Table 2.2. 2005 Baseline Greenhouse Gas Emission Estimates from Municipal and Community Sources

	Emissions Source	CO_2e (metric tons = 2205 lbs)	Data Sources
City Emissions			
City Fossil Fuel Use			
Electricity Consumption	Electricity (kwh)	12,982	CMR211:07 (CCAR). Includes distribution and transmission losses.
Natural Gas	Gas (MMBtu)	6,499	CMR211:07 (CCAR)
Liquid Fuels – Stationary and Off Road	Includes diesel, biodiesel (B20) and gasoline	864	CMR211:07 (CCAR)
Liquid fuels - Mobile	Includes gasoline, diesel	1,859	CMR211:07 (CCAR)
Employee Travel	Air Travel and ground transport	38	Employee travel was estimated by taking a sample of travel expense reports and determining distances. A sample of 25 reports was used in this estimate, which totaled $15,158 out of a total of $281,100 spent on travel in FY 06/07. This sample showed 9,212 air miles and 1664 estimated driving miles. An additional sample of 20 reports will be available on 9 Sept. These data will be included into this estimate.
Total Municipal Emissions from Using Fossil Fuels		**22,242**	CMR211:07 (CCAR)
Fugitive Sources			
Compressed Natural Gas (CNG) System leakage		3	CCAR
Natural Gas Distribution Leakage		19,355	Range: 6,350 to 19,355. Low estimate based on ½ % of sales. High estimate based on purchases minus sales.
Total Fugitive Emissions		**19,358**	

	Emissions Source	CO2e (metric tons)	Data Sources
Biogenic Sources			
Landfill Gas Flaring		5,853	CCAR
Wastewater Sludge Incineration		17,117	This serves the entire community, but is placed under municipal emissions.
Total Biogenic		**22,970**	
Other Municipal Emissions			
City Purchasing			
Paper Use	19,335 average number of reams purchased	210	Assumes 30% recyclable content for 8.5 x 11 office paper and 0% recyclable for other paper sizes.
Electronics	2061	546	Source: Recycling program of Indiana http://www.escrapindiana.org/environmentalben.html Manufacturing one computer and monitor uses at least 530 pounds of fossil fuels, 50 pounds of chemicals and 3,330 pounds of water . In addition, 81% of the energy used by a computer over its lifetime is used in the manufacture of the product, before the computer ever reaches the home or office.*
Toner Cartridges	223	2	Toner purchases from Purchasing and IT divisions. 1 cartridge – 23.1 lbs of C02; Source:the green guide.com
Ink Jet Cartridges	505	1	Cartridge purchases from Purchasing division. CO_2 impact from www.first impressionslast.com, a green provider of office supplies
Total Tracked City Purchases		**759**	
TOTAL TRACKED MUNICIPAL		**64,901**	

	Emissions Source	CO_2e (metric tons)	Data Sources
Community Emissions			
Waste Production			
Annual emissions from one year of Waste Production into Landfills		24,823	Annual lifecycle emissions from one year of waste – CPAU Emissions from annual waste production utilizing ICLEI CACP software protocol.
Methane Production from Past Palo Alto Landfill use		20,643	ICLEI Note range= 5,068 - 55,049. Low estimate based on flare station measurements and assumes 85% efficient LFG collection. High estimate from ICLEI workshop on 7 September using ICLEI CACP software. *Estimate used is data from ICLEI landfill gas report (2006*).
Total Emission from Landfill		**45,466**	
Recycled Products into Landfill - Upstream Emissions			This represents the difference in emissions between recycling these materials as opposed to producing products from virgin materials.
Paper	9955 tons in waste stream	31,299	EPA 2006 and 2006 Waste Composition Study
Plastic	2,236 tons in waste stream	3,307	EPA 2006 and 2006 Waste Composition Study
Plastic Bags	306 tons in waste stream	518	EPA 2006 and 2006 Waste Composition Study
Glass	1,147 tons in waste stream	321	EPA 2006 and 2006 Waste Composition Study
Aluminum Cans	113 tons of Aluminum in waste stream	1.537	EPA 2006 and 2006 Waste Composition Study
Mixed Metal	2,373 tons of metal in waste stream	11,274	EPA 2006 and 2006 Waste Composition Study
Concrete	1,383 tons of concrete in waste stream	14	EPA 2006 and 2006 Waste Composition Study
Wood	2,670 tons of wood in waste stream	6,568	EPA 2006 and 2006 Waste Composition Study
Total Upstream Emissions		**54,838**	

	Emissions Source	CO_2e (metric tons)	Data Sources
Community Energy Use			
Electricity Consumption	Electricity (kwh)	135,027	CMR 211:07 CCAR
Natural Gas Use	Natural Gas (MMBtu)	159,989	CMR:211:07 CCAR
Total Community Energy Use		**295,016**	
Community Transportation			
Commute within town	Gasoline and diesel	671	Estimates from GRTF Transportation Subcommittee Palo Alto ABAG Commute Data file
Commute into Palo Alto	Gasoline and diesel	38,918	Estimates from GRTF Transportation Subcommittee. Palo Alto ABAG Commute Data file. 50% of total commute into Palo Alto
Commute from Palo Alto	Gasoline and diesel	9,563	Estimates from GRTF Transportation Subcommittee. Palo Alto ABAG Commute Data file 50% of total commute out of Palo Alto
Non Commute Palo Alto Road Transportation total	Gasoline and diesel	217,348	Estimates from GRTF Transportation Subcommittee. Palo Alto ABAG Commute Data file.
Palo alto air travel	Aviation fuel	66,900	Estimates from Data from GRTF – Transportation Subcommittee
Community Transport		**333,400**	
TOTAL COMMUNITY		**728,720**	
TOTAL MUNICIPAL AND COMMUNITY		**793,621**	At population of 58,598, equals per capita emissions of 13.5 tons

Chapter 3: Utilities

Overview

This chapter describes the major utility program areas that address climate protection, both mandatory and discretionary. Many of the programs began prior to the development of a climate protection plan, but had environmental protection, including greenhouse gas (GHG) reduction, as a key impetus. Existing and new programs are described in this chapter, with quantitative estimates of greenhouse gas reduction potential associated with each major area, where possible.

Electricity and natural gas account for approximately half of the estimated GHG emissions from the community as a whole. For base year 2005, electric emissions were 145,000 metric tons of CO_2, and natural gas emissions were 165,000 metric tons of CO_2.

The key highlights of this chapter are that it proposes to:

1. Define "climate neutral" as it applies to Utilities
2. Pursue alternatives to reduce the carbon intensity of the natural gas portfolio
3. Promote the deployment of local solar energy resources
4. Facilitate and encourage voluntary emission reductions by customers
5. Support GHG-related research, development and education
6. Adopt a GHG adder of $20/metric ton in utility purchasing decisions

Goals and Actions

To meet its reduction targets, Utilities intends to pursue the recommendations formulated by the Energy Subcommittee of the Green Ribbon Task Force (GRTF):

> "Reduce greenhouse gas emissions from electricity and natural gas usage to achieve climate neutrality by 2020 by doing all of the following:
>
> 1. Reduce electricity and natural gas use through conservation and energy efficiency
> 2. Reduce carbon intensity of energy supply provided by Utilities
> 3. Expand use of renewable energy installed or purchased directly by customers
> 4. Participate in and promote greenhouse gas emissions inventory tracking and reporting
> 5. Promote and implement climate-neutral alternatives and education
> 6. Employ urban forest opportunities to reduce energy use and increase carbon sequestration
> 7. Invest in GHG-reducing projects or offsets to balance remaining emissions
> 8. Support research and development in GHG-reducing science and sociology
> 9. Coordinate energy-related climate activities with building and urban planning activities
>
> 'Climate Neutral' in this context does not necessarily mean zero emissions, but as close as is feasible and practical, similar to the goals of the Zero Waste Strategic Plan."

Should "Climate Neutral" mean mandatory inclusion for all utilities customers, or does it apply only to programs that enable a customer to choose to be climate neutral? Staff recommends a combination of both mandatory and optional programs, so that Utilities (a) reduce community-wide emissions from electricity and natural gas by at least 15% from 2005 to 2020, and (b) establish programs that enable customers to choose a climate neutral option for both electricity and natural gas (currently only offered for electric – Palo Alto Green).

The GRTF also had several recommendations regarding GHGs related to energy use associated with water use. However, as described in the April 23, 2007 staff report (CMR:211:07), GHG emissions from water use in Palo Alto are extremely small due to the gravity-fed nature of the water supply. Staff will continue to implement water conservation measures in existing buildings and in new construction, but these programs are not anticipated to yield significant direct reductions in GHG emissions. Key opportunities related to wastewater treatment, however, are included here.

Utilities' planned and existing programs for implementing the GRTF recommendations are described in detail below.

1. Reduce electricity and natural gas use through conservation and energy efficiency
Implementing the Council-approved 10-year efficiency plan, extrapolated to 2020, will reduce energy consumption by an estimated 43,300,000 kWh per year and 1,380,000 therms per year, which is equivalent to more than half of the otherwise projected load growth in electricity and nearly all of the load growth for natural gas. This translates to 15,800 metric tons from avoided fossil fuel to generate electricity (at .805 lb/kWh) and 7,300 metric tons from avoided natural gas use (at 11.7 lb/therm). The key elements of the plan are as follows.

- Implement new construction incentives to dovetail with Green Building Policy and associated programs
- Support energy code research and updates to implement local requirements in harmony with Green Building Policy and associated programs
- Expand custom rebates for commercial customers to spur innovative retrofit and "replace-on-burnout" measures by customers
- Solicit third-party "efficiency bidding" programs to spur cost-effective innovation in program design and implementation. Third-party efficiency programs deliver energy savings implemented by specialists that are customized to customer needs that are not practical to implement through conventional rebate incentive programs.
- Expand targeted programs to pursue high-yield areas (Data Centers, Motors, Air Compressors, Restaurants, etc.)
- Hire Measurement and Verification (M&V) contractor to verify and track efficiency impacts.
- Support efforts to increase efficiency of supply (e.g. improved hydro runners, lower system losses in the electric distribution system or jointly-owned electric transmission facilities, etc.)
- Investigate role for demand response and energy storage in reducing GHG emissions, such as reducing impact and cost of keeping grid reliable with increasing intermittent renewable resources.

- Evaluate energy efficiency opportunities at municipal government facilities. Develop a ranked set of energy efficiency and conservation measures with associated costs, benefits and greenhouse gas reduction implications. Recommend strategies and schedules for implementing all cost-effective efficiency measures.
- Develop a methodology to give recognition and to reimburse back to departmental budgets at least 50% of achieved utilities energy bill savings.
- Recommend strategies and schedules for implementing cost-effective efficiency measures, subject to budget availability to make these changes.

In addition, Utilities will evaluate and implement, where feasible, retail rates that encourage conservation and efficient use of resources. Reduction potential for retail rates has not yet been evaluated. Utilities will:

- Evaluate time-differentiated rates and implement where feasible;
- Evaluate modifications to tiered rate structures and implement where feasible; and
- Evaluate special rates for electric transportation or other environmentally-preferred technologies and implement where feasible.

2. Reduce Carbon Intensity of Energy Supply Provided by Utilities

Utilities will expand the use of non-fossil energy sources by implementing the existing Renewable Portfolio targets included in LEAP, exploring local renewable energy project opportunities, and pursuing non-fossil alternatives to natural gas for a portion of the natural gas supply portfolio for retail end-use. Specific action items include:

- Meet or exceed Renewable Portfolio Standard (RPS) targets (at least 33% by 2015 with less than a $0.5 ¢/kWh rate impact). The 0.5 ¢/kWh rate impact limit amounts to an additional $5 million per year. Eligible renewable energy comprised eight percent of purchases in 2005. One-third of annual electricity supply at zero emissions compared to conventional electricity translates to 120,500 metric tons saved compared to the 2004 starting point of 0%, which translates to $40/metric ton saved. The increase from 8% to 33% translates to 91,000 metric tons CO_2 saved per year. The original targets were determined based on Utilities customer preferences and not solely on GHG reduction potential, and staff is working to meet the targets at far less than the allowed rate impact limit.
- Develop short-term renewables market with wholesale suppliers of electricity and natural gas, in order to help meet seasonal and shorter-term needs.
- Continue participation in the Northern California Power Agency's Green Power Pool to meet a portion of RPS targets through joint action.
- Evaluate and, if feasible and economic, install a municipal hydro energy recovery system, which would extract energy from water flowing downhill between reservoirs in Palo Alto's municipal water system. Estimated savings are 485,000 kWh per year, or 180 metric tons per year reduction.
- Evaluate the feasibility and cost effectiveness of portfolio targets for non-fossil alternatives to natural gas (e.g. biogas).

In addition, Utilities will promote high-efficiency and ultra-clean fossil-fueled power generation at customer sites and ensure that local and long-term electricity resources outperform statewide GHG emissions limits on long-term electric power contracts. Utilities will:

- Implement the PLUG-In incentive program for cogeneration, fuel cells, waste heat recovery, and local renewables. The program maximum capacity of 20 MW would meet approximately 15% of annual energy needs, with an expected net decrease in CO_2 emissions of 20,000 metric tons per year.
- Ensure compliance with limitations on long-term electricity contracts of no more than 1,100 lb/MWh, as prescribed in state law enacted under senate bill SB1368.

3. Expand Use of Renewable Energy Installed or Purchased Directly By Customers

Utilities will continue to offer voluntary retail rates whereby customers can choose to purchase non-fossil energy sources for electricity, and will develop a similar program for natural gas. Utilities will:

- Utilize Renewable Energy Credits for PaloAltoGreen when short on RPS targets
- Increase City government participation in Palo Alto Green from the current 3% level to 5% by 2010 and 10% by 2020. The RWQCP may need to involve all jurisdictions for whom wastewater is treated. Annual electricity use at the RWQCP is 17 million kWh, and other municipal government use is 13 million kWh. Each 1% of subscription to PaloAltoGreen amounts to approximately $2,550 per year for the RWQCP and $1,950 for the rest of City government, with estimated CO_2 reductions of 62 and 47 metric tons per year, respectively.
- Increase PaloAltoGreen to 5% of load by 2010 and 10% of load by 2020, through continued growth of the program. Ten percent of electric supply with zero GHG emissions compared to conventional electricity at .805 lb/kWh would amount to a reduction of 36,500 metric tons of CO_2.
- Develop and implement a voluntary retail program similar to PaloAltoGreen for low-greenhouse gas alternatives to natural gas, such as biogas. Achieving the same 20% participation rate as PaloAltoGreen would translate to ten percent of natural gas consumption with a reduction of 16,400 metric tons of CO_2 per year.

In addition, Utilities will continue to aggressively promote the use of solar energy, by implementing the existing PV Partners program, and implementing solar thermal incentive programs that were described in the Council-approved Ten-year Energy Efficiency Portfolio Plan. The key elements of the solar plan are as follows:

- Implement PV Partners program to support state-wide goals of California Solar Initiative and SB1. The current ten-year program plan is sufficient to provide incentives for up to 6,544 kW of photovoltaics, which would generate approximately 10,500,000 kWh per year, or about 1% of annual sales, reducing GHG emissions by 3,800 metric tons.
- Facilitate expanded use of solar power for PaloAltoGreen, including local solar and lower-cost wholesale solar power. The impact of this action is uncertain, but is expected to increase deployment of solar energy systems that otherwise would not be built.
- Develop and implement solar hot water and space heating incentive program, consistent with recently-enacted assembly bill AB1470 and the California Solar Initiative solar water heating pilot program. Target 500 residential systems equivalent, with estimated savings of 500 metric tons per year.

- Develop and implement solar pool & spa heating program. Target 100 pools (there are about 4,000 in Palo Alto), with estimated savings of 1,000 metric tons per year.

4. Participate in and Promote Greenhouse Gas Emissions Inventory Tracking and Reporting

Staff recommendations regarding GHG inventory and tracking are discussed in Chapter 2. In addition, Utilities will continue it current efforts related to estimating and understanding emissions from non-CO_2 GHGs such as SF_6 and methane, whether man-made or biogenic, including the following actions:

- Expand reporting to include all six Kyoto GHGs.
- Estimate methane emissions from gas distribution and develop mitigation plan.
- Refine science and participate in protocol development for estimating emissions from refrigerants, SF_6, and non-fossil fuel sources such as landfill operations and wastewater treatment

5. Promote and Implement Climate-Neutral Alternatives and Education

Utilities will employ best practices in its own purchasing decisions and support sustainable purchasing polices. Utilities will employ a GHG adder in accordance with the California Municipal Utility Association (CMUA) GHG Emissions Reduction Principles (CMR:315:06), in order to internalize the potential financial risk associated with long-term greenhouse gas liabilities. In addition, Utilities will:

- Ensure that appropriate avoided costs are included in energy efficiency evaluation criteria to use in life-cycle costing for all utility equipment
- Specify EnergyStar appliances and energy consuming equipment, if available, in municipal purchases
- Employ a $20/metric ton GHG adder in purchasing evaluation, increasing by 5% per year starting in 2008. The adder will be applied to purchases that are not mandated or otherwise undertaken to meet other policy directives, and shall be utilized until allowance allocations, cap and trade, or other regulations are implemented that internalize the cost of GHG in utility operations. The proposed adder reflects the financial risk of future emissions regulation, not an estimate of environmental costs. Investor-owned utilities such as PG&E are currently required to use a carbon adder of approximately $10/ton of CO_2. The proposed $20 adder for Utilities is based on the same methodology used to determine the investor-owned utility adder, but with Palo Alto discount rates and updated information on emissions allowance costs. An example adder of $20/metric ton of CO_2 translates to roughly 1 ¢/kWh, 12 ¢/therm, and 20 ¢/gallon of gasoline, meaning that cost tradeoffs would treat these fuels as if they actually cost a little bit more.

Utilities will expand its efforts to mitigate emissions from all six Kyoto GHGs, whether man-made or biogenic, including the following actions:

- Seek to eliminate SF_6 from utility infrastructure where feasible as high-voltage equipment is replaced and as equipment becomes available
- Explore long-term alternatives to landfill and wastewater treatment operations to reduce methane emissions based on refined emissions estimates

6. Employ Urban Forest Opportunities to Reduce Energy Use and Increase Carbon Sequestration

Utilities will:

- Participate in American Public Power Association's "Tree Power" program. Promote use of shade trees that reduce energy use and trap carbon as an extension to the "Right Tree in Right Place" program, using a mix of education and financial incentives, and coordinating with the Urban Forest Master Plan

7. Invest in GHG-Reducing Projects or Offsets to Balance Remaining Emissions

Utilities will explore CO_2 reduction projects, allowance, and offsets to balance any remaining GHG emissions after all efficiency and supply alternatives have been exhausted. Specifically, Utilities will:

- Explore applicability of Renewable Energy Certificates (RECs) for true-up of RPS targets. RECs are a form of emission offset that is directly applicable to electricity that may be implemented more cost-effectively than long-term energy contracts
- Develop criteria for allowances and offsets for achieving climate neutrality
- Facilitate alternatives for Utilities customers to meet their climate neutral goals, such as offset alternatives similar to PG&E's "ClimateSmart" program, whereby carbon reduction projects are supported through voluntary contributions
- Monitor and comply with emission allowance regulations being developed under AB32
- Participate in regional offset efforts such as Joint Venture Silicon Valley's Climate Protection Task Force Carbon Offsets Subcommittee's endeavor to develop a local offset market

8. Support Research and Development in GHG-Reducing Science and Sociology

Utilities will conduct and promote research and development, demonstration, and education projects to enhance knowledge related to climate protection and improve information available to customers. Utilities will also:

- Actively share the information gleaned from R&D with neighboring communities and the public at large
- Provide GHG emissions estimates associated with energy use to customers by facilitating access to an on-line emission calculator, and/or developing capability to include GHG emissions estimates with utility bills
- Develop benchmarking metrics, such as home energy comparison reports
- Update electric, natural gas, and water resource plans to highlight Climate Protection efforts

9. Coordinate Energy Climate Activities with Building and Urban Planning Activities

This coordination is discussed in Chapter 6: Green Building and in Action 1 of this chapter (Reduce electricity and natural gas use through conservation and energy efficiency).

Cost-Benefit Analysis

Table 3.2 summarizes the estimated community-wide 2005 CO_2 emissions from electricity and natural gas use, and projected 2020 emissions with impact of each major utility program area for which quantitative estimates have been completed, including efficiency, solar, mandatory

renewable supply, voluntary renewable supply, and low-carbon fossil-fuel supply. The potential impacts of retail rates, offsets, research and development, non-CO_2 gases, and purchasing practices have not yet been estimated.

Table 3.2. Estimated community-wide emissions and emissions reduction impacts of utility program goals

	Electric Metric Tons CO_2 Per Year	Natural Gas Metric Tons CO_2 Per Year
Reference Year 2005	**145,000**	**165,000**
Base Case 2020 (load growth with no efficiency reduction)	178,600	174,000
Efficiency	-15,800	-7,300
Solar	-3,800	-1,500
Mandatory Renewable Energy Supply	-91,500	TBD
Voluntary Renewable Energy Supply	-36,500	-16,400
Total In-Community Reduction	-147,600	-33,400
Net In-City Emissions	31,000 (21% of 2005)	148,800 (90% of 2005)
Low-Carbon Supply (net savings realized by state)	-20,000	n/a
Net Emissions	**11,000 (8% of 2005)**	**148,800 (90% of 2005)**

The ranges for costs per metric ton of CO_2 or CO_2e reduction for each major category listed in Table 3.2 are summarized below in Table 3.3. These estimates reflect net costs incorporating savings from avoided energy purchases, and include combined costs and savings for both customers and the utility. Tax consequences are not included, such as tax credits or deductions for solar energy or energy efficiency investments. The cost effectiveness estimates represented below will continue to be refined as the Climate Protection Plan continues to evolve.

Table 3.3. Estimated cost-effectiveness ranges for community-wide emissions reduction efforts. Cost (savings) in $ per metric ton CO_2 equivalent reduced

Program Area	Electric $ per Metric Ton CO_2 Reduced	Natural Gas $ per Metric Ton CO_2 Reduced
Efficiency	(40)-0	(40)-0
Solar	200-300	(20)-20
Mandatory Renewable Energy Supply	30-40	5-40
Voluntary Renewable Energy Supply	30-40	5-40
Low-Carbon Supply	(15)-0	n/a
Offsets	5-50	5-50
Retail Rates	TBD	TBD
Research & Education	TBD	TBD
Non-CO_2 Gases	TBD	TBD
Purchasing Practices	≤20	≤20

Sample cost-benefit calculations to date include:

- **Energy efficiency programs.** Cost-effectiveness evaluation of energy efficiency programs were described in detail in the Ten Year Energy Efficiency Portfolio Plan (CMR:216:07). That plan aims to lower average bills in the long run, with a payback in six to ten years, resulting in a net savings realized in conjunction with the CO_2 emission reductions. Net savings are projected to be approximately 2 ¢/kWh saved, reducing greenhouse gas emissions by 1.1 lb/kWh, which results in savings of $40 per metric ton of CO_2 reduced. If no net financial savings are realized, the estimated net cost per ton reduced is zero.

- **Meet or exceed Renewable Portfolio Standard (RPS) targets** (at least 33% by 2015 with less than a $0.5 ¢/kWh rate impact). The 0.5 ¢/kWh rate impact limit amounts to an additional $5 million per year. Eligible renewable energy comprised eight percent of purchases in 2005. One-third of annual electricity supply at zero emissions compared to conventional electricity translates to 120,500 metric tons saved compared to the 2004 starting point of 0%, which translates to $40/metric ton saved. The increase from 8% to 33% translates to 91,000 metric tons CO_2 saved per year. The original targets were determined based on Utilities customer preferences and not only on GHG reductions, and staff is working to meet the targets at far less than the allowed rate impact limit.

- **Evaluate the feasibility and cost effectiveness of portfolio targets for non-fossil alternatives to natural gas** (e.g. cowgas). Achieving five percent of gas supply with zero GHG emissions would amount to a reduction of 8,200 metric tons of CO_2; ten percent amounts to 16,400 metric tons reduction. Methane capture from animal manure, for example, could potentially reduce state-wide emissions of methane with a

CO_2 equivalent savings 6.6 times greater due to the high global warming potential of methane. Cow gas currently is available at a price premium of approximately 20 cents per therm, which would be a roughly 20% rate increase to convert 100% of natural gas to biogas. The added cost translates to roughly $37/metric ton CO_2 reduced from not burning natural gas.

- **PV Partners** The current ten-year program plan is sufficient to provide incentives for up to 6,544 kW of photovoltaics, which would generate approximately 10,500,000 kWh per year, or about 1% of annual sales, reducing GHG emissions by 3,800 metric tons. City funding for incentives is $13 million. Currently, photovoltaic systems cost approximately $8,000/kW installed, generating approximately 1500 kWh per year, with associated reductions between .55 and .8 metric tons of CO_2 per year. Assuming a high estimate of 15 cents per kWh for energy savings over twenty years, net cost per ton would be $220 to $320.

- **Develop and implement solar hot water and space heating incentive program,** consistent with recently-enacted AB1470 and the California Solar Initiative solar water heating pilot program. This program might include incentives, education, bulk buys and low-interest financing. Residential solar hot water systems typically cost $3,000 to $6,000, offsetting approximately one metric ton per year in CO_2 and avoiding approximately $180-220 per year in natural gas costs. Assuming a 15 year life, this translates to a cost per metric ton of -$20 to $20.

- **Develop and implement solar pool & spa heating program**. Target 100 pools (there are about 4,000 in Palo Alto). One hundred pools at an average of 500 ft of collector area saving 3.7 therms per square foot per year translates to 185,000 therms per year reduction in natural gas use, reducing GHG emissions by 980 metric tons per year. Cost effectiveness is very site specific, but assuming that only systems with a reasonable economic payback are installed, pool heating measures are expected to result in cost per ton reduced near zero or negative.

- **Implement PLUG-In incentive program**. The PLUG-In program maximum capacity of 20 MW would meet approximately 15% of Palo Alto's annual energy needs, which would result in an estimated local *increase* in CO_2 of approximately 48,000 metric tons per year, but *decrease* state-wide emissions by about 68,000 metric tons per year compared to a combined-cycle power plant. Therefore the net result would be a *decrease* of 20,000 metric tons per year. The program is designed to pay for itself through shared (community and Utilities) savings in 5 to 8 years, with projected CO_2 reduction costing $15 per metric ton.

Monitoring

Utilities will monitor its progress in reducing GHG emissions by:

- Conducting and publishing annual municipal and community-wide emissions inventory estimates from electricity and natural gas use;
- Continuing to certify electric utility emissions with CCAR or equivalent;

- Conduct an engineering study of non-fossil-fuel GHG emissions from Palo Alto Landfill, waste stream, and RWQCP;
- Developing methodology and tools for tracking and for regulatory compliance; and
- Continue developing methodologies for conducting municipal inventories of non-CO_2 emissions.

Table 3.3. Summary of CPP and GRTF Recommendations

GRTF Recommendation	CPP Recommend-ations	Timing	Annual Estimated CO_2 Savings Potential (metric tons)	CO_2 Savings Costs per Metric Ton of CO_2 per year
Reduce electricity and natural gas use through conservation and energy efficiency	Follows GRTF recommendation	TBD	23,100	($40) - 0
Reduce carbon intensity of energy supply provided by Utilities	Follows GRTF recommendation	TBD	20,000	($15) - 0
Expand use of renewable energy installed or purchased directly by customers	Follows GRTF recommendation	TBD	91,500	$5 - $40
Participate in and promote greenhouse gas emissions inventory tracking and reporting	Follows GRTF recommendation	TBD	TBD	TBD
Promote and implement climate-neutral alternatives and education	Follows GRTF recommendation	TBD	TBD	TBD
Employ urban forest opportunities to reduce energy use and increase carbon sequestration	Follows GRTF recommendation	TBD	TBD	TBD
Invest in GHG-reducing projects or offsets to balance remaining emissions	Follows GRTF recommendation	TBD	n/a	$5 - $50
Support research and development in GHG-reducing science and sociology	Follows GRTF recommendation	TBD	TBD	TBD
Coordinate energy-related climate activities with building and urban planning activities	Follows GRTF recommendation	TBD	TBD	TBD

Chapter 4: Sustainable Purchasing

Overview

The City allocates $16.5 million on materials and supplies from its General, Enterprise, and Capital Improvement Project Funds.[3] Almost all of these products and some services acquired by the City will have emissions impact during their use, manufacture or disposal. Incorporating environmental performance criteria into these expenditures could have a measurable impact on climate protection, as well as on other sustainability policies and programs such as Zero Waste, green building, and pollution prevention. Beyond City operations, the City's purchase of environmentally preferable products and services, in conjunction with the environmental purchasing efforts of other Bay Area or State Public Agencies, offers the potential to stimulate market demand and further expand access to these products and services.

Many purchases that are environmentally preferable are also fiscally preferable. Other public agencies report cost savings from purchases that benefit the environment. For example[4],

- King County Washington purchased $30.5 million worth of environmentally preferable products and reported a savings of $675,000 compared to the cost of conventional products. Product examples include recycled toner cartridges, recycled motor oil and antifreeze, and retread tires.[5]
- Columbia University saved $105,000 in one year by defaulting to duplex printing in its computer center. Vendors were required to ship with double-sided copying preset as the default and to train employees to use duplexing equipment to ensure efficient paper use.[6]

Nevertheless, not all products will offer immediate cost savings, therefore a comprehensive approach to analyzing the benefits and costs of sustainable purchases is necessary and is discussed below.

Components of a Sustainable Purchasing Policy and Plan

A Sustainable Purchasing Policy and Plan will include the following:

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[3] 2007-08 Budget allocates the following for materials and supplies: CIP,$8.5 million; General Fund, $4.1 million; Enterprise Funds, $3.9 million.

[4] Realizing similar cost savings in Palo Alto would be contingent on the specific product models required, the volume purchased and the calculations used to evaluate cost benefits.

[5] United States. Department of Executive Services Finance and Business Operations Division. King County Environmental Purchasing Annual Report 2006. King County, Washington, 2006, www.metrokc.gov/procure/green/2006annrep.pdf

[6] INFORM, Waste at Work: Prevention Strategies for the Bottom Line, INFORM and Council on the Environment of New York City, 1999

1. **Prioritizing products and services that balance environmental performance and fiscal criteria**. For example, if a product's manufacture or use is energy-efficient and comparably priced, it would be prioritized for purchase. GHG reduction criteria would be quantified if available.

2. **Exploring operational changes that can offset product costs**. In the example below, 100% recycled-content paper is approximately 9% more expensive than the 30% recycled-content paper the City currently buys, based on current pricing. The additional cost of a higher recycled-content paper could be offset by setting the default on City copiers to print-double sided. This would reduce the amount of paper used and compensate for the additional cost of the product, achieving a net cost savings for the City. It would require an up-front staffing cost to reset the printers and copiers, therefore yielding a negative net cost in year 1, but positive net costs in each year thereafter.

Current cost of paper:	= $64,000
20,000 reams at $3.20	
Cost of new paper:	=$52,500
*20,000 * 75%= 15,000 reams at $3.50/ream*	
Add staff time in year 1 to change default setting on printers and copiers:	=$20,000
Total Cost year 1:	**$72,500**
Less original cost:	- $64,000
Net additional cost, year 1:*	**$8,500.**
Net reduction in cost, years 2 and on:**	**- $11,500**

*Difference between current cost and first year costs including implementation of new paper use
**Net cost=Difference between current cost of paper using 20,000 reams per year, and potential cost of using 100% recycled paper and using 25% less.

3. **Performing a life cycle cost analysis for services and capital products** that may have a longer term pay-back in cost savings. Life cycle analysis assesses the environmental impacts and financial costs of all the inputs and outputs in the life cycle of competing products. It includes the initial product cost, the costs of installation, training, maintenance, anticipated repairs, disposal and/or recycling costs, and potential cost offsets.

4. **Considering purchasing products only when needed and not solely on a replacement schedule.** For example, most of the energy used in the production, use, and disposal of computers is in the manufacture of the components. Therefore, optimizing computer exchange schedules could reduce GHG through the reduced purchase of these products.

5. **Evaluating use of a GHG "adder" in calculating purchasing costs.** Just as Utilities has proposed a $20 per metric ton of C0e in utility purchases as a risk

management cost, the City might include an adder which would quantify the costs involved in remedying the environmental impacts of a less sustainable product.

Current Emission Estimates

As shown in Chapter 2, the City's activities and purchases emit approximately 64,901 metric tons of CO_2e per year, or 8% of Palo Alto's total emissions. An exhaustive list of all City purchases, related emissions and efforts to-date to purchase energy efficient and environmentally preferable products is beyond the scope of this report. This chapter will focus on the need for implementing a system that incorporates environmental criteria into City purchasing. The City's purchase of vehicles, fuels and energy sources, which are large emitters of GHG, are discussed in Chapters 3 and 4 of this report.

The City has already incorporated environmental criteria into some of its purchasing. For example, since 2000, the City has reduced its energy use by 17% by purchasing and installing energy efficient lighting and LED street lighting, and by implementing energy management systems that optimize state-of-the-art HVAC systems. These efforts have resulted in the reduction of 670 tons of CO_2e (607 metric tons). In addition, the City's current purchase of 30% post-consumer recycled content paper compared to virgin paper has reduced CO_2e emissions by 14 metric tons per year. Other purchases include 100% recycled-content bathroom papers, and custodial and printing products with a "less-toxic" designation. These efforts, however, have been driven by specific department projects rather than by a systemic, citywide approach. To institutionalize the consideration of environmental impacts during the purchasing process, staff is drafting a Sustainable Purchasing Policy and Plan. Policy elements are currently being reviewed interdepartmentally and will be brought to Council by June 2008 with the accompanying Plan (see Appendix 3).

Sustainable Purchasing Goals and Actions

Short-Term (2008)

Goals

- Adopt a Sustainable Purchasing Policy
- Identify how City purchases affect emissions
- Engage and educate City staff in Sustainable Purchasing

Actions

- Create an interdepartmental team responsible for completing a Sustainable Purchasing Policy and Implementation Plan by June 2008
    - Include a three-year timeline for incorporating changes to the City's purchasing specifications, scopes of service, and procedures
    - Establish a framework and criteria for identifying, specifying, and evaluating the performance and costs of sustainable products and services

    - Require annual vendor reporting on sustainable product purchases, tracking dollars spent, units purchased, and other information as specified by the City
    - Determine annual reporting needs for the City
- Conduct outreach and education among City employees to promote understanding and participation in Sustainable Purchasing goals
- Present to Council the Sustainable Purchasing Policy and Implementation Plan in June 2008
- Evaluate emissions and other environmental criteria from 2005 City purchases to identify products and services that should be targeted
- Make recommendations for financial resources needed to implement Sustainable Purchasing

Medium-Term (2009-11)

Goals

- Complete implementation of the Sustainable Purchasing Plan

Actions

- Implement programs and procedures that encourage and facilitate both centralized and decentralized purchases of sustainable products and services
- Continue staff education and engagement efforts

Long-Term (2012 and beyond)

Goals

- Evaluate and adjust plan and policy as needed incorporating new technology and environmental priorities.

Actions

- Review Sustainable Purchasing Policy every three years
- Review and revise Sustainable Purchasing Plan and timeline annually and realign with City GHG emission goals and other priorities as needed

Cost Benefit Analysis

This cost benefit analysis targets a few example products for evaluation. The Sustainable Purchasing Implementation Plan will determine which products to focus on first, and cost-benefit analysis will be an integral part of that determination.

Table 4.1. Cost Benefit Analysis

Current Product/ Cost	Proposed product/cost	Reduction in CO_2e metric tons	Cost/metric ton of emission reduction	Notes
Short Term				
New copier toner Cartridges* .1 tons/ Approx $120 per cartridge or $26,760/ year	Remanufactured copier toner cartridges approx $60/cartridge or $15,120per year	.4	($7,875)	Prices vary depending on toner cartridge size and style
Medium Term				
30% recycled-content paper 50 tons $3.20 per ream or $64,000/year	100% recycled content process chlorine-free copy paper /($3.50 per ream $70,000)	32.5	$185	9% Cost difference between 30% and 100% recycled-content paper can be offset by automatic double-sided copies. Prices vary depending on volume purchase. See next action in this table. Reduction in CO_2e includes upstream emissions.
Single-sided printing and copying	Setting default of all copiers and printers to double-sided $20,000 (staff time for printer/copier setting	28.75	$696 (for set-up period only)	Assumes printer and copier replacement as scheduled (no acceleration).
Continue purchasing hybrid cars rather than a high-mileage conventional engine cars	Per car: $20,419 sticker price for hybrid vs $13,027 for high-mileage conventional car	1.37 per car per year	$88/metric ton	Resale value is included in the calculation.

