostly as a “feedback” gas. Further, water stays in the atmosphere for a few days, while other climate change emissions linger for decades or centuries. The overall impact of water vapor with respect to global climate change is not well understood as it can lead to both warming (absorption of long-wave radiation from Earth) and cooling (cloud formation/reflection of solar radiation).

### 2.3 Global Warming Potentials

Radiative forcing is often defined as a net imbalance in energy flux in the atmosphere, and is expressed in watts per square meter (W/m\(^2\)), i.e. heat per area of the Earth’s surface. Radiative forcing of the surface-troposphere system, resulting, for example, from a change in climate change pollutant concentrations, is the change in the balance between radiation coming into the atmosphere and radiation going out. A positive radiative forcing tends, on average, to warm the surface of the Earth, and negative forcing tends, on average, to cool the surface.

The impact of a climate change pollutant upon the atmosphere is related not only to radiative properties of the gas and its initial abundance, but also to the length of time the climate change pollutants remain in the atmosphere. Radiative properties control the absorption of radiation per kilogram of gas present at any instant, but the lifetime of the gas controls how long an emitted kilogram remains
in the atmosphere and hence its cumulative impact on the atmosphere's thermal budget.

Gases in the atmosphere can contribute to the greenhouse effect both directly and indirectly. Direct effects occur when the gas itself is a climate change pollutant. Indirect radiative forcing occurs when chemical transformations of the original gas produce other climate change pollutants, when a gas influences the atmospheric lifetimes of other gases, and/or when a gas affects atmospheric processes that alter the radiative balance of the Earth (e.g., cloud formation).

The concept of a Global Warming Potential (GWP) has been developed in parallel to the concept of ozone depletion potential developed under the Montreal Protocol to compare the ability of each climate change pollutant to trap heat in the atmosphere relative to another gas.

Carbon dioxide, as the primary anthropogenic climate change pollutant, has been chosen as the reference gas. GWP is defined as the ratio of the time-integrated radiative forcing from the release of 1 kilogram of a trace substance relative to that of 1 kg of CO₂ (IPCC 2001). While any length of integration can be selected, the 100-year GWPs are recommended by the IPCC and will be employed for policy-making and reporting purposes.

GWP values allow a comparison of the impacts of emission changes (reductions or increases) of different gases. According to the IPCC (2001), GWPs typically have an uncertainty of ±35 percent. In addition to communicating climate change pollutants in units of mass, we have also chosen to use GWPs to reflect their inventories in CO₂-equivalent terms because it effectively places all of the climate change pollutants on the same comparative scale.

Table 2-1 lists GWPs for CO₂, CH₄, N₂O, and HFC-134a for the 20-, 100-, and 500-year time horizons. It should be noted that when the lifetime of the species in question differs substantially from the response time of CO₂ (nominally about 150 years), then the GWP becomes very sensitive to the choice of time horizon. The GWP concept is only relevant for compounds that have sufficiently long lifetimes to become globally well-mixed. Therefore, short-lived gases and aerosols with varying atmospheric distributions and lifetimes pose a problem in the simple GWP framework.
Table 2-1. Numerical Estimates of Global Warming Potentials Compared with CO₂ (Kilograms of Gas Per Kilogram of CO₂ adapted from IPCC 2001).

<table>
<thead>
<tr>
<th>Climate Change Pollutants</th>
<th>Lifetime (years)</th>
<th>Global Warming Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 years</td>
<td>100 years</td>
</tr>
<tr>
<td>CO₂</td>
<td>~150</td>
<td>1</td>
</tr>
<tr>
<td>CH₄</td>
<td>12</td>
<td>62</td>
</tr>
<tr>
<td>N₂O</td>
<td>114</td>
<td>275</td>
</tr>
<tr>
<td>HFC-134a</td>
<td>14</td>
<td>3,300</td>
</tr>
</tbody>
</table>

2.4 Abrupt Climate Change

When most people think about climate change, they imagine gradual increases in temperature and only marginal changes in other climatic conditions, continuing indefinitely or even leveling off at some time in the future. It is assumed that human societies can adapt to gradual climate change. However, recent climate change research has uncovered a disturbing feature of the Earth’s climate system: it is capable of sudden, violent shifts. This is a critically important realization.

Climate change will not necessarily be gradual, as assumed in most climate change projections, but may instead involve relatively sudden jumps between very different states. A mounting body of evidence suggests that continued increasing climate change emissions may push the oceans past a critical threshold and into a drastically different future.

Abrupt climate change is the subject of reports commissioned by the National Academy of Science (NRC 2002) and the U.S. Department of Defense (Schwartz and Randall, 2003). Thus, in addition to the gradual (albeit accelerated) climate changes projected by current climate models, Californians need to be aware of the possibility of much more sudden climate shifts.

2.5 Summary

There is little doubt that climate change is happening today, that human-caused increases in the atmospheric abundance of climate change pollutants are a large cause of that change, and the 21st century climate change will be greater than that we have experienced in the 20th century. Much of that projected climate change is as yet unrealized warming from the climate change pollutants in the atmosphere today. Nevertheless, actions taken to reduce climate change emissions today can reduce the magnitude and rate of climate change this century.
There is no scientific uncertainty about the fact that human activities have increased the atmospheric abundance of climate change pollutants. The uncertainties center on predicting exactly what the climate changes will be in various local areas of the Earth and what the effects of clouds will be in determining the rate at which the mean temperature will increase.

There are also uncertainties associated with characterizing the timing and magnitude of other consequences of a warmer planet: sea level rise, spread of certain diseases out of their usual geographic range, the effect on agricultural production, water supply, sustainability of ecosystems, increased strength and frequency of storms, extreme heat events, air pollution episodes, and the impact of these effects on human health and the economy.

3 CALIFORNIA ACTIONS TO ADDRESS CLIMATE CHANGE

The State of California has traditionally been a pioneer in efforts to reduce air pollution, dating back to 1963 when the California New Motor Vehicle Pollution Control Board adopted the nation’s first motor vehicle emission standards. California likewise has a long history of actions undertaken in response to the threat posed by climate change.

Beginning in 1988, legislation was enacted that directed the California Energy Commission, in consultation with the Air Resources Board and other agencies, to study the implications of global warming on California’s environment, economy, and water supply.

This effort continued with Governor Schwarzenegger’s June 2005 Executive Order creating climate change emission reduction targets for the state. The Order requested a report that specifically addresses the impacts of climate change on the state and includes adaptation measures the state can implement to best respond. California state government has consistently recognized the necessity for state action on climate change to protect California’s interests.

3.1 Summary of California Activities Underway

California has a long history of environmental leadership and has continued that leadership in the efforts to reduce climate change emissions. Table 3-1 indicates those strategies that are underway in California.

Section 2.1 asserted that the transportation sector is the largest source of emissions in California. The motor vehicle standards of the Air Resources Board (ARB) provide significant emission reductions in this sector in the 2020 time frame. Two other key strategies in the state are the Renewable Portfolio Standard and the Energy Efficiency Programs. These strategies have been instrumental in California’s efforts to provide energy security for the state and have also provided significant climate change emission reductions. The state’s Energy Efficiency Programs have resulted in a stable per-capita energy use in the state even while California’s economy has soared.
It is important to note that these strategies, though underway, will require continuing efforts by the responsible agencies as well as strong leadership to ensure they remain in place. Governor Schwarzenegger has pledged his support of the ARB’s motor vehicle regulations and the acceleration of the Renewable Portfolio Standard. The Governor’s support and the continuing support of the Legislature will be essential as the state implements these strategies successfully.

Table 3-1 Emission Reduction Strategies Underway in California

<table>
<thead>
<tr>
<th>Agency Responsible</th>
<th>Climate Change Emission Reductions (Million Tons CO₂ Equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Resources Board</td>
<td></td>
</tr>
<tr>
<td>Vehicle Climate Change Standards</td>
<td>1</td>
</tr>
<tr>
<td>Diesel Anti-idling</td>
<td>1</td>
</tr>
<tr>
<td>Public Utilities Commission</td>
<td></td>
</tr>
<tr>
<td>Accelerated Renewable Portfolio Std to 33% by 2020</td>
<td>5</td>
</tr>
<tr>
<td>(including load-serving entities [LSE])</td>
<td>11</td>
</tr>
<tr>
<td>California Solar Initiative</td>
<td>0.4</td>
</tr>
<tr>
<td>Investor Owned Utility Energy Efficiency Programs</td>
<td>4</td>
</tr>
<tr>
<td>(including LSEs)</td>
<td>8.8</td>
</tr>
<tr>
<td>Integrated Waste Management Board</td>
<td></td>
</tr>
<tr>
<td>Achieve 50% Statewide Recycling Goal</td>
<td>3</td>
</tr>
<tr>
<td>Energy Commission</td>
<td></td>
</tr>
<tr>
<td>Building Energy Efficiency Standards</td>
<td>1</td>
</tr>
<tr>
<td>Appliance Energy Efficiency Standards</td>
<td>3</td>
</tr>
<tr>
<td>Fuel-efficient Replacement Tires &amp; Inflation Programs</td>
<td>1.5</td>
</tr>
<tr>
<td>State and Consumer Services and Cal/EPAs</td>
<td></td>
</tr>
<tr>
<td>Green Buildings Initiative</td>
<td>0.5</td>
</tr>
<tr>
<td>Air Resources Board and Cal/EPAs</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Highway</td>
<td>Included*</td>
</tr>
<tr>
<td>Total Potential Emission Reductions</td>
<td>22</td>
</tr>
</tbody>
</table>

* The benefits of the Hydrogen Highway have been captured in other programs such as the motor vehicle regulations and green buildings initiative.
3.2 Executive Order S-3-05

On June 1, 2005, Governor Schwarzenegger signed Executive Order S-3-05 (EO) during the United Nations World Environment Day event in San Francisco. The EO established climate change emission reduction targets for California and was heralded in the nation and around the world as a landmark event signaling that California is taking a leadership role in the United States in addressing the issue of climate change. The Governor said in his remarks preceding the signing of the EO, "...the debate is over. We know the science. We see the threat. And we know the time for action is now."

This quote appeared in the media throughout the world. Internationally the developed nations agree that the issue of climate change must be addressed. It is no exaggeration to say that the world had been waiting for a strong signal that the state which has led a nation on so many public health and environmental issues would continue that leadership in addressing climate change.

The targets established by the EO are shown in Figure 3-1. The 2010 and 2020 targets are based on an ambitious estimate of how much the state can reduce emissions with strong top-down leadership and a coordinated effort amongst various state agencies. Cal/EPA worked with the ARB, CEC and Tellus, a technical contractor, to develop the targets in the 2010 and 2020 timeframes. The 2050 target is based on emission reductions the science indicates will be necessary from all developed nations to ensure protection of the planet in the 100-year time frame.

Figure 3-1. California's Climate Change Emissions and Targets
In addition to setting targets for the state, the EO placed Cal/EPA in the lead to coordinate efforts to meet these targets among the following agencies: Business, Transportation and Housing Agency (BT&H), Department of Food and Agriculture (CDFA), Energy Commission (CEC), Resources Agency, and Public Utilities Commission (PUC). A coordinated effort is essential to success in climate change emission reduction strategies. Programmatic, incentive-based, or market-based strategies will require the efforts of agencies whose purview stretches across all sectors of the economy, from transportation to energy to agriculture to waste management.

Finally, the EO directed Cal/EPA to lead an evaluation of the impacts of climate change in California, mitigation strategies to reduce emissions, and adaptation measures that can be taken by the state to best respond to the adverse impacts of climate change. This effort is built upon the work of the CEC under the Public Interest Energy Research plan.

The CEC is currently about half way through a five-year plan that responds to many of the same directives included in the EO. Cal/EPA worked with CEC and other agencies to incorporate a broader scope and provide the Governor and Legislature with a mid-point estimate of what California can expect as a result of climate change and how the state can best respond to the adverse consequences.

3.3 Climate Action Team

In response to the EO, the Secretary of Cal/EPA created the Climate Action Team (CAT). The CAT includes knowledgeable representatives from Air Resources Board; Business, Transportation, & Housing; Department of Food and Agriculture; Energy Commission; California Integrated Waste Management Board (CIWMB), Resources Agency, and Public Utilities Commission (PUC). The CAT has prepared a recommended list of strategies for the state to pursue to reduce climate change emissions in the state. This list is described in detail in Section 0. The CAT has also contributed to and reviewed the scenario analysis described in Section 4.

There are two subgroups of the CAT, the market-based options subgroup and the scenario analysis subgroup. Both subgroups are made up of representatives appointed by the CAT and experts as appropriate. The market-based options subgroup was created by the Secretary of Cal/EPA because of the cross-cutting nature of a market-based program for the state. The scenario analysis subgroup addressed the directive in the EO to evaluate the impacts of climate change on the state and adaptation measures that can be taken by the state to best prepare for the adverse consequences of climate change.

4 SCENARIO ANALYSIS

In California and throughout western North America, signs of a changing climate are evident. Over the last 50 years, observations reveal trends toward warmer
winter and spring temperatures, a smaller fraction of precipitation falling as snow instead of rain, a decrease in the amount of spring snow accumulation in lower and middle elevation mountain zones, an advance in snowmelt of 5 to 30 days earlier in the spring, and a similar shift in the timing of spring flower blooms.

These changes are consistent with much broader scale global measures. From 1900 through 1970, the average global temperature rose by about 0.1°F (0.06 °C) per decade, but since then the rate of warming has increased markedly, to about 0.5°F (0.3°C) per decade. During the last 1,000 years, available observations suggest that the 10 warmest years all occurred after 1990. Much of the warming during the last four decades is attributable to the increasing atmospheric concentrations of climate change emissions due to human activities.¹

It is now evident that even if actions could be taken to immediately curtail climate change emissions, the potency of emissions that have already built up, their long atmospheric lifetimes, and the inertia of the Earth’s climate system could produce as much as 1.1°F (0.6°C) of additional warming.² As a result, some impacts from climate change are now unavoidable.

For example, studies show that some unique ecosystems, such as coral reefs, and those in arctic and alpine regions, have been or will be severely damaged or lost as a result of climate changes already underway.³ However, depending on the amount of climate change emissions emitted over the next few decades, an opportunity remains to avoid the most severe impacts that are expected with greater rises in temperature.

The scientific community is striving to determine how vulnerable human society and the earth systems on which it depends are to future climate changes. Although no consensus has been reached as to what constitutes “dangerous” climate change, there has been increasing warning about the impacts of global average temperatures rising over 3.6°F (2°C). These include a rapid increase in global hunger, health risks, and water shortages¹. Temperature rises above

http://www.wbgu.de/wbgu_sn2003_ex01.pdf
3.6°F (2°C) also increase the risk of abrupt climatic changes such as rapid sea level rise from continental ice including the disintegration of the West Antarctic Ice Sheet.

Linking specific temperature changes—such as the proposed 3.6°F (2°C) dangerous threshold—with particular levels of global warming emissions in the atmosphere, is complicated. Although all climate models project increased temperatures to result from higher concentrations of climate change pollutants, these models vary in their sensitivity of the global and regional temperatures and other climate measures to changes in climate change pollutant concentrations.

For example, temperature rises between 2.7°–8.1°F (1.5°–4.5°C) have been projected for a doubling of the atmospheric CO₂ concentration above pre-industrial levels. This wide range of temperature rise projections is the result of differences in the way the models represent key processes within the climate system, particularly in characterizing clouds which can lead to either damping or reinforcing of global warming.

Society can neither control nor precisely determine the sensitivity of the earth’s climate system to rising climate change emission concentrations. As a result, it is critical to carefully consider implications of a range of climate sensitivities when evaluating the risks of climate change and devising policies to manage the one factor we can control: our own climate change emissions.

For example, the United Kingdom (UK) adopted a target to limit the maximum atmospheric CO₂ concentration to 550 parts per million (ppm) and determined that reaching this target would require the industrialized world to decrease emissions by approximately 60 percent by the year 2050.

However, because of the uncertainty in climate model sensitivity, it is unclear if this 550 ppm target will keep global temperatures below a 3.6°F (2°C) dangerous threshold. Although the Intergovernmental Panel on Climate Change (IPCC) suggests that the UK concentration target is consistent with several recent climate model simulations, the 3.6°F upper warming limit under the 550 ppm threshold holds up under the lower-but is exceeded under the higher-climate
sensitivity models. This suggests that a lower concentration target, and therefore greater emission reductions, could be needed.

This chapter summarizes findings of recent analyses that explore the implications of various climate change scenarios for California. The studies focus on comparing the implications of different scenarios of climate change emissions given a range of climate sensitivities. The projections reported are driven by three climate change emission scenarios—a lower emissions, medium-high emissions, and higher emissions scenario.

The sensitivity of the climate system to increasing atmospheric concentrations of climate change pollutants is explored by comparing the projected temperature rise from three different global climate models, each containing somewhat different representations of some crucial physical processes that result in levels of climate sensitivity.

The following section describes the global warming emission scenarios and climate projections reported in this chapter. Other sections report on the projected impacts of the specific climate projections across six sectors—coasts, water resources, agriculture, forests/fire, public health, and electricity. The chapter concludes with a discussion of the implications of these projections for mitigation and adaptation.

4.1 Climate Change Scenarios

The Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios (SRES) developed a set of possible future emissions scenarios based on different assumptions about global development paths (Figure 4-1). This section relies upon the results from recent analysis for California of three SRES emission scenarios—a higher emissions scenario (A1Fi), a medium-high emission scenario (A2), and lower emission scenarios (B1).

Figure 4-1. Special Report on Emissions Scenarios
The higher emissions scenario (A1fi) represents a world of rapid fossil-fuel-intensive economic growth, global population that peaks mid-century then declines, and the introduction of new and more efficient technologies toward the end of the century. Global warming emissions grow rapidly, reaching about 25 gigatonnes per year (Gt/yr), more than 3 times the present rate of emissions, by 2050.

The medium-high emissions scenario (A2) projects continuous population growth with slower economic growth and technological change than in the other scenarios. In contrast, the lower emissions scenario (B1) characterizes a world with population growth similar to the highest emissions scenarios, but with rapid changes towards a service and information economy and with the introduction of clean and resource-efficient technologies. The B1 scenario has CO₂ emissions peaking just below 10 Gt/yr in mid-century before dropping below the current-day level of 7 Gt/yr by 2100. Under the B1 scenario, the CO₂ concentration would double, relative to its pre-industrial level, by the end of this century. For the range of climate sensitivities reported on here, the B1 scenario leads to global temperature rises between 1.8-3.1 °C, capturing yet mostly rising above the "dangerous" threshold of 2°C described above. Importantly, in the B1 scenario simulations, while the upward trend of temperature tends to level off or slow down during the last few decades of the 21st Century, in the A2 and A1fi simulations the rising trend in temperature continues at a high rate, indicating that more warming would occur under these higher scenarios before an equilibrium is reached.

To capture a range of uncertainty among climate models, this chapter reports on projections from three state-of-the-art global climate models (GCMs)—a low-sensitivity model, the Parallel Climate Model (PCM1) from the National Center for Atmospheric Research (NCAR) and the Department of Energy (DOE) groups; a medium-sensitivity model, the Geophysical Fluids Dynamic Laboratory (GFDL) CM2.1 (NOAA Geophysical Dynamics Laboratory, Princeton NJ) model; and the slightly higher-sensitivity U.K. Met Office Hadley Centre Climate Model, version 3 (HadCM3). Temperatures are projected to rise significantly over the 21st century. The magnitude of projected warming varies between models and the emission scenarios. The temperature rise (2000 to 2100) projections are from approximately 1.7°C to 3.0°C (3.0°F-5.4°F) in the lower range of projected warming, 3.1°C-4.3°C (5.5°F-7.8°F) in the medium range, and 4.4°C to 5.8°C (8.0°F-10.4°F) in the higher range. To comprehend the magnitude of these projected temperature changes, over the next century, the lower range of projected temperature rise is slightly larger than the difference in annual mean temperature between Monterey and Salinas, and the upper range of projected warming is greater than the temperature difference between San Francisco and San Jose, respectively (Figure 4-2). There is no clear trend in precipitation.
projections for California over the next century. However, the consensus of the recent IPCC model projections, including several models that were not selected for the present study, is for relatively little change in total precipitation, with a tendency toward a slightly greater winter and lower spring precipitation.
4.2 Public Health Impacts

Climate change will affect the health of Californians due to increases in the frequency, duration, and intensity of conditions conducive to air pollution formation, oppressive heat, and wildfires. The primary concern is not the change in average climate, but rather the projected increase in extreme conditions that are responsible for the most serious health consequences.

Californians experience the worst air quality in the nation, with annual health and economic impacts estimated at 9,000 deaths and $60 billion per year. Ozone and particulate matter (PM) are the pollutants of greatest concern, and the current control programs for motor vehicles and industrial sources cost about $10 billion per year.

Maximum ozone levels are about double the current air quality standards. Climate change will slow progress toward attainment and increase control costs by boosting emissions, accelerating chemical processes, and raising inversion temperatures during summertime stagnation episodes. Results from statistical analyses indicate that the number of days meteorologically conducive to pollution formation may rise by 75 to 85 percent in the high ozone areas of Los Angeles (Riverside) and the San Joaquin Valley (Visalia) by the end of the century if
temperatures rise to the higher projected warming range, and by 25 to 35 percent if temperature increases stay within the lower warming range.

Figure 4-3. Projected Days at Riverside Meteorologically Conducive to Exceedances of the 1-Hour California Ambient Air Quality Standard for Ozone of 0.09 Parts Per Million (ppm)

Geophysical Fluid Dynamics Laboratory (GFDL). Source: Kleeman and Cayan, 2006

In addition, global background ozone (primarily formed from methane and nitrogen oxides from fuel combustion) is projected to increase by 4 to 10 percent (lower emissions scenario) to 25 percent (higher emissions scenario) by 2100. If background ozone increases by the amount projected for the higher scenario, the ozone targets would be impossible to attain in much of California, even with near-zero local emissions.

The future trend for PM is not as clear, as increasing temperatures reduce some particle types while others show no change or increase slightly. In general, increased temperatures tend to reduce atmospheric nitrate, an important contributor to levels of PM2.5 (particles less than 2.5 microns) in California. However, a preliminary study by Kleeman and Cayan (2006) suggests that if global background ozone levels double, there would be an increase in PM2.5 levels despite the corresponding increase in temperature. Rainy days, wildfires, global dust storms, humidity, and other factors also affect PM and are the subject of ongoing study.

Analyses of various climate change scenarios project that the future will have a greater number of extremely hot days and fewer extremely cold days, with large increases in heat-related deaths predicted for the five cities studied.
Figure 4-4. Projected increase in extreme heat days relative to 1961-1990. "Extreme heat" defined as by the average temperature which is exceeded less than 10% of the days during the historical period (1961-1990), or approximately 36 days a year.

Source: Drechsler et al., 2006

For the higher warming range, the number of days with temperatures above 90°F in Los Angeles and higher than 95°F in Sacramento will increase to about 100 days by the end of the century, almost twice the increase projected if the temperatures stay within the lower warming range. Individuals likely to be the most affected include the elderly, already ill, and poor. On peak demand summer days in 2100, California would need at least 10 percent more electricity, compared to total generation capacity today, for air conditioning alone. Ongoing studies are investigating the relative contribution of air pollution to heat-related death, and refining the air conditioning demand estimates.

Climate change could affect asthma prevalence and attacks, but this is difficult to predict for several reasons. The most common asthma triggers are dust mites and molds, both of which are higher indoors than outdoors and require a relatively humid environment for survival. Consequently, if the climate becomes drier, these triggers will become less important, but they respond to higher humidity with increased growth. Many asthmatics are allergic to various plant pollens. Plants and trees typically have pollination seasons that last a few weeks per year. To the extent that pollen seasons lengthen or become more intense in response to climate change, increased asthma exacerbation could result.

Climate change has the potential to influence the incidence of infectious disease spread by mosquitoes, ticks, fleas, rodents, and food. More study is needed as research to date has focused on short-term changes in weather patterns (primarily in ambient temperature and rainfall), rather than long-term trends.
4.3 Water Resources Impacts

Although precipitation is projected to change only modestly over this century, rising temperatures are expected to diminish snow accumulation in the Sierra Nevada and other mountain catchments in California. Higher temperatures will result in more precipitation as rain instead of snow and earlier melt of the snow that does fall. Reductions in snow accumulation and earlier snowmelt will have cascading effects on water supplies, natural ecosystems, and winter recreation.

Snowpack

The projected losses in snowpack increase with temperature. Each of the simulations shows losses of spring snow accumulation, largely over the Sierra Nevada, to become progressively larger during the 21st century. By the 2035–2064 period, snowpack in the Sierra Nevada could decrease 10 to 40 percent depending on the amount of warming and precipitation patterns. By the end of century, snowpack could decrease by as much as 90 percent if temperatures rise to the higher warming range, almost double the loss is expected if temperature rises stay within the lower warming range.

Figure 4-5. April 1 Snow water equivalent 2070-2099 fraction of 1961–1990

Source: Cayan et al., 2006

Medium Temperature

Water Supply

Declining snowpack will aggravate the already overstretched water resources in California. The snowpack in the Sierra Nevada provides natural water storage
equal to about half the storage capacity in California’s major man-made reservoirs. The snowpack holds the winter precipitation in the form of snow and, historically, has released it in the spring and early summer as the snow melts. This loss in storage could mean more water shortages in the future. However, the full effect of this storage loss will depend in part on whether reservoirs can be managed to capture the earlier snowmelt while loosing flood control capacity.

Under most scenarios stream flows are projected to decrease slightly by mid-century with more dramatic changes by the end of the century. Flows into the major Sierra Nevada reservoirs could decline between 25 to 30 percent if temperatures rise to the medium warming range and precipitation decreases by approximately 20%. This is almost double the decrease projected if temperatures are confined to within the lower warming range. However, in one model run, projections suggest a slight increase in precipitation and a corresponding rise in projected stream flows.

After mid-century, the change in the volume and timing of runoff reduces the ability of the major projects to deliver water to agricultural users south of the Delta. The projected changes in water supply may be further exacerbated by increasing demand. By the end of century, increasing temperatures are expected to increase the crop demand for water between 2 and 13 percent in the lower and medium warming ranges, respectively.

Winter Recreation

 Declines in Sierra snowpack will also have widespread implications for winter tourism. Toward the end of the century, in lower temperature scenarios the ski season could shorten by as much as a month while projected climatic changes under the higher temperature scenario suggest that the minimum snow conditions for ski resort operation might be eliminated entirely. Many resorts would be forced to rely on snowmaking or move their operations.

4.4 Agriculture Impacts\(^{12}\)

Agriculture, along with forestry, is the sector of the California economy that is most likely to be affected by a change in climate. California agriculture is a $68 billion industry.\(^{13}\) California is the largest agricultural producer in the nation and accounts for 13 percent of all U.S. agricultural sales, including half of the nation’s total fruits and vegetables.

Regional analyses of climate trends in agricultural regions of California suggest that climate change is already in motion. During the period 1951 to 2000, the growing season has lengthened by about a day per decade, and warming temperatures have resulted in an increase of 30 to 70 growing degree days per decade, with much of the increase occurring in the spring. Climate change affects agriculture directly through increasing temperatures and rising CO\(_2\) concentrations and indirectly through changes in water availability and pests.

The agriculture sector is likely to bear a disproportionate share of any water scarcity due to any reduced water availability from climate change. A preliminary
analysis suggests that a drier climate would impose significant costs on agricultural production in the Central Valley.

Temperature

Temperature influences crop growth through its impact on photosynthesis and respiration, as well as growing season length and water use. Temperature also serves as a controlling factor for developmental processes, such as flowering and fruit maturation, which may be threatened if lengthening of the growing season introduces asynchrony between the timing of flowering and the life cycle of important insect pollinators.

In general, a warming from a low to a higher temperature raises yield at first but then becomes harmful. Possible effects of excessively high temperature include decreased fruit size and quality for stone fruits, premature ripening and possible quality reduction for grapes, reduced fruit yield for tomatoes, increased incidence of tip burn for lettuce, and similar forms of bum for other crops.

As temperatures rise toward the medium warming range, by the end of this century, the local winter climate is expected to approach critical chill-hour thresholds for many species of fruit trees. (Chill hour is the number of hours below a critical temperature.)

Carbon Dioxide (CO₂)

From a variety of studies in the literature, photosynthesis increases when a plant is exposed to a doubling of CO₂. However, whether this translates into increased yield of economically valuable plant product is uncertain and highly variable. Also, elevated CO₂ levels are associated with decreased concentrations of mineral nutrients in plant tissues, especially a decrease in plant nitrogen, which plays a central role in plant metabolism.

Some crops may benefit in quality from an increase in CO₂; for example, the fruit flavor of strawberries improves. Some crops are harmed by an increase in CO₂; for example, grain protein in crops decreases and, in the case of wheat, bread-making quality decreases.

Pests and Weeds¹⁴

Growth rates of weeds, insect pests, and pathogens are also likely to increase with elevated temperatures, and their ranges may expand. A relatively new area of research involves the use of physiologically-based dynamic models to fully understand the effects of weather (e.g., temperature, rainfall, solar radiation, etc.) on species dynamics.

One of these models was used to estimate the potential impacts of a pest (pink bollworm, or PBW) on cotton cultivation in the state. At the present time this pest is of importance only in the southern desert valleys (e.g., Imperial and Coachella Valleys) because winter frost restricts the invasion of PBW to the million acres of cotton grown in the San Joaquin Valley. However, if winter temperatures rise by 3.6°–4.5°F (2°–2.5°C), the range of PBW of this pest would likely expand northward.
The effects on winter survival (a-c) and total seasonal pest PBW larval densities (larval days, d-f) under current weather (a,d) and with 1.5°C (b,e) and 2.5°C (c,f) increases in daily temperatures respectively (Gutiérrez et al. In press).

4.5 Coastal Sea Level Impacts

California’s coastal observations and global model projections indicate that California’s open coast and estuaries will experience increasing sea levels during the next century. These changes could amplify the sea level rise which has historically affected much of the coast of California, including the Southern California coast, the Central California open coast, and the San Francisco Bay and upper estuary. These trends, quantified from a small set of long-duration California tide gages, show rises of about 2 mm/year (Figure 4-6). They are very similar to trends estimated for global sea level.
In addition to long-term trends, sea levels along the California coast undergo shorter period variability above or below predicted tide levels. Highest sea levels have usually occurred when winter storms and Pacific climate disturbances such as El Niño² have coincided with high astronomical tides. So far, there is little evidence that the rate of global sea level rise has accelerated (the rate of rise at California tide gages has actually flattened during the last several years), but climate models suggest strongly that this may change.

Figure 4-7. Observed Change in Sea Level in San Francisco during the last century and Projections of Global Mean Sea Level during next century.

Source: Cayan et al., 2006

Global sea level rise is projected to range from 4 to 33 inches during the 2000 to 2100 period. This compares to a rate of approximately 7.6 inches (19 cm) per

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² El Niño: A phenomenon in the equatorial Pacific Ocean characterized by a positive sea surface temperature departure from normal. Water in the eastern Pacific Ocean close to the equator gets warmer than normal, which results in changes in weather patterns. In some cases, El Niño results in significant increases in precipitation in California. For example the 1982-1983 El Niño event.
century observed at San Francisco and San Diego during the last 100 years. Superimposed on these rising seal levels will be astronomically-driven tides, and fluctuations from weather, El Niño and other influences, so that, the occurrence of extreme events will increase as sea level rises.

The frequency that sea level exceeds a stationary threshold, as projected over future decades for locations such as the San Francisco tide gage, increases markedly as the mean sea level increases. Thus, historical coastal structure design criteria may be exceeded, the duration of events will increase, and these events will become increasingly frequent as sea level rise continues. On the open coast, impacts during these events will continue to be exacerbated by high surf from wind, waves, and, in the Sacramento/San Joaquin Delta of the San Francisco Bay estuary, by floods that may further jeopardize levees and other structures.

4.6 Forests and Natural Landscapes Impacts

Climate changes and increased CO₂ concentrations are expected to alter the extent and character of forest and other ecosystems. The distribution of species is expected to shift, the risk of climate-related disturbance such as wildfires, disease, and drought is expected to rise, and forest productivity is projected to increase or decrease depending on species and region. The ecosystems most susceptible to temperature rise are the alpine and sub-alpine forest cover. In addition, changes in fire frequency are expected to lead to an increase in grasslands, largely at the expense of woodland and shrub-land ecosystems.

Wildfires

The changing climate may modify the natural fire regimes in ways that could have social, economic and ecological consequences. The most recent analysis, which is a conservative estimate that does not include the effects of extreme fire weather, indicates that wildfire will increase, especially as warming intensifies. These projections suggest that the risk of large wildfires statewide may rise almost 35 percent by mid-century, 55 percent by the end of the century under a medium-high emissions scenario, and almost twice that expected under lower emissions scenarios.
Figure 4-8. Percent change in the expected minimum number of large fires per year in California

Source: Westerling et al., 2006

These increases in fire season severity could lead to more "bad air" days as well as increased damage costs of approximately 30 percent above current annual damage.

Although society has developed a number of ways to adapt to wildfires, climate change, along with the multiplying impacts of other stresses such as population growth and land-use change, may be pushing California outside of its coping range.

However, in the short-term, California can take actions to improve its ability to live within the state's fire-prone landscapes while maintaining the functioning and structure of the ecosystems upon which its residents depend. These include: 1) the adoption of a risk-based framework for fire management; 2) the reintroduction of fire to fire-prone ecosystems (managing natural fires in some regions rather than suppression); 3) creation of new and flexible policies that are able to differentiate between the diverse ecosystems in California; and 4) a re-evaluation of urban planning and building in the wildland-urban interface.

Pests and Pathogens

Historically, pests and disease have caused significant damage to California forests. The changing climate may exacerbate these effects by expanding the range and frequency of pest outbreaks. For example, the introduced pathogen, pine pitch canker (Fusarium subglutinans f. sp. pini), once limited to coastal
areas of California, has expanded to the El Dorado National Forest in the Sierra Nevada. Rising winter temperatures in the Sierra Nevada would make conditions more favorable for pitch canker and could result in increased disease severity and economic loss.

Forest Productivity

Several studies have projected increases in forest productivity under future climate change. However, recent studies indicate that it is uncertain how trees will respond to elevated CO₂ concentrations, and that there will be increased risk and susceptibility to catastrophic loss. Thus, the implications for the forest productivity and the timber industry may be less optimistic.

The most recent assessment of the impact of climate change on the California forest sector used an industry standard planning tool to forecast 30-year tree growth and timber yields for forest stands in El Dorado County under a high and medium temperature scenario.

Conifer tree growth was reduced under all climate change scenarios. If temperatures rise to the projected medium warming range, productivity in mature stands is expected to decline by 20 percent toward the end of the century. The reductions in yield were more severe (30 percent) for pine plantations. Projections further indicate that the reduced growth rates could lead to substantial decrease in tree survival rates.

4.7 Electricity Sector Impacts

Changes in temperature and other meteorological variables will affect both the generation of and demand for electricity. This section discusses the potential effects of climate change on hydropower production and electricity demand in California.

Energy Supply—Hydropower

Changes in precipitation levels, should they occur, and patterns and timing of snowmelt would alter the amount of electricity that hydroelectric facilities could generate. It would also affect seasonal availability, with less water available for hydroelectric generation in the late spring and summer months when demand is the highest.

In addition, there is a high likelihood that changes in precipitation and runoff patterns would lead to changes in broader water policies and end-use priorities, such as water supply and flood control, which could impose further limitations on hydroelectric production. Currently, hydropower generation contributes about 15 percent of the in-state electricity production, with a range from 9 to 30 percent due to variations in climatic conditions.

Past studies have suggested that annual hydropower generation will increase or decrease with increasing or decreasing precipitation levels in California. The most recent study using an economic-engineering optimization model of the state water system suggests that under a medium range of temperature increase and decreased precipitation levels, annual generation by the end of this century
would decrease by about 30 percent and stream flows would decrease by 28 percent.

Another new study prepared by the Department of Water Resources (DWR) simulating the State Water and Central Valley Projects suggests reductions of approximately 7 percent in hydropower unit electricity generation for most scenarios by mid-century. However, one exception is the low temperature scenario in the less dry model, where electricity generation is projected to increase by approximately 4 percent.

It is important to emphasize that even relatively small changes in in-state hydropower generation results in substantial extra expenditures for energy generation, because losses in this “free” generation must be purchased from other sources.

For example, assuming a decrease of 10 percent from the current average in-state generation level from this renewable energy source, and assuming a price of about 10 cents per kilowatt-hour, this decrease would result in an additional $0.35 billion per year in net expenditures to purchase sufficient electricity to replace the electricity that otherwise would be generated using hydroelectric resources.

Electricity Demand

Electricity demand is projected to rise between 3 to 20 percent by the end of this century. These results are based on correlation functions relating electricity demand with temperatures in key areas in California and future climate projections assuming current socio-economic conditions, including no change in present day population. In the next 20 years electricity demand would increase from 1 to 3 percent from the baseline, and peak electricity demand would increase at a faster rate.

Since annual expenditures of electricity demand in California represent about $28 billion, even the relatively small increases in energy demand would result in substantial extra energy expenditures for energy services in the state. For example, assuming a linear increase in electricity expenditures from the historical period, a 3 percent increase in electricity demand by 2020 would translate to about $1.2 billion a year in extra electricity expenditures.

Potential Coping Strategies

There are several options to reduce the negative effect of climate change on the electricity system. The use of modern probabilistic hydrological forecasts for the management of water reservoirs in the state is a promising option being studied. Some options needed to reduce climate change emissions can be seen as coping strategies. They include, for example, enhanced energy efficiency programs, increased penetration of photovoltaic systems, and the implementation of measures designed to reduce the heat island effect.
4.8 Implications for Mitigation and Adaptation

Continued climate change would have widespread impacts on California's economy, ecosystems, and the health of its citizens. However, analyses from the present study, summarized in Figure 17, suggest that many of the more severe impacts projected under the medium and higher warming ranges could be avoided by following the lower emissions pathway. It should be noted though, that, if the actual climate sensitivity to climate change emissions reaches the level of the more sensitive global climate models employed here, an even lower emissions path than the B1 scenario may be required to avoid the medium warming range. How much would climate change emissions have to be reduced to stay below the lower emissions pathway (B1) and insure against temperatures rising to the medium and higher warming ranges presented in this study? The Governor's Executive Order #S-3-05, calls for an 80% reduction in CLIMATE CHANGE emissions, relative to 1990 levels, by 2050. If the industrialized world were to follow California's lead and the industrializing nations transitioned to a lower emissions energy system as characterized by the B1 pathway, global emissions would remain below the lower emissions scenario (B1), increasing the likelihood that California and the world would be on track to avoid the more severe impacts by preventing temperatures from rising to the medium warming range. This estimate of the impact of an 80% reduction by the industrialized world on global emissions depends crucially on the development patterns of the Industrializing Nations. The SRES B1 scenario assumes development proceeds with a "high level of environmental and social consciousness" with a transition to "alternative energy systems" (Nakicenovic et al. 2000). Emission reductions targets such as the one set by the Governor's Executive Order could spur the innovation necessary to lead the World to a transition to alternative energy systems.

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3 This was calculated as follows: 1) OECD population and total emissions were based on SRES B1 IMAGINE runs (Nakicenovic et al. 2000). OECD total emission in 1990 were 2.83 GtC; 2) 80% below this value is 566 MtC; 3) Total global emissions was calculated by adding the 566 MtC to the total emissions for non-OECD countries, as projected by SRES B1. This value is approximately 10GtC; 4) This 10 GtC/yr was compared to the global emission projected in the B1 scenario (approximately 11 GtC/yr).

4 As illustrated in figure 1, beyond 2050 global emissions will need to decrease substantially below 10 GtC/yr to stay on the B1 pathway out to the end of the century. The SRES B1 pathway assumes Global emissions decrease to 4.23 GtC/yr by 2100. However, stabilizing atmospheric concentrations will require even lower emissions as natural uptake is estimated between 0.7-2.9 GtC/yr (IPCC 2001).
Figure 4-9. Projected Impacts End of Century

Emissions Scenarios
(End of century Atmospheric CO₂ Concentration)

Statewide Temperature Rise (°C)
2070-2099

- Higher Emissions
  - A1fi (970 ppm)
  - 90% loss in Sierra snow pack
  - 55-75 cm (22-30 inches) of sea level rise
  - 3-4 times as many heat wave days in major urban centers
  - 2-5 times the number critically dry years
  - 20% increase in electricity demand
  - 4-10 times as many heat-related deaths projected for some urban centers
  - Increase in forest yield not evaluated for this scenario
  - Increase in days with extremely hot and dry conditions to cause formation

- Medium-High Emissions
  - A2 (830 ppm)
  - 70-80% loss in Sierra snow pack
  - 35-55 cm (14-22 inches) of sea level rise
  - 1-2 times as many heat wave days in major urban centers
  - 2-5 times as many heat-related deaths projected for some urban centers
  - 75-85% increase in days meteorologically conducive to fire formation
  - 2-3 times the number critically dry years
  - 11% increase in electricity demand
  - 30% decrease in forest yield (timber)
  - 5% increase in the expected risk of large fires

- Lower Emissions
  - B1 (550 ppm)
  - 30-60% loss in Sierra snow pack
  - 15-35 cm (6-14 inches) of sea level rise
  - 2-3 times as many heat wave days in major urban centers
  - 2-4 times as many heat-related deaths projected for some urban centers
  - 25-35% increase in days meteorologically conducive to fire formation
  - 3.5-7 times the number critically dry years
  - 3.6% increase in electricity demand
  - 7-14% decrease in forest yield (timber)
  - 10-35% increase in the risk of large fires

1. Impacts presented relative to 1961-1990.
4. For Los Angeles, Riverside, and Sacramento.
5. Impacts expected to be more severe as temperatures rise. However, higher temperature scenarios are not assessed for the project.

Climate projections show little difference between the emissions scenarios prior to 2035 due to the inertia of the climate system, indicating that even under the lower emissions path some further impacts from climate change are inevitable. Consequently, although it is not the solution to global warming, it is becoming clear that adaptation is an essential complementary strategy to manage some of the projected impacts of climate change. While there are many opportunities for California to increase its capacity to cope with the projected changes, these are often costly.
Furthermore, there are limits to adaptation, especially in addressing the threats of abrupt climate changes or in dealing with those impacts on natural, unmanaged species and ecosystems. These species may not be able to keep up with the increasingly rapid and severe climate change expected in future decades. Finally, the ability to cope and adapt is differentiated across populations, economic sectors, and regions within the state. As a result, without appropriate actions climate change will likely aggravate existing equity issues within California and the rest of the U.S.

For example, the most vulnerable populations to the health impacts of climate change are children, elderly people, and residents of minority and low-income communities—the same groups that already face the greatest health and environmental risks.

The Department of Water Resources and other State agencies have already started to include climate change considerations in their long-range plans. However, no cities in California have a heat emergency action plan; such plans are especially crucial to assist the elderly, especially those living in housing without air conditioning, who may be the most at risk from heat waves.

Thus, the Department of Health Services should develop heat emergency action plans for California (with a focus on protecting the economically disadvantaged) before the need arises. Existing air pollution control programs do not consider the effect of climate change on vulnerable populations; children and the elderly (especially those with pre-existing heart disease) are among the groups most vulnerable to air pollution episodes. Those that live closer to freeways and other emission sources (disproportionately in low-income and minority communities) are exposed to higher levels of pollution.

The Air Resources Board should work with the U.S. Environmental Protection Agency to begin to build climate change considerations into efforts to attain and maintain the health-based air quality standards over the long term.

Better monitoring of California's climate and sensitive climate related sectors will be crucial to detecting and understanding a complex chain of impacts. Finally, the State should continue to generate public discussion and build awareness of the need to manage climate change, develop enabling (or eliminating constraining) adaptation policies, and foster the political will necessary to critically assess and ultimately realize the State's significant adaptive potential.

5 RECOMMENDATIONS FOR EMISSION REDUCTION STRATEGIES

The CAT evaluated a significant number of strategies that could be implemented in California to reduce climate change emissions. The strategies listed in the section represent the recommendations of the CAT regarding activities that should be undertaken in the state agencies to ensure the Governor's targets are met. Most of these strategies can be implemented with existing authority of the state agencies represented on the CAT.
5.1 Process for Strategy Selection

As a starting point for emission reduction strategy selection, the CAT relied upon information provided by the Tellus Institute, Center for Clean Air Policy, CEC’s Integrated Energy Policy Report, and other existing evaluations of climate change emission reduction policies. The CAT agency representatives then went through a brainstorming exercise and each representative contributed to a larger list of potential emission reduction strategies that either their own agency or other agencies could implement.

The CAT as a whole discussed each strategy and reviewed work plans that included implementation steps, a timeline, and estimated potential emission reductions and costs. From these work plans it was determined which emission reduction strategies could be recommended to the Governor and Legislature at this time and which were either infeasible or would require further analysis.

The CAT then held two public workshops to review the strategies with the public. CAT representatives also met with representatives from low-income and minority communities, environmental organizations, industry representatives, and non-government organizations to review and discuss the list of strategies. Based on comment received at those workshops and meetings, the group made revisions and developed a final list of recommended strategies included in this document.

5.2 Strategies Cal/EPA Will Implement Over the Next Two Years

Table 5-1Table 5-2 lists all of the strategies that Cal/EPA will implement over the next two years. By 2020, the Air Resources Board’s vehicle climate change emission standards will provide the largest emission reductions of any of the strategies being recommended by the Climate Action Team. The large auto manufacturers are currently challenging California’s right to set climate change emission standards for vehicles. Governor Schwarzenegger has pledged his support in defending the State’s right to require the sale of cleaner cars. The Integrated Waste Management Board will continue to pursue stringent waste reduction and recycling goals and is working towards better understanding of landfill gas emissions and best practices for capture and use of those emissions.

Table 5-1. Environmental Protection Agency

| Climate Change Emission Reductions (Million Metric Tons CO₂ Equivalent) |
|--------------------|-----|---|
| 2010               | 2020|

<table>
<thead>
<tr>
<th>Air Resources Board</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Climate Change Standards</td>
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<td>30</td>
</tr>
<tr>
<td>Diesel Anti-Idling</td>
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<td>1.2</td>
</tr>
<tr>
<td>Other New Light Duty Vehicle Technology</td>
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<td>4</td>
</tr>
<tr>
<td>Improvements</td>
<td>2.7</td>
<td>8.5</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-----</td>
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</tr>
<tr>
<td>HFC Reduction Strategies</td>
<td></td>
<td></td>
</tr>
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<td>Transport Refrigeration Units, Off-road Electrification, Port Electrification (ship to shore)</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Manure Management</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Semi Conductor Industry Targets (PFC Emissions)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Alternative Fuels: Biodiesel Blends</td>
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<td>&lt;1</td>
</tr>
<tr>
<td>Alternative Fuels: Ethanol</td>
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<td>Integrated Waste Management Board</td>
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<tr>
<td>Landfill Methane Capture</td>
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<td>3</td>
</tr>
<tr>
<td>Zero Waste—High Recycling</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

¹ These estimates are based on best available current information and will be updated as needed.

² The benefits of the Hydrogen Highway have been captured in other programs such as the motor vehicle regulations and green buildings initiative.

A summary description of each of the strategies in Table 5-1 is included below:

**Vehicle Climate Change Standards**

With the passage of AB 1493, Pavley, Chapter 200, Statutes of 2002, California moved to the forefront of reducing vehicle climate change emissions. This bill required the state to develop and adopt regulations that achieve the maximum feasible and cost-effective reduction of climate change emissions emitted by passenger vehicles and light duty trucks. Regulations were adopted by the ARB in September 2004.

The ARB analysis of this regulation indicates emissions savings of 1 million tons CO₂ equivalent (MMtCO₂e) by 2010 and 30 million tons CO₂ equivalent by 2020.²³ This analysis also suggests that operating cost savings will more than offset the incremental costs of improved technologies, resulting in consumer savings of $5 billion annually by 2020.

**Diesel Anti-idling**

Reduced idling times and the electrification of truck stops can reduce diesel use in trucks by about 4 percent, with major air quality benefits. In July 2004 the ARB adopted a measure to limit diesel-fueled commercial motor vehicle idling.²⁴ ARB
analysis indicates that anti-idling measures could reduce climate change emissions by 1.2 MMT CO2e in 2020. ARB also estimates that the proposed measures would provide savings of up to $575 million (NPV through 2013) to California businesses as a result of fuel savings and reduced engine maintenance costs.

Other New Light Duty Vehicle Technology Improvements

In September 2004 the California Air Resources Board approved regulations to reduce climate change emissions from new motor vehicles. The regulations apply to new passenger vehicles and light duty trucks beginning with the 2009 model year. The standards adopted by the Board phase in during the 2009 through 2016 model years. When fully phased in, the near term (2009–2012) standards will result in about a 22 percent reduction as compared to the 2002 fleet, and the mid-term (2013–2016) standards will result in about a 30 percent reduction.

New standards would be adopted to phase in beginning in the 2017 model year (following up on the existing mid-term standards that reach maximum stringency in 2016). Assuming that the new standards call for about a 50 percent reduction, phased in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet—staff estimates a 2030 reduction of about 27 MMT.

Hydrofluorocarbon Reduction Strategies

ARB staff has identified five possible measures to reduce HFC emissions from vehicular and commercial refrigeration systems:

1. **Ban the retail sale of hydrofluorocarbon (HFC) in small (mostly 12-oz.) cans.** This would end the loss of can “heels” (small amounts of HFCs remaining in the can after service is complete) and prevent do-it-yourself re-filling of vehicular air conditioning systems.

2. **Require that only low-GWP refrigerants be used in new vehicular systems.** For vehicles subject to the ARB motor vehicle climate change emission reduction regulations, this requirement would take effect in 2017 because the adopted regulations already specify standards and compliance options through 2016. For medium- and heavy-duty vehicles not subject to the AB 1493 regulation, the requirement would take effect in the 2010 timeframe.

3. **Adopt specifications for new commercial refrigeration.** Limit the global warming potential of refrigerants used in refrigerators in retail food stores, restaurants, and refrigerated transport vehicles (trucks and railcars) and/or require that centralized systems with large refrigerant charges and long distribution lines be avoided in favor of systems that use much less refrigerant and lack long distribution lines.

4. **Add refrigerant leak-tightness to the “pass” criteria for vehicular Inspection and Maintenance programs (all vehicles) and adopt an “Inspect**
and repair" measure for commercial systems. Require that systems either be leak-free at smog-check or be empty and inoperable.

5. Enforce the federal ban on releasing HFCs. This measure would focus on reducing emissions during the servicing and dismantling of vehicular air conditioners and commercial refrigeration systems.

Transportation Refrigeration Units, Off-road Electrification, Port Electrification (ship to shore)

Transportation Refrigeration Units

Require all new transportation refrigeration units (TRU) to be equipped with electric standby.

Require cold storage facilities to install electric infrastructure to support electric standby TRUs.

The technologies to be employed in this measure include electric standby for TRUs and electric infrastructure at cold storage facilities.

Emission reduction estimates are about 0.14 MMT in 2020 assuming 50 percent electrification and TRU operation at a facility of about 30 percent.

Off-road Electrification

Off-road electrification would likely be achieved using a combination of regulatory and incentive approaches. ARB could conduct outreach to encourage replacement of diesel engines with electric motors to take advantage of the incentive rate structure and Moyer funding, and to comply with District and pending ARB regulations.

The in-use stationary diesel agricultural engine regulation currently under development at ARB will propose emission performance standards for engines rather than mandate electrification or any other specific technology. Staff believes that most engines will be replaced with new cleaner certified diesel engines or with electric motors. Retrofit and alternative fuels are other potential means of compliance.

Port Electrification

ARB would require phase-in of vessel modifications and infrastructure to support expanded use of shore-side power.

Technologies to be employed in this measure include vessel modifications and shore-side infrastructure.

Shore-side power could be used in 2 to 5 percent of ship visits in 2010 and 20 to 25 percent of ship visits in 2020. The reductions in CO₂ emissions are calculated as the difference between the CO₂ emissions resulting from the generation of shore-side power supplied by utility companies and the CO₂ emissions resulting from power generated by shipboard diesel generators.

2010

Goal: 5 percent of ship visits use shore-side power
Estimated CO₂ reduction: 0.016 MMT

2020

Goal: 25 percent of ship visits use shore-side power

Estimated CO₂ reductions: 0.18 MMT

Manure Management

Proposed San Joaquin Valley Rule 4570, Confined Animal Facilities, is intended to reduce volatile organic compounds (VOC) from confined animal facilities and is in the initial stages of development. Some general concepts that may appear in the rule include: (1) different requirements based on facility size; (2) specific control requirements included on a list of technologies; (3) a mix of control options selected from a list; and (4) a facility-wide control efficiency that will achieve a certain percentage reduction. Possible control options include management practices, manure handling practices, and lagoon/liquid waste control options.

Emission reduction estimates of approximately 1 million tons (MMT) could be achieved through the use of biogas digesters along with the production of electricity and/or heating applications. ARB estimates of climate change emission reductions through implementation of anaerobic digesters have yet to be determined.

Semi Conductor Industry Targets (PFC Emissions)

ARB could help target climate change emission reductions through development of a model rule to be considered for adoption by the districts. Based on the voluntary target outlined in the Memorandum of Understanding between the U.S. EPA and the Semiconductor Industry Association, emission reduction estimates of approximately 2 MMT for semiconductor operations in both 2010 and 2020 are possible.

Alternative Fuels: Biodiesel Blends

ARB would develop regulations to require the use of 1 to 4 percent biodiesel displacement of California diesel fuel. A climate change emission reduction of about 0.4 MMT would be achieved in 2010 based on 2 percent displacement of diesel fuel. ARB and CEC staff estimate that biodiesel could likely provide up to a 4 percent displacement of diesel fuel by 2020. This would provide about 0.8 MMT of climate change emission reductions. It is important to note, however, that current supplies of biodiesel are limited in California. Thus this strategy presumes significant market expansion in addition to regulatory steps.

Alternative Fuels: Ethanol

More than 200,000 flexible fueled vehicles are present in California today that could use E-85 without any equipment modifications. This number will increase as manufacturers continue to produce additional new cars that are E-85 compatible. If E-85 became widely available at prices competitive with gasoline, a significant portion of the fleet could be fueled primarily with ethanol by 2015.
The percentage of ethanol used in gasoline could be increased to the maximum 10 percent (E-10) that is compatible with current vehicles. (The current gasoline supply contains 5.7 percent ethanol). However, significant permeation emissions caused by low percentage ethanol blends used in the summertime suggest that low percentage blends are best limited to wintertime use. In addition, other fuel properties may need to be adjusted to ensure that the use of E-10 does not increase emissions of smog forming compounds.

If ethanol used in California continues to be derived from corn or other similar grains, the climate change emission benefits due to increased use of E-85 would be negligible in 2010 and 2.7 MMT in 2020 (assumes that about 10 percent of the entire light duty vehicle fleet uses E-85 regularly.) Use of ethanol derived from biomass or waste material would more than double the climate change emission reduction benefit.

Using 10 percent ethanol content in gasoline during the wintertime (six months) would result in ethanol use roughly equivalent to the level required under the recently adopted federal energy bill, and thus produce no additional climate change emission reduction benefits.

**Heavy-Duty Vehicle Emission Reduction Measures**

Climate change emissions can be reduced with improved aerodynamics, climate engine-based improved efficiency, vehicle weight reduction, and rolling and inertia resistance improvements. ARB has also identified other possible measures, such as an education program for the heavy duty vehicle sector as well as the light and medium duty vehicle sectors that would educate drivers as to how to optimize vehicle operation.

Emission reduction estimates of about 0.2 MMT for 2010 and about 3 MMT for 2020 were derived assuming an efficiency improvement of 65 percent from 1990 levels is possible by 2030. These estimates were based on ARB/CEC estimates of fleet-wide diesel-use reductions achievable under a national approach based on DOE’s 21st Century Truck Program.

**Reduced Venting and Leaks in Oil and Gas Systems**

A model rule would be developed to be considered for adoption by the Air Pollution Control Districts. This measure involves improved management practices and does not rely on the application of new technology.

Estimated potential climate change emission reductions of 1 MMT CO₂ equivalent were derived assuming reduced leak and venting in the production, processing, transport, and distribution of oil and natural gas in 2010 and 2020. This goal is based on U.S.EPA estimates that approximately 33 percent of emissions from oil and gas systems can be avoided cost-effectively.

**Hydrogen Highway**

The California Hydrogen Highway Network (CA H2 Net) is a State initiative to promote the use of hydrogen as a means of diversifying the sources of transportation energy in order achieve a secure energy future, address
environmental, public health, and economic challenges, and work in partnership with other State programs to advance energy efficiency and renewable energy. The CA H2 Net mission is to assure that hydrogen infrastructure is in place as fuel cells and other hydrogen technologies reach commercial readiness.

Hydrogen can be derived from a variety of sources including petroleum based feedstock to a range of renewable resources. To assure that the production of hydrogen and operation of hydrogen fueled vehicles is environmentally beneficial the CA H2 Net has the clearly defined goals of utilizing at least 20 percent renewable resources in the production of hydrogen, reducing climate change emissions by at least 30 percent, and to not increase smog forming and toxic pollutants relative to fossil fuel vehicle use.

**Achieve 50% Statewide Recycling Goal**

Achieving the State's 50 percent waste diversion mandate as established by the Integrated Waste Management Act of 1989, (AB 939, Sher, Chapter 1095, Statutes of 1989), will reduce climate change emissions associated with energy intensive material extraction and production as well as methane emission from landfills. Currently a diversion rate of 48 percent has been achieved on a statewide basis. This strategy would result in achieving an additional 2% waste diversion of recyclables from landfills using existing authorities and mandates, collection infrastructures, and recycling processes.

**Landfill Methane Capture**

Methane production varies greatly from landfill to landfill depending on site-specific characteristics such as the quantity of waste in place, waste composition, moisture content, landfill design and operating practices, and climate. Unless captured first by a gas recovery system, methane generated by the landfill is emitted when it migrates through the landfill cover to the atmosphere and becomes a potent climate change emission.

Landfills can install direct gas use projects or electricity projects with backup flare systems to capture and use methane. The technical applicability of any mitigation option is dependent on the amount of landfill gas generated by landfills in a given size category.

**Zero Waste—High Recycling**

Additional recovery of recyclable materials from landfills will reduce the climate change emissions associated with energy intensive material extraction and production as well as methane emission from landfills. Transforming organics/biomass and plastic waste into marketable products will also reduce the amount of material going to landfill, and therefore will further reduce climate change emissions. Currently, the State is mandated to divert 50 percent of waste going to landfills as established by the Integrated Waste Management Act of 1989. Efforts to exceed the 50 percent goal would allow for additional reductions in climate change emissions.
5.3 Strategies the Resources Agency will Implement over the Next Two Years

Table 5-2 lists all of the strategies that Resources Agency will implement over the next two years. The Forest management efforts promise not only climate change emission reductions but also protect biodiversity, water quality and habitat resources. For three decades the California Energy Commission has led the world with the most progressive new building and appliance efficiency standards. These efficiency standards have provided substantial climate change emission reductions and have saved consumers about $1,000 per household in California. Finally, by reducing the energy used to transport and deliver water in the State and increasing water use efficiency California can both protect our water supply and reduce climate change emissions.

Table 5-2. Resources Agency

<table>
<thead>
<tr>
<th>Climate Change Emission Reductions (Million Metric Tons CO₂ Equivalent)</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Forestry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest Management</td>
<td>1-2</td>
<td>2-4</td>
</tr>
<tr>
<td>Forest Conservation</td>
<td>4.2</td>
<td>8.4</td>
</tr>
<tr>
<td>Fuels Management/Biomass</td>
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<td>6.8</td>
</tr>
<tr>
<td>Urban Forestry</td>
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<td>3.5</td>
</tr>
<tr>
<td>Afforestation/Reforestation</td>
<td>0</td>
<td>12.5</td>
</tr>
<tr>
<td>Department of Water Resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Use Efficiency</td>
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<td>1.2</td>
</tr>
<tr>
<td>Energy Commission</td>
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<td></td>
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<td>2</td>
</tr>
<tr>
<td>Appliance Energy Efficiency Standards in Place</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Fuel-Efficient Replacement Tires &amp; Inflation Programs</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Building Energy Efficiency Standards in Progress</td>
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</tr>
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<td>Appliance Energy Efficiency Standards in Progress</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Cement Manufacturing</td>
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<td>&lt;1</td>
</tr>
<tr>
<td>Municipal Utility Energy Efficiency Programs/ Demand Response</td>
<td>1</td>
<td>5.9</td>
</tr>
</tbody>
</table>
A summary description of each of the strategies in Table 5-2 is included below:

**Forest Management**

Strategies for storing more carbon through forest management activities can involve a range of management activities such as increasing either the growth of individual trees, the overall age of trees prior to harvest, or dedicating land to older aged trees. With roughly 4 million acres of private managed forestland in California, changes in forest management can produce significant amounts of climate change emission reduction benefits for the state.

Inclusion of the forest sector in climate mitigation policy can lead to additional local environmental benefits that may help the state’s resources adapt to potential negative effects of climate change. Overall changes in forest management can enhance and protect biodiversity, water quality, and habitat resources that the state will increasingly seek to protect in the advent of climate change.

Forest management projects could be included in a broader multi-sector climate change emission market-based program or climate trust system. In a market-based program, forest management projects could provide offsets that would be purchased by capped entities. In a climate trust program, the state would fund forest management projects and recapture the costs by selling carbon credits to industries needing to reduce their climate change emissions.

The regulatory framework for timber harvesting requires landowners to secure permits from a large number of agencies to meet the requirements of the Forest Practice Act, Endangered Species Act, and Clean Water Act. Together the time and cost of obtaining these permits have led to conversions of timberlands to other uses and made it more difficult and time consuming to implement forest management activities that would increase carbon storage. Simplification of the permitting processes for forest management and timber harvesting would result in additional carbon being stored over a larger number of acres.

**Forest Conservation**

Conservation projects are designed to minimize/prevent the climate change emissions that are associated with the conversion of forestland to non-forest uses by adding incentives to maintain an undeveloped forest landscape.

California is losing forestland at increasing rates: 35,000 to 40,000 acres of private forestland is converted annually to non-forest uses (Bill Stewart, 2005),
which could contribute as much as 12 million tons of CO₂ emissions annually. Policies designed to minimize or prevent forestland conversion to non-forest uses could provide significant benefits by 1) preventing or minimizing climate change emissions that are associated with increasing forestland conversion in California and 2) maintaining the opportunity to increase forest carbon stocks on these lands through additional sequestration over time.

Forest conservation can also enhance and protect biodiversity, water quality, and habitat resources that the state will increasingly seek to protect from the negative effects of climate change. Finally, in contrast to the other forest sector strategies such as reforestation, the climate benefits of forest conservation are immediate.

Specific actions that can be taken include establishing a state forest conservation program that operates independently from the federal Forest Legacy program; increasing Forest Legacy Program Funding with an $11 million annual investment that could prevent the conversion of 14,000 acres of forestland. Another step could include directing the Wildlife Conservation Board, the State Conservancies, and other state land acquisition and easement programs to consider climate benefits in evaluating and ranking projects to be funded. Finally, the state could include forestland conservation as an emission reduction project in a broader multi-sector climate change market-based program or climate trust system.