*An average of the cost of various sizes
**This does not factor in the number of remanufactured cartridges that are currently purchased. This number was not available at the time of this report.
***assumes Honda Civic conventional car and Toyota Prius hybrid for purposes of calculations

Table 4.2. Summary of CPP and GRTF Recommendations on Sustainable Purchasing

GRTF Recommendation	CPP Recommendations	Annual Estimated $C0_e$ Savings Potential	$C0_e$ Reduction Costs per Metric Ton
Promote alternative fuels, with the City leading the way in purchasing fuel efficient vehicles.	The purchase of hybrid vehicles does constitute a relatively low cost opportunity to reduce emissions, especially for those staff who take home vehicles long distances. Staff has been concerned about battery and disposal costs which are not included in this analysis; the difference in resale value is included in the calculation.	1.37 metric tons per car	$88
Revise City Purchasing Policies and Practices to Incorporate Environmental Costs	The CPP strongly supports the goal of incorporating environmental costs into purchasing policy.	Mixed	Moderately high

Chapter 5: Transportation and Sustainable Land Use

Overview

The use of fossil fuels in transportation represents one of the greatest challenges in reducing GHG emissions. On a global basis, transportation represents roughly 50% of all emissions of CO_2. Based the analysis carried out in Chapter 2, plus work done by the Green Ribbon Task Force, the community's emissions of fossil fuels from transportation can be summarized as follows:

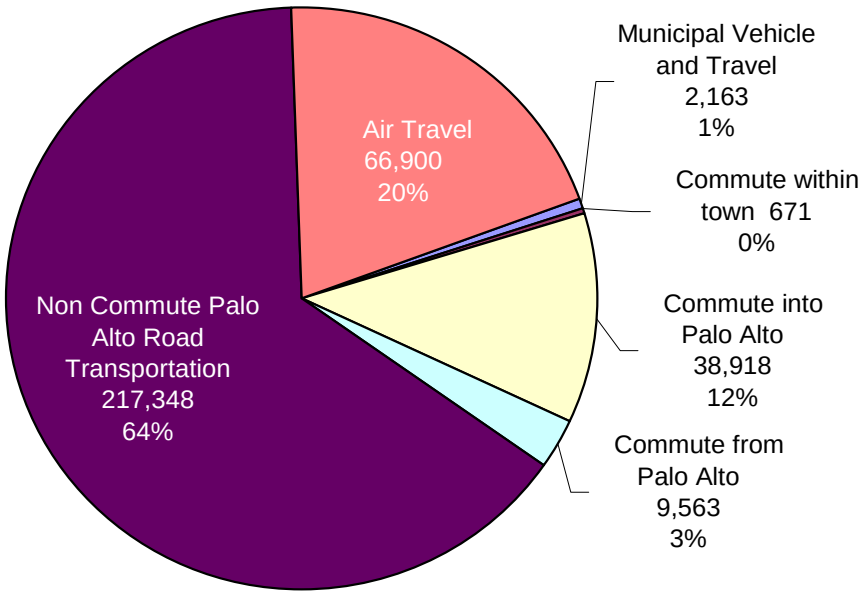
Table 5.1. Summary of Emissions from Transportation, Fuels and City Vehicle Fleet

Emissions Source	CO_2e (metric tons)	Data Source
Municipal Transportation Emissions		
Vehicle Fleet/Fuel Emissions	2,025	CMR211:11
Employee Travel	38	See chapter 2
Municipal Total	**2,063**	
Community Transportation Emissions		
Commute within town	671	GRTF Estimate
Commute into Palo Alto (50%)	38,918	GRTF Estimate
Commute from Palo Alto (50%)	9,563	GRTF Estimate
Non Commute Palo Alto Road Transportation	217,348	GRTF Estimate
Air Travel	66,900	GRTF Estimate
Community Total	**333,400**	
Total Municipal + Community Transportation	**335,463**	

City vehicles, fuel use, and travel represent less than 1% of the total estimated community-wide emissions (Figure 5.1). This illustrates that while the City should continue to most effectively use its fleet and reduce fuel use, the lion's share of reductions must come from the community's current consumption of fossil fuels for transportation. Sustainable management of the City's land is also a key part of reducing transportation-related emissions.

This chapter comprises three parts – one on City government travel-generated emissions, one on community travel-generated emissions, and one on sustainable land use.

Figure 5.1. Summary of Transportation Emissions



Part I: Municipal Travel Emissions - Goals and Actions

City Fleet Background

The current City fleet is aging, and now averages 8 years. The City currently owns just two hybrid vehicles; fleet management staff has been concerned about the long term cost of such purchases as opposed to costs of conventional high mileage vehicles and a concern over battery life and disposal of used batteries. Given the relatively low miles driven by fleet vehicles, staff has focused on 1) purchasing high mileage conventional vehicles with an average of 35 miles per gallon, 2) using CNG as fuel and, 3) implementing fleet optimization techniques. As was shown in Chapter 4, purchasing of hybrids may be less cost-effective than other measures the City could take.

As an alternative to investing in more expensive technology, the City has focused on increasing the utilization of smaller vehicles and reducing the use of larger vehicles and trucks solely to move personnel. Staff is currently looking at ways of optimizing use of the vehicles which will reduce emissions.

Short Term (2008)

Goals:

- Reduce and/or offset City travel-related emissions by 5%
- Create a program to educate and engage staff in reducing travel-related emissions

Actions:

1. Expand Use of Biodiesel in City Fleet

Expanding the use of biodiesel was recommended by the GRTF. The City is currently retrofitting some of its 50 diesel vehicles to reduce emissions as required by state regulations. This retrofit, costing some $17,000 per vehicle, will reduce emissions of NOx (the precursor of ozone or smog) and Particulate Matter (PM10) by up to 85%. While both of these reductions will improve air quality and benefit human health, they will have no effect on carbon emissions.

Currently no technology exists to reduce carbon emissions from diesel, apart from the use of biodiesel. The City does use biodiesel (B20) in heavy equipment operating at the landfill facility. Equipment Management staff purchased some 46,666 gallons in 2005, and would be interested in purchasing more biofuel. However, biodiesel cannot be used with newer vehicles because it cannot be used with the ultra low sulfur diesel they require.

2. Reduce Idling

Idling represents a relatively large component of fleet emissions—perhaps as much as 20% of total fuel use. City trucks often idle for long periods at job sites to power lighting and warning equipment. While the exact number of gallons consumed during idling is not currently known, this information will be determined through analysis of the data from the vehicle optimization system currently being installed.

The City should evaluate the options for equipping each truck with an auxiliary electrical system to power illumination and warning lights without having to run the motor. Such a system would cost approximately $2,000 per vehicle.

3. Purchase Carbon Offsets for Employee Business Travel

Emissions from business travel by City staff members are estimated at 38 metric tons of CO_2 per year. While this amount constitutes a relatively small fraction of the total transportation emissions, it is a source which could be easily offset. The City could alter its travel policy to pay for the purchase of carbon offsets from a recognized set of offset providers to cover all business-related travel, both air travel and ground travel. The City may wish to provide guidelines as to which carbon offset vendors and which types of projects are acceptable.

4. Reinstate Telecommuting Option for City Employees

The City could reduce the impact of employee commuting by allowing employees to telecommute on a limited basis. Clearly, many employees need to be at work in

order to carry out duties and serve the public. While the City policy does allow telecommuting, operating practice within the Departments severely limits the practice. Policies could be adjusted to address managers' concerns with employee telecommuting, for example limiting the practice to two days per month and specifying reporting requirements for work done on days away from the office.

Cost Benefit Analysis – Short Term Actions

1. Expanding use of Biofuel,
B20 costs $4.12 per gallon as compared to $2.80 for regular diesel. A gallon of diesel contains 22.2 lbs of CO_2. This means that the use of B20 reduces emissions by 4.4 lbs for a cost of $1.32. Therefore the cost/benefit of expanding biofuel use is as follows:

Cost: $1.32 per gallon of biodiesel. Benefit = 4.4 lbs of CO_2 emissions averted.

Thus, expanding biofuel under current pricing conditions would reduce emissions by 19 metric Tons (46,666 gals total x 20% = 9,333 gals x 4.4lbs = 41066 lbs total = 18.6 metric tons at cost of 9333 x 1.32=$12,392) cost upwards of $662 per ton of averted CO_2.

2. Reduce Idling
Cost of installation of auxiliary electrical systems: $2,000 per truck.

Annual Savings: If 20% of all diesel is consumed in idling, that translates into a savings of 12,226 gallons of diesel not consumed, or 135.7 m Tons of CO_2 not emitted. At least 20 vehicles could benefit from this retrofit for a total of $40,000.

Therefore, the cost to avoid emitting 1 ton of Carbon would be $295 per metric ton of emissions averted.

3. Purchase Carbon Offsets for Employee Business Travel
The costs of offsets would be approximately 0.77% of total annual transportation portion of travel costs, or approximately $800 plus an estimated $500 per year in administrative costs.. This would result in the offsetting of 39 tons of CO_2 at a cost of $32 per metric ton of CO_2.

4. Reinstate Telecommute Option
The costs of telecommuting include additional costs of managing staff and possibly some loss in productivity (yet gains in productivity in other cases). These costs are very difficult to calculate. Staff members receive an annual benefit which can be used to purchase computers for work at home. Therefore, additional hardware costs would be mitigated. Allowing those staff who can work from home to work 2 days a month through telecommuting could significantly reduce commute emissions. For example, if 20% of City Staff took 2 days a month to telecommute, emissions would decline by approximately 4.4 metric tons of CO_2 per month, or nearly 53 metric tons of CO_2 per year.

Medium Term Actions (2009-2011)

Goals

- Reduce emissions by an additional 5% by 2011

Actions

1. Implement Fleet Optimization Practices

Based on the experience of fleet management consulting firms, this process can save up to 15% of fuel use. This would mean a reduction of about 21,800 gallons of gasoline and about 9,180 gallons of diesel per year. This is equivalent to 284 metric tons of CO_2 per year, at a cost of $15,000 per year.

A fleet optimization system is being installed to allow for better understanding of fleet vehicle and equipment usage, and help optimize utilization. This system will include a vehicle use recording system which will download data at each visit to the City fueling facilities, and at selected data collection sites. This system should allow staff to:

- Monitor factors other than mileage or hours of usage; such as trips per calendar period, or utilization of auxiliary equipment.
- Right-size the fleet – sell off under-utilized vehicles
- Directly charge departments and divisions for use of the all fleet vehicles

2. Implement Fleet Use Accountability

Staff recommends taking additional "fleet use accountability" steps in concert with fleet optimization which would further reduce emissions from vehicle fleet:

- Develop a transportation-on-demand system and place more City vehicles into a single fleet with an on-line reservation system. That system would help employee choose the appropriate vehicle for the task at hand.
- Utilize small zero emissions vehicles for shuttling staff between City Hall, the MSC, RWQCP, and throughout the community.
- Ensure direct billing of all vehicle use to specific jobs.
- Ensure that all municipal vehicles used to drive home are high-miles-per-gallon vehicles.

3. Expand Employee Commute Incentives

Reducing the emissions from City employee commuting poses some difficult challenges. Because of the high cost of living, many employees travel long distances. The average distance per employee commute is 20.5 miles compared to the California average of 18 miles[7]. Total number of employees is 1,073,

[7] TELECOMMUTING AND RESIDENTIAL LOCATION: RELATIONSHIPS WITH COMMUTE DISTANCE TRAVELED FOR STATE OF CALIFORNIA WORKERS. By Gustavo O. Collantes and Patricia L. Mokhtarian Institute of Transportation Studies University of California, Davis Davis, CA 95616 December 2003

making the total number of miles driven during a day 43,993. Total emissions from employee commute total some 22 metric tons of CO_2e per day, or 5,542 m tons per year. Approximately 10% (110 employees) make use of commute incentives that the City offers.

There are two parts to encouraging greater use of public transit and carpooling by City employees: increasing the dollar value of commute incentives, and restructuring the current free parking benefit. The City's commute incentives are significantly less than those provided by neighboring communities. Currently, the City's commute program provides to full-time, permanent employees only $40 per month for train and $60 for van commuting, through tax free voucher. The City also provides $20 for bike and walk commuting and $30 for carpooling. These supplements are not tax free, nor have they been adjusted recently to offset increased transit fares and gasoline prices. The Federal Government allows up to $110 tax-free per month for transit and van commute support. Stanford and Mountain View provide maximum incentives to all employees, including hourly and temporary employees, and their participation rates are considerably higher.

Permanent City employees receive free parking at all City facilities. At City Hall, this benefit is valued at the market rate in Palo Alto of approximately $420 per year. Clearly this benefit promotes the use of vehicular commuting. As long as parking is free, only highly motivated staff, or those conveniently located, will use public transportation or other alternate modes of commuting. To change this situation, the City will need to develop alternative incentives to discourage the use of City parking spaces and encourage greater use of transit and carpooling.

Research shows that offering financial compensation for *not* using City parking is likely to result in significantly reduced emissions from City employee commuting. The Silicon Valley Bicycle Coalition (SVBC) published an analysis[8] of data on 10 different case studies of incentives offered for not using employer parking facilities, covering a total of over 50,000 employees. The data are shown in the Table 5.3 below. In the study, an average incentive of $46 dollars per month decreased parking demand by over 25%. The study also showed that charging for parking fundamentally changed employee's perspectives on driving alone to work and significantly altered commute patterns.

4. Other Actions Needing Evaluation

There are a number of possible actions that have not been considered in this section. These actions are either highly contentious or require the cooperation with other agencies. Additional study is required before a fully cost effective assessment can be made. Those other actions include:

1. Expansion of bike parking at transit centers

[8] Employee Parking Cashout, by Mike R. Bullock. Modern Transit Society. 1997. www.moderntransit.org

2. Provision of showers for staff commuting by bicycle or other human powered commute option
3. Incentives for low emission vehicle and hybrid parking

Cost Benefit Analysis of Medium Term Actions

1. Fleet Optimization
Cost of system is $15,000 per year. Savings are 284 metric tons CO_2e per year. Cost of emissions reductions is $52 per ton of CO_2

2. Fleet Use Accountability
Cost of implementing a system is roughly $1,000 per month in system maintenance. Savings are an additional 5% of fuel usage, based on similar systems in other cities. Therefore the cost/benefit of this system is savings of 95 metric tons of CO_2 per year at a cost of $12,000. Thus, the cost of reduction is approximately $126 per ton of CO_2.

3. Expansion of Employee Commute Incentives
If the City paid the maximum commute incentives, the number of employees commuting would increase to 25%, from 110 to 268. The additional cost outlay would be (268 x $110) – (110 x 40) per month or $300,960 per year. This would offset approximately 1,246 metric tons of CO_2 per year at a cost of approximately $242 per ton of CO_2.

Part II: Community Transportation Emissions – Goals and Actions

Community Transportation Background

As shown in table 5.1, emissions resulting from community transportation amount to 333,400 metric tons per year. The largest share of this – 217,348 metric tons or 65% -- results from "non-commute road transportation" within the City limits. The second largest share, 20%, results from air travel by Palo Alto residents. The third largest component, 12%, is commuting to Palo Alto from other communities.

The goals of the City's and community's actions should be:

- Reduce community travel-based emissions by 5% in the first year, with a goal of a 15% reduction by 2020
- Offsetting remaining travel-based emissions.

All of the following actions would move the community towards those goals, and should be begun immediately, and continued over the medium and long term. This is because effective community transportation emissions reduction programs influence the choices we make by (a) providing an array of acceptable alternatives, and (b) impressing upon the community the direct impact on climate change of their choice of transportation mode.

Short-, Medium-, and Long-Term Actions

1. Offer Additional Shuttles

The City currently operates two shuttle routes and has a cooperative arrangement with Stanford's Marguerite shuttle for noontime service between the downtown and the Quad. Offering additional shuttles would be a handy way to offer people an alternative to getting in their cars.

One option would be to add an additional shuttle bus to the current cross-town shuttle line, extending the line to the Palo Alto Medical Foundation and/or Stanford Shopping Center or other activity centers while maintaining 30 minute headways. A second option would be to offer an additional full-day cross-town shuttle route.

2. Increase the Transportation Demand Management (TDM) Coordinator from .5 FTE to 1.0 FTE.

Currently the half-time TDM coordinator is able to coordinate the Safe Routes to School programs, the Way2Go program, and employee commute incentives program. However, the 20-hour-per-week time allocation is insufficient to aggressively search for new opportunities and to expand efforts to encourage and assist businesses in the community to promote alternative commuting. Increasing this FTE allocation to a full-time position would expand those opportunities

3. Work with School District and parent community to reduce emissions from school commute

Projected enrollment increases in local schools will result in increased congestion and emissions, particularly during the morning commute period, unless the City, PAUSD and PTA volunteers can work together on innovative solutions that encourage a range of alternatives to driving one's children to school solo. Some options include:

- Exploring ways to encourage or incentivize carpooling at the beginning of the school year and as the rainy season begins, especially at schools where vehicle congestion spills over into local streets.
- Incorporating CO_2 reduction into the fall and spring promotion of green school commute choices as well as the efforts of school and district sustainability efforts.
- Expanding the coordination of City and PAUSD efforts to manage congestion on school sites and nearby streets.

4. Purchase Offsets for Community Air Travel

The Transportation Subcommittee of the GRTF estimated that 66,900 metric tons of CO_2 emissions results from air travel by Palo Alto residents. As stated in the employee travel discussion, this is a source which is more difficult to mitigate, but fairly easy to offset. The City is an active participant in developing the Joint Venture Silicon Valley Climate Protection Partners program. The program is being designed to attract donations to support local GHG reduction projects. Specifically, a list of Palo Alto projects would be offered to Palo Alto residents wishing to invest in projects to offset their air travel and

otherwise-generated emissions. Alternatively, the City could work with local non-profits to facilitate the purchase of offsets.

5. Work with VTA, Caltrain and other regional transportation agencies to improve transit services in Palo Alto

The Palo Alto Caltrain station and transit center is the second busiest station on the Caltrain line and is a major transit hub for VTA, Samtrans, AC Transit Dumbarton Express, Stanford Marguerite and Palo Alto and East Palo Alto shuttles. The City should continue to work with these agencies to realize the long term vision for the Palo Alto Intermodal Transit Center, as well as upgrading and restoring a higher level of train service to the California Avenue Caltrain station.

6. Other Actions Needing Evaluation

There are a number of possible actions that have not been considered in this section. These actions are either highly contentious or require the cooperation with other agencies. Additional study is required before a fully cost effective assessment can be made. Those other actions include:

1. Establishment of "Zip-car" or reinstating other car-share service for downtown Palo Alto
2. Incentives for low emission vehicle and hybrid parking
3. Establish bike share program
4. Establish "feebates" – charge for gas-guzzling vehicles/ rebates for fuel-efficient vehicles
5. Invest in public awareness of need to "buy local"
6. Lobby Caltrain for more frequent express train service
7. Lobby for multi-modal pass systems (tickets that work across transit systems)
8. Help establish teleconferencing center for small and home-based businesses, to reduce business travel
9. Lobby for increased carbon tax on fuel and air travel
10. Encourage the PAUSD to adopt their own goals for CO_2 reductions for school commuting
11. Create a biofuels station in Palo Alto

Cost Benefit Analysis – Short- Medium- and Long-Term Actions

1. Offer Additional Shuttles

For an additional bus on the current cross-town line:
Estimated ridership: 100-150 riders a day (equiv. of 100-150 fewer trips per day).
Estimated cost: $125,000 assuming one additional shuttle is same size as existing shuttles.

Cost Benefit: 125 riders x 10 mile trips = 1,250 city miles not driven which is approximately 0.5 metric tons of CO_2e per day x 360 days a year = 180 metric tons of CO_2 per year. Reduction is **$694 per metric ton of CO_2**, not including the effect on congestion.

For an additional all-day cross-town bus, different route:
Estimated ridership: 200-250 riders per day. Estimated cost: $125,000
225 riders x 10 mile trips = 2,250 miles not driven, 324 metric tons of CO_2 averted, at a cost of **$386 per metric ton.**

2. Increase the Transportation Demand Management (TDM) Coordinator from .5 FTE to 1.0 FTE.
Estimated cost: $42,000 plus benefits
Estimated impact: TBD

3. Work with School District on school commute
This could possibly be wrapped into TDM coordinator's job description.

4. Assist in the Purchase Offsets for Community Air Travel
The costs of establishing a "local" offsets program is relatively low. Primary costs include establishing a website for such purchases (or linking up with other cities which have created offset web sites, as well as Joint Venture Silicon Valley's local offset project under development), and administrative costs for reviewing proposed offset projects, validating the offsets are implemented, and ensuring budgetary compliance. The Berkeley system is a "for profit" organization, in that costs are covered by a small fee (5 – 10%) associated with purchases of offsets. This would cost the City nothing, and would not reduce any CO_2 emissions. If 25% of travelers participated, potentially **16,725 metric tons** of emissions could be offset or invested in other emission-reducing projects.

5. Work with VTA, Caltrain and other regional transportation agencies to improve transit services in Palo Alto
Costs for this work would be initially administrative, and could be covered by the additional 0.5 FTE staff addition to the Transportation Division within the City (see below).

Part III: Sustainable Land Use – Goals and Actions

Sustainable land use involves the planning for and development of mixed-use transit friendly live/work neighborhoods. While there is some overlap between land use and green building efforts, land use goals and actions are separately included in this chapter.

Short Term (2008)

Goals

- Develop land use patterns that reduce travel-related emissions by supporting pedestrian, bicycle and transit use
- Reduce and/or offset community travel-related emissions by 5%
- Coordinate with Green Building efforts to ensure compatibility between built environment and sustainable land use initiatives

Actions

1. Facilitate and enhance potential for mixed use development

Mixed use development reduces vehicle miles traveled by allowing residents and workers to live or work near services, such as restaurants, grocery stores, drug stores, retail shops, hair styling salons, etc., facilitating walking or bicycling to and from these services or uses rather than driving. Occasionally, such a mix of uses also allows residents to live close enough to work to avoid the need for commuting by automobile. The City's recent (January 2007) Zoning Ordinance amendments facilitate the use of mixed use on commercially-zoned parcels and allow for small retail services in residential projects. Immediate follow-up actions will include monitoring and evaluation of the effectiveness of the ordinance, so that project proponents are able to develop under the new regulations rather than by the more cumbersome Planned Community review process.

2. Zone for Mixed Use and Higher Density Around Transit Stations

Mixed use and higher density residential uses near transit service are another land use approach to encourage residents and workers to use non-vehicular means of transportation (walking, bicycling, transit), particularly in lieu of commuting by single-occupant vehicles. The City recently (September 2006) adopted a Pedestrian and Transit Oriented Development zone district in proximity to the California Avenue Caltrain station. The district allows higher density residential and mixed use on sites now zoned for industrial uses, as well as on sites primarily zoned and developed for commercial, where some residential use may also be accommodated. Immediate follow-up actions will include monitoring and evaluation of transit use, parking and Transportation Demand Management (TDM) approaches in such projects.

3. Reduce Parking Needs for New Development

Mixed use and transit oriented development, if effective, would reduce the need for parking, resulting in greater utilization of properties for development and increased potential for open space. Recent (October 2007) Zoning Ordinance revisions provide for reduced parking for mixed use development, proximity to transit, and where effective TDM measures are proposed. Immediate follow-up actions will include monitoring the effectiveness of these provisions on reducing parking needs and impacts.

4. Require Transportation Demand Management (TDM) Programs

TDM programs are sometimes proposed or required for development projects to reduce vehicle-miles traveled for commuting or for access to local services. TDM programs may include, but are not limited to, such measures as providing for transit passes, enhanced shuttle service, car-sharing, providing parking preferences for vanpools and "green" vehicles, additional bicycle parking, showers or other on-site amenities. Recent (October 2007) Zoning Ordinance amendments require TDM programs whenever parking reductions are requested or where required as environmental mitigation. The programs must specify

performance objectives, and applicants must provide monitoring information at 2 years and 5 years after project occupancy. Immediate follow-up will include the development of staffing and procedures to implement and monitor these TDM requirements.

5. Develop Monitoring Programs for Transit Use and TDM Effectiveness
The City does not have a program or dedicated staff to monitor transit use and the implementation and effectiveness of TDM programs. As these efforts are critical to reducing vehicle-miles traveled for development in the City, a specific program for these purposes is proposed. The program would include documentation of baseline transit data at transit stations and traffic data for particular developments, and would then annually update such data and incorporate information from TDM monitoring reports, in order to identify the most effective measures for implementation in future projects. A management intern is anticipated to provide an initial outline and data for such a program, and the ongoing effort would be directed by the TDM coordinator (proposed to be increased from 0.5 FTE to 1.0 FTE elsewhere in this report).

Medium Term (2009-2011)

Goals

- Reduce emissions by an additional 10% by 2015
- Increase Caltrain and other transit use by 25% by 2015
- Provide annual reporting of transit and TDM effectiveness

Actions

1. Implement Pedestrian and Transit Oriented Zoning in Downtown
The City has adopted a Pedestrian and Transit Oriented Development zoning district in the vicinity of the California Avenue Caltrain Station. A similar overlay district should be created for downtown Palo Alto in the vicinity of the University Avenue Caltrain Station. The intent of the district would be to encourage higher density residential and mixed use projects within walking distance of the train station and of local services, further reducing automobile trips in and out of downtown. A special effort should be directed at accommodating development in the area of the City's proposed Intermodal Transit Center.

2. Develop Comprehensive Plan Programs to Support Increased Density near Transit
The City's Comprehensive Plan includes a number of policies and programs in support of increased density, particularly in areas near transit stations or along major bus routes (El Camino Real) to facilitate the use of transit and other non-vehicular transportation modes. One of the obstacles to increased residential density, however, is a lack of community facilities, such as schools and parks. The City's Comprehensive Plan Amendment will be addressing these deficiencies, which is critical to effectively implementing strategies for increased

housing. Area plans will be developed for the East Meadow/West Bayshore area and the Cal-Ventura/Fry's area to assess these uses and issues in a focused manner. The City may also implement a Planned Development Area (PDA) project funded by ABAG to evaluate pedestrian and transit-friendly development in the Cal-Ventura area.

3. Modify Zoning Ordinance to Require Pricing Strategies to Reduce Parking

Recently adopted (October 2007) Zoning Ordinance regulations for parking provide reductions for mixed use development, proximity to transit, and TDM measures, as well as for affordable housing and senior housing projects. Reductions in parking should reflect trip reductions and thus reduction of carbon emissions, and should minimize land coverage with parking spaces. Other strategies available to reduce parking include pricing strategies that require developers to "unbundle" parking from rent or lease prices, or otherwise charge for parking. Parking may then become a commodity that a resident or employee can forego by using non-vehicular modes of transportation. The Zoning Ordinance should be amended to provide incentives or requirements for these approaches, which may work as well for the City and parking for its employees and for public parking spaces on streets and in parking lots and garages. Evaluation of residential permit parking may also be required to ameliorate the potential impacts of spillover parking into residential neighborhoods.

4. Develop Plans for Transportation Improvements around California Avenue Caltrain Station

In support of the Pedestrian and Transit Oriented Development zone around the California Avenue Caltrain Station, key transportation improvements will be implemented to enhance pedestrian, bicycle, and transit use in the area. These improvements include: a) streetscape enhancements and lane reductions on California Avenue; b) development of Park Boulevard as a City bicycle boulevard; and c) safety improvements (e.g., dedicated left turn lane from Park Boulevard to Oregon Expressway east, crosswalk enhancements). Additional traffic calming measures may also be evaluated to assure traffic is not diverted through the Ventura neighborhood. Caltrain is also expected to upgrade the train station with improved pedestrian access.

Long Term (2012-2020)

Goals

- Reduce emissions by an additional 10% by 2020
- Increase Caltrain and other transit use by an additional 50% by 2020

Actions

1. Evaluate Pedestrian and Transit Oriented Development Zoning Intensity, Including Along El Camino Real

Pedestrian and Transit Oriented Development zoning and the City's most intense multi-family zoning allow maximum residential development intensities of 40 units per acre. Following completion of the upcoming Comprehensive Plan Amendment, it will be appropriate to evaluate whether higher densities may be accommodated to further enhance pedestrian and transit use. The application of such densities and mixed use standards along El Camino Real may also be appropriate, particularly as the Grand Boulevard concept is implemented.

2. Develop Intermodal Transit Center and High-Density Public Transportation on Demand Project

Development of a high density, mixed use project should be promoted for the Palo Alto Intermodal Transit Center site, in conjunction with improvements to the Transit Center. The project may be a partnership between the City, Stanford, VTA, and private developers, and should stress connectivity to and from downtown, Stanford, the Medical Center, and the Shopping Center.

3. Implement Grand Boulevard Improvement Strategies for El Camino Real

Santa Clara and San Mateo Counties and several cities along El Camino Real, in conjunction with CalTrans, are developing strategies for creation of a Grand Boulevard for the roadway, including safety and streetscape enhancements and guidelines for design of quality mixed use development. The plan objective is to create a more pedestrian, bicyclist, and transit-friendly corridor to reduce the impacts of the automobile. The City of Palo Alto will be implementing one of these projects (at Stanford Avenue) in the mid-term, and others should subsequently be developed for implementation.

Monitoring

The City will measure its progress on reducing transportation-related emissions by tracking:

- Number of gallons of fuel purchased by City per year
- Mix of biofuel v. regular diesel purchased per year
- Estimated rate of idling
- Number participants in City commute program
- Number of low-mileage City vehicles in fleet (as percentage of total)
- Annual communitywide increase in ridership on Caltrain and other transit services
- Estimated annual vehicle miles traveled (community-wide)
- Average miles per gallon for City fleet

Table 5.2. Summary of CPP and GRTF Recommendations

GRTF Recommendation	CPP Recommendations	Timing	Annual Estimated CO_2 Savings Potential	CO_2 Savings Costs per Metric Ton of CO_2 per year.
Promote alternative fuels, with the City leading the way in purchasing fuel efficient vehicles.	Purchase of hybrid cars instead of high mileage conventional cars.	Short Term	1.37 per car	$88
	1. Use of Biofuels	Short Term	19 metric tons	$662
	2. Limiting Idling	Short Term	136 metric tons	$295
	3. Fleet Management	Short Term	284 metric tons	$ 52
	4. Fleet Accountability Programs	Medium Term	95 metric tons	$126
	5. Use of low-emission vehicles for City staff's local use	Medium Term	2.3 metric tons per vehicle	$510
Facilitate increased biking and walking.				
Increase mass transit availability.	Increase Cross town shuttles	Medium Term 180 metric tons	$694	
	Work with VTA, Caltrain and other regional transportation agencies to improve transit services in Palo Alto	Short Term and Medium Term	Unknown	Unkown
Encourage electronic alternatives to travel.	City should allow for telecommuting 2 days a month		53 metric tons	$0
Reduce emissions from school commuting.	School commute likely presents one of the best opportunities for the City to reduce emissions in an arena over which it can exert influence.		Unknown – unknown- fairly high	Unknown – likely fairly low

Table 5.2. (continued)
Summary of CPP and GRTF Recommendations

GRTF Recommendation	CPP Recommendations	Timing	Annual Estimated CO_2 Savings Potential	CO_2 Savings Costs per Metric Ton of CO_2 per year.
City offset its emissions, and encourage businesses and residents to do the same.	City should change travel policy to allow covering costs for emissions offset.		39 Tons	$32
(No GRTF Land Use-related recommendations)			No cost-benefit analysis done for CPP Land Use recommendations	

Table 5.3. Study of Parking Incentives

Study Location	Scope of Study	Assumed No. of Employees	Financial Incentive per mo. (1995 $'s)	Decrease in Parking Demand
Group A: Areas with little or no public transportation				
Century City District, West Los Angleles	3500 employees surveyed at 100+ firms	3,500	81	0.15
Cornell University Ithaca, NY	9000 faculty & staff	9,000	34	0.26
San Fernando Valley, Los Angles	1 large employer (850 employees)	850	37	0.3
Bellevue, WA	1 medium-sized firm (430 employees)	430	54	0.39
Weighted Average of Group		13,780	46.75	0.24
Group B: Areas with fair public transportation				
Los Angeles Civic Center	10000+ employees at several organizations	10,000	125	0.36
Mid-Wilshire Blvd., Los Angleles	1 mid-size firm	430	89	0.38
Washington DC Suburbs	5500 employees at 3 worksites	5,500	68	0.26
Downtown Los Angeles	5000 employees surveyed at 118 firms	5,000	126	0.25
Weighted Average of Group		20,930	109.52	0.31
Group C: Areas with good public transportation				
University of Washington, Seattle Wa.	50,000 faculty, staff & students	50,000	18	0.24
Downtown Ottowa, Canada	3500+ government staff	3,500	72	0.18
Weighted Average of Group		53,500	21.53	0.24
Weighted Average Over 3 Groups		**88,210**	**46.35**	**0.26**

Chapter 6: Green Building

Overview

According to the U.S. Department of Energy, buildings account for approximately 39% of total energy use, over 12% of the total water consumption, 68% of total electricity consumption, and therefore 38% of all carbon dioxide emissions annually in the United States.

These environmental costs can be significantly reduced through the use of green building practices. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if the design and construction team takes an integrated approach from the earliest stages of a building project. Potential benefits of green building include:

- **Environmental benefits,** such as enhancing and protecting biodiversity and ecosystems, improved air and water quality, reducing waste streams and conserving and restoring natural resources.

- **Economic benefits** including reduced operating costs, expanding and shaping markets for green products and services, improving occupant productivity, and optimizing life-cycle economic performance; and

- **Social benefits** including enhanced occupant comfort and health, heightened aesthetic qualities, minimized strain on local infrastructure, and improved overall quality of life.

The green building checklists commonly used in California are the Leadership in Environmental and Energy Design (LEED) and the Green Point Rated (GPR) checklists. The LEED checklist is advocated by the U.S. Green Building Council and is commonly used for nonresidential projects, and the GPR checklist is advocated by the nonprofit organization "Build It Green" and is commonly used for residential projects. The City's current Green Building Policy requires LEED certification for all new City buildings over 10,000 feet.

City staff, along with the Architectural Review Board, has been requesting green building checklists for the past four years to encourage applicants to incorporate green building materials and practices into their projects. On October 11, 2007, an ordinance went into effect citing Council adopted sustainability policy as a consideration for reviewing

certain planning applications, and thereby allowing City staff to require the submittal of a LEED, GPR or an equivalent checklist to complete an entitlement application. A minimum number of LEED or GPR points is suggested, but compliance is voluntary. Also in effect as of October 11, 2007, a revised Architectural Review Approval Finding (#15) requires the following for projects subject to Architectural Review:

> The project (must) exhibit green building and sustainable design that is energy efficient, water conserving, durable and nontoxic, with high-quality spaces and high recycled content materials. The following considerations should be utilized in determining sustainable site and building design:
>
> - Optimize building orientation for heat gain, shading, daylighting, and natural ventilation;
> - Design of landscaping to create comfortable micro-climates and reduce heat island effects;
> - Design for easy pedestrian, bicycle and transit access;
> - Maximize on-site stormwater management through landscaping and permeable paving;
> - Use sustainable building materials;
> - Design lighting, plumbing and equipment for efficient energy and water use;
> - Create healthy indoor environments; and
> - Use creativity and innovation to build more sustainable environments.

Single family residences are not subject to Architectural Review Approval Finding #15 unless there are three or more homes proposed by the same applicant. Residential projects subject to discretionary planning review in addition to building permit review are requested to submit a Green Point Rated checklist, which is included in Build It Green's Guidelines for New Home Construction and Remodeling. All applicants for single family residential projects are directed to the City's website or the Development Center's Green Building kiosk to obtain their own copy of the guidelines.

Also in October, the City launched the "Ask an Expert" service, a phone and email service that provides free assistance to building professionals and the public in an effort to make Palo Alto homes healthier and higher-performing. This service, also provided by Build It Green, is made possible by the City of Palo Alto Public Works, Utilities, and Planning and Community Environment Departments.

The consensus emerging within the City is that incentive programs will likely increase the level of green building and are an important first step before implementing mandatory requirements. The City's website now includes a green building incentives matrix (http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=9453) to help Palo Alto homeowners take advantage of incentives available to enable new homes or remodels to be higher performing (a.k.a. "green"). This matrix of rebates, tax credits, and services is organized into categories corresponding to the Build It Green Guidelines, which are (1) Site & landscape, (2) Building Envelope, (3) HVAC & Plumbing, (4)

Appliances & Lighting, (5) Renewable Energy, and (6) Tools & Financing. The City's Green Building Team is exploring additional incentives to promote green building.

Projects going through planning entitlement processes are subject to the existing City requirements for water efficient landscape design and to several existing and recently adopted zoning code requirements and guidelines (PAMC 18.23, 18.40, 18.76 and 18.83) designed to enhance the City's tree canopy and landscaping and mitigate stormwater pollution. The Urban Forest Master Plan will further address the Green Ribbon Task Force Building Committee's recommendation regarding the use of trees to save energy and the requirement for water efficiency.

Chapter 5, Transportation and Sustainable Land Use, addressed the GRTF's Building Committee's recommendations regarding transit-oriented and traffic reducing development and the promotion of biking and walking.

Additionally, the City will consider amendments to the California Energy Code, part of Title 24, or the California Building Standards Code, when the next version is published in March 2008. The anticipated amendments would establish more stringent energy efficiency standards for buildings beyond what the Energy Code currently requires. At this time, a target of 10%-15% additional energy efficiency for buildings beyond Title 24 requirements appears practical and justifiable. However, a study demonstrating the expected energy savings and cost-effectiveness of the proposed standards, as well as findings that the amendments are reasonably necessary based on local climatic, geologic or topographic conditions, will first need to be prepared. The study, proposed amendments and findings will then require approval by the City Council before submission to the California Energy Commission.

Goals and Actions

Short Term (2007/2008)

Goals

- Require LEED "Silver" certification or equivalency for new City buildings over 5,000 square feet, which are to be occupied by people, with limited exceptions (current policy requires LEED certification for new buildings over 10,000 feet)
- Require substantial renovations and additions of over 5,000 square feet to City buildings to be evaluated by an appointed green building professional to determine the costs and benefits of adding or enhancing green building features
- Require City building renovations and additions of under 5,000 square feet to use a LEED or equivalent checklist as a guideline to enhance the green building features
- Increase understanding of green building practices and benefits through stakeholder involvement

- Explore and implement incentives to increase the level of voluntary green building for all residential and commercial projects
- Require multi-family and commercial buildings (new construction and renovation) to have a minimum level of green building compliance starting July 2008
- Establish reasonable, cost-effective energy efficiency and conservation requirements for buildings that exceed California Energy Code (Title 24) standards

Actions

- Following Council discussion on December 3, 2007, update the existing City green building policy
- Create task force or review committee composed of developers, architects and other stakeholders to provide feedback and ideas on approaches to green building incentives and requirements
- Continue benchmarking green building programs of other cities
- Continue to work with Utilities staff on developing and implementing meaningful incentives
- Coordinate with Utilities and Recycling program, and with newly created staff/citizen forum on public outreach efforts
- Draft and circulate an ordinance for mandatory multi-family and commercial green building and introduce the ordinance for passage in spring 2008 (July 2008 effective date)
- Train existing staff (and possibly offer a pay incentive for certification or accreditation) or contract out for expertise in LEED and GPR (e.g. projects not designed by a LEED accredited architect/engineer could pay a fee for review by someone with LEED expertise)
- Adopt California Energy Code (CEC) (by reference). Retain consultant to perform relevant studies to justify local amendments to the CEC that will require increased energy efficiency and conservation measures. Adopt local amendments to the CEC with applicable findings and submit to the California Energy Commission

Medium Term (2009-2011)

Goals

- Require new single-family residential construction to have a minimum level of green building compliance starting July 2009.
- Monitor compliance levels and impact of new policies.
- Provide recognition for “green building.”

Actions

- Introduce an ordinance for mandatory low-density residential green building for passage in spring 2009 (effective July 2009.)

- Increase understanding of green building practices and benefits through stakeholder involvement.
- Continue to conduct staff training (and reward certification/accreditation).
- Explore new financing opportunities for green building efforts (e.g. green-friendly banks such as New Resource Bank and Valencia Green Bank.)
- Include "green building" among criteria for determining the 2010 ARB award winners.

Monitoring

The City will monitor its progress in the green building arena by tracking annually:

- Number of Green Point Rated and LEED-certified building projects completed
- Square feet of Green Point Rated and LEED-certified projects completed
- Number of building projects following LEED and BIG guidelines, but not certified
- Average point ratings achieved for City buildings
- Average point ratings achieved for residential projects
- Average point ratings achieved for commercial projects

Table 6.2. Summary of CPP and GRTF Recommendations

GRTF Recommendations	CPP Recommendations	Cost Benefit
(1) Provide green building planning and building review advice and education (2) by hiring new, (3) training existing staff or (4) using consultant time. (5) Require senior building officials to be LEED (Leadership in Energy and Environmental Design) accredited and BIG (Build it Green) certified. (6) Provide green educational materials at planning and building department.	(1) Continue to direct the public and building professionals to the Development Center Green Building kiosk, City website, and applicable City requirements and guidelines. (2) Continue to seek candidates for planning and building positions with keen interest in green building who also meet the other qualifications. (3) Continue to encourage technical staff to take green building courses and become BIG certified and/or LEED accredited and explore providing pay incentive for such achievement and maintenance of certification. (4) Continue to use green building consultants (including BIG's Ask-An-Expert) as needed. Continue to support LEED accreditation as desirable training for ARB members. Two current ARB members are LEED accredited, which helps to review ARB applications for green building features. (5) *Requirement for LEED accredited/BIG certified senior officials is not recommended,* since it can eliminate good candidates and this knowledge is only a very small portion of what such management-level officials need to know. (6) Consider differential pay for employees with BIG certification or LEED accreditation.	(1) No change in cost other than continued outreach; Potential benefits are great. (2) No cost; good potential benefit. (3) Cost could be pay differential (1%?) to encourage certification and accreditation; Benefit could include savings when outside consultants are not needed for city projects (4) Benefit of Ask An Expert could be increased green building for new homes and remodels. No cost for ARB members having LEED accreditation, as the City does not pay ARB members; benefits are great.

Table 6.2. (continued)
Summary of CPP and GRTF Recommendations

GRTF Recommendations	CPP Recommendations	Cost Benefit
(1) Require LEED/GPR checklist points list to be printed on permit drawings, and (2) require an escalating number of points be met over a period of years.	(1) Continue to require checklists with planning entitlement applications submitted after October 11 (effective date of PAMC Chapter 18.77 revision referencing Council adopted sustainability policy). Can include a condition of approval for those applications to include the checklist on building permit plan sets, HOWEVER, neither building plan checkers nor construction inspectors would be responsible for actual compliance with checklist items, would not be "signing off" building's compliance with green building checklists. The points would need to be documented by the architect/contractor/owner in a specific way (for USGBC/BIG); it would not be feasible for City inspectors to track. (2) Begin to draft mandatory green building ordinances for Council review and adoption in 2008 and 2009 that will seek enhanced green building levels over a period of years.	(1) No change in cost; requiring checklists to be printed on plan sets would not require inspectors to "sign off" and does not guarantee green building nor can the City require certification and consultant evaluation at this time. (2) Cost is City staff time needed for research, meetings, ordinance preparation, education and outreach, and eventual enforcement for non-compliance (unknown cost). Benefits not quantified.
Provide incentives or recognition for incorporating green building elements in both residential and nonresidential buildings.	The City's Green Building Team should continue to explore and promote incentives to the public. The ARB's award program (currently five-year interval) should continue to include green building as a factor for determining winners that were subject to ARB review. Green homes tours feature built Palo Alto homes, which provides recognition, but additional recognition programs could be established for single family homes.	Cost is City staff time needed for research, meetings, establishment and maintenance of incentives and recognition programs. Benefits not quantified.

Table 6.2. (continued)
Summary of CPP and GRTF Recommendations

GRTF Recommendations	CPP Recommendations	Cost Benefit
(1) Offer expedited reviews or lower costs for green energy projects. (2) Allow specific exemptions to building guidelines when green elements are applied.	(1) The City's Green Building Team should continue to explore "feebates" and the like for enhanced "green" projects or extending the review period for projects that are not "green". It is not likely that staff could review building permits in less time than current practice, and could lead to mistakes. (2) The City should consider exemptions to zoning ordinance requirements, such as using the Design Enhancement Exception (DEE) process, where there is a nexus to green building (e.g. a parking structure to exceed maximum lot coverage to allow the extended area that would have been surface parking to be landscaped instead.)	(1) City staff time needed for research, meetings, outreach and education. Benefits to customers that choose higher levels of green. Costs to customers that choose not to build green or lower levels of green. (2) City staff time needed only if exemptions are to be codified rather than considered on a project-by-project basis. If codified, would need task groups to study possible code changes prior to recommendation. Benefits not quantified.
Build or establish more traffic reducing development.	City should continue to partner with Eden Housing and Community Housing Alliance to develop affordable housing on Alma near the University Avenue Caltrain station.	Cost is City staff time needed for meetings; project development costs should be partially offset by Housing Impact Fees from other development projects in City. Benefits are likely greatest for affordable and attainable housing to reduce trips.

Table 6.2. (continued)
Summary of CPP and GRTF Recommendations

GRTF Recommendations	CPP Recommendations	Cost Benefit
(1) Provide incentives to encourage businesses and residents to invest in efficiency and renewables; and (2) explore requiring energy upgrades (e.g., installation of solar hot water) when a property changes hands or undergoes significant improvement.	(1) City should continue to provide and promote the public's use of the incentives matrix on the City's website. (2) The City's Green Building Team should continue benchmarking and discussing incentives for energy upgrades and requirements, working with stakeholders leading up to mandatory green building ordinance implementation.	(1) No change in cost; good benefit, (2) Cost is City staff time needed for research, meetings, outreach and education. Benefits not quantified.
Use trees to save energy and encourage or require water efficiency (and aquifer replenishment).	Continue to enforce existing City requirements and guidelines re: water efficient landscaping. (Aquifer replenishment is a different topic).	No change in costs for ongoing compliance.
Encourage transit-oriented development (TOD) and promote biking and walking.	Continue to encourage applicants to build TOD per the applicable Comprehensive Plan Policies and Zoning Code sections (See CPP Chapter 5)	No change in costs for ongoing encouragement.

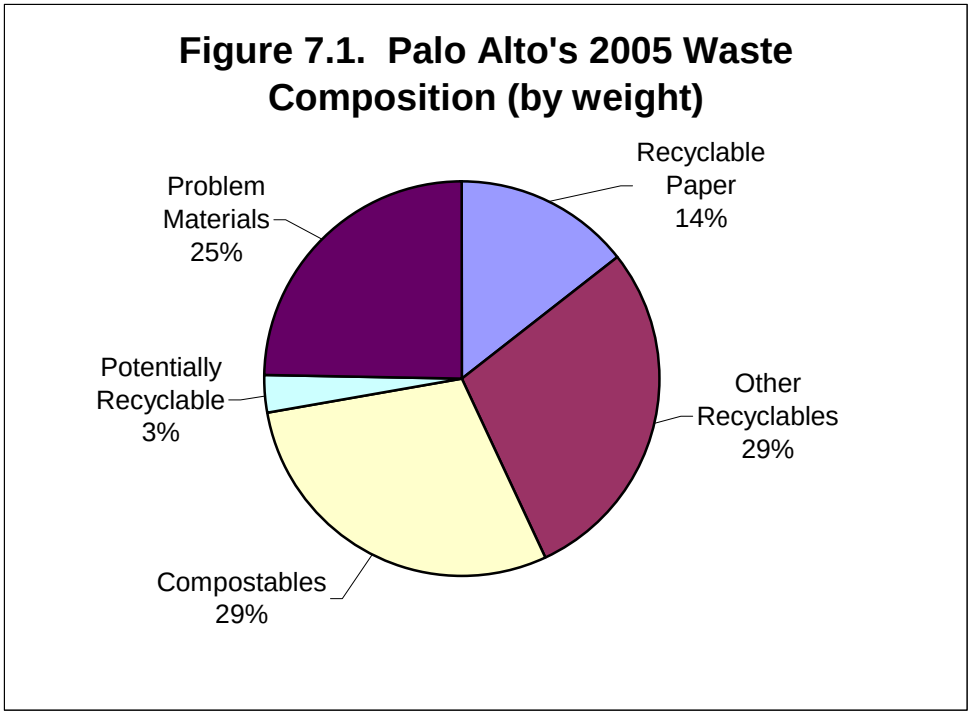
Chapter 7: Zero Waste

Overview

In October 2005, the City established a goal of 73 percent diversion by 2011 and to strive for Zero Waste by 2021. To reach these goals, the City will need to work collaboratively with all waste generators (e.g., residents, businesses, institutions) to use policies and incentives designed to eliminate waste at the source and maximize recycling through expanded collection programs, processing facilities, education, outreach and technical assistance.

The waste reduction and diversion goals of Zero Waste will have a significant impact on greenhouse gas (GHG) emission reductions through the decrease of overall production of materials (resource extraction, manufacturing, transportation and disposal) and through the diversion of materials from landfills.

A waste composition study was done as an initial step toward achieving Zero Waste to understand the current waste stream and identify opportunities for additional waste prevention, reuse, recycling and composting. Figure 7.1 shows the percentages of the components in the waste stream. Study findings indicate that approximately 43% of the waste stream is currently recyclable (recyclable paper 14% and other recyclables 29%). Problem materials are those items that are currently unrecyclable, reusable or compostable. Maximizing our use of the current recycling program is the quickest and least expensive action we can take to make significant strides toward both Zero Waste and GHG emissions reductions. Program maximization will not be easy, however, because Palo Alto has a 35 year history of a comprehensive waste reduction program that has already captured easy gains. Additional efforts must address those sectors of the community that up to now have not been engaged in waste reduction efforts or only minimally engaged. Such new efforts will need to address and overcome their barriers to participation.



The GRTF did not make recommendations on Zero Waste. Instead it deferred to the Zero Waste Operational Plan, which incorporated the recommendations of the Zero Waste Task Force.

Current Emissions Estimate

Palo Alto's total waste-related emissions in 2005 were 100,304 metric tons of CO_2e.

Waste-related emissions data are comprised of two primary components.

- 2005 Historic Emissions - Annual emissions caused by the decomposition of waste disposed in the Palo Alto landfill before 2005
- 2005 Emissions - Lifecycle emissions from materials landfilled in 2005.

Both historic and lifecycle emissions refer only to methane generated but not collected. The collected portion of emissions from the Palo Alto landfill are captured through landfill gas recovery systems and used by the Regional Water Quality Control Plant (RWQCP) to incinerate waste water treatment sludge or otherwise converted to CO_2 by flaring.

<u>2005 Historic Emissions</u>

The historic emissions were estimated 20,643 metric tons of CO_2e in 2005, although this estimate has a high degree of uncertainty. ICLEI estimated the emissions as high as 55,000 metric tons, while CCAR based estimates are approximately 3,900. These emissions are based on an estimate calculated by ICLEI using the LandGEM model from the US EPA.[9]

[9] Landfill Gas Emissions Model software from US EPA which calculates GHG emissions from landfills.

2005 Lifecycle Emissions

The emissions created by the waste generated in 2005 are factored using two calculations, Clean Air and Climate Protection (CACP) Software from ICLEI and US EPA emissions factors.

The lifecycle emissions of methane from materials that were landfilled by Palo Alto in 2005 were estimated using the CACP software from ICLEI. The emission estimates were calculated using waste tonnage data from Palo Alto's 2005 Annual Report to the California Integrated Waste Management Board (CIWMB) and the percentages of material by type in the waste stream derived from the 2006 Waste Composition Study. Palo Alto emitted 24,823 metric tons of CO_2e in 2005 from the material disposed in landfills as shown in table 7.1.

Table 7.1. ICLEI Emission Estimates for Waste Landfilled in Palo Alto in 2005

	Tons of Waste[11]	Metric Tons of CO_2e[12] (as methane)	Notes/Data sources
Total Waste to Landfill	69,491		Disposal tonnage from 2005 annual report
Paper products		12,027	ICLEI CACP protocol
Food Waste		15,237	ICLEI CACP protocol
Plant Debris		-644	ICLEI CACP protocol
Wood/Textiles		-1,797	ICLEI CACP protocol
Total Emissions from Landfilled Waste		**24,823**	

The US EPA emission factors from the 2006 *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks (3rd Edition)* report are based on a life-cycle approach, which reflects emissions and avoided emissions upstream and downstream from the point of use. As such, the emission factors provide an account of the net impact to the environment. This life-cycle approach incorporates impacts occurring outside of the community. However, Palo Alto's demand for products directly causes these products to be manufactured, thereby causing the associated emissions. For this reason, these emissions have been included in Palo Alto's inventory.

The US EPA emissions factors were used to estimate Palo Alto's emissions in 2005 due to recyclable materials that were disposed in the landfill instead of being recycled. If these items had been recycled, the following emissions could have been avoided. Additional emissions reductions are achievable than estimated by this table because the US EPA emissions factors do not include material reuse which is less energy intensive than recycling and thus emits less, and there are no emissions factors for a variety of recyclable items (listed as 'no data' in the table). Therefore, the calculations represent the minimum reduction potential for removing reusable and recyclable materials from our waste stream. These calculations, shown in table 7.2, indicate that Palo Alto was

[11] Source: Palo Alto Annual Report to CIWMB (2005)
[12] Source: Palo Alto Waste Composition Study (2006)

responsible for the emission of 54,838 metric tons of CO_2e due to landfilling of recyclable materials.

Table 7.2. Emissions Due to Landfilled Recyclables in Palo Alto in 2005

	Tons in Waste Stream[13]	**Emissions Metric tons CO_2 (2,200 lbs)**[14]
Paper		
Corrugated cardboard	1,965	6,110
Magazines	1,617	4,963
Newspaper	1,744	4,867
Office Paper	1,432	4,081
Phonebooks	46	123
Mixed Paper	3,151	11,154
Total Paper	**9,955**	**31,299**
Plastics		
HDPE	379	527
PET	293	451
Plastic Bags	306	518
Mixed Plastics	1,564	2,330
Total Plastics	**2,542**	**3,825**
Glass		
Mixed Glass	1,147	321
Total Glass	**1,147**	**321**
Metals		
Aluminum Cans	113	1,537
Steel Cans	341	611
Mixed Metal	2,031	10,662
Total Metals	**2,486**	**12,811**

[13] Sources: Palo Alto Waste Composition Study (2006), Palo Alto Annual Report to CIWMB (2005)
[14] Source: US EPA *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks (3rd Edition)*

Table 7.2 (continued)
Emissions Due to Landfilled Recyclables in Palo Alto in 2005

	Tons in Waste Stream[15]	Emissions Metric tons CO_2 (2,200 lbs)[16]
Electronic Waste		
Brown Goods	220	No Data
Computer Related Electronics	95	No Data
Other Small Consumer Electronics	17	No Data
TV's and CRT's	81	No Data
Total Electronic Waste	**412**	**No Data**
Construction and Demolition		
Concrete	1,383	14
Rock, Soil and Fines	5,115	No Data
Gypsum	1,649	No Data
Asphalt Roofing	1,792	No Data
Total C&D	**9,940**	**14**
Other Waste		
Hazardous Wastes	423	No Data
Tires	0	0
Wood	2,670	6,568
Total Other	**3,092**	**6,568**
Grand Total	**29,574**	**54,838**

Zero Waste Goals & Actions

Short Term (2008)

Goals

- Integrate Climate Protection into the Zero Waste program
- Expand implementation of Zero Waste programs

Actions

- Integrate climate protection analysis into the Zero Waste decision-making process
- Expand efforts in waste prevention through legislation, policies, ordinances, outreach and technical assistance

[15] Sources: Palo Alto Waste Composition Study (2006), Palo Alto Annual Report to CIWMB (2005)
[16] Source: US EPA *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks (3rd Edition)*

- Reduce the amount and toxicity of consumer product waste through measures that place the appropriate level of responsibility on manufacturers for the end-of-life of their products
- Encourage innovative reuse and recycling services to be added by the private sector and nonprofit groups, such as electronics and building materials, so the City does not have to invest in those activities
- Work with residents, businesses, community organizations, Bay Area Product Stewardship Council, Bay Area Zero Waste Communities, Bay Friendly Regional Coalition and other such groups to further the City's Zero Waste efforts
- Modify the Construction and Demolition (C&D) debris ordinance to:
    - Increase the amount of materials salvaged for reuse
    - Increase the diversion percentage required for demolition permits from 50% to 75%
    - Increase the number of projects that are covered by the ordinance
- Expand collaborative efforts with targeted businesses to reduce the use of disposable items such as plastic shopping bags and take-out containers
- Facilitate connections between food rescue organizations and Palo Alto businesses to reduce the amount of food discarded into the waste stream
- Support development of a Sustainable Purchasing Policy and Implementation Plan (see Sustainable Purchasing chapter)
- Propose a grant or loan program for local reuse and recycling
- Ensure that new waste collection and processing service RFP includes Zero Waste service options (e.g., expanded organics collection, expanded C&D debris collection and container inspections upon collection)
- Enhance business, multi-family and school waste reduction programs
- Divert remaining debris boxes rich in C&D materials to C&D processing facilities
- Propose a phased-in mandatory recycling ordinance
- Propose materials to be banned from the Palo Alto Landfill
- Retool the SMaRT Station to increase diversion rate from 18% to 25%
- Find a location for a local recycling drop-off center and household hazardous waste facility

Medium Term (2009-2011)

Goals

- Achieve 73% diversion of waste from landfill by 2011, with an estimated GHG emissions reduction of 6,849 metric tons CO_2e.

Actions

- Modify garbage rates to encourage Zero Waste
- Collaborate with the Planning and Community Environment Department to increase Green Building and adaptive reuse efforts (see Green Building chapter)

- Build on collaborative efforts with targeted businesses to reduce disposable items
- Propose Sustainable Gardening and Landscaping Policy and Implementation Plan
- New collection contract
    - Expand the organics program
    - Provide recycling services to all commercial customers
    - Expand the types of recyclable materials collected by the curbside program
    - Improve the current bulky item collection program to further reuse and recycling
    - Divert additional industrial loads to C&D debris processing facilities
- Propose possible product bans or fees to reduce the use of products such as plastic bags and bottled water
- Implement approved material bans and mandatory recycling ordinances
- Improve recycling in public areas

Long Term (2012-2021)

Goals

- Zero Waste by 2021 (78 – 90% diversion of waste from landfill) – estimated GHG emissions reduction of 25,251 metric tons CO_2e.

Actions

- Evaluate emerging technology or other innovative approaches to materials management
- Continue to develop and implement Zero Waste programs

Cost Benefit Analysis

Staff estimates that the above actions will impact City and communitywide emissions as follows:

Table 7.3. Costs and Emission Reductions

Percent of waste diverted from landfill	Cost (additional)[17]	Emission Reduction (metric tons CO_2e)	Cost/Metric Ton of Emissions Avoided
68%	$615,000	9,623	$64
73%	$3,376,000	10,254	$329
78%- 90%	Not available	37,806	Not available

[17] Zero Waste Operational Plan

Monitoring Plan

The City will use the data created for this plan as a baseline and will use this same measurement tool annually to calculate the impact of the City's waste reduction and diversion efforts on greenhouse gas emissions reduction using the disposal tonnage and waste percentages from the 2006 Waste Characterization Study to calculate the estimated emission changes.

This monitoring plan shall be followed until more accurate and/or reliable data become available or state regulation regarding waste reports changes the reporting data.

Chapter 8: Education and Motivation

Overview

Climate Protection is a challenge that requires innovation and collaboration among all of the stakeholders in the Palo Alto community. It will necessitate, in many cases, learning new ways of conducting our daily lives. The Palo Alto City government and community, in cooperation with surrounding communities and regional efforts, will need to work together to examine these issues from multiple angles, build cohesion among the various stakeholders, reach consensus, and move together toward achieving progressive, successful solutions.

The GRTF recommendations presented the concept of "nodes" or segments to educate and motivate the public. To achieve our emission reduction goals, the City must work with representatives of the business, nonprofit/service organization, faith, and school communities, as well as neighborhood organizations, to communicate, coordinate, and implement climate protection efforts throughout the community.

This chapter proposes a strategy based on the GRTF recommendations for both City operations and the larger community. The main focus is the creation of collaborative relationships through which all the stakeholders can freely discuss the problems associated with climate protection, gain a fuller understanding of what is required to reduce the community's carbon footprint, determine what needs to be done to move forward, and then cooperate on implementing the plan.

The actions prescribed in this chapter do not have a cost-per-ton analysis associated with them. Since education and motivation will be the foundation for the success of every other component of the CPP, the costs and benefits are not calculated separately.

Goals & Actions

City Operations

Although City operations account for 10.5% of Palo Alto's total GHG emissions, changing City operations to become more "climate smart" will set an example for the community, provide leadership, test solutions for viability, and help build markets to make products and services more readily available.

This section will address how to engage City employees in making the changes necessary to reduce City-generated emissions.

Short Term (2008)

Goals

- Increase City employee's awareness of climate protection issues and the Climate Protection Plan

Actions

- Create a Climate Protection Education & Motivation (CPEM) task group from the Environmental Stewardship Steering Committee that includes representatives from the affected departments.
- Through the new CPEM task group, create an interdepartmental outreach, education and engagement plan (which may include loop messages, flyers, intranet site, work group meetings, all-City-employee meetings, new City employee trainings, incentive programs and more)
- Identify actions that have the greatest impact on CO_2 emissions (e.g., vehicle idling, single-sided copying or printing out emails)

Medium Term (2009-2011)

Goals

- Target 5-10 core actions and/or processes for reducing emissions
- Integrate climate protection into City events and operations

Actions

- Integrate learning into new employee training
- Work with HR to create new training program for all current employees regarding climate protection and other environmental issues
- Integrate climate consciousness into City functions (e.g., make all City- sponsored events "BYOPS" [bring your own place setting] and otherwise promote Zero Waste, biking/walking/carpooling, energy efficiency, use green power, buy local and organic food products, require vendors to adhere to City sustainability policies)
- Create an incentive program to reward departments or divisions that implement effective reduction efforts
- Create working groups to address the identified actions
- Launch campaigns to encourage desired actions and practices

Long Term (2012 and beyond)

Goals

- Complete integration of climate protection into all City operations

Actions

- Continue education and outreach efforts, monitoring and adjusting them as needed

Communitywide Efforts

To effectively work with the community, the City must have an effective, two-way mechanism for communicating and collaborating with the members of the public.

The communitywide efforts section of this chapter comprises two components: the creation of a collaborative forum between citizens and staff, and the development and implementation of a citywide public information strategy.

I. Citizen/Staff Forum

Create a public private partnership where city staff, citizens, and businesses collaborate on implementing sustainability initiatives through public education and other programs. The forum should be a standing, action-oriented body focused on sustainability, with members from all six community segments articulated by the GRTF, focusing on climate protection for the first two to three years. This forum would coordinate and promote events and groups similar to some that have already taken place in the community, such as Palo Alto Business Goes Green, via the Chamber of Commerce, the Sustainable Schools Committee, the Interfaith Convocation on Climate Change, the Solar Homes Tour, and several other lectures/presentations and events throughout the community. The forum would also explore collaborating with Stanford on outreach events and programs.

Short Term (2008)

Goals

- Launch the Citizen/Staff Forum

Actions

- Create and convene a collaborative citizen/staff forum with representatives from all six segments of the community
- Create first annual Goal-Setting process for the forum
- Forum identifies its top-three priorities for the coming 1-3 year period
- Forum selects top-3 projects or actions for implementation in year 1

At the end of the first year, goals and projects will be re-evaluated and re-prioritized for the following year.

II. City Public Information Strategy

The City will develop and implement a public information strategy to integrate climate protection into ongoing City sustainability outreach and education efforts, as well as share information about other organizations throughout the community working on climate change.

The public education plan will incorporate:

- A more fully developed and accessible/searchable web site on climate change and sustainability issues
- Utility bill inserts regarding new program developments
- Utilization of other City outreach mechanisms (e.g., City Pages, Frank's Memos, Community & Business Recyclers, Utility Announcements, Libraries, Enjoy Catalog and the Family Services Ambassador Development Program)

- Press strategy aiming for systematic outreach and discussion of climate change in the local press. For example, collaborating with one or more local nonprofits to have a weekly "Ask the Environmentalist" column in one of the local papers.
- Internet-based communications – utilizing Facebook, blogs and other vehicles for getting the City's message(s) out.

Short Term (2008)

Goals

- Increase awareness of climate protection issues and new plan

Actions

- Explore the options for creating baseline data of the community's awareness
- Integrate climate protection into City outreach, harnessing the outreach currently done for City and City Utilities programs that affect climate change to help spread awareness (e.g., include climate protection plan logo)
- Create and implement an outreach, education and engagement plan coordinating the efforts of the CPEM task group and the staff/citizen forum
- Choose 2 – 5 "most-achievable" messages/actions for the first year

Medium Term to Long Term (2009-2011)

Goals

- Continue coordinated outreach, education and engagements efforts of the City and the Environmental Committee

Actions

- Choose 2-5 messages/actions to concentrate on each year
- Evaluate impact of previous years' efforts and adjust new efforts accordingly to improve impact and efficiency.
- Expand plan to additional media of communication

Monitoring

The City will measure its progress in educating and motivating the community to act on climate change by conducting informal surveys regarding community attitudes towards climate change, and by evaluating community progress on reducing emissions through the bi-annual inventories discussed in chapter 2.

Table 8.2. Summary of CPP and GRTF Recommendations

GRTF Recommendations	CPP Recommendations	Cost Benefit
Improve communication about "green" issues between nodes.	Create citizen/staff forum with representatives from each node to "institutionalize" this communication	n/a
Identify common goals and reinforce them. Encourage synergy by sharing existing ideas and programs.	Forum would identify top-priority goals and programs for each year and collaborate on implementation	n/a
Create a "bandwagon effect" by making the message about our community's response to global warming constantly reinforced and visible everywhere . Create a sense of moral imperative about this issue.	Staff and citizens would collaborate on determining the most productive mechanisms for delivering this message	n/a
Create synergy, not duplication, between new and existing green activities. Suggestions include identifying a lead organization within each node, asking that organization what is already being done in its area, creating a computer database of those actions, and encouraging each node to adopt its own "green certification" program.	Would be considered by the forum	n/a
Create an overall "PR Umbrella" for Palo Alto green action. The report contains several creative suggestions for implementation, for example: create a logo; run a "green" column in local newspaper(s), city green web page	Sustainability Coordinator would coordinate climate protection-related PR with existing City outreach programs. Each of these examples is included as part of this chapter's recommendations.	n/a
To leverage the work that's already going on and integrate it with new green action, create a public/private partnership.	The forum would serve as the venue for the partnership.	n/a

Glossary

AB1470: California Assembly Bill 1470 (2007), established a requirement for gas-utility-funded solar hot water heating incentive programs.

AB2021: California Assembly Bill 2021 (2006), added to SB1307 new and very specific long-term planning, reporting, and review requirements with specific deadlines, and a requirement to "treat efficiency as procurement investments…without regard to previous minimum investments." AB 2021 requires that utilities develop and submit 10-year energy efficiency plans on a three-year cycle.

AB32: California Assembly Bill 32 (2006), "California Global Warming Solutions Act of 2006," established greenhouse gas reduction targets for California–1990 levels by 2020 and 80% below 1990 levels by 2050.

Acterra: A Palo Alto-based non-profit organization that seeks to bring people together to create local solutions that enhance the natural environment.

Adder: A value used in evaluating investment or purchasing alternatives that credits alternatives for reduced environmental or other impacts.

Anthropogenic: Created by human activity.

Ask an Expert: Call center available to Palo Alto residents and businesses providing Green Building expertise. 1-888-40-GREEN.

B20: a blend of biodiesel which contains 20 percent biodiesel and 80 percent diesel.

BIG: Build It Green, a residential green building rating system.

Biogas: Natural gas fuel made from non-fossil fuel sources.

Biogenic: Created naturally or non-manmade.

Build It Green: A residential green building rating system.

BYOPS: Bring Your Own Place Plate Setting

CACP: ICLEI Clean Air and Climate Protection software used to help determine a portion of the City's GHG emissions.

CARB: California Air Resource Board.

CCAR: California Climate Action Registry. CCAR software is used to determine greenhouse gas emissions from City of Palo Alto Utilities.

CCP: Cities for Climate Protection™ A campaign sponsored by International Coalition of Local Environmental Initiatives which assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability.

CEC: California Energy Commission.

CH_4: Methane, a greenhouse gas with 21 times the global warming potential of CO_2.

CIWMB: California Integrated Waste Management Board

Climate Smart: PG&E retail rate program whereby customers pay extra to invest in CO2 reduction projects.

CMUA GHG Reduction Principles: California Municipal Utilities Association Greenhouse Gas Reduction Principles.

CO_2: Carbon dioxide, a greenhouse gas.

Cogeneration: Simultaneous generation of electricity and useful heat.

CPAU: City of Palo Alto Utilities

CPEM: Climate Protection Education & Motivation

CPP: The City of Palo Alto Climate Protection Plan.

EPP: Environmental Purchasing Policy.

GPR: Green Point Rated. The rating system used by Build It Green.

GRTF: Green Ribbon Task Force.

GULP: Gas utility Long-term Plan.

GWP: Global Warming Potential.

HFC: Hydrofluorocarbons, a greenhouse gas with 140-12,100 times the global warming

potential of CO_2.

ICLEI: International Council of Local Environmental Initiatives, an international association of local governments that promote sustainable development.

IPCC: Intergovernmental Panel on Climate Change, established to assess scientific technical and socio-economic information relevant to understand climate change, its potential impacts and options for adaptation mitigation.

Joint Venture Silicon Valley Climate Protection Taskforce: a Climate Protection Task Force comprised of public agencies to develop strategies for reducing greenhouse gas emissions from city, county, and other agencies' operations.

kWh: A kilowatt hour(1,000 watts). The work performed by one kilowatt of electric power in one hour.

Kyoto Protocol: the United Nations treaty which targets the reduction of greenhouse gases that cause global warming.

LEAP: Long-Term Electric Acquisition Plan.

LEED: Leadership in Energy and Environmental Design. A voluntary, consensus-based national standard for developing high-performance, sustainable buildings.

N2O: Nitrous Oxide, a greenhouse gas with 310 times the global warming potential of CO_2.

NOx: the collective symbol for nitrogen oxides.

Palo Alto Business Goes Green: The Palo Alto Chamber of Commerce campaign to encourage local businesses to become certified as a Santa Clara Valley Green Business.

Life Cycle Cost: Total costs including initial costs, operating costs, maintenance costs, and end-of-life disposal costs.

M&V: Measurement and verification

MMBtu: One million BTUs.

MWh: a Megawatt-hour, or 1,000 kWh.

NAPEE MOU: National Action Plan for Energy Efficiency Memorandum of Understanding (CMR: 316:06).

NCPA: Northern California Power Agency.

Offset: A contract to reduce emissions, by a specified amount, within a specified time, to a specified degree of certainty, or a certificate of proof thereof.

PFCs: Perfluorocarbons, a greenhouse gas with 6,500-9,200 times the global warming potential of CO2.

PM10: Particulate matter less than 10 microns in diameter.

PG&E: Pacific Gas & Electric Company.

PLUG-In: Power from Local Ultra-clean Generation Incentive program. A utilities program that provides incentives for customer-sited small-scale clean distributed power generation such as cogeneration and fuel cells.

PV: photovoltaics, a solar electric generator that converts sunlight directly into electricity using semiconductors.

REC: Renewable Energy Credit, also known as Green Tags or Tradable Renewable Certificates. A certificate of proof that one unit of electricity was generated and delivered by an eligible renewable energy resource.

RPS: Renewable Portfolio Standard.

RWQCP: Regional Water Quality Control Plant-owned and operated by the City of Palo Alto it treats wastewater from Palo Alto and its five partner cities.

SAP: the enterprise software application used by the City of Palo Alto for purchasing and finance operations.

SB 1037: Senate Bill 1037 (2005), established a "loading order" for electric power resources, specifying a preference hierarchy of: first, Energy Efficiency and Demand Reduction; second, Renewable Energy Supply; and then third, Conventional Power Supply.

SB1: California Senate Bill 1 (2006), established the California Solar Initiative to install 3,000 megawatts of solar photovoltaic systems in California over ten years, or approximately one million systems.

SB107: California Senate Bill 1078 (2006), accelerated the California RPS targets to 20% by 2010 instead of 2017, and added annual reporting requirements for publicly-owned electric utilities to report annually to the California Energy Commission.

SB1078: California Senate Bill 1078 (2002), established California's Renewable Portfolio Standard, with targets of achieving 20% of electric supply from eligible renewable resources by 2017.

SB1368: California Senate Bill 1368 (2006), established greenhouse gas content limitations on long-term electricity contracts and generation facilities.

Sequestration: processes that remove carbon dioxide from the atmosphere.

SF_6: Sulfur Hexaflouide, a greenhouse gas with 23,900 times the global warming potential of CO2.

Sinks: a carbon reservoir that is increasing in size.

SSV: Sustainable Silicon Valley, a collaboration of businesses, governments, and non-governmental organizations that are identifying and addressing environmental and resource pressures in the Valley. SSV is engaging prominent Valley organizations to work towards a goal of reducing regional carbon dioxide (CO2) emissions 20% below 1990 levels by 2010.

Sustainability Policy: The City of Palo Alto's Sustainability Policy which outlines the City's intention to meet the economic, social and environmental needs of the city.

TDM: Transportation Design Management

Therm: 100,000 BTUs (British Thermal Units), equivalent to approximately 100 standard cubic feet of natural gas.

US Mayors Climate Protection Agreement: An initiative of the US Council of Mayors in which mayors commit their City to meet or beat the Kyoto protocols.

USEPA: United States Environmental Protection Agency.

WARM: Waste Reduction Model developed by US EPA to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices.

Zero Waste: the City's initiative to reduce Palo Alto waste generation to zero by 2021, or as close as a practicable.

Appendix I:
Summary of GRTF Recommendations and CPP Cross Reference

COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
BASELINE	Observation	Would be improved with more frequently updated Palo Alto specific data.	Data on City emissions should be maintained. However, key issue is community inventory. The city should work to improve this segment.
BASELINE	Observation	The committee did not address non-fossil fuel CO2 or other greenhouse gases such as methane, nitrous oxide, refrigerants, or sulfur hexafluoride. - (Include all GHG)	Recommended in CPP Chapter 1
BASELINE	Strategy	In developing targets, devise a method to measure and track progress.	Recommended in CPP Chapter 1
BASELINE	Strategy	Measure progress against time, not against others.	Recommended in CPP Chapter 1
BASELINE	Observation	There is no uniformly accepted baseline methodology for municipalities. (standard tool is needed) Reporting protocols are being developed by agencies such as ICLEI and the California Climate Action Registry	Protocol development has improved since GRTF, but no protocol covers the full range of emissions. CPP uses 3 approved protocols: ICLEI, CCAR and EPA
ENERGY	Strategy	Community businesses, institutions and residents take individual and collective action to reduce their environmental footprint, aided, we hope, by some of the ideas and suggestions presented in this report.	City needs to serve as catalyst for action.
ENERGY	Goal	Council direct or authorize staff to develop a climate action plan for the City utilities department with the goal of achieving climate neutrality by 2020.	Recommended in CPP Chapter 1
ENERGY	Strategy	City Council, Committees, Commissions, Boards, and City staff take these suggestions into account as they develop, review and implement initiatives and programs, and adopt new codes, standards and procedures applicable to energy-related greenhouse gas emissions.	Recommended in CPP
ENERGY	Goal	1. Reduce electricity and natural gas use through conservation and energy efficiency.	Recommended in CPP Chapter 3
ENERGY	Strategy	2. Reduce carbon intensity of energy supply provided by CPAU.	Recommended in CPP Chapter 3

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
ENERGY	Strategy	3. Expand use of renewable energy installed or purchased directly by customers.	Recommended in CPP Chapter 3
ENERGY	Strategy	4. Participate in and promote greenhouse gas emissions inventory tracking and reporting.	Recommended in CPP Chapter 3
ENERGY	Strategy	5. Promote and implement climate-neutral alternatives and education.	Recommended in CPP Chapter 3
ENERGY	Strategy	6. Employ urban forest opportunities to reduce energy use and increase carbon sequestration.	Recommended in CPP Chapter 3
ENERGY	Strategy	7. Invest in GHG-reducing projects or offsets to balance remaining emissions.	Recommended in CPP Chapter 3
ENERGY	Strategy	8. Support Research and Development in GHG-reducing science and sociology.	Recommended in CPP Chapter 3
ENERGY	Strategy	9. Coordinate energy climate activities with building and urban planning activities.	Recommended in CPP Chapter 3
ENERGY	Tactic	Community challenge or incentives to report greenhouse gases with a recognized agency such as Sustainable Silicon Valley, California Climate Action registry, and/or other recognized national or international reporting groups.	
ENERGY	Tactic	Actively advertise available tax credits and incentives (such as the current CPAU website)	Recommended in CPP Chapter 3
ENERGY	Tactic	Electricity use and gas use displays in the home and business to encourage conservation, show energy, cost and environmental impacts.	
ENERGY	Tactic	Sponsor a “carbon neutral” homes tour.	
ENERGY	Tactic	Sponsor energy and the environment reference library section.	
ENERGY	Tactic	“Energy Budget”: Require that homes above a certain size be designed to use energy no more than some size (e.g. 3,000 sq ft house) at Title 24 standards, and possibly something similar for businesses.	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
ENERGY	Tactic	Add efficiency checklist as standard in planning and ARB reviews.	Recommended in CPP Chapter 5
ENERGY	Strategy	Zero energy home incentives.	
ENERGY	Tactic	Building permit review “fast lane” for low-energy buildings and energy efficiency improvements.	
ENERGY	Tactic	RECO for rental properties (Residential Energy Conservation Ordinance)	
ENERGY	Tactic	Require solar option on developments over 5 homes rather than 50.	
ENERGY	Strategy	Design for LEED/Green Points for new city buildings.	Recommended in CPP Chapter 5
ENERGY	Tactic	Build a zero-energy home and use for a B&B or Utility Director’s home! Maybe team with Sunset Magazine or other partner.	
ENERGY	Tactic	Time of use rates that incorporate CO2 impacts.	
ENERGY	Tactic	Enhance tiered rate structures to encourage electricity and natural gas conservation - add extra retail rate tier(s) to highest energy users.	
ENERGY	Tactic	Provide incentives for companies to purchase Palo Alto Green – inverse tiered rate structure -- the more you buy the cheaper it is per unit.	
ENERGY	Tactic	Provide voluntary retail rate option to invest in offsets for natural gas use or climate neutral utility bills.	
ENERGY	Tactic	Discount utility rates for Energy Star homes.	
ENERGY	Tactic	Special rates for electric vehicles	
ENERGY	Strategy	Reduce electric and gas distribution system losses.	Recommended in CPP Chapter 3
ENERGY	Tactic	Join Energy Star Partnership - both City government and commercial businesses.	