Fuels Management/Biomass

Large, episodic, unnaturally hot fires are an increasing trend on California’s wild lands because of decades of fire suppression activities, sustained drought, and increasing insect, disease, and invasive plant infestations. Actions taken to reduce wildfire severity through fuel reduction and biomass development would reduce climate change emissions from wildfire, increase carbon sequestration, replace fossil fuels, and provide significant local economic development opportunities.

Fire management and biomass development projects could be accelerated by establishing a new state goal of thinning, removing, and treating 212,000 acres of public and privately owned forestland annually by 2010, and 275,000 acres by 2020. Such projects would: 1) reduce the intensity of wildfires and their associated climate change emissions; 2) increase the carbon stock of the remaining trees, 3) remove pests that create mortality of live stored carbon and reduce large damaging wildfires, 4) reduce state and local fire suppression costs; 5) provide a source of renewable alternative fuel; and 6) provide significant rural economic development opportunities.

Urban Forestry

This strategy would expand the State Urban Forestry Program. A new state-wide goal of planting 5 million trees in urban areas by 2020 would be achieved through the expansion of local urban forestry programs. At a cost of $100 per tree, $500 million would have to be invested by local urban forestry programs to meet this target.
This could be achieved by issuing an Executive Order to establish a new state-wide goal and directing the Board of Forestry and California Department of Forestry to launch an aggressive public assistance and outreach campaign to expand local urban forestry programs. The state could request that the California Climate Action Registry develop and adopt a protocol for the certification of climate change emission reductions from local urban forestry programs.

This strategy would develop new urban biomass programs. The California Department of Forestry would develop an urban biomass utilization program to provide technical advice, planning, education, and seed money for local government marketing centers for biomass waste.

**Afforestation (Planting Trees)/Reforestation Projects**

Reforestation projects focus on restoring native tree cover on lands that were previously forested and are now covered with other vegetative types. Recent studies have estimated that approximately 9 million acres of land in California could be reforested to increase carbon stocks and provide other benefits. Each of these acres has the potential to store between 150 to 230 tons of carbon.

Specific actions that could be taken include: establishing a new statewide goal of reforesting 500,000 acres of forestlands by 2020, including 250,000 acres on private lands and 250,000 acres on federal lands; seeking $30 million annually, or $300 million in bond funds to meet these targets; establishing a long-term loan program to fund private land reforestation; establishing a multisector market-based program where reforestation projects can be included as offsets in a broader, multi-sector climate change market-based program; and establishing a state-owned carbon bank, modeled after Oregon’s Climate Trust, as part of a market-based program.

**Water Use Efficiency**

Approximately 19 percent of all electricity, 30 percent of all natural gas, and 88 million gallons of diesel are used to convey, treat, distribute and use water and wastewater. The California Energy Commission (CEC) estimates 44 million tons of CO2 emissions are expelled annually on average to provide the 44 million acre feet (MAF) of water used statewide.

The key to the reduction of climate change emissions through water use efficiency is strategic investment in measures tied to water energy intensity. When a unit of water is saved, so too is the energy required to convey, treat, affect local delivery, perform wastewater treatment and safely dispose of that unit of water. In short, saving water saves energy. Saving water that gets treated as wastewater saves more energy. Saving water that gets heated or additionally pressurized saves still more.

Region, elevation, water use sector, and energy source, among other factors, all influence water energy intensity. The statewide average for climate change emissions per acre foot is skewed by the wide local variation in the water energy intensity. Everything else being equal, a cooling tower condition meter installed in an industrial plant in Northern California will save 2,920 kWh compared to
9,270 kWh saved annually in a comparable plant south of the Tehachapi Mountains.

Increased water use efficiency is the key element in the California Water Plan Update (Bulletin 160-05) plans to meet the state's needs for water in 2030 with a growing population. The plan calls for reducing urban water use by 1.1 to 2.3 MAF per year and agricultural water use by 0.5 to 2.0 MAF per year by 2030. Accelerating the investment to attain that water use savings by 2015 would result in an estimated additional climate change emission reductions of approximately 30 million tons cumulatively by 2030. Accelerating the investment to 2010 would result in a further cumulative reduction of 10 million tons.

The California Bay-Delta Authority's larger estimated potential for 3.0 MAF per year urban water use reduction requires a greater rate of local and state/federal investment in conservation. Incentive driven advances in water-saving technology over the next 25 years potentially could further push savings beyond the levels indicated.

A comprehensive program focused on the state's water and wastewater agencies and their customers would yield significant benefits to the state including: meeting the state's water plan, increasing energy system reliability and price stability, meeting the state's renewable portfolio standard goals and reducing the state's climate change emissions. Following are measures to include in this comprehensive program:

- Accelerate investment in water use efficiency: Accelerate implementation of best management practices and efficient water management practices (EWMP) and incentives. Coordinate this accelerated investment with the state's investments in energy efficiency. Start in the areas of the state with most energy-intensive water use cycles.
- Increase the energy efficiency of all water and wastewater treatment operations. Develop long-term programs to better mesh with the long-term investments in water and wastewater infrastructure.
- Improve price signals so that water-related energy use can be shifted off periods of peak energy demand.
- Increase water storage to increase operational flexibility throughout the water use cycle and reduce peak electric system energy requirements.
- Identify suitable locations for new pumped storage facilities. Construct facilities at these locations.
- Increase energy production by water and wastewater agencies from renewable sources such as in-conduit hydropower and biogas. Add generation from solar and wind resources.

**Building Energy Efficiency Standards in Place**

Public Resources Code 25402 authorizes the Energy Commission to adopt and periodically update its building energy efficiency standards (that apply to newly constructed buildings and additions to and alterations to existing buildings). The
Energy Commission updates the standards at its discretion (i.e. three-year cycle for building standards). In addition to the long existing legislative mandates, recent policies have placed priority on and established specific goals for updating of the standards.

The Energy Action Plan and the Integrated Energy Policy Report both call for ongoing updating of the standards, including meeting energy efficiency goals, addressing demand response and promoting the combination of solar photovoltaics and high-energy efficiency buildings. The Energy Commission has also initiated work for the building standards that will go into effect in 2008 (i.e. the first of three update cycles that will occur prior to 2015).

**Appliance Energy Efficiency Standards in Place**

Public Resources Code 25402 authorizes the Energy Commission to adopt and periodically update its appliance energy efficiency standards (that apply to devices and equipment using energy that are sold or offered for sale in California). The Energy Commission updates the standards at its discretion. In addition to the long existing legislative mandates, recent policies have placed priority on and established specific goals for updating of the standards.

New standards for a variety of appliances were adopted in December 2004. Some standards under consideration in December were delayed to further consider manufacturer comments. Those standards are being developed by the Energy Commission at the present time. The estimates in Table 5-1 represent the expectation of full adoption of these standards.

**Fuel-Efficient Replacement Tires and Inflation Programs**

State legislation (Chapter 912, Statutes of 2001) directed the Energy Commission to investigate and to recommend ways to improve fuel efficiency of vehicle tires. The bill established a statewide program to encourage the production and use of more fuel efficient tires, and required the Energy Commission to:

- Establish a test procedure for measuring tire fuel efficiency.
- Develop a database on the fuel efficiency of existing tires in order to establish an accurate baseline of tire efficiency.
- Develop a rating system for tires that provides consumers with information on the fuel efficiency of individual tire models.
- Develop a consumer-friendly system to disseminate tire fuel-efficiency information as broadly as possible.
- Study the safety implications of different policies to promote fuel efficient replacement tires in the consumer market.
- Evaluate a mandatory fuel efficiency standard for all after-market tires sold in California.
➤ Develop consumer incentive programs that would offer a rebate to purchasers of replacement tires that are more fuel-efficient than the average replacement tire.

➤ Study ways to improve the fuel-efficiency of vehicles in the State's fleet.

➤ AB 844 later required tire manufacturers to report to the Energy Commission the rolling resistance and relative fuel economy of replacement tires sold in California.

Building Energy Efficiency Standards in Progress

As part of the process of updating the Building Energy Efficiency Standards, the Energy Commission evaluates new and emerging technology for possible inclusion in the standards. The CEC administers an ongoing "compliance option" process which evaluates to what extent compliance credit should be approved for new technologies and develops algorithms that can be used to properly evaluate their energy consequence within building simulation computer programs that are used for standards compliance.

Upon commission approval, compliance options can be used to demonstrate compliance with the performance approach in the standards. Once a compliance option has been in existence for a period of time, the commission often considers whether or not the compliance option should be made a requirement of the standards (as a prescriptive requirement and basis of the energy budget established for the performance standards).

Appliance Energy Efficiency Standards in Progress

As part of the process of updating the Appliance Energy Efficiency Standards, the CEC evaluates new and emerging technology for increasing the energy efficiency of appliances and equipment for possible inclusion in the standards. The Commission's Buildings and Appliances Office works on an ongoing basis with the Public Interest Energy Research (PIER) program and with the Utility Codes and Standards Programs to track promising new technologies and consider their appropriate inclusion in the standards.

Fundamentally, the standards updating process is achieved thorough technology assessment of the potential to include new technologies in the standards, and the program is continuously evaluating new technologies.

Cement Manufacturing

This strategy involves cost-effective reductions to reduce energy consumption and to lower carbon dioxide emissions in the cement industry. There is a large technical potential to improve energy efficiency in cement operations at a reasonable cost.

Climate change emissions from burning fossil fuels in the manufacturing of cement produces 1.5 to 2.0 percent of U.S. carbon dioxide emissions. Roughly half is from fossil fuel combustion and roughly half is from the conversion of limestone (45 million tons per year). California's cement industry produced 5.6
million metric tons in 2001; total statewide climate change emissions approached 500 million metric tons in 2001.

Annual emissions from the manufacturing of cement are growing at a rate of 2 percent per year, according to industry sources and using California-specific data. Direct emissions of carbon dioxide are estimated to rise from 10.4 million metric tons in 2005 to more than 15 million metric tons in 2025. Use of limestone Portland cement and the use of blended cement account for 70 percent of the potential emission reductions and would cost less than $10 per metric ton.

State policy options can take several forms, including technology mandates, financial incentives, negotiated agreements, voluntary commitments, emissions-intensity benchmarking, or mandatory measures. Policy changes would be needed to encourage the use of limestone and blended cement and to allow waste tires to be used as a fuel in cement manufacturing. Based on CEC’s analysis, these measures have been shown to provide cost-effective climate change emission reduction benefits.

Municipal Utility Energy Efficiency Programs

The Energy Commission and the California PUC are collaborating on additional energy efficiency programs beyond those programs already adopted.

While the Energy Commission does not have regulatory authority over the publicly owned utilities in the way that the CPUC regulates the IOUs, the publicly owned utilities are required to report their energy savings to the CEC. A process to ensure comparability between public benefit program savings and funding data reported by public and investor-owned utilities will need to be established. Possible steps for implementing this strategy include:

- Pursuing statutory modifications or a cooperative agreement with the publicly owned utilities to achieve the needed CO₂ reductions.
- Seeking statutory modifications or the establishment of a formal memorandum of understanding (MOU) with the utilities to achieve these targets.
- Pursuing statutory modifications or another mechanism to ensure that all load-serving entities account for climate change emissions and emission reductions in a manner consistent with investor-owned utilities.

Municipal Utility Renewable Portfolio Standard

The Energy Commission and the CPUC are responsible for implementing the RPS for the investor-owned utilities, electric service providers, and community choice aggregators. The publicly-owned utilities are responsible for implementing their own RPS programs.

The CPUC has undertaken a study to identify the steps necessary to achieve the 33 percent goal for the state’s IOUs. The Energy Commission is undertaking a similar related study on RPS programs adopted by publicly-owned utilities, including barriers and policy options to accelerate those programs to reach the 20 percent goal by 2010 and 33 percent goal by 2020. Possible steps for implementing this strategy include:

- Pursuing a cooperative agreement with the publicly-owned utilities to achieve the needed climate change emission reductions.
- Seeking statutory modifications to require the publicly owned utilities to contribute proportionally to the state’s RPS goals.
- Seeking statutory modifications or a cooperative agreement to ensure that publicly-owned utilities account for climate change emissions and emission reductions in a manner consistent with investor-owned utilities.

**Municipal Utility Combined Heat and Power**

This strategy constitutes cost-effective reductions from fossil fuel consumption in the commercial and industrial sector through application of on-site power production to meet both heat and electricity loads. To effectively implement this strategy, various policy instruments will likely be needed to attain the realistic market potential and subsequent climate change emission reductions.

These policy mechanisms may include regulatory incentives to encourage utilities to promote customer and utility-owned CHP, utility rate structures that are transparent and connected to market forces where externalities such as environmental impacts and transmission and distribution constraints are internalized, rules and regulations enabling easier access to wholesale markets, production tax credits for CHP, and other measures or incentives directed at key commercial and industrial activities in California.

Through existing efficiency commercialization programs at the CEC where relationships have been well established with the commercial and industrial sectors, a set of implementation activities will be developed that include:

- Utility tariffs to enable CHP owners to sell excess on-site electricity generation to the utility at prevailing wholesale prices. Existing analysis suggests this would be very effective in stimulating the near-team (next 5 years) market.
- Climate change emission reduction credits to reflect the net reduction of climate change emissions for the CHP systems compared to the avoided electricity and boiler fuel emissions.
- Transmission and distribution benefit payments that reflect the local and temporal benefits CHP provides utilities.

55
Utility regulatory incentives to encourage utilities to promote installation of customer- and utility-owned CHP projects.

**Municipal Utility Electricity Sector Carbon Policy**

The Energy Commission and the CPUC are collaborating on additional programs to address ways to transition investor-owned utilities away from carbon-intensive electricity sources. Some publicly owned utilities have historically relied on coal-based generation, and many of these facilities will reach the end of their design life by 2020. The Energy Commission will explore options to encourage municipal utilities to transition away from carbon-intensive generation to low-carbon alternatives, and to reduce purchases of carbon-intensive power. Options include establishing emissions targets or caps, providing incentives for preferred generation options, and setting a climate change emission performance standard for new utility resource procurement, including both coal and non-coal resource additions.

In its recently adopted *2005 Integrated Energy Policy Report*, the Energy Commission recommends:

- Any climate change emission performance standard for utility procurement should be set no higher than emission levels achieved by a new combined-cycle natural gas turbines. In the case of coal-fired generation, the capacity to capture and store carbon dioxide safely and inexpensively is essential for meeting these standards.

- The state should specify a climate change emission performance standard and apply it to all utility procurement, including in-state generation and out-of-state purchases, coal, and non-coal resources.

- Additional consideration is needed before determining what role climate change emission offsets could play in complying with such a standard.

- The Energy Commission should work with the CPUC to develop a framework that accounts for the financial risk of reliance on carbon-based generation.

- California should have a consistent electricity carbon policy for all electric utilities within the state that applies to both in-state generation and out-of-state power purchases.

**Alternative Fuels: non-Petroleum Fuels**

This strategy involves increasing the use of non-petroleum fuels in California’s transportation sector, as recommended in the Energy Commission’s *2003 and 2005 Integrated Energy Policy Reports*. The Governor has also directed the Energy Commission to develop a workable, long-term transportation fuels plan that will result in significant reductions in gasoline and diesel use and that will establish realistic and achievable objectives. The Bio-Energy Interagency Working Group, which the Energy Commission is leading, has been asked to recommend options for optimizing the market potential for bio-fuels through a coordinated state level effort.
State policy options can take several forms, including technology performance standards, financial incentives, negotiated agreements, voluntary commitments, emissions-intensity benchmarking for fuel producers or automobile manufacturers, or other mandatory measures, such as fuels or motor vehicle standards or a market-based program. Based on our analysis, some alternative fuels have been shown to provide cost-effective climate change emission reduction benefits. But they face economic, market, or regulatory barriers that are impeding their use.

To achieve the benefits of this strategy, the following implementation issues would need to be overcome:

- The high first cost of alternative-fuel vehicles, when compared to conventional vehicles using internal combustion engines.
- The absence of a convenient retail fueling network to dispense alternative fuels to customers.
- Other regulatory and market barriers.

5.4 Strategies Other State Agencies will Implement over the Next Two Years

Table 5-3 lists all of the strategies that other state agencies will implement over the next two years. Many participants at the Climate Action Team public meetings, particularly in Southern California, indicated that smart land use and increased transit availability should be a priority in the state. The participation of Business, Transportation and Housing Agency on the Climate Action Team has highlighted the fact that such strategies can provide substantial climate change emission reductions. Similarly the efforts of the Department of Food and Agriculture and the State and Consumer Resources Agency provide benefits beyond their climate change emission reduction potential.

Table 5-3. Other State Agencies

| Climate Change Emission Reductions (Million Metric Tons CO₂ Equivalent) |
|-----------------------------|------------------|
|                              | 2010  | 2020 |
| Business, Transportation and Housing |       |      |
| Measures to improve Transportation Energy Efficiency | 1.8   | 9    |
| Smart Land Use and Intelligent Transportation | 5.5   | 18   |
| Department of Food and Agriculture |       |      |
| Conservation tillage/cover crops | TBD   |      |
| Enteric Fermentation | <1    | <1   |
State and Consumer Services Agency

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<td>Transportation Policy Implementation</td>
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</tr>
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</table>

1 These estimates are based on best available current information and will be updated as needed.

A summary description of each of the strategies in Table 5-3 is included below:

**Measures to Improve Transportation Energy Efficiency**

This strategy builds on current efforts to provide a framework for expanded and new initiatives including incentives, tools and information that advance cleaner transportation and reduce climate change emissions.

The effort includes the following:

- Incorporating energy efficiency and climate change emissions reduction measures into the policy framework governing land use and transportation, including framework for developing energy element in state transportation and regional planning documents. Better coordination on cross-agency climate change and energy policy framework to ensure a concerted effort and synergy among state agencies' climate change emission reduction activities.

- Increasing incentives and accelerating technology applications to improve transportation system productivity and move toward cleaner and more efficient vehicles, especially for the public sector fleet. Enhancing outreach and educational programs to bring a coordinated message of sustainable transportation and root causes of climate change emissions.

- Diversifying transportation energy infrastructure and advancing measures to slow the rate of vehicle miles traveled growth and excessive reliance on petroleum.

**Smart Land Use and Intelligent Transportation**

Smart land use is an umbrella term for strategies that integrate transportation and land-use decisions. Such strategies generally encourage jobs/housing proximity, promote transit-oriented development, and encourage high-density residential/commercial development along transit corridors. These strategies develop more efficient land-use patterns within each jurisdiction or region to match population increases, workforce and socioeconomic needs for the full spectrum of the population.

Intelligent Transportation Systems (ITS) is the application of advanced technology systems and management strategies to improve operational efficiency of transportation systems and movement of people, goods and services. Smart growth/land use and ITS would minimize the need for major capital improvements and can provide a host of benefits including more livable communities, transportation energy efficiency, lower emissions from mobile sources, and a lower-cost provision of public services (e.g., sewer, water).
Governor Schwarzenegger is finalizing a comprehensive 10-year strategic growth plan with the intent of developing ways to promote, through state investments, incentives and technical assistance, land use, and technology strategies that provide for a prosperous economy, social equity, and a quality environment. The Administration is pursuing funding and budgetary measures to support the strategic growth plan.

Smart land use, demand management, ITS, and value pricing are critical elements in this plan for improving mobility and transportation efficiency. Specific strategies include: promoting jobs/housing proximity and transit-oriented development; encouraging high density residential/commercial development along transit/rail corridor; valuing and congestion pricing; implementing intelligent transportation systems, traveler information/traffic control, incident management; accelerating the development of broadband infrastructure; and comprehensive, integrated, multimodal/intermodal transportation planning.

Conservation/Tillage Cover Crops

Conservation tillage and cover crops practices are increasingly being used by California farmers for a variety of reasons, including improved soil tilth, improved water use efficiency, reduced tillage requirements, saving labor and fuel, and reduced fertilizer inputs. However, due to the wide diversity of California agriculture, these practices must be demonstrated in a wide variety of cropping systems, soil types, irrigation regimes, and climate conditions.

This diversity also creates difficulty in quantifying both carbon emissions and potential carbon sequestration benefits from implementing conservation tillage and cover crops in the myriad of California cropping systems. This potential needs to be verified through extensive research directly applied to California conditions. Thus, the potential climate change emission reductions for 2010 and 2020 remains to be determined.

Enteric Fermentation

Enteric fermentation is the process of feed digestion by ruminant animals (primarily dairy and beef cattle). This process results in methane emission from the animals. To reduce climate change emissions resulting from enteric fermentation, feed adjustments may be made that improve milk and meat productivity.

New measures would include establishing a research initiative to quantify emission changes from enteric fermentation resulting from changing feed regimens versus productivity impacts. Different animal populations would have differing abilities to manage feed rations. For example, grass-fed beef would have little to no ability to reduce enteric emissions. Dairy operators vary feed rations based on numerous factors. Feed rations are a complex system that not only provide nutrition to the animal, but also provide cost-effective and efficient use of other agricultural by-products including food processing residuals, fruit culls, almond hulls, cotton seed, and even rice straw.
This system would have to be carefully analyzed to determine overall climate change emission effects if the use of these other residuals is altered. This analysis would include both a technical analysis and a cost effectiveness analysis that would be initiated in 2006.

Pricing of food commodities to reflect embodied climate change emissions is not recommended for any action at this time. A "calcium crisis" currently exists in this country, where a significant portion of women and children are calcium deficient. Milk and dairy products are a major source of calcium that should be available to these at-risk populations, especially those of low and moderate income, at affordable prices.

Green Buildings Initiative

Governor Schwarzenegger's Green Building Executive Order, S-20-04, sets an ambitious goal of reducing energy use in public and private buildings by 20 percent by the year 2015, as compared with 2003 levels. The Executive Order and related action plan spell out specific actions state agencies are to take with state-owned and -leased buildings. The order and plan also discuss various strategies and incentives to encourage private building owners and operators to achieve the 20 percent target.

Preliminary estimates indicate that 6.5 million tons of CO₂ will be reduced annually by the year 2015 through building efficiency efforts in commercial and institutional buildings. This number is based on the average displaced power generation being an efficient natural gas combined cycle turbine. The 6.5 million-ton estimate has been adjusted in Table 5-2 to ensure against double counting amongst other strategies being recommended by the CAT.

5.5 Strategies the Public Utilities Commission will Implement Over the Next Two Years

Table 5-4 lists all of the strategies that the Public Utilities Commission will implement over the next two years. Working in cooperation with the Energy Commission, the Public Utilities Commission has implemented the most progressive Renewable Portfolio Standard in the nation. The Public Utilities Commission has also been progressive in energy efficiency and clean energy programs for investor-owned utilities. Many stakeholders indicated that these programs should apply to the publicly-owned utilities as well.

<table>
<thead>
<tr>
<th>Climate Change Emission Reductions</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerated Renewable Portfolio Std to 33% by 2020 (includes load-serving entities)</td>
<td>5</td>
<td>11</td>
</tr>
</tbody>
</table>
California Solar Initiative 0.4 3
Investor Owned Utility Energy Efficiency Programs (including LSEs) 4 8.8
Investor-Owned Utility (IOU) Additional Energy Efficiency Programs/Demand Response NA 6.3
IOU Combined Heat and Power initiative 1.1 4.4
IOU Electricity Sector Carbon Policy 1.6 2.7

1 These estimates are based on best available current information and will be updated as needed.

A summary description of each of the strategies in Table 5-4 is included below:

Accelerated Renewable Portfolio Standard (33 percent by 2020)

The Governor has set a goal of achieving 33 percent renewables in the State’s resource mix by 2020. The joint PUC/Energy Commission September 2005 Energy Action Plan II (EAP II) adopts the 33 percent goal. The PUC and Energy Commission have already commenced review of the legal, regulatory, and infrastructure changes necessary to achieve the Governor’s goal.

The Center for Resource Solutions has prepared a preliminary report for the CPUC entitled Achieving a 33% Renewable Energy Target (The Center for Resource Solutions, November 1, 2005), which concludes that the 33 percent target by 2020 is achievable and discusses the major hurdles and necessary implementation steps. The report is a starting point for further review by the CPUC on instituting a 33 percent goal.

California Solar Initiative

The solar initiative includes installation of 1 million solar roofs or an equivalent 3,000 MW by 2017 on homes and businesses, increased use of solar thermal systems to offset the increasing demand for natural gas, use of advanced metering in solar applications, and creation of a funding source that can provide rebates over 10 years through a declining incentive schedule.

Legislation to codify the Governor’s initiative (SB 1) failed to pass the California Assembly in the fall of 2005. However, the PUC, in cooperation with the Energy Commission and the Governor’s Office, will implement the California Solar Initiative under its existing statutory authority.

Investor-Owned Utility Energy Efficiency Programs

In September 2004, the PUC adopted aggressive savings targets for the investor-owned utility energy efficiency programs through 2013. The savings targets through 2013 are challenging goals to meet, and the PUC will reassess these targets and adopt more realistic goals during each three-year program cycle.

The PUC funds energy efficiency programs through the Public Goods Charge and the resource procurement budgets of the utilities. For the 2006–2008 program cycle, the total energy efficiency budget for all of the investor-owned
utilities is approximately $2 billion, for a total projected annual net savings of 7,371 gigawatt hours and 121,989 million therms. These projections exceed the savings targets by 108 percent and 109 percent respectively. By 2008 these programs will reduce annual carbon dioxide emissions by more than 3 million tons per year.

**Investor Owned Utility Additional Energy Efficiency Programs/Demand Response**

In September 2004, the PUC adopted aggressive savings targets for the IOUs’ energy efficiency programs through 2013. The savings targets through 2013 are stretch goals and the PUC will reassess these targets and adopt the actual goals during each three-year program cycle. The PUC funds energy efficiency programs through the Public Goods Charge and the IOUs’ resource procurement budgets. For the 2006–2008 program cycle, the total energy efficiency budget for all of the IOUs is approximately $2 billion, for a total projected annual net savings of 7,371 gigawatt hours and 121,989 million therms. These projections exceed the savings targets by 108 percent and 109 percent respectively. By 2008 these programs will reduce annual carbon dioxide emissions by more than 3 million tons per year.

Over the next year, the PUC will develop a risk/reward incentive mechanism for the IOUs and refine energy measurement and verification protocols. In 2008, the PUC will evaluate and adopt the 2009–2011 energy efficiency savings goals and programs of the IOUs.

**Investor-Owned Utility Combined Heat and Power Initiative**

This strategy encourages the installation of on-site power production to meet both heat and electricity loads, known as combined heat and power projects (CHP). The PUC’s existing Self-Generation Incentive Program allocates $0.80 per watt to eligible CHP projects in the territories of the IOUs, up to a capacity size of 5 MW. Currently, all SGIP funds are reserved through 2007, although funding may become available if proposed projects do not materialize.

This strategy would seek to develop additional programs to further encourage the development of CHP. These additional programs are not yet underway, will require further consideration, and could likely require administrative, legislative, regulatory, and budget initiatives. To effectively implement this strategy, it is likely various policy instruments will be needed to attain the realistic market potential and subsequent CO2 reductions.

These policy mechanisms may include regulatory incentives to encourage IOUs to promote customer and utility-owned CHP, changes to IOU rate design, market rules and regulations enabling easier access to wholesale markets, production tax credits for CHP, and other measures or incentives directed at key commercial and industrial activities in California. Statutory modifications are required in order to apply a similar strategy for CHP programs implemented by publicly-owned utilities.
Investor Owned Utility Electricity Sector Carbon Policy

The PUC is currently investigating various strategies and incentives to encourage the IOUs to make cost-effective procurement decisions that are based in part on reducing climate change emissions. These strategies include emissions targets or caps, incentives for preferred procurement options, and incentives for portfolio optimization and total cost minimization.

The PUC conducted workshops in March 2005 on the procurement incentive framework and issued a staff report in March 2005. The post-workshop comments were filed in April and May 2005. A final decision to include a carbon cap on emissions associated with all utility procurement activities was adopted in February of 2006. This strategy includes the following steps:

- Determine a methodology the IOUs will use to report their climate change emissions.
- Continue to work with the CEC to ensure that the IOUs and the municipal utilities use consistent methodologies to report their emissions.
- Begin work to establish emission baselines for IOUs.

5.6 The Governor’s Targets Can Be Met

Based on the emission reduction potential demonstrated in the tables above and illustrated in Figure 2-1 below, it is clear the Governor’s targets are achievable. However, continued top-down leadership as has been demonstrated by this Governor as well as a coordinated agency-level effort as has been achieved via the Climate Action Team will be essential to success.

Figure 5-1. California’s Target Can Be Met
5.7 Emission Baseline Development

For the purposes of this report, it is necessary to use historical climate change emissions for the years 1990 and 2000 and projected climate change emissions for 2010 and 2020.

Table 5-5 illustrates the baseline data was that was used:

Table 5-5 Baseline Inventory Estimates*

<table>
<thead>
<tr>
<th>Climate Change Emission Baseline</th>
<th>(Million Metric Tons CO₂ Equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>1990</td>
</tr>
<tr>
<td>Baseline Emissions</td>
<td>426</td>
</tr>
</tbody>
</table>

* Not including international marine bunker fuels

The baseline climate change emissions used to compute reductions needed to meet Governor's targets were developed with the assistance of Tellus Institute working with the ARB and CEC. The CEC publishes climate change emission inventory updates on a regular basis and updates its Integrated Energy Policy Report in odd years. In 2007, the Energy Commission will update both reports and integrate these efforts to produce projected 2010 and 2020 climate change emissions.
5.8 Economic Assessment

The overall economic impact of implementing the strategies in Section 5.2 were estimated using a computable general equilibrium (CGE) model of the California economy. A CGE model simulates the functioning of a market economy in which different sectors interact with one another (one sector supplies inputs to another, or purchases the outputs of another) and where prices and production adjust in response to changes caused by government policies applied to specific sectors. The CGE simulates these relationships among California producers, California consumers, government, and the rest of the world. Because of the interconnection between sectors, an intervention in one sector has impacts on all others, which are captured by the CGE model analysis.

The results of a preliminary assessment of the macroeconomic impacts associated with the climate change emission reduction strategies show that the overall impacts of the climate change emission reduction strategies on the California economy are expected to be positive. Specifically, when the strategies already underway as well as new strategies being proposed are considered in total, the resulting impacts on the economy are expected to translate into job and income gains for Californians. For example, in 2020 the implementation of the strategies is expected to increase jobs and income by an additional 83,000 and $4 billion, respectively, above and beyond the substantial growth that will occur between today and 2020.

The favorable impacts on the economy are possible because of the reduced costs associated with many of the strategies. The additional job growth is expected to come from the net savings to consumers associated with the implementation of the strategies. The savings will in turn promote further business expansion and job creation.

A subsequent refined analysis is planned over the next year. The refined analysis will incorporate updated cost and savings estimates for the strategies. It will also assess the cost-effectiveness of the various individual strategies. Thus, the refined economic analysis will provide additional information to decision-makers as they proceed with implementation of the strategies.

6 MARKET-BASED OPTIONS FOR CALIFORNIA

Market-based programs can be integral to California's strategy for reducing climate change emissions. Options considered by the Climate Action Team would set an emissions cap that can be phased down over time but allow regulated sources flexibility to comply with the cap. Such flexibility would be designed to provide the greatest certainty of benefits at the least cost possible.

Because climate change emissions originate from diverse sources and are long-lived gases in the atmosphere, setting an overall emission cap and allowing flexibility through trading, allocation schemes such as auctioning credits, and/or offsets is recognized as a particularly effective strategy for reducing emissions from many (but not all) climate change emission sources. This approach is best applied to sources with emissions that can be measured or calculated reliably.
Emission sources that are diffuse, difficult to quantify, or small, are not good candidates for inclusion in market-based programs.

The European Union (EU) adopted a market-based approach to reduce climate change emissions from four energy-intensive sectors: (1) energy (electric power, oil refineries, and coke ovens); (2) metal ore, iron and steel production; (3) minerals (cement, lime, glass, and ceramics); and (4) pulp and paper. Initiated in 2005, the EU program is the largest market-based program in the world, involving 25 countries and more than 12,000 installations.

In the U.S., the Acid Rain Trading Program and the Northeast NOx Program/NOx SIP Call Program have successfully implemented a market-based programs to limit air emissions. The ability to trade emission allowances has been credited with lowering significantly the cost of reducing emissions under these programs. Additionally, compliance has been nearly 100 percent, so that emissions have been reduced as scheduled.

The primary weakness associated with implementing a market-based program in California is that it will be vulnerable to emission "leakage." If the state implements the program without other states, there will be an incentive for activities that emit climate change emissions to shift to neighboring states to avoid the emission cap. If this occurs, emissions may decline in the state, only to increase in other states.

A coordinated national approach to capping climate change emissions within an international framework would be the best approach for addressing this leakage problem. In the absence of national action, leakage may be partially mitigated through the design of the program and ongoing efforts to coordinate with other states, such as the Northeast States or other Western states that are taking action to reduce climate change emissions.

As part of the implementation of a market-based program, data should be collected over time to assess the extent to which leakage occurs, and its impacts on businesses and on the effectiveness of the emissions cap.

6.1 Market-Based Program Design Options

Realizing the emissions certainty and the cost advantages of a market-based program leads to two overarching program design principles:

**Broad Coverage is Preferred**

- Broad coverage enables the program to have a direct impact on a large portion of total climate change emissions.
- By covering a broad range of emission sources, the program can capture the least-cost emission reduction opportunities.
- Broad coverage enlarges the set of emissions sources with an incentive to innovate to find ways to reduce emissions.

**Flexibility is Preferred**

66
Compliance flexibility lowers the cost of reducing climate change emissions.

Sources can meet their obligation under the cap using diverse methods.

Sources can bank early emission reductions to reduce compliance costs in subsequent time periods.

The desire for broad coverage and flexibility must be tempered by administrative realities and source-specific considerations. For example, sources with emissions that are difficult to measure or calculate reliably may not be suitable for including under the cap. Similarly, sources that derive from numerous small emission points may be administratively burdensome to include.

There is no one best answer for how to design a market-based program to reduce climate change emissions. Rather, trade-offs are required to create a program that promotes real low-cost emission reductions in a framework that is equitable and administratively feasible.

The market-based program design options are described in terms of:

- **Scope**: The scope of the program defines the sectors, sources, or activities that are included under the cap.
- **Allowance distribution**: Emission allowances can be auctioned or given to regulated sources.
- **Emission offsets**: Offsets are verified emission reductions achieved by facilities. Offsets can replace or augment emissions trading.
- **Other Program Design Elements**: The climate change emissions included; whether to place restrictions on trading, offsets or auctioning of emission allowances; the manner in which allowances can be banked for future use or borrowed against future limits; and the manner in which compliance and enforcement will be performed must be defined.

**Program Scope**

The program scope defines the entities included in the market-based program. The market-based options subgroup examined three representative alternatives for defining the program scope: a sector-based emissions cap; an emissions cap on major stationary source combustion; and a fuels-based carbon cap.

A sector-based emissions cap could cover up to 30 percent of the state’s climate change emissions by focusing on five key industries: electric power; oil refining; oil and gas extraction; landfills; and cement production (see Table 6-1). Reaching this level of coverage requires that the electric power sector be defined to capture all the emissions from electricity consumed in the state.

Approximately 10 percent of state climate change emissions come from in-state generation of electricity, and another 10 percent of emissions comes from out-of-state generation of electricity that is consumed in the state. To include the out-of-state emissions in a market-based program, the electric sector can be defined as Load Serving Entities (LSE) rather than electric generation facilities.
LSEs are responsible for procuring and delivering electric power to customers. In California there are three Investor owned utilities (IOU) that are LSEs: Pacific Gas and Electric; Southern California Edison; and San Diego Gas and Electric. Municipal utilities, irrigation districts, the Department of Water Resources, and private electric service providers are also LSEs.

Under an LSE-based definition, each LSE would be required to hold emission allowances that cover the emissions associated with the power they deliver to their customers. To comply with its emission cap, each LSE would track or calculate the emissions associated with all the electricity it delivered, regardless of whether it was produced in California or out of state.

This LSE approach differs fundamentally from the option of focusing on in-state generators. Under the LSE approach, LSEs hold the emission allowances—not the generators. Each LSE would have the responsibility to obtain power from the set of generators that enables it to comply with its emission cap. LSEs could trade emission allowances: those with extra allowances could sell to those who need additional allowances, given their procurement decisions.

### Table 6-1. Market-Based Scope Defined by Sectors

<table>
<thead>
<tr>
<th>Sector</th>
<th># Entites</th>
<th>Portion of State Climate Change Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Power Sector:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generation Based: In-state generators (≥25 MW)</td>
<td>≈313 facilities</td>
<td>≈10%</td>
</tr>
<tr>
<td>Load Serving Entity Based: All Load Serving Entities</td>
<td>≈47 LSEs</td>
<td>≈20%*</td>
</tr>
<tr>
<td>Other Sectors:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Refining</td>
<td>21 refineries</td>
<td>≈3%</td>
</tr>
<tr>
<td>Oil and Gas Extraction</td>
<td>429 facilities</td>
<td>≈3%</td>
</tr>
<tr>
<td>Landfills</td>
<td>≈300 landfills</td>
<td>≈2%</td>
</tr>
<tr>
<td>Cement Production</td>
<td>11 cement plants</td>
<td>≈1.5%</td>
</tr>
<tr>
<td>Others</td>
<td>(various)</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Mobile Sources:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Gasoline (light duty vehicles, on and off road)</td>
<td>(Not Applicable)</td>
<td>≈28%</td>
</tr>
<tr>
<td>Diesel—on road</td>
<td></td>
<td>≈7%</td>
</tr>
<tr>
<td>Domestic Aviation</td>
<td></td>
<td>≈6%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>≈2%</td>
</tr>
</tbody>
</table>
a. includes emissions from electricity imports.


This LSE-based approach has several advantages.

The LSE-based approach captures a larger portion of climate change emissions than a generator-based definition of the electric power sector.

The LSE-based approach mitigates the emission leakage problem that arises under an in-state generator-based approach. Under the LSE-based option, in-state and out-of-state generation are treated equally, and the cap applies to total emissions associated with all electricity consumed in the state. Therefore, there is no opportunity to avoid the cap and there is no leakage.

The LSE-based approach motivates emission reduction opportunities that are not motivated by a generator-based system. To comply with its emission cap, an LSE could promote energy efficiency among its customers as a means of reducing the load itself. LSEs can also procure renewable-based power or shift to fossil-generated power sources with lower emissions. An LSE by its nature has a broader set of opportunities for achieving its emissions cap, as compared with an individual power plant owner/operator.

To implement the LSE-based option, the power sector must track emissions associated with all (or nearly all) power generation through the market to its eventual delivery. Such a tracking system does not currently exist, and developing it presents significant challenges. There are several workable approaches for solving this problem, and the effort is worthwhile to enable an LSE-based approach to be used.

The other industrial sectors with significant climate change emissions are oil refining, oil and gas extraction, landfills, and cement production. These industries have a manageable number of facilities that could be included in a market-based program (see Table 6-1).

The mobile source sector, the largest individual source of climate change emissions in California (42 percent), is not easily accommodated in a market-based program defined in terms of sectors. Diverse factors affect climate change emissions from mobile sources, including the demand for mobility; the cost, availability, and convenience of travel options, including private vehicles and mass transportation; and the emissions per passenger mile of the transportation mode used, which is driven by the technology employed and the fuel used.

A coordinated set of policies is needed to address the factors that influence mobile source climate change emissions: a sector-based cap is necessarily a partial solution. The main practical sector-based option would be to make vehicle manufacturers the point of regulation.
Based on the emission intensity of each vehicle (emissions per mile) and the expected annual miles driven by each vehicle type, the emissions "embedded" in new vehicle sales could be calculated. The manufacturers could be provided with an emission cap for their total new vehicle sales each year. Manufacturers would comply with their caps by reducing the emission intensity of their vehicles or by shifting the mix of vehicles sold toward those with lower emission intensity.

This vehicle manufacturer cap is similar to recently adopted vehicle climate change emission standards that limit average emissions per mile. The standards do not cap total emissions—emissions can increase or decrease as new vehicle sales increase or decrease. By putting a cap on total emissions, the manufacturer-based emission cap would constrain emissions even if new vehicle sales increase.

While the two regulatory policies do not necessarily conflict, it would be critical to coordinate the two policies if they were to be enacted simultaneously. However, such a cap is probably not needed in the short term, while the emission standards come into force for the first time. Emissions associated with the mobile sector could be monitored over time to assess whether a cap is needed.

An alternative to a sector-based program is an emissions cap on major stationary source combustion in the state. This approach would encompass all major stationary sources of carbon dioxide (CO₂) emissions, without reference to specific sectors as being either in or out of the cap. This scope would not capture mobile source emissions.

Based on preliminary analyses, CO₂ emissions from these sources appear to be concentrated in about 750 facilities statewide. These facilities account for more than 90 percent of CO₂ emissions from stationary fossil fuel combustion, or nearly 20 percent of total state climate change emissions. As discussed above, it may be preferred to define the electric power sector as LSEs to capture emissions associated with imported power and to address the potential for leakage.

The resulting program would be a hybrid approach: the electric sector would be defined to include all LSEs, and all remaining major stationary combustion sources (not including in-state generation) would be included under the stationary source definition.

A third approach to defining the scope of the program is to set a fuels-based carbon cap. This comprehensive fuels approach would reduce climate change emissions by placing a cap on the total carbon content of oil, gas, and coal consumed in the state. The primary advantage of this approach is that it encompasses all sectors that use fossil fuels. Consequently, all options for reducing fossil fuel combustion across all sectors can contribute to achieving the emissions cap.

To achieve climate change emission reductions via this cap, "carbon allowances" would be required to be held by entities at specific points in the distribution or use of fossil fuels in the state. The points at which allowances are required should be
selected to minimize administrative burden and maximize coverage and effectiveness. For fuel markets, these considerations favor an "upstream" approach to regulating the total carbon content of fossil fuel combustion: fuel producers and importers would be required to hold carbon allowances for the fuels they produce in the state or import into the state.29

For liquid fuels, carbon allowances could be required where liquid fuels enter into commerce at refineries, marine terminals, and storage facilities. An alternative is to track the carbon content of the crude oil and natural gas liquid inputs to refineries. This refinery input tracking may be simpler than tracking the carbon content of multiple products. Additionally, it has the advantage of incorporating in the cap the carbon emissions from refinery operations. The carbon content of imported refined products would need to be tracked under either option.

The upstream point for tracking natural gas flows would be at major pipeline transfer points and the natural gas utilities. Coal does not appear to have a convenient upstream point in the market for tracking carbon consumption. Because relatively small amounts of coal are used in the state, it may be easiest to track coal combustion downstream; for example, in major boilers.

The comprehensive fuel carbon cap covers about 75 percent of the state climate change emission inventory, including mobile sources. Limits on fossil fuel supply provide incentives for both: (1) improving the efficiency with which fossil fuels are used; and (2) developing non-fossil energy sources. Comprehensive mobile sector improvements are motivated, including shifting modes of transportation, improving vehicle efficiency, and adopting non-fossil based fuels.

This comprehensive fuel approach has several drawbacks. Non-fuel related emissions are, by definition, excluded from the scope of the program. To cover these emissions, a separate program component would be needed for the specific non-fuel related sources and processes. Alternatively, emission reductions from these sources could motivated by making them eligible to produce and sell emission offsets.

Perhaps most significantly, the comprehensive cap on fossil fuel carbon essentially creates an absolute limit on the availability of fossil fuels in the state. The supply constraint would lead to increases in the prices for fuels, which would be the primary motivation for improving fuel use efficiency and for developing alternative fuels. The size of the price increase will depend on the level of the carbon cap and the cost and availability of alternative fuels. During a transition period, prior to the widespread availability of alternative fuels, price increases could be substantial if the fossil fuel carbon cap is set too low.

The impacts of increased fuel prices would need to be mitigated in order to make this approach viable. If the impacts of increased fuel prices could be managed, California businesses could realize a competitive advantage through access to a more diverse fuel supply that is both less susceptible to price shocks and supply disruptions and more sustainable economically and environmentally. The key to realizing this outcome is to adopt a gradual phase-down of fossil-carbon based
fuels that allows improved efficiency and alternative fuels to constrain the rate of price increases.

One way to prevent unacceptably high fuel price increases is to put a maximum value on the carbon allowances, and to make additional carbon allowances available at that maximum value. This "safety valve" for the market sets an upper bound on the impact of the carbon cap on fuel prices. However, it also effectively removes the cap when the maximum value is reached. Nevertheless, a safety valve of this type may be needed to help ensure that unacceptable price increases are avoided during transition periods.

The implementation of this comprehensive fuel approach would need to address the vulnerability of the electricity sector to leakage: the cap on fossil-carbon based fuels would not cover electricity imports. This electric-sector leakage could be addressed by adopting the LSE-based approach discussed above.

The resulting program would be a hybrid: an emissions cap would be placed on the electric sector, defined to include all LSEs, and a cap on fossil-carbon based fuels would also be in place (any fuels used to produce electricity delivered by the LSEs would not count against the fuel cap). The two caps, one on LSE emissions and one on carbon in fuels, could be traded to allow emissions to flow to their most highly valued uses.

If California is the only state in the western U.S. to implement this comprehensive fuel approach, a "black market" for fuels may develop, particularly for liquid transportation fuels. Although marine terminals, storage facilities, and refineries could be tracked, gasoline is easily transported long distances in tanker trucks. Fuel from neighboring states could be trucked into California without the proper carbon allowances. Policing this activity could be difficult, and if significant fuel volumes move through a black market, the effectiveness of the cap will be eroded.

We can make several observations regarding the three representative approaches for defining the scope of a market-based program for reducing climate change emissions in California:

- The fuel-based carbon cap is the most comprehensive, encompassing the greatest diversity of emission reduction opportunities and motivating action across the broadest set of emission sources (see Figure 6-1).

- The sector-based approach focuses attention on the specific industries that contribute most to state climate change emissions. Stationary sources in the largest sectors cover about 30 percent of the state emission inventory. To significantly increase coverage beyond 30 percent, mobile sources, with about 42 percent of the emission inventory, would need to be included in the cap. However, mobile sources are not conducive to a sector-based approach.

- The stationary source definition of program scope encompasses all major stationary sources of CO₂ emissions from fossil fuel combustion, without reference to specific sectors as being either in or out of the cap.
Approximately 750 facilities could be included in the program to cover the overwhelming majority of emissions from these sources. This scope does not capture mobile source emissions, and consequently is limited to about 15 to 20 percent of the state inventory. An additional 10 percent of emissions can be covered if emissions associated with imported electricity are captured using a hybrid approach that includes a comprehensive definition of the electricity sector.

➢ All three methods for defining the scope of a market-based program are vulnerable to emissions leakage. A coordinated national approach to capping climate change emissions within an international framework would be the best approach for addressing this leakage problem. In the absence of national action, or even regional action, the leakage issues can be partially mitigated.

➢ All three methods appear to be administratively workable. Also, it may be preferred to cap emissions from the electric power sector under all three scope definitions using the LSE-based approach.

➢ All three approaches to defining the program scope could be leveraged into a regional or national climate change emission reduction program. An assessment of the relative likelihood of any of the three approaches being adopted nationally is beyond the scope of this assessment. However, it can be observed that the sector and stationary source approaches are more similar to past national and regional regulatory regional programs than the comprehensive fuel approach.

Figure 6-1: Climate Change Emissions Covered Under Three Definitions for Program Scope

Percent of State GHG Inventory Included in the Scope

![Bar Chart]

Sector-Based Emission Cap for five sectors, not including mobile sources. See text.
Allowance Distribution

A market-based program requires that each facility under the cap hold sufficient emission allowances to cover its emissions. Emission allowances can be auctioned (i.e., sold) or given away. If given away, the allocation algorithm can have a significant impact on the amount of allowances received by each facility. A hybrid approach can also be used, in which some allowances are given away and some are auctioned.

Much has been written regarding the pros and cons of giving allowances away versus auctioning them. When allowances are given to entities covered by the cap, those entities receive something of value: the emission allowances. When the allowances are auctioned, the government collects a portion of the value of the allowances in the amounts paid in the auction. Both approaches can result in essentially the same cost of controlling emissions, and both approaches are expected to have the same impact on consumer prices in most cases.

If an auction is not used, the process for distributing the allowances typically considers facility-specific factors to promote equity among the regulated facilities. Although various factors can be considered, two primary factors are commonly discussed as bases for distributing emission allowances:

Baseline Emissions. Emission allowances can be distributed on the basis of recent emissions as defined in a baseline for each facility. This method has the potential to distribute fewer allowances to those entities that reduced their emissions prior to the baseline period, thereby penalizing them for taking early action.

Baseline Output. Emission allowances can be distributed using an average emission intensity for each industry and baselines of recent facility output. The average emission intensity for an industry would be equal to the total emission cap for the industry divided by the total baseline industry output. Each facility's allocation would be the product of the relevant industry average emission intensity and the individual facility's baseline output. By using this approach, past actions by a facility that reduced its emission intensity are rewarded.

Insofar as emission allowances are distributed on the basis of past emissions or output, new sources would not receive a share of the distribution of allowances. To address this issue, a portion of the emission cap can be set aside for new sources, so that they can be allocated a share of the cap. Alternatively, a share of the cap could be set aside to be auctioned off, so that all sources, new and existing, could bid for additional emission allowances over and above the allowances they receive through a distribution.

Facilities that have relatively high emissions will favor distributing allowances on the basis of recent emissions, because under this approach they will receive more allowances. Facilities that have relatively low emission intensities will favor
distributing allowances on the basis of an industry-average emission intensity. Facilities with growing levels of emissions or output would want to ensure that the method allows flexibility in the selection of the baseline year, so that recent periods of high emissions or output could be considered.

The specification of a distribution algorithm requires balancing divergent interests. One way to satisfy competing interests in this situation is to be overly-generous in the initial allocation of emission allowances. In doing so, all parties can receive a share of the emission cap that meets their current needs. In this case, care must be taken to reduce the cap over time, and to ensure that the extra allowances are not banker indefinitely in a manner that reduces the effectiveness of the emission cap over the long term.

Emission Offsets

Emission offsets are verified emission reductions achieved by entities that are outside the cap. The benefits of emission offsets are:

- Offsets help lower the cost of reducing emissions: facilities covered by the cap can purchase low-cost emission reductions from outside the cap as a means of complying with their emission limit.
- Offsets provide sources outside the cap with a financial incentive to develop low-cost emission reduction projects, thereby broadening the set of emission reduction opportunities that are motivated to be undertaken by the market-based program.

Although the forestry sector is not a strong candidate to include under an emission cap due to the diffuse nature of its emissions (and sinks), stakeholders and others have emphasized that forest management projects in California could be an important source of emission offsets. The funds received from selling the offsets could make forest management projects financially attractive. Of note is that the projects would generate multiple benefits beyond the sequestration of carbon.

To ensure that offsets do not compromise the emission reduction goal of the program, they must be real or additional, quantifiable, surplus to any regulatory requirement, enforceable, and permanent. Also, they cannot be counted toward any other climate change emission reduction targets.

Protocols for verifying offsets will be required for each of a variety of "prototype" emission reduction projects that are deemed eligible for producing emissions offsets under the state's market-based program. Each protocol would address the requirements specific to its prototype project. The California Climate Action Registry's Forest Project Protocol is an example of the type of protocol that would be needed.

A final issue to address regarding offsets is whether the market-based program should rely solely on the market to generate emission offsets, or whether an entity dedicated to producing offsets should be created. A dedicated organization could develop expertise and procedures that enable it to identify and execute emission reduction projects efficiently. The organization could specialize
in projects that are particularly relevant to California and qualify under the California program. Following initial funding for start-up, the organization could have the goal of becoming financially self-sustaining.

The primary benefit of creating an organization dedicated to creating offsets is that it can expand the availability of low-cost emission reductions. Initial experience under the primary international offset program (the Clean Development Mechanism) indicates that offset projects may be slow to materialize. The Climate Trust is an example of an organization that was formed to create emission offsets.

Other Program Design Elements

To define a market-based program fully, the following additional program design elements must be addressed:

*Climate Change Emissions Included:* To capture as many emission reduction opportunities as possible under the cap, all climate change emissions should be included. However, consideration should be given to limiting coverage, particularly during initial implementation, to those gases and sources that can be measured or calculated reliably.

*Trading/Offsets/Auction:* Flexibility is fundamental to a market-based program. However, unlimited trading, offsets, or availability of credits via auction may raise concerns about the potential concentration of emissions in impacted communities. Restrictions could be used to address this issue.

*Emission Banking and Borrowing:* Banking and borrowing are consistent with the use of a market-based program to achieve emission reductions at the lowest possible cost. Banking, in particular, can motivate early action and reduce overall compliance costs.

6.2 Compliance Tracking and Enforcement

Under all formulations of a market-based program, emissions and compliance must be tracked for all the entities covered by the cap, and appropriate action must be taken if entities fail to comply.

Emissions Tracking

Reporting procedures will be required to ensure that facilities produce consistent and reliable emission reports. The California Climate Action Registry has developed and adopted two levels of emission reporting protocols:

A General Reporting Protocol is used by sources that do not have unusual reporting or calculation needs. The GRP can be used by a wide variety of entities.

Industry-specific protocols are used to address data, measurement, calculation, or other issues that are specific to certain industries.

To date the registry has developed protocols specific to the forest sector and the power/utility sector, and work is well along in developing a protocol for the cement production industry. Additional industry-specific protocols will be
required if a multi-sector program is adopted, for oil refining, oil and gas extraction, and landfills. The registry’s methods produce emission reports that are sufficiently precise to be used by the emissions sources likely to be included in a market-based program.

The registry currently requires that emission reports be verified by qualified third-party certifiers, with the cost of certification borne by the reporting entities. With mandatory reporting, we need to assess whether the current process should be continued, or whether a new approach should be used, such as the organization receiving the emission reports being responsible for verifying the emission reports. Both approaches can ensure consistency and maintain quality control of the emission reports. However, centralizing responsibility for verification of the emission reports in the entity that receives the reports may enable efficiencies to be realized.

**Compliance Tracking**

Compliance is tracked by comparing the emission reports to the official record of emission allowances and emission offsets. A system for tracking the ownership of emission allowances and emission offsets is needed, including “expiring” the allowances and offsets when they are used to cover emissions in a compliance period. The compliance tracking needs to be done in a timely manner, so that compliance can be evaluated shortly after the end of the compliance period.

**Enforcement**

Enforcement provides consequences in the event that an entity cannot surrender emission allowances in sufficient quantity to cover its actual emissions. The design and implementation of the enforcement requirements will determine the strength of the incentives that entities have to comply. Additionally, the enforcement scheme can have a significant impact on whether the desired emission reductions are achieved.

Options for the consequences of non-compliance include:

- Require the entity to acquire emission allowances or offsets to make up its shortfall. Including this requirement will ensure that emissions are reduced to the emission cap.
- Require the entity to pay a fee per ton for which they did not have sufficient allowances. Including this requirement provides a financial incentive to comply.
- Require that the entity implement controls to reduce emissions. This requirement would reduce compliance flexibility.

If the sole enforcement method is a fee per ton of excess emissions, this would provide a “safety valve” on compliance costs. The fee would become the upper bound for the price of emission allowances. The risk of this approach is that if the fee were set too low, the emission cap may become ineffective, as entities choose to pay the fee rather than reduce emissions.
To ensure that the emission cap remains effective, the non-complying entity may be required to acquire emission allowances or offsets to make up its shortfall. The risk of maintaining the cap in this way is that the cost of the additional allowances may become very high, particularly during a period of non-compliance by many entities.

Significant volatility in the cost of complying can adversely affect the program, and could lead to the cap being relaxed in response to unsustainably high compliance costs. This situation is not hypothetical: the RECLAIM Program in 2000 displayed these conditions.31

Specifying the enforcement penalties requires balancing these benefits and risks. Analyses can forecast likely compliance costs and allowance prices. Because there is no track record for a climate change emission market-based program in the United States, the forecasts will necessarily be uncertain.

6.3 Conclusions and Next Steps

➢ A market-based program can be integral to California's strategy for reducing climate change emissions. The primary benefits of a market-based program are its ability to establish a firm climate change emission limit and to reduce emissions at the least cost.

➢ A market-based program can be implemented as part of a comprehensive emission reduction effort that includes complementary programs and initiatives.

➢ A national program to cap climate change emissions within an international framework would be the most effective approach. In the absence of national action, or even regional action, California can lead by example by developing a workable market-based program as a model for national action. The added benefit and impact on the state of taking unilateral action must be assessed.

➢ There is no single, best solution for designing an effective market-based program. Trade-offs are required to create a program that promotes real low-cost emission reductions, in a framework that is equitable and administratively feasible. Divergent interests must be balanced in designing the program scope, emission allowance distribution, and other program elements.

➢ A carbon cap on all fossil fuels provides the broadest single opportunity to reduce emissions, covering about 75 percent of state climate change emissions, including both stationary and mobile fossil fuel combustion. As an alternative, an emission cap focused on five industrial sectors would cover about 30 percent of state emissions. Mobile source emissions, accounting for about 42 percent of state emissions, are not easily incorporated into a sector-based emission cap. However, alternative strategies can focus on mobile sources.

➢ New legislative authority is required to implement a market-based program to reduce climate change emissions.
The CAT finds that a market-based program should be considered an integral part of California’s approach to reducing climate change emissions. The next steps in considering a market-based program include the following:

- Facility-level emission reporting is needed, not only to support the detailed design of a market-based program, but to better understand current emissions and options for reducing emissions. Consequently, facility-level emission reporting requirements should be adopted, along with the industry-specific reporting protocols needed to support the reporting.

- Several complete market-based programs should be defined in detail, representing the range of program design options. The program alternatives should be evaluated, including their impacts on climate change emissions; cost of reducing emissions; state competitiveness, business, and jobs; and impacted communities with environmental justice concerns.

- Administrative options for implementing a market-based program should be developed. The budget requirements to support the administration of the program should be assessed.

- The legislative authority required to implement a market-based program should be identified.

7 IMPLEMENTATION OPTIONS

This chapter discusses possible implementation options that can be used to reduce climate change emissions in the state as shown in Table 7-1. Some of these options, such as the programmatic and voluntary options, are already being implemented and will continue forward. Others, such as the public good charge for transportation fuels, cut across options and can be used to ensure success. A market-based approach is regarded as an attractive means of reducing emissions and was discussed in detail in Section 6. This section discusses fee-based options; however, such an approach would require more extensive examination of the environmental and economic consequences.

In general, the CAT supports the use of multiple implementation options designed to support one another and provide the greatest possible emission reductions for the least cost.
### Table 7-1. Implementation Options for Meeting Statewide Climate Change Emission Reduction Targets

<table>
<thead>
<tr>
<th>Implementation Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Programmatic</strong></td>
</tr>
<tr>
<td>Programs implemented by agencies.</td>
</tr>
<tr>
<td>Examples of existing programs include ARB’s motor vehicle regulations, energy efficiency standards, Renewable Portfolio Standard.</td>
</tr>
<tr>
<td><strong>Market-Based Program</strong></td>
</tr>
<tr>
<td>Climate change emission cap established for industrial sectors.</td>
</tr>
<tr>
<td>Flexibility through trading, offsets and or auctioning of emission credits.</td>
</tr>
<tr>
<td><strong>Public Goods Charge for Transportation</strong></td>
</tr>
<tr>
<td>Transportation is by far the largest source of emissions in the state. A public goods charge on transportation could be used to reduce emissions from transportation sources. Specific emphasis would be placed on transportation fuel diversity that would both benefit the environment and stabilize the economy.</td>
</tr>
<tr>
<td><strong>Fee-based Option</strong></td>
</tr>
<tr>
<td>Fees could be assessed based on entity emissions, with an emphasis on largest emission sources; or they could be broadly based on energy sources at point of origin or as close to point of origin as possible.</td>
</tr>
<tr>
<td>Proceeds could be used to provide incentives or otherwise fund emission reduction projects.</td>
</tr>
<tr>
<td><strong>Offset Program</strong></td>
</tr>
<tr>
<td>Allowing for the purchase of offsets can lower cost. However, it is essential to ensure that offsets are real, quantifiable, surplus, enforceable, and permanent.</td>
</tr>
<tr>
<td><strong>Voluntary Emission Reduction Program</strong></td>
</tr>
<tr>
<td>Participants work with the state to establish agreed-upon emission reduction activities in support of the Governor’s statewide targets.</td>
</tr>
<tr>
<td><strong>Mandatory Reporting</strong></td>
</tr>
<tr>
<td>Necessity for all programs, tracking, and accountability.</td>
</tr>
</tbody>
</table>

A more detailed description of each of the implementation options in Table 7-1 is included in the subsections below. Mandatory reporting is included in this table because it is key to all of the options considered. Mandatory reporting is also discussed below.
7.1 Programmatic

The programmatic approach has been the mainstay of the agencies represented on the CAT and is reflected in Section 5. State agencies have long been implementing programs that have provided tremendous environmental and economic benefits to the state, including those based on regulations, education, and incentives. Such programs will continue and would be used in combination with other implementation options discussed in this section.

7.2 Market-Based Program

Market-based program options are discussed in detail in Section 6. Further analysis is needed to determine how best to design a market-based program for the state. However, a well-designed market-based program has the potential to significantly reduce emissions while also providing industry with flexibility and reduced compliance costs.

7.3 Public Goods Charge for Transportation Fuels

Transportation is the largest source of emissions in the state. Accounting for more than 40 percent of the statewide emissions, it dwarfs the next largest sources of emissions—the industrial and electricity sectors—at about 20 percent each. Although both the industrial and electricity sectors are somewhat diversified as to energy source, the same cannot be said of the transportation sector. Petroleum accounts for 99 percent of the fuel used in the transportation sector. The state's dependence on petroleum has been shown to be harmful to public health and the environment.

In further contrast, a relatively small public goods charge is applied to all other energy sources in the state. The public goods charge on electricity has contributed to the fact that Californians use 30 percent less electricity per capita than the average U.S. citizen. Californians benefit from building and appliance energy efficiency programs funded with the public goods charges on electricity and natural gas that provide a net saving of more than $1,000 per household annually.

Demand for petroleum in California and around the world has skyrocketed. Petroleum is a limited resource and much of the supply is located in politically volatile parts of the world. Even so, the demand for petroleum products continues to increase, despite the fact that increases in price have reached new peaks that are being sustained for longer periods of time.

The economic consequences of the state's dependence on petroleum can be measured in personal goods and services, and macro-economic terms. Consumers have less disposable income and those with little or no disposable income suffer disproportionately.

The costs of almost all goods and services increase when the cost of petroleum increases and many businesses cannot pass these costs on to consumers. This results in lower profits. In general, small businesses are at greatest risk. Finally, the price of crude oil is the single largest cost in the
production of transportation fuels, accounting for between 42 to 56 percent of the retail price of gasoline. California’s demand for crude oil, like the U.S., is increasingly being met by international suppliers. Over the past two years, the price of crude oil has nearly doubled, which has resulted in an increasing percentage of California’s consumer wealth being exported outside the state’s economy.

The environmental consequences of petroleum are significant. As indicated above, climate change emissions from the transportation sector are large and growing. Using less petroleum also reduces smog-forming and toxic pollutants that occur at each point in the distribution system. Many alternative-fuel vehicles produce fewer emissions than their gasoline and diesel counterparts while also contributing to the need for fuel diversity in the transportation sector.