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Summary of GRTF Recommendations and CPP Cross Reference

COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
ENERGY	Tactic	Acterra Cool Homes program to install compact fluorescent lights (CFLs), low flow shower heads, programmable thermostats, water heater blankets, close lines, adjust water heater temp. and other energy efficiency measures.	
ENERGY	Tactic	Recommission commercial and public facilities to ensure that efficiency measures already taken are working properly.	
ENERGY	Tactic	Install high-efficiency lighting and controls. Lighting is the number one electric end-use and has the highest potential for cost-effective energy efficiency reductions.	
ENERGY	Strategy	Increase use of clotheslines. Natural gas use for residential laundry emits approximately 2,200 tpy.	
ENERGY	Tactic	LED holiday lights for University Avenue would save up to 10-20 tonnes CO2 per year, but more importantly could have a striking visibility and strategic impact if combined with educational information.	
ENERGY	Tactic	Expand solar programs to install solar water, heating, hybrid lighting, and passive solar design.	
ENERGY	Strategy	Support “Solar for schools” program	
ENERGY	Goal	Install 13 MW of Photovoltaics (Goal implied by Million Solar Roofs Legislation SB1)	
ENERGY	Strategy	Install solar hot water systems.	
ENERGY	Tactic	Implement a “Solar Garden” (central PV with subscribers). A solar garden would enable customers without adequate solar resources on their own home or businesses to have solar energy delivered into the CPAU grid from collective action.	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
ENERGY	Tactic	Solar heating for all City and PAUSD pools. Natural gas use for swimming pool heating emits over 4,000 tpy in Palo Alto. Implementing solar sets an example for the community and will save money.	
ENERGY	Tactic	Offer solar-type incentives and rebates for GHG reduction from energy use regardless of technology involved.	
ENERGY	Strategy	Meet all energy load growth with efficiency and renewable resources.	
ENERGY	Tactic	Sign up for Palo Alto Green – e.g. set goal to sign up 50% of load to be PaloAltoGreen. Would likely require Renewable Energy Credits or a change to mix other than 97.5% wind/2.5% solar.	CPP calls for achieving 5% in short term and 10% in long term.
ENERGY	Tactic	Deploy clean small-scale distributed generation, including incentives for local renewables and low-net-GHG cogeneration.	
ENERGY	Tactic	Expand City urban forest management/master plan to recognize energy savings and CO2 sequestration benefits.	
ENERGY	Tactic	Enhance utilities' "Right tree in the Right Place" program expanded to accommodate solar access for PV and hot water.	
ENERGY	Tactic	Increase tree canopy coverage for parking lots. Reduces fuel consumption for car air conditioners and heat island effect.	
ENERGY	Tactic	Utilities purchase GHG offsets equal to the residual GHG content of utilities energy supply offsets (natural gas and electricity).	
ENERGY	Tactic	Individuals and companies purchase GHG offsets equal to the GHG content of utilities energy supply offsets (voluntary).	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
ENERGY	Strategy	Establish a Green Tech Center to facilitate the commercialization of new technologies.	
ENERGY	Strategy	Reduce energy used for landscape maintenance, such as landscaping not requiring lawnmowers (no grass) or using goats instead of lawnmowers.	Recommended in Chapter 6
TRANSPORTATION	Goal	Get more car drivers biking and walking to their destination or to mass transit.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Facilitate increased biking and walking.	Recommended in Chapter 5
TRANSPORTATION	Goal	Improve both local and regional mass transit options and functionality.	Recommended in Chapter 5
TRANSPORTATION	Goal	Increase mass transit availability.	
TRANSPORTATION	Goal	Reduce carbon emissions from vehicles and passenger planes.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Encourage electronic alternatives to travel.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Reduce carbon emissions from vehicles and passenger planes through the increased use of high speed web access and ultimately “live like” video conferencing as an alternative to commuting and traveling.	
TRANSPORTATION	Strategy	Reduce the number of cars driving kids to school and make Palo Alto a leader in safe, healthy, and green school commute options.	Recommended in Chapter 5
TRANSPORTATION	Goal	Reduce emissions from school commuting.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Encourage people to drive less by modifying parking policies.	
TRANSPORTATION	Goal	Improve the efficiency and lower emissions from vehicles in the City and the general public.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Promote alternative fuels.	Recommended in Chapter 5
TRANSPORTATION	Strategy	City leading the way in purchasing fuel-efficient vehicles. (alternative fuel vehicles implied)	Recommended in Chapter 5

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Tactic	Encourage people to drive, fly, and consume less by providing access to web-based educational tools that make the connections between transport and carbon emissions.	
TRANSPORTATION	Goal	Educate the public on transport emissions	Recommended in Chapter 8
TRANSPORTATION	Goal	Reduce commercial transport emissions	
TRANSPORTATION	Strategy	Encourage local purchasing.	
TRANSPORTATION	Strategy	After reductions, offset emissions from remaining driving on fossil fuel.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Consider having the City offset its emissions.	
TRANSPORTATION	Strategy	Encourage businesses and residents to offset its emissions,	Recommended in Chapter 3
TRANSPORTATION	Strategy	Encourage State and Federal legislation in topic areas that would decrease Transportation's contribution to net GHG emissions.	
TRANSPORTATION	Strategy	Lobby for policy changes at region, state, and federal levels.	
TRANSPORTATION	Strategy	Increase bike carriage on mass transit.	
TRANSPORTATION	Tactic	Usage data on bike carriers on VTA buses might reveal further areas where small investments could increase demand.	
TRANSPORTATION	Strategy	Increase bike parking at mass transit stations.	Recommended in Chapter 5 (assume it will be added)
TRANSPORTATION	Tactic	Secure bike storage at transit points can also encourage mass transit use.	Recommended in Chapter 5 (assume it will be added)
TRANSPORTATION	Strategy	Create more bike boulevards and other bike friendly improvements.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Create pedestrian retail zones with enhanced transit, biking & walking access. See also the "Green Parking Policies" section.	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Strategy	CPA should integrate planning for bike and pedestrian friendly crossings at all future street improvement, repaving projects. A request process should formally take public input in this specific area.	
TRANSPORTATION	Tactic	More stoplights sensitive to bikes	
TRANSPORTATION	Tactic	Single car lane through-fares with wide bike paths (e.g. Charleston)	
TRANSPORTATION	Strategy	Pedestrian & bike only street sections in retail areas.	
TRANSPORTATION	Tactic	Better bike parking downtown and at businesses	
TRANSPORTATION	Tactic	over/underpasses to create bike/walk short cuts across otherwise impassible streets/rail lines to transit or other popular destinations	
TRANSPORTATION	Tactic	CPA can focus more effort on improving bike and pedestrian access and bike carriers on VTA, CalTrain, and BART points within Palo Alto.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Require showers at all businesses. Local businesses that generate significant parking demand should make such facilities available to their employees, directly or through health clubs, etc.	
TRANSPORTATION	Tactic	CPA Website should provide information about cycling options within and around the city. It should also support other websites dedicated to addressing the topic such as the bicycling section of 511.org	
TRANSPORTATION	Tactic	Expand Palo Alto shuttle service, with more routes and greater frequency.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Improve system interconnectivity with Caltrain, so that buses and shuttles are synchronized with arriving and departing trains.	

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Summary of GRTF Recommendations and CPP Cross Reference

COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Strategy	Lobby for multi-modal passes and/or tickets that work across transit systems. One implementation of this could be based on the use of personal transponders (similar to FasTrak system used at Bay Area toll plazas).	
TRANSPORTATION	Tactic	Launch public awareness campaign (mass transit)	Recommended in Chapter 8
TRANSPORTATION	Strategy	Require local employers to offer financial incentives for taking public transit.	
TRANSPORTATION	Tactic	Make VTA buses free within Palo Alto or encourage distribution of bus passes by local employers.	
TRANSPORTATION	Tactic	Sync up existing transit, traffic, and weather systems into city sponsored info service.	
TRANSPORTATION	Strategy	Investigate the deployment of an innovative bus based transit solution designed for low density communities.	
TRANSPORTATION	Tactic	Lobby for extending BART around the Bay	
TRANSPORTATION	Tactic	Lobby for a statewide Bullet train system that would connect the major metropolitan areas.	
TRANSPORTATION	Tactic	Lobby for an increase in the frequency of Caltrain express trains.	
TRANSPORTATION	Tactic	Lobby for increased grade separations for Caltrain (to facilitate increase in Caltrain frequency, Bullet Trains, and cross bicycling and walking)	
TRANSPORTATION	Tactic	Promote comparison table from 511.org showing each area employer's support activities for different commute modes. Lets employers see where they stand and how to improve.	
TRANSPORTATION	Tactic	Enable use of Alma/High Garage (Word Garage) as Caltrain parking lot overflow by installing a Day Pass vending machine.	
TRANSPORTATION	Tactic	Facilitate high speed reliable broadband access to homes and businesses	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Tactic	Partner with hotels to support videoconferencing in hotel conference rooms	
TRANSPORTATION	Tactic	Include videoconferencing capabilities in libraries	
TRANSPORTATION	Tactic	Create telecommuting incentives for companies	
TRANSPORTATION	Tactic	Encourage public private cooperation in building web conferencing facilities for small and home based business and residential market.	
TRANSPORTATION	Tactic	Collect videoconferencing best practices for setup and operations	
TRANSPORTATION	Tactic	Consider building or zoning incentives for business who build web conferencing facilities for their employees, other business and the public.	
TRANSPORTATION	Tactic	Offer carbon offsets to employers and individuals who use web conferencing.	
TRANSPORTATION	Tactic	Explore efficacy of block purchases of unused web conferencing time from existing web conferencing facilities by public/private cooperatives.	
TRANSPORTATION	Tactic	Impose annual impact fees for unsuccessful TDM programs (also under Green Parking)	
TRANSPORTATION	Tactic	Make telecommuting a Green Biz Certification Req.	
TRANSPORTATION	Tactic	Promote EPA's Best Workplaces for Commuters program	
TRANSPORTATION	Tactic	Run census on home-based businesses	
TRANSPORTATION	Tactic	Lobby for increased (carbon) tax on fuel and air travel	
TRANSPORTATION	Strategy	Develop more busing programs.	Recommended in Chapter 5
TRANSPORTATION	Tactic	City sponsored shuttles (e.g. Go Fast bus for Gunn), VTA, or PAUSD busing solutions for high traffic routes.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Consider parent user fees to fund useful solutions.	
TRANSPORTATION	Tactic	The City needs to track more data in this area. (school commute)	

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Summary of GRTF Recommendations and CPP Cross Reference

COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Strategy	Support the local Safe Routes to School priorities and programs. This program has shown success by increasing biking, walking, and busing and mostly through grass roots efforts. Volunteers at each school promote commute alternatives and work with the district and City for positive change. This program addresses all modes such as Walking and Biking, Busing, & Carpooling This group has a network in place and can help guide increased efforts to measure and improve the major school commute corridors like the successful Charleston / Arastradero redevelopment.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Encourage PAUSD to take responsibility for reducing emissions.	Recommended in Chapter 5
TRANSPORTATION	Tactic	The district should be encouraged to adopt goals and measures for CO2 reductions from school commuting.	
TRANSPORTATION	Tactic	Adjust and coordinate School start and end times.	
TRANSPORTATION	Tactic	Academic "Choice" programs that require cross town commuting.	
TRANSPORTATION	Strategy	The existing City/School/Parent forums could work to address these (school emissions) concerns with the help of stronger leadership on the city side.	
TRANSPORTATION	Tactic	More and better walking paths to schools	
TRANSPORTATION	Strategy	Facilitate carpooling through coordinated programs	
TRANSPORTATION	Strategy	Empower school commute coordinators	
TRANSPORTATION	Strategy	Promote environmental awareness and change in schools	
TRANSPORTATION	Tactic	Provide covered and secured bike parking at all schools	
TRANSPORTATION	Tactic	Provide transit surge capacity on days of inclement weather	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Tactic	Charge developers a transportation impact fee that pays for shuttles	
TRANSPORTATION	Tactic	Create endowment for school bus shuttles	
TRANSPORTATION	Strategy	Expand parking benefits for green vehicles.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Create more free green vehicle spaces.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Extend parking times for green vehicles.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Provide electric outlets and free charging.	Recommended in Chapter 5
TRANSPORTATION	Tactic	Create pedestrian (i.e. automobile free) retail zones with enhanced transit, biking & walking access. (was in Green parking Policies Section)	
TRANSPORTATION	Tactic	Reduce parking requirements for successful telecommute programs. (also under Electronic Travel)	
TRANSPORTATION	Strategy	Discourage unsuccessful Transport Demand Management programs. (with parking policies)	
TRANSPORTATION	Tactic	Bring parking charges to offices in Palo Alto This would have a big impact but requires Palo Alto to pioneer a parking charges policy for other cities to follow.	Recommended in Chapter 5
TRANSPORTATION	Strategy	Encourage offices to implement parking cashout programs. Parking cashout is where employer gives alternative commuter the value of the freed up parKing space. A parking district could lease the freed up space from employer for more retail/restaurant parking or auto dealer car storage etc.	Recommended in Chapter 5
TRANSPORTATION	Tactic	REALLY compact car parking ('Smart' Car, electric cars)	Being Rolled out in US in late October
TRANSPORTATION	Tactic	Free vanpool parking in downtown lots	
TRANSPORTATION	Tactic	Free, secured parking for scooters, bikes	
TRANSPORTATION	Tactic	Free parking for scooters, bikes	
TRANSPORTATION	Tactic	More parking meters in downtown, in parking lots	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Tactic	Make train accessible/high traffic streets more expensive to park on (except for those driving to train station to use train)	
TRANSPORTATION	Tactic	Permit parking for residents on residential streets near downtown and limited 2 hr parking for the rest.	
TRANSPORTATION	Tactic	Free vanpool parking in downtown lots	
TRANSPORTATION	Strategy	Change city purchasing policy to factor in clean energy/efficiency with special attention to clean energy vehicle procurement	Recommended in Chapter 4, within limitations
TRANSPORTATION	Goal	Enhance the City's ability to promote alternative fuels within the City	Not discussed
TRANSPORTATION	Tactic	Create incentives bio-fuels infrastructure	Not discussed
TRANSPORTATION	Tactic	Create first bay area biofuels gas station in PA	Not discussed
TRANSPORTATION	Strategy	Endorse proposed feebate programs for vehicles based on emissions	
TRANSPORTATION	Tactic	Time of Use electric metering for electric and plug-in hybrid vehicles	Not recommended
TRANSPORTATION	Tactic	Increase low electric rate limit for those with electric and plug-in hybrid vehicles	Not recommended
TRANSPORTATION	Tactic	Partner with the Post Office to partially fund or fuel alternative fuel or hybrid or electric postal vehicles	
TRANSPORTATION	Tactic	Join with Plug-in Partners. The City should promise to purchase of a fleet of plug-in hybrid vehicles once an automaker begins producing such cars commercially	
TRANSPORTATION	Tactic	City should develop or partner to develop a "Reducing Emissions" portion of the Palo Alto City website.	Already in Existence
TRANSPORTATION	Tactic	The reducing emission website should include a carbon calculator and make it available on the web.	
TRANSPORTATION	Tactic	Integrate the carbon calculator with a public awareness campaign to educate people about their carbon emissions.	Recommended in Chapter 3

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Tactic	Add a household transportation related carbon emissions survey to the website.	
TRANSPORTATION	Tactic	Add a carbon-offset clearing-house section that explains the concept of carbon offsets and points users towards existing organizations that sell offsets. (website)	
TRANSPORTATION	Strategy	Ensure the school curriculum includes education on the sources and impact of GHGs and the individual and community strategies to reduce them.	
TRANSPORTATION	Tactic	Use website to highlight the impact of carbon intensive hobbies on emissions such as skiing in Tahoe, buying and keeping empty cabins, etc.	
TRANSPORTATION	Tactic	Palo Alto City website that educates Palo Altans on emissions from long distance transport and encourages citizens to buy locally produced goods and locally grown produce. Educate on the positive climate benefits of patronizing local farmer's markets, which sell local food by definition.	
TRANSPORTATION	Tactic	Integrate website with a public awareness campaign: "Buy Local".	
TRANSPORTATION	Strategy	Encourage grocers to work farmers produce in next to their regular supply of "factory" produce.	
TRANSPORTATION	Strategy	Encourage consumers to favor vegetables over of meat and unprocessed food over processed food. Both meat and processed food have higher carbon footprints.	
TRANSPORTATION	Tactic	Create "Grow your own" campaign and build on the recycling center's "Give and Experience for Christmas (e.g. movie, play, sports event, rather than a physical good)" communications to reduce refuse	
TRANSPORTATION	Strategy	Combine efforts to create local buying options with neighboring cities	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Strategy	Encourage less packaging to reduce deliveries	
TRANSPORTATION	Tactic	Sponsor a tax on non-recyclable packaging	
TRANSPORTATION	Strategy	Encourage consumers to buy produce "in season"	
TRANSPORTATION	Tactic	Purchase carbon credits to offset City owned fleet vehicle emissions	
TRANSPORTATION	Strategy	Provide incentives to cause businesses to offset carbon emissions in vehicles and travel in general.	
TRANSPORTATION	Strategy	Encourage businesses and individuals to purchase carbon offsets when they buy air travel either directly through travel websites or offset firms.	
TRANSPORTATION	Tactic	Build carbon offset option into DMV vehicle license renewal.	
TRANSPORTATION	Tactic	Use parking meter revenues to offset carbon emissions.	
TRANSPORTATION	Tactic	Create gas tax to purchase carbon credits.	
TRANSPORTATION	Tactic	Offer carbon offset option at PA gas pumps used to subsidize e-cars.	
TRANSPORTATION	Tactic	Encourage carbon offset groups and airline Frequent Flyer miles programs to develop "use your miles to buy offsets" program.	
TRANSPORTATION	Strategy	Lobby at all levels for increased (carbon) tax on fuel for auto, air, and sea transportation.	
TRANSPORTATION	Strategy	Lobby for increased Bike Carriage on Mass Transit	
TRANSPORTATION	Strategy	Lobby to Change State purchasing policy to factor in clean energy/efficiency with special attention to clean energy vehicle procurement	
TRANSPORTATION	Strategy	Lobby to Create incentives bio-fuels infrastructure	
TRANSPORTATION	Strategy	Endorse proposed fee-bate programs for vehicles based on emissions	
TRANSPORTATION	Strategy	Sponsor a tax non-recyclable packaging	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
TRANSPORTATION	Strategy	Lobby for multi-modal passes and/or tickets that work across transit systems. One implementation of this could be based on the use of personal transponders (similar to FasTrak system used at Bay Area toll plazas).	
TRANSPORTATION	Strategy	Lobby for a statewide Bullet train system that would connect the major metropolitan areas.	
TRANSPORTATION	Strategy	Lobby for extending BART down the Peninsula and also providing a line across the bay at the Dumbarton bridge instead of the proposed rail line.	
TRANSPORTATION	Strategy	Lobby to Increase the frequency of Caltrain express trains.	
TRANSPORTATION	Strategy	Lobby for Grade separations for Caltrain (to facilitate increase in Caltrain frequency, Bullet Trains, and cross bicycling and walking)	
TRANSPORTATION	Strategy	Lobby to Build carbon offset option into DMV vehicle license renewal	
TRANSPORTATION	Strategy	Lobby to Create state or local gas tax to purchase carbon credits	
BUILDINGS	Strategy	Provide incentives to encourage businesses and residents to invest in efficiency and renewables; and explore requiring energy upgrades (e.g., installation of solar hot water) when a property changes hands or undergoes significant improvement).	
BUILDINGS	Strategy	Use trees to save energy.	
BUILDINGS	Strategy	Encourage or require water efficiency and aquifer replenishment.	
BUILDINGS	Strategy	Encourage transit-oriented development	
BUILDINGS	Strategy	Promote biking and walking.	Recommended in Chapter 5

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
BUILDINGS	Tactic	Provide green building planning and building review advice and education by hiring new, training existing staff or using consultant time.	Recommended in Chapter 6
BUILDINGS	Tactic	Require senior building officials to be LEED (Leadership in Energy and Environmental Design) accredited and BIG (Build it Green) certified.	Recommended in Chapter 6
BUILDINGS	Tactic	Provide green educational materials at planning and building department. Some examples might include Building Resource guides; Information on Green lenders; Energy Star and water-wise incentives; Information on nonprofit benefits, e.g., tax deduction for donation of building materials deconstructed for reuse rather than demolition; Information on tax credits for energy-efficient and green building projects.	Recommended in Chapter 6
BUILDINGS	Tactic	Require LEED points list to be printed on nonresidential permit drawings, and require an escalating number of points be met over a period of years.	
BUILDINGS	Tactic	Require BIG points list to be printed on residential permit drawings, and require an escalating number of points be met over a period of years.	
BUILDINGS	Tactic	Provide incentives or recognition for incorporating green building elements in both residential and nonresidential buildings.	
BUILDINGS	Tactic	Offer expedited reviews or lower costs for green energy projects. Examples of eligible projects might include: · Projects that exceed Title 24 guidelines by at least 15 percent. · Projects that incorporate radiant barriers for all new and re-roofing.	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
BUILDINGS	Tactic	Allow specific exemptions to building guidelines when green elements are applied. For example, provide floor-area ratio allowances in cases where walls are built extra thick for energy efficiency. Likewise, allow some flexibility in setbacks to allow solar building orientation.	
BUILDINGS	Tactic	Establish special considerations for green building/high-performance building projects. In a vein similar to HIE (Home Improvement Exemption), consider creating a "Green Improvement Exemption" (GIE).	
BUILDINGS	Tactic	Build or establish more traffic reducing housing (TRH) in Palo Alto. For example, when selling or renting new apartments, condos, and town homes, select residents who commit to owning fewer cars and driving less.	
BUILDINGS	Tactic	Increase incentives for traffic-reducing commercial. For example, offer stipends for employees that live within a short distance of their work.	
BUILDINGS	Tactic	Create a fund for energy efficiency consultants to address the needs of both large and small clients.	
BUILDINGS	Strategy	Encourage renewable power, such as photovoltaics.	Recommended in Chapter 3
BUILDINGS	Strategy	Encourage energy-efficient water heating solutions, such as tankless and solar water heating.	
BUILDINGS	Tactic	Explore a residential energy consumption ordinance (RECO) similar to that in effect in the city of Berkeley, which requires an energy upgrade when a property changes hands or undergoes significant improvement.	
BUILDINGS	Tactic	Increase ratio of trees to spaces in parking areas and in paved areas to prevent heat islands.	
BUILDINGS	Strategy	Implement water efficiency. Examples might include Xeriscaping, weather linked irrigation controllers, native plantings.	
BUILDINGS	Strategy	Implement trees planted optimally for building shading	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
BUILDINGS	Strategy	Encourage aquifer replenishment. For example, require use of pervious concrete for paved areas or rainwater catchment.	
BUILDINGS	Goal	Create more residential density downtown, near train stations, and at public transit corridors (e.g., El Camino Real).	Recommended in Chapter 5
BUILDINGS	Strategy	Implement bike circulation and bike parking in all areas, and increase communication of bike routes and amenities.	
BUILDINGS	Strategy	Encourage outdoor seating and pedestrian access at commercial areas such as University Avenue and California Avenue, similar the City of Mountain View's approach.	
BUILDINGS	Strategy	Reduce parking space requirements for well-located, high-density residential developments.	
EDUCATION	Mission	Improve communication about "green" issues between nodes.	Possible role for Sustainability Coordinator
EDUCATION	Mission	Identify common goals and reinforce them. Encourage synergy by sharing existing ideas and programs.	Possible role for Sustainability Coordinator
EDUCATION	Mission	Create a "bandwagon effect" by making the message about our community's response to global warming constantly reinforced and visible everywhere . Create a sense of moral imperative about this issue.	Possible role for Sustainability Coordinator
EDUCATION	Strategy	(1) Create synergy, not duplication, between new and existing green activities.	Primary goal of CPP
EDUCATION	Tactic	Identify a lead organization within each node, asking that organization what is already being done in its area, creating a computer database of those actions, and encouraging each node to adopt its own "green certification" program.	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
EDUCATION	Strategy	(2) Create an overall “PR Umbrella” for Palo Alto green action.	Possible role for Sustainability Coordinator
EDUCATION	Tactic	Create a name, logo and branding for GRTF activities.	Possible role for Sustainability Coordinator
EDUCATION	Tactic	Brand Palo Alto as the Green City.	Possible role for Sustainability Coordinator
EDUCATION	Tactic	Permission to use PaloAltoGreen logo	Possible role for Sustainability Coordinator
EDUCATION	Tactic	Green column in the PA Weekly, daily news, on-line news sources.	Possible role for Sustainability Coordinator
EDUCATION	Tactic	City Green web page	Already in Existence
EDUCATION	Tactic	Create easy way to use green logo and tagline.	Already in Existence
EDUCATION	Tactic	Publicize need to reduce emissions with billboards, contest and workshops	
EDUCATION	Tactic	(3) To leverage the work that’s already going on and integrate it with new green action, create a public/private partnership.	Primary goal of CPP to actuate this recommendation
EDUCATION	Tactic	Assign a part-time City staff person to this public/private partnership,	Part of Sustainability Coordinator
EDUCATION	Strategy	Act as a "filter" for the findings of the other GRTF subcommittees (Baseline, Buildings, Education, Energy, Transportation, and Waste Reduction) which can be effectively communicated to the public.	Primary goal of CPP
EDUCATION	Goal	Educate and motivate all segments of the Palo Alto community to take quantifiable action to reduce carbon emissions.	Primary goal of CPP
EDUCATION	Strategy	Identify and publicize the actions that people and organizations are now already doing about climate change.	
EDUCATION	Strategy	Using the recommendations of the GRTF, synthesize and design a community awareness program.	
EDUCATION	Tactic	Measure the results of this education/motivation program.	

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COMMITTEE	GOAL STRATEGY TACTIC OBSERVATION MISSION	Green Ribbon Task Force Recommendation or Idea	Climate Protection Plan Cross Reference
EDUCATION	Tactic	Honor the accomplishments of the community on a yearly basis.	

Appendix II:
Possible Actions by Short Term, Medium Term, and Long Term

Chapter	Short Term =-1; Medium Term = 2, Long Term =3	Possible Action	Total Cost to City	Total metric tons of CO_2e Reduced	Cost Per Ton of CO_2e Removed	Budget Implications
Short Term		**Goal by July 2009 = for the City to reduce emissions by 5%= reduction of 3,266 tons**		**Goal = 3,266**		
Chapter 3 Utilities	1	Promote and Implement Climate-Neutral Alternatives and Education	TBD	TBD	TBD	Funding in current budget
Chapter 3 Utilities	1	Support Research and Development in GHG-Reducing Science and Sociology	TBD	TBD	TBD	Partial funding in current budget
Chapter 3 Utilities	1	Expand Use of Renewable Energy Installed or Purchased Directly By Customers	$ 135,000	3,280	41	Funding in current budget
Chapter 3 Utilities	1	Achieve participation in Palo Alto Green to meet 5% of load	-	17,700		There is a cost to the community of 1.5 cents per kilowatt hour (50,000 MWh)
Chapter 3 Utilities	1	City match community participation level in subscription to Green Power 5%	$ 22,000	550	40	Needs additional funding
Chapter 4 Sustainable Purchasing	1	Create an interdepartmental team responsible for completing a Sustainable Purchasing Policy and Implementation Plan by June 2008	TBD	TBD	TBD	Partial funding in current budget
Chapter 4 Sustainable Purchasing	1	Conduct outreach and education among City employees to promote understanding and participation in Sustainable Purchasing goals	TBD	TBD	TBD	Costs to be determined
Chapter 4 Sustainable Purchasing	1	Establish a framework and criteria for identifying, specifying, and evaluating the performance and costs of sustainable products and services	TBD	TBD	TBD	Funding in current budget
Chapter 4 Sustainable Purchasing	1	Determine annual reporting needs for the City	TBD	TBD	TBD	Funding in current budget
Chapter 4 Sustainable Purchasing	1	Include a three-year timeline for incorporating changes to the City's purchasing specifications, scopes of service, and procedures	TBD	TBD	TBD	Funding in current budget
Chapter 4 Sustainable Purchasing	1	Present to Council the Sustainable Purchasing Policy and Implementation Plan by June 2008	TBD	TBD	TBD	Funding in current budget
Chapter 4 Sustainable Purchasing	1	Make recommendations for financial resources needed to implement Sustainable Purchasing	TBD	TBD	TBD	Funding in current budget
Chapter 4 Sustainable Purchasing	1	Require annual vendor reporting on sustainable product purchases, tracking dollars spent, units purchased, and other information as specified by the City	TBD	TBD	TBD	Costs to be determined
Chapter 4 Sustainable Purchasing	1	Purchase only remanufacturered toner cartridges when available.	$ (13,380)	$ 2	$ (6,690)	Funding in current budget
Chapter 4 Sustainable Purchasing	1	Mandate Purchasing of only 100% recycled content paper when available.	$ 6,000	33	185	Needs additional funding
Chapter 5 Transportation	1	City allows telecommuting to reduce emissions by 53 metric tons.	$ -	53	-	While there would be no budget implications, telecommuting may cause an increase in administrative costs.
Chapter 5 Transportation	1	Purchase Carbon Offsets for Employee Business Travel (38 ton reduction)	$ 1,300	39	33	Not currently funded
Chapter 5 Transportation	1	Increase the TDM Coordinator from .5 FTE to 1.0 FTE	$ 50,000	TBD		Not currently funded

Chapter	Short Term =-1; Medium Term = 2, Long Term =3	Possible Action	Total Cost to City	Total metric tons of CO_2e Reduced	Cost Per Ton of CO_2e Removed	Budget Implications
Chapter 5 Transportation	1	Facilitate and enhance potential for mixed use development	TBD	TBD	TBD	Funding in current budget
Chapter 5 Transportation	1	Zone for Mixed Use and Higher Density Around Transit Stations	TBD	TBD	TBD	Funding in current budget
Chapter 5 Transportation	1	Reduce Parking Needs for New Development	TBD	TBD	TBD	Funding in current budget
Chapter 5 Transportation	1	Require Transportation Demand Management (TDM) Programs	TBD	TBD	TBD	Funding in current budget
Chapter 5 Transportation	1	Develop Monitoring Programs for Transit Use and TDM Effectiveness	TBD	TBD	TBD	Funding in current budget
Chapter 5 Transportation	1	Reduce idling by installing auxiliary electrical systems	$ 40,000	136	295	Not currently funded
Chapter 6 Green Building	1	Create task force or review committee composed of developers, architects and other stakeholders to provide feedback and ideas on approaches to green building incentives and requirements.	TBD	TBD	TBD	Costs to be Determined
Chapter 6 Green Building	1	Continue benchmarking green building programs of other cities and identify and resolve any potential legal issues related to mandatory compliance.	TBD	TBD	TBD	Costs to be Determined
Chapter 6 Green Building	1	Continue to work with Utilities staff on developing and implementing meaningful incentives.	TBD	TBD	TBD	Costs to be Determined
Chapter 6 Green Building	1	Coordinate with Utilities and Public Works programs, and with newly created staff/citizen forum on public	TBD	TBD	TBD	Costs to be Determined
Chapter 6 Green Building	1	Draft and circulate an ordinance for mandatory multi-family and commercial green building and introduce the ordinance for passage in spring 2008 (July 2008 effective date).	TBD	TBD	TBD	Costs to be Determined
Chapter 6 Green Building	1	Train existing staff (and possibly offer a pay incentive for certification or accreditation) or contract out for expertise in LEED and Green Point Rated (e.g. projects not designed by a LEED accredited architect/engineer could pay a fee for review by someone with LEED expertise).	TBD	TBD	TBD	Costs to be Determined
Chapter 6 Green Building	1	Following Council discussion on December 3, 2007, update the existing City green building policy.	TBD	TBD	TBD	Funding in current budget
Chapter 6 Green Building	1	Retain consultant to perform relevant studies to justify local amendments to the CEC that will require increased energy efficiency and conservation measures. Adopt local amendments to the CEC with applicable findings and submit to both the California Building Standards Commission and California Energy Commission	TBD	TBD	TBD	Staff and consulting costs to be determined
Chapter 7 Zero Waste		Integrate climate protection analysis into the Zero Waste decision-making process	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Expand efforts in waste prevention through legislation, policies, ordinances, outreach and technical assistance	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Reduce the amount and toxicity of consumer product waste through measures that place the appropriate level of responsibility on manufacturers for the end-of-life of their products	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Encourage innovative reuse and recycling services to be added by the private sector and nonprofit groups, such as electronics and building materials, so the City does not have to invest in those activities	TBD	TBD	TBD	Funding in current budget

Chapter	Short Term =-1; Medium Term = 2, Long Term =3	Possible Action	Total Cost to City	Total metric tons of CO_2e Reduced	Cost Per Ton of CO_2e Removed	Budget Implications
Chapter 7 Zero Waste	1	Work with residents, businesses, community organizations, Bay Area Product Stewardship Council, Bay Area Zero Waste Communities, Bay Friendly Regional Coalition and other such groups to further the City's Zero Waste efforts	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Modify the Construction and Demolition (C&D) debris ordinance to: increase the amount of materials salvaged for reuse; ncrease the diversion percentage required for demolition permits from 50% to 75%; and increase the number of projects that are covered by the ordinance	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Expand collaborative efforts with targeted businesses to reduce the use of disposable items such as plastic shopping bags and take-out containers	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Facilitate connections between food rescue organizations and Palo Alto businesses to reduce the amount of food discarded into the waste stream	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Support development of a Sustainable Purchasing Policy and Implementation Plan	TBD	TBD	TBD	Needs additional funding
Chapter 7 Zero Waste	1	Propose a grant or loan program for local reuse and recycling	TBD	TBD	TBD	Needs additional funding
Chapter 7 Zero Waste	1	Ensure that new waste collection and processing service RFP includes Zero Waste service options (e.g., expanded organics collection, expanded C&D debris collection and container inspections upon collection)	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Enhance business, multi-family and school waste reduction programs	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Divert remaining debris boxes rich in C&D materials to C&D processing facilities	TBD	TBD	TBD	Needs additional funding
Chapter 7 Zero Waste	1	Propose a phased-in mandatory recycling ordinance	TBD	TBD	TBD	Needs additional funding
Chapter 7 Zero Waste	1	Propose materials to be banned from the Palo Alto Landfill	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Retool the SMaRT Station to increase diversion rate from 18% to 25%	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	1	Find a location for a local recycling drop-off center and household hazardous waste facility	TBD	TBD	TBD	Needs additional funding
Chapter 8 Education/ Motivation	1	Create an internal Climate Protection Education and Motivation (CPEM) task group from the Environmental Stewardship Steering Committee that includes representatives from the affected departments	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	1	Create and convene a collaborative citizen/staff forum	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	1	Define goal-setting process for staff/citizen forum	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	1	Forum identifies its top-three priorities for the coming 1-3 year period	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	1	Forum selects top-3 projects or actions for implementation in year 1	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	1	Create and implement an outreach, education and engagement plan coordinating the efforts of the CPEM task group and the staff/citizen forum	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	1	Choose 2 – 5 most-achievable messages/actions for the first year	TBD	TBD	TBD	Costs to be determined

Chapter	Short Term =-1; Medium Term = 2, Long Term =3	Possible Action	Total Cost to City	Total metric tons of CO_2e Reduced	Cost Per Ton of CO_2e Removed	Budget Implications
Chapter 8 Education/ Motivation	1	Explore the options for creating baseline data of the community's awareness	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	1	Integrate climate protection into City outreach, harnessing outreach currently done by City and CPAU	TBD	TBD	TBD	Costs to be determined
Medium Term		**Goal by July 2011 = for the City and community to reduce emissions by 5%= reduction of 39,702 tons**				
Chapter 3 Utilities	2	Develop voluntary CO2 reductions for Gas	$ -	16,400	-	
Chapter 3 Utilities	2	Invest in GHG-Reducing Projects or Offsets to Balance Remaining Emissions	$ 25,000	1,000	25	Partial funding in current budget
Chapter 3 Utilities	2	Participate in and Promote Greenhouse Gas Emissions Inventory Tracking and Reporting	TBD	TBD	TBD	Funding in current budget
Chapter 3 Utilities	2	Employ Urban Forest Opportunities to Reduce Energy Use and Increase Carbon Sequestration	TBD	TBD	TBD	Funding in current budget
Chapter 3 Utilities	2	Coordinate Energy Climate Activities with Building and Urban Planning Activities	TBD	TBD	TBD	Funding in current budget
Chapter 4 Sustainable Purchasing	2	Implement full duplexing as default in all printers and copiers in City facilities when possible	$ 20,000	29	$ 696	Additional funding required for set-up period only. Assumes printer and copier replacement as scheduled (no acceleration).
Chapter 4 Sustainable Purchasing	1	Expand staff education and engagement efforts	TBD	TBD	TBD	Staff costs to be determined
Chapter 4 Sustainable Purchasing	2	Implement programs and procedures that encourage and facilitiate both centralized and decentralized purchases of sustainable products and services	TBD	TBD	TBD	Costs to be determined
Chapter 4 Sustainable Purchasing	2	Review and revise Sustainable Purchasing Plan and timeline annually and realign with City GHG emission goals and other priorities as needed	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	2	Fleet optimization to reduce emissions by 284 metric tons	$ 14,820	285	$ 52	Funding for implementation is in FY 06/07 budget. There would be some additional administrative costs, but these would likely be offset by savings on fuel and vehicle use.
Chapter 5 Transportation	2	Purchase 2 Hybrids (per car/Total) – CO2 reduction of 1.37/car or 27 metric tons for fleet total	$ 1,700	3	88	Needs additional funding
Chapter 5 Transportation	2	Fleet Accountability Programs to reduce emissions by 95 metric tons	$ 12,000	95	126	Needs additional funding
Chapter 5 Transportation	2	Limit Idling to same 136 metric tons CO2 (approximately $2,000 per truck)	$ 40,000	136	294	Needs additional funding
Chapter 5 Transportation	2	Expand use of biodiesel (18.6 metric tons emission reduction)	$ 12,392	19	652	Needs additional funding
Chapter 5 Transportation	2	Increase Employee Commute Incentives ($242/metric ton)	$ 301,532	284	1,062	Needs additional funding
Chapter 5 Transportation	2	Enhance use of Cross town shuttles (180 metric tons reduced)	$ 125,000	180	694	Needs additional funding
Chapter 5 Transportation		Increase the Transportation Demand Management (TDM) Coordinator from .5 FTE to 1.0 FTE.	$ 50,000	TBD	TBD	Needs additional funding
Chapter 5 Transportation	2	Purchase Offsets for Community Air Travel	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	2	Work with School District and parent community to reduce emissions from school commute	TBD	TBD	TBD	Costs to be determined