The Energy Commission in its 2005 Integrated Energy Policy Report, which is the state’s energy plan submitted to the Governor, has identified and recommended the concept of a public goods charge to finance programs that reduce petroleum demand and emissions for the transportation sector. A public goods charge on gasoline and diesel, if constructed appropriately, could be a very effective, fair, and efficient means to reduce climate change emissions from the transportation sector and mitigate these damaging consequences to our environment and our economy. Crucial questions about how the funds are administered and expended need to be addressed before a public goods charge for transportation fuels could be proposed.

7.4 Fee-Based Option

Fee-based options exist and merit further evaluation but have not been fully explored at this point. The primary attractiveness of such programs is that they can be centrally managed and can be targeted towards the largest sources or broadly targeted at energy sources at point of origin or as close to point of origin as possible. Proceeds could be used to provide incentives or otherwise fund emission reduction projects.

At this time the CAT would not recommend this option as it cannot guarantee emission reductions. The extensive consultation with industry and other stakeholders necessary also has not been completed.

7.5 Offset Program

Allowing for the purchase of offsets can lower cost. However, it is essential to ensure that offsets are real, quantifiable, surplus, enforceable, and permanent. A preliminary investigation into offset programs indicates that there are successful examples of such programs.

In Oregon and Washington, the Climate Trust program generates offsets for purchase by industry that take into consideration climate change emission reductions as well as reductions in other pollutants. The focus is to ensure high-quality, cost-effective offsets that provide a permanent and viable nexus between
those responsible for climate change emissions and the currently available solutions to reduce and eliminate those emissions over time.

A program similar to the Climate Trust program could be considered for California. Such a program could be designed to address the critical need to reduce pollution in low-income and minority communities and other priority issues in our state. Further analysis and review is needed for this implementation option, so the CAT has no specific recommendation regarding offsets at this juncture.

7.6 Voluntary Actions

There are many proactive industries that are taking actions to reduce climate change emissions. The Sustainable Silicon Valley group is made up of a number of large companies including Calpine, Hewlett-Packard Company, and Pacific Gas and Electric, who have pledged to voluntarily reduce their emissions to 20 percent below 1990 levels by 2010. The California Climate Action Registry allows companies to register their climate change emissions and assists these companies in tracking and reducing these emissions. British Petroleum, Eastman Kodak, Pacific Forest Trust and U.S. Borax are among the more than 50 companies that are currently members of the registry.

Such voluntary actions are instrumental in the effort to meet statewide targets. The CAT encourages such efforts as evidence that many in the business community as well as with local governments clearly believe action must be taken to reduce climate change emissions.

One of the overarching recommendations, which has been championed by industry and environmental groups alike, is recognition of early actions in any and all emission reduction programs implemented. Recognition of early action is also important as California joins its western state partners and the North East States in cooperative efforts to reduce emissions. State partnerships are expected to lead to national and international cooperative efforts.

7.7 Mandatory Emission Reporting

One of the overarching recommendations included in this report is the need for some level of mandatory reporting that builds upon the California Climate Action Registry. We simply don't have the basic information needed to track and account for emission reductions. The Energy Commission maintains a planning inventory that provides an overall picture of where emissions are coming from in the state. However, this inventory cannot be used for the purposes of determining baseline emissions from a source or for tracking emission reductions from a source.

The California Climate Action Registry does have emissions data that can be used for tracking emissions from a source and for accounting purposes. However, the Registry is voluntary, and many of the largest emitters in the state have not yet joined. There is no way to determine whether or when emission sources will join under the current provisions of law.
A preliminary estimate of the largest sources for which emissions data is needed in the state indicates that it would be prudent to begin with data collection from the electric power sector, oil refining and oil and gas extraction sector, landfills, and cement production. To the extent that industries have joined the registry voluntarily, the CAT believes this fulfills any reporting requirement for climate change emissions data.

As this state moves towards mandatory reporting of climate change emissions, the question as to where that data should be stored and managed arises. The CAT does not believe that such a program can be managed under a non-government organization such as the current Registry. However, some of the current duties and functions of the Registry could be placed within government for the purposes of mandatory data collection. The registry represents an excellent starting point for the process of mandatory reporting.

The role of Air Quality Management Districts, Local Enforcement Agencies, and other entities with within the state that have permit and enforcement authority will need to be determined. These entities already collect much of the data that would be needed under a mandatory reporting program and have existing enforcement and permit authority. This should be considered as a mandatory reporting program is developed.

8 ECONOMIC ASSESSMENT

This section discusses the results from a preliminary assessment of the macroeconomic impacts associated with the climate change emission reduction strategies presented in this report. The results show that the overall impacts of the climate change emission reduction strategies are expected to be positive. Specifically, when the strategies already underway as well as new strategies being proposed are considered in total, the resulting impacts on the economy are expected to translate into job and income gains for Californians.

In summary, the net impact of the strategies on jobs in year 2020, when the strategies are expected to be fully implemented, is expected to be a gain of 83,000 above what the California economy would gain without the climate change emission reduction strategies. The implementation of the strategies is also likely to add an additional income of about $4 billion to Californians in 2020, again, above what the economy is expected to produce without the strategies.

These favorable impacts on the economy are possible because of the reduced operating costs associated with many of the strategies. The additional job growth is expected to come from a net savings to consumers associated with the implementation of the strategies. The savings will in turn promote further business expansion and job creation.

The results presented in this section are considered preliminary because the cost and potential savings information associated with most of the individual strategies have not yet been fully developed. Therefore, when available, other sources have been drawn on to provide an initial assessment of the costs and
savings. Although this analysis needs refinement, we expect that the fundamental conclusion—that the suite of strategies discussed in this report has a net positive impact on California's economy—will stand.

The subsequent refined analysis will incorporate updated cost and savings estimates for the strategies. It will also assess the cost effectiveness of the various individual strategies. Thus, the refined economic analysis will provide additional information to decision-makers as they proceed with implementation of the strategies.

The remainder of this section discusses the model of the California economy used for the assessment, the analysis of the strategies in Section 5, a discussion, as well as a summary.

8.1 Economic Model

This economic assessment uses a computable general equilibrium (CGE) model of the California economy called E-DRAM, developed by the University of California, Berkeley. It has been used by the Department of Finance for the revenue impacts of tax and other State policies, by the California Energy Commission and ARB to assess impacts of reducing petroleum dependency (AB2076)\(^5\), and by ARB for the Vehicle Climate Change Standards\(^6\), the State Implementation Plan\(^7\) analysis, and others. As a part of the application of the model to these analyses, it has been peer reviewed and calibrated to be representative of the California economy.


\(^7\) ARB 2003, 2003 State and Federal Strategy for the California State Implementation Plan. At http://www.arb.ca.gov/planning/slip/stfed03/stfed03.htm
A CGE model simulates the functioning of a market economy in which different sectors interact with one another (one sector supplies inputs to another, or purchases the outputs of another) and where prices and production adjust in response to changes caused by government policies applied to specific sectors. The CGE simulates these relationships among California producers, California consumers, government, and the rest of the world. Because of the interconnection between sectors, an intervention in one sector has impacts on others, which are captured by the CGE model analysis.

The inner workings of the CGE model can be graphically illustrated. Figure 8-1 shows a simplified version of the sectors that interact and participate in goods, services, and labor flows that make up the economy. The diagram shows that the households sell factors of production (labor and capital) to the firms which use the factors to produce goods and services to sell to the households. It also shows the flow of payments that accompany the transactions between the firms and the households. The diagram includes the flow of transactions between the firms; this is, how the firms buy and sell intermediate goods amongst themselves to produce the final products sold to the households.

**Figure 8-1 Circular Flow of Goods and Services in the Economy**

![Circular Flow of Goods and Services in the Economy](image)

Figure 8-2 shows the complexity of the complete California economy and the many sectors involved in producing goods and services for final consumption by the households inside and outside of California.
The E-DRAM model accounts for all of the flows in the California economy using many equations. When a regulation or a policy is adopted that could affect costs of production in one part or sector of the economy, the rest of the economy has to adjust to the perturbation through price or employment changes. The CGE tracks the changes and produces results that show how much each sector has changed. The main economic indicators are number of jobs and income. It is believed that these two key indicators are particularly informative for characterizing the impact of potential policies on California’s economy. Jobs are an important indicator for decision-making, and income closely follows the gross state product, which is an indicator of overall economic well-being in the State. This economic assessment presents the changes in these two indicators as the net economic impacts of the strategies.

### 8.2 Analysis of Climate Change Emission Reduction Strategies

The strategies evaluated in this analysis are taken from Section 5. The objective of the analysis is to draw on available cost and savings data to provide an overall assessment of the impact of the strategies on California’s economy.

The E-DRAM model of the California economy was run with the strategy costs and savings as inputs into the model to assess the economic impacts for years 2010 and 2020. Two major economic indicators were selected to
demonstrate economic well-being. Job creation indicates a healthy economy providing opportunities to Californians. Income is an indicator of the output of goods and services and therefore gauges progress in economic activity. The impacts are shown as the difference between the predicted economic indicators with and without implementation of the strategies.

Table 8-1 shows the impacts of the strategies on income and employment in 2010. Many of the strategies have both costs and savings. Generally, the costs are incurred for technology and/or changes in behavior that reduces emissions, and savings are accrued from reduced operating costs. The costs of the strategies for the year 2010 are estimated at $1.3 billion, and the savings at $2.9 billion for a net savings of $1.6 billion. The net savings stimulate additional economic activity and generate about $2 billion of additional income (about a 0.13% increase in total income) and 19,000 new jobs (about 0.11% of the 2010 total employment). For context, Table 8-1 and Table 8-2 also show the growth expected for the economy between 2004 and 2010 or 2020 irrespective of the strategies discussed in this report.

Table 8-1. Impacts of Achieving the Climate Change Emission Reduction Targets on California Economy in 2010*

<table>
<thead>
<tr>
<th>Economic Indicator</th>
<th>In 2004</th>
<th>Without the Strategies**</th>
<th>With the Strategies</th>
<th>Impacts</th>
<th>Percentage of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income (Billions of 2005$)</td>
<td>1,317</td>
<td>1,527</td>
<td>1,529</td>
<td>2</td>
<td>0.13%</td>
</tr>
<tr>
<td>Employment (thousands)</td>
<td>16,460</td>
<td>17,969</td>
<td>17,988</td>
<td>19</td>
<td>0.11%</td>
</tr>
</tbody>
</table>

* We display several digits to make it clear how we calculated the difference associated with the strategies.

** This column indicates the income and employment forecast for 2010 without the implementation of the strategies presented in this report. Note that between 2004 and 2010, the economy is expected to realize substantial growth (e.g., income increases by about $200 billion while the number of jobs increase by about 1.5 million).

By 2020, additional savings from the strategies stimulates the economy further. The strategy costs are on the order of $7.9 billion, with a savings of $16.9 billion for a net savings of $9.0 billion. Table 8-2 shows the impacts of the strategies in 2020. The results also reflect the fact that the strategies that would be in effect by 2020 have a different mix of costs and savings than those in 2010.

The impact on income is about $4 billion, about a 0.19% increase, and the impact on jobs is creation of 83,000 new jobs, about a 0.40% increase, in the year 2020 for the California economy.
Table 8-2. Impacts of Achieving the Climate Change Emission Reduction Targets on California Economy in 2020*

<table>
<thead>
<tr>
<th>Economic Indicator</th>
<th>In 2004</th>
<th>Without the Strategies**</th>
<th>With the Strategies</th>
<th>Impacts</th>
<th>Percentage of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income (Billions of 2006$)</td>
<td>1,317</td>
<td>2,128</td>
<td>2,132</td>
<td>4</td>
<td>0.19%</td>
</tr>
<tr>
<td>Employment (thousands)</td>
<td>16,460</td>
<td>20,704</td>
<td>20,787</td>
<td>83</td>
<td>0.40%</td>
</tr>
</tbody>
</table>

* We display several digits to make it clear how we calculated the difference associated with the strategies.

** This column indicates the income and employment forecast for 2020 without the implementation of the strategies presented in this report. Note that between 2004 and 2020, the economy is expected to realize substantial growth (e.g., income increases by about $800 billion while the number of jobs increase by about 4.3 million).

Although these of the economic impacts seem small when considered as a percentage of the total economy, the positive direction of the impacts indicate that the California economy is highly unlikely to suffer negative impacts from achieving the climate change emission reduction targets as directed by the Governor’s Executive Order. Rather, implementation of the suite of strategies indicates a positive net impact on the economy. Refinement of the strategy cost and saving estimates, which is planned for the near future, will provide further details regarding the impacts of strategy implementation on the California economy.

With the exception of the Green Building Initiative and the strategies in Section 5 for which reductions are not reported, the economic impacts shown in Table 8-1 and Table 8-2 reflect the combined effect of all of the strategies (those underway and those proposed). The strategies not included in this analysis will be included in the subsequent refined analysis along with updated costs and savings information for the strategies analyzed thus far. However, the inclusion of these additional strategies is not expected to change the fundamental conclusions presented in this analysis because the additional strategies are, in total, expected to result in a net savings.

Discussion of the Economic Assessment of the Strategies Already Underway in California: One key observation on the strategies already underway is that almost all of them result in increased energy efficiency, which historically been shown to be highly cost effective. It is thus expected that the net effect of strategies underway, by themselves, will be to benefit the economy by providing additional jobs and income. As previously indicated, a subsequent economic
analysis will draw on refined cost and savings information for these strategies to support a more robust macroeconomic assessment of the individual strategies as well as their combined impact. Discussions of the strategies already underway are presented below. The cost and savings estimates are preliminary and are already being evaluated for refinement.

The Vehicle Climate Change Standards strategy was developed to support a regulation approved by the Air Resources Board in 2004. The staff report including the economic analysis is fully documented and was the subject of several public workshops. For example, the ARB economic analysis of the strategy concluded that by 2020, jobs increase by 53,000. The benefits result from operating cost savings by consumers which in turn are spent on other goods and services, generating additional jobs and income beyond what the economy normally would produce. Further, the Diesel Anti-idling strategy is expected to save several hundred million over its implementation by reducing diesel fuel consumption⁸. Because of the savings, its impact on the economy is expected to be positive.

In general, energy efficiency programs positively impact the economy. Most of the strategies already underway concern efficiency improvements. Although the State agencies developing these strategies may not have completed a refined assessment of the associated costs and savings, analyses of similar strategies by universities and institutes have shown net benefits for these strategies, and thus, positive impacts on the economy. Such strategies include Investor Owned Utility Energy Efficiency Programs, Building and Appliance Energy Efficiency Programs, Achieve 50% Statewide Recycling Goal, and Fuel-Efficient Replacement Tire and Inflation Programs. In total, these programs will almost certainly benefit the economy by producing additional jobs and income for California.

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The Green Building Initiative is expected to produce net benefits and therefore positively impact the economy. Based on historical experience, every dollar spent on energy efficiency typically provides about $2 in benefits. As indicated, the Green Building Initiative will be folded into the subsequent refined analysis.

The California Public Utilities Commission (CPUC) is currently reviewing a statewide solar incentive program proposal. If adopted by the CPUC in January 2006, the proposed California Solar Initiative (CSI) will provide close to $2.9 billion in incentives between 2007 and 2017. The program is anticipated to bring on line or displace 3,000 MW of power. As costs and savings estimates are further developed they will be included in a refined economic impact analysis of the climate change emission reduction strategies.

In addition to the Solar Initiative, the CPUC commissioned a report entitled "Achieving a 33% Renewable Energy Target" to identify feasibility and next steps to accelerate and expand the current CPUC Renewable Portfolio Standard program. The report determines that after the initial infrastructure costs are borne, the resulting benefits to ratepayers in 2021 and beyond are net positive. Using the CEC's long-term forecast of natural gas prices, the report finds that ratepayers would likely realize a net benefit over a 20 year period.

Discussion of Economic Impacts of the Strategies Needed to Meet California's Targets: All of the strategies presented in Section 5 where estimated climate change emission reductions are available were included in the analysis that generated the results shown in Table 8-1 and Table 8-2. Several sources were drawn on to identify preliminary cost information including analyses done by UC Berkeley, and the Tellus Institute. Many of the strategies have implementation costs. However, several strategies also have savings that may cover or exceed the costs.

8.3 Discussion

The economic impacts presented in this analysis are from the combined strategies listed in the tables in Section 5 for which preliminary cost information is available. Some of the strategies in Section 5 have net costs while others have net savings typically due to decreased operating costs. Those with net costs would be expected to adversely affect job growth if considered in isolation. However, those with savings will increase job growth and income. For example, the Air Resources Board's Heavy Duty Vehicle Emission Reduction Strategy would be expected to lower the operating costs of transporting goods.

Lower costs of producing a certain amount of goods or services lead to more economic activity and create more jobs and income as people spend savings from the lower costs.

The refined analysis would be expected to provide additional information to facilitate a focused consideration of each strategy with respect to several factors including cost effectiveness. Further, the refined analyses can include additional strategies that may be identified by stakeholders. Specifically,
stakeholders may identify additional cost-effective strategies that have the potential to provide additional emission reductions. However, as with the analysis presented here, a key product of the subsequent refined analysis will include the macroeconomic impacts of the suite of strategies rather than each strategy.

Subsequent analysis of the strategies may also be affected by overall program implementation methods that have the potential to promote further cost reductions or savings. For example, cap-and-trade policies can unleash internal innovative powers of the private sector to adopt and invest in processes and methods that lower energy use and increase efficiency. Like energy efficiency standards that have been shown to create jobs, the innovative efforts induced by cap-and-trade or other similar tools would likely further enhance the cost effectiveness of reaching the climate change emission reduction targets.

Many of the strategies that end up with net costs may have benefits that are not directly estimated or may not be the focus of the climate change emission reduction efforts. For example, the afforestation strategy has a net cost. However, planting forests may provide indirect benefits to the public or other sectors of the economy that are not captured in this analysis. Specifically, strategies currently believed to result in a net cost may actually provide a savings when both direct and indirect benefits are considered.

Further, the benefits of strategies that already indicate a net savings may not be fully recognized in a conventional economic analysis. For example, several of the energy efficiency strategies may also facilitate increased security through further energy independence. Such indirect benefits should at least be qualitatively identified and considered when evaluating the strategies.

Finally, it may not be appropriate to assign all of the costs of the strategies currently underway to the climate change emission reduction efforts given that there are typically other considerations that contributed to the policy. Specifically, many of the strategies that are underway are being pursued to achieve other objectives (e.g., the Diesel Anti-Idling Strategy from Section 5 focused on reducing the population’s exposure and risk associated with diesel particulate emissions as well as reducing smog precursors) with the associated climate change emission reductions being an added benefit. Many of the proposed strategies in Section 5 have the potential to address other programmatic objectives beyond climate change.

8.4 Summary

Based on this preliminary analysis, it appears that the climate change emission reduction targets can be met without adversely affecting the California economy. It is possible to adopt a suite of strategies in a manner that continuously benefits the economy. The strategies that focus on increased energy efficiency and produce net savings can greatly contribute to economic activity while reducing climate change emissions. Further, technology
improvements and innovative implementation of strategies currently estimated to have net positive costs may, in the long-run, result in net savings.

As refined cost information is developed for the strategies, a subsequent analysis of the economic impacts will be performed. In addition to characterizing the overall impacts of the strategies on California's economy, the subsequent analysis will allow individual strategies to be evaluated. The analysis may also facilitate the identification and inclusion of new cost-effective strategies that are not currently presented in Section 5. The analysis will also further inform decision-makers on the approach to strategy implementation that maximizes both environmental benefits and the benefits to the economy.

8.5 Implementation Options Assessment

With the exception of the programmatic option, the implementation options shown in Table 7-1 have not yet been evaluated in terms of their economic impacts.

In the case of the market-based implementation option, an economic analysis will be needed once the state determines the design of such a program. By its nature the market-based option is designed to reduce the costs associated with achieving emission reductions relative to a command and control approach. Therefore, the primary concern with implementation of this option is typically not the economic impacts but rather the assurance of real emission reductions and the implications for low-income and minority communities.

In the case of the public goods charge for transportation, such a charge would be designed to provide economic security, risk reduction and cost savings to the paying public. In the case of the public goods charge on electricity, California consumers save approximately $1,000 per year as a direct result of conservation efforts.

The public goods charge for transportation would be designed to provide economic benefits as well. Given the current volatility in the price of petroleum, risk reduction for a diversified transportation fuels market and reduced dependence on petroleum will provide a significant benefit to both consumers and to the economy as a whole.

The CAT is not recommending the fee-based and offset program options at this time. Both would require an economic evaluation prior to implementation.

9 IMPACTS ON LOW INCOME AND MINORITY COMMUNITIES

Low-income and minority communities are disproportionately affected by pollution and other adverse environmental damages. Disproportionate access to health care and/or lack or resources have contributed to a situation in which residents of low-income and minority communities are more likely to be exposed to toxics and other pollutants and are less likely to have the resources to adequately respond. The environmental justice (EJ) movement was created as part of the larger social justice movement with the intent to ensure that residents
of low-income and minority communities were equally protected from exposure to toxic and other pollutants.

Environmental justice is an issue that has been embraced as a priority for the Governor and the Legislature. As this state moves forward in reducing climate change emissions, evaluating the impacts of climate change, and considering adaptation strategies, EJ concerns must be addressed.

9.1 Environmental Justice Programs

The Governor's Office of Planning and Research (OPR) is the coordinating agency for environmental justice programs for the state. In 2003, OPR incorporated environmental justice elements within the General Plan Guidelines. This effort marked a beginning to a number of other State agencies, such as California Department of Transportation and the California Resources Agency, in adopting environmental justice policies.

Cal/EPA is the model agency (1999 Statutes) for implementing EJ into its programs, policies, and activities. In 2004, under the Schwarzenegger administration, Cal/EPA established its Intra-agency EJ Strategy, model EJ mission statement, and EJ Action Plan to ensure fair treatment and equity for all Californians regardless of race, age, culture, income, or geographic location.

The EJ Strategy is a long-term planning process and marks an important step toward addressing disproportionate environmental impacts on low-income and minority populations. To compliment the EJ Strategy, Cal/EPA also initiated the EJ Action Plan, a three-year action-oriented process, to explore complex issues such as cumulative impacts and precautionary approaches within six pilot projects throughout various regions in California.

The goal of the action plan is to develop environmental risk reduction plans for children's health, develop guidance for precautionary approaches and cumulative impacts, and improve public participation in the decision-making process. Cal/EPA reports to the Legislature every three years on the status of the EJ Strategy and Action Plan.

9.2 Outreach to Minority and Low Income Communities

In order to solicit comment and promote dialogue with representatives from low-income and minority communities, the Climate Action Team made it a priority to attend local environmental justice community meetings. At these meetings, CAT representatives provided general background information on climate change and updated the groups on climate change activities and potential issues that might arise. Below is a list of meetings attended:

<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 30, 2005</td>
<td>California Environmental Rights (Los Angeles)</td>
</tr>
<tr>
<td>October 5, 2005</td>
<td>North Richmond Air Quality Committee (Richmond)</td>
</tr>
</tbody>
</table>
9.3 Strategy Evaluation

As the efforts of the CAT agencies to implement strategies outlined in section 5 move forward, outreach to communities must continue. Each of the agencies on the CAT has committed to support this priority.

Implementation of climate change emission reduction strategies will most likely benefit communities. In many cases, such as electrification of ports, efforts to reduce climate change emissions will provide a direct benefit. In these instances, the support of the communities is essential, and the support of the larger EJ movement will be an asset. If implementation of a strategy would require concomitant measures to ensure against harmful consequences to communities, State agencies must work with communities. In all cases, an open public process that is accessible to community representatives will ensure that EJ concerns are addressed and the statewide targets are met equitably.

9.4 Scenario Analysis

When considering the impacts of climate change on California and adaptation measures necessary, the State must also consider impacts specific to communities and the degree to which low-income and minority residents are affected.

The impacts of global warming will have economic and social consequences for low-income and minority communities. The adaptive capacity of people in these communities is lower than for average Californians.

Specific examples of situations in which low-income and minority communities are likely to be more adversely affected include:

Increasing costs for food, water, and energy will disproportionately affect the low-income communities.

Increasing use of pesticides will have an economic and public health impact on the farm workers.

An increase in the number of days Californians are exposed to ozone will disproportionately affect the people who do not have insurance or access to health care resources.

9.5 Market-Based Options

Low-income and minority communities are particularly wary of market-based because of the general belief that emissions trading allows for increased emissions at a local level and those increases are believed more likely to occur in the communities. The principal concern is not with the climate change emissions themselves because, in most instances, these emissions do not directly cause
local air quality problems. Rather, the concern is with the emissions of other pollutants (CO, NOx, SOx, PM, toxics) which may be affected by efforts to reduce climate change emissions. Two types of impacts may be of particular concern:

- Options that reduce climate change emissions could increase emissions of pollutants that cause local air pollution. For example, shifting from a fossil fuel to a biomass fuel could increase emissions of smog-forming pollutants unless appropriate emission control technologies are installed as part of the switch.

- Efforts to reduce climate change emissions may result in facilities with lower climate change emissions per unit of output being operated more than would otherwise be the case. Under these conditions, emissions of local air pollutants may increase near the facility that increases its operations.

In both of these cases, a local community could be impacted by increased emissions, even though climate change emissions decline overall. Because a market-based program provides substantial flexibility for facilities to select their preferred methods for achieving the climate change emission cap, the design of the program does not automatically mitigate this concern. Rather, steps must be taken to address this issue through additional measures.

### 9.6 Implementation Options

For all of the implementation options shown in Table 7-1 it will be essential to involve community representatives as these options are developed. As indicated in Sections 9.5 and 9.6, both the programmatic and market-based program options will need to involve community representatives.

In the case of the Public Goods Charge for Transportation, the State must work with communities to ensure that costs are not unduly burdensome and benefits are equitable.

Although the CAT is not recommending Fee-Based and Offset Program options at this time, both would require an open public process that ensured participation from communities prior to implementation.

### 10 SUMMARY AND CLIMATE ACTION TEAM RECOMMENDATIONS

This report lays out a path forward to ensure that California's climate change emission reduction targets are met. Following the signing of Executive Order S-3-05, the Secretary of Cal/EPA created a Climate Action Team. The CAT has accomplished three main objectives: completion of a list of recommended strategies to reduce climate change emissions in the state; completion of a significant first step in what will be an ongoing scenario analysis that provides insight into the impacts of climate change on the state and presents adaptation plans; and evaluation of options for a market-based program in the state including next steps recommendations.

The CAT produced two categories of overarching recommendations. First and foremost, the overarching recommendations considered essential by the CAT in
meeting the statewide climate change emission reduction targets. The general recommendations listed in Section 10.2 are second tier recommendations that consist primarily of recommended next steps and indications of where further analysis is needed.

10.1 Climate Action Team Overarching Recommendations

This final report has been revised from the December 2005 draft to reflect the comments, recommendations and suggestions that have been submitted. The final report proposes a path to achieve the Governor's targets that will build on voluntary actions of California businesses, local government and community actions, and state incentive and regulatory programs. The Governor's climate change emission reduction targets are achievable with economic benefit for California.

The climate strategies set forth in this report are in various stages of development. Some of the strategies, such as the California Solar Initiative, are being implemented this year. Other strategies, such as those related to biofuels, may require stationary modification this year for implementation to proceed. Still others, such as Smart Land Use and Intelligent Transportation and Semiconductor Industry Targets, are sound but require further analysis and development and should be allowed to evolve over the next two years. The Climate Action Team preliminary economic assessment, which is based on the Environmental Dynamic Revenue Model, indicates that, by 2020, implementation of these strategies will result in 83,000 new jobs and an increase in personal income of $4 billion.

The Climate Action Team process for developing this report has been successful and the Team should be charged with the next phase of activity. Since the signing of the Executive Order, under the leadership of Cal/EPA, the Climate Action Team has provided a forum for coordinating State agency actions, program development, and budget proposals in addition to this report. It allows for collaboration, reduced internal competition and conflict, and provides a single point of contact.

The Climate Action Team recognizes that reducing climate change emissions is challenging and will need to be addressed in a deliberative on-going manner. The Team also recognizes that many of the reductions will come from technological innovations that are not yet fully developed. We have identified key recommendations that will help ensure the Governor's targets are met:

- A multi-sector market-based system uses economic incentives to lower costs, protect economic growth and promote innovation. The Climate Action Team should proceed with the development of a multi-sector market-based program which considers trading, emissions credit auction and offsets. The Climate Action Team should develop a multi-sector market-based program and make a recommendation to the Governor on
the structure for such a program no later than January 1, 2008. The Governor’s 2020 climate change emission reduction target to reach 1990 emission levels should be the basis for an emissions cap in the development of program. The Climate Action Team should consider working with other western states to develop a multi-state program to minimize emissions leakage.

- Mandatory emissions reporting from the largest sources oil and gas extraction, oil refining, electric power, cement manufacturing and solid waste landfills, that builds on the California Climate Action Registry is essential. Mandatory reporting will ensure an accurate inventory of emissions which is critical to ensure that decision-making is based on real emissions and emission reductions. Equally essential are provisions for early action credit and a mechanism to ensure that companies are not penalized for early action. Early action will be attributed to California businesses that have voluntarily joined the California Climate Action Registry and have reduced emissions. Although the voluntary Climate Action Registry is a foundation, the Climate Action Team believes mandatory reporting must occur through a state government agency.

- A multi-generational public education campaign should be implemented to ensure that the public is informed about the issue of climate change and what they can do to reduce emissions and adapt to adverse consequences. Such a program can build upon successful campaigns in place, such a Flex Your Power. The Education and the Environment Initiative mandates the development of a unified strategy to bring education about the environment into California’s K-12 schools through California’s Environmental Principles & Concepts and a standards-aligned, State Board of Education-approved model curriculum. It is essential that California’s children understand the impacts and consequences of climate change on the State’s resources as well as mitigation and adaptation strategies.

- The macroeconomic analysis should be updated to reflect refined data collected over the next year. A cost-effectiveness analysis of all the strategies recommended in this report should be developed. Both should be completed by July 2007 and should incorporate a peer review process.

- Transportation is the largest source of climate change emissions in California. The Air Resources Board’s vehicle climate change standards address a significant portion of the transportation sector. However, an aggressive alternative fuels program will significantly reduce climate change emissions. The California Energy Commission working with Cal/EPA and its boards and departments, and the Department of Food and Agriculture is currently developing an aggressive biofuels program that will be available this Spring. This biofuels program should be
considered an essential component of the effort to reduce California's carbon footprint.

- The Governor's climate change emission reduction targets are based in part on the planning assumptions in the California Energy Commission's Integrated Energy Policy Report. Specifically the Integrated Energy Policy Report recommends that all long-term new electricity generated for use in the state must come from sources with climate change emissions equivalent to or less than a new combined cycle natural gas power plant. The Public Utilities Commission's recently adopted proposal for an electricity sector carbon policy is generally consistent with the Integrated Energy Policy Report and will set forth a regulatory scheme for enforcing such a policy applicable to investor-owned utilities. The Climate Action Team recommends the policy, including an accountability mechanism, in the Integrated Energy Policy Report be extended to apply to all load-serving entities in the State, including municipal utilities, electric service providers and community choice aggregators. The Public Utilities Commission will work with the Climate Action Team so that this effort is consistent with the development of a multi-sector market-based program.

- All utilities should meet the energy efficiency goals and the Renewable Portfolio Standard required of investor-owned utilities. The State has adopted energy efficiency goals and a Renewable Portfolio Standard for investor-owned utilities. Publicly-owned utilities should match this level of performance and account for their achievements in a manner consistent with that of investor-owned utilities. Because publicly-owned utilities provide 25% to 30% of the electricity used in California, these entities are essential to the state's overall goal to reduce electricity demand and increase the State's use of renewable resources. The Energy Commission should work with the publicly-owned utilities to develop an accurate accounting system that captures climate emission reduction efforts by publicly-owned utilities so that their performance can be evaluated comparatively to investor owned utilities.

- The California Climate Action Registry, in cooperation with the Energy Commission, should develop emission reporting protocols for local government. Local governments are already contributing to the effort to reduce climate change emissions and an accurate tracking system of their contributions is essential.

➤ Over time funding will be needed to implement the strategies set forth in this plan and to provide incentives for industry to develop emission reduction technologies for use in California and abroad. A coordinated investment strategy can leverage the talent of California's universities, community colleges, and other entities and to lead technology development and train the next generation of technicians that will be
needed to operate and service those technologies. A public goods charge for transportation that funds key strategies to reduce climate change emissions and to reduce dependence on petroleum should be considered. Overdependence on petroleum fosters undesirable geopolitical, economic, energy, and environmental consequences. Other possible funding could come from the PIER program at the Energy Commission, targeted dedication of other state funds, or philanthropic and corporate investment. The electricity sector and natural gas Public Goods charges should continue at projected levels. Any new funding concepts require additional study until the preliminary recommendations noted above can be more fully developed. Accordingly, the Governor’s 2006-07 budget proposes $7.2 million across several state agencies to begin implementation of the recommendations in this report.

10.2 General Recommendations

General recommendations included in this report are listed below. These recommendations are broken down into broad categories according to their relation to the emission reduction strategies, economics analysis, climate change emission reduction inventory, or market-based program options.

**Economic Analysis**

The State needs to take the following actions by July 2007:

Complete an analysis of the individual strategies presented in Section 5 to determine the cost-effectiveness for each strategy.

Develop a revised macroeconomic impact assessment to include updated cost estimates for the individual strategies.

Determine preliminary costs associated with the impacts of climate change on public health, water, agriculture, coastlines, and forests in California.

Determine updated costs associated with adaptation.

**Climate Change Emission Inventory**

It is essential that the California Energy Commission continue to refine the planning inventory they currently keep.

**Market-Based Program**

A market-based program should be considered further as an integral part of California’s approach to reducing climate change emissions. In the absence of national action, California can lead by example by developing a market-based program as a model for national action.

Market-based program alternatives should be defined in detail and evaluated in terms of impacts on emissions; costs of reducing emissions; state competitiveness, businesses, and jobs; Impacted communities with environmental justice concerns; and administrative and budget requirements.
Legislative authority required to implement a market-based program should be identified.

**Scenario Analysis**

California should continue to support research relevant to policy on climate change, including support of the research activities of the California Climate Change Center. Some of the areas of research in need of attention include the study of ecological impacts, the development of probabilistic climate projections for the state, a geographically-detailed analysis of the impacts of sea level rise on the California coast and the San Francisco Bay and Delta, the impact of climate change on energy generation and demand and human health, and new methods for economic impact analyses.

Climate change may disproportionately impact the most vulnerable groups in our society, including children, the elderly and frail, and residents in low-income and minority communications. For this reason, future scenario analysis should strive to identify these potential impacts and suggest solutions.

Given the serious potential consequences of climate change on the State’s resources, California should expand its support of climate change research to create the tools, methods, and information that will be needed to develop robust coping and adaptation strategies in the state.
LIST OF ACRONYMS AND ABBREVIATIONS

ARB  California Air Resource Board
BT&H  Business, Transportation and Housing Agency
CA H₂ Net  California Hydrogen Highway Network
Cal/EPA  California Environmental Protection Agency
CAT  Climate Action Team
CCA  Community Choice Aggregators
CDFA  Department of Food and Agriculture
CEC  California Energy Commission
Center  California Climate Change Center
CEQA  California Environmental Quality Act
CGE  Computable General Equilibrium
CH₄  Methane
CHP  Cooling, Heating and Power
CIWMB  California Integrated Waste Management Board
CO  Carbon Monoxide
CO₂  Carbon Dioxide
CO₂e  climate change emissions expressed as CO₂ equivalent.
DHS  Department of Health Services
DOE  United States Department of Energy
DWR  Department of Water Resources
EAP  Energy Action Plan
E-DRAM  Environmental Dynamic Revenue Model
EJ  Environmental Justice
EO  Executive Order
ESP  Energy Service Providers
EWMP  Efficient Water Management Practices
GCMs  Global Climate Models
GFDL  Geophysical Fluid Dynamic Laboratory
GHGs  Greenhouse Gases
GWP  Global Warming Potential
HadCM3  Hadley Centre Climate Model, version 3
HFC  Hydrofluorocarbons
IEPR  Integrated Energy Policy Reports
IOU  Investor Owned Utility
IPCC  Intergovernmental Panel on Climate Change
ITS  Intelligent Transportation Systems
IWMA  Integrated Waste Management Act
kWh  kilowatt hour = 3.6 MJ = 3,412 Btu
LEAs  Local Enforcement Agencies
MAF  Million Acre Feet
MMt  Million Metric Tons
MOU  Memorandum of Understanding
N₂O  Nitrous Oxide
NAST  National Assessment Synthesis Team
NCAR  National Center for Atmospheric Research
NMVOCs  Nonmethane Volatile Organic Compounds
NO  Nitrogen Oxides
NOAA  National Oceanic & Atmospheric Administration
NPV  Net Present Value
O₃  Tropospheric
°C  Celsius
ODS  Ozone Depleting Substances
°F  Fahrenheit
PCM1  Parallel Climate Model
PFC  Perfluorocarbons
PIER  Public Interest Energy Research
PM  Particulate Matter
PPM  Parts per Million
PUC  Public Utilities Commission
Registry  California Climate Action Registry
RPS  Renewable Portfolio Standard
SF₆  Sulfur Hexafluoride
SO₂  Sulfur Dioxide
SRES  Special Report on Emissions Scenarios
TRUs  Transportation Refrigeration Units
103
U.S. EPA  United States Environmental Protection Agency
UK     United Kingdom
VMT    Vehicle Miles Traveled
VOC    Volatile Organic Compound
W/m²   Watts per Square Meter
WUI    Wildland-Urban Interface
11 This section summarize results from: Brian Joyce et al., “Climate Change Impacts on Water for Agriculture in California: A case study in the Sacramento Valley,” 2006; Jouse Medellin, Julien Harou, Marcelo Olivares, Jay Lund,

17 This section summarizes reports prepared by:

13 This is the 1998 figure for the total sales of agricultural and processing products in California. N. V. Kuminoff, A. D. Sokolow, and D. A. Sumner, "Farmland Conversion: Perceptions and Realities," Agricultural Issues Center, Issues Brief, No 16. 2001.

14 Gutierrez, "Climatic limits of pink bollworm."

15 Dan Cayan et al., 2006.


17 J.S. Freid et al., and Westerling et al. 2006
19 John Battles et al., 2006.
20 Summarizes results from Battles et al. 2006
21 This section summarizes work from the following sources:
22 More discussion on the role of mitigation and adaptation can be found in A. Luers and S. Moser, "Preparing for the Impacts of Climate Change in California: Advancing the Debate on Adaptation," 2006.
25 This figure is net of added electricity use at truck stops.
26 The Acid Rain Trading Program caps total sulfur dioxide (SO2) emissions from all fossil-fueled electric generating units in the United States with capacity of 25 MW or more. The Northeast NOx Program caps total emissions of nitrogen oxides (NOx) from electric generating units and large industrial boilers in 19 states and the District of Columbia.


28 A third cap and trade program in the U.S. is the Regional Clean Air Incentives Market (RECLAIM) program. The RECLAIM Program caps NOx and SOx emissions in the South Coast air basin from about 350 NOx sources and 40 SOx sources. In 2000, after seven years of operation, the emission trading market for the RECLAIM Program experienced volatile price swings that eventually led to the program being restructured to exclude electric generating units. Multiple factors contributed to the difficulties in the RECLAIM Program, including impacts from the deregulation of the electric power sector. U.S.EPA, An Evaluation of the South Coast Air Quality Management District's Regional Clean Air Incentive market—Lessons in Environmental Markets and Innovation, U.S. Environmental Protection Agency, Washington, D.C., 2002, p. 24.


BAAQMD CEQA GUIDELINES
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Assessing the Air Quality Impacts of Projects and Plans

Prepared by the Planning and Research Division of the Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

December, 1999

This document is intended to serve as a guide for those who prepare or evaluate air quality impact analyses for projects and plans in the San Francisco Bay Area. The GUIDELINES include information on legal requirements, BAAQMD rules, plans and procedures, methods of analyzing air quality impacts, thresholds of significance, mitigation measures, and background air quality information. Copies and updates are available from the BAAQMD Public Information Office at (415) 749-4900. Questions on content may be addressed to the BAAQMD’s Planning and Transportation Section at (415) 749-4995.

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CHAPTER 1 - INTRODUCTION

1.1 Background

The purpose of these Guidelines is to assist Lead Agencies, as well as consultants, project proponents and other interested parties, in evaluating potential air quality impacts of projects and plans proposed in the San Francisco Bay Area. Specifically, these Guidelines explain the procedures that the Bay Area Air Quality Management District (BAAQMD or "District") recommends be followed during environmental review processes required by the California Environmental Quality Act (CEQA). The Guidelines provide direction on how to evaluate potential air quality impacts, how to determine whether these impacts are significant, and how to mitigate these impacts. It is hoped that by providing this guidance, the air quality impacts of plans and development proposals will be analyzed accurately and consistently, and adverse impacts will be minimized.

These guidelines do not attempt to address every type of project that may be subject to CEQA analysis. Greatest emphasis is placed on: development proposals, such as commercial or residential projects, that generate significant numbers of vehicle trips (and associated air pollutant emissions); impacts related to nuisances (such as odors and dust), toxic air contaminants and accidental releases of hazardous materials, often resulting from air pollutant sources and members of the public being in close proximity; and preparation or revision of plans, such as general plans or specific plans.

1.2 How to Use These Guidelines

This document replaces the District's previous CEQA guidance document, Air Quality and Urban Development: Guidelines for Assessing Impacts of Projects and Plans, published in November 1985 (with revisions through August 1991). This 1996 document has more current information regarding issues including federal and State requirements, regional air quality plans, emission inventories, analytical procedures and mitigation strategies. Some of the more significant additions or revisions in this document include the following:

- Recommendations regarding early consultation procedures between Lead Agencies and project proponents on issues such as land use and design measures to reduce auto use, land use conflicts and sensitive receptors, and District regulatory requirements. (See pages 9-11.)

- Thresholds of significance for impacts associated with construction, project operations, odors, toxics, accidental releases, cumulative impacts, and plans. (See pages 13-25.)

- Calculating mobile source emissions using the URSEMIS model. (See pages 31-33.)

- Determining background carbon monoxide (CO) concentrations for use in microscale CO modeling. (See pages 41-46.)

- Mitigating air quality impacts through land use and design measures. (See pp. 9-11, 53-56.)
The recommendations in these Guidelines should be viewed as minimum considerations for air quality analysis. A Lead Agency or a project proponent may substitute more sophisticated models, more precise input data, innovative mitigation measures and/or other features. The District encourages creative approaches to impact analysis and mitigation in planning for air quality improvement.

 Portions of these Guidelines will be revised as new information becomes available on such matters as revised emission factors for the Bay Area motor vehicle fleet or emission inventories. Copies and updates of these Guidelines are available from the District's Public Information Office at (415) 749-4900. Questions on content may be addressed to the District's Planning and Transportation Section at (415) 749-4995.

Organization of the Guidelines

Chapter 1 provides a summary of the purpose of the document, a brief overview of District responsibilities, and summary information regarding air pollution in the Bay Area.

Chapter 2 suggests early consultation procedures and issues for consideration by Lead Agencies, discusses preparation of the Initial Study, and provides thresholds of significance for determining whether an air quality impact is significant.

Chapter 3 describes methods for estimating air quality impacts. The chapter addresses impacts from project construction, project operations, and plans.

Chapter 4 describes methods for mitigating air quality impacts. The chapter discusses mitigation strategies to be considered at the general plan level, and project-specific mitigation measures.

Appendix A discusses laws, regulations, programs and plans related to air quality management.

Appendix B summarizes sources and effects of air pollutants.

Appendix C summarizes the region's attainment status with respect to national and State air quality standards, and discusses air quality problems and trends.

Appendix D discusses how climate and topography influence air quality conditions, and provides a detailed description of climate and topography for various subregions in the Bay Area.

Appendix E summarizes the District's activities with respect to toxic air contaminants.

Appendix F summarizes recommended resources and guidance documents that Lead Agencies may wish to consult when developing mitigation measures.

Appendix G provides a glossary.

Appendix H provides the references used in the preparation of this document.
1.3 District Responsibilities

The District is the agency primarily responsible for assuring that national and State ambient air quality standards are attained and maintained in the San Francisco Bay Area. Among the District's many responsibilities are the following: preparation of plans for attaining and maintaining ambient air quality standards in the region; adoption and enforcement of rules and regulations concerning air pollutant sources; issuing permits for stationary sources of air pollutants; inspecting stationary sources of air pollutants and responding to citizen complaints; monitoring ambient air quality and meteorological conditions; awarding grants to reduce motor vehicle emissions; conducting public education campaigns; and many other activities. The District's jurisdiction includes all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo and Santa Clara Counties, and the southern portions of Solano and Sonoma Counties. Figure 1 shows the boundaries of the District's jurisdiction. Further information about District activities is provided in Appendix A.

In its efforts to reduce air pollution and achieve ambient air quality standards, the District also works with many other agencies and organizations, including: U.S. Environmental Protection Agency, California Air Resources Board, Metropolitan Transportation Commission, Association of Bay Area Governments, congestion management agencies, cities and counties, and various non-governmental organizations. Appendix A provides further information regarding other agencies with whom the District cooperates. Appendix A also provides an overview of federal and State laws and programs that affect air quality.

The District is involved in the CEQA process in a variety of ways.

Lead Agency - The District acts as a Lead Agency when it has the primary authority to implement or approve a project. The District acts as a Lead Agency when it adopts air quality plans for the region, as well as when it adopts rules and regulations. The District also occasionally acts as a Lead Agency, or prepares supplemental environmental documentation, for projects subject to District permit requirements.

Responsible Agency - The District acts as a Responsible Agency when it has discretionary authority over a project, but does not have the primary discretionary authority of a Lead Agency. As a Responsible Agency, the District may coordinate the environmental review process with the District's permitting process, provide comments to the Lead Agency regarding potential impacts, and recommend mitigation measures.

Commenting Agency - The District acts as a Commenting Agency when it is not a Lead or Responsible Agency (i.e., it does not have discretionary authority over a project), but when it may have concerns about the air quality impacts of a proposed project or plan. As a Commenting Agency, the District reviews environmental documents prepared for development proposals and plans in the Bay Area and provides comments to Lead Agencies regarding air quality impacts and mitigation measures.
1.4 Air Pollutants of Concern in the Bay Area

State and national ambient air quality standards have been established for the following pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, fine particulate matter (PM$_{10}$) and lead. For some of these pollutants, notably ozone and PM$_{10}$, the State standards are more stringent than the national standards. The State has also established ambient air quality standards for sulfates, hydrogen sulfide, vinyl chloride and visibility reducing particles. The above-mentioned pollutants are generally known as "criteria pollutants." Appendix A provides further information on ambient air quality standards.

District regulations and programs seek to minimize emissions of all air pollutants. These Guidelines, however, focus primarily on the criteria pollutants for which the region periodically exceeds State and national standards (ozone and PM$_{10}$) or for which the region occasionally exceeded State or national standards in the recent past (carbon monoxide).

Ground level ozone, often referred to as smog, is not emitted directly, but is formed in the atmosphere through complex chemical reactions between nitrogen oxides (NO$_x$) and reactive organic gases (ROG) in the presence of sunlight. The principal sources of NO$_x$ and ROG, often termed ozone precursors, are combustion processes (including motor vehicle engines) and evaporation of solvents, paints and fuels. Motor vehicles are the single largest source of ozone precursor emissions in the Bay Area. Exposure to ozone can cause eye irritation, aggravate respiratory diseases and damage lung tissue, as well as damage vegetation and reduce visibility.

Fine particulate matter (PM$_{10}$, or particulate matter less than 10 microns in diameter) includes a wide range of solid or liquid particles, including smoke, dust, aerosols and metallic oxides. There are many sources of PM$_{10}$ emissions, including combustion, industrial processes, grading and construction, and motor vehicles. Of the PM$_{10}$ emissions associated with motor vehicle use, some are tailpipe and tire wear emissions, but greater quantities are generated by resuspended road dust. Consequently, improvements in motor vehicle engines and fuels have not reduced PM$_{10}$ emissions as significantly as they have reduced emissions of other pollutants. Reductions in motor vehicle use are needed to significantly reduce PM$_{10}$ emissions from resuspended road dust. District research also has shown that wood burning in fireplaces and stoves is a significant source of PM$_{10}$, particularly during episodes when PM$_{10}$ levels are at their highest.

Fine particulate matter is of concern because it can bypass the body's natural filtration system more easily than larger particles, and can lodge deep in the lungs. Health effects of PM$_{10}$ vary depending on a variety of factors, including the type and size of particle. Research has demonstrated a correlation between high PM$_{10}$ concentrations and increased mortality rates. Elevated PM$_{10}$ concentrations can also aggravate chronic respiratory illness such as bronchitis and asthma.

U.S. EPA in 1997 announced new ambient air quality standards for ozone and fine particulate matter. The new standards were intended to provide greater protection of public health. EPA proposed to phase out the 1-hour ozone standard and replace it with an 8-hour standard. With respect to fine particulate, EPA proposed a new standard for the smaller particles, PM$_{2.5}$, or particulate matter less than 2.5 microns in diameter. The new PM$_{2.5}$ standards included an
annual standard and a 24-hour standard. Following the announcement of the new national standards, the District began collecting monitoring data to determine the region's attainment status with respect to the new standards. Industry groups challenged the new standards in court, but as of December 1999 the status of the new standards was uncertain.

Carbon monoxide (CO) is an odorless, colorless gas that is formed by the incomplete combustion of fuels. Motor vehicles are by far the single largest source of CO in the Bay Area. At high concentrations, CO reduces the oxygen-carrying capacity of the blood and can cause headaches, dizziness, unconsciousness, and even death. CO also can aggravate cardiovascular disease.

In addition to the criteria pollutants discussed above, toxic air contaminants (TACs) are another group of pollutants of concern in the Bay Area. There are many different types of TACs, with varying degrees of toxicity. Sources of TACs include industrial processes such as petroleum refining and chrome plating operations, commercial operations such as gasoline stations and dry cleaners, and motor vehicle exhaust. Public exposure to TACs can result from emissions from normal operations, as well as accidental releases of hazardous materials during upset conditions. Health effects of TACs include cancer, birth defects, neurological damage and death.

Diesel exhaust is a growing concern in the Bay Area and throughout California. The California Air Resources Board (ARB) in 1998 identified diesel engine particulate matter as a toxic air contaminant. The exhaust from diesel engines includes hundreds of different gaseous and particulate components, many of which are toxic. Many of these toxic compounds adhere to the particles, and because diesel particles are very small, they penetrate deeply into the lungs. Diesel engine particulate matter has been identified as a human carcinogen. Mobile sources – including trucks, buses, automobiles, trains, ships and farm equipment – are by far the largest source of diesel emissions. Studies show that diesel particulate matter concentrations are much higher near heavily traveled highways and intersections. District analysis shows that the cancer risk from exposure to diesel exhaust is much higher than the risk associated with any other toxic air pollutant routinely measured in the region.

Prior to the listing of diesel exhaust as a toxic air contaminant, California had already adopted various regulations that would reduce diesel emissions. These regulations include new standards for diesel fuel, emission standards for new diesel trucks, buses, autos, and utility equipment, and inspection and maintenance requirements for heavy duty vehicles. Following the listing of diesel engine particulate matter as a toxic air contaminant, ARB is currently (as of December 1999) evaluating what additional regulatory action is needed to reduce public exposure. ARB does not plan on banning diesel fuel or engines. ARB may consider additional requirements for diesel fuel and engines, however, as well as other measures to reduce public exposure.

Other air quality issues of concern in the Bay Area include nuisance impacts of odors and dust. Objectionable odors may be associated with a variety of pollutants. Common sources of odors include wastewater treatment plants, landfills, composting facilities, refineries and chemical plants. Similarly, nuisance dust may be generated by a variety of sources including quarries, agriculture, grading and construction. Odors rarely have direct health impacts, but they can be very unpleasant and can lead to anger and concern over possible health effects among the public. Each year the District receives thousands of citizen complaints about objectionable odors. Dust
emissions can contribute to increased ambient concentrations of PM$_{10}$, particularly when dust settles on roadways where it can be pulverized and resuspended by traffic. Dust emissions also contribute to reduced visibility and soiling of exposed surfaces.

1.5 Air Quality Conditions in the Bay Area

Air quality conditions in the San Francisco Bay Area have improved significantly since the District was created in 1955. Ambient concentrations of air pollutants and the number of days on which the region exceeds air quality standards have fallen dramatically. Public health benefits, improved visibility, and reduced damage to plants and materials are among the benefits of this progress.

Continued progress is necessary, however. Following years of declining emissions and ambient concentrations of ozone, the Bay Area in 1995 was redesignated as an attainment area for the national 1-hour ozone standard. However, unusual heat waves triggered new exceedances of the national ozone standard during the summers of 1995 and 1996. As a result, in 1998 U.S. EPA redesignated the region back into nonattainment status for the national 1-hour ozone standard. The region also periodically exceeds State ambient air quality standards for ozone and particulate matter. The State standards for these pollutants are more stringent than the national standards. Exceedances of air quality standards occur primarily during meteorological conditions conducive to high pollution levels, such as cold, windless winter nights (for particulate matter) or hot, sunny summer afternoons (for ozone). As is true throughout much of the U.S., motor vehicle use is projected to increase substantially in the region. The District, local jurisdictions, and other parties responsible for protecting public health and welfare will need to continue to minimize the air quality impacts of growth and development.

Table 1 provides a summary of the current attainment status for the San Francisco Bay Area with respect to national and State ambient air quality standards. Appendix B provides information regarding sources and effects of air pollutants. Appendix C discusses air pollutant status, problems and trends in the Bay Area and summarizes ambient air quality monitoring data for recent years.
### TABLE 1
**BAY AREA ATTAINMENT STATUS AS OF DECEMBER 1999**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Time</th>
<th>California Standards 1</th>
<th>National Standards 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Concentration</td>
<td>Attainment Status</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Concentration</td>
</tr>
<tr>
<td>Ozone</td>
<td>8-hour</td>
<td>0.08 ppm</td>
<td>U&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1-hour</td>
<td>0.09 ppm</td>
<td>N&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>8-hour</td>
<td>9.0 ppm</td>
<td>A&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>1-hour</td>
<td>20 ppm</td>
<td>A</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>Annual Average</td>
<td>0.053 ppm</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>1 Hour</td>
<td>0.25 ppm</td>
<td>A</td>
</tr>
<tr>
<td>Sulfur Dioxide</td>
<td>Annual Average</td>
<td>0.03 ppm</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>24 Hour</td>
<td>0.05 ppm</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>1-hour</td>
<td>0.25 ppm</td>
<td>A</td>
</tr>
<tr>
<td>Fine Particulate Matter (PM&lt;sub&gt;10&lt;/sub&gt;)</td>
<td>Annual Arithmetic Mean</td>
<td>50 µg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Annual Geometric Mean</td>
<td>30 µg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>24 Hour</td>
<td>50 µg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>15 µg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>150 µg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>U</td>
</tr>
<tr>
<td>Fine Particulate Matter (PM&lt;sub&gt;2.5&lt;/sub&gt;)</td>
<td>Annual Arithmetic Mean</td>
<td>15 µg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>U&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>24 Hour</td>
<td>65 µg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>U&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

A=Attainment  N=Nonattainment  U=Unclassified  
ppm=parts per million  µg/m<sup>3</sup>=micrograms per cubic meter

1. California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, and PM<sub>10</sub> are values that are not to be exceeded. If the standard is for a 1-hour, 8-hour or 24-hour average, then some measurements may be excluded. In particular, measurements are excluded that ARB determines would occur less than once per year on the average.

2. National standards other than for ozone and those based on annual averages or annual arithmetic means are not to be exceeded more than once a year. For example, the ozone standard is attained if, during the most recent three-year period, the average number of days per year with maximum hourly concentrations above the standard is equal to or less than one.

3. In August 1998 the Bay Area was redesignated to nonattainment for the national 1-hour ozone standard.

4. In June 1998 the Bay Area was redesignated to attainment for the national 8-hour CO standard.

5. In 1997 EPA established an 8-hour standard for ozone, and annual and 24-hour standards for very fine particulate matter (PM<sub>2.5</sub>). As of December 1999, the District did not have sufficient monitoring data to determine the region's attainment status. The new standards were challenged in court, and as of December 1999 their status was uncertain.
CHAPTER 2 - PRELIMINARY REVIEW AND THRESHOLDS OF SIGNIFICANCE

This chapter of the District's CEQA Guidelines provides guidance regarding early consultation between project proponents and local governments. This chapter also provides thresholds to be used to determine whether a project or plan will have a significant air quality impact.

2.1 Early Consultation

The District encourages local jurisdictions to address air quality issues as early as possible in the development review process. Issues such as potential land use conflicts (e.g., odors) or site design to encourage alternatives to the automobile should be considered. Addressing land use and site design issues while a proposed project is still in the conceptual stage increases opportunities to incorporate mitigation measures and desirable modifications to minimize air quality impacts. By the time a project enters the CEQA process, it is usually more costly and time-consuming to redesign the project to incorporate mitigation measures. Early consultation may be achieved by including a formal step in the jurisdiction's development review procedures or simply by discussing air quality concerns at the planning counter when a project proponent makes an initial contact regarding a proposed development. Regardless of the specific procedures a local jurisdiction employs, the objective should be to incorporate air quality beneficial features into a project before significant resources (public and private) have been devoted to the project.

The following air quality considerations warrant particular attention during early consultation between Lead Agencies and project proponents: 1) land use and design measures to encourage alternatives to the automobile and conserve energy; 2) land use conflicts and exposure of sensitive receptors to odors, toxics and criteria pollutants; and 3) applicable District rules, regulations and permit requirements. Lead Agencies and project proponents also are encouraged to consult with the District on these issues.

Land Use and Design Considerations - Land use decisions are critical to air quality planning because land use patterns greatly influence transportation needs, and motor vehicles are the largest source of air pollution. The location, intensity and design of land use development projects significantly influences how people travel. For example, land use strategies such as locating moderate or high density development near transit stations increases opportunities for residents/employees to use transit rather than drive their cars. Similarly, design considerations such as orienting a building entrance towards a sidewalk and/or transit stop increases the attractiveness of walking and transit as an alternative to driving. Some important land use and design issues to consider include the following:

- Encourage the development of higher density housing and employment centers near transit stations.
- Encourage compact development featuring a mix of uses that locates residences near jobs and services.
- Provide neighborhood retail within or adjacent to large residential developments.
- Provide services, such as restaurants, banks, copy shops, post office, etc., within office 
parks and other large employment centers.
- Encourage infill development.
- Ensure that the design of streets, sidewalks and bike paths/routes within a development 
encourages walking and biking.
- Orient building entrances towards sidewalks and transit stops.
- Provide landscaping to reduce energy demand for cooling.
- Orient buildings to minimize energy required for heating and cooling.

Local governments and other Lead Agencies are encouraged to consider land use and design 
measures to reduce auto use and promote energy conservation early in planning and development 
review processes. By incorporating such measures in local plans and addressing them during 
initial contacts with project proponents, Lead Agencies greatly increase the likelihood of their 
implementation. The environmental impacts of development proposals may be lessened and 
environmental review processes simplified.

Further information regarding land use and design strategies is provided in Chapter 4 and 
Appendix F. Also, the District and ABAG have prepared a guidance document on these issues 
ettitled Improving Air Quality Through Local Plans and Programs. The document provides 
guidance to local officials and staff on developing and implementing local policies and programs 
to improve air quality. Lead Agency staff also may contact District planners for assistance.

**Land Use Conflicts and Sensitive Receptors** - The location of a development project is a major 
factor in determining whether it will result in localized air quality impacts. The potential for 
adverse air quality impacts increases as the distance between the source of emissions and 
members of the public decreases. Impacts on sensitive receptors are of particular concern. 
Sensitive receptors are facilities that house or attract children, the elderly, people with illnesses 
or others who are especially sensitive to the effects of air pollutants. Hospitals, schools, 
convalescent facilities, and residential areas are examples of sensitive receptors.

For each of the situations discussed below, the impacts generally are not limited only to sensitive 
receptors. All members of the population can be adversely affected by criteria pollutants, toxic 
air contaminants, odor and dust, and thus any consideration of potential air quality impacts 
should include all members of the population. This discussion focuses on sensitive receptors, 
however, because they are the people most vulnerable to the effects of air pollution.

Air quality problems arise when sources of air pollutants and sensitive receptors are located near 
one another. There are several types of land use conflicts that should be avoided:

- A sensitive receptor is in close proximity to a congested intersection or roadway with 
  high levels of emissions from motor vehicles. High concentrations of carbon 
  monoxide, fine particulate matter or toxic air contaminants are the most common 
  concerns.

- A sensitive receptor is close to a source of toxic air contaminants or a potential source 
  of accidental releases of hazardous materials.
- A sensitive receptor is close to a source of odorous emissions. Although odors generally do not pose a health risk, they can be quite unpleasant and often lead to citizen complaints to the District and to local governments.

- A sensitive receptor is close to a source of high levels of nuisance dust emissions.

Localized impacts to sensitive receptors generally occur in one of two ways:

- A (new) source of air pollutants is proposed to be located close to existing sensitive receptors. For example, an industrial facility is proposed for a site near a school.

- A (new) sensitive receptor is proposed near an existing source of air pollutants. For example, a residential development is proposed near a wastewater treatment plant.

Early consultation between project proponents and Lead Agency staff can avoid or minimize localized impacts to sensitive receptors. When evaluating whether a development proposal has the potential to result in localized impacts, Lead Agency staff need to consider the nature of the air pollutant emissions, the proximity between the emitting facility and sensitive receptors, the direction of prevailing winds, and local topography. Often, the provision of an adequate distance, or buffer zone, between the source of emissions and the receptor(s) is necessary to mitigate the problem. This underscores the importance of addressing these potential land use conflicts during the preparation of the general plan and as early as possible in the development review process for specific projects.

It should be noted that there may be instances when some of the land use considerations discussed above, such as infill development and mixed use projects, could result in localized impacts to sensitive receptors. For example, an infill or mixed use project might result in residences being in close proximity to a source of odors or toxic air contaminants. Or a child care facility might be proposed at a worksite in an area where large quantities of hazardous materials are stored and used. Such situations should be avoided. Lead Agencies should bear in mind that while infill and mixed use development are desirable (to reduce auto trips), such projects should be approved only when they do not subject receptors to health or nuisance impacts.