Chapter	Short Term =-1; Medium Term = 2, Long Term =3	Possible Action	Total Cost to City	Total metric tons of CO_2e Reduced	Cost Per Ton of CO_2e Removed	Budget Implications
Chapter 5 Transportation	2	Purchase very low emission vehicles to serve as shuttle services between City Hall, Municipal Services Center and the Regional Water Quality Plant	$1,175 per vehicle per year	2.3	$ 510	
Chapter 5 Transportation	2	Implement Pedestrian and Transit Oriented Zoning in Downtown	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	2	Develop Comprehensive Plan Programs to Support Increased Density near Transit	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	2	Modify Zoning Ordinance to Require Pricing Strategies to Reduce Parking	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	2	Develop Plans for Transportation Improvements around California Avenue Caltrain Station	TBD	TBD	TBD	Costs to be determined
Chapter 6 Green Building	2	Explore new financing opportunities for green building efforts (e.g. green-friendly banks such as New Resource Bank and Valencia Green Bank.)	TBD	TBD	TBD	Costs need to be determined, though the costs will be at least partially offset by reduced fuel use by fleet.
Chapter 6 Green Building	2	Introduce an ordinance for mandatory low-density residential green building for passage in spring 2009 (effective July 2009.)	TBD	TBD	TBD	Staff Administrative costs
Chapter 6 Green Building		Increase understanding of green building practices and benefits through stakeholder involvement.	TBD	TBD	TBD	Staff Administrative costs
Chapter 6 Green Building	2	Continue to conduct staff training (and reward certification/accreditation).	TBD	TBD	TBD	Staff Administrative costs
Chapter 6 Green Building	2	Review and revise Sustainable Purchasing Plan and timeline annually and realign with City GHG emission goals and other priorities as needed	TBD	TBD	TBD	Staff and consulting costs to be determined
Chapter 6 Green Building	2	Include “green building” among criteria for determining the 2010 ARB award winners.	TBD	TBD	TBD	Funding in current budget
Chapter 7 Zero Waste	2	Achieve 68% waste diverted from landfill	$615,000	6,427	96	Needs additional funding
Chapter 7 Zero Waste	2	Modify garbage rates to encourage Zero Waste	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	2	Collaborate with the Planning and Community Environment Department to increase Green Building and adaptive reuse efforts	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	2	Build on collaborative efforts with targeted businesses to reduce disposable items	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	2	Propose Sustainable Gardening and Landscaping Policy and Implementation Plan	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	2	In new collection contract, expand the organics program; provide recycling services to all commercial customers; expand types of recyclable materials collected; improved bulky item collection; and divert	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	2	Propose possible product bans or fees to reduce product use, such as bottled water or plastic bags	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	2	Implement approved material bans and mandatory recycling ordinances	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	2	Improve recycling in public areas	TBD	TBD	TBD	Costs to be Determined
Chapter 8 Education/ Motivation	2	Integrate learning into new employee training	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	2	Work with HR to create new training program for all current employees regarding climate protection and other environmental issues	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	2	Integrate climate consciousness into City functions	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	2	Create an incentive program to reward departments or divisions that implement effective reduction efforts	TBD	TBD	TBD	Costs to be determined

Chapter	Short Term =-1; Medium Term = 2, Long Term =3	Possible Action	Total Cost to City	Total metric tons of CO_2e Reduced	Cost Per Ton of CO_2e Removed	Budget Implications
Chapter 8 Education/ Motivation	2	Evaluate impact of previous years' efforts and adjust new efforts accordingly to improve impact and efficiency.	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	2	Expand plan to additional media of communication	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation		CPEM to identify staff actions that have the greatest impact on CO_2 emissions	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	2	Create internal working groups to address the identified actions	TBD	TBD	TBD	Costs to be determined
Chapter 8 Education/ Motivation	2	Launch campaigns to encourage desired actions and practices.	TBD	TBD	TBD	Costs to be determined
Long Term		**Goal by July 2020 = for the City and community to reduce emissions by 15%= reduction of 119,107 tons**				
Chapter 3 Utilities	3	Reduce electricity and natural gas use through conservation and energy efficiency. Extrapolated from 10 year efficiency plan.	$0.00	22,100	-	Funding in current budget
Chapter 3 Utilities	3	Reduce Carbon Intensity of Energy Supply Provided by CPAU	$ 5,000,000	91,000	55	Funding in current budget
Chapter 3 Utilities	3	Promote Solar Initiatives	$ 25,000	250	100	Funding in current budget
Chapter 3 Utilities	3	Achieve participation in Palo Alto Green to meet 10% of load	-	35,400		There is a cost to the community of 1.5 cents per kilowatt hour (50,000 MWh)
Chapter 3 Utilities	3	City to increase its participation in Palo Alto Green from 5% to to match community 10% of load	$ 22,500	550	41	1.5 cents per kilowatt hour
Chapter 7 Zero Waste	3	Achieve 73% of Diverted Waste	$ 3,376,000	$ 6,849	493	
Chapter 4 Sustainable Purchasing	3	Review Sustainable Purchasing Plan every 3 years	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	3	Evaluate Pedestrian and Transit Oriented Development Zoning Intensity, Including Along El Camino Real	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	3	Develop Intermodal Transit Center and High-Density Public Transportation on Demand Project	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	3	Implement Grand Boulevard Improvement Strategies for El Camino Real	TBD	TBD	TBD	Costs to be determined
Chapter 5 Transportation	3	Work with VTA, Caltrain and other regional transportation agencies to improve transit services in Palo Alto	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	3	Evaluate emerging technology or other innovative approaches to materials management	TBD	TBD	TBD	Costs to be determined
Chapter 7 Zero Waste	3	Continue to develop and implement Zero Waste programs	TBD	TBD	TBD	Costs to be determined

Appendix III:
Draft Elements of Palo Alto Sustainable Purchasing Policy

The City recognizes that its purchases of goods and services can contribute significantly to the success of its sustainability policies and goals. Therefore, the City shall incorporate environmental, economic and social stewardship criteria into its purchases of products and services. This policy will align the City's purchases and Purchasing Department policies and procedures with the City's sustainability policies and programs to:

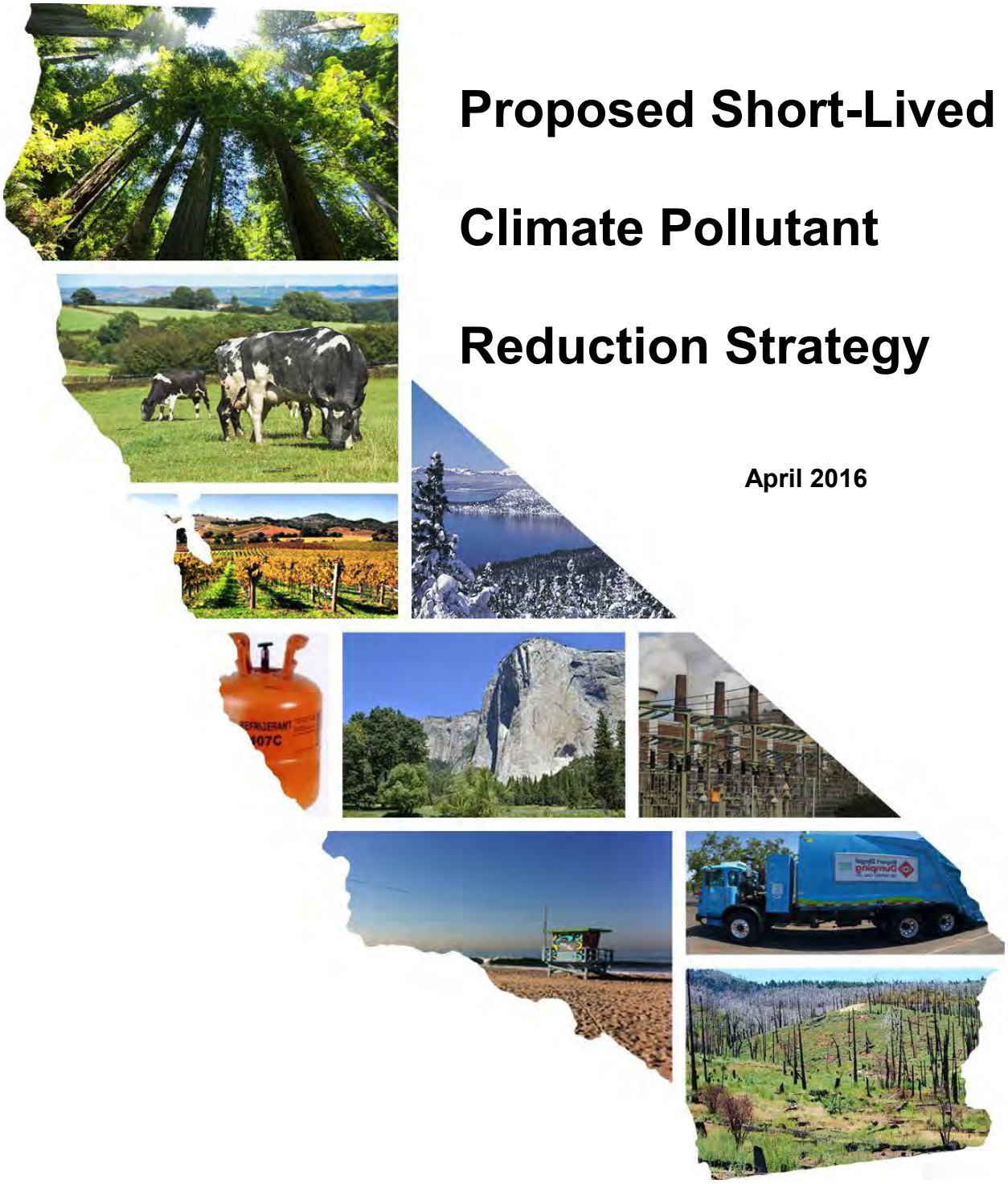
- protect and conserve natural resources
- minimize the City's contributions to global warming, solid waste, local and global pollution, and toxic chemical exposures to people and the environment and
- promote human health and well-being.

This policy shall not require the City to exclude competition, or to purchase products or services that do not perform adequately or are not available at a reasonable price in a reasonable period of time.

To achieve these goals the City shall create and maintain a Sustainable Purchasing Committee and Sustainable Purchasing Plan. The Committee will include management-level staff from Purchasing and representatives from Public Works, Utilities, Transportation, and other relevant departments as identified by the City Manager or his/her designee. The Committee will write a plan and procedures that:

- provide a three year timeline for implementing changes to the City's purchasing specifications, scopes of service, and procedures. Tasks will be prioritized based on need and available resources. This timeline will be reviewed annually and adjusted as needed.
- develop a framework to identify preferable products and services
- develop criteria to evaluate the cost, performance and sustainable benefits of those products and services. This criteria would employ a total cost of ownership analysis which includes life cycle factors such as energy and water use, maintenance, replacement, disposal and recycling, and environmental and social benefits to the local and global community
- engage all City staff to identify sustainable products and services that are not purchased centrally, e.g., via CalCards
- educate staff on new products and purchasing procedures that are centrally purchased
- support external purchasing-related initiatives and programs that benefit City sustainability goals, e.g., extended producer responsibility and independent product and service performance certifications
- require annual vendor reports on sustainable product purchases tracking dollars spent, units purchased, and other information as specified by the City
- determine an appropriate program reporting approach
- create financial recommendations for resources that are needed to implement and maintain this policy

This policy and plan will be reviewed every three years by the Sustainable Purchasing Committee or as needed to realign with City priorities and requirements.



Proposed Short-Lived Climate Pollutant Reduction Strategy

April 2016

California Environmental Protection Agency

Air Resources Board

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Appendices

EXECUTIVE SUMMARY

Eureka! Synonymous with discovery and opportunity, California represents an ideal; a state of mind—stunning scenery, recreational opportunities, a thriving economy and a culturally diverse people. However, climate change is threatening this ideal, and our very way of life. It is clear that the impacts of climate change are already upon us. California continues to suffer through historic temperatures, persistent droughts, and more intense and frequent wildfires. Each year seems to bring a new global temperature record, and new evidence suggests sea levels are rising much faster than predicted. What was once, and remains, a generational problem of greenhouse gas (GHG) balance in the atmosphere has now become an immediate threat to our California lifestyle.

The only practical way to rapidly reduce the impacts of climate change is to employ strategies built on the tremendous body of science. The science unequivocally underscores the need to immediately reduce emissions of short-lived climate pollutants (SLCPs), which include black carbon (soot), methane (CH_4), and fluorinated gases (F-gases, including hydrofluorocarbons, or HFCs). They are powerful climate forcers and harmful air pollutants that have an outsized impact on climate change in the near term, compared to longer-lived GHGs, such as carbon dioxide (CO_2). SLCPs are estimated to be responsible for about 40 percent of current net climate forcing. Action to reduce these powerful "super pollutants" today will provide immediate benefits as the effects of our policies to reduce long-lived GHGs further unfold.

While we must continue to steadily reduce CO_2 emissions for long-term climate stability, we also need a global commitment and near-term actions to dramatically reduce SLCP emissions over the next 10–15 years. Deploying existing technologies and resource management strategies globally to reduce SLCP emissions can cut the expected rate of global warming in half and keep average warming below the dangerous 2°C threshold at least through 2050. We can slow sea level rise significantly, reduce disruption of historic rainfall patterns, and boost agricultural productivity by reducing crop losses to air pollution. Cutting global SLCP emissions immediately will slow climate feedback mechanisms in the Arctic and elsewhere that would otherwise further accelerate global warming and make climate change far more difficult to solve and far more costly to live with – as more resources would be required for disaster relief, conflict management, and adaptation. Most importantly, we can dramatically reduce global air pollution, saving millions of lives each year. Many of these benefits will primarily accrue in regions and populations disproportionately impacted by climate change, including the developing world.

Using cost-effective and available technologies and strategies, worldwide anthropogenic sources of SLCP emissions can be largely controlled by 2030 and the global benefits of a collective commitment to substantially reduce SLCP emissions would be profound. Leading efforts by California, the United States, Mexico, Norway, Europe, the Arctic Council, and several countries and non-governmental entities acting through the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) are already targeting SLCPs. Many other countries included SLCP emissions in their commitments made at the Paris climate conference, or are targeting them through separate policies to improve air quality and promote sustainable agriculture and transportation, among other efforts.

California's seminal Global Warming Solutions Act, AB 32 (Nuñez, Chapter 488, Statutes of 2006), charges the California Air Resources Board (ARB or Board) with achieving and maintaining a statewide GHG emission limit, while seeking continuing GHG emission reductions. SLCP emission reductions are critical to achieving this mandate. California is committed to taking further action to reduce SLCP emissions by 2030. Senate Bill 605 (Lara, Chapter 523, Statutes of 2014) requires the ARB to develop a plan to reduce emissions of SLCPs. Additionally, Governor Brown has identified reductions of SLCP emissions as one of "five pillars" to meet an overarching goal to reduce California's GHG emissions by 40 percent below 1990 levels by 2030. This proposed SLCP Reduction Strategy (Proposed Strategy) was developed pursuant to SB 605 and lays out a range of options to accelerate SLCP emission reductions in California, including regulations, incentives, and other market-supporting activities. Governor Brown's 2016-2017 Proposed Budget includes $215 million from Cap-and-Trade expenditures specifically targeting SLCP emission reductions. These include $40 million for black carbon residential woodsmoke reductions, $20 million for HFC reductions from refrigerants, $100 million for waste diversion, $20 million for Healthy Soils, and $35 million for dairy digester development.

An Opportunity for California

Historic action is not enough. Many opportunities to reduce emissions of SLCPs still exist, and California is doubling down on its efforts to control these emissions from all sources. A dedicated commitment, as described in this Proposed Strategy, to achieve sustainable reductions in SLCP emissions in California will provide significant benefits throughout the State.

In this Proposed Strategy, we outline SLCP emission reduction actions that provide a wide array of climate, health, and economic benefits throughout the State. The State's organic waste should be put to beneficial use, such as for soil amendments/compost,

electrical generation, transportation fuel, and pipeline-injected renewable natural gas. Practical solutions must be developed and implemented to overcome barriers to waste gas utilization for pipeline injection and grid interconnection. Additional data on SLCP sources must be collected in order to improve California's SLCP emission inventory and better understand potential mitigation measures. Finally, the State should provide incentives to accelerate market transitions to cleaner technologies that foster significant system-wide solutions to cut emissions of SLCPs. Many of the sources and sectors responsible for SLCP emissions are concentrated in communities with high levels of pollution or unemployment, which could especially benefit from targeted investments to improve public health and boost economic growth.

In the coming years, many billions of dollars in public and private investments are anticipated to support efforts to reduce SLCP and CO_2 emissions and support our agricultural and waste sectors, build sustainable freight systems, encourage low-Global Warming Potential (GWP) refrigerants and grow healthy forests. These investments will strengthen the State as a whole and the communities where they occur. Many of the benefits will accrue in the Central Valley, rural parts of the State, or other areas disproportionately impacted by pollution, such as those along freight corridors.

Stubborn barriers remain, including connecting distributed electricity and biogas projects, which have slowed previous efforts to reduce emissions of SLCPs and capture a wide array of benefits. These barriers are not insurmountable, and now is the time to solve them. State agencies, utilities, and other stakeholders need to work immediately to identify and resolve remaining obstacles to connecting distributed electricity with the grid and injecting renewable natural gas into the pipeline. Supporting the use of the cleanest technologies with funding and strategies that maximize air quality, climate, and water quality benefits can accelerate their introduction. Building market certainty and value for the energy, soil amendment, and other products that come from compost or anaerobic digestion facilities will help to secure financing to accelerate and scale project development.

Building on California Leadership

This Proposed Strategy builds on California's ongoing leadership to address climate change and improve air quality. It has been developed with input from State and local agencies, academic experts, a working group of agricultural experts and farmers convened by the California Department of Food and Agriculture (CDFA), businesses, and other interested stakeholders in an open and public process. ARB and State agencies collaborated to identify reduction measures for specific sectors, including the dairy, wastewater, and waste sectors. In addition, ARB collaborated with the local air districts to identify SLCP emission reduction measures that could be implemented

through district action. Throughout this process, ARB has sought advice from academic, industry, and environmental justice representatives. Additionally, ARB staff is working closely with manufacturers to determine the feasibility and cost of replacement products for high-GWP refrigerants, and with the dairy industry and academics to evaluate options and costs for reducing emissions of methane at dairies.

While reducing GHG emissions is a key objective for the State, California remains committed to further reducing emissions of criteria (smog-forming) pollutants and toxic air pollutants, as well. Many of the concepts described in this Proposed Strategy have already been discussed in the context of the California Sustainable Freight Action Plan, 2016 Mobile Source Strategy and other efforts related to developing State Implementation Plans for air quality, and plans for bioenergy, waste management, water management, healthy soils, and sustainable management of the state's natural resources. The SLCP Strategy, along with those other planning efforts, will inform and be integrated into the upcoming 2030 Target Scoping Plan Update, which will incorporate input from a wide range of stakeholders to develop an integrated plan for reducing emissions of GHGs, criteria pollutants, and toxic air pollutants through 2030. The process for updating the Scoping Plan began in fall 2015 and is scheduled for completion by 2017.

State agencies and the air districts are committed to continuing to work together to ensure that the concepts outlined in this Proposed Strategy are implemented in a coordinated and synergistic way. The sections below describe goals, regulations, incentives, and other efforts that would:

- Encourage national and international deployment of California's well-established and proven measures to reduce black carbon emissions;
- Further reduce black carbon emissions from off-road and non-mobile sources, including forests;
- Cut in half methane emissions from dairy operations and effectively eliminate disposal of organics in landfills;
- Create and expand industries to capture value from organic waste resources in California;
- Significantly reduce fugitive methane emissions from oil and gas systems and other sources; and
- Accelerate the transition to low-GWP refrigerants and more energy efficient refrigeration systems.

ARB staff will receive and consider comments on this Proposed Strategy and prepare a final Strategy to present to the Board for consideration in fall 2016.

Achieving Significant Emission Reductions

Based on stakeholder feedback on the Concept Paper released in May 2015 and the subsequent Draft Strategy, ARB is proposing planning targets to reduce emissions of methane and HFCs by 40 percent below current (2013) levels by 2030, and

anthropogenic (non-forest) black carbon emissions by 50 percent below current levels by 2030. Meeting these targets will help to achieve the Governor's goal to cut all GHG emissions in California by 40 percent below 1990 levels by 2030 and help meet federal air quality standards for 2031 and beyond.

The proposed targets are summarized in Table 1. The goals and proposed measures included in this Proposed Strategy will reduce SLCP emissions to levels in line with these targets. Due to the urgency of the issue, and recognizing the climate potency of SLCPs in the near-term, we use 20-year global warming potential values (GWPs) in this report to quantify emissions of SLCPs.

Table 1: California SLCP Emissions and Proposed Target Emission Levels (MMTCO2e)*

Pollutant	2013	2030 BAU**	2030 Proposed Strategy
Black carbon (non-forest)	38	26	19
Methane	118	117	71
Hydrofluorocarbons (HFCs)	40	65	24

*Using 20-year GWPs from the 4th Assessment report of the IPCC for methane and HFCs, and 5th Assessment report for black carbon (the first report to define a GWP for black carbon)

**Business As Usual (BAU) forecasted inventory includes reductions from implementation of current regulations

Black Carbon

Black carbon is not one of the climate pollutants originally included in international climate frameworks, and it is not included in California's AB 32 inventory. However, recent studies have shown that black carbon plays a far greater role in global warming than previously believed. California has made tremendous progress in reducing black carbon emissions as part of its efforts to reduce carcinogenic diesel particulate matter emissions and improve air quality. California has already cut anthropogenic black carbon emissions by over 90 percent since the 1960s, and existing measures are projected to cut mobile source emissions by 75 percent and total anthropogenic emissions by nearly 60 percent between 2000 and 2020. Putting measures in place to achieve similar levels of reductions worldwide is the quickest way to reduce the impacts of climate change, and would save millions of lives per year.

These reductions have come from strong efforts to reduce on-road vehicle emissions, especially diesel particulate matter. Car and truck engines used to be the largest sources of black carbon emissions in California, but the State's existing air quality

policies will virtually eliminate black carbon emissions from on-road diesel engines within 10 years. These policies are based on existing technologies, which could be deployed throughout the U.S. and the world.

With the large reduction in emissions of black carbon from vehicles, other sources of black carbon emissions will become more significant contributors to the State's black carbon inventory over time. In particular, without additional actions, off-road mobile, fuel combustion in the industrial and power sectors, and woodstoves and fireplaces will account for more than three-quarters of anthropogenic black carbon emissions in California in 2030. However, black carbon emissions from these sources have declined significantly as well, by almost 30 percent since 2000. Continued progress on these sectors—transitioning to cleaner and more efficient uses of energy, reducing emissions from woodstoves and fireplaces, taking steps to meet federal health-based air quality standards by 2031, and developing and implementing a sustainable freight system—will continue to reduce black carbon emissions and should allow us to meet the targets established in this Proposed Strategy. The State's 2016 Mobile Source Strategy, 2030 Target Scoping Plan Update, and Sustainable Freight Action Plan, a multi-agency effort to deploy a sustainable and efficient system for goods movement, will build on these measures to reduce black carbon. Additionally, ARB will work with local air districts to further reduce particulate matter and black carbon emissions from woodstoves and fireplaces. Governor Brown's 2016-17 proposed budget includes $40 million to reduce black carbon from woodsmoke.

The largest source of black carbon emissions in California is, by far, wildfire. An average wildfire season contributes two-thirds of current black carbon emissions in California. As climate change accelerates, our drought-ravaged forests will only become more vulnerable to wildfire and disease. Indeed, many of California's forests are already in a perilous condition and require accelerated management and investment to protect them. Several Federal, State, and local agencies are currently coordinating on forest planning, pursuant to Governor Brown's Proclamation of a State of Emergency on Tree Mortality and through other forums.

This Proposed Strategy focuses on actions to reduce wildfire risk and black carbon emissions by increasing the rate of fuel reduction to improve forest health, aligning financial incentives with beneficial uses of woody waste, supporting management efforts and market development through research, and integrating state planning efforts. The State's Forest Carbon Plan and the 2030 Target Scoping Plan Update will identify additional goals and measures to improve forest health. Goals and actions identified in the 2030 Target Scoping Plan Update and Forest Carbon Plan will include those related to forest carbon storage, which is beyond the scope of this Proposed Strategy. State agencies are coordinating to ensure that the goals and recommendations in each of

these plans complement one another. Any proposed targets or actions will be considered through those public planning processes.

Methane

Methane is responsible for about 20 percent of current net climate forcing globally. In California, about half of methane emissions come from organic waste streams that can be put to valuable use as sources of renewable energy or fuel and soil amendments. The other half mostly comes from enteric fermentation (burps) from dairy cows and livestock and fugitive emissions (leaks) from oil production, processing, and storage, gas pipeline system, or industrial operations. California can cut methane emissions by 40 percent below current levels in 2030 by capturing or altogether avoiding methane from manure at dairies, meeting national industry targets for reducing methane emissions from enteric fermentation, effectively eliminating disposal of organics in landfills, and reducing fugitive methane emissions by 40-45 percent from all sources.

Strong market support and broad collaboration among State agencies, industry, and other stakeholders will be necessary to reduce landfill and manure methane emissions by putting organic waste streams to beneficial use. The State will support early action to build infrastructure capacity and reduce emissions through existing incentives and accelerated efforts to overcome barriers and foster markets. Government agencies and stakeholders will work to foster market conditions to support private sector investment in expanded or new infrastructure, including building markets for compost and soil amendments, overcoming barriers to pipeline injection of biomethane, and identifying optimal financing mechanisms and levels to reach the goals in this Proposed Strategy.

Ultimately, a combination of incentives, State and private sector investment, and regulations will be necessary to capture the value in organic waste streams and ensure lasting emission reductions. For dairies, California will aim to reduce methane emissions from dairy manure management by at least 20 percent in 2020, 50 percent in 2025, and 75 percent in 2030. The State will encourage and support near-term actions by dairies to reduce emissions through financial incentives, collaboration to overcome barriers, and other market support, before subsequent regulations take hold. Following ARB approval of the final SLCP strategy, and in coordination with CDFA and local air quality and water quality agencies, ARB will initiate a rulemaking process to reduce manure methane emissions from the dairy industry in-line with the objectives in this Proposed Strategy. The regulatory process will include consideration of available financial incentives, market support, and the potential for emissions leakage in identifying appropriate timelines and requirements for the industry.

The rulemaking will also include requirements for mandatory reporting and recordkeeping of parameters affecting GHG emissions at California dairy farms. Reported information will be used to refine inventory quantification, evaluate policy effectiveness, and aid in future policy planning and regulatory development. ARB will work with other State agencies and industry groups to improve outreach on new

reporting requirements, as well as merge and streamline reporting activities with current forms and requirements to avoid duplicative reporting wherever feasible.

For landfills, ARB will work with CalRecycle to develop a regulation by 2018 to effectively eliminate organic disposal in landfills by 2025. To support this, CalRecycle will build on its partnerships with local governments, industry, nonprofits, local air districts and water boards to support regional planning efforts and identify ways to safely and effectively develop necessary organics recycling capacity. CalRecycle will also explore new ways to foster food waste prevention and food rescue, to help meet a goal of 10 percent food rescue by 2020, and 20 percent by 2025. Recovering and utilizing food that would otherwise be landfilled can help to reduce methane emissions and increase access to healthy foods for millions of Californians who suffer from food insecurity. Additionally, ARB and CalRecycle will work with the State and regional Water Boards to assess the feasibility and benefits of actions to require capturing and effectively utilizing methane generated from wastewater treatment, and opportunities for co-digestion of food waste at existing or new anaerobic digesters at wastewater treatment plants.

This Proposed Strategy also establishes a goal of reducing fugitive methane emissions from oil and gas by 40 percent below current levels in 2025 and 45 percent in 2030, and from all other sources by 40 percent in 2030. This aligns with the Obama Administration goal of reducing methane emissions from oil and gas operations by 40–45 percent below 2012 levels by 2025.

California has a comprehensive and stringent emerging framework to reduce methane emissions from oil and gas systems. ARB is developing a regulation to reduce fugitive methane emissions from the oil and gas production, processing and storage sector, which will be among the most stringent such regulations in the country. Additionally, pursuant to Senate Bill 1371 (Leno, Chapter 525, Statutes of 2014), the California Public Utilities Commission has launched a rulemaking to minimize methane leaks from natural gas transmission and distribution pipelines. Increases in energy efficiency and renewable energy, as well as more dense development patterns, will reduce oil and gas demand and fugitive emissions. ARB and the California Energy Commission (CEC) have also conducted several research projects to improve methane emission monitoring and accounting, as well as identify emission “hotspots,” which are responsible for large fractions of total fugitive emissions. These efforts will continue, and are critical to accelerating leak detection and fugitive methane emission reductions from all sectors, not just oil and gas. Ultimately, to

eliminate fugitive methane emissions, the State needs to transition away from its use of oil and natural gas.

HFCs

Fluorinated gases, and in particular HFCs, are the fastest-growing source of GHG emissions in California and globally. More than three-quarters of HFC emissions in California come from the use of refrigerants in the commercial, industrial, residential, and transportation sectors. In many cases, alternatives with much lower GWPs are already available and the United States Environmental Protection Agency (U.S. EPA) is beginning to impose bans on the use of F-gases with the highest GWPs in certain applications and sectors. Additionally, there is strong international momentum and interest to phase down the use of HFCs under the Montreal Protocol, as has already been done for other F-gases. The annual Meeting of Parties in November 2015 resulted in a decision to continue working on an HFC phasedown schedule in 2016. In the absence of a sufficiently rigorous international agreement by the end of 2016, ARB will evaluate the feasibility of a phasedown for California that aligns with similar efforts and stringency levels in Australia, Canada, Europe, and Japan.

California can complement these national and potential international actions by taking additional steps to reduce HFC emissions at low cost. Early action, ahead of some of the phase down schedules being proposed internationally, can avoid locking-in the use of high-GWP refrigerants in new or retrofitted systems in the coming years. Without early action to reduce unnecessary emissions now and into the future, the State would need to take additional—likely more costly—steps to meet its 2030 climate targets. An important step would be developing an incentive program to encourage the use of low-GWP refrigerants, which could lead to very low cost emission reductions and could be implemented while further regulations are considered or developed. The Governor's proposed 2016-2017 budget includes $20 million for incentives to reduce HFC emissions from refrigerants. Also, as effective alternatives become available, ARB will consider developing bans on the use of high-GWP refrigerants in sectors and applications not covered by U.S. EPA regulations.

This Proposed Strategy identifies measures that can reduce HFC emissions by 40 percent in California by 2030 and potentially capture additional, available reductions in HFC emissions now, and into the future. Many of these measures could have associated energy efficiency benefits, as well.

A summary of all proposed SLCP emission reduction measures and estimated reductions is presented in Table 2.

Table 2: Summary of Proposed New SLCP Measures and Estimated Emission Reductions (MMTCO2e)*

Measure Name	2030 Annual Emission Reductions	2030 Annual Emissions
BLACK CARBON (NON-FOREST)		
2030 BAU**		**26**
Residential Fireplace and Woodstove Conversion	3	
California Sustainable Freight Action Plan State Implementation Plans Clean Energy Goals***	4	
2030 BAU with new measures		**19**
METHANE		
2030 BAU**		**117**
Dairy Manure	21	
Dairy and Livestock Enteric Fermentation	5	
Landfill	5	
Wastewater, industrial and Other Miscellaneous Sources	7	
Oil and Gas Sector	8	
2030 BAU with new measures		**71**
HYDROFLUOROCARBONS		
2030 BAU**		**65**
Financial Incentive for Low-GWP Refrigeration Early Adoption	2	
HFC Supply Phasedown	19	
Sales ban of very-high GWP refrigerants	5	
Prohibition on new equipment with high-GWP Refrigerants	15	
2030 BAU with new measures		**24**

*Using 20-year GWPs from the 4th Assessment report of the IPCC for methane and HFCs, and 5th Assessment report for black carbon (the first report to define a GWP for black carbon)

**Business As Usual (BAU) forecasted inventory includes reductions from implementation of current regulations

***Future emission reduction measures that will be developed to help the State meet its air quality and climate change goals are also expected to help the State meet the black carbon target by 2030. However, an estimate of emission reductions is not currently available, but will be developed as part of these planning efforts.

Cost-Effective Measures with Significant Health Benefits

Significantly reducing SLCP emissions in line with the targets presented in this Proposed Strategy will continue California's long and successful legacy of implementing innovative and effective environmental and health policies while fostering the growth of a vibrant and sustainable economy. The proposed actions can contribute to health, environmental, and economic benefits that will positively impact Californian businesses and individuals. Many of these benefits will be concentrated in disadvantaged communities or other parts of the State most in need of economic development opportunities, including the San Joaquin Valley, rural areas where wood smoke is a primary health concern, and communities along freight corridors.

Collectively, implementing these measures would bring thousands of jobs from several billion dollars of investment in clean technologies and strategies that would lead to significant reductions in SLCP emissions. Potential revenues and efficiency savings could also be significant – and potentially outweigh the costs of some measures. In particular, for projects that utilize organic waste to create transportation fuel, the value of LCFS credits and RIN credits from the federal Renewable Fuel Standard can make these projects profitable. However, there remain significant institutional, market, and technical uncertainties that must be addressed, and continued incentives and State support can help to demonstrate and scale these strategies. In other cases, there may be net costs, but associated SLCP emission reductions may come at relatively low cost or provide other environmental and health benefits. For example, strategies at dairies that may not include energy production and associated revenues can still reduce emissions at low cost, and may deliver other environmental benefits, as well. And the collection of HFC measures identified in this Proposed Strategy could reduce GHG emissions by 260 $MMTCO_2e$ cumulatively through 2030 (20-year GWP) at a very low cost per tonne.

Achieving the targets identified in this Proposed Strategy would help reduce ambient levels of ozone and particulate matter, and the cardiovascular and respiratory health effects associated with air pollution. These and other health benefits can be maximized as part of an integrated approach to ensure that strategies used to reduce SLCP emissions also help to improve air quality and water quality on a regional basis. Many of these benefits would accrue in disadvantaged communities, which are often located near sources of SLCP emissions.

The proposed actions are supported through an integrated set of air quality and climate policies in the State, including the Low Carbon Fuel Standard, Bioenergy Feed-In-Tariff, utility investments to defray the costs of connecting renewable natural gas supplies to the pipeline, and direct investments from State funds. Together, and with additional targeted State support, we can meet the goals identified in this Proposed Strategy and capture additional economic, environmental and health benefits.

Putting the Strategy into Action

All regulatory measures developed pursuant to the SLCP Reduction Strategy would undergo a complete, public rulemaking process including workshops, and economic and environmental evaluations. While this Proposed Strategy is intended to be comprehensive, it is not exhaustive. We will continue to pursue new cost-effective programs and measures as technology and research on SLCP emission sources and potential mitigation measures advances.

Effectively implementing this Proposed Strategy will require working with local, regional, federal and international partners, and strategically investing time and money to overcome market barriers that hinder progress. The extent to which we do so will drive results, which can include a wide range of significant economic and environmental benefits for California broadly, and many of the State's most disadvantaged communities, specifically.

Finally, the State will only realize the full benefits of strong action to reduce SLCP and CO_2 emissions if others take committed action, as well. Strong, near-term action to cut emissions of SLCPs, in conjunction with immediate and continuous reductions in emissions of CO_2, is the only way to stabilize global warming below 2^oC. Accordingly, California has signed a number of agreements to work together with other countries, including China and Mexico, to support actions to fight climate change and cut air pollution. Additionally, California is bringing together subnational jurisdictions under the Subnational Global Climate Leadership Memorandum of Understanding (the "Under 2 MOU"), which commits signatories to take steps to reduce SLCP and CO_2 emissions and meet the goal of keeping global average warming below the 2^oC threshold by reducing their GHG emissions to under 2 metric tons per capita, or 80–95 percent below 1990 levels, by 2050. To date, a total of 127 jurisdictions have signed or endorsed the Under 2 MOU, collectively representing more than 729 million people and $20.4 trillion in GDP, equivalent to more than a quarter of the global economy. If the signatories represented a single country, it would be the second largest economy in the world behind only the United States. As it implements the actions identified in this Proposed Strategy and other related climate change planning efforts, California will continue to share its successes and approach with others, to expand action to address climate change and deliver local and global benefits for the State.

I. Introduction: Showing the Way to 2°C

California must achieve deep reductions in short-lived climate pollutant (SLCP) emissions by 2030 to help avoid the worst impacts of climate change and meet air quality goals. Additionally, intensified, global action to reduce these emissions is the only practical way to immediately slow global warming and is necessary to keep warming below 2°C through at least 2050, which is a critical threshold to manage the damaging effects of climate change. A broad scientific consensus has emerged, based on extensive research, that a 2°C (3.6°F) increase in global average temperature above pre-industrial levels poses severe risks to natural systems and human health and well-being. This is an increase of only 1.1°C (2.0°F) above the present level. Even a slight increase in global warming would lead to significant sea level rise, and the overall impact from climate change would be substantially greater if global warming exceeds 2°C. Strong, near-term action to cut emissions of SLCPs, in conjunction with immediate and continuous reductions in emissions of carbon dioxide (CO_2), is the only way to stabilize global warming below 2°C.

In December 2015, at the 21st Conference of Parties (COP21), 25,000 delegates from 196 countries gathered recognizing that "climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries, and their participation in an effective and appropriate international response, with a view to accelerating the reduction of global greenhouse gas emissions." An agreement was reached to substantially reduce GHG emissions with the aim of limiting a global temperature increase to below 2°C, mobilize investments to support low-carbon development, and create a pathway for long-term de-carbonization. Additionally, the agreement aims to strengthen the ability to deal with the impacts of climate change.

Short-lived climate pollutants, including methane (CH_4), black carbon (soot), and fluorinated gases (F-gases, including hydrofluorocarbons, or HFCs), are among the most harmful to both human health and global climate. They are powerful climate forcers that remain in the atmosphere for a much shorter period of time than longer-lived climate pollutants, including CO_2, which is the primary driver of climate change. Their relative climate forcing, when measured in terms of how they heat the atmosphere, can be tens, hundreds, or even thousands of times greater than that of CO_2. Short-lived climate pollutants contribute about 40 percent to current anthropogenic global radiative forcing, which is the primary forcing agent for observed climate change. [1,2,3,4,5]

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[1] Calculation based on IPCC AR5 WGI Chapter 8. https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf

[2] Ramanathan V, Xu Y. The Copenhagen Accord for limiting global warming: criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences of the United States of America. 2010;107 (18):8055–8062. [PMC free article]

[3] IGSD (2013) Primer on Short-Lived Climate Pollutants, Institute for Governance and Sustainable Development, February 2013. http://igsd.org/documents/PrimeronShort-LivedClimatePollutantsFeb192013.pdf

California has taken significant steps to reduce SLCP emissions, especially black carbon from transportation, methane from oil and gas operations and landfill emissions, and HFC emissions from refrigerants, insulating foams, and aerosol propellants. Still, more can and must to be done to reduce emissions from these and other sources in the State, including methane from waste management and dairies, black carbon from off-road and non-mobile sources, and HFC emissions from refrigeration and air conditioning systems.