**BAAQMD Rules and Regulations** - District regulations and permit requirements apply to most industrial processes (e.g., manufacturing facilities, cement terminals, food processing), many commercial operations (e.g., print shops, drycleaners, gasoline stations), and other miscellaneous activities (e.g., demolition of buildings containing asbestos and aeration of contaminated soils). During early consultation, Lead Agency staff should address air pollution regulations and requirements of other public agencies that may apply to the proposed project. Lead Agency staff are encouraged to coordinate directly with the District during the environmental review process on issues such as regulatory requirements, impact analyses and mitigation measures.
2.2 Preparation of the Initial Study

Projects that are subject to CEQA generally undergo a preliminary evaluation in an Initial Study, which is prepared by the Lead Agency. The Initial Study is used to determine if a project may have a significant effect on the environment. The Initial Study should evaluate the potential impact of a proposed project upon air quality. The air quality impact of a project is determined by examining the types and levels of emissions generated by the project, the existing air quality conditions and neighboring land uses. The Initial Study should analyze all phases of project planning, construction and operation, as well as cumulative impacts. The District recommends that the answers/determinations provided in an Initial Study checklist be explained.¹

The District has established significance thresholds to assist Lead Agencies in determining whether a project or plan may have a significant air quality impact. The District's thresholds of significance are based on the State Office of Planning and Research definitions of significant environmental effect. Section 15382 of the State CEQA Guidelines defines "significant effect on the environment" as "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including ... air."

Appendix G to the State CEQA Guidelines contains a list of effects that will normally be considered significant. These include:

- A project that will "violate any ambient air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations;"
- A project that "conflicts with adopted environmental plans or goals of the community where it is located;"
- A project that would "create a potential public health hazard or involve the use, production or disposal of materials which pose a hazard to people or animal or plant populations in the area affected;" or
- A project that would "have a substantial, demonstrable negative aesthetic effect."

Appendix I of the State CEQA Guidelines also indicates that a project could have a significant air quality impact if it would result in:

- "The creation of objectionable odors;" or
- "Alteration of air movement, moisture, or temperature, or change in climate, either locally or regionally."

The Lead Agency should determine whether the proposed project or plan would exceed any of the thresholds discussed in this chapter. If any of the thresholds are exceeded, then an EIR should be prepared. The more comprehensive analysis of an EIR will provide a more detailed picture of the project's or plan's impacts and will help identify the most appropriate and effective mitigation measures to minimize the impacts. Where no significant air quality impacts of a

¹ The Initial Study identifies potential effects by use of a checklist, matrix or other method. The process, contents, and use of the Initial Study are contained in Section 15063 and Appendix I of the State CEQA Guidelines.
project or plan can be identified in the Initial Study (i.e., none of the significance thresholds are exceeded), the District recommends the Lead Agency either prepare a Negative Declaration or include in an EIR a statement indicating the reasons why potential air quality impacts were determined not to be significant.

Sources of air pollutant emissions complying with all applicable District regulations generally will not be considered to have a significant air quality impact.\(^2\) Stationary sources that are exempt from District permit requirements because they fall below emission thresholds for permitting will not be considered to have a significant air quality impact (unless it is demonstrated that they may have a significant cumulative impact). The Lead Agency can and should make exception to this determination if special circumstances suggest that the emissions from the permitted or exempt source may cause a significant air quality impact. For example, if a permitted or exempt source may emit objectionable odors, then odor impacts on nearby receptors should be considered a potentially significant air quality impact.

### 2.3 Thresholds of Significance

This section describes the District's recommended thresholds of significance to be used by a Lead Agency when preparing an Initial Study. If, during the preparation of the Initial Study, the Lead Agency finds that any of the following thresholds may be exceeded, then an EIR should be prepared in order to more accurately evaluate project impacts and identify mitigation measures. These thresholds also may be used when preparing an EIR. If the more detailed analysis in an EIR indicates that any of these thresholds would be exceeded, the document should identify the impact as a significant air quality impact and propose mitigation measures. Chapter 3 explains how to calculate emissions to determine whether the thresholds have been exceeded. The following thresholds address impacts associated with: 1) project construction, 2) project operations, and 3) plans.

#### Threshold of Significance for Construction Impacts

Construction-related emissions are generally short-term in duration, but may still cause adverse air quality impacts. Fine particulate matter (PM\(_{10}\)) is the pollutant of greatest concern with respect to construction activities.\(^3\) PM\(_{10}\) emissions can result from a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved surfaces, and vehicle and equipment exhaust. Construction-related emissions can cause substantial increases in localized concentrations of PM\(_{10}\). Particulate emissions from construction activities can lead to adverse health effects as well as nuisance concerns such as reduced visibility and soiling of exposed surfaces.

Construction emissions of PM\(_{10}\) can vary greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, weather conditions and other factors. Despite this variability in emissions, experience has shown that there are a number of

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\(^2\)CEQA Guidelines, Section 15064(j).
\(^3\) Construction equipment emits carbon monoxide and ozone precursors. However, these emissions are included in the emission inventory that is the basis for regional air quality plans, and are not expected to impede attainment or maintenance of ozone and carbon monoxide standards in the Bay Area.
feasible control measures that can be reasonably implemented to significantly reduce PM$_{10}$ emissions from construction. The District's approach to CEQA analyses of construction impacts is to emphasize implementation of effective and comprehensive control measures rather than detailed quantification of emissions.

The District has identified a set of feasible PM$_{10}$ control measures for construction activities. These control measures are listed in Table 2. As noted in the table, some measures ("Basic Measures") should be implemented at all construction sites, regardless of size. Additional measures ("Enhanced Measures") should be implemented at larger construction sites (greater than 4 acres) where PM$_{10}$ emissions generally will be higher. Table 2 also lists other PM$_{10}$ controls ("Optional Measures") that may be implemented if further emission reductions are deemed necessary by the Lead Agency.

The determination of significance with respect to construction emissions should be based on a consideration of the control measures to be implemented. From the District's perspective, quantification of construction emissions is not necessary (although a Lead Agency may elect to do so - see Section 3.3 of these Guidelines, "Calculating Construction Emissions," for guidance). The Lead Agency should review Table 2. If all of the control measures indicated in Table 2 (as appropriate, depending on the size of the project area) will be implemented, then air pollutant emissions from construction activities would be considered a less than significant impact. If all of the appropriate measures in Table 2 will not be implemented, then construction impacts would be considered to be significant (unless the Lead Agency provides a detailed explanation as to why a specific measure is unnecessary or not feasible).

Project construction sometimes requires the demolition of existing buildings at the project site. Buildings constructed prior to 1980 often include building materials containing asbestos. Airborne asbestos fibers pose a serious health threat. The demolition, renovation or removal of asbestos-containing building materials is subject to the limitations of District Regulation 11, Rule 2: Hazardous Materials; Asbestos Demolition, Renovation and Manufacturing. The District's Enforcement Division should be consulted prior to commencing demolition of a building containing asbestos building materials. Any demolition activity subject to but not complying with the requirements of District Regulation 11, Rule 2 would be considered to have a significant impact.
### TABLE 2  
**FEASIBLE CONTROL MEASURES FOR CONSTRUCTION EMISSIONS OF PM$_{10}$**

#### Basic Control Measures.  - The following controls should be implemented at all construction sites.
- Water all active construction areas at least twice daily.
- Cover all trucks hauling soil, sand, and other loose materials or require all trucks to maintain at least two feet of freeboard.
- Pave, apply water three times daily, or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas and staging areas at construction sites.
- Sweep daily (with water sweepers) all paved access roads, parking areas and staging areas at construction sites.
- Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.

#### Enhanced Control Measures.  - The following measures should be implemented at construction sites greater than four acres in area.
- All “Basic” control measures listed above.
- Hydroseed or apply (non-toxic) soil stabilizers to inactive construction areas (previously graded areas inactive for ten days or more).
- Enclose, cover, water twice daily or apply (non-toxic) soil binders to exposed stockpiles (dirt, sand, etc.)
- Limit traffic speeds on unpaved roads to 15 mph.
- Install sandbags or other erosion control measures to prevent silt runoff to public roadways.
- Replant vegetation in disturbed areas as quickly as possible.

#### Optional Control Measures.  - The following control measures are strongly encouraged at construction sites that are large in area, located near sensitive receptors or which for any other reason may warrant additional emissions reductions.
- Install wheel washers for all exiting trucks, or wash off the tires or tracks of all trucks and equipment leaving the site.
- Install wind breaks, or plant trees/vegetative wind breaks at windward side(s) of construction areas.
- Suspend excavation and grading activity when winds (instantaneous gusts) exceed 25 mph.
- Limit the area subject to excavation, grading and other construction activity at any one time.
Thresholds of Significance for Impacts From Project Operations

For many types of land use development, such as office parks, shopping centers, residential subdivisions and other "indirect sources", motor vehicles traveling to and from the projects represent the primary source of air pollutant emissions associated with project operations. Significance thresholds discussed below address the impacts of these indirect source emissions on local and regional air quality. Thresholds are also provided for other potential impacts related to project operations, such as odors and toxic air contaminants.

(Lead Agencies may refer to Section 2.4, Project Screening, for guidance on determining whether significance thresholds for project operations may be exceeded, and thus whether more detailed air quality analysis may be needed.)

1. **Local Carbon Monoxide Concentrations.** Localized carbon monoxide concentrations should be estimated for projects in which: 1) vehicle emissions of CO would exceed 550 lb./day, 2) project traffic would impact intersections or roadway links operating at Level of Service (LOS) D, E or F or would cause LOS to decline to D, E or F, or 3) project traffic would increase traffic volumes on nearby roadways by 10% or more. A project contributing to CO concentrations exceeding the State Ambient Air Quality Standard of 9 parts per million (ppm) averaged over 8 hours and 20 ppm for 1 hour would be considered to have a significant impact.

2. **Total Emissions.** Total emissions from project operations should be compared to the thresholds provided in Table 3. Total operational emissions evaluated under this threshold should include all emissions from motor vehicle use associated with the project. A project that generates criteria air pollutant emissions in excess of the annual or daily thresholds in Table 3 would be considered to have a significant air quality impact.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>ton/yr</th>
<th>lb/day</th>
<th>kgm/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROG</td>
<td>15</td>
<td>80</td>
<td>36</td>
</tr>
<tr>
<td>NO&lt;sub&gt;x&lt;/sub&gt;</td>
<td>15</td>
<td>80</td>
<td>36</td>
</tr>
<tr>
<td>PM&lt;sub&gt;10&lt;/sub&gt;</td>
<td>15</td>
<td>80</td>
<td>36</td>
</tr>
</tbody>
</table>

3. **Odors.** While offensive odors rarely cause any physical harm, they still can be very unpleasant, leading to considerable distress among the public and often generating citizen complaints to local governments and the District. Any project with the potential to frequently expose members of the public to objectionable odors would be deemed to have a significant

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4 Unless the increase in traffic volume is less than 100 vehicles per hour.
5 The thresholds for ROG and NOx are equivalent to the District offset requirement threshold (15 tons per year) for stationary sources (Regulation 2-2-302). The threshold for PM<sub>10</sub> is based on the District's definition of a major modification to a major facility (Regulation 2-2-221).
impact. Odor impacts on residential areas and other sensitive receptors warrant the closest scrutiny, but consideration should also be given to other land uses where people may congregate, such as recreational facilities, worksites and commercial areas. Analysis of potential odor impacts should be conducted for both of the following situations: 1) sources of odorous emissions locating near existing receptors, and 2) receptors locating near existing odor sources.

Determining the significance of potential odor impacts involves a two-step process. First, determine whether the project would result in an odor source and receptors being located within the distances indicated in Table 4. Table 4 lists types of facilities known to emit objectionable odors. The Lead Agency should evaluate facilities not included in Table 4 or projects separated by greater distances than indicated in Table 4 if warranted by local conditions or special circumstances. Second, if the proposed project would result in an odor source and receptors being located closer than the screening level distances indicated in Table 4, a more detailed analysis, as described in Chapter 3, should be conducted.

After reviewing District enforcement records as described in Chapter 3, a determination of significance should be made. For a project locating near an existing source of odors, the project should be identified as having a significant odor impact if it is proposed for a site that is closer to an existing odor source than any location where there has been:

a) more than one confirmed complaint per year averaged over a three year period, or
b) three unconfirmed complaints per year averaged over a three year period.

For projects locating near a source of odors where there is currently no nearby development and for odor sources locating near existing receptors, the determination of significance should be based on the distance and frequency at which odor complaints from the public have occurred in the vicinity of a similar facility.

If a proposed project is determined to result in potential odor problems, mitigation measures should be identified. For some projects, add-on controls or process changes, such as carbon absorption, incineration or relocation of stacks/vents, can reduce odorous emissions. In many cases, however, the most effective mitigation strategy is the provision of a sufficient distance, or buffer zone, between the source and the receptor(s).

| TABLE 4 |

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6 In a January, 1995 decision (Baird v. County of Contra Costa, 32 Cal. App. 4th 1464), a California appellate court held that the effects of a contaminated pre-existing environment upon the residents of a proposed project were beyond the scope of CEQA.

Notwithstanding this decision, the District believes that the Legislature generally did intend that CEQA documents should consider the effects of the pre-existing environment on a proposed project, and that the ruling in the Baird case should be limited to the factual particulars of the decision (which involved a neighborhood group's attempt to set aside the approval of an addiction treatment facility).

In the District's view, Lead Agencies therefore should not rely on the Baird decision and should analyze the impacts of existing sources of air pollution on occupants or residents of proposed projects. Such impacts include, but are not limited to, those from toxic air contaminants, odors and dust.
PROJECT SCREENING TRIGGER LEVELS
FOR POTENTIAL ODOR SOURCES

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Project Screening Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater Treatment Plant</td>
<td>1 mile</td>
</tr>
<tr>
<td>Sanitary Landfill</td>
<td>1 mile</td>
</tr>
<tr>
<td>Transfer Station</td>
<td>1 mile</td>
</tr>
<tr>
<td>Composting Facility</td>
<td>1 mile</td>
</tr>
<tr>
<td>Petroleum Refinery</td>
<td>2 miles</td>
</tr>
<tr>
<td>Asphalt Batch Plant</td>
<td>1 mile</td>
</tr>
<tr>
<td>Chemical Manufacturing</td>
<td>1 mile</td>
</tr>
<tr>
<td>Fiberglass Manufacturing</td>
<td>1 mile</td>
</tr>
<tr>
<td>Painting/Coating Operations (e.g. auto body shops)</td>
<td>1 mile</td>
</tr>
<tr>
<td>Rendering Plant</td>
<td>1 mile</td>
</tr>
<tr>
<td>Coffee Roaster</td>
<td>1 mile</td>
</tr>
</tbody>
</table>

4. **Toxic Air Contaminants.** Any project with the potential to expose sensitive receptors (including residential areas) or the general public to substantial levels of toxic air contaminants would be deemed to have a significant impact. This applies to receptors locating near existing sources of toxic air contaminants, as well as sources of toxic air contaminants locating near existing receptors.

Proposed development projects that have the potential to expose the public to toxic air contaminants in excess of the following thresholds would be considered to have a significant air quality impact. These thresholds are based on the District's Risk Management Policy.

**Thresholds of Significance for Toxic Air Contaminants**

1. Probability of contracting cancer for the Maximally Exposed Individual (MEI) exceeds 10 in one million.
2. Ground-level concentrations of non-carcinogenic toxic air contaminants would result in a Hazard Index greater than 1 for the MEI.

5. **Accidental Releases/Acutely Hazardous Air Emissions.** The determination of significance for potential impacts from accidental releases of acutely hazardous materials should be made in consultation with the local administering agency of the Risk Management Prevention Program (RMPP). The county health department is usually the administering agency. A determination of significance regarding accidental releases of acutely hazardous materials (AHMs) should be made for: 1) projects using or storing AHMs locating near existing receptors, and 2) development projects resulting in receptors locating near existing facilities using or storing AHMs.
The District recommends, at a minimum, that the Lead Agency, in consultation with the administering agency of the RMPP, find that any project resulting in receptors being within the Emergency Response Planning Guidelines (ERPG) exposure level 2 for a facility has a significant air quality impact. ERPG exposure level 2 is defined as "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action".  

6. Cumulative Impacts. Any proposed project that would individually have a significant air quality impact (see Thresholds of Significance for Impacts from Project Operations, above) would also be considered to have a significant cumulative air quality impact.

For any project that does not individually have significant operational air quality impacts, the determination of significant cumulative impact should be based on an evaluation of the consistency of the project with the local general plan and of the general plan with the regional air quality plan. (The appropriate regional air quality plan for the Bay Area is the most recently adopted Clean Air Plan.) See Thresholds of Significance for Plan Impacts, below, for guidance on evaluating the consistency of a local general plan with the Clean Air Plan. Figure 2 provides a flow chart depicting the process for evaluating cumulative impacts.

Projects in Jurisdictions with Local Plans Consistent with the Clean Air Plan

If a project is proposed in a city or county with a general plan that is consistent with the Clean Air Plan (see below) and the project is consistent with that general plan (i.e., it does not require a general plan amendment), then the project will not have a significant cumulative impact (provided, of course, the project does not individually have any significant impacts). No further analysis regarding cumulative impacts is necessary.

In a jurisdiction with a general plan consistent with the Clean Air Plan, a project may be proposed that is not consistent with that general plan because it requires a general plan amendment (GPA). In such instances, the cumulative impact analysis should consider the difference(s) between the project and the original (pre-GPA) land use designation for the site with respect to motor vehicle use and potential land use conflicts. A project would not have a significant cumulative impact if: VMT from the project would not be greater than the VMT that would be anticipated under the original land use designation, and 2) the project would not result in sensitive receptors being in close proximity to sources of objectionable odors, toxics or accidental releases of hazardous materials.

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FIGURE 2

EVALUATING CUMULATIVE IMPACTS

Yes

Project individually has a significant impact.

No

Project is located in a jurisdiction with a general plan consistent with the CAP. Consistency determination requires:
- General plan population projections are consistent with CAP and ABAG projections.
- Rate of increase in VMT does not exceed rate of increase in population.
- General plan implements CAP transportation control measures.
- General plan provides buffer zones around sources of odors, toxics and accidental releases.

Quantitative analysis of the combined impacts of the project and past, present and reasonably foreseeable future projects exceeds any significance threshold(s) for project operations:
- CO concentrations above State or national standards.
- Emissions of ROG, NOx or PM_{10} exceed 80 lb/day.
- Potential odor impact.
- Potential toxics impact.
- Potential accidental release impact.

Project causes city/county growth inconsistent with CAP population and VMT assumptions:
- Project, in combination with past, present and reasonably foreseeable future projects, causes jurisdiction's population to exceed CAP and ABAG population projections.
- Project, in combination with past, present and reasonably foreseeable future projects, causes rate of increase in VMT to exceed rate of increase in population.

No

Project does not have a significant cumulative impact.

Yes

Project is consistent with the general plan i.e., does not require a general plan amendment (GPA).

Yes

Compare the project with the pre-GPA land use designation.
- Project VMT would not exceed VMT anticipated under previous land use designation.
- Project would not result in sensitive receptors being in proximity to sources of odors, toxics or accidental releases.

No

Project does have a significant cumulative impact.
Lead Agencies should note that demonstrating general plan consistency with the CAP (and project consistency with the general plan) is the minimum that must be done to support a finding of no significant cumulative impact. Depending on the specific type of project and its setting, there may be additional measures - such as additional measures to reduce auto use, scrappage of high emitting vehicles, conversion to alternative fuels, etc. - that could be implemented to reduce emissions. Even in jurisdictions with a general plan consistent with the CAP, Lead Agencies are encouraged to pursue all feasible measures to minimize cumulative air quality impacts.

**Projects in Jurisdictions with Local Plans Not Consistent with the Clean Air Plan**

For a project in a city or county with a general plan that is not consistent with the Clean Air Plan, the cumulative impact analysis should consider the combined impacts of the proposed project and past, present and reasonably anticipated future projects. ("Reasonably anticipated future projects" should include, at a minimum, projects of which the Lead Agency is aware based on applications for permits and other land use entitlements, environmental documents, and discussions with probable future developers.) A project would have a significant cumulative impact if these combined impacts would exceed any of the thresholds established above for project operations. A quantitative analysis of past, present and future projects would be required as part of this determination. The analysis should also address how the project and past, present and future projects would influence population and vehicle use projections (see Thresholds of Significance for Plan Impacts, Determining Consistency with Clean Air Plan Population and VMT Assumptions, below).

**Thresholds of Significance for Plan Impacts**

Regarding plans, the State CEQA Guidelines, Section 15125(b), states that an EIR shall discuss "any inconsistencies between a proposed project and applicable general plans and regional plans. Such regional plans include, but are not limited to, the applicable Air Quality Management Plan (or State Implementation Plan)....". General Plans of cities and counties must show consistency with regional plans and policies affecting air quality to claim a less than significant impact on air quality. General plan amendments, redevelopment plans, specific area plans, annexations of lands and services, and similar planning activities should receive the same scrutiny as general plans with respect to consistency with regional air quality plans.

For a local plan to be consistent with the regional air quality plan it must be consistent with the most recently adopted Clean Air Plan (CAP). (At the time of this writing, December 1999, the most recently adopted CAP is the *Bay Area '97 Clean Air Plan.*) The goal of the CAP is to reduce ground-level ozone and satisfy other California Clean Air Act (CCAA) requirements (e.g., performance objectives related to motor vehicle use). **All of the following criteria must be satisfied for a local plan to be determined to be consistent with the CAP.** Local plans found to be consistent with the CAP would have a less than significant impact on air quality.
1. **Determining Local Plan Consistency With Clean Air Plan Population and VMT Assumptions.** Plans must show over the planning period of the plan that:

   a) population growth for the jurisdiction will not exceed the values included in the current CAP, and

   b) the rate of increase in VMT for the jurisdiction is equal to or lower than the rate of increase in population.

The first criterion (a) is necessary to establish that population growth in cities and counties will not exceed the growth assumed in the preparation of the CAP emission inventory. Air pollutant emissions are a function of population and human activity. If growth in population is greater than assumed in the CAP emission inventory, then population-based emissions also are likely to be greater than assumed in the CAP. Consequently, attainment of the State air quality standards would be delayed. Therefore, plans showing estimated population greater than that assumed in the ABAG Projections would be inconsistent with air quality planning and have a significant air quality impact.

The second plan criterion (b) is derived from the CCAA, Section 40919(d), which requires regions to implement "transportation control measures to substantially reduce the rate of increase in passenger vehicle trips and miles traveled." Plans showing a VMT growth rate higher than the population growth rate would be considered to be hindering progress towards achieving this performance objective, and thus inconsistent with regional air quality planning. This would represent a significant air quality impact.

2. **Determining Local Plan Consistency With Clean Air Plan Transportation Control Measures.** Determining consistency of local plans with the CAP also involves assessing whether CAP transportation control measures (TCMs) for which local governments are implementing agencies are indeed being implemented. The CAP identifies implementing agencies/entities for each of the TCMs included in the Plan. Cities and counties are identified among the implementing agencies for some of the TCMs. These TCMs are listed in Table 5. Local plans that do not demonstrate reasonable efforts to implement TCMs in the CAP would be considered to be inconsistent with the regional air quality plan and therefore have a significant air quality impact. For further information regarding CAP TCMs, refer to Appendix A of these Guidelines and the Bay Area '97 Clean Air Plan.

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8 For the 1997 CAP, ABAG’s Projections ’96 are the appropriate set of population projections.

9 In some cases, estimating total VMT at the general plan horizon year may be beyond the level of analysis historically conducted in assessing general plan impacts. Lead Agencies may wish to consult with MTC and the county congestion management agency for assistance in developing VMT estimates.
<table>
<thead>
<tr>
<th>Transportation Control Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Support Voluntary Employer-Based Trip Reduction Programs</td>
<td>• Provide assistance to regional and local ridesharing organizations; advocate legislation to maintain and expand incentives (e.g., tax deductions/credits).</td>
</tr>
</tbody>
</table>
| 9. Improve Bicycle Access and Facilities                | • Improve and expand bicycle lane system by providing bicycle access in plans for all new road construction or modifications.  
• Establish and maintain bicycle advisory committees in all nine Bay Area counties.  
• Designate a staff person as a Bicycle Program Manager.  
• Develop and implement comprehensive bicycle plans.  
• Encourage employers and developers to provide bicycle access and facilities.  
• Provide bicycle safety education.                                                                                                                                                                                     |
| 12. Improve Arterial Traffic Management                 | • Study signal preemption for buses on arterials with high volume of bus traffic.  
• Improve arterials for bus operations and to encourage bicycling and walking.  
• Continue and expand local signal timing programs, only where air quality benefits can be demonstrated.                                                                                                                                                                |
| 15. Local Clean Air Plans, Policies and Programs         | • Incorporate air quality beneficial policies and programs into local planning and development activities, with a particular focus on subdivision, zoning and site design measures that reduce the number and length of single-occupant automobile trips.                                                                                             |
| 17. Conduct Demonstration Projects                      | • Promote demonstration projects to develop new strategies to reduce motor vehicle emissions. Projects include: low emission vehicle fleets and LEV refueling infrastructure.                                                                                                                                         |
| 19. Pedestrian Travel                                  | • Review/reverse general/specific plan policies to promote development patterns that encourage walking and circulation policies that emphasize pedestrian travel and modify zoning ordinances to include pedestrian-friendly design standards.  
• Include pedestrian improvements in capital improvement programs.  
• Designate a staff person as a Pedestrian Program Manager.                                                                                                                                                               |
| 20. Promote Traffic Calming Measures                    | • Include traffic calming strategies in the transportation and land use elements of general and specific plans.  
• Include traffic calming strategies in capital improvement programs.                                                                                                                                                                                                          |
3. **Local Plan Impacts Associated with Odors and Toxics.** For local plans to have a less than significant impact with respect to potential odors and/or toxic air contaminants, buffer zones should be established around existing and proposed land uses that would emit these air pollutants. Buffer zones to avoid odors and toxics impacts should be reflected in local plan policies, land use map(s), and implementing ordinances (e.g., zoning ordinance). Refer to the discussion regarding project operations impacts related to odors, toxics and accidental releases for guidance in establishing buffer zones in local plans.

2.4 **Project Screening**

It sometimes may be evident to the Lead Agency that an EIR will be required for a project. In such cases the Lead Agency may forgo preparing an Initial Study and immediately begin preparing an EIR (State CEQA Guidelines, Section 15060(c)). In many cases, however, the Lead Agency will need to prepare an Initial Study to determine whether any of the thresholds of significance discussed in this chapter would be exceeded. Chapter 3 provides guidance on how to assess the air quality impacts of a proposed project.

For one of the thresholds of significance (total emissions from project operations), project screening may provide a simple indication of whether a project may exceed the threshold. The Lead Agency may consult Table 6 for an indication as to whether the threshold for total emissions from project operations might be exceeded. Table 6 provides size or activity levels for various types of land uses which, based on default assumptions, would result in mobile source emissions exceeding the District's threshold of significance for NOx (80 lbs/day). The values provided in Table 6 are based on average, default assumptions for modeling inputs using the URBEMIS7G model (described in Section 3.4). Therefore, the values in Table 6 represent approximate sizes of projects for which total emissions may exceed the threshold. The values should be used only for project screening, and should not be considered absolute thresholds of project significance. Projects approaching or exceeding the levels indicated in Table 6 should undergo a more detailed analysis, as described in Chapter 3. The District recommends that a more detailed analysis be conducted for any project whose size is within 20% of the values indicated in Table 6. The District generally does not recommend a detailed air quality analysis for projects generating less than 2,000 vehicle trips per day, unless warranted by the specific nature of the project or project setting.

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10 The values were calculated using the URBEMIS7G model based on default assumptions for the SF Bay Area:
- Emission factors based on EMFAC7G.
- Average speed of 30 mph and URBEMIS7G default trip lengths.
- Analysis year of 2000.
- Trip generation rates as indicated in table.

The total number of trips for projects with potentially significant impacts varies somewhat between land uses. This is primarily because different land uses generate different distributions of trip type (e.g., home to work, home to shop, etc.) with varying percentages of cold and hot starts.
The Lead Agency should note that Table 6 only addresses one threshold of significance. There are other air quality issues, such as high CO concentrations, odors, toxics and cumulative impacts, that must be considered when evaluating a project's potential for causing adverse air quality impacts. Depending on the nature of the project and local conditions, a project below the values in Table 6 could still cause an adverse air quality impact.

### TABLE 6

**PROJECTS WITH POTENTIALLY SIGNIFICANT EMISSIONS**

<table>
<thead>
<tr>
<th>Land Use Category</th>
<th>Trip Generation Rate*</th>
<th>Size of Project Likely to Generate 80 lb/day NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Housing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Family</td>
<td>9.4/d.u.</td>
<td>320 units</td>
</tr>
<tr>
<td>Apartments</td>
<td>5.9/d.u.</td>
<td>510 units</td>
</tr>
<tr>
<td><strong>Retail</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount Store</td>
<td>48.3/1000 sq.ft.</td>
<td>87,000 sq.ft.</td>
</tr>
<tr>
<td>Regional Shopping Center</td>
<td>96.2/1000 sq.ft.</td>
<td>44,000 sq.ft.</td>
</tr>
<tr>
<td>Supermarket</td>
<td>178/1000 sq.ft.</td>
<td>24,000 sq.ft.</td>
</tr>
<tr>
<td><strong>Office</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Office</td>
<td>10.9/1000 sq.ft.</td>
<td>280,000 sq.ft.</td>
</tr>
<tr>
<td>Government Office</td>
<td>68.9/1000 sq.ft.</td>
<td>55,000 sq.ft.</td>
</tr>
<tr>
<td>Office Park</td>
<td>12.8/1000 sq.ft.</td>
<td>210,000 sq.ft.</td>
</tr>
<tr>
<td>Medical Office</td>
<td>37.1/1000 sq.ft.</td>
<td>110,000 sq.ft.</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>13.8/1000 sq.ft.</td>
<td>240,000 sq.ft.</td>
</tr>
<tr>
<td>Hotel</td>
<td>8.7/room</td>
<td>460 rooms</td>
</tr>
</tbody>
</table>

* Trip rates for many land uses will vary depending upon size of project. See latest edition of *Trip Generation*, Institute of Transportation Engineers.
CHAPTER 3 - ASSESSING AIR QUALITY IMPACTS

3.1 Introduction

This chapter provides guidance on how to evaluate the impact(s) of a proposed project or plan\textsuperscript{11} on local and regional air quality. The impact assessment portion of an environmental document should evaluate all stages of a project. This chapter addresses the following issues:

- Information that should be discussed in the description of the project's environmental setting
- Evaluating emissions from project construction
- Calculating emissions from project operations, including:
  - mobile source (or "indirect") emissions
  - localized carbon monoxide concentrations
  - stationary source emissions
  - odor impacts
  - toxic air contaminants
- Cumulative impacts

The basic method for calculating project emissions is to apply specific emission factors to sources of air pollutants whose magnitude and characteristics are either known or estimated. Emission factors may be defined as standardized relationships between particular sources of air pollution, such as motor vehicles or pieces of industrial equipment, and their air pollutant emissions. For example, emission factors for motor vehicles generally specify the amount (in grams) of certain air pollutants emitted, per mile traveled. This chapter provides emission factors and quantification procedures for construction activities, motor vehicles, and stationary sources. This chapter also describes methods for evaluating air quality impacts that are not easily quantified, such as impacts associated with objectionable odors.

Once the impacts of a proposed project have been identified, a determination must be made as to whether the project would have a significant adverse impact on the environment. Significance criteria discussed in Chapter 2 of these Guidelines should be used in making this determination. For any potentially significant impacts, mitigation measures should be incorporated into the project to reduce the impact(s) to a level of insignificance. Chapter 4 provides guidance on mitigation measures.

CEQA requires that the project description include a list of agencies that are expected to use the EIR in their decision-making, and a list of the approvals for which the EIR will be used (State CEQA Guidelines Section 15124(d)). If the project will require a permit from the District, all applicable District regulations should be cited in the project description section of the EIR.

\textsuperscript{11} This chapter discusses how to evaluate the air quality impacts of development projects and plans. For the sake of brevity, this chapter generally refers only to "project(s)". The reader should note, however, that unless specifically noted otherwise, the discussion also addresses plans.
3.2 Environmental Setting

In order to assess whether a proposed project would have a significant air quality impact, it is necessary to prepare a detailed description of the environmental setting in which the project would be located. Developing the environmental setting, or baseline, is necessary for establishing a basis for comparing the project's subsequent air quality impacts. The environmental setting should also discuss the adverse health effects of air pollutants. With respect to air quality impacts, the description of the project's environmental setting should include the following components:

- Climate and topography influencing the project's impacts on local and regional air quality should be described. Appendix D provides an overview of how climate and topography affect air quality conditions. Appendix D also provides more detailed information on climate, topography and pollution potential for various climatological subregions in the Bay Area.

- Existing air quality conditions should be described. A discussion of trends and expected future conditions (without the project) also should be included. Data from the air quality monitoring station(s) closest to the project site should be included. Appendix C provides ambient air quality monitoring data. Appendix C also provides projections of expected emissions for future years.

- Any sensitive receptors located near the project site should be identified. Areas that are currently undeveloped but that may include sensitive receptors in the future, for example a future school site or residential area, also should be identified.

- Sources of air pollutants located near the project site (including existing sources at the project site, if applicable) should be identified. The description of existing air pollution sources should include criteria pollutants, toxic air contaminants and nuisance emissions such as odors and dust. More detailed information regarding existing emissions, including emissions of odors and toxic air contaminants, may be obtained by contacting the District.

- The transportation system serving the project site should be described. Describe traffic conditions, including traffic volumes and levels of service; transit service; and other relevant transportation facilities such as bicycle facilities, shuttle services, telecommuting centers, etc. The discussion of the existing transportation system should describe both current conditions and future conditions without the project.

- Any special circumstances, such as sources of odors, toxic air contaminants or accidental releases of hazardous materials located near the project site, should be described.

- Provide a discussion of why air pollution is a concern, including adverse health effects of criteria and toxic pollutants, nuisance impacts such as odors and dust, and other effects such as reduced visibility and plant damage. Appendix B provides information on effects of air pollution.
Special emphasis should be placed on air quality resources that are rare or unique to the region and would be affected by the project (State CEQA Guidelines Section 15125 (a)). Regulatory requirements identify areas which are pristine and classified as Class I airsheds. These airsheds are subject to specific standards (Prevention of Significant Deterioration requirements). Within the Bay Area, the Point Reyes National Seashore is designated as a Class I area. Projects proposed in the vicinity of that area should note the project’s proximity to a Class I area in the description of the project setting.

3.3 Evaluating Construction Emissions

Construction activities result in air pollutant emissions and should be addressed in environmental documents. Although construction-related emissions are generally temporary in duration, they can be substantial and can represent a significant impact on air quality. This is particularly true with respect to emissions of PM$_{10}$. Construction-related emissions come from a variety of activities including: 1) grading, excavation, roadbuilding and other earth-moving activities, 2) travel by construction equipment, especially on unpaved surfaces, and 3) exhaust from construction equipment. Demolition of buildings also generates PM$_{10}$ emissions, and is of particular concern if the building(s) contain any asbestos-bearing materials.

PM$_{10}$ emissions from construction activity can vary considerably depending on factors such as the level of activity, the specific operations taking place, and weather and soil conditions. As noted in Section 2.3, the District emphasizes implementation of effective and comprehensive control measures rather than detailed quantification of construction emissions. The District urges Lead Agencies to consider the size of the construction area and the nature of the activities that will occur, and require the implementation of all feasible control measures (indicated in Table 2).

If a Lead Agency wants to quantify construction emission, however, generalized emission factors are available. U.S. EPA has developed an approximate emission factor for construction-related emissions of total suspended particulate of 1.2 tons per acre per month of activity. This factor assumes a moderate activity level, moderate silt content in soils being disturbed, and a semi-arid climate. ARB estimates that 64% of construction-related total suspended particulate emissions is PM$_{10}$.$^{12}$ This yields the following emission factors for uncontrolled construction-related PM$_{10}$ emissions:

- 0.77 tons per acre per month of PM$_{10}$, or
- 51 lbs. per acre per day of PM$_{10}$.$^{13}$

The emission factors provided above are approximate values and do not reflect site-specific conditions and operations. EPA recommends that if construction emissions from a specific site are to be quantified, the construction process should be divided into component operations (e.g., bulldozing, loading of excavated materials, vehicular traffic, etc.) and more specific emission factors should be used. See Section 13.2.3, Heavy Construction Operations, and related sections.

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In addition to particulate emissions from earthmoving, air pollutants also are emitted in the exhaust of construction equipment. Table 7 presents emission factors for estimating construction equipment emissions (assuming an average of 0.27 gallons of fuel burned per cubic yard of earth moved). These emission factors represent a composite fleet of heavy and light duty construction equipment in the Bay Area. Emissions from construction equipment during building construction, as differentiated from earthmoving in site preparation, vary greatly from project to project. Table 7 can be used to estimate construction exhaust emissions based on gallons of fuel consumed or cubic yards of material moved. Lead Agencies also may consult the most recent edition of U.S. EPA's AP-42 for emission factors for specific types of construction equipment.

**Table 7**

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>gm/yd³*</th>
<th>gm/gallon**</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM₁₀</td>
<td>2.2</td>
<td>8.0</td>
</tr>
<tr>
<td>CO</td>
<td>138.0</td>
<td>511.0</td>
</tr>
<tr>
<td>ROG</td>
<td>9.2</td>
<td>34.0</td>
</tr>
<tr>
<td>NOₓ</td>
<td>42.4</td>
<td>157.0</td>
</tr>
<tr>
<td>SOₓ</td>
<td>4.6</td>
<td>17.0</td>
</tr>
</tbody>
</table>

* Grams per cubic yard of earth moved.  ** Grams per gallon of fuel burned.

Project construction sometimes involves the demolition of existing buildings. Demolition also produces PM₁₀ emissions. PM₁₀ emissions from demolition activities may be estimated using the following emission factor: 0.00042 lbs PM₁₀ per cubic feet of building volume. Buildings constructed prior to 1980 often include building materials containing asbestos. As noted in Section 2.3, Thresholds of Significance, the demolition, renovation or removal of asbestos-containing building materials is subject to District Regulations. The District's Enforcement Division should be consulted prior to commencing demolition of a building containing asbestos building materials.

The emission factors provided above represent uncontrolled emissions. Section 2.3, Thresholds of Significance, and Section 4.2, Mitigating Construction Impacts, provide information on mitigating construction-related emissions. If an environmental document will include quantification of construction emissions, the Lead Agency should be sure to apply the estimated control effectiveness to the appropriate emission source. For example, watering a construction site can reduce PM₁₀ emissions from earthmoving activities, but will not reduce equipment exhaust emissions.

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3.4 Calculating Emissions from Project Operations

Introduction

Several types of emissions should be considered when evaluating the impacts of a project's operations. For many types of land use development projects, the principal sources of air pollutant emissions are the motor vehicle trips generated by the project. These are often referred to as "indirect sources" and include projects such as shopping centers, office buildings, arenas and residential developments. The evaluation of an indirect source's impact should consider localized pollutants such as carbon monoxide and PM$_{10}$ as well as regional pollutants such as ozone. This section describes methods for estimating total project emissions from motor vehicles (see "Calculating Mobile Source Emissions"), as well as methods for estimating localized CO concentrations (see "Calculating Carbon Monoxide Concentrations").

Most land use projects also generate "area source" emissions. Area sources are sources that individually emit fairly small quantities of air pollutants, but which cumulatively may represent significant quantities of emissions. Water heaters, fireplaces, lawn maintenance equipment, and application of paints and lacquers are examples of area source emissions.

Certain projects also may generate stationary, or "point", source emissions. Although most area sources discussed above are usually stationary, the terms stationary or point source usually refer to equipment or devices operating at industrial and commercial facilities. Examples of facilities with stationary sources include manufacturing plants, quarries, print shops and gasoline stations.

Depending on the nature of the proposed project and/or the land uses near the project site, other air quality impacts associated with project operation may arise. These impacts include odor problems, emissions of toxic air contaminants and accidental releases of hazardous/toxic materials. Most of this chapter addresses the evaluation of the impacts a project would have on the surrounding environment. However, with respect to potential impacts related to odors, toxics, and accidental releases it is equally important to also consider the impact of the surrounding environment on the proposed project. For example, if a residential development were proposed for a site near an existing wastewater treatment plant, exposure of the new residents to objectionable odors would be a significant air quality impact associated with the project.

Calculating Mobile Source Emissions

As noted above, virtually all land use development projects result in indirect source emissions due to the motor vehicle trips generated by the project. The following discussion describes how to calculate these emissions.

Whenever possible, the air quality impact analysis for a project should be based on the results of a traffic study conducted specifically for the project. The number of vehicle trips that a project will generate, and the average speed and length of the trips, will vary depending on a variety of factors such as the specific nature of the project and its location. If project-specific data are not available, then the default values provided in this chapter may be used. The most recently
published set of trip generation rates from the Institute of Transportation Engineers (ITE) also may be used.

Transportation analyses for projects consisting of two or more land uses often adjust the number of anticipated new vehicle trips to account for internal trips. These adjustments (or “capture rates”) reflect the fact that some trips at multi-use projects will occur internally to the project. As a result, the total number of new vehicle trips associated with the project would be less than the sum of the trips expected from all of the individual land uses. Traffic studies for such projects should include a clear explanation of all capture rate assumptions. Internal trips should be excluded from the air quality analysis only if they are expected to occur by walking, bicycling or other nonpolluting mode.

Traffic studies for commercial projects often distinguish between primary trips and pass-by and diverted linked trips.\textsuperscript{15} The air quality analysis for such projects should include emissions from pass-by and diverted linked trips. While the emissions from these trips will be lower than for primary trips (due to shorter trip lengths), they still do produce emissions (trip end emissions and some running emissions). Adjustments can be made to trip length and cold start/hot start assumptions for pass-by and diverted linked trips. Assumptions regarding pass-by and diverted linked trips should be clearly identified and the underlying rationale explained.

ARB calculates motor vehicle emissions using computer models. Currently, ARB is using the Motor Vehicle Emissions Inventory model (MVEI). Motor vehicle emission factors are calculated with the EMFAC model, which is a component of MVEI. ARB periodically revises emission factors. At the time of this writing (December 1999), the most recent set of motor vehicle emission factors is MVEI7G, Version 1.0c. The emission factors provided in these Guidelines (Table 10) are based on MVEI7G,1.0c. The differences between successive versions of the model can lead to significant variation in estimates of mobile source emissions calculated using these emission factors. As of December 1999, ARB was preparing updated emission factors ("EMFAC2000"), but it is uncertain when the new emission factors will be released. As future revisions to the model are approved by ARB, the District will revise the emission factors in Table 10. Lead Agencies should always use the most recent emission factors prepared by the District.

\textbf{URBEMIS7G}

The Air Resources Board developed the URBEMIS model to calculate mobile source emissions associated with various types of land use projects, using EMFAC emission factors and ITE trip generation rates. URBEMIS calculates emissions of ROG, NO\textsubscript{x}, CO and PM\textsubscript{10}, as well as total vehicle trips. ARB's last update of the model was URBEMISS, released in 1995. In 1998, the San Joaquin Valley Unified Air Pollution Control District coordinated an update of the URBEMIS model, released as URBEMIS7G. The new version is different from previous versions in several ways. URBEMIS7G uses more recent motor vehicle emission factors, EMFAC7G, as well as updated ITE trip generation rates. It can calculate construction emissions.

\textsuperscript{15} Primary trips are trips made specifically to visit a particular facility. Pass-by trips are trips made as intermediate stops on the way to a primary trip destination. Diverted linked trips are trips attracted from roadways near a facility, but which require a diversion from the roadway to another roadway to access the facility.
and area source emissions, and also can estimate emission reductions from construction and area source mitigation measures. URBEMIS7G also can calculate air quality benefits of mitigation measures to reduce motor vehicles emissions. The model includes options to minimize “double-counting” of trips in mixed use projects and to account for “pass-by” trips.

URBEMIS7G is a sketch planning tool for calculating criteria air pollutant emissions from land use development projects. URBEMIS7G is not appropriate for calculating air pollutant emissions associated with plans. Other models, such as the Direct Travel Impact Model (DTIM), may be used to quantify (mobile source) air pollutant emissions associated with plans.

The program provides default values for all modeling parameters for several regions within California, including the San Francisco Bay Area. The user may use the default values or may provide project-specific values for parameters including trip generation, trip length, trip speed, vehicle fleet mix, percentage of cold starts, and temperature. The District recommends that the following input assumptions be used for projects in the San Francisco Bay Area. If project-specific travel data are available, that data should be used. The source(s) of any project-specific data should be described.

**Recommended URBEMIS7G Inputs for the San Francisco Bay Area**

**Trip Generation** - Use the default values for the San Francisco Bay Area or the most recent version of ITE's *Trip Generation* manual if project-specific data are not available.

**Fleet Mix** – Generally, use the default values for the San Francisco Bay Area. If evaluating a project that is likely to have a different fleet mix, e.g., an industrial project with many heavy duty vehicle trips, make the necessary adjustments.

**Temperature** - Meteorological conditions in the Bay Area vary considerably between climatological subregions. Refer to Appendix D for subregional information. Use mean summer maximum temperatures for all pollutants except CO. Use mean winter minimum temperatures for CO.

**Trip Length** - Use the data in Table 9 or the most recent edition of MTC's *Bay Area Travel Forecasts* if project-specific data are not available.

**Variable Starts** - Use the default values for the San Francisco Bay Area if project-specific data are not available.

**Trip Speed** - Use 25 mph for San Francisco and 30 mph for all other Bay Area counties if project-specific data are not available.

**Percent Trip** - Use the default values for the San Francisco Bay Area if project-specific data are not available.

The URBEMIS7G program and Users’Guide is available free of charge on the ARB’s website, at [www.arb.ca.gov/urbemis7/urbemis7.htm](http://www.arb.ca.gov/urbemis7/urbemis7.htm). Because of URBEMIS7G’s many enhancements, its
ease of use, and its ready availability, the District strongly encourages Lead Agencies to use the model to estimate motor vehicle emissions from development proposals. Because URBEMIS7G includes the most current emission factors (EMFAC7G), as well as other improvements, older versions of URBEMIS should not be used.

**Manual Calculation**

The District has developed a methodology for manually calculating mobile source emissions associated with land use development. The manual method may be useful for project screening purposes or for quickly generating rough estimates of project impacts. For this calculation it is necessary to provide the following inputs: trip generation rate, average trip length, exhaust emission factors (varying by analysis year), and trip end emission factors.

As previously noted, project-specific traffic data should be used in the air quality analysis whenever it is available. If project-specific data are not available, the default values provided in these Guidelines may be used. Table 8 provides trip generation rates for various types of land uses. The trip generation rates provided in Table 8 are based on data in the Institute of Transportation Engineers (ITE) *Trip Generation*, 6th Edition, 1997. For land use projects not included in Table 8 and for which project-specific data are not available, consult the most recent edition of ITE's *Trip Generation* manual.

Table 9 provides average trip lengths for each of the nine Bay Area counties. These trip lengths were derived from MTC travel data used by the District in the preparation of the Bay Area mobile source emission inventory.

Table 10 provides emission factors, based on MVEI7G,1.0c. The emission factors in Table 10 are representative of Bay Area driving conditions and the District's emission inventory. They reflect the mix of vehicles typical of Bay Area roadways, as well as climatic conditions assumed in the emission inventory. The emission factors also include the benefits of the 1995 motor vehicle Inspection and Maintenance program and reformulated fuels requirements.

Table 11 provides trip end emission factors. These include start emissions for ROG, NOx, and CO (reflecting cold and hot start emissions consistent with Bay Area driving conditions) and "hot soak" emissions for ROG. The total mobile source emissions from a project are the sum of trip end emissions and "running" emissions.
### TABLE 8
**AVERAGE TRIP GENERATION RATES FOR SELECTED LAND USES**

<table>
<thead>
<tr>
<th>LAND USE</th>
<th>UNIT OF MEASURE</th>
<th>TRIP RATE</th>
<th>LAND USE</th>
<th>UNIT OF MEASURE</th>
<th>TRIP RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESIDENTIAL</strong></td>
<td></td>
<td></td>
<td><strong>INDUSTRIAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Family Housing</td>
<td>D.U.</td>
<td>9.6</td>
<td>Light Industrial</td>
<td>1000 GSF</td>
<td>7.0</td>
</tr>
<tr>
<td>Apartment</td>
<td>D.U.</td>
<td>6.6</td>
<td>Industrial Park</td>
<td>1000 GSF</td>
<td>7.0</td>
</tr>
<tr>
<td>Resid. Condominium</td>
<td>D.U.</td>
<td>5.9</td>
<td>Manufacturing</td>
<td>1000 GSF</td>
<td>3.8</td>
</tr>
<tr>
<td>Mobile Home Park</td>
<td>D.U.</td>
<td>4.8</td>
<td>Warehousing</td>
<td>1000 GSF</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>RETAIL</strong></td>
<td></td>
<td></td>
<td><strong>OFFICE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount Store (Saturday)</td>
<td>1000 GFA</td>
<td>72.0</td>
<td>General Office Building</td>
<td>1000 GSF</td>
<td>11.0</td>
</tr>
<tr>
<td>Factory Outlet Center (Saturday)</td>
<td>1000 GFA</td>
<td>41.0</td>
<td>Corp. Headquarters Building</td>
<td>1000 GSF</td>
<td>7.7</td>
</tr>
<tr>
<td>Shopping Center (Saturday)</td>
<td>1000 GLA</td>
<td>50.0</td>
<td>Gov't Office Building</td>
<td>1000 GSF</td>
<td>68.9</td>
</tr>
<tr>
<td>Supermarket (Saturday)</td>
<td>1000 GSF</td>
<td>177.6</td>
<td>Medical/Dental Office Building</td>
<td>1000 GSF</td>
<td>36.1</td>
</tr>
<tr>
<td>Convenience Market (24 hour) (Saturday)</td>
<td>1000 GSF</td>
<td>863.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>INSTITUTIONAL</strong></td>
<td></td>
<td></td>
<td><strong>RECREATIONAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>1000 GSF</td>
<td>13.3</td>
<td>Office Park</td>
<td>1000 GSF</td>
<td>11.4</td>
</tr>
<tr>
<td>Community College</td>
<td>1000 GSF</td>
<td>18.4</td>
<td>Business Park</td>
<td>1000 GSF</td>
<td>12.8</td>
</tr>
<tr>
<td>Church (Sunday)</td>
<td>1000 GSF</td>
<td>36.6</td>
<td>Research and Development Center</td>
<td>1000 GSF</td>
<td>8.1</td>
</tr>
<tr>
<td><strong>LODGING</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td>Room</td>
<td>8.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motel</td>
<td>Room</td>
<td>5.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GSF = Gross Square Feet; GLA = Gross Leasable Area; GFA = Gross Floor Area; D.U. = Dwelling Unit

All rates are for weekdays unless otherwise noted.

For some land uses, trip rates will vary depending upon size of project. See the most recent edition of *Trip Generation*, Institute of Transportation Engineers.

### TABLE 9
**AVERAGE TRIP LENGTH (in miles)**
**BY COUNTY AND YEAR**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameda</td>
<td>7.7</td>
<td>7.7</td>
<td>7.7</td>
<td>7.3</td>
<td>7.0</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>7.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Marin</td>
<td>8.0</td>
<td>8.0</td>
<td>8.2</td>
<td>7.7</td>
<td>7.2</td>
</tr>
<tr>
<td>Napa</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>6.2</td>
<td>5.9</td>
</tr>
<tr>
<td>San Francisco</td>
<td>6.5</td>
<td>6.5</td>
<td>6.2</td>
<td>6.0</td>
<td>5.9</td>
</tr>
<tr>
<td>San Mateo</td>
<td>8.0</td>
<td>7.8</td>
<td>7.7</td>
<td>7.5</td>
<td>7.2</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
</tr>
<tr>
<td>Solano</td>
<td>10.4</td>
<td>10.1</td>
<td>9.8</td>
<td>8.8</td>
<td>8.2</td>
</tr>
<tr>
<td>Sonoma</td>
<td>7.2</td>
<td>7.0</td>
<td>6.9</td>
<td>6.5</td>
<td>6.2</td>
</tr>
<tr>
<td><strong>District Average</strong></td>
<td><strong>7.5</strong></td>
<td><strong>7.4</strong></td>
<td><strong>7.3</strong></td>
<td><strong>7.6</strong></td>
<td><strong>6.9</strong></td>
</tr>
</tbody>
</table>

Average trip lengths are based on MTC data used in preparation of Bay Area mobile source emission inventory.

### TABLE 10
**AVERAGE EXHAUST EMISSION RATES**

<table>
<thead>
<tr>
<th>Year</th>
<th>ROG</th>
<th>NO₂</th>
<th>CO</th>
<th>SO₂</th>
<th>PM₁₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>1.08</td>
<td>2.04</td>
<td>13.45</td>
<td>0.06</td>
<td>0.47</td>
</tr>
<tr>
<td>2000</td>
<td>0.62</td>
<td>1.42</td>
<td>7.27</td>
<td>0.03</td>
<td>0.45</td>
</tr>
<tr>
<td>2005</td>
<td>0.36</td>
<td>0.97</td>
<td>4.63</td>
<td>0.03</td>
<td>0.44</td>
</tr>
<tr>
<td>2010</td>
<td>0.22</td>
<td>0.76</td>
<td>3.66</td>
<td>0.03</td>
<td>0.44</td>
</tr>
<tr>
<td>2015</td>
<td>0.15</td>
<td>0.66</td>
<td>3.07</td>
<td>0.03</td>
<td>0.44</td>
</tr>
</tbody>
</table>

**Notes:**

1) Emission rates from CARB's MVEI7G,1.0e (5/97).
2) Fleet mix as per CARB's MVEI7G,1.0e (5/97).
3) Inspection and Maintenance Program effectiveness included.
4) Ambient temperatures consistent with District Planning Inventory (varies throughout region).
5) ROG emission rates include evaporative running loss emissions.
6) Particulate matter emission rates include exhaust, tire wear, and entrained road dust emissions.
7) Trip end emissions are not included and must be calculated separately as described in the text.
Mobile source emissions from land use projects may be calculated using the equation provided below. A separate calculation must be made for each pollutant.

\[ E = (U \times T) \times [(L \times R) + S] \]

Where:

E equals total emissions (of each pollutant), in grams per day;

U equals number of units in the project, e.g. number of dwelling units or thousands of square feet in shopping center buildings (see units in Table 8);

T equals trip generation rate, or average trips per day generated per unit of land use (Table 8);

L equals average trip length, in miles per trip (Table 9);

R equals motor vehicle emission rate, or emission factor, for each pollutant, by analysis year (Table 10);

S equals trip end emissions, comprised of start emissions for ROG, NO\textsubscript{x} and CO, and "hot soak" emissions for ROG (Table 11).

To convert grams per day to pounds per day, divide the total by 454. To convert grams per day to tons per day, divide the total by 908,000.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Year & ROG & NO\textsubscript{x} & CO \\
\hline
1995 & 3.44 & 1.89 & 49.89 \\
2000 & 2.20 & 1.35 & 35.53 \\
2005 & 1.36 & 1.08 & 21.07 \\
2010 & 0.79 & 0.89 & 12.85 \\
2015 & 0.50 & 0.78 & 8.33 \\
\hline
\end{tabular}
\caption{TRIP END EMISSION FACTORS (grams per trip)}
\end{table}

Calculating Carbon Monoxide Concentrations

Emissions and ambient concentrations of carbon monoxide have decreased greatly in recent years. These improvements are due largely to the introduction of cleaner burning motor vehicles and motor vehicle fuels. No exceedances of the State or national CO standard have been recorded at any of the region's monitoring stations since 1991. The Bay Area has attained the State and national CO standard.
Despite this progress, however, localized CO concentration still warrant concern in the Bay Area and should be addressed in environmental documents. The reasons for this are twofold. First, State and federal laws require the region to attain and maintain ambient air quality standards. The region must ensure that increased motor vehicle use and congestion do not nullify the great strides that have been made with respect to ambient concentrations of CO. Secondly, the region must safeguard against localized high concentrations of CO that may not be recorded at monitoring sites. Because elevated CO concentrations are generally fairly localized, heavy traffic volumes and congestion can lead to high levels of CO, or "hotspots," while concentrations at the closest air quality monitoring station may be below State and national standards.

A variety of computer models have been developed to estimate local CO concentrations resulting from motor vehicle emissions. One of the most common models is CALINE4, developed by and available from the California Department of Transportation. The District has developed a simplified screening method, which is based on CALINE4 and takes into account CO field studies conducted by the District in the Bay Area. The screening method enables the user to manually calculate local CO concentrations resulting from motor vehicles. Except for very large projects, the District recommends that the manual method be used to estimate CO concentrations. The resulting estimated CO concentrations should be compared to State and national CO standards to determine whether the project would have a significant air quality impact. If the results of the manual method indicate CO concentrations below the standards, then no further CO analysis is required. If the manual method predicts concentrations above the standards, the Lead Agency may either: make a finding of a significant impact and identify mitigation measures, or conduct a more detailed analysis using the CALINE4 model. Similarly, if the results of a CALINE4 analysis indicate a significant impact, mitigation measures should be identified. The effectiveness of any proposed mitigation measure(s) should be quantified by estimating the effects of the measure(s) on traffic volumes and/or speeds, and CO concentrations.

Manual Calculation of CO Concentrations

The following procedure is designed to provide a reasonable estimate of carbon monoxide concentrations near roads under worst case conditions. It is a simplified version of CALINE4. The District suggests that the full CALINE4 model be used, instead of this simplified formula, for any projects or plans that will generate 10,000 or more motor vehicle trips per day. The full CALINE4 model also may be used for smaller projects if the simplified screening method indicates that an air quality standard may be exceeded.

In the Bay Area, the highest CO concentrations usually occur in winter, on cold, clear days and nights with little or no wind. Low wind speeds inhibit horizontal dispersion and radiation inversions inhibit vertical mixing. Worst case conditions are built into the simplified model formula. Default conditions are as follows:

1. wind direction parallel to the primary roadway, 90° angle to secondary road;
2. wind speed less than 1 meter per second;
3. extreme atmospheric stability (class F);
4. receptor at edge of the roadway.

The carbon monoxide concentration, $C_t$, is the sum of a background value, $C_o$, and the total contribution from local traffic $C_p$.
\[ C = C_0 + C_t \]

The total contribution from local traffic, \( C_t \), is the sum of the contributions from each contributing local road, \( C_i \),

\[ C_t = C_{i1} + C_{i2} \]

The contribution from one road, \( C_i \), can be computed by the formula:

\[
C_i = \frac{C_{ri} \times V_i \times EF_i}{V_r \times EF_r}
\]

where:

- \( C_{ri} \) is a reference case concentration for the \( i \)-th roadway,
- \( V_r \) is the traffic volume for the reference case,
- \( V_i \) is the traffic volume for the \( i \)-th roadway,
- \( EF_r \) is the emission factor for the reference case,
- \( EF_i \) is the emission factor for the \( i \)-th roadway,

Table 12 gives reference case concentrations for various road configurations with traffic volumes of 1000 vehicles per hour and emission factors of 100 grams per mile. The concentration relative to this reference case is then computed in parts per million (ppm), by the formula:

\[
C_i = \frac{C_{ri} \times V_i \times EF_i}{100,000}
\]

where \( C_{ri} \) is taken from Table 12, \( V_i \) is the estimated traffic volume in vehicles per hour, and \( EF_i \) is the emission factor taken from Table 10 for the appropriate year of analysis.

The following discussion provides guidance on how to use the formulas provided above, and describes in detail each step of the manual method for calculating CO concentrations.
### TABLE 12
REFERENCE CARBON MONOXIDE CONCENTRATIONS (ppm)

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Primary Road (Highest Volume Road)</th>
<th>Secondary Road (Intersecting Road)</th>
<th>(receptor distance from edge—in feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At Edge</td>
<td>25'</td>
<td>50'</td>
</tr>
<tr>
<td>At Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 lane</td>
<td>14.0</td>
<td>7.6</td>
<td>5.7</td>
</tr>
<tr>
<td>4 lane</td>
<td>11.9</td>
<td>7.0</td>
<td>5.4</td>
</tr>
<tr>
<td>6 lane</td>
<td>9.5</td>
<td>6.1</td>
<td>4.9</td>
</tr>
<tr>
<td>8 lane</td>
<td>8.5</td>
<td>5.7</td>
<td>4.6</td>
</tr>
<tr>
<td>Depressed 15 feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 lane</td>
<td>20.9</td>
<td>8.2</td>
<td>4.7</td>
</tr>
<tr>
<td>8 lane</td>
<td>15.4</td>
<td>6.3</td>
<td>3.6</td>
</tr>
<tr>
<td>Depressed 30 feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 lane</td>
<td>26.8</td>
<td>7.9</td>
<td>3.4</td>
</tr>
<tr>
<td>8 lane</td>
<td>21.3</td>
<td>6.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Elevated 15 feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 lane</td>
<td>14.0</td>
<td>7.3</td>
<td>5.7</td>
</tr>
<tr>
<td>8 lane</td>
<td>8.5</td>
<td>5.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Elevated 30 feet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 lane</td>
<td>14.0</td>
<td>7.3</td>
<td>5.4</td>
</tr>
<tr>
<td>8 lane</td>
<td>8.5</td>
<td>5.4</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Notes: Normalized CO concentration is calculated based on the following assumptions: wind direction parallel to the highest volume roadway; wind speed less than 1 meter per second; extreme atmospheric stability (class F); receptor at edge of roadway; emission rate = 100 gm/mi.; vehicles per hour = 1,000; surface roughness = 100 cm; mixing cell width = roadway width (2 lane = 40 ft; 4 lane = 64 ft; 6 lane = 88 ft; 8 lane = 112 ft).

This simplified model was adapted from CALINE3 and CALINE4 (California Department of Transportation) by Mike Kim, Senior Transportation Engineer, BAAQMD.
Step by Step Procedure for CO Analysis

Make separate computations for current conditions, future no-project conditions (including cumulative), and future conditions with the project. For future year project and no-project conditions, select an analysis year corresponding to the estimated year of project completion. Also use the procedure to show the effects of mitigation measures, where such effects are quantifiable.

1. Identify intersections and/or roadway links that will be most impacted by the proposed project, according to the traffic impact analysis. An analysis should be made for each such intersection and link. (Include a map showing these points.)

2. Obtain peak-hour traffic volumes in both directions on each roadway considered for each year of consideration. If only average daily traffic is known, assume 10% for peak hour volumes. Use actual traffic counts, if available, for current year. Traffic levels for future years should include traffic generated by the proposed project plus other estimated growth distributed among roadway links.

3. Obtain the CO emission factor for each roadway, for each relevant year from Table 10. (Interpolate if necessary.)

4. Determine the number of lanes and type of each roadway. (Do not count turning or parking lanes.) If the road is to be altered, use the appropriate width for the year being analyzed.

5. Based on the number of lanes, obtain the reference one hour concentration for each roadway from Table 12. The road with the most traffic should be considered the "Primary Road". Be careful to use the proper reference factor in the table if the receptor is not at the edge of the road or if one or both of the roadways is elevated or depressed.

6. Compute each roadway's contribution to the total concentration by using the equation above. If modeling an intersection, add the concentrations of all roadways.

7. Add the total roadway (local) contribution to the one hour background value from the background map (Figure 3) to obtain the estimated worst case concentration. Interpolate between isopleth lines and apply rollback factors for future years (Table 13) to determine the appropriate background value. Refer to the discussion below for guidance on determining background values.

8. To obtain the worst case eight hour concentration, multiply the one hour value for the local contribution by 0.7 (persistence factor). Add this derived eight hour local contribution to the eight hour background level (Figure 4). Interpolate between isopleth lines and apply rollback factors (Table 13) to determine the appropriate background value. Refer to the discussion below for guidance on determining background values.
Determining Background CO Concentrations

As noted above, estimating a project's impact on ambient CO concentrations involves adding the contribution from the project to existing background levels. Background carbon monoxide is defined as that part of the ambient CO concentration that is not attributable to traffic sources from a nearby street or intersection. Thus, during stagnant conditions, the background conditions at a site may include carbon monoxide emitted from outside the modeling area, as well as carbon monoxide emitted within the modeling area during the previous time periods.

In order to determine a reasonable background CO concentration, refer to Figures 3, 4 and 5 and Table 13. Figures 3 and 4 are isopleth maps of the Bay Area Air Basin showing estimated one hour and eight hour background CO values, respectively, in parts per million (ppm) for 1992. The maps are based on 1990 to 1992 CO concentration data from multiple monitoring sites of various types located throughout the region. Table 13 provides rollback factors to be used in conjunction with the isopleth maps when determining CO background concentrations for years beyond 1992. 1992 background values may be derived from the maps according to the following procedures, after first locating the project on the map.

If the project site happens to fall on an isopleth (contour) line, use the value marked for that line. If the project is determined to be between two different isopleth lines (i.e., between 3.0 and 6.0 or between 6.0 and 9.0 ppm), interpolate to select the appropriate intermediate value. Calculate the shortest distance to the lower and higher isopleths. Call these distances X and Y, respectively. Divide X by the sum of X + Y. Multiply this quotient by 3.0 ppm, and add this product to the lower isopleth value, I. This methodology is illustrated in Figure 5 and is represented by the following formula:

\[
\left( \frac{X}{X+Y} \right) \times 3.0 \text{ ppm} + I_L = \text{CO background concentration in ppm},
\]

\[
I_L = \text{the lower isopleth concentration}
\]

\[
X = \text{shortest distance to lower isopleth}
\]

\[
Y = \text{shortest distance to higher isopleth}
\]
**TABLE 13**

**FUTURE YEAR CARBON MONOXIDE ROLLBACK FACTORS**

*Rollback Factors to be used in conjunction with Figures 3 and 4 to determine one hour and eight hour average carbon monoxide background concentrations from 1993 to 2010*

<table>
<thead>
<tr>
<th>Year</th>
<th>Rollback Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>1.0</td>
</tr>
<tr>
<td>1993</td>
<td>0.97</td>
</tr>
<tr>
<td>1994</td>
<td>0.94</td>
</tr>
<tr>
<td>1995</td>
<td>0.90</td>
</tr>
<tr>
<td>1996</td>
<td>0.87</td>
</tr>
<tr>
<td>1997</td>
<td>0.84</td>
</tr>
<tr>
<td>1998</td>
<td>0.81</td>
</tr>
<tr>
<td>1999</td>
<td>0.78</td>
</tr>
<tr>
<td>2000</td>
<td>0.75</td>
</tr>
<tr>
<td>2001</td>
<td>0.73</td>
</tr>
<tr>
<td>2002</td>
<td>0.70</td>
</tr>
<tr>
<td>2003</td>
<td>0.67</td>
</tr>
<tr>
<td>2004</td>
<td>0.65</td>
</tr>
<tr>
<td>2005</td>
<td>0.63</td>
</tr>
<tr>
<td>2006</td>
<td>0.62</td>
</tr>
<tr>
<td>2007</td>
<td>0.60</td>
</tr>
<tr>
<td>2008</td>
<td>0.59</td>
</tr>
<tr>
<td>2009</td>
<td>0.59</td>
</tr>
<tr>
<td>2010</td>
<td>0.58</td>
</tr>
</tbody>
</table>

*After the 1992 carbon monoxide background concentration has been determined, estimates of any year through 2010 can be made using the factors above. For the year desired, multiply the 1992 concentration times the appropriate factor. For example, if the 1992 concentration is 6.0 ppm, the 1999 concentration is calculated to be (6.0 ppm) x (.78) = 4.7 ppm.*

Note: Ambient concentrations of carbon monoxide are expected to decline, *on average*, in future years. This will occur because emission controls on new vehicles will reduce CO emission rates faster than vehicle travel increases. *(Local CO emissions and concentrations might increase under conditions of intense development and increasing travel. These procedures are intended to assess such situations.)*
FIGURE 3
ONE HOUR CO BACKGROUND CONCENTRATIONS
FIGURE 4

EIGHT HOUR CO BACKGROUND CONCENTRATIONS
**Figure 1A:**
Intersection of Rtes. 29 and 121 in Napa County:
An intersection project at this location would be between the 3.0 and 6.0 isopleths. The shortest distance to the 3.0 isopleth is represented by line segment X, and measures 5 mm. The shortest distance to the 6.0 isopleth is represented by line segment Y, and measures 15 mm. The background concentration for the project would thus be found as follows:

\[
\frac{5 \text{ mm}}{5 \text{ mm} + 15 \text{ mm}} = \frac{5}{20} = 0.25
\]

\[
0.25 \times (3.0 \text{ ppm}) + 3.0 \text{ ppm} = \text{the background concentration} = 3.93 \text{ ppm}
\]

**Figure 1B:**
Project on I-80 in San Ramon:
A project on this section of interstate would be between the 3.0 and 6.0 isopleths. The shortest distance to the 3.0 isopleth is represented by line segment X, and measures 2 mm. (Note that the project is roughly equidistant from 2 distinct 3.0 isopleths. One is due east, and one is due west.) The shortest distance to the 6.0 isopleth is 23 mm. The background concentration for the project would thus be found as follows:

\[
\frac{2 \text{ mm}}{2 \text{ mm} + 23 \text{ mm}} = \frac{2}{25} = 0.08
\]

\[
0.08 \times (3.0 \text{ ppm}) + 3.0 \text{ ppm} = \text{the background concentration} = 3.24 \text{ ppm}
\]
If the project is located within a "peak" on the map (i.e., within an enclosed area free of a higher isopleth), use the following procedure. (Such a peak could be above a 3.0, 6.0 or 9.0 ppm isopleth.) Measure the shortest distance to the isopleth forming the boundary of the peak. Call this distance X. Measure the distance to the centroid of the enclosure. Call this distance Z. Divide X by the sum of X + Z. Multiply this quotient by 2.9 ppm, and add this product to the boundary isopleth value, \( I_B \). This methodology is illustrated in Figure 5 and is represented by the following formula:

\[
\left\{ \left[ \frac{X}{(X + Z)} \right] \times 2.9 \text{ ppm} \right\} + I_B = \text{CO background concentration in ppm, where}
\]

\[
I_B = \text{boundary isopleth concentration}
\]

\[
X = \text{shortest distance to boundary isopleth}
\]

\[
Y = \text{distance to centroid}
\]

For projects located in areas of the map below the 3.0 isopleth, a background concentration of 2.5 ppm should be assumed.

**Example Calculation**

**Situation:** Analysis year: 2000

Intersection of 6-lane highway and a 4-lane road at grade level.

Receptor point at edge of roadway.

Background one hour CO concentration is 9.0 ppm.

Background eight hour CO concentration is 6.0 ppm.

<table>
<thead>
<tr>
<th>Primary Road</th>
<th>Secondary Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hourly Traffic Volume</td>
<td>3400</td>
</tr>
<tr>
<td>Equation</td>
<td>((9.5)(3400)(7.27))%</td>
</tr>
<tr>
<td>100,000</td>
<td>100,000</td>
</tr>
</tbody>
</table>

1-Hr Local Concentration: \(2.4 + 0.7 = 3.1\) ppm

1-Hr Total Concentration: \(3.1\) (intersection) + 9.0 (1-hr background) = 12.1 ppm

8-Hr Local Concentration: \((3.1) \times (0.7) = 2.2\) ppm

8-Hr Total Concentration: \(2.2\) (intersection) + 6.0 (8-hr background) = 8.2 ppm
Evaluating Diesel Engine Exhaust Emissions

As noted in Section 1.4, ARB in 1998 identified diesel engine particulate matter as a toxic air contaminant, and is evaluating what regulatory action may be needed to reduce public exposure. ARB and the District do not currently have recommended methodologies for Lead Agencies to use in quantifying impacts from diesel exhaust emissions. Because of the potential public health impacts, however, the District strongly encourages Lead Agencies to consider the issue and address potential impacts based on the best information available at the time the analysis is prepared. Particular attention should be paid to projects that might result in sensitive receptors being exposed to high levels of diesel exhaust. This applies both to situations where a new or modified source of emissions is proposed near existing receptors and to new receptors locating near an existing source. Facilities that may have substantial diesel exhaust emissions include the following.

- Truck stop
- Warehouse/distribution center
- Large retail or industrial facility
- High volume transit center
- School with high volume of bus traffic
- High volume highway
- High volume arterial/roadway with high level of diesel traffic

The most current information regarding ARB programs to reduce emissions from diesel engines is available at ARB’s website at http://www.arb.ca.gov/toxics/diesel/diesel.htm.

Estimating Stationary Source Emissions

Environmental documents for proposed stationary sources of air pollutants should include a detailed analysis of the project's emissions of criteria pollutants and toxic air contaminants. The document also should describe District regulations applicable to the project and summarize how project design and operations will comply with applicable regulations. Lead Agencies should consult the District's Permit Services Division for guidance on calculating emissions from stationary sources of air pollutants.

For stationary sources being evaluated at an early planning stage, only a general planning or zoning classification may be available, e.g. "research and development" or "light industry". Use of specific emission factors may be difficult. In such cases, the best estimate of future uses should be made. Where an industry designation like "electronic components" or "food processing" is known or assumed, generalized emission factors may be used. Table 14 provides generalized estimates of air contaminant emissions for various categories of industrial land uses in the region. These generalized emission factors were derived from information in the District's emission inventory. Caution should be exercised in using these figures because of the wide range of facilities under each of the categories. However, they may be useful as first estimates of contaminant levels to be expected when only the general category of development is known.
These estimates do not include emissions that can be expected from motor vehicles attracted to these facilities. The indirect source emissions should be calculated separately, as explained earlier in this chapter. Total emissions generated by a proposed project would be the sum of the direct and indirect emissions calculated.

**Table 14**

**Generalized Emission Factors for Selected Industry Groups**

<table>
<thead>
<tr>
<th>Industry Group (Sub-groups)</th>
<th>Average Emissions per Facility (lbs/acre/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Part</td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td>Food Canning (2032, 2033)</td>
<td>0.3</td>
</tr>
<tr>
<td>Paper Prod. (2643, 2647, 2649, 2653, 2654)</td>
<td>0.2</td>
</tr>
<tr>
<td>Printing &amp; Publishing (2700-2771)</td>
<td>3.5</td>
</tr>
<tr>
<td>Inorganic Chemicals (2812, 2813, 2816, 2819)</td>
<td>1.6</td>
</tr>
<tr>
<td>Paints, Varnishes, etc. (2851)</td>
<td>0.2</td>
</tr>
<tr>
<td>Organic Chemicals (2861, 2865, 2869)</td>
<td>1.4</td>
</tr>
<tr>
<td>Petroleum Refining (2911)</td>
<td>1.4</td>
</tr>
<tr>
<td>Paving &amp; Roofing (2951, 2952)</td>
<td>17.0</td>
</tr>
<tr>
<td>Plastic Products, Misc. (3079)</td>
<td>1.1</td>
</tr>
<tr>
<td>Stone, Clay, Glass &amp; Concrete Prod. (3200-3299)</td>
<td>14.0</td>
</tr>
<tr>
<td>Iron &amp; Steel Foundries (3321, 3324, 3325)</td>
<td>11.0</td>
</tr>
<tr>
<td>Metal Containers (3411, 3412)</td>
<td>0.5</td>
</tr>
<tr>
<td>Heating Equipment (3433)</td>
<td>0.1</td>
</tr>
<tr>
<td>Metal Work (3443, 3444, 3448, 3449)</td>
<td>5.3</td>
</tr>
<tr>
<td>Metal Coating (3471, 3479)</td>
<td>0.3</td>
</tr>
<tr>
<td>Machinery, except electrical (3500-3599)</td>
<td>72.0</td>
</tr>
<tr>
<td>Semiconductors, etc. (3674)</td>
<td>0.1</td>
</tr>
<tr>
<td>Electronic Components (3679)</td>
<td>0.1</td>
</tr>
<tr>
<td>Instruments (3800-3873)</td>
<td>0.3</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Electric Utility plus Other Services (4931)</td>
<td>17.0</td>
</tr>
<tr>
<td>Petroleum Bulk Stations &amp; Terminals (5171)</td>
<td>0.01</td>
</tr>
<tr>
<td>Dry Cleaning Plants (7216)</td>
<td>0.00</td>
</tr>
<tr>
<td>General Hospitals (8062)</td>
<td>2.9</td>
</tr>
<tr>
<td>National Security (9711)</td>
<td>2.8</td>
</tr>
</tbody>
</table>

* Based on U.S. Standard Industrial Classification (S.I.C.) Code groupings. As compiled by the Statistical Policy Division, Office of Management and Budget.

** Table lists total organic gases (TOG). Reactive organic gases (ROG) is virtually the same for the industrial categories.
3.5 Evaluating Odor Impacts

As noted in Chapter 2, an analysis of potential odor impacts should be conducted for both of the following situations: 1) a potential source of objectionable odors is proposed for a location near existing sensitive receptors, and 2) sensitive receptors are proposed to be located near an existing source of objectionable odors. Section 2.3 discusses thresholds of significance for odor impacts.

Odor problems vary greatly. The occurrence and severity of odor impacts depends on numerous factors, including: the nature, frequency and intensity of the source; wind speed and direction; and the sensitivity of the receptor(s). Therefore, to the extent feasible, the analysis of potential odor impacts should be based on District experience and data regarding similar facilities in similar settings. Lead Agencies should consult the District's Enforcement Division for information regarding specific facilities and categories of facilities, and associated odor complaint records.

Any project that would result in an odor source and sensitive receptors being located closer to one another than the distances indicated in Table 4 should be subjected to a more detailed analysis. (Table 4 lists types of facilities that commonly emit objectionable odors.) For any projects triggering the screening level distances in Table 4, the District's Enforcement Division should be contacted for information regarding odor complaints. For projects involving a new receptor being located near an existing odor source(s), the District's inventory of odor complaints for the nearest odor emitting facility(ies) should be reviewed for the previous three years. Odor complaints should be mapped in relation to the odor source to establish a general boundary of any existing impacts. The location of the proposed project should be identified.

For projects involving new receptors locating near an existing odor source where there is currently no nearby development, and for new odor sources locating near existing receptors, the analysis should be based on a review of odor complaints for similar facilities.

In assessing potential odor impacts, consideration also should be given to local meteorological conditions, particularly the intensity and direction of prevailing winds. Refer to Appendix D or contact the District for local meteorological data.

3.6 Evaluating Impacts of Toxic Air Contaminants

The District limits emissions of and public exposure to toxic air contaminants (TACs) through a number of programs. TAC emissions from new and modified stationary sources are limited through an air toxics new source review program, which implements the District’s Risk Management Policy via the District’s permitting process for stationary sources. TAC emissions from existing sources are limited by: 1) District adoption and enforcement of rules aimed at specific types of sources known to emit high levels of TACs (e.g., chrome plating operations), and 2) implementation of the Air Toxics "Hot Spots" (AB 2588) Program. Appendix E provides more detailed information on District air toxics programs.

16 Due to confidentiality requirements regarding odor complaints, only the block number will be provided for mapping. The name of the complainant, date of complaint, and specific address of the complainant will not be provided.
When considering potential impacts related to TACs, Lead Agencies should consider both of the following situations: 1) a new or modified source of TACs is proposed for a location near an existing residential area or other sensitive receptor, and 2) a residential development or other sensitive receptor is proposed for a site near an existing source of TACs.

For the first scenario, a source of TACs proposed near sensitive receptors, the Lead Agency should consult with the District's Toxics Evaluation Section for information regarding anticipated TAC emissions, potential health impacts and control measures. Preparation of the environmental document should be closely coordinated with the District review of the facility's permit application.

For the second scenario, sensitive receptors locating near sources of TACs, the Lead Agency should consult the District's Toxics Evaluation Section to review information gathered pursuant to the AB 2588 Program. AB 2588 requires plants emitting TACs to prepare inventories of TAC emissions from the facility. The District has prioritized these facilities based on the quantity and toxicity of the emissions, and their proximity to areas where the public may be exposed. Facilities put in a "high priority" category were required to prepare a comprehensive, facility-wide health risk assessment. The Lead Agency should review the health risk assessments for facilities subject to AB 2588 on file at the District offices. For facilities for which risk assessments have been conducted, these assessments may be used to identify an area around the facility within which individuals would be exposed to cancer or noncancer risks that would be identified as significant impacts. For facilities for which risk assessments have not been conducted, the District's Toxics Evaluation Section should be consulted to determine whether location of nearby sensitive receptors would expose individuals to cancer or noncancer risks that would be considered significant.

3.7 Evaluating Impacts of Accidental Releases of Hazardous Materials

Health and safety impacts associated with accidental releases of acutely hazardous materials (AHMs) should be evaluated when: 1) a facility storing or using AHMs is proposed near an existing residential area or other sensitive receptor, and 2) a proposed project would result in new receptors locating near an existing facility storing or using AHMs. As noted in Section 2.3, this evaluation should be based on the analyses conducted pursuant to the Risk Management Prevention Program (RMPP) process. Lead Agencies should consult with the local administering agency of the RMPP process (usually the county health department) for guidance in evaluating impacts from accidental releases.
3.8 Evaluating Cumulative Impacts

The evaluation of a project's cumulative impacts should be based on an analysis of the consistency of the project with the local general plan and the local general plan with the regional air quality plan. Refer to the discussion in Section 2.3 of these Guidelines regarding Cumulative Impacts and Plan Impacts for guidance on evaluating cumulative impacts.

3.9 Evaluating Plans

Planning documents such as city and county general plans, specific area plans and redevelopment plans should be evaluated for their potential air quality impacts. The evaluation of a plan's air quality impacts should focus on an analysis of the plan's consistency with the most recently adopted regional air quality plan. At the time of this writing, the most recently adopted regional air quality plan is the *Bay Area 1997 Clean Air Plan* (CAP). (As the CAP is updated in future years, the analysis should evaluate consistency with the updated CAP.)

To evaluate local plan consistency with the CAP, the Lead Agency should consider the following: the local plan's consistency with CAP population and vehicle use projections, the extent to which the plan implements CAP transportation control measures, and whether the plan provides buffer zones around sources of odors and toxics. Refer to Section 2.3, Thresholds of Significance, for guidance on how to determine whether a local plan is consistent with the CAP.

In most cases, quantification of future air pollutant emissions is not necessary as part of this analysis. If a Lead Agency does quantify emissions, note that the URBEMIS7G model discussed previously should not be used to analyze plan impacts. Other models, such as DTIM or BURDEN, may be more appropriate. There may be some instances where quantification of a plan's air quality impacts is appropriate. For example, a specific plan or a redevelopment plan might lead to increased traffic congestion (and possibly cause high CO concentrations) or result in substantial growth in stationary sources of air pollutants. Lead Agencies should consider including a quantitative assessment of a plan's impacts if warranted by special circumstances.
CHAPTER 4 - MITIGATING AIR QUALITY IMPACTS

4.1 Introduction

CEQA requires Lead Agencies to eliminate or minimize significant environmental impacts associated with proposed projects subject to their (discretionary) approval. If an environmental document indicates that a proposed project will have any significant environmental impacts, the document should identify feasible mitigation measures to reduce the impacts below a level of significance. If, after the identification of all feasible mitigation measures, a project is still deemed to have significant environmental impacts, the Lead Agency must adopt a Statement of Overriding Considerations to explain why further mitigation measures are not feasible and why approval of a project with significant unavoidable impacts is warranted.

The District considers a project's air quality impacts to be reduced below a level of significance if the impacts are mitigated to levels below the thresholds discussed in Chapter 2 of these Guidelines. CEQA documents should identify all significant air quality impacts that may result from a project, propose mitigation measures to reduce those impacts, and evaluate the effectiveness of the mitigation measures. To the extent feasible, the effectiveness of mitigation measures should be quantified. The analysis of mitigation measures' effectiveness should be based on reasonable assumptions, and the analysis and underlying assumptions should be clearly explained. The estimation of the effectiveness of mitigation measures is discussed further below.

This chapter provides guidance on mitigation measures that may be implemented to reduce air quality impacts from project construction and operations. The chapter also provides guidance regarding evaluating mitigation measure effectiveness, addresses mitigation monitoring and reporting requirements, and identifies other useful resources and guidance documents. The lists of mitigation measures included in this chapter are not considered to be exhaustive, and Lead Agencies and project proponents are encouraged to think creatively in devising measures to mitigate air quality impacts.

4.2 Mitigating Construction Impacts

Although the impacts from construction related air pollutant emissions are temporary in duration, such emissions can still represent a significant air quality impact. In some cases, construction impacts may represent the largest air quality impact associated with a proposed project. Construction activities such as grading, excavation and travel on unpaved surfaces can generate substantial amounts of dust, and can lead to elevated concentrations of PM$_{10}$. Emissions from construction equipment engines also can contribute to high localized concentrations of PM$_{10}$, as well as increased emissions of ozone precursors and carbon monoxide.

Control measures for construction emissions of PM$_{10}$ are discussed in Section 2.3, Thresholds of Significance. Table 2 describes a variety of measures to mitigate construction-related emissions of PM$_{10}$. Some control measures, e.g., watering the site twice daily and sweeping roadways, should be implemented at all construction sites, regardless of size. Additional measures are recommended for larger sites (over four acres) where emissions will usually be greater.
As noted previously in these Guidelines, the District does not expect Lead Agencies to provide detailed quantification of construction emissions. Similarly, Lead Agencies need not quantify emission reductions from construction-related mitigation measures. The District's recommended approach to mitigating construction emissions focuses on a consideration of whether all feasible control measures are being implemented. (See Section 2.3 for further information.) If a Lead Agency chooses to quantify the effect of construction-related mitigation measures, the Lead Agency should consult Section 13.2.3, Heavy Construction Operations, and related sections of the most recent edition of U.S. EPA's *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary, Point and Area Sources*, AP-42. (When quantifying the effectiveness of construction mitigation measures, the estimated effectiveness of each mitigation measure should be applied only to the corresponding source of emissions. For example, paving or sweeping access roads will reduce emissions of entrained dust from travel on the roadways, but will not reduce emissions from grading and earth moving.)

The discussion of construction impacts and mitigation measures in these Guidelines focuses primarily on PM_{10} emissions from fugitive dust sources. Lead Agencies seeking to reduce emissions from construction equipment exhaust should consider the following mitigation measures:

- Use alternative fueled construction equipment.
- Minimize idling time (e.g., 5 minute maximum).
- Maintain properly tuned equipment.
- Limit the hours of operation of heavy duty equipment and/or the amount of equipment in use.

### 4.3 Mitigating Air Quality Impacts Through Land Use and Design Measures

There is a growing recognition among air quality professionals that the location, intensity, configuration and design of land use development greatly influences travel behavior and air quality. Land use patterns typical of post-World War II development have contributed greatly to increases in motor vehicle use and emissions. Characteristics that contribute to automobile dependency include low residential and commercial densities, segregated land uses, and street and site design guided solely by the needs of the automobile. Air quality and transportation planners are concluding that we must reexamine the way we build our communities in order to reduce reliance on the automobile. There are myriad ways in which land use influences travel behavior. Examples of such considerations include the following:

- Are residential and commercial developments of sufficient density to support transit service?
- Are neighborhoods sufficiently "compact" to encourage walking and biking for errands, socializing, etc.?
- Are houses, jobs and services located close enough together to allow walking and biking for at least some trips?
- Does the circulation network and the design of individual streets provide a safe and attractive environment for bicyclists and pedestrians?
- Do the designs of individual development projects provide direct, safe and attractive pedestrian access to transit stops and nearby development?

- Does the community have a rough balance between the number of jobs and the number of employed residents?

Solutions do not necessarily have to occur on a grand scale. Incremental improvements can be made by actions as simple as including a neighborhood commercial center within a residential development, locating a child care center near a transit station, placing parking in the rear of a commercial building, or providing sidewalks and benches in new subdivisions or commercial development. The District strongly encourages Lead Agencies and project proponents to take advantage of every opportunity to make development projects more pedestrian-, bicycle- and transit-friendly.

In recent years, increased attention is also being paid to more ambitious solutions, such as "Transit-Oriented Development". Transit-Oriented Development (TOD) is a land use strategy which is intended to reduce the automobile dependence of typical suburban growth. TOD designs specifically emphasize the needs of pedestrians and transit users. TOD designs include features such as clustering of public and commercial uses around a "town center", a range of residential densities, narrower street widths, and a gridded street pattern. TODs can be defined as follows:

(TODs) are mixed-use neighborhoods, up to 160 acres in size, which are developed around a transit stop and core commercial area. The entire TOD site must be within an average 2,000 foot walking distance of a transit stop. Secondary areas of lower density housing, schools, parks, and commercial and employment uses surround TODs for up to one mile.\(^\text{17}\)

TODs may come in various shapes and sizes, depending on the surrounding built environment. "Urban TODs" are oriented toward rail stations and express bus stops, and are characterized by a greater proportion of employment-generating land uses and higher commercial and residential densities. "Neighborhood TODs" are more appropriate for high frequency bus routes and feeder routes, and place greater emphasis on housing and local-serving shopping and services.

Improved coordination of land use and transportation planning and greater emphasis on making communities more transit-, bicycle- and pedestrian-friendly can reduce reliance on the automobile for all kinds of trips: trips to work, shopping, school, recreation, personal business. Such strategies can result in many other benefits to the community as well, such as reduced traffic congestion, energy conservation, preservation of open space, improved water quality (fewer contaminants in urban run-off), and more attractive, cohesive communities.

Land use considerations also can reduce air quality problems not related to motor vehicle use. By separating residential areas and other sensitive receptors from sources of odors, dust and

toxic air contaminants, health and nuisance impacts can be minimized. Buffer zones should *always* be provided between sensitive receptors and sources of odors, dust, toxics and accidental releases of hazardous materials. (As noted in Section 2.1, Early Consultation, some infill and mixed use projects occasionally may result in sensitive receptors and sources of odors or toxics being in close proximity. Lead Agencies are encouraged to promote infill and mixed use development, but should avoid locations that would lead to health or nuisance impacts to sensitive receptors.)

Many land use and design measures can be implemented on a project-by-project level. For instance, the site plan for a commercial development can promote pedestrian access by locating parking lots in the rear of the building and placing building entrances near transit stops and sidewalks. Or the circulation plan for a residential subdivision can provide dedicated bicycle routes and direct pedestrian access to transit stops and adjacent development. (As noted in Section 2.1, Early Consultation, land use and design measures targeted at individual projects should be addressed as early in the development review process as possible so as to minimize costs to developers and local government and increase the likelihood of implementation.)

Many land use and design measures, however, are most effective if implemented community-wide, or even at the subregional level. Issues such as allowable land use densities, mixing of land uses, street standards, parking requirements, etc. are most appropriately addressed throughout the entire community or subregion. Policy documents such as general plans and specific area plans, as well as implementing mechanisms such as zoning ordinances, parking standards and design guidelines, may need to be revised. Ad hoc implementation of these strategies to individual projects can still be beneficial, even absent a community-wide strategy, but the benefits will be greater if implemented broadly. For example, a 1993 study by U.C. Berkeley researchers examined the effects of (rail) transit-based development on transit ridership.\(^{18}\) The study found that residents of higher density housing located near rail transit stations commuted by rail at much higher rates than did residents living further away from transit stations. The study concluded, however, that the increases in transit ridership were much more pronounced if the worksite also was located near a transit station and if the worksite charged for parking. In other words, concentrating housing near transit helps, but the location and parking policies of the destinations are also critical factors.

Therefore, the District strongly encourages local governments to examine local plans and implementing programs to look for opportunities to better coordinate land use, transportation and air quality planning. To the extent that cities and counties can make their communities more transit-, bicycle- and pedestrian-friendly, and minimize land use conflicts that lead to toxics and nuisance problems, the need to mitigate significant air quality impacts of individual development proposals will be minimized. The District and ABAG have jointly prepared a guidance document to assist local governments in developing these strategies, *Improving Air Quality Through Local Plans and Programs, A Guidebook for City and County Governments.* Copies are available from ABAG. Appendix F of these Guidelines lists additional resources that may be useful.

\(^{18}\) Cervero, Robert, "Ridership Impacts of Transit-Focused Development in California", for the National Transit Access Center, November 1993.
A study released by the ARB in June 1995 may be especially useful to Lead Agencies considering land use strategies to reduce air pollutant emissions. The report, prepared by JHK & Associates, is titled *Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emissions: An Indirect Source Research Study*. The report discusses a number of land use strategies that can reduce motor vehicle use and emissions:

- Provide pedestrian facilities.
- Increase density near transit corridors.
- Increase density near transit stations.
- Encourage mixed-use development.
- Encourage infill and densification.
- Develop concentrated activity centers.
- Strengthen downtowns.
- Develop interconnected street network.
- Provide strategic parking facilities.

The report provides estimates of the measures’ effectiveness in reducing vehicle use and emissions in various types of communities (urban, suburban and exurban). The estimated ranges of effectiveness are based on quantitative data from existing California communities. It is hoped that by identifying ranges of effectiveness for the land use measures, local officials will be able to set performance goals (e.g., vehicle trips or emissions per household) for their communities. The report recommends combinations of strategies to achieve the performance goals, and provides guidance on implementation mechanisms. One of the study’s findings is that although it is difficult to quantify reductions in vehicle use and emissions from individual strategies applied at individual sites, combinations of strategies implemented community-wide can achieve significant reductions in vehicle use and emissions. The report is available from ARB’s Transportation Strategies Group.

### 4.4 Mitigating Impacts of Project Operations

#### Introduction

In many cases, motor vehicles traveling to and from a facility represent the principal source of air pollutants associated with the project. Therefore, this section focuses primarily on measures to reduce mobile source emissions by reducing motor vehicle trips and vehicle miles traveled. If the procedures outlined in Chapters 2 and 3 of these Guidelines indicate that a project's motor vehicle emissions would be a significant impact, mitigation measures should be identified to reduce the impact to a level of insignificance.

A wide variety of measures may be implemented to reduce air pollutant emissions resulting from land use development. The appropriateness of a given mitigation measure depends on a number of factors, such as the type and size of project being proposed, the location and characteristics of the community in which the project will be located, neighboring land uses, availability of transit, etc. For example, consider the provision of bicycle racks and showers and lockers at a worksite in order to encourage commuters to bike to work. Such measures will be more effective in a
community with a comprehensive network of bicycle routes and fairly flat terrain than in a community with poor bicycle access and hilly terrain. Lead Agencies and project proponents should carefully consider the specific nature of the project and its setting when developing mitigation measures.

**Estimating the Effectiveness of Mitigation Measures for Project Operations**

To the extent feasible, the effectiveness of proposed mitigation measures should be quantified. Because the measures' effectiveness will depend greatly on the specific characteristics of the project and its setting, this quantification should be based on a project-specific analysis whenever possible. For mitigation measures to reduce vehicle use, this means conducting a travel analysis for the project using appropriate local modeling inputs.

Tables 15 and 16 identify mitigation measures that may be used to reduce motor vehicle emissions from commercial and residential projects, respectively. The tables provide estimates of each measure’s effectiveness in reducing vehicle trips. In cases where a range of estimated effectiveness is provided, the low end of the range should be used unless local conditions warrant a higher figure. The column of supporting factors should be consulted to see if a higher figure is justified. The effectiveness estimates are based on a review of published literature and represent what the District believes to be reasonable expectations regarding effectiveness. However, the percentages in Tables 15 and 16 are default values, and should be used only in the absence of project-specific analysis.

Several cautionary notes regarding estimating the effectiveness of mitigation measures are warranted.

**Clearly explain the assumptions underlying the environmental document’s analysis of mitigation measures’ effectiveness.** The analysis should specifically describe the mitigation measure, identify the source(s) of air pollutants that are expected to be affected by the measure, clearly explain how and to what extent the measure will affect the source(s), and identify the basis for the estimate (empirical observations, computer modeling, case studies, etc.). Critical assumptions should be linked to the mitigation monitoring and reporting program. For example, if the environmental analysis for a commercial development assumes that 20% of employees will carpool to work, then such an objective should be included in the mitigation monitoring and reporting program as a test of whether the measure is being implemented.

**Be specific regarding implementation of mitigation measures.** The environmental document should describe each mitigation measure in detail, identify who is responsible for implementing the measure, and clearly explain how and when the measure will be implemented. Methods for assessing the measure's effectiveness once it is in place, and possible triggers for additional mitigation if necessary, are also desirable. This level of detail regarding mitigation measure implementation frequently is not addressed until the preparation of the mitigation monitoring and reporting program, which often takes place very late in the environmental review process. In order to reliably assess the effectiveness and feasibility of mitigation measures, however, the District believes it is necessary to
consider the specifics of mitigation measure implementation as early in the environmental review process as possible.

Be sure not to double count the effect of proposed mitigation measures. The project description and assumptions underlying the analysis of project impacts should be carefully considered when estimating the effect of mitigation measures. If certain conditions or behavior are assumed in the impact analysis, then credit may not be claimed when proposing mitigation measures. For example, if the traffic and air quality analyses for a proposed project assume that a certain percentage of people will access the project by transit or bicycle, then any credit claimed for transit- or bicycle-related mitigation must clearly demonstrate effectiveness above and beyond the mode split assumed in the impact analysis.

In some cases it simply may not be possible to quantify the effect of proposed mitigation measures. It may be that the specific conditions surrounding a particular project are so unique as to render extrapolation from other examples unreliable. A proposed measure may be innovative, with little precedent. The combined effects of a package of measures may be too difficult to quantify. While a certain degree of professional judgment is usually involved in estimating the effectiveness of mitigation measures, overly speculative estimates should be avoided. If the Lead Agency cannot quantify mitigation effectiveness with a reasonable degree of certainty, the environmental document should at least address effectiveness qualitatively. If the Lead Agency makes a finding that non-quantified mitigation measures reduce an impact to a level of insignificance, the document should provide a detailed justification of that conclusion.

Mitigating Impacts from Motor Vehicles

Several general approaches can be taken to reduce emissions from motor vehicles:

- Reduce vehicle trips. These measures reduce air pollutant emissions by eliminating entirely some of the vehicle trips associated with a project. An example would be the provision of bicycle facilities to encourage bicycle use instead of driving.

- Reduce vehicle miles traveled. These measures reduce emissions by reducing the length of vehicle trips associated with a project. An example would be the provision of satellite offices/telecommuting centers to reduce the distance of employee commute trips.

- Use of low emission vehicles. These measures do not aim to reduce trips or VMT, but rather promote the use of fuels that are less polluting than gasoline or diesel. An example would be the conversion of a vehicle fleet to operate on compressed natural gas.

- Improve traffic flows/reduce congestion. These measures reduce emissions by reducing traffic congestion and/or reducing stops and starts. This allows vehicles to operate at steady and moderate speeds, and thus lowers pollution per mile traveled. An example would be timing the traffic signals on an arterial to facilitate uninterrupted travel.
• Support measures. These measures may not directly reduce emissions, but rather support and facilitate other emission reduction strategies. An example would be a guaranteed ride home program implemented at a worksite in order to encourage employees to use commute alternatives by allaying concerns over being without a vehicle in case of emergency.

Emission reduction measures from each of the above categories can be implemented in combination with one another. (Support measures, by definition, are implemented to reinforce other emission reduction strategies.) In general, the District prefers measures that reduce vehicle trips entirely, as they achieve the greatest emission reductions. (This is because vehicle emissions are highest during the first several miles of a trip.) Strategies to reduce VMT should also be pursued, however. Reducing VMT has a greater impact on PM\textsubscript{10} emission than other pollutants, because PM\textsubscript{10} emission (due to entrained road dust) are more directly correlated to VMT. Measures to encourage low emission vehicles are also desirable, especially for projects that include a sizable fleet of vehicles (delivery services, taxis, airport shuttles, airport ground support equipment, etc.). Traffic flow improvements may be beneficial if congestion is a major factor in the air quality impact, but particular caution is warranted to avoid traffic-inducing effects of increased roadway capacity.

There is an increasing range of alternatively-fueled, low emission vehicles and equipment available on the market. Examples include light and medium duty automobiles and vans, heavy duty trucks and buses, and specialty equipment such as forklifts, construction equipment, parking enforcement vehicles, and airport ground support equipment. Compressed natural gas-powered vehicles and electric vehicles (EVs) are probably the most common in the Bay Area, but other fuels such as liquefied natural gas and propane are also in use. Emerging technologies such as hybrid electric vehicles and fuel cells also are promising.

While the District urges Lead Agencies to emphasize measures to reduce trips and VMT, careful consideration should always be given to opportunities to promote use of low emission fuels. Low emission vehicles and equipment are particularly well suited in situations where there is a large fleet of vehicles, at large facilities (either a single facility or a conglomeration of multiple facilities in proximity) where there may be the critical mass to justify a fueling facility, and at projects where trip reduction strategies are less promising due to specific circumstances (e.g., little or no transit service, poor bike/ped access, etc.). Low emission vehicles and equipment also are a good complement to trip reduction strategies. For trips that can't or won't be eliminated, low emission vehicles reduce emissions with little or no change in behavior. Use of low emission vehicles and equipment will help implement mobile source control measures in the 1997 CAP that aim to increase the use of this equipment.

Table 17 provides examples of low emission vehicle projects that may be appropriate at a variety of land uses. Lead Agencies and project proponents should always consider such opportunities when devising mitigation strategies. More information on low emission vehicles and equipment is available at the websites listed below.

The District administers several programs that provide funding assistance for low emission vehicles and infrastructure. Information on these programs, as well as information on low emission vehicle technology in general, is available on the District's website at
www.baaqmd.gov/planning/plntrns/tfcapage.htm. ARB and the U.S. Department of Energy also provide extensive information on low emission vehicles at www.arb.ca.gov/altfuels/altfuels.htm and www.afdc.nrel.gov, respectively.

If a project may result in public exposure to high levels of diesel exhaust, the Lead Agency should propose mitigation measures to reduce this impact. Although the District does not currently (as of December 1999) provide a methodology for quantifying the effectiveness of these measures, they should be given careful consideration. In addition to reducing toxic diesel exhaust emissions, these measures also will reduce emissions of NOx and PM10. Possible mitigation measures include the following.

**Heavy Duty Truck Emissions**
- Truck stop electrification – minimize truck idling for heating, air conditioning and refrigeration units
- Conversion to cleaner engines
- Use of cleaner (reduced sulfur) fuel
- Regular maintenance – keep equipment well tuned
- Add-on control devices, e.g., particulate traps, catalytic oxidizers
- Buffer zone between facility and sensitive receptors

**Heavy Duty Bus Emissions**
- Conversion to cleaner engines
- Use of cleaner (reduced sulfur) fuel
- Regular maintenance – keep equipment well tuned
- Reduce idling
- Add-on control devices, e.g., particulate traps, catalytic oxidizers
- Buffer zone between facility and sensitive receptors

**Other Mobile Equipment Emissions (construction equipment, locomotives, marine vessels)**
- Conversion to cleaner engines
- Use of cleaner (reduced sulfur) fuel
- Regular maintenance – keep equipment well tuned
- Add-on control devices, e.g., particulate traps, catalytic oxidizers
- Buffer zone between facility and sensitive receptors
<table>
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<tr>
<th>Mitigation Measure</th>
<th>Supporting Factors to Enhance Effectiveness</th>
<th>Effectiveness</th>
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<tbody>
<tr>
<td><strong>Rideshare Measures</strong></td>
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<tr>
<td>Implement carpool/vanpool program e.g.,</td>
<td>• Employer provides support measures such as carpool/vanpool subsidies, preferential parking, guaranteed</td>
<td>1% - 4% (work trips)</td>
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<td>carpool ridematching for employees,</td>
<td>ride home program, etc.</td>
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<tr>
<td>assistance with vanpool formation,</td>
<td>• Coordinate with regional ridesharing organization, e.g., RIDES for Bay Area Commuters.</td>
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<td>provision of vanpool vehicles, etc.</td>
<td>• Multiple smaller worksites coordinate programs.</td>
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<td></td>
<td>• Limited parking supply and/or implementation of parking fees or parking cash-out.</td>
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<td><strong>Transit Measures</strong></td>
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<td>Construct transit facilities such as bus turnouts/bus</td>
<td>• Transit service with frequent headways available at project or on roadways adjacent to project.</td>
<td>0.5% - 2% (all trips)</td>
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<td>bulbs, benches, shelters, etc.</td>
<td>• Transit use incentives for employees, e.g., on-site distribution of passes, subsidized transit passes, etc.</td>
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<td></td>
<td>• Transit route maps and schedules posted at stops.</td>
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<td>• Shade trees/landscaping planted at transit stops.</td>
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<td>Design and locate buildings to facilitate transit</td>
<td>• Jurisdiction provides design guidelines addressing transit accessibility.</td>
<td>0.1% - 0.5% (all trips)</td>
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<tr>
<td>access, e.g., locate building entrances near transit</td>
<td>• Consultation with transit provider during project design, review.</td>
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<td>stops, eliminate building setbacks, etc.</td>
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<td><strong>Services Measures</strong></td>
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<td>Provide on-site shops and services for employees, such</td>
<td>• Sufficient number of employees at worksite, or cooperation among multiple worksites.</td>
<td>0.5% - 5% (work trips)</td>
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<td>as cafeteria, bank/ATM, dry cleaners, convenience</td>
<td>• Safe, direct pedestrian access between employment and retail areas.</td>
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<td>market, etc.</td>
<td>• Jurisdiction provides density bonuses, other incentives to encourage mixed land uses.</td>
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<tr>
<td>Provide on-site child care, or contribute to off-site</td>
<td>• Sufficient number of employees at worksite, or cooperation among multiple worksites.</td>
<td>0.1% - 1% (work trips)</td>
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<tr>
<td>child care within walking distance.</td>
<td></td>
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<tr>
<td>Shuttle Measures</td>
<td>Description</td>
<td>Impact</td>
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| Establish mid-day shuttle service from worksite to food service establishments/commercial areas. | • Sufficient number of employees at worksite, or cooperation among multiple worksites.  
• Commercial area located within 3 miles.  
• Frequent, scheduled service during lunch hours.  
• Coordination among multiple employers, e.g., at business parks.  
• Provide commute shuttle to transit station, use same vehicle for mid-day shuttle. | 0.5% - 1.5% (work trips)            |
| Provide shuttle service to transit stations/multimodal centers.                | • Major transit facility/multimodal center located within 3 miles of project.  
• Transit use incentives for employees, e.g., on-site distribution of passes, subsidized transit passes, etc.  
• Frequent, scheduled service during peak commute periods.  
• Coordination among multiple employers, e.g., at business parks.  
• Free or subsidized service.  
• Provide mid-day shuttle to commercial areas, use same vehicle for commute shuttle. | 1% - 2% (work trips)                |

<table>
<thead>
<tr>
<th>Parking Measures</th>
<th>Description</th>
<th>Impact</th>
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<tr>
<td>Provide preferential parking (e.g., near building entrance, sheltered area, etc.) for carpool and vanpool vehicles.</td>
<td>• Most effective if parking supply is limited and/or located far from building entrance.</td>
<td>0.5% - 1.5% (work trips)</td>
</tr>
</tbody>
</table>
| Implement parking fees for single occupancy vehicle commuters.                | • Reduced or waived fees for carpools and vanpools.  
• Complemented by transit, ridesharing programs, other commute alternatives.  
• Revenues used to support commute alternatives.  
• Provisions in place to avoid offsite parking spillover. | 2% - 20% (work trips)               |
| Implement parking cash-out program for employees (i.e., non-driving employees receive transportation allowance equivalent to value of subsidized parking). | • Complemented by transit, ridesharing programs, other commute alternatives.  
• Implement at worksites not subject to State parking cash-out requirements.  
• Tax benefits if travel allowance offered as transit/ridesharing subsidy.  
• Provisions in place to avoid offsite parking spillover. | 2% - 20% (work trips) |
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<tr>
<td><strong>Bicycle and Pedestrian Measures</strong></td>
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| Provide secure, weather-protected bicycle parking for employees. | • Bicycle parking location is more convenient than auto parking.  
• Project located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle lane.  
• Significant number of employees live within 5 miles of worksite.  
• Employer provides bicycle support measures, e.g., bicycle route maps, tools for emergency repairs, etc. | 0.5% - 2% (work trips) |
| Provide safe, direct access for bicyclists to adjacent bicycle routes. | • Local jurisdiction has adopted comprehensive bicycle plan.  
• Significant number of employees live within 5 miles of worksite.  
• Employer provides bicycle support measures, e.g., bicycle route maps, tools for emergency repairs, etc.  
• Provide push buttons or sensors to activate traffic signals. | 0.5% - 2% (work trips) |
| Provide showers and lockers for employees bicycling or walking to work. | Significant number of employees live within 5 miles (bicycling)/2 miles (walking).  
- Project located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle lane.  
- Employer provides bicycle support measures, e.g., bicycle route maps, tools for emergency repairs, etc. | 0.5% - 2% (work trips) |
| Provide secure short-term bicycle parking for retail customers and other non-commute trips. | Bicycle parking location is more convenient than auto parking.  
- Project located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle route. | 1% - 2% (non-work trips) |
| Provide direct, safe, attractive pedestrian access from project to transit stops and adjacent development. | Jurisdiction provides design guidelines addressing pedestrian accessibility.  
- Pedestrians separated from traffic, parking areas.  
- Shade trees/landscaping planted at pedestrian areas.  
- Benches, fountains, other amenities provided to enhance pedestrian environment. | 0.5% - 1.5% (all trips) |

<table>
<thead>
<tr>
<th><strong>Other Measures</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement compressed work week schedule (e.g., 4/40, 9/80).</td>
</tr>
</tbody>
</table>
| Implement home-based telecommuting program. | Participation increased if employer provides/assists with provision of equipment (modem, computer, etc.).  
- Especially effective if employee commute trips are long. | 0.5% - 1.5% (work trips) |
<table>
<thead>
<tr>
<th>Mitigation Measure</th>
<th>Supporting Factors to Enhance Effectiveness</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide neighborhood-serving shops and services within or adjacent to (1/4-1/2</td>
<td>• Direct pedestrian/bicycle access is available.</td>
<td>1% - 4% (all trips)</td>
</tr>
<tr>
<td>mile) residential project.</td>
<td>• Medium or high residential densities located closer to commercial areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Jurisdiction has design guidelines addressing issues such as pedestrian access, parking, compatibility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with neighboring land uses, etc.</td>
<td></td>
</tr>
<tr>
<td>Provide transit facilities, e.g., bus bulbs/turnouts, benches, shelters, etc.</td>
<td>• Transit service is available in or adjacent to project.</td>
<td>0.2% - 2% (all trips)</td>
</tr>
<tr>
<td></td>
<td>• Project is of sufficient density to support transit service.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transit service with frequent headways.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Consultation with transit provider during project design, review</td>
<td></td>
</tr>
<tr>
<td>Provide shuttle service to regional transit system or multimodal center.</td>
<td>• Transit station or multimodal center located within 5 miles of project.</td>
<td>0.1% - 0.5% (all trips)</td>
</tr>
<tr>
<td></td>
<td>• Medium to high residential densities.</td>
<td></td>
</tr>
<tr>
<td>Provide shuttle service to major destinations such as employment centers,</td>
<td>• Destinations located within 5 miles of project.</td>
<td>0.1% - 0.3% (all trips)</td>
</tr>
<tr>
<td>shopping centers, schools.</td>
<td>• Medium to high residential densities.</td>
<td></td>
</tr>
<tr>
<td>Provide bicycle lanes and/or paths, connected to community-wide network.</td>
<td>• Local jurisdiction has adopted comprehensive bicycle plan.</td>
<td>0.1% - 2% (all trips)</td>
</tr>
<tr>
<td></td>
<td>• Project is located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle lane.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Routes are direct and convenient, not curving recreational paths.</td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td>Benefits</td>
<td>Impact</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
</tbody>
</table>
| Provide sidewalks and/or paths, connected to adjacent land uses, transit stops, and/or community-wide network. | • Destinations such as commercial areas, schools, parks, community centers, etc. are located nearby.  
• Cul-de-sacs are discouraged, or easements are provided for pedestrian access.  
• Shade trees/landscaping provided. | 0.1% - 1% (all trips) |
| Provide satellite telecommute centers in large residential developments. | • Most effective if residential area is located far from employment centers | 0.1% - 1.5% (work trips) |
| Provide interconnected street network, with a regular grid or similar interconnected street pattern. | • Multiple ingress/egress points are available.  
• Large, multi-lane arterials are discouraged.  
• Reduced street widths and curb radii.  
• Cul-de-sacs are discouraged.  
• Street trees required. | 1% - 5% (all trips) |
<table>
<thead>
<tr>
<th>Electric Vehicles/Equipment</th>
<th>Office (office building, office park)</th>
<th>Retail (large retail building, shopping center, mall)</th>
<th>Institutional (airport, university, hospital, etc.)</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install EV charging facility</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Provide EVs in vehicle fleet</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Preferential parking location for EVs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reduced/no parking fee for EVs</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Use electric lawn &amp; garden equipment</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Use electrically powered specialty equipment, e.g., utility carts, airport ground support equipment, etc.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Require/provide incentives for airport tenants to use electrically powered shuttles, GSE, rental cars, etc.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Provide electrical power in garage/driveway for EV charging</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Provide electrical power outdoors to allow use of electric lawn &amp; garden equipment</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>At multifamily residential projects, provide EV charging facilities and/or preferential parking for EVs</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

**Compressed Natural Gas Vehicles/Equipment**

<table>
<thead>
<tr>
<th>Provide CNG vehicles in vehicle fleet</th>
<th>Office (office building, office park)</th>
<th>Retail (large retail building, shopping center, mall)</th>
<th>Institutional (airport, university, hospital, etc.)</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferential parking location for CNG vehicles</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reduced/no parking fee for CNG vehicles</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Install CNG fueling facility</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Use CNG specialty equipment, e.g., utility carts, airport ground support equipment, etc.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Require/provide incentives for airport tenants to use CNG powered shuttles, GSE, rental cars, etc.</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

**Other Vehicles/Equipment**

<table>
<thead>
<tr>
<th>Use propane powered specialty equipment, e.g., forklifts, utility carts, airport GSE, etc.</th>
<th>Office (office building, office park)</th>
<th>Retail (large retail building, shopping center, mall)</th>
<th>Institutional (airport, university, hospital, etc.)</th>
<th>Residential</th>
</tr>
</thead>
</table>
4.5 Mitigating Odor Impacts

Projects that have a significant odor impact because they place sources of odors and members of the public near each other should establish a buffer zone to reduce odor impacts to a less than significant level. The dimensions of the buffer zone must ensure that the encroaching project does not expose the public to nuisance levels of odorous emissions. In establishing the appropriate dimensions of the buffer zone, the Lead Agency should consider actions currently being taken at the facility to control odors, as well as any future actions to which the facility is firmly committed. A safety margin also should be considered in establishing a buffer zone to allow for future expansion of operations at the source of the odors.

In order to reduce the dimensions of the buffer zone, add-on control devices (e.g., filters or incinerators) and/or process modifications implemented at the source of the odors may be feasible, depending on the specific nature of the facility. Lead Agencies should consult the District’s Enforcement Division for further information regarding add-on controls and process modifications to control odors. Odor mitigation measures that are targeted at the receptors (e.g., residential areas) that rely on sealing buildings, filtering air or disclosure statements are not appropriate mitigation measures to be used in lieu of buffer zones or technical controls.

4.6 Mitigating Impacts from Toxic Air Contaminants and Accidental Releases of Hazardous Materials

A project would have a significant impact if it resulted in members of the public being close enough to either 1) a source of toxic air contaminants (TACs) or 2) a potential source of accidental releases of hazardous materials, such that the thresholds described in Section 2.3 would be exceeded. To mitigate such impacts, a buffer zone should be provided between the source and the receptors. The appropriate dimensions of the buffer zone will depend on a variety of factors, including the nature of the activities occurring at the source, the types and quantities of materials being stored or used at the facility, and local topography and meteorology.

As discussed in Section 2.3, the determination of significant impact with respect to accidental releases should be based on analyses prepared pursuant to the Risk Management Prevention Program (RMPP). RMPP analyses will be key inputs in establishing the appropriate dimensions of buffer zones around potential sources of accidental releases. Lead Agencies should consult with the local administering agency of the RMPP process (usually the county health department) when establishing buffer zones around sources of accidental releases to assure that the thresholds described in Section 2.3 are not exceeded.

The determination of significance with respect to TAC emissions will generally be based on analyses conducted as part of the District’s permitting process and/or implementation of the Air Toxics “Hot Spots” (AB 2588) program. Section 3.6 describes processes for evaluating
potential TAC impacts. These analyses will assist Lead Agencies in establishing buffer zones and, if necessary, identifying other mitigation measures to reduce TAC impacts.

In most cases, control devices and/or changes in industrial processes may be implemented at the source(s) in order to reduce the risk from TAC emissions or accidental releases. All feasible measures to reduce risks from TAC emissions and accidental releases should be implemented. While such measures may reduce the necessary dimensions of a buffer zone, they do not obviate the need to maintain buffer zones to protect public health and safety. This is particularly true in situations where residential development (or any other sensitive receptor) is encroaching on an existing source of TACs or accidental releases. Also, as noted above regarding odor impacts, mitigation measures for TACs or accidental releases (such as disclosure statements, sealing of buildings, community alert procedures, etc.) that are targeted at potential receptors are not appropriate mitigations to be used in lieu of buffer zones or technical controls.

4.7 Mitigation Monitoring and Reporting

State law requires that when a public agency makes findings based on an EIR that mitigation measures are required to avoid or lessen significant environmental effects identified in the EIR, the public agency must adopt a reporting or monitoring program for those mitigation measures (California Public Resources Code, Section 21086.6). This requirement is intended to assure that mitigation measures included in a certified EIR are indeed implemented. A mitigation monitoring and reporting program should include the following components:

- A description of each mitigation measure adopted by the Lead Agency.
- The party responsible for implementing each mitigation measure.
- A schedule for the implementation of each mitigation measure.
- The agency or entity responsible for monitoring mitigation measure implementation.
- Criteria for assessing whether each measure has been implemented.
- Enforcement mechanism(s).

Although the mitigation monitoring and reporting program is not required to be included in the EIR, the District recommends that the Lead Agency do so. This will encourage the Lead Agency and other entities to specifically consider the feasibility and effectiveness of each mitigation measure while the environmental analysis is still underway.

If a responsible agency or any agency having jurisdiction over natural resources affected by the project proposes mitigation measures, the Lead Agency may require that agency to prepare a monitoring and reporting program for those mitigation measures.
APPENDIX A - AIR QUALITY LAWS, PROGRAMS AND STANDARDS

This appendix summarizes the major federal and State laws, regulations and programs that establish the legal framework for protecting and improving air quality in the Bay Area. Some of these regulations have air quality improvement as their primary purpose. Others deal with air quality within the context of other public objectives. Table A-1 summarizes national and State ambient air quality standards — the quantitative air quality objectives that the Bay Area is required to attain.

FEDERAL PROGRAMS

Federal Clean Air Act and 1990 Clean Air Act Amendments. National ambient air quality standards (NAAQS) were established in 1970 by the federal Clean Air Act for six pollutants: carbon monoxide, ozone, particulate, nitrogen dioxide, sulfur dioxide and lead. These pollutants are commonly referred to as "criteria" pollutants because they are considered the most prevalent air pollutants that are known to be hazardous to human health and because criteria documents, including ambient air quality standards, have been prepared for each of these contaminants.

The Act required states exceeding the NAAQS to prepare air quality plans showing how the standards were to be met by December 1987. The Act was amended in 1977, and again in 1990, to extend the deadline for compliance and require that revised State Implementation Plans (SIP) be prepared. Failure to submit and implement an acceptable plan meant a state could be denied federal highway funding and/or be required to increase emission offsets for industrial expansion. The 1990 Clean Air Act Amendments established categories of air pollution severity for nonattainment areas ("marginal" to "extreme"). SIP requirements varied, depending on degree of severity. (For a discussion of the Bay Area's portion of the California SIP, see "Bay Area Regional Agencies and their Programs" below.)

The conformity provisions of the Act are essentially designed to ensure that federal agencies contribute to, instead of jeopardizing, efforts to achieve the NAAQS. In November of 1993, U.S. EPA issued two regulations implementing these provisions. The transportation conformity regulation deals with transportation projects. The general conformity regulation addresses actions of federal agencies other than the Federal Highway Administration and the Federal Transit Administration.

The primary requirements of transportation conformity of note to Lead Agencies are that transportation plans and programs cannot produce more emissions than were budgeted for in the latest SIP. Projects receiving federal funds or approvals also must undergo localized air quality modeling. Finally, emissions from local projects with no federal funding must be included in regional plans and programs, if the sponsoring agency receives any federal funds.
# TABLE A-1 Ambient Air Quality Standards

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Time</th>
<th>California Standards&lt;sup&gt;1,3&lt;/sup&gt;</th>
<th>National Standards&lt;sup&gt;1,3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone</td>
<td>1 Hour</td>
<td>0.09 ppm</td>
<td>0.12 ppm</td>
</tr>
<tr>
<td></td>
<td>8 Hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>8 Hour</td>
<td>9.0 ppm</td>
<td>9 ppm</td>
</tr>
<tr>
<td></td>
<td>1 Hour</td>
<td>20 ppm</td>
<td>35 ppm</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>Annual Average</td>
<td></td>
<td>0.053 ppm</td>
</tr>
<tr>
<td></td>
<td>1 Hour</td>
<td>0.25 ppm</td>
<td></td>
</tr>
<tr>
<td>Sulfur Dioxide</td>
<td>Annual Average</td>
<td>80 µg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 Hour</td>
<td>0.04 ppm</td>
<td>365 µg/m³</td>
</tr>
<tr>
<td></td>
<td>1 Hour</td>
<td>0.25 ppm</td>
<td></td>
</tr>
<tr>
<td>Fine Particulate Matter (PM&lt;sub&gt;10&lt;/sub&gt;)</td>
<td>Annual Arithmetic Mean</td>
<td>50 µg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual Geometric Mean</td>
<td>30 µg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 Hour</td>
<td>50 µg/m³</td>
<td>150 µg/m³</td>
</tr>
<tr>
<td>Fine Particulate Matter (PM&lt;sub&gt;2.5&lt;/sub&gt;)</td>
<td>Annual Arithmetic Mean</td>
<td>15 µg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 Hour</td>
<td>65 µg/m³</td>
<td></td>
</tr>
<tr>
<td>Sulfates</td>
<td>24 Hour</td>
<td>25 µg/m³</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>Calendar Quarter</td>
<td>1.5 µg/m³</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>30 Day Average</td>
<td>1.5 µg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Hour</td>
<td>0.03 ppm</td>
<td></td>
</tr>
<tr>
<td>Vinyl Chloride (chloroethene)</td>
<td>24 Hour</td>
<td>0.010 ppm</td>
<td></td>
</tr>
<tr>
<td>Visibility Reducing Particles&lt;sup&gt;5&lt;/sup&gt;</td>
<td>8 Hour (10 am to 6 pm PST)</td>
<td>10-mile visual range when relative humidity is less than 70%</td>
<td></td>
</tr>
</tbody>
</table>

---

**FOOTNOTES**

1. California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, fine particulate matter, and visibility reducing particles are values that are not to be exceeded. The standards for sulfates, lead, hydrogen sulfide, and vinyl chloride are not to be equaled or exceeded. If the standard is for a 1-hour, 8-hour or 24-hour average (i.e., all standards except for lead and the PM<sub>10</sub> annual standard), then some measurements may be excluded. In particular, measurements are excluded that ARB determines would occur less than once per year on the average.

2. National standards other than for ozone and those based on annual averages or arithmetic means are not to be exceeded more than once a year. The ozone standard is attained if, during the most recent 3-year period, the average number of days per year with maximum hourly concentrations above the standard is one or less.

3. National air quality standards are set at levels determined, by the U.S. Environmental Protection Agency, to be protective of public health with an adequate margin of safety. The State of California has set more stringent standards for a number of contaminants, based on independent medical judgment.

4. In 1997 EPA established an 8-hour standard for ozone, and annual and 24-hour standards for very fine particulate matter (PM2.5). The new standards were challenged in court, and as of December 1999 their status was uncertain.

5. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range when relative humidity is less than 70 percent.
General conformity applies to a wide range of actions or approvals by federal agencies. Potentially covered by the regulation are actions of concern to local governments such as decisions on wastewater treatment facilities and airport expansions. Essentially, projects are subject to general conformity if they generate more emissions than minimum thresholds set in the rule (currently 100 tons per year of ROG, NOx, or CO in the Bay Area), and that are not specifically exempted by the regulation. Such projects are required to fully offset or mitigate the emissions caused by the action. This includes both direct emissions and indirect emissions over which the federal agency has some control.

The U.S. EPA also has programs for identifying and regulating toxic air pollutants (air toxics). The Clean Air Act Amendments of 1990 directed EPA to set standards for air toxics and to require facilities to sharply reduce emissions of controlled chemicals. The 1990 Amendments specified 174 industrial sources that are to be regulated. An industry is classified as a major source — and must be regulated — if it emits ten tons per year of any of the listed air toxics, or a combination of 25 tons or more of all listed air toxics.

**National Environmental Policy Act (NEPA).** NEPA requires that major projects to be conducted or approved by the federal government be subject to environmental assessments. If the potential for significant adverse environmental impacts exists, an Environmental Impact Statement (EIS) must be prepared and circulated to affected jurisdictions and the interested public.

**Intermodal Surface Transportation Efficiency Act, 1991 (ISTEA).** This law requires a regional transportation planning process that includes consideration of 15 factors, two of which address consistency with adopted land use plans and potential environmental effects. ISTEA also provides funds for transportation projects and activities that contribute to meeting air quality standards, including transit, pedestrian, and bicycle-oriented projects. The Congestion Management and Air Quality Improvement Program (CMAQ) directs funds toward transportation projects that will contribute to the attainment of NAAQS for ozone and carbon monoxide. The funds are distributed based on population size and severity of a region's air pollution problem.

**California Programs**

**California Clean Air Act, 1988.** The 1988 California Clean Air Act (CCAA), amended in 1992, requires regions to develop and implement strategies to attain California's ambient air quality standards. For some pollutants, the California standards are more stringent than the national standards. In addition to the six criteria pollutants regulated by the federal Clean Air Act, California has established standards for three other pollutants: hydrogen sulfide, sulfates, and vinyl chloride. In general, the CCAA requires regions like the Bay Area, which exceed certain State air quality standards for criteria pollutants, to reduce emissions of harmful pollutants by five percent or more per year or implement all feasible measures to meet the state air quality standards as expeditiously as possible. Regional air quality management districts like the BAAQMD must prepare air quality plans specifying how State
standards would be met. State agencies are required to implement a number of statewide automobile emission control regulations, including the "Smog Check" program.