The State is committed to further reducing SLCP emissions. SLCP emission reductions are important, first of all, to continuing and maintaining the GHG emission reductions called for by AB 32, and to ensuring emissions meet the statewide GHG emission limit it established. The Proposed Strategy is identified in the First Update to the Climate Change Scoping Plan as one of the recommended actions to achieve additional GHG emission reductions. Growing SLCP emissions (such as from fluorinated gases) threaten to erode the State's progress towards this limit; in other sectors (such as from oil and gas and agriculture) continued emissions will put increased pressure on the remainder of ARB's regulatory structure to maintain overall emissions below the GHG limit and to continue reductions. Conversely, addressing SLCP emissions will help to ensure that the AB 32 limit is maintained, and will fulfill AB 32's mandate to continue to seek the maximum technologically feasible and cost-effective reductions of GHG emissions. Reducing these powerful climate-forcers early also produces a compound-interest effect through which the effectiveness of future reductions are magnified: those future reductions start from a baseline substantially lower than where they would have started in the absence of aggressive early reduction efforts.

The Legislature directly recognized the critical role that SLCPs must play in the State's climate efforts with the passage of Senate Bill 605 (Lara, Chapter 523, Statutes of 2014), which requires the Air Resources Board (ARB or Board) to develop a strategy by the end of 2015 to reduce SLCP emissions. In his 2015 Inaugural Address, Governor Brown reinforced this commitment and called on California to show the world the path to limiting global warming below 2°C through 2050, while highlighting the role that action to cut SLCPs must play in this effort. In April 2015, the Governor set a target for reducing overall GHG emissions to 40 percent below 1990 levels by 2030, which the actions identified in this report will support.

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[4] Akbar, Sameer; Ebinger, Jane; Kleiman, Gary; Oguah, Samuel. 2013. *Integration of short-lived climate pollutants in World Bank activities: a report prepared at the request of the G8*. Washington DC ; World Bank. http://documents.worldbank.org/curated/en/2013/06/18119798/integration-short-lived-climate-pollutants-world-bank-activities-report-prepared-request-g8
web.stanford.edu/group/efmh/jacobson/Articles/VIII/BCClimRespJGR0710.pdf

[5] Molina M, Zaelke D, Sarma KM, Andersen SO, Ramanathan V, Kaniaru D. Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions. *Proceedings of the National Academy of Sciences of the United States of America*. 2009;106(49):20616-20621. doi:10.1073/pnas.0902568106.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2791591/

Significant reductions in SLCP emissions can be achieved globally using cost-effective technologies and strategies, some of which have already been demonstrated effectively in California. Over the past several decades, the State's efforts in controlling these harmful emissions have prevented thousands of premature deaths in California, saved the State many tens of billions of dollars in energy and health costs, and have occurred alongside strong economic growth throughout our diverse economy. Applying California's experiences to reduce SLCP emissions globally would help prevent millions of premature deaths each year; boost agricultural productivity; limit disruption of historic rainfall patterns; slow the melting of glaciers, snowpack, and sea ice; reduce sea level rise; and provide trillions of dollars in economic benefits each year.

A. Significant Benefits from Accelerated Action to Cut SLCP Emissions

While reducing CO_2 emissions limits climate change over the long term, reducing emissions of SLCPs will effectively slow the rate of climate change in the near-term. Therefore, the best path forward is to emphasize parallel strategies for reducing SLCP and CO_2 emissions.[6,7] Studies indicate that available technologies, if universally adopted, can effectively reduce global methane emissions an estimated 40 percent and black carbon an estimated 80 percent below 1990 levels by 2030.[8] Additionally, a new proposed global phase down of HFCs under the Montreal Protocol (if adopted) and other efforts could cut the expected production of HFCs by up to 70 percent by 2030, and up to 85 percent by 2035.[9,10]

Achieving this scale of global reductions would deliver significant climate benefits. It would cut the expected rate of global warming in half by 2050, slowing global temperature rise by about 0.6°C,[11,12] which would reduce the risk of dangerous climate

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[6] Shoemaker, J K; Schrag, D P; Molina, M J; Ramanathan, V (2013) What Role for Short-Lived Climate Pollutants in Mitigation Policy? Science 342 (6164) 1323-1324

[7] Rogelj, J, Schaeffer M, Meinshausen M, Shindell D, Hare W, Klimont Z, Velders G, Amann M, Schellnhuber HJ. 2014. Disentangling the effects of CO2 and short-lived climate forcer mitigation. Proceedings of the National Academy of Sciences (PNAS). http://www.pnas.org/cgi/doi/10.1073/pnas.1415631111

[8] UNEP (2014) Time to Act (To Reduce Short-Lived Climate Pollutants), The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, United Nations Environment Programme, Second Edition, May. http://www.unep.org/ccac/Publications/Publications/TimeToAct/tabid/133392/Default.aspx

[9] Velders et al (2009) The Large Contribution of Projected HFC Emissions to Future Climate Forcing, *Proceedings of the National Academies* 106 (27), 10949-10954. www.pnas.org/cgi/doi/10.1073/pnas.0902817106

[10] Velders et al (2014) "Growth of climate change commitments from HFC banks and emissions", G. J. M. Velders, S. Solomon, and J. S. Daniel. *Atmospheric Chemistry and Physics*, 14, 4563–4572, 2014. doi:10.5194/acp-14-4563-2014. www.atmos-chem-phys.net/14/4563/2014/.

[11] Ramanathan V, Xu Y. The Copenhagen Accord for limiting global warming: criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences of the United States of America. 2010;107 (18):8055–8062. [PMC free article]

[12] UNEP (2014) Time to Act (To Reduce Short-Lived Climate Pollutants), The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, United Nations Environment Programme, Second Edition, May. http://www.unep.org/ccac/Publications/Publications/TimeToAct/tabid/133392/Default.aspx

feedbacks such as accelerated Arctic melting and sea level rise.[13] It would also increase the probability of staying below the 2°C threshold to more than 90 percent through 2050.[14,15]

The benefits could be even greater in the Arctic, which is especially vulnerable to black carbon emissions and is warming twice as fast as the rest of the world.[16] Slowing climate change impacts in the Arctic could be critically important for stabilizing climate change and its impacts, as the Arctic is an important driver of sea level rise and weather patterns throughout the Northern Hemisphere.[17,18] Reducing emissions of SLCPs can slow down the rate of sea level rise by 24–50 percent this century, if efforts to reduce emissions begin now. Mitigating emissions of both CO_2 and SLCPs can reduce the projected sea level rise rate by 50–67 percent by 2100.[19]

Deploying existing, cost-effective technologies to reduce SLCP emissions can also cut global emissions of fine particulate matter (PM2.5) by an estimated 50 percent, oxides of nitrogen (NO_x) emissions by 35 percent, and carbon monoxide (CO) emissions by 60 percent.[20] If these measures were fully in place by 2030, an estimated 3.5 million premature deaths and 53 million metric tons of crop losses could be avoided globally, each year. The economic value of these climate, crop, and health benefits is estimated to be about $5.9 trillion annually.[21] Most of these benefits would accrue in the developing world and places where disproportionate climate impacts are already being felt.

Many of the benefits of cutting SLCP emissions in California will accrue in the most disadvantaged parts of the State, where pollution levels and their health impacts are

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[13] UNEP and WMO (2011) Integrated Assessment of Black Carbon and Tropospheric Ozone, United Nations Environment Programme and World Meteorological Association. http://www.unep.org/dewa/Portals/67/pdf/BlackCarbon_report.pdf

[14] Ramanathan, V. and Yangyang Xu (2010) The Copenhagen Accord for Limiting Global Warming: Criteria, Constraints, and Available Avenues, *Proceedings of the National Academies of Sciences* **107** (18), pp.8055-8062. http://www.pnas.org/content/107/18/8055

[15] Xu, Y., D. Zaelke, G. J. M. Velders, and V. Ramanathan (2013), The role of HFCs in mitigating 21st century climate change, *Atmos. Chem. Phys.*, 13(12), 6083–6089

[16] Quinn et al (2008) Short-lived pollutants in the Arctic: Their impact and possible mitigation strategies, *Atmospheric Chemistry and Physics* **8**, 1723-1735. http://www.atmos-chem-phys.net/8/1723/2008/acp-8-1723-2008.html

[17] Francis, J. A. and S. J. Vavrus. 2012. Evidence linking Arctic amplification to extreme weather in mid-latitudes. Geophysical Research Letters 39.

[18] Screen, J. A. and I. Simmonds. 2013. Exploring links between Arctic amplification and mid-latitude weather. Geophysical Research Letters 40(5):959-964.

[19] Hu, A., Y. Xu, C. Tebaldi, W. M. Washington, and V. Ramanathan (2013), Mitigation of short-lived climate pollutants slows sea-level rise *Nature Climate Change* 3(5), 1–5, doi:10.1038/nclimate1869

[20] UNEP and WMO (2011) Integrated Assessment of Black Carbon and Tropospheric Ozone, United Nations Environment Programme and World Meteorological Association. http://www.unep.org/dewa/Portals/67/pdf/BlackCarbon_report.pdf

[21] Shindell et al. (2012) Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security, *Science* **335**, 183 (2012). http://www.sciencemag.org/content/335/6065/183

often highest, and where further economic development may be most needed. For example:

- Further cutting black carbon emissions from the transportation sector and building a sustainable freight system would have health and economic benefits for communities in the East Bay, Southern California, and the Inland Empire along freight corridors and near ports and railyards where diesel particulate matter concentrations are highest.
- Investments to cut methane and black carbon emissions as part of an integrated strategy to reduce emissions from agriculture and waste can provide important benefits for the Central Valley and other agricultural communities. They can help build an increasingly resilient and competitive agricultural sector by supporting jobs and economic growth, healthy soils, and improved air quality, water quality, and public health in those communities.
- Improving management and health of forests and rural landscapes to sustainably sequester carbon and mitigate black carbon emissions from wildfires can help bring investment, economic, and climate resiliency benefits throughout the Sierra, the North Coast, and other rural parts of California.
- Switching to low-GWP refrigerants can also improve the energy efficiency of refrigeration and air conditioning equipment, which can help to cut electricity bills throughout the State.

B. Building on California's Air Quality and Climate Leadership

California's ongoing efforts to improve air quality and address climate change have already led to important reductions in SLCP emissions, and they provide a strong foundation to support further efforts to reduce emissions of these dangerous pollutants.

- *Black carbon*: California has cut anthropogenic sources of black carbon emissions by more than 90 percent since the 1960s. From 2000 to 2020, California will have cut black carbon from mobile sources by 75 percent. These efforts prevent an estimated 5,000 premature deaths in the State each year, and deliver important climate benefits. If the world replicated this success, it would slow global warming by an estimated 15 percent,[22] essentially offsetting one to two decades' worth of CO_2 emissions.[23]
- *Methane*: California has the nation's strongest standards for limiting methane emissions from landfills, has offset protocols under our Cap-and-Trade program to encourage the reduction of methane emissions, and has rules under development and being implemented to create a comprehensive approach to limit methane leaks from the oil and gas production, processing, and storage

[22] Ramanathan et al (2013) Black Carbon and the Regional Climate of California, Report to the California Air Resources Board, Contract 08-323, April 15. http://www.arb.ca.gov/research/single-project.php?row_id=64841

[23] Wallack, J. and Veerabhadran Ramanathan (2009) The Other Climate Changers: Why Black Carbon and Ozone Also Matter, *Foreign Affairs*, September/October 2009, pp. 105-113. https://www.foreignaffairs.com/articles/2009-09-01/other-climate-changers

sector, and the natural gas pipeline system. These efforts are serving to keep methane emissions fairly steady in the State.

- *HFCs*: The State has regulations in place to reduce emissions from refrigerants, motor vehicle air-conditioning, and consumer products that together will cut emissions of HFCs by 25 percent below otherwise projected levels in 2020.

Still, more remains to be done. California is home to some of the highest levels of air pollution in the country, and although the State has substantially reduced particulate matter and black carbon emissions from on-road transportation, vehicles still pollute the air in our communities and harm the lungs of some of our most vulnerable populations. Global methane emissions are responsible for about 20 percent of current global warming, [24] and its emissions continue to increase. F-gases, specifically HFCs, are the fastest growing source of GHG emissions in California and globally.

C. Purpose of SLCP Reduction Strategy

The State is committed to further reducing SLCP emissions. The 2014 Update to the Climate Change Scoping Plan (2014 Scoping Plan Update) identified SLCPs as an important aspect of a comprehensive approach to addressing climate change. Senate Bill 605 (Lara, Chapter 523, Statutes of 2014) requires ARB to develop a plan to reduce emissions of SLCPs. Additionally, Governor Brown has identified reductions of SLCP emissions as one of "five pillars" to meet an overarching goal to reduce California's GHG emissions by 40 percent below 1990 levels by 2030. Senate Bill 605 (Lara, Chapter 523, Statutes of 2014), requires ARB to develop a comprehensive strategy to reduce emissions of SLCPs in the State, and in developing the strategy to:

- Complete an inventory of sources and emissions of SLCPs in the State based on available data;
- Identify research needs to address any data gaps;
- Identify existing and potential new control measures to reduce emissions;
- Prioritize the development of new measures for SLCPs that offer co-benefits by improving water quality or reducing other air pollutants that impact community health and benefit disadvantaged communities, as identified pursuant to California Health and Safety Code Section 39711;
- Coordinate with other State agencies and air districts to develop and implement measures identified as part of the comprehensive strategy;
- Consult with experts in academia, industry, and the community on SLCPs. The topics shall include, but not be limited to, all of the following:
    - Assessment of the current status of controls that directly or indirectly reduce emissions of SLCPs in the State.
    - Identification of opportunities and challenges for controlling emissions.
    - Recommendations to further reduce emissions; and
- Hold at least one public workshop during the development of the strategy.

[24] Kirschke, S. *et al.* (2013) Three decades of global methane sources and sinks. *Nature Geosci.* **6**, 813–823. http://www.nature.com/ngeo/journal/v6/n10/full/ngeo1955.html?WT.ec_id=NGEO-201310

ARB developed this proposed SLCP Reduction Strategy report (Proposed Strategy) pursuant to SB 605, in coordination with other State agencies and local air quality management and air pollution control districts. The Proposed Strategy has been developed with input from interested stakeholders in an open and public process and describes a proposed strategy for California to reduce emissions of SLCPs through 2030. It describes ongoing and potential new measures to reduce SLCP emissions from all major sources in the State, and describes current and future research needs for improving the SLCP emission inventory and better understanding potential mitigation measures. California's SLCP emission inventory[25] and current and future research needs are included in Appendix A, and research efforts to evaluate potential mitigation measures for each SLCP is included in Appendix B. Measures included in the final SLCP Reduction Strategy would be developed under future public regulatory processes with the appropriate public process, economic analyses, environmental analyses, and consideration of environmental justice.

D. Achieving Science-Based Targets

This Proposed Strategy is designed to meet planning targets of reducing methane and HFC emissions by 40 percent below current (2013) levels by 2030, and black carbon emissions by 50 percent below current levels by 2030. The targets are translated into millions of metric tonnes of CO_2-equivalent ($MMTCO_2e$) in Table 3. These proposed targets are in-line with science-based assessments of reductions needed globally to limit warming below 2°C through at least 2050, as well as efforts needed in California to reduce overall GHG emissions by 40 percent below 1990 levels by 2030.

Table 3: California SLCP Emissions and Proposed Target Emission Levels ($MMTCO_2e$)*

Pollutant	Inventory 2013	Forecast** 2030	Targets 2030
Black Carbon***	38	26	19
Methane	118	117	71
Hydrofluorocarbons	40	65	24

*Using 20-year Global Warming Potentials and AR4 except Black Carbon, which uses AR5 (the first report to define a GWP for black carbon)
**Includes reductions from implementation of current regulations
***All non-forest sources

These targets are not binding, but provide important indices against which to measure the State's progress to reduce SLCP emissions. California efforts to reduce SLCP emissions, consistent with these targets, are important to further the purposes of AB 32, whose requirements charge ARB with reaching and maintaining the statewide GHG limit, as well as taking steps to continue reductions. Several Executive Orders (EO), including Governor Brown's EO B-30-15, further charge ARB with continuing and

[25] Inventory methodology and detailed inventory tables available at: http://www.arb.ca.gov/cc/inventory/slcp/slcp.htm

maintaining emission reductions. The measures identified in this Proposed Strategy and their expected emission reductions will feed into the update to the Climate Change Scoping Plan that is currently being developed pursuant to EO B-30-15. The 2030 Target Scoping Plan Update will establish a broad framework for meeting all of California's climate-related targets and will include an evaluation of all proposed GHG reducing activities, for both short-lived and longer-lived pollutants.

Throughout this Proposed Strategy, there is an emphasis on early actions, often supported by public investments and strong policy incentives. This approach is intended to achieve earlier reductions (in the 2020 timeframe), bring projects online quickly, and help scale sector-wide solutions while potential regulatory or other measures to reduce SLCP emissions are developed. By supporting early action through investments and commitments to overcome barriers, we can maximize benefits throughout California, while minimizing the impact of future regulations on businesses in these sectors.

Together with California's previous efforts to successfully reduce black carbon and other SLCP emissions, implementing the measures identified in this Proposed Strategy to meet these targets would put California on the path to meet the Governor's 2030 climate goals, while delivering significant agricultural, air quality, economic, health, water, and other climate co-benefits.

E. Coordinating Research Efforts Related to SLCPs

Many California State agencies sponsor climate-related research. State-sponsored climate research, including research related to SLCPs, has been guided by the needs identified in state laws, Executive Orders, and other policy documents, as well as the best and latest science.

Since 2008, the Climate Action Team Research Working Group (CATRWG) has provided a forum for State agencies to discuss and coordinate their proposed research activities. The CATRWG also facilitates coordination with external groups including academia, federal agencies, the international community, and private entities. Integration and coordination with non-state sponsored research programs is important to leverage State resources and to provide coherent and practical research results for California.

To support these efforts, the CATRWG has created a catalog of relevant research projects supported by the State since the early 2000s.[26] The catalog keeps State agencies and interested stakeholders informed about the range of activities and the status of individual projects. The catalog includes a number of projects related to the impacts of SLCPs on regional climate in California, research underway to enhance SLCP inventories, and evaluations of SLCP mitigation strategies.

In 2015, the CATRWG released a Climate Change Research Plan for California.[27] The Plan synthesizes the knowledge gaps, and presents research priorities for the next three to five years for policy-relevant, California-specific research. It includes research needs related to the mitigation of SLCPs and specific needs to improve SLCP inventories. The Plan outlines these research needs in order to inform the State's ongoing activities without duplicating federal research activities. This is an unprecedented effort resulting in the first comprehensive climate change research plan developed by any state. The CATRWG will update the Plan every other year, with major revisions every four years. Research related to SLCPs will continue to be a priority in these updates.

Future State-sponsored research will be guided by recommendations in the CATRWG Research Plan, as well as other documents such as the SLCP Reduction Strategy. State agencies will continue to leverage funding and avoid duplication of effort through coordination in CATRWG meetings. State agencies that sponsor research will also continue their individual efforts to align future research needs with input from stakeholders, academic experts and other public and private research entities.

F. Process for Developing the SLCP Reduction Strategy

This Proposed Strategy was developed with input from State and local agencies, academic experts, a working group of agricultural experts and farmers convened by CDFA, and other interested stakeholders in an open and public process. ARB and State agencies collaborated to identify reduction measures for specific sectors, including the dairy, wastewater, and waste sectors. In addition, ARB collaborated with the local air districts to identify SLCP emission reduction measures that could be implemented through district action. The Proposed Strategy will be further refined based on stakeholder input.

In May 2015, ARB released for public review, a Concept Paper to initiate discussion on the

[26] California's State-sponsored Research Catalog: http://cal-adapt.org/research/
[27] Climate Change Research Plan for California (2015) http://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf

development of this Proposed Strategy.[28] The paper described initial ideas to be explored as the Strategy was developed, and sought to elicit new ideas and refinement of current measures to reduce emissions of SLCPs throughout the State. The Concept Paper was presented at a public meeting later in May, to solicit public input. After consideration of comments received, staff developed a Draft SLCP Reduction Strategy,[29] which was released for public comment on September 30, 2015. Comments received on the Draft Strategy are posted at:
http://www.arb.ca.gov/lispub/comm2/bccommlog.php?listname=slcpdraftstrategy-ws

ARB held workshops in October 2015 to solicit comments on the Draft Strategy, including comments related to the development of a California Environmental Quality Act (CEQA) document. After consideration of public comments received, ARB developed this Proposed Strategy and an accompanying draft Environmental Analysis (Appendix C). Additional workshops will be held to solicit comments on this Proposed Strategy, before it is presented to the Board in May 2016. Staff will present the final proposed SLCP Reduction Strategy, the final EA, and written responses to comments received on the EA to the Board for consideration at a public hearing in fall 2016.

[28] http://www.arb.ca.gov/cc/shortlived/concept_paper.pdf
[29] http://www.arb.ca.gov/cc/shortlived/2015draft.pdf

II. California's Approach to Reducing SLCP Emissions

The 2014 Scoping Plan Update described California's approach to climate change as one reliant on science and foundational research. The Update focused on: preserving natural resources that provide for our economy and define our lifestyle in California, fostering resilient economic growth throughout the State, improving public health, and supporting economic, social and environmental justice. The State's commitment to addressing climate change and public health is born of necessity, but provides tremendous opportunity to build competitiveness and resilience into our communities, resources, and economy. We understand that steps we take to reduce emissions and strengthen our State against the impacts of climate change provide economic opportunities today, and untether our future potential from limits imposed by resource constraints and pollution.

This approach continues to guide us as we focus on reducing emissions of SLCPs to meet science-based targets in this Proposed Strategy. Additionally, California's approach to reducing SLCP emissions is framed by the principles described below.

A. Prioritize Actions with Diverse Benefits

The direct benefits of cutting SLCP emissions will be immediately tangible, and can be substantial. As part of an integrated strategy to not only reduce emissions of SLCPs, but also to develop renewable sources of energy and strengthen the competitiveness and resiliency of our agricultural, waste, and other sectors, they can deliver even greater benefits, including:

- Reduced asthma risk, hospitalization, premature death, and associated medical costs from air pollution, especially in disadvantaged communities;
- Reduced global and localized climate change impacts, including sea level rise and disrupted precipitation patterns, and associated costs;
- Reduced crop losses from air pollution;
- Healthier forests, wildlife habitats, and watersheds;
- Healthy soils that are more sustainable and resilient to climate change, sequester GHGs, require less synthetic amendments, and improve water retention;
- The creation of a new industry, mostly in rural parts of the State and the Central Valley, around utilizing organic waste streams to generate renewable energy, fuels, and compost—bringing billions in investment; and
- Stronger agricultural and freight sectors that are well positioned to continue competing globally and growing as a source of jobs and economic development in California.

Clearly, there are a number of drivers and benefits to reducing SLCP emissions that extend beyond mitigating the impacts of climate change. The measures identified in this Proposed Strategy are intended to provide a wide array of climate, health, and economic benefits throughout the State. As they are further developed and implemented, a key focus will be to provide and maximize multiple benefits.

B. Put Organic Waste to Beneficial Use

California's organic waste streams are responsible for half of the State's methane emissions and represent a valuable energy and soil-enhancing resource. Effectively implementing the measures described in this Proposed Strategy will not only reduce methane emissions but provide many other benefits as well, including cutting emissions of CO_2 and boosting economic growth in agricultural and rural communities.

Building infrastructure to better manage organic waste streams could lead to billions of dollars of investment and thousands of jobs in the State.[30,31] This infrastructure could provide valuable new sources of renewable electricity or biogas, clean transportation fuels, compost other beneficial soil amendments, and other products. Adopting state policies to promote biogas from organic waste would provide a strong durable market signal to industry, agencies, and investors. In addition, this biogas can help the State meet its 33 percent renewable mandate for hydrogen transportation fuel. The State's new 50 percent renewable portfolio standard may drive renewable hydrogen production even higher. Collectively, products from organic waste streams in California, and potential environmental credits from them, could represent a market worth billions of dollars in California.

Utilizing clean technologies to put organic waste streams to a beneficial use can also serve to improve regional air and water quality and support economic growth in agricultural and other communities throughout the State. For example, most dairies in California currently store manure in uncovered lagoons and use lagoon water to fertilize on-site forage crops. This approach to managing manure has helped to improve the efficiency of dairy farms and milk production over the years. However, these lagoons also create one of the largest sources of methane emissions in the State, and—when combined with imprecise or improper land application of nutrients, water, and salts via flood irrigation of lagoon effluent—can create adverse groundwater

[30] Kaffka et al (2011) Economic, Social, and Environmental Effects of Current and Near-term Biomass Use in California, California Biomass Collaborative, University of California, Davis. http://biomass.ucdavis.edu/publications/

[31] Due to its large dairy industry, California likely represents more than its share of the estimated 11,000 potential new biogas systems that could be built in the U.S. and the associated $33 billion in capital deployment, 275,000 short-term construction jobs, and 18,000 permanent jobs.
USDA, USEPA, USDOE (2014) Biogas Opportunities Roadmap: Voluntary Actions to Reduce Methane Emissions and Increase Energy Independence.
http://www.usda.gov/oce/reports/energy/Biogas_Opportunities_Roadmap_8-1-14.pdf

and nutrient management issues on farms. Alternatively, manure can be managed in a way to reduce or avoid methane emissions and open up opportunities for improving farm nutrient management activities.

In order to capture the entire potential value from California's waste resources, significant amounts of infrastructure remain to be built and markets must be fully enabled. Barriers remain to achieving these wide-ranging economic and environmental benefits, and must be addressed.

C. Identify Practical Solutions to Overcome Barriers

Maximizing the diverse benefits of putting organic waste streams to beneficial uses will require overcoming barriers that have hindered such efforts in the past. Barriers affect many parts of the supply and marketing chain, including feedstock, technology, market/economics, permitting, technical feasibility, infrastructure, logistics, and user behavior.

For example, inexpensive and abundant landfill capacity may make diverting organic material relatively costly in some cases. Developing projects to generate renewable energy and soil amendments from this waste stream will require additional investments in clean technology and management practices, aligning economic incentives that currently favor landfilling with the State's objectives to put organic resources to better use, and streamlining various governmental and utility permitting processes.

Technology or market barriers also remain in some sectors. Interconnecting distributed sources of renewable energy onto the electricity grid, or biogas into pipelines, remains an unnecessarily long and costly process in many cases. Utilizing biogas in a conventional combustion engine to create electricity can exacerbate air quality problems in many parts of the State, including the Central Valley and Southern California. Clean engine and fuel options, or low-GWP refrigerants, are not available for all applications. Markets for compost and soil amendments need to be built out and strengthened, which would provide an important value stream for financing anaerobic digestion and compost facilities. Additional support and time may be needed to strengthen existing and emerging markets for renewable natural gas and fuels, soil amendments, and their associated environmental attributes.

But these barriers are not insurmountable. As California develops a SLCP Strategy to reduce SLCP emissions and plans to meet its climate and air quality goals for 2030, now is the time to solve them. This Proposed Strategy identifies strategies and funding mechanisms to encourage the use of the cleanest technologies to advance the State's air quality, water quality, climate change, and other environmental objectives. Solutions that address several environmental concerns—air quality, climate, and water quality—and can be easily financed, are clear winners.

Several existing programs already provide incentives to convert waste streams to various forms of energy, which can be leveraged along with new efforts to increase the

share of renewable biogas used in California buildings, industry, and transportation. For example, the Low Carbon Fuel Standard (LCFS) and federal Renewable Fuel Standard provide strong economic incentives to utilize organic waste resources for production of transportation fuels. At current LCFS and RIN credit prices, anaerobic digestion projects that generate transportation fuels at dairies, wastewater treatment plants, or elsewhere can be profitable (see Chapter VIII). In order to enable this market, however, barriers to pipeline injection of biogas, among others, must be addressed. The CPUC has authorized an incentive program, capped at $40 million, to offset half of renewable natural gas interconnection costs, up to $1.5 million per project. State agencies are already collaborating to overcome barriers to pipeline injection of biogas, pursuant to the Governor's call to make heating fuels cleaner,[32] and they will redouble their efforts. This includes monitoring market progress pursuant to Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012) and considering appropriate adjustments, as needed. Also, supplemental policy options to accelerate biogas projects and access to the pipeline will be considered, including steps that utilities can take, options to accommodate varying heat rates of pipeline gas in certain instances, and potential new policies like a feed-in-tariff for renewable natural gas.

Building market certainty and value for compost and other soil amendment products will also help to secure financing for projects to use organic waste and cut emissions of SLCPs. Soil amendments from organic waste streams in California represent a potential $200-400 million market in California, exceeding the likely value of energy products from the resource.[33] Efforts to increase composting and anaerobic digestion—and capture the diverse benefits from doing so—can be supported by efforts to promote and account for the benefits of using compost, manure, and other soil amendments that come from these processes. ARB is coordinating with CDFA and other agencies working on the Healthy Soils Initiative to identify additional research needs to inform the science and accounting methods necessary to quantify the benefits of using compost and other soil amendments and address any potential problems such as buildup of salts or heavy metals in soil. Collaboration among state agencies, water districts, and local governments will help quantify the benefits of using compost for urban storm water management, soil remediation, water conservation, and other beneficial uses.

[32] https://www.gov.ca.gov/news.php?id=18828
[33] Informa Economics (2013) National Market Value of Anaerobic Digester Products, Prepared for the Innovation Center for U.S. Dairy, February.

D. Invest in SLCP Emission Reductions and Communities

Achieving significant reductions in SLCPs will require substantial investments to provide incentives and direct funding for priority sectors, sources, and technologies. Public investments should be smart and strategic, to leverage private investment and accelerate market transitions to cleaner technologies that foster significant system-wide solutions to cut emissions of SLCPs, maximize resource recovery from organic waste streams, and provide economic and health benefits in agricultural, disadvantaged, and rural parts of the State. Examples may include targeted support to reduce emissions of SLCPs and CO_2 through integrated strategies at dairies and in organic waste management; throughout the freight system; in commercial refrigeration applications; and from the management of woody waste materials in the urban, agricultural and forestry sectors.

Many of the sources and sectors responsible for SLCP emissions are concentrated in communities with high levels of pollution or unemployment, which could especially benefit from targeted investments to improve public health and boost economic growth. These include SLCP emissions from sources of organic waste and dairies in the Central Valley; ports and freight corridors in the East Bay, Los Angeles area and Inland Empire; and oil production, landfills and other sources of SLCP emissions throughout the State. Many communities in these areas, along with forested and rural communities in the northern part of the State and the Sierra, have some of the worst pollution burdens in the State, and high rates of poverty and unemployment. They are also where many billions of dollars in public and private investment will accrue in the coming years to reduce SLCP and CO_2 emissions and strengthen our agricultural sector, build sustainable freight systems, and grow healthy forests.

Initial estimates regarding State support for infrastructure to meet the goals identified in this Proposed Strategy is similar for both the waste sector and dairy sector. CalRecycle and CDFA both estimate that direct investments or incentives on the order of $100 million per year for five years could significantly scale project development to cut SLCP emissions associated with dairy manure and waste management. There could also be some opportunity to optimize investments and co-locate infrastructure or utilize existing infrastructure, including excess digestion capacity that exists at many wastewater treatment plants, which could potentially reduce the level of incentive funding needed to reach the targets outlined in this Proposed Strategy. Additional research and working group efforts will focus on opportunities to optimize infrastructure rollout and maximize benefit from any State investment.

The State will need to continue coordinating and utilizing funding sources, such as the Greenhouse Gas Reduction Fund (Cap-and-Trade auction proceeds),[34] the Alternative and Renewable Fuel and Vehicle Technology Program (AB 118), Electric Program Investment Charge (EPIC) Program, Carl Moyer program, Air Quality Improvement

[34] AB 1532 (Pérez, Chapter 807), SB 535 (De León, Chapter 830), and SB 1018 (Senate Budget Committee, Chapter 39) established the GHG Reduction Fund to receive Cap-and-Trade auction proceeds.

Program, and Proposition 39 to expand clean energy investments in California and further reduce emissions of SLCPs and other GHGs. Additionally, programs including the Bioenergy Feed-In Tariff, created by Senate Bill 1122 (Rubio, Chapter 612, Statutes of 2012), Low Carbon Fuel Standard, Cap-and-Trade, Self-Generation Incentive Program, Federal Renewable Fuel Standard, utility incentives pursuant to Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012), and others provide important market signals and potential revenue streams to support projects to reduce SLCP emissions. These programs are described in more detail in Chapter VII.

Potential new funding mechanisms and incentive structures must also be considered. These could include adjusting the waste disposal tipping fee structure to account for the full cost of managing organic materials and landfills, state procurement contracts for renewable natural gas and other fuels in buildings or vehicles as well as for compost and mulch products in landscaping and erosion control, or labeling programs to recognize leading companies in the market place, including those producing milk with low levels of dairy methane emissions or freight haulers using clean technologies.

E. Advance the Science of SLCP Sources and Emissions

Data related to SLCPs and their sources is often less available or of lower quality than it is for CO_2. One reason is that energy-related emissions of CO_2 are often easier to quantify than emissions of other GHGs, which may form through complex biological or other processes where existing reporting guidelines and procedures may not apply. There has also been less of a focus on collecting additional data that could help to quantify GHG emissions from some non-CO_2 sources.

This Proposed Strategy, including Appendices A and B, describes several coordinated research efforts under way and potential new ones. To provide a better understanding of methane emissions from the natural gas system and natural gas and oil supplied to California, dairy operations, landfills, as well as various sources of HFCs and black carbon emissions, others not identified here also may be considered in the future.

For example, methane emissions are emitted from a wide range of biological processes and fugitive and area sources that make estimating emissions difficult. California's methane emission estimates are derived from a variety of surveys, government data sources, growth assumptions and modeling methodologies. ARB staff is continuously assessing ways to improve the methane inventory by incorporating the latest scientific understanding of methane sources, through coordinated research with other agencies, and by using the best available activity data. Additional research and improved data sources will be needed to continue to refine the methane inventory and provide California-specific activity data.

While improving data access and quality is not a prerequisite for many actions to reduce emissions of SLCPs, it is nonetheless important for informing ongoing efforts to reduce SLCP emissions and meet broader climate targets. Improved data and reliable GHG measurements from landfills, dairies, and other more difficult-to-measure sources would also be necessary before these sources could be potentially included in California's Cap-and-Trade Program. State agencies will continue to monitor technology development and support continued research to improve the accuracy and reliability of emissions accounting from these sources.

F. Need for Focused SLCP Programs

This Proposed Strategy outlines specific emission reduction measures that could reduce California's emissions of SLCPs. This reliance on direct regulations, in concert with the existing greenhouse gas Cap-and-Trade Program, is consistent with California's approach on addressing climate change. California has already adopted several direct measures that ensure GHG emission reductions are achieved in specific sectors, including for SLCPs (for example, the Refrigerant Management Program that regulates F-gas emissions). These types of requirements motivate focused change—such as increased deployment of renewable energy (Renewable Portfolio Standard) or transformation of transportation fuels (Low Carbon Fuel Standard)—which may be more readily realized through direct measures than sole reliance on the Cap-and-Trade Program.

The Cap-and-Trade Program covers combustion and process operations. These emissions can be measured according to the accuracy requirements of the Mandatory Greenhouse Gas Emissions Reporting Regulation, which includes accurate quantification methodologies that allow for consistent carbon costs,[35] and the sources align with those covered by federal reporting programs.[36] In contrast, most fugitive emissions[37] (a category into which SLCP emissions generally fall) do not meet these criteria.[38] They are frequently difficult to measure, measurements have high

[35] *California Air Resources Board (2011) California's Cap-and-Trade Program Final Statement of Reasons*, Response to Comment E-31, at pg. 425. available at http://www.arb.ca.gov/regact/2010/capandtrade10/fsor.pdf.

[36] *Id.*, Response to Comment E-69, at pg. 448. available at http://www.arb.ca.gov/regact/2010/capandtrade10/fsor.pdf.

[37] Fugitives from certain oil and gas sources are an exception because, unlike other fugitive emissions, they are possible to quantify with rigor.

[38] ARB's responses to comments in the 2011 Final Statement of Reasons for the Regulation and Western Climate Initiative design documentation provide detailed rationale for the treatment of fugitive emissions in specific sectors. For example, the quantification methods that are often used to quantify fugitive emissions, including calibrated bagging, high volume sampling, and a default emissions factor, only provide a snapshot of emissions rather than actual measurements of emissions from the source. *See also* Western Climate Initiative, Inc. (2010) WCI Comments on the Proposed Mandatory Reporting of GHG Emissions from Proposed Reporting for Oil and Gas Operations (Subpart W), at pg. 44. available at http://www.westernclimateinitiative.org/document-archives/func-download/258/chk,ab6041717dc1be9cd3430f4f7585cb8e/no_html,1/.

uncertainties,[39] measurement methods are often difficult and less precise,[40] and carbon costs are hard to assign with the same reliability as for combustion sources of CO_2.[41] Because of these difficulties, and the importance of seeking SLCP-specific emission reductions, which the Cap-and-Trade Program is not designed to produce, this Proposed Strategy does not recommend expanding Cap-and-Trade Program coverage.[42] Instead, the Proposed Strategy focuses on specific measures for SLCP-emitting sectors, consistent with the approach ARB adopted while developing the AB 32 Scoping Plan and Cap-and-Trade Program.

ARB notes that stakeholders have expressed divergent views on this basic approach as it relates to animal agriculture. On one hand, the Animal Legal Defense Fund has petitioned ARB to include emissions from that sector in the Cap-and-Trade Program. On the other hand, representatives of many environmental justice and environmental groups have argued that direct, sector-specific measures are preferable, as have representatives of the dairy industry. This Proposed Strategy focuses on direct measures, consistent with the necessity of reducing SLCP emissions from the dairy sector specifically, and in-line with the design principles that underlie the State's climate strategy and the Cap-and-Trade Regulation.[43]

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[39] Western Climate Initiative, Inc. (2010) WCI Comments on the Proposed Mandatory Reporting of GHG Emissions from Proposed Reporting for Oil and Gas Operations (Subpart W) at pg. 39. available at http://www.westernclimateinitiative.org/document-archives/func-download/258/chk,ab6041717dc1be9cd3430f4f7585cb8e/no_html,1/.