**State Motor Vehicle Emission Control Program.** The California Air Resources Board (ARB) regulates the amount of pollutants that can be emitted by new motor vehicles sold in California. California motor vehicle emission standards are more stringent than the federal standards and have become increasingly more stringent since they were first imposed in 1961 by the State Motor Vehicle Pollution Control Board (the predecessor to the ARB). To help meet the State ambient air quality standards, the ARB has instituted regulations that will require manufacturers selling vehicles in California to manufacture and phase-in a proportion of motor vehicles in the following categories: Transitional Low Emission Vehicles, Low Emission Vehicles, Ultra-Low Emission Vehicles, and Zero Emission Vehicles (e.g., electric vehicles — 10% of California-sold vehicles by 2003). These requirements apply to passenger vehicles and are intended to reduce emissions of carbon monoxide, reactive hydrocarbons, and nitrogen oxides. The ARB has also set requirements for the distribution of alternative fuels.

ARB also has implemented a heavy duty vehicle inspection program, which applies to diesel-powered trucks and buses. The ARB is also working on fuel requirements that would reduce toxic emissions from motor vehicles. The California Bureau of Automotive Repair continues to administer the vehicle inspection and maintenance program (I/M or "Smog Check" Program).

**Air Toxics "Hot Spots" Information and Assessment Act, 1987.** The Air Toxic "Hot Spots" Information and Assessment Act was enacted by the California Legislature to identify toxic air contaminant hot spots where emissions from specific sources may expose individuals to elevated risk of adverse health effects. The State Department of Health Services and the Air Resources Board work together to administer the provisions of this Act statewide, but its implementation and enforcement are the responsibility of local/regional air districts. The Act requires that a business or other establishment, identified as a significant source of toxic emissions, notify the affected population and provide them with information about health risks posed by the emissions. (While not part of the Hot Spots program, the State of California Health and Safety Code, Section 25534 allows "Administering Agencies" — usually county health departments — to require "Risk Management and Prevention Plans" of facilities which handle hazardous materials.) Appendix E provides further information on the Air Toxics "Hot Spots" program.

**California Planning Law and Guidelines.** The State of California does not require air quality elements for general plans. Seven elements are mandated by the California Government Code. Air quality is mentioned as an optional issue in the "Conservation" element. Nonetheless, the District has been urging all cities and counties in the Bay Area to include an air quality element or section in their general plans since 1986.

One of the most important features of California general plans is that even though air quality elements are not mandated, general plans are required by law to be consistent with any air
quality policies and programs that exist within local jurisdiction. Local plans must also be consistent with regional air quality plans such as the Bay Area Clean Air Plan.

California Transportation Plan. The most recent State transportation plan prepared by Caltrans addresses air quality, and cites the funding of transportation control measures (TCMs) as a high priority. In addition, telecommuting is promoted as well as other "nonstructural" transportation solutions such as: reducing demand, increasing transit service, and implementing market-based measures (e.g., a demonstration project of congestion pricing on the San Francisco-Oakland Bay Bridge).

Bay Area Regional Agencies and Their Programs

Bay Area Air Quality Plan, 1979 and 1982. The Bay Area Air Quality Plan is a regional plan required by the federal government. It is prepared jointly by the District, the Metropolitan Transportation Commission (MTC), and the Association of Bay Area Governments (ABAG) to address how the Bay Area will attain the NAAQS. The plan contains stationary source controls, motor vehicle emission controls, and transportation system improvement measures that would reduce the amount of air pollutants released into the atmosphere. These measures are implemented primarily by the District, ARB and MTC, respectively.

The federal Clean Air Act (1970, 1977) required the District, MTC and ABAG to prepare the first Bay Area Air Quality Plan in 1979 and then amend it in 1982. Its primary objective was to attain NAAQS by 1987. The 1982 Air Quality Plan required that: (1) major stationary sources install emission control devices, (2) new sources apply for air quality permits, (3) registered Bay Area vehicles pass a vehicle inspection and maintenance program (e.g., "Smog Check") every two years, (4) transportation control measures be implemented, and (5) MTC assess the conformity of regional transportation plans, programs and projects to air quality objectives.

Although these requirements resulted in significant air quality improvement, the Bay Area failed to attain NAAQS for carbon monoxide and ozone by 1987. In 1989, in response to a court order, MTC implemented contingency measures to assure that the Bay Area was making all reasonable further progress toward attaining NAAQS. These measures included additional transportation control measures and a revised conformity assessment procedure.

Ozone Maintenance Plan, 1993. Through 1989, the Bay Area air basin had continued to violate the national ozone standard. Under the 1990 federal Clean Air Act amendments, the Bay Area was classified as a "moderate" nonattainment area for the national ozone standard. But because of significant improvements in Bay Area air quality over the last couple of decades, the number of exceedances of the national ozone standard declined greatly. Air quality monitoring data from 1990 to 1994 indicated that the region had attained the national ozone standard. Based on monitoring data collected from 1990 to 1992, the District, MTC and ABAG requested in 1993 that the U.S. EPA redesignate the Bay Area as an attainment area and approve the Ozone Maintenance Plan. In June, 1995 U.S. EPA approved the
request and the Bay Area was redesignated an attainment area with respect to the national ozone standard. EPA also approved the Ozone Maintenance Plan.

**Ozone Attainment Plan, 1999.** Hot stagnant weather in the summers of 1995 and 1996 led to exceedances of the national 1-hour ozone standard, leading U.S. EPA in 1998 to redesignate the region back into nonattainment status for the national 1-hour ozone standard. EPA's redesignation required the region to prepare a plan with three principal elements: 1) a 1995 emission inventory for ROG and NOx, 2) an assessment of the reductions in these precursor pollutants needed to attain the national standard by 2000 ("attainment assessment"), and 3) a control strategy of adopted regulations and/or control measures sufficient to meet reasonable further progress and attain the 1-hour standard no later than November 15, 2000. The attainment assessment estimates the amount by which ROG and NOx emissions must be reduced between 1995 and 2000 in order to meet the national 1-hour ozone standard of 0.12 parts per million, and the control strategy describes how these reductions will be achieved.

The *San Francisco Bay Area Ozone Attainment Plan* was prepared by the three co-lead agencies: the District, MTC and ABAG. The Plan includes control measures to reduce emissions from stationary, area and mobile sources sufficient to achieve the necessary emission reductions by June 2000. The Plan also includes contingency measures in case the control measures do not result in attainment by the deadline. The Plan was adopted by the co-lead agencies in June 1999. The Plan was approved by ARB in July 1999 and transmitted to U.S. EPA.


**Bay Area Clean Air Plan, 1997.** The *Bay Area 1997 Clean Air Plan* (CAP) was prepared pursuant to the 1988 California Clean Air Act. Prepared by the District in cooperation with MTC and ABAG, its main objective is to attain the State air quality standards for ozone. The CAP presents a comprehensive strategy to reduce emissions from stationary, area and mobile sources. The CAP includes a specific measure which encourages cities and counties to develop and implement local plans, policies and programs to reduce auto use and improve air quality. The California Clean Air Act requires regions to update their (State) air quality plans every three years. The CAP will be updated in 2000.

Under the California Clean Air Act nonattainment classifications, the Bay Area is classified as a "serious" air basin for ozone. (The state classification system for nonattainment areas uses the designations "Moderate," "Serious," "Severe," and "Extreme.") The region had been classified a "moderate" air basin for CO, but the region was redesignated an attainment area
for the State CO standard in 1994 and thus the Act's planning requirements for CO nonattainment areas no longer apply to the Bay Area. The CAP must indicate how the District will attain the State ozone standard by the earliest practicable date, including: (1) additional control measures for existing stationary sources, (2) a permitting program that will result in no net increase in emissions from new stationary sources, (3) provisions for indirect source controls, and (4) transportation control measures.

The prime objective of transportation control measures (TCMs) is to reduce vehicle trips and vehicle miles traveled within the region. These measures are geared toward the following: (1) trip reduction, (2) mobility improvements, (3) implementation support, (4) traffic operation management, (5) user incentives, and (6) pricing strategies.

The CAP also strives to reduce emissions by implementing additional and more stringent stationary source control measures. These include measures to control emissions from surface coating and solvent use, fuels/organic liquids storage and distribution, refinery and chemical processes, combustion of fuels, and other industrial/commercial processes.

The California Clean Air Act expanded the scope and accelerated the pace of air pollution control efforts in California. If possible, air quality plans should achieve a reduction in district-wide emissions of 5% per year for each nonattainment pollutant or its precursors. As an alternative strategy (employed in the Bay Area CAP), the adoption of all feasible measures on an expeditious schedule is acceptable, even if a district is unable to achieve 5% annual reduction.

Other legal requirements applicable to the Bay Area include the following:

- Indirect source and area source control programs.

- A regional public education program.

- Transportation controls to achieve a 1.4 average vehicle ridership during weekday commute hours by 1999, substantial reduction in the rate of increase of vehicle trips and vehicle miles traveled and no net increase in motor vehicle emissions after 1997.

- An assessment of cost-effectiveness of proposed control measures.

- Transport mitigation requirements.

**Toxic Air Contaminant Control Program.** The Toxic Air Contaminant Control Program is a regional program administered by the District. Its main objective is to reduce public exposure to toxic air contaminants. Appendix E provides further information on the District's Air Toxics program.

**Odorous Substances Regulation.** The District has enacted an odorous substance control program as part of its effort to control the use and emission of odorous substances within the Bay Area. This program places general limitations on odorous substances and provides the
District with authority to respond to public complaints about offensive odors. The regulation is intended to help the public identify and control offensive odors that are not otherwise controlled by other federal or State air quality laws.

**Regional Transportation Plan, 1994.** The Metropolitan Transportation Commission’s Regional Transportation Plan (RTP) guides Bay Area transportation system improvement projects and shows how they will help attain regional air quality objectives. The plan promotes projects that will provide reasonable and predictable mobility within the region, ensure that all people have equitable access to transportation, support a healthy environment and mitigate any adverse impacts, and promote economic vitality within the region. The plan identifies and evaluates the Bay Area Metropolitan Transportation System, a network of regionally significant streets and highways, transit systems and intermodal transfer facilities, and recommends projects that will improve its performance. Many of these recommendations implement federal (1982 Bay Area Air Quality Plan and contingencies) and state (94 CAP) TCMs.

**Congestion Management Program.** Each county in the state is required to establish a Congestion Management Agency (CMA) and prepare a Congestion Management Program (CMP). The main goals of the CMP are to establish a political process through which countywide roadway congestion can be controlled or relieved, and to develop a comprehensive strategy to respond to countywide transportation needs. State law requires that each CMA prepare, implement and biennially update the CMP. The CMP consists of the following basic elements: (1) a transportation network that includes State highways and principal arterials, (2) traffic level of service (LOS) standards for the CMP network, (3) performance measures to evaluate current and future multimodal system performance for the movement of people and goods, (4) a travel demand program to promote travel by alternative transportation modes (non-single-occupancy vehicle), (5) a land use impact analysis program to evaluate land use development impacts on the CMP network, and (6) a multi-year capital improvement program (CIP) to fund transportation projects that support CMP goals. The CMP must be updated biennially to reflect changing transportation needs and conditions within the county. The CMP CIP must be submitted to MTC every two years to be incorporated into the Bay Area Regional Transportation Improvement Program.

If traffic conditions on a roadway segment or intersection fall below the LOS standard, the local jurisdiction is required to develop a Deficiency Plan. In some instances, cities and counties may be monitoring LOS based upon transportation models, attempting to predict conditions in the future. The intent is to develop plans for deficient segments prior to the actual occurrence of a deficiency. The CMP statutes direct the District to establish and periodically update a list of improvements, programs and actions which can be used by local governments in developing Deficiency Plans. The list should include items that "...measurably improve multimodal performance, and contribute to significant improvements in air quality, such as improved public transit service and facilities, improved non-motorized transportation facilities, high occupancy vehicle facilities, parking cash out programs, and transportation control measures." The statutes also state that "if an improvement, program, or action is not on the approved list, it shall not be implemented unless approved by the local
air quality management district." In 1992, the District prepared the *Deficiency List: Programs, Actions and Improvements for Inclusion in Congestion Management Program Deficiency Plans*. Subsequent consultation with Bay Area CMAs has not indicated a need to revise the deficiency list.

**Transportation Fund for Clean Air (AB 434).** Assembly Bill 434 (Sher, 1991) established a vehicle registration surcharge to fund specified TCMs. This bill gave the District the authority to impose a $4 surcharge on motor vehicle registrations within the Bay Area to pay for programs that reduce mobile source emissions. These fees generate approximately $17 million per year. The District directly allocates 40 percent of the funds to county program managers who then distribute the funds to agencies sponsoring eligible projects. The District allocates the remaining 60 percent regionwide to public agencies sponsoring the most cost-effective projects.

The projects and programs eligible for AB 434 funds are: (1) ridesharing and trip reduction programs, (2) clean fuel buses for schools and transit operators; (3) feeder bus/shuttle service to rail and ferry stations and airports; (4) local arterial traffic management; (5) rail-bus integration and regional transit information; (6) congestion pricing and low emission vehicle demonstration projects; (7) vehicle buy back; (8) a smoking vehicle program (citizen reports to the District about vehicles with visible exhaust); and (9) bicycle facility improvements.
APPENDIX B - AIR POLLUTANT SOURCES AND EFFECTS

This appendix discusses the harmful effects of air pollutants on health and other qualities of life and the environment. Sources of air pollution are described. Appendix C provides more detailed information on air pollutant emissions in the Bay Area.

CRITERIA CONTAMINANTS — HEALTH EFFECTS AND SOURCES

Criteria contaminants are those air pollutants for which ambient air quality standards have been set by the United States Environmental Protection Agency or the California Air Resources Board. Most of the criteria contaminants are generated to a large degree by motor vehicles, as well as by industry and other stationary sources. Appendix C provides further detail regarding the sources of each criteria contaminant in each county of the Bay Area.

Carbon Monoxide (CO) is an odorless, colorless gas. It is formed by the incomplete combustion of fuels. The single largest source of CO is the motor vehicle. Emissions are highest during cold starts, hard acceleration, stop-and-go driving, and when a vehicle is moving at low speeds. New findings indicate that CO emissions per mile are lowest at about 45 mph for the average light-duty motor vehicle and begin to increase again at higher speeds.

When inhaled at high concentrations, CO combines with hemoglobin in the blood and reduces the oxygen-carrying capacity of the blood. This results in reduced oxygen reaching the brain, heart and other body tissues. This condition is especially critical for people with cardiovascular diseases, chronic lung disease or anemia, as well as fetuses. Even healthy people exposed to high CO concentrations can experience headaches, dizziness, fatigue, unconsciousness, and even death.

Ozone (O₃), or smog, is not emitted directly into the environment, but is formed in the atmosphere by complex chemical reactions between oxides of nitrogen and reactive organic gases (ROG) in the presence of sunlight. Ozone formation is greatest on warm, windless, sunny days. The main sources of nitrogen oxides (NOₓ) and ROG, often referred to as ozone precursors, are combustion processes (including motor vehicle engines) and the evaporation of solvents, paints and fuels. As with CO, automobiles are the single largest source of ozone precursors in the Bay Area. Tailpipe emissions of ROG follow CO. They are highest during cold starts, hard acceleration, stop-and-go conditions, and slow speeds. They decline as speeds increase up to about 50 mph, then increase again at high speeds and high engine loads. ROG emissions associated with evaporation of unburned fuel depends on vehicle and ambient temperature cycles. Nitrogen oxide emissions exhibit a different curve; emissions decrease as the vehicle approaches 30 mph and then begin to increase with increasing speeds.

Ozone levels usually build up during the day and peak in the afternoon hours. Short-term exposure can irritate the eyes and cause constriction of the airways. Besides causing shortness of breath, it can aggravate existing respiratory diseases such as asthma, bronchitis and emphysema. Chronic exposure to high ozone levels can permanently damage lung tissue. Ozone can also damage plants and trees, and materials such as rubber and fabrics (see Non-Health Effects, below).
Nitrogen dioxide \((NO_2)\) is a reddish brown gas that is a by-product of combustion processes. Automobiles and industrial operations are the main sources of \(NO_2\). Aside from its contribution to ozone formation, nitrogen dioxide can increase the risk of acute and chronic respiratory disease and reduce visibility. \(NO_2\) may be visible as a coloring component of a brown cloud on high pollution days, especially in conjunction with high ozone levels.

Sulfur dioxide \((SO_2)\) is a colorless acid gas with a strong odor. It has potential to damage materials and it can have health effects at high concentrations. It is produced by the combustion of sulfur-containing fuels, such as oil, coal and diesel. Sulfur dioxide can irritate lung tissue and increase the risk of acute and chronic respiratory disease.

\(PM_{10}\) (Particulate matter 10 microns or less in diameter) refers to a wide range of solid or liquid particles in the atmosphere, including smoke, dust, aerosols, and metallic oxides. Some particulate matter, such as pollen, is naturally occurring. However, in the Bay Area most particulate matter is caused by combustion, factories, construction, grading, demolition, agricultural activities and motor vehicles. Extended exposure to particulate matter can increase the risk of chronic respiratory disease. \(PM_{10}\) is of concern because it bypasses the body’s natural filtration system more easily than larger particles, and can lodge deep in the lungs. Thus, the U.S. EPA and the state of California revised their PM standards several years ago to apply only to these fine particles.

As with CO and ozone precursors, motor vehicles constitute the single largest source of \(PM_{10}\) in the Bay Area, based on the best available data. Motor vehicles produce particulates through direct tailpipe emissions of particulate matter; direct emissions of nitrogen oxides, which become particulate ammonium nitrate in the atmosphere; and the kicking up of road dust by tires. Vehicles also produce \(PM_{10}\) from brake pad and tirewear. Motor vehicles are currently responsible for about half of Bay Area particulates.

Fine particulate pollution is an example of a problem that is projected to increase in the Bay Area as motor vehicle use increases, though there may be short-term decreases. For instance, when construction activity is reduced during a recession, direct construction dust is reduced. Therefore there is less dirt spilled on roads via trucks and other mobile equipment, reducing the amount of dust that can be resuspended by the tires of passing motor vehicles. But, as seen in the graph of Bay Area Emissions Inventory Projections (in Appendix C), total \(PM_{10}\) emissions are expected to increase, and the proportion attributable to motor vehicles will also increase. Resuspended road dust has not been reduced by improvements in motor vehicle air pollution controls. In fact, road dust is expected to continue to increase unless there is a reduction in motor vehicle use and adoption of dust control measures. Dust control measures may be needed at construction sites, unpaved roads and parking lots, agricultural and other area sources that emit dust directly into the ambient air and/or convey mud and dirt to roadways.

Wood burning in fireplaces and stoves is another large source of fine particulates. The District and consultants have recently analyzed the results of a study of the sources of particulates at two monitoring sites in San Jose. In and near downtown San Jose — and
perhaps in many other parts of the Bay Area — wood smoke can contribute up to 40% of the particulate mix during the winter months. Wood burning alone may cause exceedances of California's particulate standard.19

Among the criteria pollutants that the District regulates, particulates appear to represent the most serious overall health hazard. Studies in a number of cities have demonstrated statistically significant correlations between daily and average annual particulate levels and mortality. According to one estimate, elevated particulate levels contribute to the death of approximately 200 people annually for the Bay Area.20 Other studies, which include findings from the Bay Area, yield higher estimates of mortality — 300 to 500 deaths per year in the Bay Area — based on a one percent increase in mortality per 10 micrograms per cubic meter increase in PM$_{10}$ levels.2122 High levels of particulates have also been known to exacerbate chronic respiratory ailments, such as bronchitis and asthma, and have been associated with increased emergency room visits and hospital admissions.

TOXIC AIR CONTAMINANTS

In addition to the criteria pollutants listed above, another group of pollutants, commonly referred to as toxic air contaminants (TACs) or hazardous air pollutants, has received increasing scrutiny in recent years and warrant concern for several reasons. First, the health effects can be quite severe. Many hazardous air pollutants are confirmed or suspected carcinogens, or are known or suspected to cause birth defects or neurological damage. Secondly, many hazardous air pollutants can be toxic at very low concentrations. For some chemicals, such as carcinogens, there are no thresholds below which exposure can be considered risk-free.

Industrial facilities are significant sources of toxic air contaminants. Rather than coming out of a smokestack, however, toxic contaminants often result from "fugitive emissions," such as leaking valves and pipes. The electronics industry, including semiconductor manufacturing, has the potential to contaminate both air and water due to the highly toxic chlorinated solvents commonly used in semiconductor production processes. Sources of air toxics go beyond industry, however. Various common urban facilities also produce hazardous pollutants, such as gasoline stations (benzene), hospitals (ethylene oxide), and dry cleaners (perchloroethylene). Automobile exhaust also contains toxic air pollutants such as benzene and 1,3-butadiene. (Lead as a gasoline additive has been phased out in California). District research indicates that mobile source emissions of benzene and 1,3-butadiene represent a substantial portion of the ambient background risk from toxic air contaminants in the Bay

19Chow, Judith, and David Fairley et al., "Source Apportionment of Wintertime PM$_{10}$ at San Jose, California," Journal of Environmental Engineering, May 1995.
Area. Reformulated fuel requirements that have already been adopted are expected to reduce, but not eliminate, mobile source TAC emissions.

**Non-Health Effects Of Air Pollution**

**Visibility Reduction**

Visibility reduction and discoloration of the sky are obvious effects of air pollution. Reduced visibility may be caused by the brownish haze of nitrogen dioxide or by the accumulation of particulate matter in the atmosphere. When particles are present in sufficient quantities, distant objects become obscured. Visibility reduction is primarily caused by emissions from the following sources:

- Construction and demolition.
- Auto exhaust, diesel soot, and resuspended road dust.
- Wood burning, incineration, and other combustion activities.
- Particles or aerosols formed by photochemical reactions occurring in the atmosphere.
- Agricultural and mining activities.
- Stationary sources such as cement kilns and refineries.
- Naturally occurring particles from salt water, vegetation, soil, and wind erosion processes.
- Atmospheric particles, normally too small to affect visibility, which grow to visibility-reducing size through the process of agglomeration (clustering) or through condensation, where moisture condenses on small particles causing them to grow to visibility-reducing size.

Visibility in the Bay Area can vary dramatically, depending on meteorological conditions. The major factors causing these fluctuations are the amount of moisture in the air, the strength of the air currents, and the volume of air available for dilution and dispersion of visibility-reducing particles. Under adverse weather conditions, particularly high heat and intense sunlight, some or all of the factors discussed above cause visibility to become very restricted. These conditions are especially common in summer and early fall.

During the winter months, visibility-reducing particles from photochemical activity are greatly diminished due to colder temperatures and the decreased intensity of ultraviolet light. Thus, when restricted visibility occurs during this period, it is often caused by smoke and dust particles and the growth of particles through agglomeration and condensation.

**Effects on Materials**

Air pollution effects on materials vary widely in type and severity among the different contaminants. For example, ozone, the primary constituent of photochemical smog, can
harden and crack rubber materials, causing them to lose their flexibility. It also affects other types of synthetic materials. For example, it can weaken nylon, and can cause fabric dye fading and paint damage.

Other pollutants in combination produce synergistic effects, causing greater damage than each could cause alone. The interaction of sulfur dioxide and particulate matter has a greatly enhanced ability to corrode materials such as steel, iron, copper, zinc, tin, and stone. In some industries, extensive measures must be taken to protect equipment from polluted air. In the aerospace industry, for example, where silver and other metals used in sensitive electronic equipment are particularly vulnerable to corrosion, great care must be taken to protect components.

Particles settling on buildings, automobiles, outdoor furniture, and other surfaces are usually considered to be nuisances causing soiling, even when they do not produce damage to health or materials.

Plant Damage

The effects of air pollution on plants, crops, and forests depend both on plant susceptibility and the types of pollutants involved. Plant damage is difficult to assess because damage is often manifested as stunted growth or diminished yields, rather than the death of the plant.

Among the recorded effects of air pollution on plants are flower and foliage discoloration; bloom failure; plant malformation; leaf, needle, and fruit drop; and failure of fruit to ripen. Particularly vulnerable to ozone damage are grapes, lettuce, spinach and many garden flowers and shrubs. Additionally, some greenhouse crops, including flowers and some herbs, suffer damage when certain hydrocarbon levels are elevated.

Localized plant damage has been noted in the Bay Area from other gases, including nitric oxide, hydrogen chloride, formaldehyde, sulfur dioxide, and fluorides. Sulfur dioxide, for example, is particularly damaging to pasture crops and leafy vegetables. And although a highly localized problem, fluoride threatens both plants and animals. The susceptibility of plants to fluoride damage varies greatly; apricots, grapes, strawberries, bulb crops, and conifers have low resistance. The more serious effect is seen in animals, who may consume fodder that offers no detectable signs of damage but in fact contains relatively high concentrations of fluorides. Over a period of time, animals build up a concentration of fluorides in their tissues, which eventually leads to fluorosis, a bone disease.
APPENDIX C - AIR POLLUTION — STATUS, PROBLEMS AND TRENDS

Monitoring Data and Attainment Status

The District operates a regional air quality monitoring network that regularly measures the concentrations of the five major criteria air pollutants. Figure C-1 indicates the location of the District's permanent monitoring stations and lists the pollutants monitored at each station. Tables C-1, C-2, C-3 and C-4 summarize the exceedance records for the last decade for ozone, CO and PM_{10}.

Air quality conditions in the San Francisco Bay Area have improved significantly since the District was created in 1955. Ambient concentrations and the number of days on which the region exceeds standards have declined dramatically. Following years of declining emissions and ambient concentrations, the Bay Area in 1995 was redesignated as an attainment area for the national 1-hour ozone standard. However, hot stagnant weather led to new exceedances of the national ozone standard in the summers of 1995 and 1996. As a result, U.S. EPA in 1998 redesignated the region back as a nonattainment area for the national 1-hour ozone standard. Table C-1 summarizes recent monitoring data with respect to the national 1-hour ozone standard.

The Bay Area also violates the State ozone standard. The State 1-hour ozone standard, 9 parts per hundred million (9 ppb), is considerably more stringent than the national standard of 12 ppb. Table C-2 indicates the number of days the State ozone standard has been exceeded in recent years.

The region has made significant progress in reducing carbon monoxide levels in the Bay Area. The District's air monitoring records of 1992 through 1998 demonstrate attainment of the national and State 8-hour standard, and neither the national 1-hour standard nor the State 1-hour standard has been exceeded since the 1980s. The Bay Area is now an attainment area for the State and national CO standard. Table C-3 summarizes recent monitoring data for the State and national CO standard.

With regard to fine particulate matter (PM_{10}), the State standard has been exceeded fairly frequently in recent years. The national standard was exceeded a few times in 1990 and 1991, but has not been exceeded since then. Table C-4 summarizes recent monitoring data for the State and national PM_{10} standards.

Additional criteria pollutants include nitrogen dioxide, sulfur dioxide, sulfates, lead, hydrogen sulfide, and vinyl chloride (chloroethane). Neither State nor national ambient air quality standards of these chemicals have been violated in recent decades. Table 1 (in Chapter 1 of these Guidelines) summarizes the Bay Area's attainment status for the State and national ambient air quality standards.
### TABLE C-1
EXCEEDANCES OF THE NATIONAL OZONE STANDARD
Number Of Days With Maximum One-Hour Concentration Exceeding 12 Parts Per Hundred Million (pphm)
1988 - 1998

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**AIR DISTRICT DAYS**: 5 4 2 2 3 2 11 3 0 8

"AIR DISTRICT DAYS" are the number of days in a year that one or more monitoring stations recorded an exceedance. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day. More than three exceedances in three years, at any one monitoring station, rates a federal classification of "nonattainment" for ozone for the entire air basin.

- = Monitor not operational.
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*AIR DISTRICT DAYS* are the number of days in a year that one or more monitoring stations recorded an exceedance. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day.

- = Monitor not operational.
## TABLE C-3
EXCEEDANCES OF NATIONAL AND STATE* CARBON MONOXIDE STANDARD
Number Of Days With Maximum 8-Hour Concentration Exceeding 9 Parts Per Million (ppm)
1988-1998

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*The recorded number of exceedances of the State — as differentiated from the National — Carbon Monoxide 8-Hour Ambient Air Quality Standard is sometimes slightly higher due to prescribed procedures for calculating each. The State Standard is given as 9.0 ppm and is considered to be exceeded when a monitor records a CO 8-hour average level of 9.1 or higher. The National Standard is given as 9 ppm and is considered to be exceeded at a level of 9.5 ppm or higher. In the table above, when the number of days of exceedance in a year differed among the two, the number of days exceeding the State Standard is given in parentheses.

"AIR DISTRICT DAYS" are the number of days in a year that one or more monitoring stations recorded an exceedance of the ambient air quality standard for CO. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day. More than one exceedance per year, at any one monitoring station, rates a federal classification of "nonattainment" for CO.

- = Monitor not operational.
TABLE C-4
EXCEEDANCES OF THE STATE AND NATIONAL* FINE PARTICULATE MATTER STANDARD
Number Of Days With Maximum 24-Hour Concentration Exceeding 50 micrograms per cubic meter (µg/m³)
1988 - 1998

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<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>San Mateo County</td>
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<td>5</td>
<td>10</td>
<td>8</td>
<td>12</td>
<td>7</td>
<td>5</td>
<td>6</td>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>San Jose-4th St.</td>
<td>14</td>
<td>15</td>
<td>9 (1)</td>
<td>10</td>
<td>13</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>County</td>
<td>Moorpark</td>
<td>8</td>
<td>13</td>
<td>11</td>
<td>13</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>San Carlos St./</td>
<td>-</td>
<td>7</td>
<td>9</td>
<td>14</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Burbank</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11 (1)</td>
<td>11</td>
<td>7</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Solano County</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Sonoma County</td>
<td>Santa Rosa</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

AIR DISTRICT DAYS

|                | 24 | 21 | 15 (3) | 18 (1) | 18 | 10 | 9 | 7 | 3 | 4 | 5 |

*In instances when the National PM₁₀ 24-Hour Standard (150 µg/m³) has been exceeded, the number of days of exceedance of the National Standard is given in parentheses.

"AIR DISTRICT DAYS" are the number of days in a year that one or more monitoring stations recorded an exceedance. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day. PM₁₀ is only sampled every sixth day. Actual days over standards can be estimated as six times the number shown.

- = Monitor not operational.
Problems and Trends

Throughout the Bay Area, automobile ownership and use is increasing at a faster rate than population growth. Countering this trend is the move toward cleaner, newer vehicles with fleet turnover and the introduction of cleaner fuels. Overall, projections indicate a net reduction in the emissions of ozone precursors and carbon monoxide, while fine particulate emissions are expected to increase with total miles traveled.

Table C-5 shows projected future emissions of criteria pollutants for the Bay Area for the years 1995, 2000, 2005 and 2010 in terms of total emissions and motor vehicle emissions. Total emissions and the amount and proportion attributable to motor vehicles are expected to decline, especially for reactive organic gases (ROG), nitrogen oxides (NOx) and carbon monoxide. A small increase is predicted for SO2 emissions. Most significant is the predicted increase in PM10 emissions.

Regionally, the most complex air quality problem has been ozone. Ozone is formed in the atmosphere through a complex series of photochemical reactions involving ROG and NOx. Because it takes some time for the photochemical reactions to occur, emissions of ROG and NOx are transported away from their sources and affect ozone concentrations in downwind areas. Motor vehicles account for the majority of the ROG and NOx emissions. Although the Bay Area's highest ozone levels can fluctuate from year to year depending on weather conditions, ambient ozone standards are exceeded most often in the Santa Clara, Livermore and Diablo valleys.

In contrast to ozone, carbon monoxide (CO) is a more localized concern in the Bay Area, because CO is a nonreactive pollutant with one major source — motor vehicles. Approximately 70 percent of CO in the Bay Area is generated by motor vehicles. The areas with the highest CO levels typically have been those with high levels of vehicular traffic. CO levels are strongly influenced by meteorological factors such as wind speed and atmospheric stability. High concentrations of CO build up on cold, clear winter nights with no wind. The eight-hour CO standards historically were occasionally exceeded in those parts of the Bay Area subject to a combination of high traffic density and susceptibility to the occurrence of surface-based radiation inversions, during the winter months. The CO standards were last exceeded prior to 1992 in San Francisco, San Jose and Vallejo.

Air pollution problems related to particulate matter also occur during winter months, usually under the same weather conditions that foster CO buildup. Particulate levels in the Bay Area are typically low near the coast and higher inland, with the highest levels in dry, sheltered valleys, such as the Santa Clara, Livermore and Diablo valleys. The major human-generated (anthropogenic) sources in the Bay Area include motor vehicle travel over paved and unpaved roads, demolition and construction activity and woodburning in fireplaces and stoves. Agricultural operations and burning also contribute significantly to particulate concentrations in rural areas. PM10 emissions are expected to increase in future years.
### TABLE C-5
MOTOR VEHICLE SHARE OF CRITERIA CONTAMINANT EMISSIONS

Total Emissions and On-Road Motor Vehicle Emissions in the Bay Area Air Basin

<table>
<thead>
<tr>
<th>Year</th>
<th>CO</th>
<th>ROG*</th>
<th>NOx</th>
<th>SO2</th>
<th>PM10**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Emissions</td>
<td>3705</td>
<td>550</td>
<td>624</td>
<td>91</td>
<td>200</td>
</tr>
<tr>
<td>Motor Vehicle (MV) Emissions</td>
<td>2952</td>
<td>294</td>
<td>351</td>
<td>8</td>
<td>106</td>
</tr>
<tr>
<td>MV as % of Total</td>
<td>80%</td>
<td>54%</td>
<td>56%</td>
<td>9%</td>
<td>53%</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Emissions</td>
<td>2615</td>
<td>435</td>
<td>508</td>
<td>99</td>
<td>218</td>
</tr>
<tr>
<td>Motor Vehicle Emissions</td>
<td>1853</td>
<td>189</td>
<td>265</td>
<td>4</td>
<td>111</td>
</tr>
<tr>
<td>MV as % of Total</td>
<td>71%</td>
<td>44%</td>
<td>52%</td>
<td>4%</td>
<td>51%</td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Emissions</td>
<td>2051</td>
<td>372</td>
<td>419</td>
<td>103</td>
<td>231</td>
</tr>
<tr>
<td>Motor Vehicle Emissions</td>
<td>1265</td>
<td>120</td>
<td>198</td>
<td>4</td>
<td>117</td>
</tr>
<tr>
<td>MV as % of Total</td>
<td>62%</td>
<td>32%</td>
<td>47%</td>
<td>4%</td>
<td>51%</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Emissions</td>
<td>1763</td>
<td>335</td>
<td>394</td>
<td>107</td>
<td>241</td>
</tr>
<tr>
<td>Motor Vehicle Emissions</td>
<td>960</td>
<td>76</td>
<td>163</td>
<td>4</td>
<td>122</td>
</tr>
<tr>
<td>MV as % of Total</td>
<td>55%</td>
<td>23%</td>
<td>41%</td>
<td>4%</td>
<td>51%</td>
</tr>
</tbody>
</table>

* Reactive organic gases (anthropogenic — i.e. excluding emissions from natural vegetation).
** Including entrained road dust.

Projections are based on the District Base Year 1996 Emission Inventory, using ARB’s EMFAC7G.
The major sources of nitrogen oxides (NO$_X$) are vehicular, residential and industrial fuel combustion. Concentrations of nitrogen dioxide, the most abundant form of ambient NO$_X$, are highest in the South Bay, where the standard was last exceeded in 1980.

Major sources of ambient sulfur dioxide (SO$_2$) include activities such as electricity generation, petroleum refining and shipping. The highest levels of SO$_2$ are recorded by monitoring stations located in northern Contra Costa County, where most of the major sources of SO$_2$ are located. The SO$_2$ standard is currently being met throughout the Bay Area, with seasonal maximums rarely exceeding 50 percent of the standard. SO$_2$ levels at most Bay Area monitoring stations are less than 10 percent of the standard.

**Emissions Inventory**

The District estimates emissions of criteria pollutants from approximately nine hundred source categories. The estimates are based on District permit information for "point sources" (e.g. manufacturing industries, refineries, dry-cleaning plants) plus more generalized estimates for "area sources" (e.g. house heating, use of consumer products) and "mobile sources" (trains, ships and planes, as well as on-road and off-road motor vehicles). Figure C-2 and Table C-5 indicate future projections of emissions for the region. The significant role of mobile sources is highlighted in these charts. More detailed information on individual point sources may be obtained by contacting the District.

The emission inventories and projections assume that the Bay Area will continue to grow as forecast and that all currently adopted control measures will continue. Assumptions underlying the projections include the following:

- Population, housing, employment, economic growth and land use development will increase as regionally forecast (ABAG, *Projections '96*).

- New cars will be cleaner than older model vehicles, as required by California regulations.

- The recently improved "Smog Check" program will continue.

- Controls on industry and business will continue.

- Currently implemented transportation control measures will continue.

Lead agencies should be aware that actions which alter these assumptions may also affect progress toward attainment and maintenance of ambient air quality standards.
FIGURE C-2
BAY AREA EMISSION INVENTORY PROJECTIONS 1985-2010
(Base Year 1996)
Annual Average Daily Emissions

Legend:
- On-Road Mobile Vehicles
- On-Road Mobile Sources and Aircraft
- Industrial Processes and Other Sources
- Energetic Road Dust

C20051

BAAQMD CEQA GUIDELINES  
C-10  
December, 1999
Transport of Pollutants

The California Clean Air Act, Section 39610 (a), directs the ARB to "identify each district in which transported air pollutants from upwind areas outside the district cause or contribute to a violation of the ozone standard and to identify the district of origin of transported pollutants." The information regarding the transport of air pollutants from one basin to another was to be quantified to assist interrelated basins in the preparation of plans for the attainment of State ambient air quality standards.

Numerous studies conducted by the ARB have identified air basins that are impacted by pollutants transported from other air basins (as of 1993). Among the air basins affected by air pollution transport from the Bay Area are the North Central Coast Air Basin, the Mountain Counties Air Basin, the San Joaquin Valley Air Basin, and the broader Sacramento Area. The Bay Area was also identified as an area impacted by the transport of air pollutants from the Sacramento area.

Other possible transport corridors being studied by the District and the ARB are from the Bay Area to the Upper Sacramento Valley and from the San Joaquin Valley Air Basin to the Bay Area.

Toxic Air Contaminants

The District has established a number of monitoring stations to track ambient levels of 11 toxic air pollutants: benzene, 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), chloroform (TCM), 1,2-dichloroethane (EDC), 1,2-dibromoethane (EDB), methylene dichloride (DCM), carbon tetrachloride, tetrachloroethylene (perc), vinyl chloride, and toluene. The District is also in the process of establishing a monitoring network to trace 1,3-butadiene. Of the toxins monitored by the District, State ambient air quality standards have been set only for vinyl chloride. (Other toxic substances are regulated or controlled through risk assessment and risk management programs. See Appendix E.)

Because the District's air toxics monitoring program is relatively new, little trend information is available. Based on ARB information, it is expected that benzene and 1,3-butadiene — both generated largely by motor vehicles — will be reduced substantially when reformulated fuels are introduced. These two toxic compounds together account for more than half the background health risk from identified air toxics.

Global Warming and Stratospheric Ozone Depletion

Global warming and stratospheric ozone depletion are issues which have gained increased public attention over the last decade. Unlike emissions of criteria and toxic air pollutants, which have local or regional impacts, emissions contributing to global warming and ozone depletion have a broader, global impact.
Global warming is a process whereby "greenhouse gases" accumulating in the atmosphere contribute to an increase in the temperature of the earth's atmosphere. The principal compounds contributing to global warming are carbon dioxide (CO$_2$), methane, nitrous oxide, ozone and water vapor. These gases allow visible and ultraviolet light from the sun to pass through the atmosphere, but they prevent heat from escaping back out into space. Among the potential implications of global warming are rising sea levels, climate changes and adverse impacts to agriculture, forestry and natural habitats. In addition, global warming may increase electricity demand for cooling, decrease the availability of hydroelectric power, and affect regional air quality and human health. Like most criteria and toxic pollutants, much of the greenhouse gas production comes from motor vehicles. Greenhouse gas emissions can be reduced to some degree by improved coordination of land use and transportation planning on the city, county and subregional level and other measures to reduce auto use. Energy conservation measures also can contribute to reductions in greenhouse gas emissions.

One group of greenhouse gases, chlorinated fluorocarbons (CFCs) also depletes stratospheric ozone in addition to causing global warming. Ozone in the stratosphere, unlike ground-level ozone, is beneficial. It acts as a solar radiation "screen" reducing the amount of short-wave ultraviolet radiation which can cause skin cancer, damage agricultural crops and increase photochemical smog. By depleting ozone in the upper atmosphere, CFCs not only allow more short-wave ultraviolet radiation to enter the earth's atmosphere, but they are several thousand times more effective than CO$_2$ in trapping infrared radiation. Since the mid-1930s, CFCs have been used as refrigerants, solvents, and in the production of foam materials. Moreover, CFCs survive in the atmosphere for decades.

National and international agreements have been made to control CFCs and to study air quality problems related to ozone depletion. Recent laws and practices governing repair and recharging of air conditioners and refrigerators have served to reduce CFC emissions. Although local governments alone cannot solve these global problems, some cities in the Bay Area have already demonstrated that local and regional efforts can make a contribution, e.g., banning the sale and commercial use of plastics made with CFCs.
APPENDIX D - CLIMATE, TOPOGRAPHY AND AIR POLLUTION POTENTIAL

Appendix D provides climatological and topographic information about the Bay Area, and explains how these natural factors influence air quality conditions. The first two sections address region-wide conditions relevant to all cities and counties in the Bay Area. The final sections discuss climatological subregions in the Bay Area.

BAY AREA CLIMATE AND TOPOGRAPHY

High Pressure Cell

During the summer, the large-scale meteorological condition that dominates the West Coast is a semipermanent high pressure cell centered over the northeastern Pacific Ocean. This high pressure cell keeps storms from affecting the California coast. Hence, the Bay Area experiences little precipitation in the summer months. Winds tend to blow on shore out of the north/northwest.

The steady northwesterly flow induces upwelling of cold water from below. This upwelling produces a band of cold water off the California coast. When air approaches the California coast, already cool and moisture-laden from its long journey over the Pacific, it is further cooled as it crosses this bank of cold water. This cooling often produces condensation resulting in a high incidence of fog and stratus clouds along the Northern California coast in the summer.

Generally in the winter, the Pacific high weakens and shifts southward, winds tend to flow offshore, upwelling ceases and storms occur. During the winter rainy periods, inversions (layers of warmer air over colder air; see below) are weak or nonexistent, winds are usually moderate and air pollution potential is low. The Pacific high does periodically become dominant however, bringing strong inversions, light winds and high pollution potential.

Topography

Bay Area topography is characterized by complex terrain, consisting of coastal mountain ranges, inland valleys and bays. This complex terrain, especially the higher elevations, distorts the normal wind flow patterns in the Bay Area. The greatest distortion occurs when low-level inversions are present and the air beneath the inversion flows independently of air above the inversion, a condition that is common in the summer time.

The only major break in California's Coast Range occurs in the Bay Area. Here the Coast Range splits into western and eastern ranges. Between the two ranges lies San Francisco Bay. The gap in the western coast range is known as the Golden Gate, and the gap in the eastern coast range is the Carquinez Strait. These gaps allow air to pass into and out of the Bay Area and the Central Valley.
Wind Patterns

During the summer, winds flowing from the northwest are drawn inland through the Golden Gate and over the lower portions of the San Francisco Peninsula. Immediately south of Mount Tamalpais, the northwesterly winds accelerate considerably and come more directly from the west as they stream through the Golden Gate. This channeling of wind through the Golden Gate produces a jet that sweeps eastward and splits off to the northwest toward Richmond and to the southwest toward San Jose when it meets the East Bay hills.

Wind speeds may be strong locally in areas where air is channeled through a narrow opening, such as the Carquinez Strait, the Golden Gate or the San Bruno gap. For example, the average wind speed at San Francisco International Airport in July is about 17 knots (from 3 p.m. to 4 p.m.), compared with only 7 knots at San Jose and less than 6 knots at the Farallon Islands.

The air flowing in from the coast to the Central Valley, called the sea breeze, begins developing at or near ground level along the coast in late morning or early afternoon. As the day progresses, the sea breeze layer deepens and increases in velocity while spreading inland. The depth of the sea breeze depends in large part upon the height and strength of the inversion. If the inversion is low and strong, and hence stable, the flow of the sea breeze will be inhibited and stagnant conditions are likely to result.

In the winter, the Bay Area frequently experiences stormy conditions with moderate to strong winds, as well as periods of stagnation with very light winds. Winter stagnation episodes are characterized by nighttime drainage flows in coastal valleys. Drainage is a reversal of the usual daytime air-flow patterns; air moves from the Central Valley toward the coast and back down toward the Bay from the smaller valleys within the Bay Area.

Temperature

Summertime temperatures in the Bay Area are determined in large part by the effect of differential heating between land and water surfaces. Because land tends to heat up and cool off more quickly than water, a large-scale gradient (differential) in temperature is often created between the coast and the Central Valley, and small-scale local gradients are often produced along the shorelines of the ocean and bays. The temperature gradient near the ocean is also exaggerated, especially in summer, because of the upwelling of cold ocean bottom water along the coast. Thus, on summer afternoons the temperatures at the coast can be 35°F cooler than temperatures 15 to 20 miles inland. At night this contrast usually decreases to less than 10°F.

In the winter, the relationship of minimum and maximum temperatures is reversed. During the daytime the temperature contrast between the coast and inland areas is small, whereas at night the variation in temperature is large.
Precipitation

The Bay Area is characterized by moderately wet winters and dry summers. Winter rains account for about 75 percent of the average annual rainfall. The amount of annual precipitation can vary greatly from one part of the Bay Area to another even within short distances. In general, total annual rainfall can reach 40 inches in the mountains, but it is often less than 16 inches in sheltered valleys.

During rainy periods, ventilation (rapid horizontal movement of air and injection of cleaner air) and vertical mixing are usually high, and thus pollution levels tend to be low. However, frequent dry periods do occur during the winter where mixing and ventilation are low and pollutant levels build up.

AIR POLLUTION POTENTIAL

The potential for high pollutant concentrations developing at a given location depends upon the quantity of pollutants emitted into the atmosphere in the surrounding area or upwind, and the ability of the atmosphere to disperse the contaminated air. The topographic and climatological factors discussed above influence the atmospheric pollution potential of an area. Atmospheric pollution potential, as the term is used here, is independent of the location of emission sources and is instead a function of factors described below.

Wind Circulation

Low wind speed contributes to the buildup of air pollution because it allows more pollutants to be emitted into the air mass per unit of time. Light winds occur most frequently during periods of low sun (fall and winter, and early morning) and at night. These are also periods when air pollutant emissions from some sources are at their peak, namely, commute traffic (early morning) and wood burning appliances (nighttime). The problem can be compounded in valleys, when weak flows carry the pollutants upvalley during the day, and cold air drainage flows move the air mass downvalley at night. Such restricted movement of trapped air provides little opportunity for ventilation and leads to buildup of pollutants to potentially unhealthful levels.

Wind roses (Figure D-1) provide useful information for communities that contain industry, landfills or other potentially odorous or noxious land uses. Each wind-rose diagram provides a general indication of the proportion of time that winds blow from each compass direction. The longer the vector length, the greater the frequency of wind occurring from that direction. Such information may be particularly useful in planning buffer zones. For example, sensitive receptors such as residential developments, schools or hospitals are inappropriate uses immediately downwind from facilities that emit toxic or odorous pollutants, unless adequate separation is provided by a buffer zone. Caution should be taken, however, in using wind-roses in planning and environmental review processes. A site on the opposite side of a hill or tall building, even a short distance from a meteorological monitoring station, may experience a significant difference in wind pattern. Figure D-1 is a map of simplified wind roses, composed of data from a number of Bay Area meteorological stations. Lead agencies should consult District meteorologists if more detailed information is needed.
Inversions

An inversion is a layer of warmer air over a layer of cooler air. Inversions affect air quality conditions significantly because they influence the mixing depth, i.e., the vertical depth in the atmosphere available for diluting air contaminants near the ground. The highest air pollutant concentrations in the Bay Area generally occur during inversions.

There are two types of inversions that occur regularly in the Bay Area. One is more common in the summer and fall, while the other is most common during the winter. The frequent occurrence of elevated temperature inversions in summer and fall months acts to cap the mixing depth and consequently limit the depth of air available for dilution. Elevated inversions are caused by subsiding air from the subtropical high pressure zone, and from the cool marine air layer that is drawn into the Bay Area by the heated low pressure region in the Central Valley.

The inversions typical of winter, called radiation inversions, are formed as heat quickly radiates from the earth's surface after sunset, causing the air in contact with it to rapidly cool. Radiation inversions are strongest on clear, low-wind, cold winter nights, allowing the build-up of such pollutants as carbon monoxide and particulate matter. When wind speeds are low, there is little mechanical turbulence to mix the air, resulting in a layer of warm air over a layer of cooler air next to the ground. Mixing depths under these conditions can be as shallow as 50 to 100 meters, particularly in rural areas. Urban areas usually have deeper minimum mixing layers because of heat island effects and increased surface roughness. During radiation inversions downwind transport is slow, the mixing depths are shallow, and turbulence is minimal. All of these factors contribute to increased pollution levels near the ground.

Although each type of inversion is most common during a specific season, either inversion mechanism can occur at any time of the year. Sometimes both occur simultaneously. Moreover, the characteristics of an inversion often change throughout the course of a day. The terrain of the Bay Area also induces significant variations among subregions.

Stability

Stability is defined as the atmosphere's resistance to vertical motions. The more stable the air, the slower the mixing, resulting in increased probability for air pollutants to build up and exceed ambient air quality standards.

The stability of the atmosphere is highly dependent upon the vertical distribution of temperature with height. When the temperature decreases vertically ("lapse rate") at 10 degrees Celsius per 1000 meters, the atmosphere is classified as "neutral stability". When the lapse rate is greater than 10 degrees C per 100 meters, the atmosphere is "unstable". If the lapse rate is less than 10 degrees per 1000 meters, or the temperature increases with height, the atmosphere is "stable". These stabilities have been categorized for use in dispersion models. Stability categories range from "Extremely Unstable" (Stability Class A), through "Neutral" (D), to "Stable" (F).

Unstable conditions can only occur during daytime hours when solar heating warms the lower layers sufficiently. Under A stability conditions, large horizontal wind direction fluctuations occur, along with large vertical mixing. These motions usually only occur midday during
summer months on cloudless days with light winds. Under B stability conditions, wind direction fluctuations and vertical mixing are less pronounced, because the heating is less strong. The fluctuations found during both A and B stability conditions are mostly due to thermal turbulence. Under C stability conditions, the solar insulation is weaker, or the wind speeds are stronger, so that the surface heating is weaker. The horizontal and vertical fluctuations are weaker yet, and are caused by a combination of thermal and mechanical turbulence.

D stability can occur either during the day or at night. Under D stability conditions, the wind speeds are usually strong — greater than 5 meters per second — or the sky is obscured by clouds. Wind direction fluctuations are small, while vertical motions are primarily generated by mechanical turbulence.

Stabilities E and F can only occur at night. The necessary conditions can only occur in the absence of sunlight, and with light to moderate winds. Under these conditions, there is little turbulence because of the atmosphere's resistance to vertical motion. Pollutants emitted into a stable air mass will travel downwind with little dispersion.

**Solar Radiation**

The frequency of hot, sunny days during the summer months in the Bay Area is another important factor that affects air pollution potential. It is at the higher temperatures that ozone is formed. In the presence of ultraviolet sunlight and warm temperatures, reactive organic gases and oxides of nitrogen react to form secondary photochemical pollutants, including ozone. Because temperatures in many of the Bay Area inland valleys are so much higher than near the coast, the inland areas are especially prone to photochemical air pollution.

In late fall and winter, solar angles are low, resulting in insufficient ultraviolet light and warming of the atmosphere to drive the photochemical reactions. Consequently, ozone concentrations do not reach significant levels in the Bay Area during these seasons.

**Sheltered Terrain**

The hills and mountains in the Bay Area contribute to the high pollution potential of some areas. During the day, or at night during windy conditions, areas in the lee sides of mountains are sheltered from the prevailing winds, thereby reducing turbulence and downwind transport. At night, when wind speeds are low, the upper atmospheric layers are often decoupled from the surface layers during radiation conditions. If elevated terrain is present, it will tend to block pollutant transport in that direction. Elevated terrain also can create a recirculation pattern by inducing upvalley air flows during the day and reverse downvalley flows during the night, allowing little inflow of fresh air.

The areas having the highest air pollution potential tend to be those that experience the highest temperatures in the summer and the lowest temperatures in the winter. Bay Area coastal areas are exposed to the prevailing marine air and consequently have cooler temperatures in the summer, warmer temperatures in winter, and experience stratus clouds all year. The inland valleys are sheltered from the marine air and consequently experience hotter summers and colder
winters. Thus, the topography of the inland valleys creates conditions conducive to high air pollution potential.

**Pollution Potential Related to Emissions**

Although air pollution potential is strongly influenced by climate and topography, the air pollution that occurs in a location also depends upon the amount of air pollutant emissions in the surrounding area or transported from more distant places. Air pollutant emissions generally are highest in areas that have high population densities, high motor vehicle use and/or industrialization. However, contaminants created by photochemical processes in the atmosphere, such as ozone, may result in high concentrations many miles downwind from the sources of their precursor chemicals.

**CLIMATOLOGICAL SUBREGIONS**

This section discusses the varying climatological and topographic conditions, and the resulting variations in air pollution potential, within inhabited subregions of the Bay Area Air Basin. All urbanized areas of the Bay Area are included in one of 11 climatological subregions. Sparsely inhabited areas are excluded from the subregional designations. Some of the climatological subregions discussed in this appendix overlap county boundaries. Lead Agencies analyzing projects located close to the boundary between subregions may need to examine the characteristics of the neighboring subregions in order to adequately evaluate potential air quality impacts. The 11 subregions are portrayed in Figure D-2.

The information about each subregion includes location, topography and climatological factors relevant to air quality. Where relevant to air quality concerns, more localized subareas within a subregion are discussed. Each subregional section concludes with a discussion of pollution potential resulting from climatological and topographic variables and the major types of air pollutant sources in the subregion.

**Carquinez Strait Region**

The Carquinez Strait runs from Rodeo to Martinez. It is the only sea-level gap between San Francisco Bay and the Central Valley. The subregion includes the lowlands bordering the strait to the north and south, and includes the area adjoining Suisun Bay and the western part of the Sacramento-San Joaquin Delta as far east as Bethel Island. The subregion extends from Rodeo in the southwest and Vallejo in the northwest to Fairfield on the northeast and Brentwood on the southeast.

Prevailing winds are from the west in the Carquinez Strait. During the summer and fall months, high pressure offshore coupled with low pressure in the Central Valley causes marine air to flow eastward through the Carquinez Strait. The wind is strongest in the afternoon. Afternoon wind speeds of 15 to 20 mph are common throughout the strait region. Annual average wind speeds
are 8 mph in Martinez, and 9 to 10 mph further east. Sometimes atmospheric conditions cause air to flow from the east. East winds usually contain more pollutants than the cleaner marine air from the west. In the summer and fall months, this can cause elevated pollutant levels to move into the central Bay Area through the strait. These high pressure periods are usually accompanied by low wind speeds, shallow mixing depths, higher temperatures and little or no rainfall.

Summer mean maximum temperatures reach about 90° F. in the subregion. Mean minimum temperatures in the winter are in the high 30's. Temperature extremes are especially pronounced in sheltered areas farther from the moderating effects of the strait itself, e.g. at Fairfield.

Many industrial facilities with significant air pollutant emissions — e.g., chemical plants and refineries — are located within the Carquinez Strait Region. The pollution potential of this area is often moderated by high wind speeds. However, upsets at industrial facilities can lead to short-term pollution episodes, and emissions of unpleasant odors may occur at anytime. Receptors downwind of these facilities could suffer more long-term exposure to air contaminants than individuals elsewhere. Consequently, it is important that local governments and other Lead Agencies maintain buffers zones around sources of air pollution sufficient to avoid adverse health and nuisance impacts on nearby receptors. Areas of the subregion that are traversed by major roadways, e.g. Interstate 80, may also be subject to higher local concentrations of carbon monoxide and particulate matter, as well as certain toxic air contaminants such as benzene.

**Cotati and Petaluma Valleys**

The subregion that stretches from Santa Rosa to the San Pablo Bay is often considered as two different valleys: the Cotati Valley in the north and the Petaluma Valley in the south. To the east, the valley is bordered by the Sonoma Mountains, while to the west is a series of low hills, followed by the Estero Lowlands, which open to the Pacific Ocean. The region from the Estero Lowlands to the San Pablo Bay is known as the Petaluma Gap. This low-terrain area allows marine air to travel into the Bay Area.

Wind patterns in the Petaluma and Cotati Valleys are strongly influenced by the Petaluma Gap, with winds flowing predominantly from the west. As marine air travels through the Petaluma Gap, it splits into northward and southward paths moving into the Cotati and Petaluma valleys. The southward path crosses San Pablo Bay and moves eastward through the Carquinez Strait. The northward path contributes to Santa Rosa's prevailing winds from the south and southeast. Petaluma's prevailing winds are from the northwest.

When the ocean breeze is weak, strong winds from the east can predominate, carrying pollutants from the Central Valley and the Carquinez Strait. During these periods, upvalley flows can carry the polluted air as far north as Santa Rosa.

Winds are usually stronger in the Petaluma Valley than the Cotati Valley because the former is directly in line with the Petaluma Gap. Consequently, Petaluma's climate is similar to areas closer to the coast even though Petaluma is 28 miles from the ocean. Average annual wind speed at the Petaluma Airport is seven mph. The Cotati Valley, being slightly north of the
Petaluma Gap, experiences lower wind speeds. The annual average wind speed in Santa Rosa is five mph.

Air temperatures are very similar in the two valleys. Summer maximum temperatures for this subregion are in the low-to-mid-80's, while winter maximum temperatures are in the high-50's to low-60's. Summer minimum temperatures are around 50 degrees, and winter minimum temperatures are in the high 30's.

Generally, air pollution potential is low in the Petaluma Valley because of its link to the Petaluma Gap and because of its low population density. However, there are two scenarios that could produce elevated pollutant levels: 1) stagnant conditions in the morning hours created when a weak ocean breeze meets a weak bay breeze, and 2) an eastern or southeastern wind pattern in the afternoon brings in pollution from the Carquinez Strait Region and the Central Valley.

The Cotati Valley has a higher pollution potential than does the Petaluma Valley. The Cotati Valley lacks a gap to the sea, contains a larger population and has natural barriers at its northern and eastern ends. There are also industrial facilities in and around Santa Rosa. Both valleys of this subregion are also threatened by increased motor vehicle traffic and the associated air contaminants. Population and motor vehicle use are increasing significantly, and housing costs and the suburbanization of employment are leading to more and longer commutes traversing the subregion.

**Diablo and San Ramon Valleys**

East of the Coast Range lie the Diablo and San Ramon Valleys. The valleys have a northwest to southeast orientation, with the northern portion known as Diablo Valley and the southern portion as San Ramon Valley. The Diablo Valley is bordered in the north by the Carquinez Strait and in the south by the San Ramon Valley. The San Ramon Valley is long and narrow and extends south from Walnut Creek to Dublin. At its southern end it opens onto the Amador Valley.

The mountains on the west side of these valleys block much of the marine air from reaching the valleys. During the daytime, there are two predominant flow patterns: an upvalley flow from the north and a westerly flow (wind from the west) across the lower elevations of the Coast Range. On clear nights, surface inversions separate the flow of air into two layers: the surface flow and the upper layer flow. When this happens, there are often drainage surface winds which flow downvalley toward the Carquinez Strait.

Wind speeds in these valleys generally are low. Monitoring stations in Concord and Danville report annual average wind speeds of 5 mph. However, winds can increase in the afternoon near San Ramon because it is located at the eastern edge of the Crow Canyon gap. Through this gap, polluted air from cities near the bay travels to the valley in the summer months.

Air temperatures in these valleys are cooler in the winter and warmer in the summer than are temperatures further west, as these valleys are far from the moderating effect of the bay and ocean. Mean summer maximum temperatures are in the low- to mid-80's. Mean winter minimum temperatures are in the high-30's to low-40's.
Pollution potential is relatively high in these valleys. On winter evenings, light winds combined with surface-based inversions and terrain that restricts air flow can cause pollutant levels to build up. San Ramon Valley can experience high pollution concentrations due to motor vehicle emissions and emissions from fireplaces and wood stoves. In the summer months, ozone and ozone precursors are often transported into the valleys from both the central Bay Area and the Central Valley.

Livermore Valley

The Livermore Valley is a sheltered inland valley near the eastern border of the District. The western side of the valley is bordered by 1,000 to 1,500 foot hills with two gaps connecting the valley to the central Bay Area, the Hayward Pass and Niles Canyon. The eastern side of the valley also is bordered by 1,000 to 1,500 foot hills with one major passage to the San Joaquin Valley called the Altamont Pass and several secondary passages. To the north lie the Black Hills and Mount Diablo. A northwest to southeast channel connects the Diablo Valley to the Livermore Valley. The south side of the Livermore Valley is bordered by mountains approximately 3,000 to 3,500 feet high.

During the summer months, when there is a strong inversion with a low ceiling, air movement is weak and pollutants become trapped and concentrated. Maximum summer temperatures in the Livermore Valley range from the high-80's to the low-90's, with extremes in the 100's. At other times in the summer, a strong Pacific high pressure cell from the west, coupled with hot inland temperatures causes a strong onshore pressure gradient which produces a strong, afternoon wind. With a weak temperature inversion, air moves over the hills with ease, dispersing pollutants.

In the winter, with the exception of an occasional storm moving through the area, air movement is often dictated by local conditions. At night and early morning, especially under clear, calm and cold conditions, gravity drives cold air downward. The cold air drains off the hills and moves into the gaps and passes. On the eastern side of the valley the prevailing winds blow from north, northeast and east out of the Altamont Pass. Winds are light during the late night and early morning hours. Winter daytime winds sometimes flow from the south through the Altamont Pass to the San Joaquin Valley. Average winter maximum temperatures range from the high-50's to the low-60's, while minimum temperatures are from the mid-to-high-30's, with extremes in the high teens and low-20's.

Air pollution potential is high in the Livermore Valley, especially for photochemical pollutants in the summer and fall. High temperatures increase the potential for ozone to build up. The valley not only traps locally generated pollutants but can be the receptor of ozone and ozone precursors from San Francisco, Alameda, Contra Costa and Santa Clara counties. On northeasterly wind flow days, most common in the early fall, ozone may be carried west from the San Joaquin Valley to the Livermore Valley.

During the winter, the sheltering effect of the valley, its distance from moderating water bodies, and the presence of a strong high pressure system contribute to the development of strong, surface-based temperature inversions. Pollutants such as carbon monoxide and particulate matter, generated by motor vehicles, fireplaces and agricultural burning, can become
concentrated. Air pollution problems could intensify because of population growth and increased commuting to and through the subregion.

Marin County Basins

Marin County is bounded on the west by the Pacific Ocean, on the east by San Pablo Bay, on the south by the Golden Gate and on the north by the Petaluma Gap. Most of Marin's population lives in the eastern part of the county, in small, sheltered valleys. These valleys act like a series of miniature air basins.

Although there are a few mountains above 1500 feet, most of the terrain is only 800 to 1000 feet high, which usually is not high enough to block the marine layer. Because of the wedge shape of the county, northeast Marin County is further from the ocean than is the southeastern section. This extra distance from the ocean allows the marine air to be moderated by bayside conditions as it travels to northeastern Marin County. In southern Marin the distance from the ocean is short and elevations are lower, resulting in higher incidence of maritime air in that area.

Wind speeds are highest along the west coast of Marin, averaging about 8 to 10 miles per hour. The complex terrain in central Marin creates sufficient friction to slow the air flow. At Hamilton Air Force Base, in Novato, the annual average wind speeds are only 5 mph. The prevailing wind directions throughout Marin County are generally from the northwest.

In the summer months, areas along the coast are usually subject to onshore movement of cool marine air. In the winter, proximity to the ocean keeps the coastal regions relatively warm, with temperatures varying little throughout the year. Coastal temperatures are usually in the high-50's in the winter and the low-60's in the summer. The warmest months are September and October.

The eastern side of Marin County has warmer weather than the western side because of its distance from the ocean and because the hills that separate eastern Marin from western Marin occasionally block the flow of the marine air. The temperatures of cities next to the bay are moderated by the cooling effect of the bay in the summer and the warming effect of the bay in the winter. For example, San Rafael experiences average maximum summer temperatures in the low-80's and average minimum winter temperatures in the low-40's. Inland towns such as Kentfield experience average maximum temperatures that are two degrees cooler in the winter and two degrees warmer in the summer.

Air pollution potential is highest in eastern Marin County, where most of population is located in semi-sheltered valleys. In the southeast, the influence of marine air keeps pollution levels low. However, as development moves further north, there is greater potential for air pollution to build up because the valleys are more sheltered from the sea breeze. While Marin County does not have many polluting industries, the air quality on its eastern side — especially along the U.S. 101 corridor — may be affected by emissions from increasing motor vehicle use within and through the county.

Napa Valley
The Napa Valley is bordered by relatively high mountains. With an average ridge line height of about 2000 feet, with some peaks approaching 3000 to 4000 feet, these mountains are effective barriers to the prevailing northwesterly winds. The Napa Valley is widest at its southern end and narrows in the north. During the day, the prevailing winds flow upvalley from the south about half of the time. A strong upvalley wind frequently develops during warm summer afternoons, drawing air in from the San Pablo Bay. Daytime winds sometimes flow downvalley from the north. During the evening, especially in the winter, downvalley drainage often occurs. Wind speeds are generally low, with almost 50 percent of the winds less than 4 mph. Only 5 percent of the winds are between 16 and 18 mph, representing strong summertime upvalley winds and winter storms.

Summer average maximum temperatures are in the low 80's at the southern end of the valley and in the low 90's at the northern end. Winter average maximum temperatures are in the high-50's and low-60's, and minimum temperatures are in the high to mid 30's with the slightly cooler temperatures in the northern end.

The air pollution potential in the Napa Valley could be high if there were sufficient sources of air contaminants nearby. Summer and fall prevailing winds can transport ozone precursors northward from the Carquinez Strait Region to the Napa Valley, effectively trapping and concentrating the pollutants when stable conditions are present. The local upslope and downslope flows created by the surrounding mountains may also recirculate pollutants already present, contributing to buildup of air pollution. High ozone concentrations are a potential problem to sensitive crops such as wine grapes, as well as to human health. The high frequency of light winds and stable conditions during the late fall and winter contribute to the buildup of particulate matter from motor vehicles, agriculture and woodburning in fireplaces and stoves.

Northern Alameda and Western Contra Costa Counties

This climatological subregion stretches from Richmond to San Leandro. Its western boundary is defined by San Francisco Bay and its eastern boundary by the Oakland-Berkeley Hills. The Oakland-Berkeley Hills have a ridge line height of approximately 1500 feet, a significant barrier to air flow. The most densely populated area of the subregion lies in a strip of land between the bay and the lower hills.

In this area, marine air traveling through the Golden Gate, as well as across San Francisco and through the San Bruno Gap, is a dominant weather factor. The Oakland-Berkeley Hills cause the westerly flow of air to split off to the north and south of Oakland, which causes diminished wind speeds. The prevailing winds for most of this subregion are from the west. At the northern end, near Richmond, prevailing winds are from the south-southwest.

Temperatures in this subregion have a narrow range due to the proximity of the moderating marine air. Maximum temperatures in summer average in the mid-70's, with minimums in the mid-50's. Winter highs are in the mid- to high-50's, with lows in the low- to mid-40's.

The air pollution potential is lowest for the parts of the subregion that are closest to the bay, due largely to good ventilation and less influx of pollutants from upwind sources. The occurrence of light winds in the evenings and early mornings occasionally causes elevated pollutant levels.
The air pollution potential at the northern (Richmond) and southern (Oakland, San Leandro) parts of this subregion is marginally higher than communities directly east of the Golden Gate, because of the lower frequency of strong winds.

This subregion contains a variety of industrial air pollution sources. Some industries are quite close to residential areas. The subregion is also traversed by frequently congested major freeways. Traffic and congestion, and the motor vehicle emissions they generate, are increasing.

**Peninsula**

The peninsula region extends from northwest of San Jose to the Golden Gate. The Santa Cruz Mountains run up the center of the peninsula, with elevations exceeding 2000 feet at the southern end, decreasing to 500 feet in South San Francisco. Coastal towns experience a high incidence of cool, foggy weather in the summer. Cities in the southeastern peninsula experience warmer temperatures and fewer foggy days because the marine layer is blocked by the ridgeline to the west. San Francisco lies at the northern end of the peninsula. Because most of San Francisco's topography is below 200 feet, marine air is able to flow easily across most of the city, making its climate cool and windy.

The blocking effect of the Santa Cruz Mountains results in variations in summertime maximum temperatures in different parts of the peninsula. For example, in coastal areas and San Francisco the mean maximum summer temperatures are in the mid-60's, while in Redwood City the mean maximum summer temperatures are in the low-80's. Mean minimum temperatures during the winter months are in the high-30's to low-40's on the eastern side of the Peninsula and in the low 40's on the coast.

Two important gaps in the Santa Cruz Mountains occur on the peninsula. The larger of the two is the San Bruno Gap, extending from Fort Funston on the ocean to the San Francisco Airport. Because the gap is oriented in the same northwest to southeast direction as the prevailing winds, and because the elevations along the gap are under 200 feet, marine air is easily able to penetrate into the bay. The other gap is the Crystal Springs Gap, between Half Moon Bay and San Carlos. As the sea breeze strengthens on summer afternoons, the gap permits maritime air to pass across the mountains, and its cooling effect is commonly seen from San Mateo to Redwood City.

Annual average wind speeds range from 5 to 10 mph throughout the peninsula, with higher wind speeds usually found along the coast. However, winds on the eastern side of the peninsula are often high in certain areas, such as near the San Bruno Gap and the Crystal Springs Gap.

The prevailing winds along the peninsula's coast are from the west, although individual sites can show significant differences. For example, Fort Funston in western San Francisco shows a southwest wind pattern while Pillar Point in San Mateo County shows a northwest wind pattern. On the east side of the mountains winds are generally from the west, although wind patterns in this area are often influenced greatly by local topographic features.

Air pollution potential is highest along the southeastern portion of the peninsula. This is the area most protected from the high winds and fog of the marine layer. Pollutant transport from upwind sites is common. In the southeastern portion of the peninsula, air pollutant emissions are
relatively high due to motor vehicle traffic as well as stationary sources. At the northern end of the peninsula in San Francisco, pollutant emissions are high, especially from motor vehicle congestion. Localized pollutants, such as carbon monoxide, can build up in "urban canyons". However, winds are generally fast enough to carry the pollutants away before they can accumulate.

**Santa Clara Valley**

The Santa Clara Valley is bounded by the San Francisco Bay to the north and by mountains to the east, south and west. Temperatures are warm on summer days and cool on summer nights, and winter temperatures are fairly mild. At the northern end of the valley, mean maximum temperatures are in the low-80’s during the summer and the high-50’s during the winter, and mean minimum temperatures range from the high-50’s in the summer to the low-40’s in the winter. Further inland, where the moderating effect of the bay is not as strong, temperature extremes are greater. For example, in San Martin, located 27 miles south of the San Jose Airport, temperatures can be more than 10 degrees warmer on summer afternoons and more than 10 degrees cooler on winter nights.

Winds in the valley are greatly influenced by the terrain, resulting in a prevailing flow that roughly parallels the valley’s northwest-southeast axis. A north-northwesterly sea breeze flows through the valley during the afternoon and early evening, and a light south-southeasterly drainage flow occurs during the late evening and early morning. In the summer the southern end of the valley sometimes becomes a "convergence zone," when air flowing from the Monterey Bay gets channeled northward into the southern end of the valley and meets with the prevailing north-northwesterly winds.

Wind speeds are greatest in the spring and summer and weakest in the fall and winter. Nighttime and early morning hours frequently have calm winds in all seasons, while summer afternoons and evenings are quite breezy. Strong winds are rare, associated mostly with the occasional winter storm.

The air pollution potential of the Santa Clara Valley is high. High summer temperatures, stable air and mountains surrounding the valley combine to promote ozone formation. In addition to the many local sources of pollution, ozone precursors from San Francisco, San Mateo and Alameda Counties are carried by prevailing winds to the Santa Clara Valley. The valley tends to channel pollutants to the southeast. In addition, on summer days with low level inversions, ozone can be recirculated by southerly drainage flows in the late evening and early morning and by the prevailing northwesterlies in the afternoon. A similar recirculation pattern occurs in the winter, affecting levels of carbon monoxide and particulate matter. This movement of the air up and down the valley increases the impact of the pollutants significantly.

Pollution sources are plentiful and complex in this subregion. The Santa Clara Valley has a high concentration of industry at the northern end, in the Silicon Valley. Some of these industries are sources of air toxics as well as criteria pollutants. In addition, Santa Clara Valley's large population and many work-site destinations generate the highest mobile source emissions of any subregion in the Bay Area.
Sonoma Valley

The Sonoma Valley is west of the Napa Valley. It is separated from the Napa Valley and from the Cotati and Petaluma Valleys by mountains. The Sonoma Valley is long and narrow, approximately 5 miles wide at its southern end and less than a mile wide at the northern end.

The climate is similar to that of the Napa Valley, with the same basic wind characteristics. The strongest upvalley winds occur in the afternoon during the summer and the strongest downvalley winds occur during clear, calm winter nights. Prevailing winds follow the axis of the valley, northwestern/southeastern, while some upslope flow during the day and downslope flow during the night occurs near the base of the mountains. Summer average maximum temperatures are usually in the high-80’s, and summer minimums are around 50 degrees. Winter maximums are in the high-50’s to the mid-60’s, with minimums ranging from the mid-30’s to low-40’s.

As in the Napa Valley, the air pollution potential of the Sonoma Valley could be high if there were significant sources of pollution nearby. Prevailing winds can transport locally and non-locally generated pollutants northward into the narrow valley, which often traps and concentrates the pollutants under stable conditions. The local upslope and downslope flows set up by the surrounding mountains may also recirculate pollutants.

However, local sources of air pollution are minor. With the exception of some processing of agricultural goods, such as wine and cheese manufacturing, there is little industry in this valley. Increases in motor vehicle emissions and woodsmoke emissions from stoves and fireplaces may increase pollution as the valley grows in population and as a tourist attraction.

Southwestern Alameda County

This subregion encompasses the southeast side of San Francisco Bay, from Dublin Canyon to north of Milpitas. The subregion is bordered on the east by the East Bay hills and on the west by the bay. Most of the area is flat.

This subregion is indirectly affected by marine air flow. Marine air entering through the Golden Gate is blocked by the East Bay hills, forcing the air to diverge into northerly and southerly paths. The southern flow is directed down the bay, parallel to the hills, where it eventually passes over southwestern Alameda County. These sea breezes are strongest in the afternoon. The further from the ocean the marine air travels, however, the ocean’s effect is diminished. Thus, although the climate in this region is affected by sea breezes, it is affected less so than the regions closer to the Golden Gate.

The climate of southwestern Alameda County is also affected by its close proximity to San Francisco Bay. The bay cools the air with which it comes in contact during warm weather, while during cold weather the bay warms the air. The normal northwest wind pattern carries this air onshore. Bay breezes push cool air onshore during the daytime and draw air from the land offshore at night.

Winds are predominantly out of the northwest during the summer months. In the winter, winds are equally likely to be from the east. Easterly-southeasterly surface flow into southern Alameda
County passes through three major gaps: Hayward/Dublin Canyon, Niles Canyon and Mission Pass. Areas north of the gaps experience winds from the southeast, while areas south of the gaps experience winds from the northeast. Wind speeds are moderate in this subregion, with annual average wind speeds close to the bay at about 7 mph, while further inland they average 6 mph.

Air temperatures are moderated by the subregion's proximity to the bay and to the sea breeze. Temperatures are slightly cooler in the winter and slightly warmer in the summer than East Bay cities to the north. During the summer months, average maximum temperatures are in the mid-70's. Average maximum winter temperatures are in the high-50's to low-60's. Average minimum temperatures are in the low 40's in winter and mid-50's in the summer.

Pollution potential is relatively high in this subregion during the summer and fall. When high pressure dominates, low mixing depths and bay and ocean wind patterns can concentrate and carry pollutants from other cities to this area, adding to the locally emitted pollutant mix. The polluted air is then pushed up against the East Bay hills. In the wintertime, the air pollution potential in southwestern Alameda county is moderate. Air pollution sources include light and heavy industry, and motor vehicles. Increasing motor vehicle traffic and congestion in the subregion may increase Southwest Alameda County pollution as well as that of its neighboring subregions.
APPENDIX E - TOXIC AIR CONTAMINANTS

Introduction

Toxic air contaminants (TACs) are air pollutants which may lead to serious illness or increased mortality, even when present in relatively low concentrations. Potential human health effects of TACs include birth defects, neurological damage, cancer and death. There are hundreds of different types of TACs, with varying degrees of toxicity. TACs may be produced by a variety of sources, including industrial facilities such as refineries, chemical plants and chrome platers, commercial facilities such as dry cleaners and gasoline stations, and motor vehicles.

District Programs

The District has regulated TACs since the 1980's as a complement to the traditional efforts to reduce emissions of criteria air pollutants. To date, the District's air toxics program has been a risk-based approach, meaning that the decisions over what sources and pollutants to control and the degree to which to control them have been based on the results of health risk assessment. A health risk assessment is an analysis where human health exposure to toxic substances is estimated, and then considered together with information regarding the toxic potency of the substances, to provide quantitative estimates of health risks. (The risk assessments used by the District do not address the possibility of, or adverse health effects resulting from, accidental releases of toxic materials such as a fire or major spill. Review of industry's preparation for, and protection from, accidental releases is performed by emergency response agencies, such as local fire and health departments.) The District's air toxics program consists of three major elements: a program to control emissions from new and modified sources; and two programs directed at existing sources - one with retrofit requirements for categories of sources, and another which is based on facility-specific analyses.

Air Toxics New Source Review

The District reviews new and modified source permit applications in accordance with the District's Risk Management Policy (adopted by the District Board of Directors in 1987). The goal of the program is to prevent any proposed stationary sources from creating new air toxics problems. In addition, benefits are realized when older, more highly polluting sources are replaced with new sources that must meet more stringent control requirements.

The need for, and degree of, emissions control required in toxics new source review is based on the results of health risk screening analysis or health risk assessment. All new/modified permit applications are reviewed for potential health impacts. If any TACs are emitted in amounts that exceed de minimus levels, a risk screening analysis, using computer-modeled estimates of atmospheric dispersion, is completed by District staff. Table E-1 lists the pollutants that trigger the District's risk screening requirements. A project that passes this risk screen is judged to have an insignificant impact on public health. A project that fails the screen does not necessarily have a significant impact, but requires further review. Further review usually consists of more detailed dispersion modeling (including the use of actual meteorological data when applicable), and consideration of other site-specific factors.
# TABLE E-1
## POLLUTANTS THAT TRIGGER
### DISTRICT RISK SCREENING REQUIREMENTS

<table>
<thead>
<tr>
<th>Carcinogenic Compounds</th>
<th>Noncarcinogenic Compounds</th>
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<tbody>
<tr>
<td>Acetaldehyde</td>
<td>Glycol ethers:</td>
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<tr>
<td>Acrylamide</td>
<td>Methyl ethyl ketone (MEK)</td>
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<tr>
<td>Acrylonitrile</td>
<td>Methyl mercaptan</td>
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<tr>
<td>Arsenic and arsenic compounds</td>
<td>2-ethoxyethanol (Cellosolve)</td>
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<tr>
<td>Asbestos</td>
<td>2-methoxymethanol (Methylcellosolve) Methyl methacrylate</td>
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<td>Benzene</td>
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<tr>
<td>Benzidine and salts</td>
<td>2-butoxyethanol (Butylicellosolve) N-Methylpyrroldione</td>
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<td>Beryllium</td>
<td>Hexachlorocyclopentadiene</td>
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<td>Butadiene, 1,3-</td>
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<td>Carbon tetrachloride</td>
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<td>Chlorinated dibenzodioxins and</td>
<td>Hydrogen sulfide</td>
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<td>toluene disiocyanate</td>
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<td>isopropyl alcohol</td>
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<td>Lead, inorganic, and compounds</td>
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<td>Maleic anhydride</td>
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<td>Manganese and compounds</td>
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<td>Mercuric and compounds</td>
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<td>Methyl alcohol (ethanol)</td>
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<td>Methyl alcohol (methylene)</td>
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<td>Methyl bromide</td>
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<td>Vapam</td>
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<td></td>
<td>(Na diethylthio-carbamate)</td>
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<td>Xylene</td>
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<td></td>
<td>Zinc and compounds</td>
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</tbody>
</table>
Where risks cannot be reduced below specified health-based significance levels, sources must use the Best Available Control Technology for Toxics, or "T-BACT". The significance level for T-BACT is an individual cancer risk of 1-in-one million, or an ambient concentration above a non-cancer reference exposure level. If the residual health risks, after controls are applied, result in risks that exceed higher significance levels established for the overall acceptability of a project, then other risk reduction measures may be required, or the permits for the proposed source(s) may be denied.

The program has resulted in T-BACT being implemented on a variety of the most significant sources of TACs in the Bay Area. The program also encourages sound land use planning in that, through the risk assessment process, control requirements for sources increase in relation to their proximity to downwind sources.

**Retrofit Requirements for Categories of Existing Sources**

The primary mechanism for the development of retrofit air toxics control measures in California has been through the Toxic Air Contaminant Act, also referred to as the Tanner Act, adopted by the State legislature in 1983. The Tanner Act establishes a process for the identification of TACs, and for the preparation of retrofit toxic control measures on a Statewide basis. TACs are identified in a scientific review process involving the Air Resources Board (ARB), the Office of Environmental Health Hazard Assessment, and an independent scientific review panel. Once a contaminant is identified as a TAC, control measures, called Airborne Toxic Control Measures (ATCMs), are developed by the ARB. The measures are implemented and enforced by the local air districts, which may adopt the ATCMs as established by ARB, or set more stringent standards.

As of February 1996, 19 compounds have been identified as TACs through the State's scientific review process, and eight statewide ATCMs have been adopted. The first six adopted ATCMs have been adopted into District Rules and have been fully implemented in the Bay Area. These include measures for chrome plating, cooling towers, commercial and hospital sterilizers, medical waste incinerators, paving operations that use serpentine materials, and gasoline stations. The two most recently adopted ATCMs have been adopted as District rules, but final compliance dates have not yet been reached (as of February 1996). These rules address secondary metal melting operations and perchloroethylene dry cleaners.

The District has accelerated the control of air toxics for existing air toxics by supplementing the ATCMs with rules developed locally. Examples of these rules include those covering aeration of contaminated soil and water, marine vessel loading and unloading, and the addition of more stringent requirements for gasoline stations.

In 1990, the federal Clean Air Act was amended creating an ambitious federal air toxics program. In 1992, the State legislature adopted AB 2728 to provide a legal framework for the integration of the existing air toxics programs in California with the new federal program. This legislation required ARB to designate the 189 substances that were listed as Hazardous Air Pollutants in the federal Clean Air Act as TACs without going through the scientific review process. The list of substances designated by the ARB as TACs (as of August 1995) is given in Table E-2.
### Table E-2

**Substances Designated by ARB as Toxic Air Contaminants**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS No.</th>
<th>Chemical Name</th>
<th>CAS No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td>75070</td>
<td>Cresol(o)</td>
<td>95487</td>
</tr>
<tr>
<td>Acetamide</td>
<td>60355</td>
<td>Cresol(p)</td>
<td>106445</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>75058</td>
<td>Cresol/Cresylic acid</td>
<td>1319773</td>
</tr>
<tr>
<td>Acetophenone</td>
<td>98862</td>
<td>Cumene (Isopropylbenzene)</td>
<td>98828</td>
</tr>
<tr>
<td>Acetylaminofluorene(2)</td>
<td>53963</td>
<td>Cyanide Compounds$^{23}$</td>
<td></td>
</tr>
<tr>
<td>Acrolein</td>
<td>107028</td>
<td>D(2,4) salts and esters</td>
<td>94757</td>
</tr>
<tr>
<td>Acrylamide</td>
<td>79061</td>
<td>DDE</td>
<td>3547044</td>
</tr>
<tr>
<td>Acrylic acid</td>
<td>79107</td>
<td>Diazomethane</td>
<td>334883</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>107131</td>
<td>Dibenzofurans</td>
<td>132649</td>
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<tr>
<td>Allylchloride</td>
<td>107051</td>
<td>Dibromo-3-chloropropano(1,2)</td>
<td>96128</td>
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<tr>
<td>Aminobiphenyl(4)</td>
<td>92671</td>
<td>Dibutylylphthalate</td>
<td>84742</td>
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<tr>
<td>Aniline</td>
<td>62533</td>
<td>Dichlorobenzene(1,4)(p)</td>
<td>106467</td>
</tr>
<tr>
<td>Anisidine(o)</td>
<td>90040</td>
<td>Dichlorobenzene(3,3)</td>
<td>91941</td>
</tr>
<tr>
<td>Antimony Compounds</td>
<td>----</td>
<td>Dichloroethyl ether</td>
<td></td>
</tr>
<tr>
<td>Arsenic Compounds</td>
<td>----</td>
<td>(Bidichloroethyl)ether</td>
<td>111444</td>
</tr>
<tr>
<td>(inorganic including arsenic)</td>
<td>----</td>
<td>Dichloropropene(1,3)</td>
<td>542756</td>
</tr>
<tr>
<td>Asbestos</td>
<td>1332214</td>
<td>Dichlorvos</td>
<td>62737</td>
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<tr>
<td>Benzene</td>
<td>71432</td>
<td>Diethanolamine</td>
<td>111422</td>
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<tr>
<td>Benzidine</td>
<td>92875</td>
<td>Diethylenelamine(N,N)</td>
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<tr>
<td>Benzo(1,3)disulfide</td>
<td>98077</td>
<td>(Dimethylamidine(N,N))</td>
<td>121697</td>
</tr>
<tr>
<td>Benzylic chloride</td>
<td>100447</td>
<td>Diethyl sulfate</td>
<td>66475</td>
</tr>
<tr>
<td>Beryllium Compounds</td>
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<td>Dimethoxybenzidine(3,3)'</td>
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<td>Biphenyl</td>
<td>192524</td>
<td>Dimethyl aminozincobenzene</td>
<td>60117</td>
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<tr>
<td>Bis(2-ethylhexyl)phthalate(DEHP)</td>
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<td>Dimethyl Benzidene(3,3)'</td>
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<tr>
<td>Bis(chloromethyl)ether</td>
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<td>Dimethyl carbamoyl chloride</td>
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<td>Bromoform</td>
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<td>Dimethyl formamide</td>
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<td>Butadiene(1,3)</td>
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<td>Dimethyl hydrazine(1,1)</td>
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<td>Cadmium Compounds</td>
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<td>Calcium cyanamide</td>
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<td>Dimethyl sulfate</td>
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<td>Caprolactam</td>
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<td>Dimtro-o-cresol(4,6), and salts</td>
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<td>Captan</td>
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<td>Dimtrophenol(2,4)</td>
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<td>Caranyl</td>
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<td>Dimtrotofuene(2,4)</td>
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<td>Carbon disulfide</td>
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<td>Dioxane(1,4)(1,4-Diethylenoxide)</td>
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<td>Carbon tetrachloride</td>
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<td>Diphenylhydrazine(1,2)</td>
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<td>Carbonyl sulfide</td>
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<td>Epichlorohydrin</td>
<td></td>
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<td>Catechol</td>
<td>120809</td>
<td>(Chloro-2,3-epoxypropane(1))</td>
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<tr>
<td>Chloramben</td>
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<td>Epoxybutan(1,2)(1,2-Butylene oxide)</td>
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<td>Chlordane</td>
<td>57749</td>
<td>Ethyl acrylate</td>
<td>140885</td>
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<td>Chlorine</td>
<td>7782505</td>
<td>Ethyl benzene</td>
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<td>Chloroacetic acid</td>
<td>79118</td>
<td>Ethyl carbamate (Urethane)</td>
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<td>Chloroacethonephene(2)</td>
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<td>Ethyl chloride (Chloroethane)</td>
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<td>Chlorobenzene</td>
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<td>Ethylene dibromide (1,2-Dibromoethane)</td>
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<td>Chlorobenzilate</td>
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<td>Ethylene dichloride (1,2-Dichloroethane)</td>
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<td>Chloroform</td>
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<td>Chloroprene (Neoprene; 2-chloro-1,3-butadiene)</td>
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<td>Ethylene thiourea</td>
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<td>Chromium Compounds</td>
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<td>Ethylidene dichloride</td>
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<td>Cobalt Compounds</td>
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<td>(1,1-Dichloroethane)</td>
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<td></td>
<td>Formaldehyde</td>
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<tr>
<td>Cresol(m)</td>
<td>108394</td>
<td>Glycol ethers$^{24}$</td>
<td></td>
</tr>
</tbody>
</table>

$^{23}$ XCN where X = H' or any other group where a formal dissociation may occur, for example KCN or Ca(CN)$_2$.

$^{24}$ Includes mono- and di-ethers of ethylene glycol, diethylene glycol and triethylene glycol R-(OCH$_2$CH$_2$)$_n$-OR where: $n = 1,2,3$ - R = alkyl or aryl groups - R' = R, H, or group which, when removed, yield glycol ethers with the structure: R-(OCH$_2$CH$_2$)$_n$-OH.

Polymers are excluded from the glycol category.
<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS No.</th>
<th>Chemical Name</th>
<th>CAS No.</th>
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<tr>
<td>Heptachlor</td>
<td>76448</td>
<td>Phenylelenediamine(p)</td>
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<tr>
<td>Hexachlorobenzene</td>
<td>118741</td>
<td>Phosgene</td>
<td>75445</td>
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<td>Hexachlorobutadiene</td>
<td>87683</td>
<td>Phosphine</td>
<td>7803512</td>
</tr>
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<td>Hexachlorocyclopentadiene</td>
<td>77474</td>
<td>Phosphorus</td>
<td>7723140</td>
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<td>Hexachloroethane</td>
<td>67721</td>
<td>Pthalic anhydride</td>
<td>85449</td>
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<td>Hexamethylenediisocyanate</td>
<td>822050</td>
<td>Polychlorinated diphenyls(Aroclor)</td>
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<td>Hexamethylphosphoramide</td>
<td>680319</td>
<td>Polysyrlic Organic Matter&lt;sup&gt;25&lt;/sup&gt;</td>
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<td>Hexane</td>
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<td>Hydrazine</td>
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<td>Propiolactone(beta)</td>
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<td>Propionaldehyde</td>
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<td>Propoxur (Baygon)</td>
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<td>Hydroquinone</td>
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<td>Propylene dichloride</td>
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<td>Isophorone</td>
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<td>(1,2-Dichloropropane)</td>
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<td>Lead Compounds</td>
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<td>Propylene oxide</td>
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<td>Lindane (all isomers)</td>
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<td>Propylenimine(1,2) (2-Methyl aziridine)</td>
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<td>Maleic anhydride</td>
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<td>Quinoline</td>
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<td>Quinone (1,4-Cyclohexadiene)</td>
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<td>Mercury Compounds</td>
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<td>Radionuclides (including radon)&lt;sup&gt;26&lt;/sup&gt;</td>
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<td>Methanol</td>
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<td>Methyl bromide (Bromomethane)</td>
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<td>Styrene oxide</td>
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<td>Methyl chloride (Chloromethane)</td>
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<td>Tetrachlorobenzophenol</td>
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<td>Methyl chloroform (1,1,1-Trichloroethane)</td>
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<td>Tetrachloroethane(1,1,2,2)</td>
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<td>Tetrachloroethylene (Perchloroethylene)</td>
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<td>Methyl hydrazine</td>
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<td>Methyl iodide (Iodomethane)</td>
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<td>Methyl isobutyl ketone (Hexone)</td>
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<td>Toluene diaminodiene(2,4)</td>
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<td>(2,4-Diaminodiethylene)</td>
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<td>Methyl methacrylate</td>
<td>80626</td>
<td>Toluene diisocyanate(2,4)</td>
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</tr>
<tr>
<td>Methyl tert butyl ether</td>
<td>1634044</td>
<td>Toluidine(o)</td>
<td>95534</td>
</tr>
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<td>Methylene bis(2-chloroaniline)(4,4)</td>
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<td>Toxaphene (Chlorinated camphene)</td>
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<td>Methylene chloride (Dichloromethane)</td>
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<td>Tetrachloroethylene</td>
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<td>Mineral fibers&lt;sup&gt;27&lt;/sup&gt;</td>
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<tr>
<td>Naphthalene</td>
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<td>Trichlorophenol(2,4,6)</td>
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<td>Nickel Compounds</td>
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<td>Nitrobenzene</td>
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<td>Nitrobenzophenyl(4)</td>
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<td>Trimethylpentane(2,2,4)</td>
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<td>Nitrophenol(4)</td>
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<td>Vinyl acetate</td>
<td>108054</td>
</tr>
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<td>Nitropropane(2)</td>
<td>79469</td>
<td>Vinyl bromide</td>
<td>593602</td>
</tr>
<tr>
<td>Nitroso-N-methylurea(N)</td>
<td>684935</td>
<td>Vinyl chloride</td>
<td>75014</td>
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<td>Nitroso dimethylurea(N)</td>
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<td>Nitrosodimethylurea(N)</td>
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<td>(1,1-Dichloroethylene)</td>
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<td>Nitrosomorpholine(N)</td>
<td>56382</td>
<td>Xylenes(m)</td>
<td>108383</td>
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<td>Parathion</td>
<td>82688</td>
<td>Xylenes(o)</td>
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<td>Pentachloronitrobenzene(Quinobenzene)</td>
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<td>Xylenes(p)</td>
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<td>Pentachlorophenol</td>
<td>108952</td>
<td>Xylenes(mixed)</td>
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</tbody>
</table>

<sup>25</sup> Include organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100°C.

<sup>26</sup> A type of atom which spontaneously undergoes radioactive decay.

<sup>27</sup> Includes glass microfibers, glass wool fibers, rock wool fibers, and slag wool fibers, each characterized as "respirable" (fiber diameter less than 3 micrometers and possessing an aspect ratio (fiber length divided by fiber diameter) greater than 3.)
Because of the federal program, the primary source of new air toxics rules in the Bay Area has shifted from the ATCMs developed by ARB to the National Emission Standards for Hazardous Air Pollutants (NESHAPs), developed by the U.S. EPA. (These federal rules are also commonly referred to as MACT standards, because they reflect the Maximum Achievable Control Technology.) A large number of MACT standards are due to be promulgated on a schedule extending through the year 2000. AB 2728 requires the District to implement and enforce all MACT standards, or rules that are at least as stringent.

**Air Toxics "Hot Spots" Program**

Assembly Bill 2588, the Air Toxics "Hot Spots" Information and Assessment Act, was enacted by the State legislature in 1987. AB 2588 requires plants emitting TACs to prepare inventories of the toxic air emissions from their entire facility. Air districts are then required to prioritize these facilities based on the quantity and toxicity of these emissions, and their proximity to areas where the public may be exposed.

Each facility that is put into a "high priority" category as a result of this review is required to prepare a comprehensive facility-wide health risk assessment. AB 2588 requires that exposed individuals then be notified of any "significant health risks" identified in the health risk assessment. The health risk levels used for public notification in the "hot spots" program are set by each individual air district. In the Bay Area, the District used a maximum individual cancer risk of 10 in one million, or an ambient concentration above a non-cancer reference exposure level, as the threshold of notification.

The first cycle of the District's "hot spots" program was completed in 1991. Out of the 129 "high priority" facilities preparing risk assessments, 30 had risk levels that required public notification. The number of facilities with risks over the notification levels was reduced to 16 in 1992. As of 1995, the number of facilities requiring public notification was 5. These reductions were attributable to efforts to further reduce emissions and to further refine risk assessments. Through 1995, no new high priority facilities had been identified since the original prioritization.

As part of the "hot spots" program, the District also is focusing on "industry-wide" risk assessments, which AB 2588 provides for small businesses that operate in a similar manner. Under the industry-wide program, the District is responsible for the preparation of risk assessments and for performing public notification. Industry-wide studies for gasoline stations and dry cleaners are scheduled for completion in 1996.

In 1992, the State "hot spots" program was amended with the passage of SB 1731. This legislation requires facilities to implement measures to reduce risks below levels determined by the District to be significant within a certain time frame. In 1994, the District took its first regulatory action under SB 1731 with the adoption of a more stringent rule for perchloroethylene dry cleaners. The risk reduction requirements of SB 1731 were incorporated into this rule because many dry cleaners (and in particular those that are located in residential buildings) have been identified with lifetime cancer risks that exceed 100-in-one-million.
APPENDIX F - RESOURCE DOCUMENTS

There is a growing body of research concerning land use and design strategies to reduce automobile use. This appendix identifies selected resources that may be useful to Lead Agencies and other parties interested in pursuing such strategies. This is not intended to be a comprehensive list, but rather a good starting point for those interested in land use-related measures to reduce auto use. Interested parties are encouraged in particular to refer to the report prepared by JHK & Associates for the California Air Resources Board indicated below (Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emission: An Indirect Source Research Study). The report includes an annotated bibliography listing over 150 documents.

Association of Bay Area Governments and Bay Area Air Quality Management District, Improving Air Quality Through Local Plans and Programs, A Guidebook for City and County Governments, April 1994.


Calthorpe Associates, Transit-Oriented Development Design Guidelines (final public review draft), prepared for Sacramento County Planning and Community Development Department, September 1990.


Cervero, Robert, Suburban Gridlock, 1986.

Cervero, Robert, America's Suburban Centers: The Land Use-Transportation Link, 1989.


Handy, Susan, How Land Use Patterns Affect Travel Patterns: A Bibliography, 1992.


Oregon Department of Transportation, Transportation Development Branch, "Best Management Practices for Transportation/Land Use Planning" (working draft), August 1993.


APPENDIX G - GLOSSARY

**Acid Deposition** -- Conversion of sulfur oxide and nitrogen oxide emissions into acidic compounds which precipitate in rain, snow, fog, or dry particles.

**Aerosol** -- Particle of solid or liquid matter that can remain suspended in the air because of its small size (generally under one micron).

**Air Quality Management District (AQMD)** -- Local agency charged with controlling air pollution and attaining air quality standards. The Bay Area Air Quality Management District is the regional AQMD that includes Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo and Santa Clara Counties and the southern halves of Solano and Sonoma Counties.

**Air Resources Board (ARB)** -- The State of California agency responsible for air pollution control. Responsibilities include: establishing State ambient air quality standards, setting allowable emission levels for motor vehicles in California and oversight of local air quality management districts.

**Area Sources** -- Sources of air pollutants that individually emit relatively small quantities of air pollutants, but which cumulatively may emit large quantities of emissions. Examples include water heaters, lawn maintenance equipment and consumer products.

**Authority to Construct (A/C)** -- A preconstruction permit issued by the District. An A/C typically includes conditions which the applicant must incorporate into facility design, operations, etc. in order to comply with District regulations.

**Best Available Control Technology (BACT)** -- The most stringent emissions control that has been achieved in practice, identified in a state implementation plan, or found by the District to be technologically feasible and cost-effective for a given class of sources.

**California Clean Air Act (CCAA)** -- Legislation enacted in 1988 mandating a planning process to attain state ambient air quality standards.

**CALINE** -- A model developed by the Air Resources Board that calculates carbon monoxide concentrations resulting from motor vehicle use.

**Carbon Monoxide (CO)** -- A colorless, odorless, toxic gas produced by the incomplete combustion of carbon-containing substances. It is emitted in large quantities by exhaust of gasoline-powered vehicles.

**Catalytic Converter** -- An air pollution abatement device used primarily on motor vehicles. It removes organic contaminants by oxidizing them into carbon dioxide and water through chemical reaction. May convert nitrogen dioxide to nitrogen and oxygen, as well as promoting other similar reactions.

**Chlorofluorocarbons (CFCs)** -- A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. CFCs drift into the upper atmosphere where their chlorine components destroy stratospheric ozone.
Clean Air Act (CAA) -- Long-standing federal legislation, last amended in 1990, that is the legal basis for the national clean air programs.

Cold Start -- Starting a motor vehicle after the engine has cooled. The duration of time after engine shut-off needed to produce a cold start is typically about an hour for a catalyst equipped vehicle and about four hours for a non-catalyst equipped vehicle.

Conformity -- A requirement in federal law and administrative practice that requires that projects will not be approved if they do not conform with the State Implementation Plan by: causing or contributing to an increase in air pollutant emissions, violating an air pollutant standard, or increasing the frequency of violations of an air pollutant standard.

Criteria Air Pollutants -- Air pollutants for which the federal or State government has established ambient air quality standards, or criteria, for outdoor concentration in order to protect public health. Criteria pollutants include: ozone, carbon monoxide, sulfur dioxide PM10 (previously total suspended particulate), nitrogen oxide, and lead.

EMFAC - The computer model developed by the California Air Resources Board to estimate composite on-road motor vehicle emission factors by vehicle class.

Emission Factor -- The amount of a specific pollutant emitted from a specified polluting source per unit quantity of material handled, processed, or burned.

Emission Inventory -- A list of air pollutants emitted into an area's atmosphere, in amounts (commonly tons) per day or year, by type of source.

Environmental Protection Agency (EPA) -- The federal agency responsible for control of air and water pollution, toxic substances, solid waste, and cleanup of contaminated sites.

Exceedance -- A monitored level of concentration of any air contaminant higher than national or state ambient air quality standards.

Hazardous Air Pollutants -- Air pollutants which are not covered by ambient air quality standards but which may reasonably be expected to cause or contribute to serious illness or death (see NESHAPs).

Health Risk Assessment -- An analysis where human exposure to toxic substances is estimated, and considered together with information regarding the toxic potency of the substances, to provide quantitative estimates of health risk.

Hot Spot -- A location where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects and contribute to the cumulative health risks of emissions from other sources in the area.

Hot Start - Starting a motor vehicle while the engine is still fully warmed up.

Hydrocarbon -- Any of a vast family of compounds containing carbon and hydrogen in various combinations; found especially in fossil fuels. Some of the hydrocarbon compounds are major air pollutants; they may be active participants in the photochemical process or affect health.
Hydrogen Sulfide (H₂S) -- A gas characterized by "rotten egg" smell, found in the vicinity of oil refineries, chemical plants and sewage treatment plants.

Indirect Sources -- Land-uses and facilities which attract or generate motor vehicle trips and thus result in air pollutant emissions, e.g., shopping centers, office buildings, and airports.

Inversion -- The phenomenon of a layer of warm air over cooler air below. A special problem in polluted areas because this atmospheric structure resists the natural dispersion and dilution of air contaminants.

Level of Service (LOS) -- A transportation planning term for a method of measurement of congestion. The LOS compares actual or projected traffic volume to the maximum capacity of the road under study. LOS ranges from A through F. LOS A describes free flow conditions, while LOS F describes the most congested conditions, up to or over the maximum capacity for which the road was designed.

Mixing Depth -- The expanse in which air rises from the earth and mixes with the air above it until it meets air equal or warmer in temperature -- the inversion cap.

Mobile Source -- Any vehicle that produces air pollution, such as cars, trucks and motorcycles (on road mobile sources) or airplanes, trains and construction equipment (off-road mobile sources).

National Ambient Air Quality Standards (NAAQS) -- Health-based pollutant concentration limits established by EPA that apply to outside air (see Criteria Air Pollutants).

National Emissions Standards for Hazardous Air Pollutants (NESHAPs) -- Emissions standards set by EPA for air pollutants not covered by NAAQS that may cause an increase in deaths or in serious, irreversible, or incapacitating illness.

Nitrogen Oxides (NOₓ) -- Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; NOₓ is a criteria air pollutant.

Non-Attainment Area -- Defined geographic area that does not meet one or more of the Ambient Air Quality Standards for the criteria pollutants designated in the federal Clean Air Act and/or California Clean Air Act.

Organic Compounds -- Large group of chemical compounds that contain carbon. Some types of organic gases, including olefins, aromatics and aldehydes, are highly reactive -- that is, participate in photochemical reactions in the atmosphere to form oxidant.

Ozone (Ο₃) -- A pungent, colorless, toxic gas. A product of complex photochemical processes, usually in the presence of sunlight. Tropospheric (lower atmosphere) ozone is a criteria air pollutant.

Ozone Depletion -- Destruction of the stratospheric ozone layer (10 to 20 miles above the earth) which shields the earth from ultraviolet radiation. This destruction is caused by the breakdown of certain chlorine and/or bromine-containing compounds (chlorofluorocarbons or halons).
Particulate -- A particle of solid or liquid matter; soot, dust, aerosols, fumes and mists.

Permit to Operate (P/O) -- An operational permit issued yearly by the Air District to industrial sources which emit air contaminants.

Photochemical Process -- The chemical changes brought about by the radiant energy of the sun acting upon various polluting substances. The products are known as photochemical smog.

Pollution Standards Index (PSI) -- A national, standardized system of reporting air pollution levels to the public by assigning them a numerical value.

PM$_{10}$ -- Fine particulate matter (solid or liquid) with an aerodynamic diameter equal to or less than 10 microns. Individual particles of this size are small enough to be inhaled into human lungs; they are not visible to the human eye.

Precursor -- Compounds that change chemically or physically after being emitted into the air and eventually produce air pollutants. For example, organic compounds are precursors for ozone.

Prevention of Significant Deterioration (PSD) -- EPA program in which state and/or federal permits are required that are intended to restrict emissions for new or modified sources in places where air quality is already better than required to meet primary and secondary ambient air quality standards.

Reactive Organic Gases (ROG) -- Classes of organic compounds, especially olefins, substituted aromatics and aldehydes, that react more rapidly in the atmosphere to form photochemical smog or ozone.

Risk Management and Prevention Program (RMPP) -- A program enacted by the State Legislature in 1986 in order to reduce the risk of public exposure to acutely hazardous materials resulting from upsets at industrial and commercial facilities. RMPP analyses identify possible hazards at a facility, estimate potential consequences of an upset to public health and safety, address measures to reduce the chances of an upset, and identify measures for responding to accidents that may occur. The program is usually administered by the county health department or the local fire department.

Sensitive Receptors -- Facilities or land uses that include members of the population that are particularly sensitive to the effects of air pollutants, such as children, the elderly and people with illnesses. Examples include schools, hospitals and residential areas.

State Implementation Plan (SIP) -- EPA-approved state plans for attaining and maintaining federal air quality standards.

Stationary Source -- A fixed, non-mobile source of air pollution, usually at industrial or commercial facilities.

Sulfur Oxides (SO$_x$) -- Pungent, colorless gases formed primarily by the combustion of sulfur-containing fossil fuels, especially coal and oil. Considered a criteria air pollutant, sulfur oxides may damage the respiratory tract as well as vegetation.
Total Suspended Particulate Matter (TSP) -- Particles of solid or liquid matter -- soot, dust, aerosols, fumes and mist -- up to approximately 30 microns in size. As a criteria pollutant TSP has been replaced by PM$_{10}$.

Toxic Air Pollutants -- Air pollutants which cause illness or death in relatively small quantities. Non-criteria air contaminants that, upon exposure, ingestion, inhalation, or assimilation into organisms either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformations in such organisms or their offspring.

Transportation Control Measures (TCMs) -- Measures to reduce congestion and decrease emissions from motor vehicles by reducing vehicle use.

URBEMIS - A computer model developed by the California Air Resources Board to estimate air pollutant emissions from motor vehicle trips associated with land use development.

Volatile Organic Compound (VOC) -- An organic compound that evaporates readily at normal temperatures; a precursor to ozone.
APPENDIX H - REFERENCES


Monterey Bay Unified Air Pollution Control District, CEQA Air Quality Guidelines, October 1995.


South Coast Air Quality Management District, CEQA Air Quality Handbook, April 1993.


SAQMD RECOMMENDED GUIDANCE FOR 
LAND USE EMISSION REDUCTION
Sacramento Metropolitan Air Quality Management District

Recommended Guidance for Land Use Emission Reductions

Version 2.4, updated on August 15, 2007
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TDM and Miscellaneous Measures ......................................................... 28
SMAQMD Guidance for
Land Use Emission Reductions

The mitigation measures listed in this guidance document are divided into categories based on the anticipated end use of the project (residential, commercial, or mixed-use). The categories are denoted within the measures by letter: C=Commercial, R=Residential, and M=Mixed-use.

Mitigation points are used to quantify the approximate emission reduction factor associated with a particular mitigation measure. The points are equivalent to a percentage of emission reduction associated with using a particular measure in a project. For example, implementing mitigation measures in a project that add up to 15 mitigation points means that the measures are anticipated to make a 15% reduction in the project’s anticipated operational emissions.
<table>
<thead>
<tr>
<th>Measure #</th>
<th>Title</th>
<th>Use</th>
<th>Description</th>
<th>Mitigation Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bike parking</td>
<td>C,M</td>
<td>Non-residential projects provide plentiful short-term and long-term bicycle parking facilities to meet peak season maximum demand</td>
<td>0.625</td>
</tr>
<tr>
<td>2</td>
<td>End of trip facilities</td>
<td>C,M</td>
<td>Non-residential projects provide &quot;end-of-trip&quot; facilities including showers, lockers, and changing space</td>
<td>0.625</td>
</tr>
<tr>
<td>3</td>
<td>Bike parking at multi-unit residential</td>
<td>R</td>
<td>Long-term bicycle parking is provided at apartment complexes or condominiums without garages</td>
<td>0.625</td>
</tr>
<tr>
<td>4</td>
<td>Proximity to bike path/bike lanes</td>
<td>R,C,M</td>
<td>Entire project is located within 1/2 mile of an existing Class I or Class II bike lane and project design includes a comparable network that connects the project uses to the existing offsite facility</td>
<td>0.625</td>
</tr>
<tr>
<td>5</td>
<td>Pedestrian network</td>
<td>R,C,M</td>
<td>The project provides a pedestrian access network that internally links all uses and connects to all existing or planned external streets and pedestrian facilities contiguous with the project site.</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
<td>Pedestrian barriers minimized</td>
<td>R,C,M</td>
<td>Site design and building placement minimize barriers to pedestrian access and interconnectivity. Physical barriers such as walls, berms, landscaping, and slopes between residential and non-residential uses that impede bicycle or pedestrian circulation are eliminated</td>
<td>1.0</td>
</tr>
<tr>
<td>7</td>
<td>Bus shelter for existing transit service</td>
<td>R,C,M</td>
<td>Bus or Streetcar service provides headways of one hour or less for stops within 1/4 mile; project provides safe and convenient bicycle/pedestrian access to transit stop(s) and provides essential transit stop improvements (i.e., shelters, route information, benches, and lighting).</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Category</td>
<td>Notes</td>
<td>Score</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td>----------</td>
<td>----------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>8</td>
<td>Bus shelter for planned transit service</td>
<td>R,C,M</td>
<td>Project provides transit stops with safe and convenient bicycle/pedestrian access. Project provides essential transit stop improvements (i.e., shelters, route information, benches, and lighting) in anticipation of future transit service.</td>
<td>0.25</td>
</tr>
<tr>
<td>9</td>
<td>Traffic calming</td>
<td>R,C,M</td>
<td>Project design includes pedestrian/bicycle safety and traffic calming measures in excess of jurisdiction requirements. Roadways are designed to reduce motor vehicle speeds and encourage pedestrian and bicycle trips by featuring traffic calming features.</td>
<td>0.25-1.0</td>
</tr>
</tbody>
</table>

**Parking Measures**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Category</th>
<th>Notes</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>10a</td>
<td>Paid parking</td>
<td>R,C,M</td>
<td>Employee and/or customer paid parking system</td>
<td>1.0-7.2</td>
</tr>
<tr>
<td>10b</td>
<td>Parking cash out</td>
<td>C, M</td>
<td>Employer provides employees with a choice of forgoing subsidized parking for a cash payment equivalent to the cost of the parking space to the employer</td>
<td>0.6-4.5</td>
</tr>
<tr>
<td>11</td>
<td>Minimum parking</td>
<td>R,C,M</td>
<td>Provide minimum amount of parking required. Special review of parking required.</td>
<td>0.1-6.0</td>
</tr>
<tr>
<td>12</td>
<td>Parking reduction beyond code</td>
<td>R,C,M</td>
<td>Provide parking reduction less than code. Special review of parking required. Recommend a Shared Parking strategy.</td>
<td>0.1-12</td>
</tr>
<tr>
<td>13</td>
<td>Pedestrian pathway through parking</td>
<td>R,C,M</td>
<td>Provide a parking lot design that includes clearly marked and shaded pedestrian pathways between transit facilities and building entrances</td>
<td>0.5</td>
</tr>
<tr>
<td>14</td>
<td>Off street parking</td>
<td>R,C,M</td>
<td>Parking facilities are not adjacent to street frontage</td>
<td>0.1-1.5</td>
</tr>
</tbody>
</table>

**Site Design Measures**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Category</th>
<th>Notes</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Office/Mixed-use density</td>
<td>C, M</td>
<td>Project provides high density office or mixed-use proximate to transit</td>
<td>0.1-2.0</td>
</tr>
<tr>
<td>16</td>
<td>Orientation to existing transit, bikeway, or pedestrian corridor</td>
<td>R,C,M</td>
<td>Project is oriented towards existing transit, bicycle, or pedestrian corridor. Setback distance is minimized</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Orientation toward planned transit, bikeway, or pedestrian corridor</td>
<td>Project is oriented towards planned transit, bicycle, or pedestrian corridor. Setback distance is minimized</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>--------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Residential density</td>
<td>Project provides high-density residential development</td>
<td>1.0-12</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Street grid</td>
<td>Multiple and direct street routing (grid style)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Neighborhood electric vehicle access</td>
<td>Make physical development consistent with requirements for neighborhood electric vehicles</td>
<td>0.5-1.5</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Affordable housing component</td>
<td>Residential development projects of 5 or more dwelling units provide a deed-restricted low-income housing component on-site (as defined in Ch 22.35 of Sacramento County Ordinance Code) [Developers who pay into In-Lieu Fee Programs are not considered eligible to receive credit for this measure]</td>
<td>0.6-4.0</td>
<td></td>
</tr>
</tbody>
</table>

**Mixed-use Measures**

<table>
<thead>
<tr>
<th></th>
<th>Urban mixed-use</th>
<th>Development of projects predominantly characterized by properties on which various uses, such as office, commercial, institutional, and residential, are combined in a single building or on a single site in an integrated development project with functional interrelationships and a coherent physical design.</th>
<th>3.0-9.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Suburban mixed-use</td>
<td>Have at least three of the following on site and/or offsite within ¼ mile: Residential Development, Retail Development, Park, Open Space, or Office</td>
<td>3.0</td>
</tr>
<tr>
<td>23</td>
<td>Other mixed-use</td>
<td>All residential units are within ¼ mile of parks, schools or other civic uses.</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Building Component Measures**

<table>
<thead>
<tr>
<th></th>
<th>No fireplace</th>
<th>Project does not feature fireplaces or wood burning stoves</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Ozone destruction catalyst</td>
<td>Install ozone destruction catalyst on air conditioning systems</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Responsibility</td>
<td>Details</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td>----------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>27</td>
<td>Energy Star roof</td>
<td>R,C,M</td>
<td>Install Energy Star labeled roof materials</td>
</tr>
<tr>
<td>28</td>
<td>Onsite renewable energy system</td>
<td>R,C,M</td>
<td>Project provides onsite renewable energy system(s)</td>
</tr>
<tr>
<td>29</td>
<td>Exceed title 24</td>
<td>R,C,M</td>
<td>Project Exceeds title 24 requirements by 20%</td>
</tr>
<tr>
<td>30</td>
<td>Solar orientation</td>
<td>R</td>
<td>Orient 75 or more percent of homes and/or buildings to face either north or south (within 30 degrees of N/S)</td>
</tr>
<tr>
<td>31</td>
<td>Non-roof surfaces</td>
<td>R,C,M</td>
<td>Provide shade (within 5 years) and/or use light-colored/high-albedo materials (reflectance of at least 0.3) and/or open grid pavement for at least 30% of the site’s non-roof impervious surfaces, including parking lots, walkways, plazas, etc.; OR place a minimum of 50% of parking spaces underground or covered by structured parking; OR use an open-grid pavement system (less than 50% impervious) for a minimum of 50% of the parking lot area. Unshaded parking lot areas, driveways, fire lanes, and other paved areas have a minimum albedo of .3 or greater.</td>
</tr>
<tr>
<td>32</td>
<td>Green roof</td>
<td>R,C,M</td>
<td>Install a vegetated roof that covers at least 50% of roof area</td>
</tr>
<tr>
<td>33</td>
<td>Transportation Management Association membership</td>
<td>R,C,M</td>
<td>Include permanent TMA membership and funding requirement. Funding to be provided by Community Facilities District or County Service Area or other non-revocable funding mechanism.</td>
</tr>
<tr>
<td>34</td>
<td>Electric lawnmower</td>
<td>R</td>
<td>Provide a complimentary electric lawnmower to each residential buyer</td>
</tr>
<tr>
<td>99</td>
<td>Other</td>
<td>R,C,M</td>
<td>Other proposed strategies, in consultation with project lead agency and SMAQMD</td>
</tr>
</tbody>
</table>
Scaling methodology for projects with multiple land use types:

In mixed use projects with multiple land use types measures that are limited in application to one type of land use will only be counted as mitigating the emissions associated with the trip generation for that land use type. This scaling shall be done using one of the following methodologies:

Scaling method 1: Trip Generation

In projects where the total floor area for each specific land use type is known and an associated trip generation rate can be determined by utilizing the Institute of Transportation Engineers (ITE) trip generation publication, the measure shall be scaled using the following methodology. The total point value of the measure shall be scaled by a factor of X, where X is equal to the amount of trip generation associated with the specific land use type to which the measure applies as a percentage of the total trip generation associated with the entire project. For example, if a project has a commercial use component that as anticipated to generate 40% of the total trips associated with the entire project, a measure that only applies to the commercial portion of the project shall be scaled down to 40% of the total point value listed in this document.

Scaling method 2: Specific use by square footage

In projects where the total square footage for each general land use type (commercial, residential, mixed use, etc) is known, the measure shall be using the following methodology. The measure shall be scaled by a factor of Y, where Y is the percentages of net square footage designated for that land use as a portion of the total square footage for the entire project. For example, if 40% of the total square footage in a project is designated for residential uses, a measure that only applies to the residential portion of the project shall be scaled down to 40% of the total point value listed in this document.

Scaling method 3: Specific use by percentage of net lot area

In projects where the total square footage designated for each land use is not known, measures that apply only to one type of land use shall be scaled based on the percentage of net lot area designated for that use. For example, a hypothetical project has 50% of the net lot area designated for residential uses, 40% designated for commercial uses, and 10% devoted to other purposes. The project includes a residential only measure in the Air Quality Mitigation Plan. If the measure’s mitigation value is one point, the maximum mitigation value the project would receive for this measure is .5 points, because the measure only applies to 50% of the project.

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1 The ITE Trip Generation Manual is available online at: http://www.ite.org/tripgen/trippubs.asp. The ISBN number for this publication is 0-935403-79-5.

2 Net lot area is defined by SMAQMD as the total horizontal net area within the lot lines of the lot(s) or parcel(s) that make up the project site excluding land designated for undeveloped open space, but including publicly dedicated land, public streets, highways, roads, alleys, pedestrian pathways, bicycle pathways, and transit facilities.
Bicycle/Pedestrian/Transit Measures

1. **Non-residential projects provide plentiful short-term and long-term bicycle parking facilities to meet peak season maximum demand.**

   C,M 0.625

   The location and design of bicycle parking facilities minimizes impediments to pedestrian activity.

   Short-term facilities are provided at a minimum ratio of one bike rack space per 20 vehicle spaces. Long-term facilities provide a minimum ratio of one long-term bicycle storage space per 20 employee parking spaces.

   Short-term facilities are located adjacent to destination(s); within 50' of all primary entrances unless it can be demonstrated that a greater distance is necessary for safety. Racks have a non-enclosed design that allows for the use of high-security U-shaped locks to lock the frame and one wheel to the rack.

   Long-term facilities consist of one of the following; a bicycle locker, a locked room with short-term bicycle parking facilities and access limited to bicyclists only, or a standard rack in a location that is staffed or monitored by video surveillance during standard operating hours.

   Facilities are weather-protected and secure. Facilities are at the ground level and are free of access restrictions that could impede bicycle storage. Facilities comply with the California Department of Transportation "Pedestrian and Bicycle Facilities in California" technical reference document.

   Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to: a map/graphic depicting the location of bicycle parking facilities within the project site, a graphic depiction of the parking facilities to be used, and a description of how the quantity of facilities was calculated (show the calculations).

   If the project documentation does not include a figure for the quantity of parking devoted to employees, the project shall provide one long-term bicycle storage space per 20 employees (include a description of the method used to estimate the number of individuals employed on site when the project is operational).

   The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that bicycle parking facilities installed in the project match the products described in the Air Quality Mitigation Plan.

2. **Non-residential projects provide “end-of-trip” facilities including showers, lockers, and changing space.**

   C,M 0.625

   Facilities shall be provided in the following ratio: four clothes lockers and one shower provided for every 80 employee parking spaces. For projects with 160 or more employee parking spaces, separate facilities are required for each gender. Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to a description of how the quantity of facilities was calculated (show the calculations).

   If the project documentation does not include a figure for the quantity of parking devoted to employees, facilities shall be provided in the following ratio: four clothes lockers and one shower
provided for every 80 employees (include a description of method used to estimate the number of individuals employed on site when the project is operational).

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that end-of-trip facilities installed in the project match the facilities described in the Air Quality Mitigation Plan.

3. **Long-term bicycle parking is provided at apartment complexes or condominiums without garages.**
   
   Project provides one long-term bicycle parking space for each unit without a garage. Long-term facilities shall consist of one of the following: a bicycle locker, a locked room with standard racks and access limited to bicyclists only, or a standard rack in a location that is staffed and/or monitored by video surveillance 24 hours per day. Facilities comply with standards listed in SMAQMD Mitigation Measure #1 (one) and the "Pedestrian and Bicycle Facilities in California" technical reference document published by the California Department of Transportation.

   Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to; a map/Graphic depicting the location of bicycle parking facilities within the project site:

   1. If each unit is to include bike parking, provide a graphic depicting the size and layout of bicycle parking facility.
   2. If multiple or group bicycle parking facilities are utilized, provide a narrative description of how the facilities will be permanently maintained and operated during project operation.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that bicycle parking facilities installed in the project match the facilities described in the Air Quality Mitigation Plan.

4. **Entire project is located within 1/2 mile of an existing Class I or Class II bike lane and project design includes an internal network that connects the project uses to the existing offsite facility.**

   Existing facilities are defined as those facilities that are physically constructed and ready for use prior to the first 20% of the project's occupancy permits being granted.

   Project design includes a designated bicycle route connecting all units, on-site bicycle parking facilities, offsite bicycle facilities, site entrances, and primary building entrances to existing Class I or Class II bike lane(s) within ½ mile. Bicycle route connects to all streets contiguous with project site. Bicycle route has minimum conflicts with automobile parking and circulation facilities. All streets internal to the project wider than 75 feet have class II bicycle lanes on both sides. Facilities comply with the "Pedestrian and Bicycle Facilities in California" technical reference document published by the California Department of Transportation.

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3 The "Pedestrian and Bicycle Facilities in California" document is available online at: 
Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to; a map/graphic depicting the bicycle route.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the bicycle route installed in the project match the layout of the bicycle route described in the Air Quality Mitigation Plan.

5. The project provides a pedestrian access network that internally links all uses and connects to all existing or planned external streets and pedestrian facilities contiguous with the project site.
R,C,M

1.0 for connecting to existing external streets and pedestrian facilities

0.5 for connecting to planned external streets and pedestrian facilities (facilities must be included pedestrian master plan or equivalent)

Existing facilities are defined as those facilities that are physically constructed and ready for use prior to the first 20% of the projects occupancy permits being granted.

Project design includes a designated pedestrian route interconnecting all internal uses, site entrances, primary building entrances, public facilities, and adjacent uses to existing external pedestrian facilities and streets. Route has minimal conflict with parking and automobile circulation facilities. Streets (with the exception of alleys) within the project have sidewalks on both sides. All sidewalks internal and adjacent to project site are minimum of five feet wide. All sidewalks feature vertical curbs. Pedestrian facilities and improvements such as grade separation, wider sidewalks, and traffic calming are implemented wherever feasible to minimize pedestrian barriers. All site entrances provide pedestrian access. Facilities comply with the California Department of Transportation "Pedestrian and Bicycle Facilities in California" technical reference document.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a narrative description and a map to scale that graphically depicts the pedestrian route.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the pedestrian route installed in the project match the layout of the pedestrian route described in the Air Quality Mitigation Plan.

6. Site design and building placement minimize barriers to pedestrian access and interconnectivity. Physical barriers such as walls, berms, landscaping, and slopes between residential and non-residential uses that impede bicycle or pedestrian circulation are eliminated.
R,C,M 1.0

Barriers to pedestrian access of neighboring facilities and sites are minimized. This measure is not meant to prevent the limited use of barriers to ensure public safety by prohibiting access to hazardous areas, etc.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a map/graphic depicting the pedestrian route. Denote the location and design of any pedestrian access barriers incorporated into the project design to ensure public safety.
The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the barrier-free site design described in the Air Quality Mitigation Plan matches the layout of the site as built.

7. **Bus or streetcar service provides headways of one hour or less for stops within 1/4 mile; project provides safe and convenient bicycle/pedestrian access to transit stop(s) and provides essential transit stop improvements (i.e., shelters, route information, benches, and lighting).**
   R,C,M 0.25-1.0

Bus or streetcar service must be in place prior to the first 20% of the projects occupancy permits being granted.

Mitigation Value varies depending on the frequency of bus or streetcar service. For bus service with headways of one hour, 0.25 points are available. For bus service with headways of 30 minutes, 0.5 points are available. For service of 15 minutes or greater, one mitigation point is available.

Safe and convenient bicycle/pedestrian access must be provided to all transit stops within ¼ mile of project site border.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff and to ensure that the transit stop improvements and access routes installed in the project match the route and facilities described in the Air Quality Mitigation Plan. SMAQMD may further verify implementation by consulting with the transit service provider to ensure that the transit route(s) adjacent to the project site run at the minimum required frequency described in the Air Quality Mitigation Plan.