[40] California Air Resources Board (2011) California's Cap-and-Trade Program Final Statement of Reasons, Response to Comment E-69, pg. 430 and 448. available at http://www.arb.ca.gov/regact/2010/capandtrade10/fsor.pdf.

[41] *Id.*, Response to Comment E-31, at pg. 425. available at http://www.arb.ca.gov/regact/2010/capandtrade10/fsor.pdf.

[42] ARB considered this option in detail, however. Further discussion is available in the California Environmental Quality Act (CEQA) appendix to this Proposed Strategy (Appendix C).

[43] The Livestock Project Compliance Offset Protocol is one such more focused measure now in operation. It contrasts with the wholesale coverage of the sector by the Cap-and-Trade Program that some stakeholders suggest. This protocol, focused on encouraging sector-specific reductions, would not operate if facilities in the sector had compliance obligations in the Program. The protocol balances the need for clear quantification methodologies and regulatory program requirements and ensures any credited voluntary GHG emission reductions meet the AB 32 criteria. The quantification methods included in this protocol use conservative factors to ensure that only real emission reductions are eligible for issuance of compliance offset credit.

III. Latest Understanding of Science on SLCPs

Climate change is already beginning to transform life on Earth**.** Around the globe, seasons are shifting, temperatures are climbing and sea levels are rising. Continued emissions of GHGs will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of GHG emissions.

There is growing recognition within the scientific and policy communities that efforts to address climate change should focus not only on reducing CO_2 emissions, but also on reducing emissions of SLCPs. While reducing CO_2 emissions will limit total warming over the long-term, reducing emissions of SLCPs will effectively slow the near-term rate of climate change. Therefore, the best path forward is to emphasize a coordinated strategy for simultaneous emission reductions for both SLCPs and CO_2,[44,45] which is needed to keep average warming below 2°C this century.

Short-lived climate pollutants have atmospheric lifetimes on the order of a few days to a few decades, and their relative climate forcing impacts, when measured in terms of how they heat the atmosphere, can be tens, hundreds, or even thousands of times greater than that of CO_2. Short-lived climate pollutants contribute about 40 percent to the current anthropogenic global radiative forcing, which is the primary forcing agent for observed climate change.[46,47,48,49,50]

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[44] Shoemaker, J K; Schrag, D P; Molina, M J; Ramanathan, V (2013) What Role for Short-Lived Climate Pollutants in Mitigation Policy? Science 342 (6164) 1323-1324

[45] Rogelj, J, Schaeffer M, Meinshausen M, Shindell D, Hare W, Klimont Z, Velders G, Amann M, Schellnhuber HJ. 2014. Disentangling the effects of CO2 and short-lived climate forcer mitigation. Proceedings of the National Academy of Sciences (PNAS). http://www.pnas.org/cgi/doi/10.1073/pnas.1415631111

[46] Calculation based on IPCC AR5 WGI Chapter 8. https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf

[47] Molina M, Zaelke D, Sarma KM, Andersen SO, Ramanathan V, Kaniaru D. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO_2 emissions. *Proceedings of the National Academy of Sciences of the United States of America*. 2009;106(49):20616-20621. doi:10.1073/pnas.0902568106. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2791591/

[48] Ramanathan V, Xu Y. (2010) The Copenhagen Accord for limiting global warming: criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences of the United States of America. 2010;107 (18):8055–8062. [PMC free article]

[49] IGSD (2013) Primer on Short-Lived Climate Pollutants, Institute for Governance and Sustainable Development, February 2013. http://igsd.org/documents/PrimeronShort-LivedClimatePollutantsFeb192013.pdf.

[50] Akbar, Sameer; Ebinger, Jane; Kleiman, Gary; Oguah, Samuel. (2013) *Integration of short-lived climate*

Co-Benefits of Reducing SLCPs

In addition to limiting climate change impacts already underway, SLCP emission reductions would reduce local air pollution and produce other co-benefits. The benefits could be even greater in the Arctic, which is especially vulnerable to black carbon emissions and is warming twice as fast as the rest of the world.[51] This would be critically important for stabilizing climate change and its impacts, as the Arctic is an important driver of sea level rise and weather patterns throughout the Northern Hemisphere. Climate change in the Arctic potentially impacts drought in California and extreme snow and cold in the upper Midwest and New England, although such links have not been definitively proven.[52,53] Accelerated warming in the Arctic could also lead to irreversible climate "tipping points," such as the release of vast quantities of CO_2 and methane from melting permafrost.[54]

In California, State and international action to reduce emissions of SLCPs can improve air quality and reduce related health risks. Other benefits to California include reducing damage to forests and crops, reducing background ozone and particulate levels to help meet federal air quality standards, and reducing disruption of historic rainfall patterns. California is working with a set of national and subnational partners throughout the world to fight air pollution and climate change, which will help deliver these benefits to our State while providing significant benefits where emission reductions occur.

Climate Impact

Global mean sea level will continue to rise during the twenty-first century, and the rate of sea level rise will exceed that observed during 1971 to 2010 due to increased ocean warming and increased loss of mass from glaciers and ice sheets.[55] A recent study raises the possibility of a more rapid rate of sea level rise in this century than forecast

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pollutants in World Bank activities: a report prepared at the request of the G8. Washington DC; World Bank. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/08/19/000333037_20130819113818/Rendered/PDF/804810WP0G80Re00Box0379805B00OUO090.pdf

[51] Quinn et al (2008) Short-lived pollutants in the Arctic: Their impact and possible mitigation strategies, *Atmospheric Chemistry and Physics* **8**, 1723-1735. http://www.atmos-chem-phys.net/8/1723/2008/acp-8-1723-2008.html

[52] Francis, J. A. and S. J. Vavrus. 2012. Evidence linking Arctic amplification to extreme weather in mid-latitudes. Geophysical Research Letters 39.

[53] Screen, J. A. and I. Simmonds (2013) Exploring links between Arctic amplification and mid-latitude weather. Geophysical Research Letters 40(5):959-964.

[54] Ramanathan V, Xu Y. The Copenhagen Accord for limiting global warming: criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences of the United States of America. 2010;107 (18):8055–8062. [PMC free article].

[55] IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.climatechange2013.org/images/report/WG1AR5_SPM_FINAL.pdf.

by the U.N.'s Intergovernmental Panel on Climate Change (IPCC).[56] The authors conclude that 2° C global warming above the preindustrial level would spur ice shelf melt sufficient to cause a sea level rise of several meters. Sea level rise is an important impact of climate change on California due to the long coastline and large population that lives near coastal waters. Mitigating SLCP emissions can have significant benefits for slowing sea level rise, reducing the rate by 24-50 percent by 2100, if it begins now. Mitigating emissions of both CO_2 and SLCPs can reduce the projected rate of sea level rise by 50–67 percent by 2100.[57]

Climate warming has intensified the recent drought in the southwestern U.S. as part of a trend toward enhanced drought that is projected to intensify through this century.[58] California droughts may be increasingly intensified due to declining availability of groundwater reserves. In the Central Valley, the current drought has cost California agriculture about $2.7 billion and more than 20,000 jobs in 2015, and agriculture is expected to face more frequent drought.[59] The current California drought highlights the critical need for developing drought resilience, even if wet conditions mitigate the current drought.[60,61]

Achieving Climate Stabilization

Scientific research indicates that an increase in the global average temperature of 2°C (3.6°F) above pre-industrial levels, which is only 1.1°C (2.0°F) above present levels, poses severe risks to natural systems and human health and well-being. Increased climate extremes, already apparent at present day climate warming (~0.9°C), will be

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[56] Hansen, J., Sato, M., Hearty, P., Ruedy, R., Kelley, M., Masson-Delmotte, V., Russell, G., Tselioudis, G., Cao, J., Rignot, E., Velicogna, I., Kandiano, E., von Schuckmann, K., Kharecha, P., Legrande, A. N., Bauer, M., and Lo, K.-W.(2015) Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming is highly dangerous, Atmos. Chem. Phys. Discuss., 15, 20059-20179, doi:10.5194/acpd-15-20059-2015, 2015. http://www.atmos-chem-phys-discuss.net/15/20059/2015/acpd-15-20059-2015.html

[57] Hu, A., Y. Xu, C. Tebaldi, W. M. Washington, and V. Ramanathan (2013), Mitigation of short-lived climate pollutants slows sea-level rise *Nature Climate Change* 3(5), 1–5, doi:10.1038/nclimate1869

[58] Cook, B. I., T. R. Ault, and J. E. Smerdon (2015), Unprecedented 21st century drought risk in the American Southwest and Central Plains, *Science Advances*, *1*(1), e1400082, doi:10.1126/sciadv.1400082.

[59] Economic Analysis of the 2015 Drought for California Agriculture. https://watershed.ucdavis.edu/droughtimpacts

[60] Noah S. Diffenbaugh, N.S., D.L. Swain, and D. Touma (2015) Anthropogenic warming has increased drought risk in California *PNAS 2015 112 (13) 3931-3936; published ahead of print March 2, 2015, doi:10.1073/pnas.1422385112. http://www.pnas.org/content/112/13/3931.abstract*

[61] A.P. Williams et al. (2015) Contribution of anthropogenic warming to California drought during 2012–2014**.** *Geophysical Research Letters*, 2015 DOI: 10.1002/2015GL064924

more severe. Studies indicate that available technologies, if universally adopted, can effectively reduce global methane emissions an estimated 40 percent and black carbon an estimated 80 percent below 1990 levels by 2030.[62] Additionally, a new proposed global phase down of HFCs under the Montreal Protocol (if adopted) and other efforts could cut the expected production of HFCs by up to 70 percent by 2030, and up to 85 percent by 2035.[63,64] Achieving this scale of global reductions would deliver significant climate benefits. It would cut the expected rate of global warming in half by 2050, slowing global temperature rise by about 0.6°C,[65,66] which would reduce the risk of dangerous climate feedbacks such as accelerated Arctic melting and sea level rise.[67] It would also increase the probability of staying below the 2°C threshold to more than 90 percent through 2050.[68,69]

Global Warming Potential

The IPCC developed the concept of global warming potential (GWP) as an index to evaluate the climate impacts of different GHGs, including SLCPs. This metric provides a comparison of the ability of each GHG to trap heat in the atmosphere relative to CO_2 over a specified time horizon. Global warming potentials account for the lifetime of different GHGs in the atmosphere, and the amount of energy they absorb on a per-kilogram basis, relative to CO_2, to represent the relative climate forcing of a kilogram of emissions when averaged over a time period of interest (for example, 20 years or 10 years). Current practice in most of the world for developing GHG emission inventories, including California's inventory, is to use GWP values from the 4th Assessment Report of the IPCC (AR4), which was released in 2007. For the first time, GWP estimates for black carbon are reported in the 5th Assessment Report of the IPCC (AR5), which includes the independent scientific assessment of black carbon

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[62] UNEP (2014) Time to Act (To Reduce Short-Lived Climate Pollutants), The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, United Nations Environment Programme, Second Edition, May. http://www.unep.org/ccac/Publications/Publications/TimeToAct/tabid/133392/Default.aspx

[63] Velders et al (2009) The Large Contribution of Projected HFC Emissions to Future Climate Forcing, *Proceedings of the National Academies* 106 (27), 10949-10954. www.pnas.org/cgi/doi/10.1073/pnas.0902817106

[64] Velders et al (2014) "Growth of climate change commitments from HFC banks and emissions", G. J. M. Velders, S. Solomon, and J. S. Daniel. *Atmospheric Chemistry and Physics*, 14, 4563–4572, 2014. doi:10.5194/acp-14-4563-2014. www.atmos-chem-phys.net/14/4563/2014/.

[65] Ramanathan V, Xu Y. The Copenhagen Accord for limiting global warming: criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences of the United States of America. 2010;107 (18):8055–8062. [PMC free article]

[66] UNEP (2014) Time to Act (To Reduce Short-Lived Climate Pollutants), The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants, United Nations Environment Programme, Second Edition, May. http://www.unep.org/ccac/Publications/Publications/TimeToAct/tabid/133392/Default.aspx

[67] UNEP and WMO (2011) Integrated Assessment of Black Carbon and Tropospheric Ozone, United Nations Environment Programme and World Meteorological Association. http://www.unep.org/dewa/Portals/67/pdf/BlackCarbon_report.pdf

[68] Ramanathan, V. and Yangyang Xu (2010) The Copenhagen Accord for Limiting Global Warming: Criteria, Constraints, and Available Avenues, *Proceedings of the National Academies of Sciences* **107** (18), pp.8055-8062. http://www.pnas.org/content/107/18/8055

[69] Xu, Y., D. Zaelke, G. J. M. Velders, and V. Ramanathan (2013), The role of HFCs in mitigating 21st century climate change, *Atmos. Chem. Phys.*, 13(12), 6083–6089

radiative forcing published by Bond et al.[70] This Proposed Strategy uses AR4 values for methane and HFCs, but AR5 for black carbon.

Considering ways of comparing the contributions of different climate pollutants to climate change has been raised in the IPCC AR5. The report focuses the discussion on the more well-known GWP and Global Temperature change Potential (GTP), though other concepts are also briefly discussed. The GTP is defined as the change in global mean surface temperature at a chosen point in time in response to an emission pulse, relative to that of CO_2. The Norwegian Environment Agency has recently performed an integrated assessment of climate, health and environmental effects of Norwegian emissions of SLCPs, and proposed measures for reducing such effects by 2030.[71] Specifically, they used the "GTP10, Norway", a global temperature change potential calculated ten years after the emission occurred in Norway, which they identify as the most practically appropriate metric for analyzing measures for Norwegian emissions of SLCPs in the short term. Overall, there is not one, single metric that describes the comparative climate effects of various short-lived and long-lived climate pollutants perfectly. The use of GWPs with a time horizon of 20 years better captures the importance of the SLCPs and gives a better perspective on the speed at which SLCP emission controls will impact the atmosphere relative to CO_2 emission controls. Thus, the emission estimates presented later in this report are calculated using 20-year GWP. Table 4 illustrates the lifetime and 20-year GWP for each SLCP.

Table 4: Global Warming Potential for SLCPs[1]

Pollutant	Lifetime (years)	20-year GWP
Carbon dioxide	~100[2]	1
Methane	12	72
F-Gases (Hydrofluorocarbons)	1.4 – 52	437 – 6350
Black carbon	Days to weeks	3,200

[1]All AR4 except black carbon which uses AR5 (the first report to define a GWP for black carbon)
[2]CO_2 has a variable atmospheric lifetime and cannot be readily approximated as a single number

The following sections describe the major SLCPs. An inventory of sources and emissions, and a discussion of current and proposed new control measures are included in other portions of this report.

[70] Bond, T. C., S. J. Doherty, D. W. Fahey, et al. (2013) "Bounding the role of black carbon in the climate system: A scientific assessment." Journal of Geophysical Research: Atmospheres doi:10.1002/jgrd .50171. http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50171/pdf
[71] Norwegian Environment Agency, *Summary of proposed action plan for Norwegian emissions of short lived climate forcers*, report M135/2014; http://www.miljodirektoratet.no/Documents/publikasjoner/M135/M135.pdf

A. Black Carbon

Airborne particulate matter (PM) varies in its composition and plays a significant role in human health and the climate system. Particulate matter is emitted from a variety of natural processes and human activities, and tends to remain in the air for only a few days to about a week, resulting in extreme spatial and temporal variability. Among different types of particles, carbonaceous particles (those that contain organic and black carbon) are particularly important because of their abundance in the atmosphere. With respect to climate impact, black carbon is the principal absorber of visible solar radiation in the atmosphere while organic carbon is often described as a light-reflecting compound.

Black carbon is emitted from burning fuels such as coal, diesel, and biomass. Black carbon contributes to climate change both directly by absorbing sunlight and indirectly by depositing on snow and by interacting with clouds and affecting cloud formation. In addition to its climate and health impacts, black carbon disrupts cloud formation, precipitation patterns, water storage in snowpack and glaciers, and agricultural productivity.

Scientists have known for some time that sources that emit black carbon also emit other short-lived particles that may either cool or warm the atmosphere. Lighter colored particles, for example, tend to reflect rather than absorb solar radiation and so have a cooling rather than warming impact. Until recently, it had been thought that the impact of lighter colored and reflecting organic carbon from combustion sources largely offset the warming impact of black carbon from this source. However, new studies have suggested that certain fractions of organic carbon known as “brown carbon” could be a stronger absorber of solar radiation than previously understood.[72,73] The warming effect of brown carbon may offset the cooling impact of other organic carbon particles; hence, quantification of that absorption is necessary so that climate models can evaluate the net climate effect of organic carbon.

To help characterize and differentiate sources of brown carbon from black carbon and understand their climate impact in California, a current ARB-funded research project is applying advanced measurement methodology along with regional and global climate modeling simulations to characterize the extent to which brown carbon contributes to climate forcing in California. This project will improve our understanding of the fundamental processes that dominate brown carbon formation, and help to determine the potential climate benefit of mitigating sources of brown carbon emissions in California.

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[72] Jacobson, M. Z. (2014), Effects of biomass burning on climate, accounting for heat and moisture fluxes, black and brown carbon, and cloud absorption effects, J. Geophys. Res. Atmos., 119, 8980–9002, doi:10.1002/2014JD021861 http://onlinelibrary.wiley.com/doi/10.1002/2014JD021861/pdf

[73] Kodros, J. K., Scott, C. E., Farina, S. C., Lee, Y. H., L'Orange, C., Volckens, J., and Pierce, J. R.: Uncertainties in global aerosols and climate effects due to biofuel emissions, Atmos. Chem. Phys., 15, 8577-8596, doi:10.5194/acp-15-8577-2015, 2015. http://www.atmos-chem-phys.net/15/8577/2015/acp-15-8577-2015.pdf

B. Methane

Methane is the principal component of natural gas and is also produced biologically under anaerobic conditions in ruminants (animals with a four-part stomach, including cattle and sheep), landfills, and waste handling. Atmospheric methane concentrations have been increasing as a result of human activities related to agriculture, fossil fuel extraction and distribution, and waste generation and processing. The atmospheric lifetime of methane is about 12 years. It is well-mixed within the atmosphere, and like other GHGs, warms the atmosphere by blocking infrared radiation (heat) that is re-emitted from the earth's surface from reaching space. Almost all of methane's impact occurs within the first two decades after it is emitted.

Methane is responsible for about 20 percent of current global warming,[74] and methane emissions continue to increase globally. There is particular concern among scientists that continued climate warming may cause massive releases of methane from thawing arctic permafrost, and dissolve frozen methane clathrate deposits trapped within shallow ocean sea floors.

A recent study, which examines the interaction of methane with other atmospheric gases, indicates methane emissions may have even greater climate change impacts than previously understood.[75] In the AR5 report, when all the feedbacks are included, the GWP for methane was increased, from 25 to 28 over a 100-year timespan and from 72 to 84 over a 20-year timespan. However, for consistency with reporting requirements under the United Nations Framework Convention on Climate Change, ARB is using GWP values from the AR4.

Methane also contributes to global background levels of ozone in the lower atmosphere (troposphere). Photo-oxidation of both methane and carbon monoxide lead to net production of global background levels of ozone. Ozone itself is a powerful SLCP as well as a regional ground level air pollutant. Tropospheric ozone is not emitted directly into the atmosphere, but rather formed by photochemical reactions. Its average atmospheric lifetime of a few weeks produces a global distribution highly variable by season, altitude, and location. The radiative forcing of tropospheric ozone is primarily attributed to emissions of methane, but also to carbon monoxide, volatile organics, and nitrogen oxides that eventually form ozone.

Ozone negatively impacts human health, and can lead to asthma attacks, hospitalizations, and even premature death. It impairs the ability of plants to absorb CO_2, thereby suppressing crop yields and harming ecosystems. Ozone also affects evaporation rates, cloud formation, and precipitation levels. In addition to the direct climate benefits of cutting methane emissions, it can also reduce global background

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[74] Kirschke, S. *et al.* (2013) Three decades of global methane sources and sinks. *Nature Geosci.* **6**, 813–823. http://www.nature.com/ngeo/journal/v6/n10/full/ngeo1955.html?WT.ec_id=NGEO-201310

[75] Holmes, C. D., M. J. Prather, O. A. Sovde, and G. Myhre. 2013. "Future methane, hydroxyl, and their uncertainties: Key climate and emission parameters for future predictions." Atmospheric Chemistry and Physics 13: 285–302. http://www.atmos-chem-phys.net/13/285/2013/acp-13-285-2013.pd

levels of ozone pollution and provide additional climate, health, and other benefits.[76,77,78]

Regional ozone concentrations reflect contributions from both ozone formed from criteria pollutant emissions (NO_X and volatile organic compounds [VOCs]) on a regional scale, and ozone transported on hemispheric scales (global background levels of ozone). Due to its low reactivity, methane emissions do not affect regional scale ozone production that occurs over hours to days. However, regional methane emissions which are fairly well-mixed in the atmosphere contribute to the global abundance of methane, which in turn contributes to global background levels of ozone. About two-thirds of the rise in global levels of tropospheric background ozone can be attributed to methane emissions. Studies have also shown that the global background ozone concentrations can approach 40 parts per billion and have been increasing in recent years. Increases in background ozone make it harder to attain the health-based ambient air quality standards set by U.S. EPA and California.

C. Fluorinated Gases (Hydrofluorocarbons)

Hydrofluorocarbons (HFCs) are synthetic gases used in refrigeration, air conditioning, insulating foams, solvents, aerosol products, and fire protection. They are primarily produced for use as substitutes for ozone-depleting substances, including chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), which are being phased out under the Montreal Protocol. Currently, HFCs are a small fraction of the total climate forcing, but they are the fastest growing source of GHG emissions in California and globally, primarily driven by the increased demand for refrigeration and air conditioning.

HFCs vary significantly in their ability to influence climate. Their differing ability is mostly due to differences in their atmospheric lifetimes, which determine how much they accumulate in the atmosphere. The mix of HFCs in current use, weighted by usage (tonnage), has an average atmospheric lifetime of 15 years. HFCs are also potent GHGs, with a warming effect hundreds to thousands of times more powerful than CO_2. The average 100-year GWP of the current mix of HFCs being used is about 1600, and the average 20-year GWP is about 3500. The major concern with respect to HFCs is that their contribution to climate forcing is expected to increase rapidly in the future as

[76] Fiore, A. M., J. J. West, L. W. Horowitz, V. Naik, and M. D. Schwarzkopf (2008) Characterizing the tropospheric ozone response to methane emission controls and the benefits to climate and air quality, J. Geophys. Res., 113, D08307, doi:10.1029/2007JD009162.
[77] West, J. J., A. M. Fiore, L. W. Horowitz, and D. L. Mauzerall (2006), Global health benefits of mitigating ozone pollution with methane emission controls, Proc. Natl. Acad. Sci. U.S.A., 103, 3988–3993.
[78] Fiore, A. M., F. J. Dentener, O. Wild, C. Cuvelier, M. G. Schultz, P. Hess, C. Textor, M. Schulz, R. M. Doherty, L. W. Horowitz, I. A. MacKenzie, M. G. Sanderson, D. Shindell, D. S. Stevenson, S. Szopa, R. Van Dingenen, G. Zeng, C. Atherton, D. J. Bergmann, I. Bey, G. Carmichael, W. J. Collins, B. Duncan, G. Faluvegi, G. Folberth, M. Gauss, S. Gong, D. Hauglustaine, T. Holloway, I. S. A. Isaksen, D. Jacob, J. E. Jonson, J. W. Kaminski, T. J. Keating, A. Lupu, E. Marmer, V. Montanaro, R. J. Park, G. Pitari, K. J. Pringle, J. A. Pyle, S. Schroeder, M. G. Vivanco, P. Wind, G. Wojcik, S. Wu, and A. Zuber (2009), Multimodel estimates of intercontinental source-receptor relationships for ozone pollution, J. Geophys. Res., 114, D04301, doi:10.1029/2008JD010816.

they continue to replace ozone depleting substances (ODS), such that they will become very significant contributors. Studies indicate that a lack of action to prevent the growth of HFCs would greatly undermine efforts to address climate change. A recent study concluded that replacing high-GWP HFCs with low-GWP alternatives could avoid 0.1°C of warming by 2050 and warming of up to 0.5°C by 2100,[79] offering one of the most cost-effective climate mitigation strategies available.

The successful phase-out of CFCs and the ongoing phase-out of HCFCs have made the Montreal Protocol an effective climate treaty.[80,81] Between 1990 and 2010 the Montreal Protocol reduced CO_2e emissions nearly twenty times more than the initial commitment period of the Kyoto Protocol.[82] Although HFCs have contributed a miniscule amount of historical climate forcing, they are projected to increase significantly in the absence of control policies. Hence, a global phase down of HFCs is necessary to slow their effect on climate change. International, national, and state efforts to reduce emissions of HFCs are discussed in more detail in Chapter VI.

[79] Xu Y., Zaelke D., Velders G. J. M., & Ramanathan V. (2013) The role of HFCs in mitigating 21st century climate change , ATMOS. CHEM. PHYS. 13:6083-608.
[80] Velders G. J. M. *et al.* (2007) *The importance of the Montreal Protocol in protecting climate*, Proc. Nat'l. Acad. Sci. USA 104:4814.
[81] Wu, Y., L.M. Polvani and R. Seager, (2013): The Importance of the Montreal Protocol in Protecting the Earth's Hydroclimate. *J. Climate*, 26, DOI: 10.1175/JCLI-D-12-00675.1, http://www.ldeo.columbia.edu/res/div/ocp/glodech/PDFS/Wu_etal_O3_2013.pdf
[82] UNEP (2012) The Montreal Protocol and the Green Economy: Assessing the contributions and co-benefits of a Multilateral Environmental Agreement.

IV. Reducing Black Carbon Emissions

Black carbon is the light-absorbing component of fine particulate matter (PM) produced during incomplete combustion of fuels. Black carbon does not account for the warming effects of brown carbon. The lifetime of black carbon is very short, from days to weeks, compared to other SLCPs, which may remain in the atmosphere for a few decades.

California has done more than any other jurisdiction in the world to reduce PM and black carbon emissions. As a result, ambient levels of black carbon in California are now 90 percent lower than in the early 1960s, despite the use of diesel fuel more than tripling over the same time period.[83] If the rest of the world achieved similar reductions, it could substantially improve health and slow global warming. California's actions can serve as a blue print for other jurisdictions to reduce SLCP emissions and improve public health. California is continuing to explore additional ways to reduce black carbon emissions. Complying with federal air quality standards and reducing localized risk will require substantial reductions in smog-forming and PM emissions from mobile sources and other source categories.

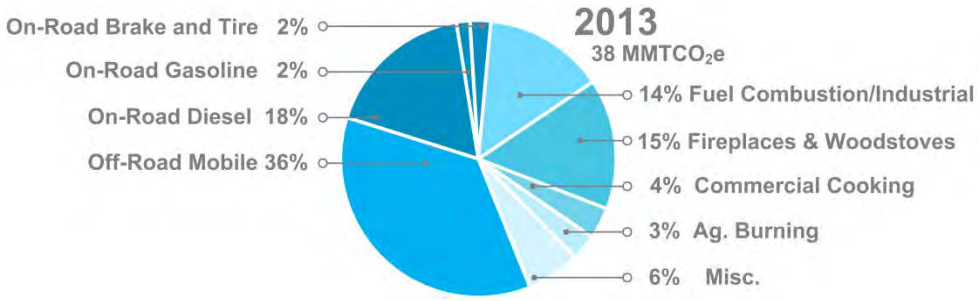
For purposes of this report, black carbon emissions are discussed in two categories, anthropogenic (non-forest) sources and forest-related sources. Anthropogenic sources include on- and off-road transportation, residential wood burning, fuel combustion, and industrial processes. Forest-related sources include prescribed fire and wildfire and are separated to account for the unique challenges associated with inventorying and mitigating these sources. In a typical year, wildfires account for approximately two-thirds of California's black carbon emissions, but this varies from year to year. Prescribed fires also emit black carbon, but are an important tool for forest managers to help restore and maintain forest health, which in turn can reduce wildfire severity and the associated black carbon emissions from catastrophic wildfires.

A. Anthropogenic (Non-Forest) Sources of Black Carbon Emissions

California's major anthropogenic sources of black carbon include off-road transportation, on-road transportation, residential wood burning, fuel combustion, and industrial processes (Figure 1). The fuel combustion and industrial source categories include a variety of stationary and portable equipment such as boilers, turbines, and steam generators, as well as process emissions from industrial operations, such as cement and asphalt production and pulp and paper mills. Sources in the miscellaneous category include dust, waste disposal, unplanned structure and car fires, residential natural gas combustion, and non-agricultural open burning (mostly residential green waste burning).

[83] V. Ramanathan et al. 2013. Black Carbon and the Regional Climate of California. Report to the California Air Resources Board No. 08-323. http://www.arb.ca.gov/research/apr/past/08-323.pdf

Figure 1: California 2013 Anthropogenic (non-forest) Black Carbon Emission Sources*

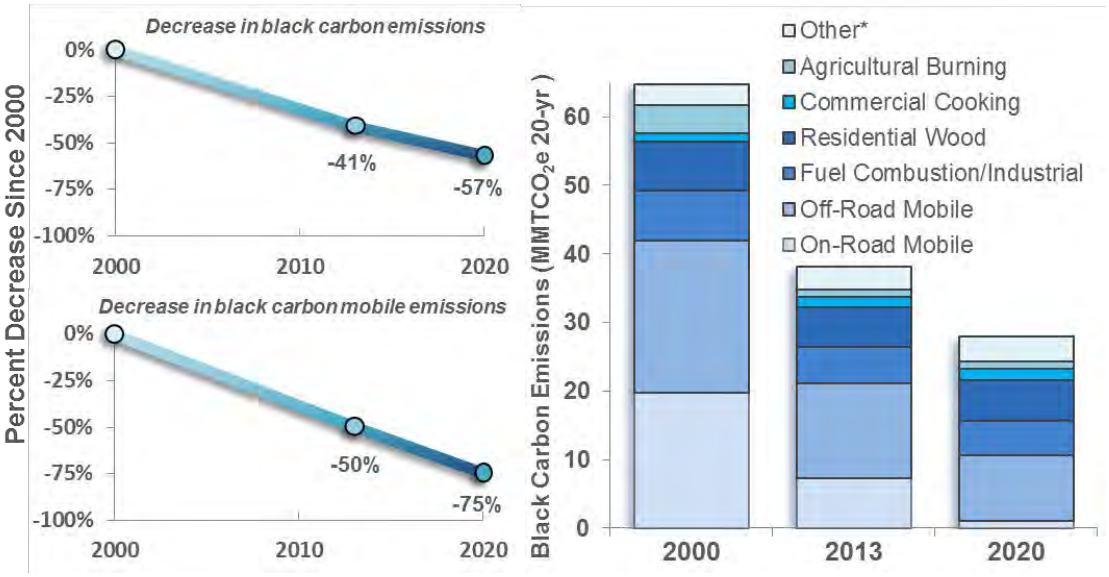


*Using 20-year GWP

1. Progress to Date

California's program to reduce emissions from transportation sources of black carbon can serve as a blueprint for other jurisdictions seeking to address both the climate change and public health impacts of mobile sources, particularly diesel engines. Over the last few decades, ARB has employed a variety of strategies that has drastically reduced black carbon emissions from mobile sources, including lower emission standards, clean fuel requirements, in-use rules, incentives, and investments in research and new technology. Diesel particulate filters have been instrumental in reducing black carbon in on-road and major portions of the off-road sector. Today's diesel particulate filter-equipped trucks are more than 99 percent cleaner than those manufactured in 1990. Measures have also been implemented on the State and local level to reduce PM, and thus black carbon, emissions from non-mobile sources, including residential burning, commercial cooking, and agricultural burning. Existing measures are projected to cut mobile source emissions by 75 percent and total anthropogenic (non-forest) emissions by nearly 60 percent between 2000 and 2020 (Figure 2).

Figure 2: California's Black Carbon Emissions between 2000 and 2020 with Existing Measures



California has highlighted our accomplishments in discussions with other jurisdictions, including a SLCP-focused side event, jointly hosted with Mexico, at the Conference of Parties in Lima in 2014 and at international climate conferences in 2015. We will continue to work closely with our partners in other states, in the federal government, and internationally to highlight the successful actions California has taken, and will continue to take, to reduce black carbon from mobile sources.

Mobile Sources

In 2000, ARB approved a Diesel Risk Reduction Plan, calling for an 85 percent reduction in diesel PM emissions by 2020.[84] Diesel engines often operate for decades after they are purchased, so while lower emission standards provide major emission reductions, those reductions can take time to materialize as older engines are replaced with new ones meeting the standard. To reduce risk and speed emission reductions, ARB implemented in-use rules for on-road and off-road fleets to meet performance standards through the use of alternative fuels, after-treatment retrofits, or replacement of older vehicles with newer vehicles manufactured to current emission standards. In-use on-road rules are expected to reduce black carbon emissions from on-road sources by 80 percent between 2000 and 2020. ARB's off-road rules

[84] Final Diesel Risk Reduction Plan available at: http://www.arb.ca.gov/diesel/documents/rrpapp.htm

apply to approximately 150,000 off-road vehicles and are expected to reduce diesel PM emissions by 20 percent between 2009 and 2023.

These regulations provide significant reduction in diesel PM exposure in communities located near California's major ports and intermodal railyards and contribute to a larger coordinated effort to reduce black carbon and PM emissions from all sources at ports and railyards.[85] Overall, since 2005, California has reduced diesel particulate emissions, along with the associated health risks, by 70 percent at the largest ports and 50–70 percent at the highest-risk railyards.

Incentive programs, including the Carl Moyer Memorial Program, AB 923, AB 118 Air Quality Improvement Program (AQIP), Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP), and Proposition 1B, have provided the means to transform California's mobile fleet into one of the cleanest in the world. These programs have provided more than $1.6 billion over the past 15 years to clean up diesel engines and simultaneously reduce black carbon.

Cleaner fuels have been a cornerstone of ARB efforts to reduce mobile emissions, enabling cleaner vehicle technologies that have reduced smog-forming emissions by 15 percent and reduced cancer risks from vehicle pollution by 40 percent. The Low Carbon Fuel Standard provides a strong financial incentive to develop clean fuel alternatives, which may also reduce black carbon. For example, renewable diesel and biodiesel may reduce both PM and black carbon emissions compared to conventional diesel, especially in engines where diesel particulate filter technology is not available.

California has also paved the way for increased penetration of zero-emission vehicles (ZEV) through incentive programs and investment in new technology. The ZEV regulation was first adopted in 1990, as part of the Low Emission Vehicle Program. Today California is the world's single largest market for light-duty passenger ZEVs, accounting for 20 percent of all ZEVs on the road.[86] ARB will continue to lead in this area with the Governor's ZEV action plans to accelerate use of ZEVs and deploy 1.5 million passenger ZEVs in California by 2025. Providing financial and technological pathways to accelerating growth in ZEVs and other advanced engine technologies within California will push market development for clean and zero-emission vehicles throughout the world, providing additional black carbon emission reductions outside of California.

ARB is developing an integrated mobile source strategy to meet California's air quality and climate mandates, reduce petroleum use, and reduce near source risk. Accomplishing this will require a transformation to near-zero and zero emission technologies, cleaner renewable fuels, greater system and operational efficiencies, and

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[85] Dallmann et al. 2011. Effects of Diesel Particle Filter Retrofits and Accelerated Fleet Turnover on Drayage Truck Emissions at the Port of Oakland, Environmental Science & Technology, 45, 10773-10779.

[86] Draft 2015 ZEV Action Plan available at: http://gov.ca.gov/docs/DRAFT_2015_ZEV_Action_Plan_042415.pdf

new approaches to passenger and freight mobility. These coordinated efforts will provide California a clear path forward to reduce the State's impacts on climate change including reductions in black carbon emissions.

In April 2015, ARB released the *Sustainable Freight Pathways to Zero and Near-Zero Discussion Document* that outlines initial steps ARB is taking to accelerate progress toward zero and near-zero emission freight vehicle and equipment technology in California.[87] In July 2015, the Governor signed Executive Order B-32-15, that directs the Secretaries of Transportation, Environmental Protection, and Natural Resources to lead staff from the California Department of Transportation (Caltrans), ARB, the California Energy Commission (Energy Commission), and the Governor's Office of Business and Economic Development (GO-Biz), in the development of an integrated action plan, the California Sustainable Freight Action Plan (Action Plan). The agencies must develop the Action Plan by July 2016 that establishes targets, identifies actions to achieve the targets, and initiates work on pilot projects.

In September 2015, ARB staff released the *Mobile Source Strategy Discussion Draft*, which introduced a comprehensive plan to control emissions from mobile sources in order to meet critical air quality and climate goals over the next fifteen years.[88] Since October, developments in planning efforts have continued to shape staff's mobile source approach. The Mobile Source Strategy will be released in April 2016, reflecting these developments.

Specifically for criteria pollutants, the ARB staff developed the State SIP Strategy that will propose measures to meet federal air quality standards for ozone and fine particulate matter (PM2.5). SIPs are due to U.S. EPA in 2016. Building on measures first introduced in the *Mobile Source Strategy Discussion Draft,* the State SIP Strategy will be also released in April 2016.

As emissions from mobile sources decrease, non-mobile sources will become an increasingly important fraction of the black carbon inventory. The main non-mobile emission sources include residential wood combustion, fuel combustion from stationary and small portable equipment, and industrial sources. Commercial cooking and agricultural burning make up a smaller portion of emissions.

Residential Wood Combustion

A number of local air districts have residential wood combustion rules, and are working to make further progress in this category to meet air quality standards and protect public health.[89] Strategies in place to reduce emissions from residential wood combustion

[87] http://www.arb.ca.gov/gmp/sfti/sustainable-freight-pathways-to-zero-and-near-zero-emissions-discussion-document.pdf
[88] http://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc_dd.pdf
[89] Yap and Garcia 2015. Effectiveness of residential wood-burning regulation on decreasing particulate matter levels and hospitalizations in the San Joaquin Valley Air Basin, Am J Public Health, 105(4), 772-778.

include winter burning curtailment, opacity emission limits, incentives to replace old wood burning devices with more efficient models, and banning or limiting wood burning devices in new and existing housing. Additionally the U.S. EPA has recently introduced a new source performance standard requiring manufacturers of residential wood stoves, pellet stoves, forced air furnaces, and hydronic heaters to meet national emission standards. Statewide black carbon emissions from residential wood combustion have declined by nearly 20 percent between 2000 and 2013 in response to existing district rules.