8. **Project provides transit stops with safe and convenient bicycle/pedestrian access. Project provides essential transit stop improvements (i.e., shelters, route information, benches, and lighting) in anticipation of future transit service.**
   R,C,M 0.25

This measure applies only to planned projects that do not have transit service within ¼ a mile. A project cannot get points for both this measure and measure seven.

Safe and convenient bicycle/pedestrian access must be provided to all transit stops within ¼ mile of project site border. The air district will determine if the access is “safe and convenient” by making the following design considerations: Is this the most direct route for the accessing the transit stop? Does the access route contain barriers or safety hazards that would discourage pedestrian use? Does the access route adequately connect to all portions of the project? Does the route feature amenities to encourage use, such as landscaping, proximity to open space, etc?

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff and to ensure that the transit stop improvements and access routes installed in the project match the route and facilities described in the Air Quality Mitigation Plan.

9. **Project design includes pedestrian/bicycle safety and traffic calming measures in excess of jurisdiction requirements. Roadways are designed to reduce motor vehicle speeds and encourage pedestrian and bicycle trips by featuring traffic calming measures.**
   R,C,M see table
All sidewalks internal and adjacent to project site are minimum of five feet wide. All sidewalks feature vertical curbs. Roadways that converge internally within the project are routed in such a way as to avoid "skewed intersections;" which are intersections that meet at acute, rather than right, angles.

Intersections internal and adjacent to the project feature one or more of the following pedestrian safety/traffic calming design techniques: marked crosswalks, count-down signal timers, curb extensions, speed tables, raised crosswalks, raised intersections, median islands, tight corner radii, and roundabouts or mini-circles. Measures should comply with California Department of Transportation "Pedestrian and Bicycle Facilities in California" technical reference document.

Streets internal and adjacent to the project feature pedestrian safety/traffic calming measures such as on-street parking, planter strips with street trees, and chicanes/chokers (variations in road width to discourage high-speed travel).

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to; a map depicting which intersections/streets feature improvements, narrative descriptions and graphic representations of planned improvements, and narrative description of how the project utilized pedestrian/bicycle safety measures and traffic calming measures to encourage walking and the use of bicycles.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the pedestrian/bicycle safety and traffic calming measures are incorporated into the project as specified in the project’s Air Quality Mitigation Plan.

Percent Reduction Table:

<table>
<thead>
<tr>
<th></th>
<th>Percent of streets with improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25%</td>
</tr>
<tr>
<td>Percent of intersections with improvements</td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td>0.25</td>
</tr>
<tr>
<td>50%</td>
<td>0.25</td>
</tr>
<tr>
<td>75%</td>
<td>0.5</td>
</tr>
<tr>
<td>100%</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Parking measures

10a. Employee and/or customer paid parking system (incorporate 10b Parking Cash Out).
    **R, C, M** see table

Project must have a permanent and enforceable method of maintaining user fees for all parking facilities. This method must be approved by SMAQMD as part of the project’s Air Quality Mitigation Plan. The facility may not provide customer or employee validations.

Daily charge for parking must be equal to or greater than the cost of a Sacramento Regional Transit daily pass plus 20%. Monthly charge for parking must be equal to or greater than the cost of a Sacramento Regional Transit Monthly pass plus 20%.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a narrative describing the method in which fees will be assessed and a description of how parking facility will be managed.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that parking fees are being collected in the manner described in the Air Quality Mitigation Plan.

<table>
<thead>
<tr>
<th>% Emission Reduction for all Pollutants</th>
<th>&lt;=$7.00/day</th>
<th>$8.00/day</th>
<th>$9.00/day</th>
<th>&gt;=$10.00/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban site within ¼ mile of transit stop</td>
<td>5.0</td>
<td>6.0</td>
<td>6.5</td>
<td>7.2</td>
</tr>
<tr>
<td>Urban site greater than ¼ mile from transit stop</td>
<td>1.5</td>
<td>2.4</td>
<td>3.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Suburban site within ¼ mile of transit stop</td>
<td>2.0</td>
<td>2.8</td>
<td>3.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Suburban site greater than ¼ mile from transit stop</td>
<td>1.0</td>
<td>1.9</td>
<td>2.8</td>
<td>3.7</td>
</tr>
</tbody>
</table>

10b Parking Cash Out

**C, M**

In addition, a flexibility mechanism for measure 10a shall be that of a parking cash-out program. For example, if parking spaces are included as part of a commercial property lease to an employer and, as a result, are provided free to employees, an employer can still provide this alternative transit incentive to achieve a discounted emission reduction. Under this program, employees of the commercial business shall be given the option to elect a cash payment to opt out of the use of an employer-subsidized parking space. The cash payment shall be equal to the cost to the employer on a per space basis. Implementation of the parking cash-out mechanism shall be awarded 2/3 times the applicable value in the above table.

The proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a narrative describing the method in which the cash-out program will be implemented and enforced. The successful implementation of this provision and its enforcement are the same as discussed above.

11. Provide minimum amount of parking required. (Special review of parking required)
    **R, C, M** see below
Project utilizes all parking reductions available under jurisdiction code to reduce required parking. Aisle and lane widths are reduced in area to the minimum allowed under code. Most zoning codes in the Sacramento area have provisions that allow a project to build less than the typically mandated amount of parking if the development features design elements that reduce the need for automobile use. This measure recognizes the air quality benefit that results when facilities minimize parking needs, and grants mitigation value to projects that implement all available parking reductions.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a recitation of the appropriate jurisdiction's code, a calculation that determines what the minimum amount is for this particular project and a commitment to provide no more than that amount of parking. In addition, if the uses of the project are not yet determined, there should be a declaratory statement in the plan declaring that the amount of parking will be recalculated again at the time those uses are finally determined in the planning stage and that no more than the minimum will be provided. Since parking mandates in Sacramento County vary based on location (Central Business District, incorporated area, or unincorporated area), and since Sacramento County Zoning Code is currently in the process of being updated, a specific percent trip reduction cannot be determined.

Once land uses are determined, the trip reduction factor associated with this measure can be determined by utilizing the Institute of Transportation Engineers (ITE) parking generation publication⁴. The reduction in trips can be computed as shown below by the ratio of the difference of minimum parking required by code and ITE peak parking demand to ITE peak parking demand for the land uses multiplied by 50%. The maximum achievable trip reduction is 6%. For projects where retail space occupies 50% or more of the total built space, do not use December specific parking generation rates.

\[
\text{Percent Trip Reduction} = 50 \times \left(\frac{\text{min parking required by code} - \text{ITE peak parking demand}}{\text{ITE peak parking demand}}\right)
\]

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that parking facilities in the completed project did not deviate from the parking described in the Air Quality Mitigation Plan provided to SMAQMD.

12. Provide parking reduction less than code. (Special review by jurisdiction may be required)
R,C,M see below

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a restatement of the minimum amount of parking determined in measure 11, a description of how many parking spaces are allocated to each land use. Proponent shall include calculations that show the parking reduction of spaces for each land use type, a commitment to provide the reduced amount of parking, and a statement confirming that if uses change in the planning stage, parking will be recalculated and reduced according to the measure.

Trip reductions associated with parking reductions beyond code shall be computed in the same manner as described under measure 11, as the same methodology applies. The maximum achievable trip reduction is 12%.

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The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the parking facilities in the completed project did not deviate from the parking described in the Air Quality Mitigation Plan provided to SMAQMD.

This measure can be readily implemented through a Shared Parking strategy, wherein parking is utilized jointly among different land uses, buildings, and facilities in an area that experience peak parking needs at different times of day and day of the week. For example, residential uses and/or restaurant/retail uses, which experience peak parking demand during the evening/night and on the weekends, arrange to share parking facilities with office and/or educational uses, which experience peak demand during business hours and during the week.

13. **Provide a parking lot design that includes clearly marked and shaded pedestrian pathways between transit facilities and building entrances.**
   R,C,M 0.5

Pathway must connect to all transit facilities internal or adjacent to project site.

Proponent shall provide information including, but not limited to, a written description and site plan of how the pathways are clearly marked, shaded, and are placed between transit facilities and building entrances.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to determine if the built pedestrian pathways through parking facilities match the pedestrian pathways described in the Air Quality Mitigation Plan provided to SMAQMD.

14. **Parking facilities are not adjacent to street frontage.**
   R,C,M 1.5 if parking facilities are located entirely behind buildings in relation to street frontage, in an area proximate to high density/mixed-use, in conjunction with other pedestrian-oriented measures, and where surrounding uses are also hiding parking.

   1.0 if structured parking facilities with frontage along streets provide retail and commercial uses along the street frontage on the ground floor.

   0.1 if surrounding development is not pedestrian-oriented, not hiding its parking, or not proximate to high density/mixed-use.

For **1.5% reduction**, parking facilities shall not be sited adjacent to public roads contiguous with project site. Functioning pedestrian entrances to major site uses are located along street frontage. Parking facilities do not restrict pedestrian, bicycle, or transit access from adjoining uses. Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a description of where parking is located relative to the buildings on the site, site plans, maps, or other graphics, which demonstrate the placement of parking facilities behind on-site buildings relative to streets contiguous with the project site.

Since the nature of this measure is psychological, rather than direct (such as parking pricing), the efficacy of this measure is highly dependent on surrounding uses and measures. For this measure to be fully effective, and to warrant a 1.5% trip reduction, surrounding uses shall be high density or mixed-use, there shall be other adjoining pedestrian and bicycle connections, such as wide sidewalks and bike lanes, and surrounding uses shall also implement measure 15.
For single family housing units, the parking space/garage access does not front thoroughfares. Parking/Garage access is relegated to rear of buildings and accessed from alleys or secondary streets.

For 1.0% reduction, (parking structures only) proponent must show that parking facilities that face street frontage feature ground floor retail along street frontage. Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a written description of the parking facility and the amount of retail space on the ground floor, site plans, maps, or other graphics demonstrating the placement of retail/commercial space along all street fronts contiguous with parking structure.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to determine if the built facilities match graphic exhibits in the Air Quality Mitigation Plan provided to SMAQMD.

For 0.1% reduction, the project is not among high-density or mixed uses, is not connected to pedestrian or bicycle access ways, or is among uses that do not also hide parking. This point value is reflective of the importance that other pedestrian and density measures be in place in order for this measure to be effective. Implementation shall be in accordance with that discussed above.
Site Design Measures

15. Project provides high density office or mixed-use proximate to transit.
C,M See table

Mitigation value is based on project density and proximity to transit. Planned transit must be in MTP or RT Master Plan. Maximum credit is 2.0 (light rail and bus points cannot be combined).

To count as "existing transit" service must be fully operational prior to the first 20% of the projects occupancy permits being granted.

Project must provide safe and convenient pedestrian and bicycle access to all transit stops within ¼ mile. Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a written description of how the project complies with the measure, a map or graphic depicting the location of the project in relation to the transit stop. Graphic should demonstrate a ¼-mile radius arc from transit and planned pathways and linkages to the transit stop. The proponent shall also provide graphics depicting the size and layout of building as well as calculations demonstrating the FAR (floor to area ratio).

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the measure is being implemented in the manner described in the Air Quality Mitigation Plan.

Percent Reduction Table:

<table>
<thead>
<tr>
<th>Transit Type:</th>
<th>No Transit</th>
<th>Planned Light Rail Transit</th>
<th>Planned Bus Rapid Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>15 min.</td>
<td>30 min.</td>
</tr>
<tr>
<td>Headway frequency:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75–1.5 FAR</td>
<td>0.05</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>1.5–2.25 FAR</td>
<td>0.1</td>
<td>0.75</td>
<td>0.5</td>
</tr>
<tr>
<td>2.25 or greater FAR</td>
<td>0.2</td>
<td>1.0</td>
<td>0.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transit Type:</th>
<th>No Transit</th>
<th>Existing Light Rail Transit</th>
<th>Existing Bus Rapid Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>15 min.</td>
<td>30 min.</td>
</tr>
<tr>
<td>Headway frequency:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75–1.5 FAR</td>
<td>0.05</td>
<td>1.0</td>
<td>0.75</td>
</tr>
<tr>
<td>1.5–2.25 FAR</td>
<td>0.1</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>2.25 or greater FAR</td>
<td>0.2</td>
<td>2.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

16. Project is oriented towards existing transit, bicycle, or pedestrian corridor. Setback distance is minimized.
R,C,M 0.5

Cannot get points for both this measure and measure 17.

Setback distance between project and adjacent uses is reduced to the minimum allowed under jurisdiction code. Setback distance between different buildings on project site is reduced to the minimum allowed under jurisdiction code. Setbacks between project buildings and sidewalks is
reduced to the minimum allowed under jurisdiction code. Buildings are oriented towards street frontage. Primary entrances to buildings are located along public street frontage. Project provides bicycle access to existing bicycle corridor. Project provides pedestrian access to existing pedestrian corridor.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a written description of how the project complies with the measure, a map or graphic depicting the project's site design in relation to existing transit, bicycle, or pedestrian corridor. Graphic shall depict planned connections to existing transit, bicycle, or pedestrian corridor. Graphic shall depict setback distances between all project buildings and all adjacent streets, transit corridors, bicycle corridors, and pedestrian corridors.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the measure is being implemented in the manner described in the Air Quality Mitigation Plan.

17. **Project is oriented towards planned transit, bicycle, or pedestrian corridor. Setback distance is minimized.**

R,C,M 0.25

Cannot get points for both this measure and measure 16.

Planned transit, bicycle or pedestrian corridor must be in MTP, RT Master Plan, General Plan, or Community Plan.

Setback distance between project and existing or planned adjacent uses is minimized or non-existent. Setback distance between different buildings on project site is minimized. Setbacks between project buildings and planned or existing sidewalks are minimized. Buildings are oriented towards existing or planned street frontage. Primary entrances to buildings are located along planned or existing public street frontage. Project provides bicycle access to any planned bicycle corridor(s). Project provides pedestrian access to any planned pedestrian corridor(s).

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a written description of how the project complies with the measure, a map or graphic depicting the project's site design in relation to planned transit, bicycle, or pedestrian corridor. Graphic shall depict planned connections to planned transit, bicycle, or pedestrian corridor. Graphic shall depict setback distances between all project buildings and all planned adjacent streets, transit corridors, bicycle corridors, and pedestrian corridors.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the measure is being implemented in the manner described in the Air Quality Mitigation Plan.

18. **Project provides high-density residential development.**

R see table

Mitigation value is based on project density and proximity to transit. Density is calculated by determining the number of units per acre ("du/acre") within the residential portion of the project's net lot area. Transit facilities must be within ¼ mile of project border. Project provides safe and convenient bicycle/pedestrian access to all transit stop(s) within ¼ mile of project border. Planned transit must be in MTP or RT Master Plan.
Maximum credit is 12 mitigation points (light rail and bus points cannot be combined). Reductions are calculated relative to a baseline 3 du/acre residential development. Net residential density excludes the area devoted to arterials, open space, and other land uses, but includes local streets.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a written description of how the project complies with the measure, a map or graphic depicting the project's site design and density in various portions. Calculations shall be provided that clearly show how the density figures were arrived.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the project was built at the density described in the Air Quality Mitigation Plan and is within ¼ mile of existing transit, if applicable.

Percent Reduction Table:

To use this table, determine the residential density of the proposed project, and corresponding Base Percent Emission Reduction. This is the range of emission reductions that density of project provides relative to a 3 du/residential acre baseline. Next, determine where the proposed project falls in the range corresponding to where the number of dwelling units fits within this given range. Finally, if the project is within ¼ mile of existing or planned transit of the listed type and headways, add the additional percent emission reduction to the base percent emission reduction, to determine the total percent reduction for this measure.

<table>
<thead>
<tr>
<th>Transit Type:</th>
<th>Mitigation Points</th>
<th>Additional Mitigation points for Proximity to Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Transit</td>
<td>Planned Light Rail Transit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 min.</td>
</tr>
<tr>
<td>Headway frequency:</td>
<td>3–6 du/acre</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7–10 du/acre</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>11–20 du/acre</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>21–30 du/acre</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>31–40 du/acre</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>41–50 du/acre</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>50+ du/acre</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transit Type:</th>
<th>No Transit</th>
<th>Existing Light Rail Transit</th>
<th>Existing Bus Rapid Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>15 min.</td>
<td>30 min.</td>
</tr>
<tr>
<td>Headway frequency:</td>
<td>3–6 du/acre</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7–10 du/acre</td>
<td>1</td>
<td>+2.0</td>
</tr>
<tr>
<td></td>
<td>11–20 du/acre</td>
<td>3</td>
<td>+2.0</td>
</tr>
<tr>
<td></td>
<td>21–30 du/acre</td>
<td>5</td>
<td>+2.0</td>
</tr>
<tr>
<td></td>
<td>31–40 du/acre</td>
<td>6</td>
<td>+2.0</td>
</tr>
<tr>
<td></td>
<td>41–50 du/acre</td>
<td>8</td>
<td>+2.0</td>
</tr>
<tr>
<td></td>
<td>50+ du/acre</td>
<td>10</td>
<td>+2.0</td>
</tr>
</tbody>
</table>

Note: reductions in columns indicating type of transit within ¼ mile of the project site shall be added to those in the "No Transit" column. Cannot get percentage points for more than one transit type.
19. **Multiple and direct street routing (grid style).**
R,C,M  1.0

This measure only applies to projects with an internal connectivity factor (CF) >= 0.80, and average of \( \frac{3}{4} \) mile or less between external connections along perimeter of project. [CF = # of intersections / (# of cul-de-sacs + intersections)]

Cul-de-sacs with bicycle/pedestrian through access may be considered “complete intersections” when calculating the project’s internal connectivity factor.

External connections are bike/pedestrian pathways and access points, or streets with safe and convenient bicycle and pedestrian access that connect the project to adjacent streets, sidewalks, and uses. If project site is adjacent to undeveloped land; streets, pathways, access points, and right-of-ways that provide for future access to adjacent uses may count for up to 50% of the external connections.

Block perimeter (the sum of the measurement of the length of all block sides) is limited to no more than 1,350 feet. Streets internal to the project should connect to streets external to the project whenever possible. Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a written description of connectivity within and external to the project and a map or graphic depicting the project’s transportation network design. The graphic shall depict the layout and specifications of all bike paths, pedestrian paths, streets, and sidewalks in relation to planned transit, bicycle, or pedestrian corridor. Graphic shall depict connections to adjacent uses. Calculations will clearly show how the “Connectivity Factor” was derived (show the work).

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the measure is being implemented in the manner described in the Air Quality Mitigation Plan.

20. **Make physical development consistent with requirements for neighborhood electric vehicles (NEV)\(^5\).**
R,C,M  0.5–1.5

Current studies show that for most trips, NEVs do not replace gas-fueled vehicles as the primary vehicle. For the purposes of providing incentives for developers to promote NEV use, assume the following:

For 1.5% reduction, a neighborhood shall have internal NEV connections and connections to other existing NEV networks serving all other types of uses.

For 1.0% reduction, a neighborhood shall have internal and external connections to surrounding neighborhoods.

For 0.5% reduction, a neighborhood has internal connections only.

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\(^5\) NEVs are a form of Low Speed Vehicle (LSV) and are governed by California Vehicle Code sections 21250 through 21266. The text of these codes may be viewed at: [http://www.dmv.ca.gov/pubs/vctop/vc/tocd11c1a5-2.htm](http://www.dmv.ca.gov/pubs/vctop/vc/tocd11c1a5-2.htm).
Project design includes designated Neighborhood Electric Vehicles (NEV) routes and facilities. Roadways internal to project site are designed to accommodate NEVs.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to; a map/graphic depicting NEV routes and exclusive NEV roadways within project site, graphics of street layout's for roadways with separate NEV lanes depicting lane width and layout, a narrative description of any design modifications made to accommodate NEVs.

Commercial and Mixed-use projects must provide exclusive NEV parking facilities.

Emission benefits associated with this measure are difficult to quantify. Credit for this measure will be granted only in limited circumstances to specific types of developments, in conjunction with coordination with SMAQMD during the design phase of the project. The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that project roadways match the NEV supportive design described in the Air Quality Mitigation Plan.

21. **Affordable Housing Component.**

R 0.6-4.0

Residential development projects of five (5) or more dwelling units provide a deed-restricted low-income housing component on-site (as defined in Ch 22.35 of Sacramento County Ordinance Code).

Proponents who pay into In-Lieu Fee programs are not eligible for this measure. In-Lieu Fees are offered as an alternative way to meet affordable housing obligations. Inclusionary housing programs are designed to construct affordable housing. Sometimes an in-lieu fee is accepted in place of actual housing construction, to promote flexibility for land developers. In-lieu fees for an inclusionary program are intended to result in affordable housing construction off-site, although the amount of in-lieu fee collected is often not sufficient to construct the intended number of housing units. Assuming the in-lieu program is successful, when a developer elects to meet affordable housing requirements through an in-lieu program off-site, this creates more housing units (and therefore more vehicle trips) compared to meeting affordable housing requirements on-site and compared to having no inclusionary program at all. The affordable housing trip reduction credit reflects the fact that, in general, income is one of the most important predictors of household trip generation characteristics. If a market-rate housing project is constructed and an in-lieu contribution is accepted to meet affordable housing requirements, the housing that is later constructed using those in-lieu funds would potentially be eligible for trip reduction credit.

However, the credit would be issued to the developer of the affordable housing (traffic studies do not typically take into account the future income levels of households when preparing trip generation assumptions) and not the various market rate housing developers that may have contributed to the fund. The award of emission reduction credit shall be based only on the proportion of affordable housing developed on-site because In-lieu programs simply induce a net increase in development.

Percentage reduction shall be calculated according to the following formula:

\[
\text{% reduction} = \text{% units deed-restricted below market rate housing} \times 0.04
\]

The proponent shall provide the number of dwelling units and associated reduction in the Air Quality Mitigation Plan. The successful implementation of this measure may be verified by a site
review and/or consultation with lead agency staff to ensure that measure is being implemented in the manner described in the Air Quality Mitigation Plan.

**Mixed-use Measures**

22. **Urban Mixed-use**: Development of projects predominantly characterized by properties on which various uses, such as office, commercial, institutional, and residential, are combined in a single building or on a single site in an integrated development project with functional interrelationships and a coherent physical design.

M 3.0, up to 9.0 depending on job to housing ratio

Mitigation point values subject to change following technical review.

In buildings that are ten floors high or less, no single use may constitute less than 10% of total floor space. For buildings with more than ten floors, 75% of ground level floor space must be designated for retail uses.

Maximum Mitigation granted only for vertical mixed-use in single buildings with a FAR of 1.5 or greater. For projects with detached buildings, the Air Quality Mitigation Plan must include measure six. For detached buildings within a single site, all buildings must be placed within ¼ mile of the geographic center of the project site.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a narrative description of the functional interrelationships between project uses, a map or graphic(s) demonstrating coherent physical design and pedestrian access route.

Cannot get credit for both this measure and measures 23 or 24

Up to 6 additional mitigation points may be recognized for projects that provide employment and housing in a ratio that leads to trip reduction. This reduction is based on an employment/housing balance, and assumes an ideal balance of 1.5 jobs per household. The exact reduction shall be computed according to the formula below, and the total reduction received through utilization of this measure shall not exceed 9 mitigation points. Proponent must provide calculation to receive greater than 3 mitigation point credit.

Employment/housing balance formula:

\[
\text{Mitigation points} = (1-(\text{ABS}(1.5^h-e)/(1.5^h+e))-0.25)/0.25*0.03
\]

- \(h\) = study area housing units
- \(e\) = study area employment
- ABS= absolute value

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that measure is being implemented in the manner described in the Air Quality Mitigation Plan.

23. **Suburban mixed-use**: Have at least three of the following on site and/or offsite within ¼ mile: Residential Development, Retail Development, Park, Open Space, or Office.

R,C,M 3.0

23
PropONENT shall provide information demonstrating compliance with measure requirements including, but not limited to, a narrative description of the functional interrelationships between the three onsite and/or offsite project uses, a map or graphic(s) demonstrating coherent physical design between all uses.

Cannot get credit for both this measure and measures 22 or 24.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the measure is being implemented in the manner described in the Air Quality Mitigation Plan.

24. **Other mixed-use**: All residential units are within ¼ mile of parks, schools or other civic uses.

R,M  1.0

Civic uses are government facilities that provide services directly to the public (post office, city hall, courthouse, community center, etc).

PropONENT shall provide information demonstrating compliance with measure requirements including, but not limited to, a narrative description of park(s), school(s), and civic uses within ¼-mile, a map or graphic(s) demonstrating the location of the three facility types in relation to the project site, and a map or graphic demonstrating the pedestrian routes between the facilities and the project site.

Cannot get points for both this measure and measures 22 or 23.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the measure is being implemented in the manner described in the Air Quality Mitigation Plan.
Building Component Measures

25. Project does not feature fireplaces or wood burning stoves.\(^6\)
R 1.0

All buildings, units, and facilities; indoors or out, are free of devices designed to facilitate the combustion of wood or wood products. The use of Natural Gas or Electric Fireplaces is not limited by this measure, and the inclusion of natural gas or electric fireplaces in a project design will not affect SMAQMD endorsement of this measure as a part of an Air Quality Mitigation Plan.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a written commitment in design documents, environmental documents and the project's Air Quality Mitigation Plan to refrain from installing any devices that facilitate the combustion of wood or wood products.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to confirm that the project as built does not contain fireplaces or other devices designed to facilitate the combustion of wood or wood products.

This measure may not be used if the project is subject to a legal mandate governing the inclusion of devices designed to facilitate the combustion of wood in new development.

26. Install ozone destruction catalyst on air conditioning systems.
R,C,M 1.25 if installed on all air conditioning units

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, specifications and any available manufacturer's documentation on the devices to be used.

The successful implementation of this measure may be verified by a site review following construction to confirm that the project as built contains ozone destruction catalysts as described in the Air Quality Mitigation Plan.

27. Install Energy Star labeled roof materials.
R,C,M 0.5-1.0

Energy star qualified roof products reflect more of the sun's rays, decreasing the amount of heat transferred into a building.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, specifications of the roofing products and documentation confirming that products to be utilized are Energy Star Certified. 0.5 points are available for Energy Star labeled roof materials, while an additional 0.5 points is available (for a total of 1.0 point) for qualified roof products that meet ATSM high emissivity requirements.

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\(^6\) As of January, 2007, this measure is of benefit to Air Quality because it is more stringent than the recently adopted SMAQMD Rule 417 (Wood Burning Appliances) which allows for the installation of wood burning devices in new residential construction as long as they are USEPA-Certified Phase II or equivalent devices.
The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that roofing products installed in the project match the roofing products described in the Air Quality Mitigation Plan.

28. **Project provides onsite renewable energy system(s).**
R,C,M 1.0-3.0

The number of mitigation points granted for this measure is based on project performance. Performance is expressed as the electricity produced by the renewable system(s) as a percentage of the annual energy cost. Building energy cost is calculated using averages from the Department of Energy (DOE) Commercial Building Energy Consumption Survey database (CBECS) for Commercial and Mixed-use Projects, and averages from the DOE Residential Energy Consumption Survey database (RECS) for residential projects.

- Projects that install renewable energy systems capable of generating 2.5% of project’s projected annual energy need shall receive 1.0 mitigation points.
- Projects that install renewable energy systems capable of generating 7.5% of project’s projected annual energy need shall receive 2.0 mitigation points.
- Projects that install renewable energy systems capable of generating 12.5% of project’s projected annual energy need shall receive 3.0 mitigation points.

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to; detailed specifications of the renewable energy devices to be utilized, analysis of the buildings’ projected energy consumption using averages from CBECS or RECS as relevant to the building type, and analysis of the projected power output from the renewable energy system. Analysis should include detailed background information on the calculations made (show the work).

The successful implementation of this measure may be verified by a site review of the installation to confirm that components and devices match the renewable energy system described in the project’s Air Quality Mitigation Plan.

29. **Project Exceeds Title 24 requirements by 20%.**
R,C,M 1.0

Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to a copy of the Title 24 compliance sheet.

The Title 24 compliance documentation will serve as verification of implementation of this measure.

30. **Orient 75 or more percent of homes and/or buildings to face either north or south (within 30 degrees of N/S).**
R 0.5

Building design includes roof overhangs that are sufficient to block the high summer sun, but not the lower winter sun, from penetrating south facing windows. Trees, other landscaping features and other buildings are sited in such a way as to maximize shade in the summer and maximize solar access to walls and windows in the winter.
Proponent shall provide information and calculations demonstrating compliance with measure requirements including, but not limited to a map/graphic depicting the orientation of the buildings and the dimensions of the roof overhangs on project building(s).

The successful implementation of this measure may be verified by a site review following construction to confirm that the project as built contains the same building orientation.

31. **Non-Roof Surfaces.**
   R,C,M 1.0

The mitigation measure reduces heat islands (thermal gradient differences between developed and undeveloped areas to minimize impact on microclimate and human and wildlife habitats. The measure offers project proponents the ability to provide any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards, and parking lots):

- Shade (within 15 years of occupancy)
- Paving materials with a Solar reflectance Index (SRI) of at least 29
- Open grid pavement system

This measure requires the use of patented or copywrite protected methodologies created by the American Society for Testing Materials (ASTM)\(^7\).

The Solar Reflectance Index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small rise in temperature. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is "0" and a standard white (reflectance 0.80, emittance 0.90) is 100. To calculate SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980-01. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Default values for some materials will be available in the LEED-NC v2.2 Reference Guide\(^8\).

Proponents may alternatively place a minimum of 50% of parking spaces under cover (defined as underground, under deck, under roof, or under a building). Any roof used to shade or cover must have a SRI of at least 29. Shade constructed surfaces with landscape features that use highly reflective materials. For additional benefits, combine this measure with a vegetated green roof mitigation measure option, or use of high-albedo materials to reduce heat absorption.

The successful implementation of this measure may be verified by a site review and/or consultation with lead agency staff to ensure that the measure is being implemented in the manner described in the Air Quality Mitigation Plan.

32. **Install a vegetated roof that covers at least 50% of roof area.**
   R,C,M 0.5

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Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, detailed graphics depicting the planned roof, detailed information on maintenance requirements for the roof, and the facilities plan for maintaining the roof post-construction.

This measure may be combined with measure 29 for un-vegetated portion of roof.

The successful implementation of this measure may be verified by a site review to ensure that the vegetated roof installed in the project matches the roof described in the Air Quality Mitigation Plan. Project may also be reviewed to ensure that the roof is being maintained as outlined in the Air Quality Mitigation Plan.

**TDM and Miscellaneous Measures**

33. **Include permanent TMA membership and funding requirement. Funding to be provided by Community Facilities District or County Service Area or other non-revocable funding mechanism.**
   
   R,C,M  5.0

   Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to, a copy of the agreement/formal commitment of the project to ongoing membership through a non-revocable funding mechanism to the appropriate TMA, Community Facilities District, County Service Agency for the area in which the project is located.

   The successful implementation of this measure may be verified by consultation with the funding oversight agency and project’s lead agency to ensure that building occupants are maintaining commitments outlined in the Air Quality Mitigation Plan.

34. **Provide a complimentary electric lawn mower to each residential buyer.**
   
   R    1.0

   This measure may only be used in residential communities with outdoor areas featuring grass lawns where unit occupant is responsible for maintenance/landscaping. Proponent may provide either cordless (battery powered) or standard electric lawn mowers.

   The successful implementation of this measure may be verified by consultation with lead agency to ensure that the electric lawn mowers are distributed to building occupants upon initial occupation as outlined in the project’s Air Quality Mitigation Plan.

99. **Other proposed strategies, in consultation with project lead agency and SMAQMD.**
   
   R,C,M  TBD

   Other proposed strategies must be permanent and enforceable methods of reducing emissions created by the project. Other proposed strategies cannot duplicate existing measures.

   Proponent shall provide information demonstrating compliance with measure requirements including, but not limited to; evidence supporting emissions benefit such as device specifications or quantitative analysis of air quality benefit resulting from other proposed strategy.

   The successful implementation of this measure may be verified by site inspection and/or consultation with lead agency to ensure that building occupants are maintaining commitments outlined in the project’s Air Quality Mitigation Plan.
GOVERNOR'S OFFICE OF PLANNING AND RESEARCH
TECHNICAL ADVISORY – CEQA AND CLIMATE CHANGE:
ADDRESSING CLIMATE CHANGE THROUGH CALIFORNIA
ENVIRONMENTAL QUALITY ACT (CEQA) REVIEW
| Update 1.1  
| January 9, 2007: |
| The guidance document was updated with several minor grammatical corrections and the addition of footnote #6 on page 25, which explains the nexus between mitigation measure 25 and Rule 417 (Wood Burning Appliances), which was adopted on October 26, 2006. Both the measure and the rule address the inclusion of wood burning devices in new construction. |

| Update 2.2.  
| June 13, 2007 |
| The guidance document was updated to correct several minor errors in numbering in measures 16,17,22,23,and 24. The guidance was also updated with a change in version number to improve clarity, and measure 11 was updated to ensure that the area devoted parking lanes and aisle ways in parking lots is minimized. |

| Update 2.4  
| August 15, 2007 |
| Scaling methodology two was updated to improve clarity. Measure 10a was changed to correctly refer to measure 10b. Measure 11 was changed twice to correctly refer to the ITE parking generation manual, replacing the incorrect reference to the ITE trip generation manual. Measure 11 was also updated with a provision that the December peak parking rates are not to be used when calculating the emission reduction point value for this measure. Measures 33 and 34 were updated to match the numbering in the summary table at the beginning of the document. |
CEQA AND CLIMATE CHANGE: Addressing Climate Change Through California Environmental Quality Act (CEQA) Review

This technical advisory is one in a series of advisories provided by the Governor's Office of Planning and Research (OPR) as a service to professional planners, land use officials and CEQA practitioners. OPR issues technical guidance from time to time on issues that broadly affect the practice of CEQA and land use planning. The emerging role of CEQA in addressing climate change and greenhouse gas emissions has been the topic of much discussion and debate in recent months. This document provides OPR's perspective on the issue.

I. PURPOSE

General scientific consensus and increasing public awareness regarding global warming and climate change have placed new focus on the California Environmental Quality Act (CEQA) review process as a means to address the effects of greenhouse gas (GHG) emissions from proposed projects on climate change. Many public agencies—along with academic, business, and community organizations—are striving to determine the appropriate means by which to evaluate and mitigate the impacts of proposed projects on climate change. Approaches and methodologies for calculating GHG emissions and addressing the environmental impacts through CEQA review are rapidly evolving and are increasingly available to assist public agencies to prepare their CEQA documents and make informed decisions.
The Governor's Office of Planning and Research (OPR) will develop, and the California Resources Agency (Resources Agency) will certify and adopt amendments to the Guidelines implementing the California Environmental Quality Act ("CEQA Guidelines"), on or before January 1, 2010, pursuant to Senate Bill 97 (Dutton, 2007). These new CEQA Guidelines will provide regulatory guidance on the analysis and mitigation of GHG emissions in CEQA documents. In the interim, OPR offers the following informal guidance regarding the steps lead agencies should take to address climate change in their CEQA documents. This guidance was developed in cooperation with the Resources Agency, the California Environmental Protection Agency (Cal/EPA), and the California Air Resources Board (ARB).

11. BACKGROUND

Climate change refers to any significant change in measures of climate, such as average temperature, precipitation, or wind patterns over a period of time. Climate change may result from natural factors, natural processes, and human activities that change the composition of the atmosphere and alter the surface and features of the land. Significant changes in global climate patterns have recently been associated with global warming, an average increase in the temperature of the atmosphere near the Earth's surface, attributed to accumulation of GHG emissions in the atmosphere. Greenhouse gases trap heat in the atmosphere, which in turn heats the surface of the Earth. Some GHGs occur naturally and are emitted to the atmosphere through natural processes, while others are created and emitted solely through human activities. The emission of GHGs through the combustion of fossil fuels (i.e., fuels containing carbon) in conjunction with other human activities, appears to be closely associated with global warming.

State law defines GHG to include the following: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (Health and Safety Code, section 38505(g)). The most common GHG that results from human activity is carbon dioxide, followed by methane and nitrous oxide.

Requirements of AB 32 and SB 97

Assembly Bill 32 (AB 32), the California Global Warming Solutions Act of 2006 (Nunez, 2006), recognizes that California is the source of substantial amounts of GHG emissions. The statute begins with several legislative findings and declarations of intent, including the following:
Global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California. The potential adverse impacts of global warming include the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snow pack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems. (Health and Safety Code, section 38501.)

In order to avert these consequences, AB 32 establishes a state goal of reducing GHG emissions to 1990 levels by the year 2020 (a reduction of approximately 25 percent from forecast emission levels) with further reductions to follow. The law requires the ARB to establish a program to track and report GHG emissions; approve a scoping plan for achieving the maximum technologically feasible and cost effective reductions from sources of GHG emissions; adopt early reduction measures to begin moving forward; and adopt, implement and enforce regulations — including market mechanisms such as “cap-and-trade” programs — to ensure the required reductions occur. The ARB recently adopted a statewide GHG emissions limit and an emissions inventory, along with requirements to measure, track, and report GHG emissions by the industries it determined to be significant sources of GHG emissions.

CEQA requires public agencies to identify the potentially significant effects on the environment of projects they intend to carry out or approve, and to mitigate significant effects whenever it is feasible to do so. While AB 32 did not amend CEQA to require new analytic processes to account for the environmental impacts of GHG emissions from projects subject to CEQA, it does acknowledge that such emissions cause significant adverse impacts to human health and the environment.

Senate Bill 97, enacted in 2007, amends the CEQA statute to clearly establish that GHG emissions and the effects of GHG emissions are appropriate subjects for CEQA analysis. It directs OPR to develop draft CEQA Guidelines “for the mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions” by July 1, 2009 and directs the Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

Requirements of CEQA

CEQA is a public disclosure law that requires public agencies to make a
good-faith, reasoned effort, based upon available information, to identify the potentially significant direct and indirect environmental impacts—including cumulative impacts—of a proposed project or activity. The CEQA process is intended to inform the public of the potential environmental effects of proposed government decisions and to encourage informed decision-making by public agencies. In addition, CEQA obligates public agencies to consider less environmentally-damaging alternatives and adopt feasible mitigation measures to reduce or avoid a project’s significant impacts.

The lead agency is required to prepare an Environmental Impact Report (EIR), a Mitigated Negative Declaration, or equivalent document, when it determines that the project’s impacts on the environment are potentially significant. This determination of significance must be based upon substantial evidence in light of all the information before the agency.

Although the CEQA Guidelines, at Appendix G, provide a checklist of suggested issues that should be addressed in an EIR, neither the CEQA statute nor the CEQA Guidelines prescribe thresholds of significance or particular methodologies for performing an impact analysis. This is left to lead agency judgment and discretion, based upon factual data and guidance from regulatory agencies and other sources where available and applicable. A threshold of significance is essentially a regulatory standard or set of criteria that represent the level at which a lead agency finds a particular environmental effect of a project to be significant. Compliance with a given threshold means the effect normally will be considered less than significant. Public agencies are encouraged but not required to adopt thresholds of significance for environmental impacts. Even in the absence of clearly defined thresholds for GHG emissions, the law requires that such emissions from CEQA projects must be disclosed and mitigated to the extent feasible whenever the lead agency determines that the project contributes to a significant, cumulative climate change impact.

We realize that perhaps the most difficult part of the climate change analysis will be the determination of significance. Although lead agencies typically rely on local or regional definitions of significance for most environmental issues, the global nature of climate change warrants investigation of a statewide threshold of significance for GHG emissions. To this end, OPR has asked ARB technical staff to recommend a method for setting thresholds which will encourage consistency and uniformity in the CEQA analysis of GHG emissions throughout the state. Until such time as state guidance is available on thresholds of significance for GHG emissions, we recommend the following approach to your CEQA analysis.
III. RECOMMENDED APPROACH

Each public agency that is a lead agency for complying with CEQA needs to develop its own approach to performing a climate change analysis for projects that generate GHG emissions. A consistent approach should be applied for the analysis of all such projects, and the analysis must be based on best available information. For these projects, compliance with CEQA entails three basic steps: identify and quantify the GHG emissions; assess the significance of the impact on climate change; and if the impact is found to be significant, identify alternatives and/or mitigation measures that will reduce the impact below significance.

Lead agencies should determine whether greenhouse gases may be generated by a proposed project, and if so, quantify or estimate the GHG emissions by type and source. Second, the lead agency must assess whether those emissions are individually or cumulatively significant. When assessing whether a project’s effects on climate change are “cumulatively considerable” even though its GHG contribution may be individually limited, the lead agency must consider the impact of the project when viewed in connection with the effects of past, current, and probable future projects. Finally, if the lead agency determines that the GHG emissions from the project as proposed are potentially significant, it must investigate and implement ways to avoid, reduce, or otherwise mitigate the impacts of those emissions. Although the scientific knowledge and understanding of how best to perform this analysis is rudimentary and still evolving, many useful resources are available (see Attachment 1).

Until such time as further state guidance is available on thresholds of significance, public agencies should consider the following general factors when analyzing whether a proposed project has the potential to cause a significant climate change impact on the environment.

Identify GHG Emissions

- Lead agencies should make a good-faith effort, based on available information, to calculate, model, or estimate the amount of CO₂ and other GHG emissions from a project, including the emissions associated with vehicular traffic, energy consumption, water usage and construction activities.
- Technical resources, including a variety of modeling tools, are available to assist public agencies to quantify GHG emissions. OPR recognizes that more sophisticated emissions models for particular types of projects are continually being developed and that the state-of-the-art quantification
models are rapidly changing. OPR will periodically update the examples of modeling tools identified in Attachment 2.

- There is no standard format for including the analysis in a CEQA document. A GHG/climate change analysis can be included in one or more of the typical sections of an EIR (e.g., air quality, transportation, energy) or may be provided in a separate section on cumulative impacts or climate change.

Determine Significance

- When assessing a project's GHG emissions, lead agencies must describe the existing environmental conditions or setting, without the project, which normally constitutes the baseline physical conditions for determining whether a project's impacts are significant.

- As with any environmental impact, lead agencies must determine what constitutes a significant impact. In the absence of regulatory standards for GHG emissions or other scientific data to clearly define what constitutes a “significant impact”, individual lead agencies may undertake a project-by-project analysis, consistent with available guidance and current CEQA practice.

- The potential effects of a project may be individually limited but cumulatively considerable. Lead agencies should not dismiss a proposed project's direct and/or indirect climate change impacts without careful consideration, supported by substantial evidence. Documentation of available information and analysis should be provided for any project that may significantly contribute new GHG emissions, either individually or cumulatively, directly or indirectly (e.g., transportation impacts).

- Although climate change is ultimately a cumulative impact, not every individual project that emits GHGs must necessarily be found to contribute to a significant cumulative impact on the environment. CEQA authorizes reliance on previously approved plans and mitigation programs that have adequately analyzed and mitigated GHG emissions to a less than significant level as a means to avoid or substantially reduce the cumulative impact of a project.

Mitigate Impacts

- Mitigation measures will vary with the type of project being contemplated, but may include alternative project designs or locations that conserve energy and water, measures that reduce vehicle miles traveled
(VMT) by fossil-fueled vehicles, measures that contribute to established regional or programmatic mitigation strategies, and measures that sequester carbon to offset the emissions from the project.

- The lead agency must impose all mitigation measures that are necessary to reduce GHG emissions to a level less than significant. CEQA does not require mitigation measures that are infeasible for specific legal, economic, technological, or other reasons. A lead agency is not responsible for wholly eliminating all GHG emissions from a project; the CEQA standard is to mitigate to a level that is "less than significant".

- If there are not sufficient mitigation measures that the lead agency determines are feasible to achieve the less than significant level, the lead agency should adopt those measures that are feasible, and adopt a Statement of Overriding Considerations that explains why further mitigation is not feasible. A Statement of Overriding Considerations must be prepared when the lead agency has determined to approve a project for which certain impacts are unavoidable. These statements should explain the reasons why the impacts cannot be adequately mitigated in sufficient detail, and must be based on specific facts, so as not to be conclusory.

- Agencies are encouraged to develop standard GHG emission reduction or mitigation measures that can be applied on a project-by-project basis. Attachment 3 contains a preliminary menu of measures that lead agencies may wish to consider. This list is by no means exhaustive or prescriptive. Lead agencies are encouraged to develop their own measures and/or propose project alternatives to reduce GHG emissions, either at a programmatic level or on a case-by-case review.

- In some cases GHG emission reduction measures will not be feasible or may not be effective at a project level. Rather, it may be more appropriate and more effective to develop and adopt program-level plans, policies and measures that will result in a reduction of GHG emissions on a regional level.

### ADDITIONAL LAND USE CONSIDERATIONS

CEQA can be a more effective tool for GHG emissions analysis and mitigation if it is supported and supplemented by sound development policies and practices that will reduce GHG emissions on a broad planning scale and that can provide the basis for a programmatic approach to project-specific CEQA analysis and mitigation.
Local governments with land use authority are beginning to establish policies that result in land use patterns and practices that will result in less energy use and reduce GHG emissions. For example, some cities and counties have adopted general plans and policies that encourage the development of compact, mixed-use, transit-oriented development that reduces VMT; encourage alternative fuel vehicle use; conserve energy and water usage; and promote carbon sequestration. Models of such developments exist throughout the state (see OPR climate change website for examples of city and county plans and policies, referenced in Attachment 1).

For local government lead agencies, adoption of general plan policies and certification of general plan EIRs that analyze broad jurisdiction-wide impacts of GHG emissions can be part of an effective strategy for addressing cumulative impacts and for streamlining later project-specific CEQA reviews.

International, national, and statewide organizations such as ICLEI (Local Governments for Sustainability), the Cities for Climate Protection, and the Clean Cities Coalition — to name just a few — have published guidebooks to help local governments reduce GHG emissions through land use planning techniques and improved municipal operations. Links to these resources are provided at the end of this advisory.

Regional agencies can also employ a variety of strategies to reduce GHG emissions through their planning processes. For example, regional transportation planning agencies adopt plans and programs that address congestion relief, jobs-to-housing balance, reduction of vehicle miles traveled (VMT), and other issues that have implications for GHG emission reductions.

State agencies are also tackling the issue of climate change. Some have adopted or support policies and programs that take climate change into account, including the Department of Water Resources' State Water Plan; the Department of Transportation's State Transportation Plan; and the Business, Housing and Transportation Agency's Regional Blueprint Planning Program. These efforts not only raise public awareness of climate change and how the State can reduce GHG emissions, but also offer specific information and resources for lead agencies to consider.

V. NEXT STEPS

OPR has asked ARB technical staff to recommend a method for setting a threshold of significance for GHG emissions. OPR has requested that the ARB identify a range of feasible options, including qualitative and quantitative options.
OPR is actively seeking input from the public and stakeholder groups, as it develops draft CEQA Guidelines for GHG emissions. OPR is engaged with the Resources Agency and other expert state agencies, local governments, builders and developers, environmental organizations, and others with expertise or an interest in the development of the Guidelines.

OPR will conduct public workshops later this year to receive input on the scope and content of the CEQA Guidelines amendments. It is OPR’s intent to release a preliminary draft of the CEQA Guidelines amendments for public review and comment in the fall. This will enable OPR to deliver a proposed package of CEQA Guidelines amendments to the Resources Agency as early as January 2009, well before the statutory due date of July 1, 2009.

We encourage public agencies and the public to refer to the OPR website at www.opr.ca.gov for information about the CEQA Guidelines development process and to subscribe to OPR’s notification system for announcements and updates.

For more information about this technical advisory and assistance in addressing the impacts of GHG emissions on the environment, please contact:

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ATTACHMENTS

1. References and Information Sources
2. Technical Resources/Modeling Tools to Estimate GHG Emissions
3. Examples of GHG Reduction Measures
References and Information Sources

The following is a list of websites of organizations that can offer additional information regarding methods to characterize, quantify, assess and reduce GHG emissions. In addition, a list of useful resources and reference materials is provided on the subject of climate change and greenhouse gases.

- Governor's Office of Planning and Research
  http://www.opr.ca.gov
- California Climate Action Team
  http://www.climatechange.ca.gov/climate_action_team/
- California Climate Change Portal
  http://www.climatechange.ca.gov
- California Air Resources Board Climate Change Website
  http://www.arb.ca.gov/cc/cc.htm
- California Climate Action Registry
  http://www.climateregistry.org/
- California Department of Water Resources, Climate Change and California Water Plan Website
  http://www.waterplan.water.ca.gov/climate/
- California Energy Commission Climate Change Proceedings
  http://www.energy.ca.gov/global_climate_change/index.html
- California Public Utilities Commission, Climate Change Website
  http://www.cpuc.ca.gov/static/energy/electric/climate+change/_index.htm
- Green California Website
  http://www.green.ca.gov/default.htm
- Western Climate Initiative
  http://www.westernclimateinitiative.org
- California Air Pollution Control Officers Association
  http://www.capcoa.org
- Local Governments for Sustainability (ICLEI)
  http://www.iclei.org/
- ICLEI Cities for Climate Protection (CCP)
  http://www.iclei.org/index.php?id=800
- United Nations Framework Convention on Climate Change
  http://unfccc.int/2860.php
- Intergovernmental Panel on Climate Change
  http://www.ipcc.ch
- United States Environmental Protection Agency
  http://www.epa.gov/climatechange/
- City of Seattle U.S. Mayors Climate Protection Agreement
  http://www.seattle.gov/mayor/climate/
- Mayors for Climate Protection
  http://www.coolmayors.com
- U.S. Conference of Mayors Climate Protection Web Page
  http://usmayors.org/climateprotection
- Institute for Local Government California Climate Action Network
  http://www.ca-ilg.org/climatechange

STATUTES, REGULATIONS, AND EXECUTIVE ORDERS

- SB 97
  http://opr.ca.gov/ceqa/pdfs/SB_97_bill_20070824_chaptered.pdf
- SB 97 Governor’s Signing Message
- AB 32
  http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf
- AB 1493
  http://www.leginfo.ca.gov/pub/01-02/bill/asm/ab_1451-1500/ab_1493_bill_20020722_chaptered.pdf
- Regulations implementing AB 1493
- SB 1368
  http://www.loginfo.ca.gov/pub/05-06/bill/sen/sb_1351-1400/sb_1368_bill_20060929_chaptered.pdf
- Executive Order S-01-07 regarding low carbon standard for transportation fuels
- Executive Order S-20-06 regarding implementation of AB 32
  http://gov.ca.gov/index.php?/executive-order/4484/
- Executive Order S-3-05 regarding greenhouse gas goals
- Executive Order S-20-04 regarding energy conservation by state

PORTS

- OPR List of Environmental Documents Addressing Climate Change
  http://opr.ca.gov/ceqa/pdfs/
  Environmental_Assessment_ClimateChange.pdf
- OPR List of Local Plans Addressing Climate Change
  http://opr.ca.gov/ceqa/pdfs/
  City_and_County_Plans_Addressing_ClimateChange.pdf
- Climate Action Team Proposed Early Action Measures to Mitigate Climate Change in California, April 2007
  http://www.climatechange.ca.gov/climate_action_team/reports/2007-04-20_CAT_REPORT.PDF
- California Air Resources Board, Early Action Items to Mitigate Climate Change in California, October 2007
  http://www.arb.ca.gov/cc/ceqa/meetings/ea_final_report.pdf
- California Air Resources Board, Draft Greenhouse Gas Inventory, November 2007
  http://www.arb.ca.gov/cc/inventory/data/tables/rpt_Inventory_IPCC_All_2007-11-19.pdf
- Climate Action Team Report to the Governor and Legislature, March 2006,
  http://www.climatechange.ca.gov/climate_action_team/reports/index.html
• California Climate Change Center, *Our Changing Planet: Assessing the Risks to California* - Summary Report


• California Department of Water Resources, *Progress on Incorporating Climate Change into Management of California's Water Resources*
  http://baydeltaoffice.water.ca.gov/climatechange/DWRClimateChangeJuly06.pdf - pagemode=bookmarks&page=1

• *Climate Action Program at Caltrans, December 2006*

• California Air Pollution Control Officers Association, *CEQA & Climate Change, January 2008*

• West Coast Governors’ Global Warming Initiative, November 2004

• Western Climate Initiative Work Plan, October 2007

• California Climate Change Center, University of California at Berkeley, *Managing Greenhouse Gas Emissions in California, 2007*
  http://calcclimate.berkeley.edu/managing_GHGs_in_CA.html

• U.S. Conference of Mayors, *Energy & Environment Best Practices*
  http://www.usmayors.org/climateprotection/AtlantaEESummitCDROMVersion.pdf

• U.S. Mayors Climate Protection Agreement *Climate Action Handbook, 2006*

• Natural Capitalism Solutions *Climate Protection Manual for Cities, June 2007*
  http://www.climatemanual.org
• National Governor's Association Center for Best Practices Growing with Less Greenhouse Gases, November 2002
  http://www.nga.org/cda/files/112002ghg.pdf

• National Governor's Association Center for Best Practices State and Regional Greenhouse Gas Initiatives, October 2006
  http://www.nga.org/Files/pdf/0610GREENHOUSE.PDF

• United States Climate Change Program The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, May 2008
## Attachment 2

### Technical Resources/Modeling Tools to Estimate GHG Emissions

<table>
<thead>
<tr>
<th>TOOL</th>
<th>AVAILABILITY</th>
<th>SCOPE LOCAL/REGIONAL</th>
<th>SCOPE TRANSPORTATION/BUILDINGS</th>
<th>DATA INPUT REQUIREMENTS</th>
<th>DATA OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>URBES</td>
<td>Download</td>
<td>Local project level</td>
<td>Transportation Some building (area source) outputs Construction</td>
<td>Land use information Construction, area source, and transportation assumptions</td>
<td>CO2 (pounds per day) Mitigation impacts</td>
</tr>
<tr>
<td>Clean Air and Climate Protection (CACP) Software</td>
<td>Download</td>
<td>Local project level</td>
<td>Buildings Communities Governments</td>
<td>Energy usage Waste generation and disposal Transportation fuel usage or VMT</td>
<td>CO2e (ton per year)</td>
</tr>
<tr>
<td>Sustainable Communities Model (SCM)</td>
<td>Custom model</td>
<td>Regional Scalable to site level</td>
<td>Transportation Buildings Neighborhoods Master planned communities</td>
<td>Location and site specific information Transportation assumptions On-site energy usage</td>
<td>CO2e (ton per year)</td>
</tr>
<tr>
<td>Internet-accessed Planning for Community Energy, Economic and Environmental Sustainability H-PLACE'S</td>
<td>Web-based</td>
<td>Regional Scalable to site level</td>
<td>Transportation Housing Land Use Buildings Energy Economics</td>
<td>Parcel level land use data ability to work with less data Project-level data for alternative comparisons</td>
<td>CO2 (any quantity over any time)</td>
</tr>
<tr>
<td>Climate Action Registry Reporting On-Line Tool (CARROT)</td>
<td>Web-based Available to Registry members General public can view entity reports</td>
<td>Regional Scalable to facility level</td>
<td>General Reporting and Certification Protocols Transportion Buildings/facilities Specific protocols for some sectors</td>
<td>Mobile source combustion (VMT or fuel usage) Stationary combustion (fuel usage) Indirect emissions (electricity usage)</td>
<td>CO2 and methane (grams per mile) emission factors</td>
</tr>
<tr>
<td>EMFAC</td>
<td>Download</td>
<td>Statewide Regional (air basin level)</td>
<td>Transportation emission factors</td>
<td>Travel activity data to calculate CO2 from projects</td>
<td></td>
</tr>
</tbody>
</table>

VMT = Vehicle miles traveled  
CO2e = Carbon dioxide equivalent emissions  
Note: This is not meant to be a definitive list of modeling tools to estimate climate change emissions impacts. Other tools may be available.
Description of Modeling Tools

URBEMIS

The Urban Emissions Model is used extensively during the CEQA process by local air districts and consultants to determine the impacts of projects on criteria pollutants. It was recently updated to calculate CO2 emissions as well. Future updates will include additional greenhouse gases. URBEMIS uses the ITE Trip Generation Rate Manual and the Air Resources Board's (ARB) motor vehicle emissions model (EMFAC) to calculate transportation-related CO2 emissions and ARB's OFFROAD2007 model for CO2 emissions from off-road equipment. Area source outputs include natural gas use, landscaping equipment, consumer products, architectural coatings, and fireplaces. It also estimates construction impacts and impacts of mitigation options. Web site: http://www.urbemis.com.

Clean Air and Climate Protection (CACP) Software

This tool is available to state and local governments and members of ICLEI, NACAA, NASEO and NARUC to determine greenhouse gas and criteria pollutant emissions from government operations and communities as a whole. The user must input aggregate information about energy (usage), waste (quantity and type generated, disposal method, and methane recovery rate) and transportation (VMT) for community analyses. CACP uses emission factors from EPA, DOE, and DOT to translate the energy, waste and transportation inputs into greenhouse gas (in carbon dioxide equivalents) and criteria air pollutant emissions. If associated energy, waste and transportation reduction are provided, the model can also calculate emission reductions and money saved from policy alternatives. Web site: http://cacpsoftware.org.

Sustainable Communities Model (SCM)

This model quantifies total CO2e emissions allowing communities the ability to optimize planning decisions that result in the greatest environmental benefit for the least cost. Total CO2e emissions are based on emissions from energy usage, water consumption and transportation. The model provides an interactive comparison of various scenarios to provide environmental performance, economic performance, and cost benefit analysis.


I-PLACE'S

This model is an internet-accessed land use and transportation model designed specifically for regional and local governments to help understand how their growth and development decisions can contribute to improved sustainability. It estimates CO2, criteria pollutant and energy impacts on a neighborhood or
regional level for existing, long-term baseline and alternative land use plans. The data input requirements are extensive and require a fiscal commitment from the Metropolitan Planning Organization and its member local governments. Once the data is available, the IPLACES tool can be developed for that region relatively quickly, in approximately one week. The benefits include a multifunctional tool that provides immediate outputs to compare alternatives during public meetings, multilevel password protected on-line access, as well as providing access for local development project CEQA analyses. This tool also supports regional travel models and integrated land use and transportation assessments. Web site: http://www.sacregionblueprint.org/sacregionblueprint/the_project/technology.cfm and http://www.places.energy.ca.gov/places

CARROT

The California Climate Action Registry offers the Climate Action Registry Reporting On-Line Tool (CARROT) for Registry members to calculate and report annual greenhouse gas (GHG) emissions. CARROT calculates direct and indirect GHG emissions for the following emission categories by source: stationary combustion, process emissions, mobile source combustion, fugitive emissions and electricity use by source. It calculates emissions using entity collected data such as fuel purchase records, VMT and utility bills. While reporting and certification through CARROT is only available to members, the public may access entity reports online. Reporting protocols are also available to the public, including the General Reporting Protocol (www.climateregistry.org/docs/PROTOCOLS/GRP%20V2-March2007_web.pdf) and cement, forestry and power/utility sector protocols. Additional sector protocols are under development. Website: www.climateregistry.org/CARROT/

EMFAC

The Air Resources Board’s EMission FACtors (EMFAC) model is used to calculate emission rates from all motor vehicles in California. The emission factors are combined with data on vehicle activity (miles traveled and average speeds) to assess emission impacts. The URBEMIS model described above uses EMFAC to calculate the transportation emission impacts of local projects. Web site: http://www.arb.ca.gov/msei/onroad/onroad.htm
Attachment 3

Examples of GHG Reduction Measures

The following are examples of measures that have been employed by some public agencies to reduce greenhouse gas emissions, either as general development policies or on a project-by-project basis. These are provided for illustrative purposes only.

LAND USE AND TRANSPORTATION

• Implement land use strategies to encourage jobs/housing proximity, promote transit-oriented development, and encourage high density development along transit corridors. Encourage compact, mixed-use projects, forming urban villages designed to maximize affordable housing and encourage walking, bicycling and the use of public transit systems.

• Encourage infill, redevelopment, and higher density development, whether in incorporated or unincorporated settings

• Encourage new developments to integrate housing, civic and retail amenities (jobs, schools, parks, shopping opportunities) to help reduce VMT resulting from discretionary automobile trips.

• Apply advanced technology systems and management strategies to improve operational efficiency of transportation systems and movement of people, goods and services.

• Incorporate features into project design that would accommodate the supply of frequent, reliable and convenient public transit.

• Implement street improvements that are designed to relieve pressure on a region's most congested roadways and intersections.

• Limit idling time for commercial vehicles, including delivery and construction vehicles.

URBAN FORESTRY

• Plant trees and vegetation near structures to shade buildings and reduce energy requirements for heating/cooling.

• Preserve or replace onsite trees (that are removed due to development) as a means of providing carbon storage.
GREEN BUILDINGS

- Encourage public and private construction of LEED (Leadership in Energy and Environmental Design) certified (or equivalent) buildings.

ENERGY CONSERVATION POLICIES AND ACTIONS

- Recognize and promote energy saving measures beyond Title 24 requirements for residential and commercial projects.
- Where feasible, include in new buildings facilities to support the use of low/zero carbon fueled vehicles, such as the charging of electric vehicles from green electricity sources.
- Educate the public, schools, other jurisdictions, professional associations, business and industry about reducing GHG emissions.
- Replace traffic lights, street lights, and other electrical uses to energy efficient bulbs and appliances.
- Purchase Energy Star equipment and appliances for public agency use.
- Incorporate on-site renewable energy production, including installation of photovoltaic cells or other solar options.
- Execute an Energy Savings Performance Contract with a private entity to retrofit public buildings. This type of contract allows the private entity to fund all energy improvements in exchange for a share of the energy savings over a period of time.
- Design, build, and operate schools that meet the Collaborative for High Performance Schools (CHPS) best practices.
- Retrofit municipal water and wastewater systems with energy efficient motors, pumps and other equipment, and recover wastewater treatment methane for energy production.
- Convert landfill gas into energy sources for use in fueling vehicles, operating equipment, and heating buildings.
- Purchase government vehicles and buses that use alternatives fuels or technology, such as electric hybrids, biodiesel, and ethanol. Where feasible, require fleet vehicles to be low emission vehicles. Promote the use of these vehicles in the general community.
- Offer government incentives to private businesses for developing buildings with energy and water efficient features and recycled materials. The incentives can include expedited plan checks and reduced permit fees.
- Offer rebates and low-interest loans to residents that make energy-saving improvements on their homes.
• Create bicycle lanes and walking paths directed to the location of schools, parks and other destination points.

PROGRAMS TO REDUCE VEHICLE MILES TRAVELED

• Offer government employees financial incentives to carpool, use public transportation, or use other modes of travel for daily commutes.
• Encourage large businesses to develop commute trip reduction plans that encourage employees who commute alone to consider alternative transportation modes.
• Develop shuttle systems around business district parking garages to reduce congestion and create shorter commutes.
• Create an online ridesharing program that matches potential carpoolers immediately through email.
• Develop a Safe Routes to School program that allows and promotes bicycling and walking to school.

PROGRAMS TO REDUCE SOLID WASTE

• Create incentives to increase recycling and reduce generation of solid waste by residential users.
• Implement a Construction and Demolition Waste Recycling Ordinance to reduce the solid waste created by new development.
• Add residential/commercial food waste collection to existing greenwaste collection programs.