Stationary Fuel Combustion and Industrial Sources

Emissions from stationary fuel combustion will be addressed by a number of State and federal planning efforts, including the SIP, Cap-and-Trade Program, increased building energy efficiency and renewable energy goals, and the federal Clean Power Plan (promulgated under Clean Air Act Section 111(d)). California's Cap-and-Trade regulation and the LCFS create market signals to incentivize efficiency improvements as well as the use of biomass-derived liquid fuels that would emit lower levels of PM and black carbon than traditional fossil fuels. The federal Clean Power Plan, which accelerates the transition from coal towards lower carbon-intensive fuels for electricity production, will reduce black carbon emissions, and emissions of other GHGs, across the nation. Further emission reduction opportunities from stationary fuel combustion and industrial processes may also be identified as part of the SIP process.

Commercial Cooking

Commercial cooking emissions are primarily from charbroiling. The two types of charbroilers include chain-driven, where food moves mechanically through a semi-enclosed broiler, and under-fired, where food is cooked on a grill similar to a home barbeque. A number of local air districts require air pollution control technologies for chain-driven broilers, reducing particulate emissions from these charbroilers by over 80 percent. Under-fired charbroilers are a larger source of PM, but no cost-effective air pollution control technology has been identified to date. Air districts are working to develop air pollution control devices for under-fired charbroilers. Demonstration projects for emerging control technologies are in progress and it is anticipated that large districts will develop rules for these emissions going forward.

Agriculture

Agricultural burning was historically used as a cost-effective way to remove agricultural residue left behind on fields, help control weeds and pests, and prevent the spread of plant disease, but emissions impacted local air quality and prompted concern for public health. Various programs are currently administered by the local air districts in

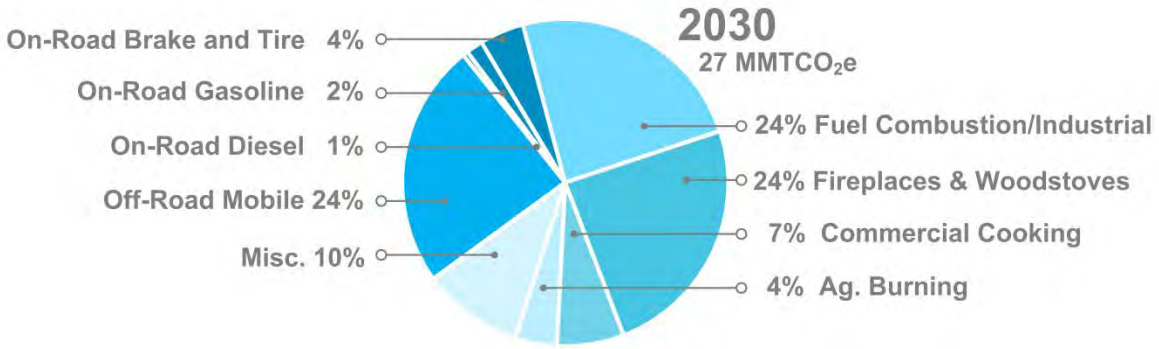
coordination with ARB to reasonably regulate agricultural burning as required by state law. The Sacramento Valley Rice Straw Burning Phasedown Program, local district Smoke Management Programs, and San Joaquin Valley agricultural burning phase down efforts have resulted in an approximately 70 percent reduction in black carbon emissions from agricultural burning between 2000 and 2013. Some agricultural waste that was previously burned went to bioenergy facilities; however, many of these facilities have shut down over the last few years due to their inability to procure long-term power purchase contracts. If this trend continues, the diminishing agricultural waste utilization options could result in the potential for increased agricultural burning. The San Joaquin Valley Air Pollution Control District is considering the need to allow increased agriculture burning of certain crops due to the lack of feasible alternatives to removing this waste in the fields. Programs to support clean energy and fuel production and markets for wood products, similar to the recommendations later in this section for forest woody biomass, would provide opportunities for alternative beneficial uses for this waste material.

Agriculture irrigation pumps are a small source of black carbon on a statewide level, but may be an important local source. Multiple federal, state, and local governments have provided incentives to convert agricultural diesel irrigation engines to either newer cleaner diesel engines or to electric motors. This has led to black carbon emissions from irrigation pumps declining by half between 2000 and 2013, with additional reductions expected going forward in response to existing measures.

California has achieved tremendous reductions in black carbon emissions, especially in the mobile sector, and even more reductions are expected as current measures are fully implemented. In 2000, on-road mobile sources contributed a third of anthropogenic black carbon emissions, but are projected to account for only a small fraction of total emissions by 2030. Off-road mobile emissions, including aircraft, watercraft, trains, small equipment, forklifts and farm equipment, have declined by over a third since 2000, and are projected to decrease by another half by 2030.

However, meeting the 2030 black carbon emission target identified in this Proposed Strategy (for non-forest only) requires additional emission reductions across multiple sectors. Off-road mobile sources, along with stationary fuel combustion and residential wood burning, will make up the majority of emissions by 2030 (Figure 3). Additional 2030 reductions will be realized through implementation of measures identified in plans currently being developed, including the California Sustainable Freight Action Plan and the State Implementation Plans (SIPs). Additional reductions are also expected through a district-lead commercial cooking regulation, but the magnitude of emission reductions is currently unknown.

Figure 3: California's 2030 Anthropogenic (non-forest) Black Carbon Emission Sources with Existing Measures*



*Using 20-year GWP

2. Recommended Actions to Further Reduce Non-Forest Black Carbon Emissions

This section describes proposed new measures (summarized in Table 5 below) to assist the State in meeting the proposed 2030 black carbon emission target.

Table 5: Proposed New Black Carbon Emission Reduction Measures and Estimated Emission Reductions ($MMTCO_2e$)[1]

Measure Name	2030 Annual Emission Reductions	2030 Annual Emissions
2030 BAU[2]		**26**
Residential Fireplace and Woodstove Conversion	3	
California Sustainable Freight Action Plan State Implementation Plans Clean Energy Goals[3]	4	
2030 BAU with new measures		**19**

[1]Using 20-year GWPs from the 5th Assessment report of the IPCC
[2]Business As Usual (BAU) forecasted inventory includes reductions from implementation of current regulations
[3]Additional black carbon reductions will be realized from planned measures and are expected to help the State meet the black carbon target. However, an estimate of emission reductions is not currently available, but will be developed as part of these planning efforts.

Residential Fireplace and Woodstove Conversion Measure

Residential wood combustion is forecast to be the largest individual anthropogenic source of black carbon in 2030 if no new programs are implemented, accounting for a quarter of anthropogenic black carbon emissions. Reducing 2030 residential wood

combustion black carbon emissions by half (3 $MMTCO_2e$) would set California on a path toward meeting the 2030 target in this Proposed Strategy.

Removal of old fireplaces and woodstoves and replacement with EPA-Certified wood-burning devices, electric heaters, or gas fireplaces can provide long lasting reductions in emissions of black carbon, criterial pollutants, and air toxics in residential neighborhoods. Removed wood burning devices should be destroyed or recycled to ensure permanent emission reductions.

Monetary incentives to stimulate removal of old wood burning devices are popular and can achieve significant emission reductions. Multiple air districts have invested in incentive programs, but additional funding is necessary to continue to realize emission reductions in this category. In addition, programs should be expanded to include all regions of California. Incentive funding to support further district efforts could come from a variety of national, State, and local resources. The Governor's 2016-2017 proposed budget includes $40 million of Cap-and-Trade expenditure for a residential woodstove replacement incentive program, but this potential incentive program will not be developed and implemented until the Legislature appropriates funds for this Program.

In addition, ARB is proposing to work with the air districts to determine the most effective approach to avoid new residential wood combustion emissions in California. This could include encouraging the installation of non-wood burning centralized heating in new construction. In areas where central heat is cost-prohibitive, the cleanest available burning technology could be required.

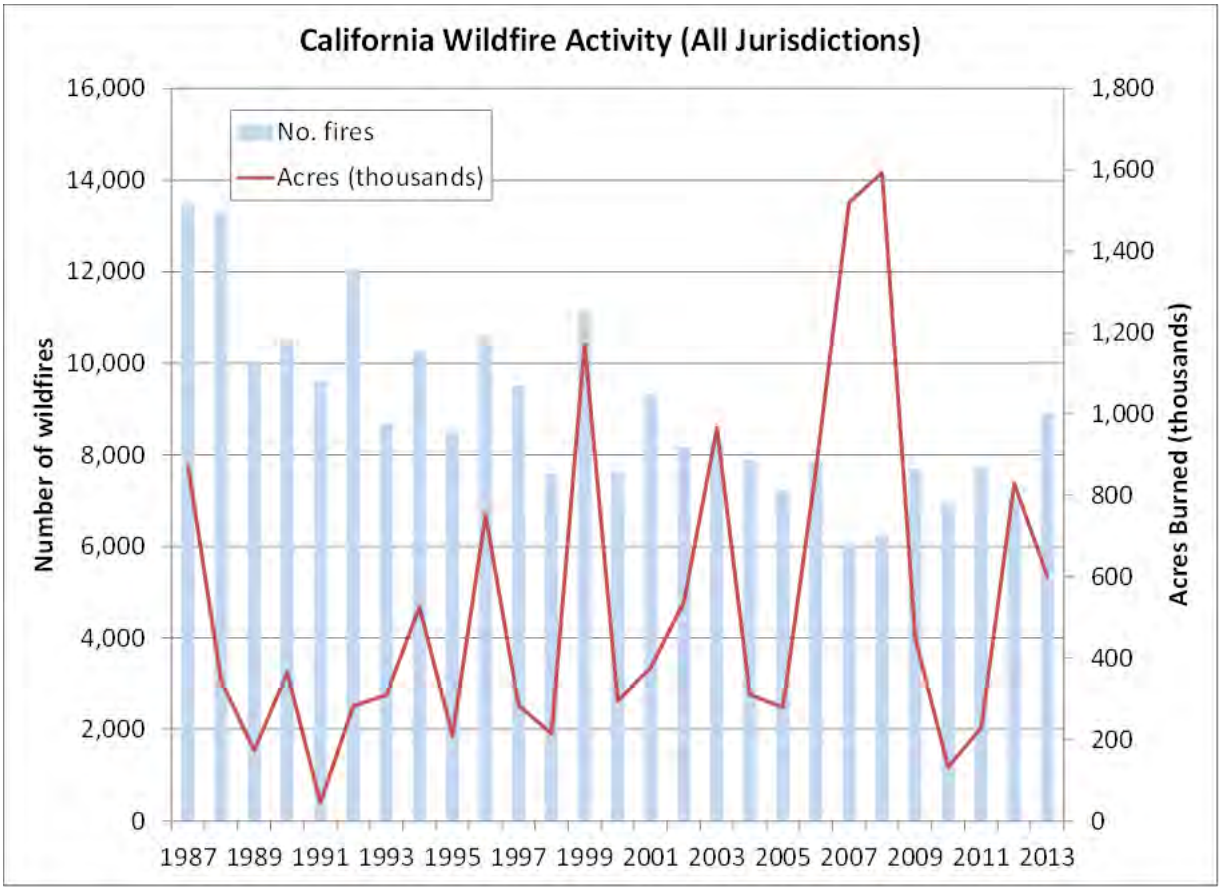
Education and outreach are important tools to reduce emissions from residential wood combustion. A broader public understanding of the health and environmental impacts of wood smoke may cause voluntary changes in behavior to use other heating sources and may cause individuals to avoid unnecessary burning both indoors and outdoors. Education on proper burn practices may reduce emissions when wood is used, and is essential to achieve full emission reductions from EPA-Certified wood burning devices. Some districts have already implemented education programs, which should be expanded to all parts of the State as part of this measure.

B. Forest-Related Sources of Black Carbon Emissions

Wildfires account for the majority of black carbon emissions during a typical year in California. On average, an area the size of Las Vegas burns each year. The extent and severity of wildfire varies significantly from one year to the next and is impacted by forest conditions that are influenced by historic management, drought, and climate change (see Figure 4).

While we must act to reduce wildfire risk in the State, we will never be able to fully control wildfire and associated black carbon emissions to meet specific targets in any given year. Consequently, forest-related emissions are not included in the anthropogenic black carbon emission reduction target identified in this Proposed Strategy. Still, efforts to reduce black carbon from wildfires are critical to California's efforts to cut SLCP emissions. As part of an integrated and long-term effort to sustainably manage forests, California can reduce the risk of catastrophic wildfire and forest-related black carbon emissions in California over time.

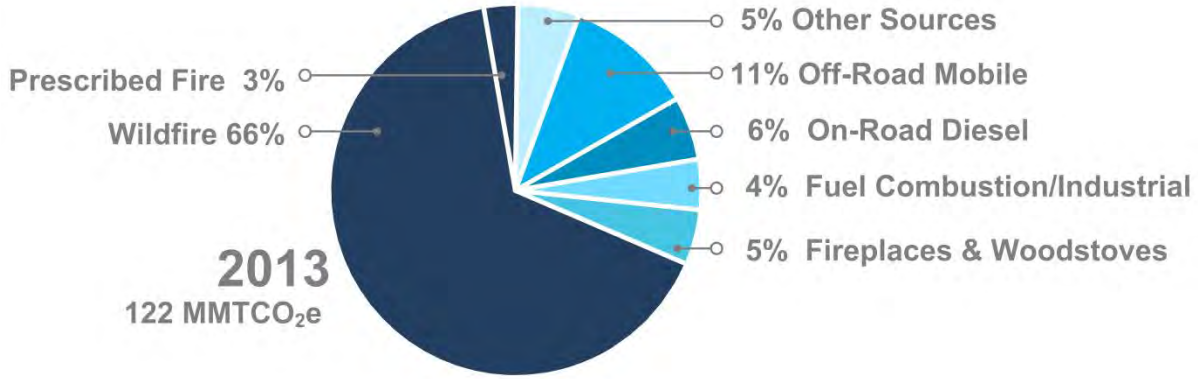
Figure 4: Wildfire Activity in California.[90]



California's black carbon inventory uses the 10-year average from 2001-2011 of PM2.5 emissions from wildfire to represent average conditions and avoid large year-to-year variations in the inventory. Based on these methods, a typical recent wildfire year would account for two-thirds of the State's black carbon emissions in 2013 (Figure 5). The frequency of large fire events and the associated emissions will likely increase in the future, due to climate change, heavy fuel loading, historic fire suppression practices, and development in forested areas.[91,92]

[90] http://calfire.ca.gov/communications/downloads/fact_sheets/AllAgenciesAcres&Fires.pdf
[91] Westerling et al. 2006. Warming and earlier spring increase western US forest wildfire activity. Science, 313(5789), 940-943.

Figure 5: California 2013 Black Carbon Emissions (including 10-year average emissions from forest-related sources)*



*Using 20-year GWP. "Prescribed Fire" does not include agriculture.

California's forests consist of a range of ecosystems, managed under various regulatory structures by different landowners. This patchwork of regulation and ownership, as well as physical accessibility, affects forest conditions and management practices. Private forests and areas designated as timberlands tend to be less susceptible to wildfire, as they are managed to minimize fuel loads and protect commercial assets. The value of timber harvest can help offset forest management costs, but may not be optimal from an ecological standpoint. More than 35 percent of California's forests are privately-owned, 60 percent of which is managed as timberlands. Federal agencies manage well over half of the nearly 33 million acres of forestland in California. Federal lands are managed for multiple objectives, including timber harvest, but also with ecological restoration as a focal point. Continued coordination with private and federal land owners is necessary to ensure that improved management practices, resulting in overall black carbon and GHG benefits, reach throughout California's forest lands.

1. Progress to Date

After a century of fire suppression, chronic underfunding for forest management at the State and Federal level, and exacerbating impacts of climate change, bark beetle infestations and drought, California's forests are highly vulnerable and potentially a source of increasing black carbon emissions. The current rate of fuel reduction activity is insufficient to improve forest health, avoid catastrophic wildfire, produce resilient forests, and reduce black carbon emissions. For example, the U.S. Forest Service estimates that less than 20 percent of the Forest Service lands in need of fuels reduction treatment have been treated.[93] Once treated, these forest stands must be retreated every 15-30 years to be properly maintained. California is accelerating its efforts to improve forest health and reduce wildfire risk, but doing so requires

[92] Hurteau et al. 2014. Projected effects of climate and development on California wildfire emissions through 2100. Environmental Science & Technology, 48(4), 2298-2304.
[93] North, M., Collins, B.M., and Scott Stephens (2012) Using Fire to Increase the Scale, Benefits, and Future Maintenance of Fuels Treatments, *Journal of Forestry* 110**(7)**:392-401.

comprehensive planning and strategic investment and will take time before there is a steady trend toward declining wildfire and associated black carbon emissions.

In response to the current epidemic of tree mortality, Governor Brown issued a Proclamation of a State of Emergency on Tree Mortality (Proclamation) in October 2015.[94] It requires State agencies to identify high hazard zones for wildfire and falling trees and prioritize tree removal in those areas. Among several actions to reduce wildfire risk and support forest management operations, the Proclamation calls for expanding the practice of prescribed burns, extending operation of existing biomass power plants that receive feedstock from high hazard zones, and facilitating power contracts for new facilities. To help implement the Proclamation, the Governor launched the State Tree Mortality Task Force in November 2015. The group includes State, Federal, and local government agencies, as well as key stakeholders, and will also monitor tree removal efforts and forest health and resilience.

This Proposed Strategy is one in a series of planning efforts underway that collectively contribute towards an integrated forest management and climate strategy for the State. Here, the focus is on actions to help reduce wildfire risk and black carbon emissions. The State's Forest Carbon Plan will identify climate-related targets for the natural and working lands sector, including forests, for incorporation into the 2030 Target Scoping Plan Update that will build on these recommendations. Goals and actions identified in the 2030 Target Scoping Plan Update and Forest Carbon Plan will include those related to forest carbon storage, which is beyond the scope of this Proposed Strategy. State agencies are coordinating to ensure that the goals and recommendations in each of these plans complement one another. And any proposed targets or actions will be considered through those public planning processes.

Reducing wildfire risk requires active management to reduce fuel availability and returning forests to more resilient states that can withstand fire. This starts with thinning overstocked forests, removing dead and dying trees, and altering stand characteristics to allow mature, larger trees to proliferate and thrive. Forests may be thinned manually, mechanically, or through the use of prescribed fire. These activities also reduce competition from understory vegetation and remove “ladder fuels” that allow ground fires to propagate into the forest canopy and quickly spread.

Prescribed fire can be a useful management tool, particularly in areas that are not suitable for other fuel reduction treatments. While prescribed fire emits black carbon, it can reduce the risk of crown fires, which are a driver for large, catastrophic wildfires.[95,96] Unlike wildfire, prescribed fire can be timed with favorable atmospheric conditions and managed to minimize air quality impacts. ARB and the local air districts have smoke

[94] http://gov.ca.gov/docs/10.30.15_Tree_Mortality_State_of_Emergency.pdf
[95] Schweizer and Cisernos 2014. Wildland fire management and air quality in the southern Sierra Nevada: Using the Lion Fire as a case study with a multi-year perspective on PM2.5 impacts and fire policy. Journal of Environmental Management 144, 265-278.
[96] Cisneros et al. 2014. Spatial and seasonal patterns of particulate matter less than 2.5 microns in the Sierra Nevada Mountains, California. Atmospheric Pollution Research 5, 581-590.

management programs in place to manage the timing and location of prescribed burns to protect public health.

Mechanical or manual thinning produces a large amount of woody biomass. While much of this is not marketable as commercial timber, it represents a potentially valuable resource that can support new industries in rural parts of the State and elsewhere. Currently, however, more than half of it is likely left in the forest, where it is often simply piled up and burned. This produces uncontrolled black carbon emissions and wastes a resource that could preferably be used to produce renewable electricity or low-carbon fuels, create wood products or landscaping materials, or potentially as a soil amendment in the form of biochar. These uses can help to reduce forest-related black carbon emissions, while creating jobs and fostering rural economic development. In addition, enabling markets that would capture value from this resource would help foster broader investment in active forest management practices that are needed to improve forest health and reduce wildfire risk on a lasting basis.

Utilizing more of this resource in a beneficial way to avoid open pile burning requires additional infrastructure to generate clean energy, fuels, or other products in areas near the resource base. Current capacity, mostly in the form of electricity production, is aging and insufficient for the existing resource, much less increased volumes that could come from increased forest management activities. Additionally, many of these facilities face expiring power contracts and are shutting down or in danger of doing so. In the near term, a priority is to keep existing facilities operating that receive woody biomass from high hazard areas, as called for in the Governor's Proclamation.

A longer-term, sustainable biomass management strategy requires increasing the capacity and diversity of uses and prioritizing community-scaled facilities near the forest. The most value from woody biomass may come from converting the feedstock into liquid or gaseous transportation fuels, which is supported by the State's Low Carbon Fuel Standard (LCFS). Additionally, the State's bioenergy feed-in tariff (Senate Bill 1122, Rubio, Statutes of 2012) requires the State's large investor-owned utilities to procure 50 MW of electricity from new, small scale bioenergy facilities using byproducts of sustainable forest management. Finally, part of the funding from the State's Electric Program Investment Charge (EPIC) is dedicated to research and development, deployment, and market facilitation for biomass-fueled facilities.

California, in partnership with Tuolumne County and the U.S. Department of Agriculture Forest Service (USFS), was awarded a $70 million grant as part of the National Disaster Resilience Competition to develop and implement such an integrated community-scale strategy.[97] The proposed $117 million project would create a replicable model for community and watershed resilience that could facilitate transitions to sustainable forest economies in rural parts of California. It includes three pillars related to recovery from the catastrophic Rim Fire in 2013:

[97] http://www.hcd.ca.gov/nationaldisaster/ndrc-application.html

- Forest and Watershed Health: Thinning, biomass removal, restoration, and reforestation activities in the Rim Fire burn area.
- Integrated Biomass and Wood Products Campus: The campus hosts facilities that will provide clean power, cooling and heating, and wood products to utilize biomass material and serve communities near the impacted disaster area.
- Community Resilience Centers: These facilities will provide services during an emergency and also provide year-round services, including education and job training to support forest and watershed work and the biomass facility.

As recent years of historic drought and wildfire have made abundantly clear, California needs to adjust historic forest management practices to reduce wildfire risk in the face of a changing climate. The State is responding quickly and effectively, but more needs to be done to build resiliency into our forests.

2. Recommended Actions to Reduce Wildfire Risk and Black Carbon Emissions

Reducing black carbon emissions from forests requires reducing wildfire risk by actively managing forests to reduce the threats posed by historic fire suppression activities and the increasing effects of drought and climate change. The U.S. Forest Service, which owns and manages approximately 20 million acres in California, has established a restoration goal of 500,000 acres/year in the State, including fuels reduction. Reaching that goal would require an additional $300 million per year to more than double the current pace of restoration, but could potentially save $800 million per year in fire suppression costs.[98] A matching goal for the State and private landowners to treat 500,000 acres per year of non-federal forestlands could require annual investment on the order of $500 million to $1 billion [99]

There is a clear need to identify sustainable funding streams to support this level of treatment. Increased State and Federal funding is needed, as well as private sector investment. Enabling markets for the beneficial use of woody biomass can help to support and maximize these investments. For example, coupled with the Low Carbon Fuel Standard, additional steps to help to facilitate affordable and reliable supplies of sustainably harvested woody biomass could help spur a biofuels industry in rural parts of the State that could foster significant private sector investment in forest management activities.

The recommendations below will help reduce wildfire risk by improving forest management, putting woody waste resources to beneficial use to create value from forest management activities, and supporting these efforts with research and ongoing coordination. These actions will help increase public and private investment to unlock a broad array of economic and environmental benefits in rural communities and Statewide.

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[98] http://www.fs.usda.gov/detail/r5/landmanagement/?cid=stelprdb5412095

[99] Assuming average treatment costs of $1,000-2,000/acre. Actual treatment costs will vary across the landscape.

Increase Rate of Fuel Reduction to Reduce Wildfire Risk

The State is committed to increasing active management of its forests to reduce fuel loadings, wildfire risk, and black carbon emissions. Wherever possible, material should be thinned and put to beneficial use, which in turn, can help to finance fuel reduction activities. Prescribed fire has an important role to play, and should be utilized in manners protective of public health and as part of a scaled effort to improve forest and ecosystem health. Throughout, activities to reduce wildfire risk should be coordinated to support various State priorities, including enhancing forest health, protecting air quality, addressing climate change, and supporting watersheds, biodiversity and other ecosystem services. The State will work in these regards, and with federal and private land owners, to accelerate activities to reduce wildfire risk and associated black carbon emissions:

- **Increase investment in forest health programs.** Governor Brown's Cap-and-Trade Expenditure Plan in his proposed budget for fiscal years 2016-17 includes $140 million for CAL FIRE to support forest health and resiliency programs that reduce GHG emissions. While additional public and private investment is needed on an ongoing basis, this represents an appropriate and significant increase beyond the $24 million that these efforts received in the 2014-15 budget year.
- **Foster private sector investment.** The State will continue to support programs such as the Low Carbon Fuel Standard and Bioenergy Feed-In Tariff that support private sector investment to support sustainable forest management and utilization of woody biomass. Additionally, in developing the Scoping Plan and Forest Carbon Plan, State agencies will consider opportunities to support thinning, collecting, and transporting woody biomass to facilities that can beneficially use it. This may come in the form of direct investment, coordination to streamline facility development, or other activities as described below. These efforts will help to scale private sector investment in forest management and clean energy efforts, and reduce black carbon emissions from pile burning and wildfire.
- **Implement Governor Brown's Proclamation.** Among other activities, the Proclamation calls for ARB and CAL FIRE to work with federal agencies and land managers to "expand the practice of prescribed burns, which reduce fire risk and avoid significant pollution from major wildfires, and increase the number of allowable days on a temporary basis to burn tree waste that has been removed in high hazard areas." The agencies will implement this Proclamation to reduce the wildfire risk posed by dead and dying trees, through the public process of the Tree Mortality Task Force.
- **Collaborate with federal and private landowners.** The State is targeting investments to achieve net GHG emission benefits in areas that have high rates of carbon stock and face heightened wildfire risk from overstocked forests and dead or dying trees. Coordinating with public and private land owners in shared watersheds or firesheds is important to maximize the positive impacts of these treatments beyond the immediately treated area. Additionally, CAL FIRE will

continue working with Federal agencies, local jurisdictions and private land owners through existing agreements and mechanisms to support forest management operations.

Align Financial Incentives with Beneficial Use of Woody Waste

Current volumes of woody waste from forests and other sources, let alone increased volumes that will come from improved forest management practices, far exceed the markets and available uses for this material. By helping to develop markets for industries that can utilize this material, the State can help unlock the value intrinsic in California's woody biomass waste streams and capture additional economic and environmental benefits associated with forest management. This will help improve the economics associated with transporting residues from the forest, providing alternatives to pile burning and reducing black carbon emissions associated with forest management. It will also help to scale investment to help sustain forest management operations at necessary levels. Accordingly, the State will take additional steps to support beneficial uses of woody waste:

- **Demonstrate and prioritize integrated, community-based models.** Projects like the one awarded to California as part of the National Disaster Resilience Competition offer a wide array of benefits, including community-scale benefits much broader than those just associated with forest health. This project can serve as a model for rural communities near forested lands to support ecological restoration and hazardous fuels reduction, while supporting economic growth and diversification and community wildfire protection. The State will work with its partners to secure financing and develop this project, with a key focus on replicability and scalability.
- **Support clean energy and fuel production.** As described above, California has several programs in place to support clean energy and fuel production from sustainably harvested forest waste and other organic resources. Some of these programs, such as the bioenergy feed-in tariff, LCFS, and Cap-and-Trade, are relatively new programs and could support more clean projects moving forward. The State will encourage policies, strategies and investments, from both private and public funds, to further support clean energy and fuel production from forest biomass. One potential source of public funding is the $140 million for healthy forests in the Governor's 2016-17 budget proposal, which includes support for biomass electricity generation projects. Governor Brown's Proclamation directs the CEC to prioritize EPIC grant funding for woody biomass-to-energy technology development and deployment. CEC is now accelerating the schedule for more than $15 million in EPIC research funding to support woody biomass to energy projects. The State is also evaluating a variety of potential policies that could reduce the cost to collect and transport woody biomass to energy and fuel production facilities, modernize existing biomass facilities, build new community-scale facilities that use the best available emission control technologies, and develop and transfer new technologies to market. To the extent possible,

policies will support technologies and strategies that minimize criteria and air toxic pollutants.

- **Foster markets for sustainably harvested wood products.** A diversified industry infrastructure is necessary to allow different species and sizes of woody biomass to be effectively utilized. Wood products industries are an important element of this infrastructure. They can also be an important part of integrated, community-based models that the State will continue to prioritize. In addition to scaling these models, and pursuant to Governor Brown's Proclamation, State agencies will work to expand and diversify markets for sustainably harvested wood products.

Support Management Efforts and Market Development through Research

Additional research will help support the actions identified above to further target forest management activities to reduce black carbon emissions, accelerate market development for beneficial use of woody biomass, and to maximize the economic and environmental benefits provided by California's forests. Several benefits associated with forest management practices are not well-understood or valued in current markets or policy programs. For example, current research suggests biochar could contribute to significant carbon storage globally, but the benefits of large-scale projects have not been demonstrated or quantified, and several research gaps remain. Healthy, resilient forests provide water supply and quality benefits to major metropolitan areas and agricultural landowners but management is not supported through user fees.[100] Quantifying and verifying these benefits could allow them to be captured in State policies or commercial transactions, supporting private investment in healthy forest management.

- **Improve understanding of the feedstock.** Pursuant to the Emergency Proclamation on Tree Mortality, CAL FIRE and CEC will work with land managers to estimate biomass feedstock availability, storage locations, and volumes that may be available for use as bioenergy feedstock at existing and new facilities. These data will be used to develop medium- and long-range plans to diversify biomass markets, expand existing ones, and for the identification and distribution of incentives.
- **Identify a broad scope of benefits and options to value them.** Resilient forests and healthy watersheds provide valuable goods and services, including but not limited to secure water supply and water quality, wildlife habitat, clean air, carbon storage and reduced forest GHG emissions, timber resources and local economic development opportunities. Investing in forest health has a large multiplier impact, however several of these goods and services are difficult to quantify and even those that can be quantified are often not accounted for when evaluating economic benefits. State agencies will support research and demonstration projects to improve accounting of potential benefits associated with healthy forest management, and will consider incorporating the range of

[100] R Bales, M Conklin et al. (2015) Sierra Nevada Adaptation Management Project, Appendix E: Water Team Final Report.

benefits into programs and cost/benefit calculations where they can be appropriately quantified. If they can be reliably quantified and valued, these benefits may provide a revenue source to support forest management.

Integrate State Planning Efforts and Goals

The actions identified in this Proposed Strategy, and those already underway pursuant to Governor Brown's Proclamation on Tree Mortality, represent immediate steps that the State can take to reduce wildfire risk and black carbon emissions. Additional planning efforts underway will flesh out a broader vision and set of activities to improve forest health and enhance carbon storage over time. Throughout these and other efforts, State agencies will coordinate efforts to align priorities and actions. They will also increase information sharing associated with research, monitoring, and the state of forest management practices.

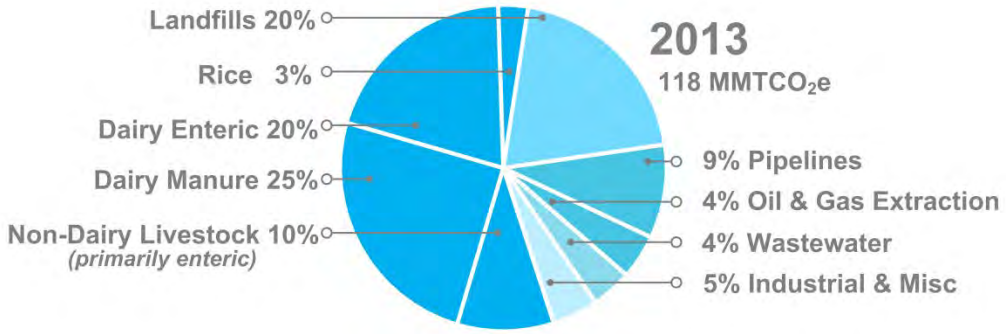
- **Identify targets for forest and climate planning in 2030 Target Scoping Plan Update.** The 2030 Target Scoping Plan Update will include specific climate-related planning targets for natural and working lands, including forests, and an accounting and monitoring framework for monitoring progress toward meeting the targets. Agencies will work together to develop methods for monitoring the black carbon and GHG emission reductions and carbon sequestration associated with these targets, and will report on progress in regular updates to the Scoping Plan.
- Develop Forest Carbon Plan to outline implementation activities to meet 2030 Target Scoping Plan Update and other targets. The Forest Climate Action Team (F-CAT) will complete a Forest Carbon Plan, which will cover a broad range of management and conservation priorities for California's forests and implementation mechanisms and strategies for achieving them, including the targets and recommendations included in this Proposed Strategy and the 2030 Target Scoping Plan Update. This coordinated planning process will provide for an ongoing and collaborative forum guiding sustainable forest management activities in California moving forward.

V. Reducing Methane Emissions

Methane is emitted from a wide range of fugitive sources and biological processes, and is the second largest source of GHG emissions globally. Methane emissions are growing globally as a result of human activities related to agriculture, waste handling and treatment, and oil and gas production. Agriculture represents the largest methane source in California, accounting for nearly 60 percent of methane emissions (Figure 6). Landfills are the next largest source of methane, accounting for a fifth of statewide methane emissions. Pipeline leaks, oil and gas extraction, wastewater, and other industrial and miscellaneous sources make up the remainder of emissions. As California continues to rely on natural gas for a large fraction of its energy supply, it is critical to increase supplies of renewable natural gas and minimize fugitive emissions of methane from natural gas infrastructure.

In California, where natural gas may increasingly fuel trucks and heavy-duty vehicles, we must ensure that the use of natural gas provides a climate benefit compared to the diesel fuel it displaces. As we increase the number of facilities producing and using renewable supplies of natural gas, hydrogen, or other fuels in a cleaner energy economy, we must also take steps to minimize potential methane leaks from those facilities. ARB and other agencies are funding research to identify high-methane "hot spot" emitters in the oil and natural gas sector and other sectors throughout California.

Figure 6: California 2013 Methane Emission Sources*



* Using 20-yr GWP

California can cut methane emissions by 40 percent below current levels in 2030 by avoiding or capturing methane from manure at large dairies, meeting industry targets for reducing methane emissions from enteric fermentation, effectively eliminating disposal of organics in landfills, and reducing fugitive methane emissions by 40-45 percent from all sources.

A. Progress to Date

The State has taken important steps to reduce methane emissions from all its major sources, but more needs to be done to control methane emissions, especially from organic waste streams going to landfills and at dairies. In addition to reducing methane

emissions from these sources, capturing methane can provide fuel for power plants, buildings, vehicles and industrial operations to displace fossil-based natural gas use.

Technologies to recover methane are already widely available and used in key sectors. For example, some methane emissions from landfills, wastewater treatment facilities or from manure at dairies are already captured and used as a renewable source of natural gas to fuel vehicles or generate electricity. Some organic materials, such as food waste and yard trimmings, are being redirected from landfill disposal to anaerobic digestion and composting facilities to produce renewable energy, fuel and soil amendments.

Steps are also being taken to reduce natural gas leaks from oil and gas wells, pipelines, valves, and pumps to improve safety, avoid energy losses, and reduce methane emissions associated with natural gas use.

In addition to ongoing efforts and practices to reduce and use captured methane for beneficial purposes, several recent legislative and regulatory actions will further support the reduction or capture of methane within these sectors. These actions prioritize diverting organic material from landfills and include incentivizing the use of biogas for transportation fuel, pipeline injection, or electricity generation.

- California has established clear goals to reduce waste disposal, and divert organic material from landfills for beneficial purposes. AB 341 (Chesbro, Chapter 476, Statutes of 2011) established a State target to reduce the amount of solid waste sent to landfills by 75 percent by 2020, through recycling, composting, and source reduction practices. The 2014 Scoping Plan Update calls for eliminating the disposal of organic materials at landfills, which would potentially eliminate future methane emissions from landfills.

- The Legislature recently took steps to further increase the diversion of organic materials from landfills. AB 1826 (Chesbro, Chapter 727, Statutes of 2014) requires businesses generating specified amounts of organic wastes to begin arranging for the recycling and diversion of those wastes from landfill disposal beginning in 2016. CalRecycle will provide an annual public update on the disposal, diversion, and recycling of organics, beginning in 2016, pursuant to this mandate. AB 1594 (Williams, Chapter 719, Statutes of 2014) re-classifies the use of green waste for landfill “alternative daily cover” as disposal, beginning in 2020. AB 876 (McCarty, Chapter 593, Statutes of 2015) requires local governments, beginning August 2017, to assess the amount of organic waste that will be generated in a region during a 15-year period and identify locations

for new or expanded organic waste recycling facilities capable of handling this material.

- Methane emissions from landfills are controlled under ARB's Landfill Methane Control Measure, which was approved in 2009. The regulation requires owners and operators of certain previously uncontrolled municipal solid waste landfills to install gas collection and control systems, and requires existing and newly installed gas and control systems to operate in an optimal manner. The regulation allows local air districts to voluntarily enter into agreements with ARB to implement and enforce the regulation and to assess fees to cover costs. .

- Senate Bill 1122 (Rubio, Chapter 612, Statutes 2012), directed the California Public Utility Commission (CPUC) to require the State's investor owned utilities to develop and offer 10 to 20 year market-price contracts to procure an additional 250 megawatts of cumulative electricity generation from biogas facilities that commence operating on or after June of 2013. Eligible projects and sources include biogas-generated electricity from wastewater treatment, municipal organic waste, food processing, dairy manure and agricultural organic material, and sustainable forest materials.

- The Low Carbon Fuel Standard (LCFS) requires transportation fuel providers to procure clean fuels to reduce the carbon intensity of California's fuel mix. In doing so, it provides a market signal to incentivize developing clean fuel options, including capturing or avoiding methane emissions and using associated renewable natural gas as a transportation fuel. Some LCFS pathways related to renewable natural gas have the lowest carbon intensities of pathways to date. Specifically, the production of biomethane from high solids anaerobic digestion of organic (food and green) wastes has a carbon intensity of -15 gCO_2/MJ, and a recently approved pathway for biogas from a dairy digester project has a carbon intensity of -276 gCO_2/MJ. If LCFS credit prices are $100/MT, as they have been recently, the value of LCFS credits from these pathways is about $1.50 per diesel-gallon equivalent and $5.00 per diesel gallon equivalent, respectively (or about $11/MMBtu and $36/MMBtu of natural gas, respectively). Transportation fuel derived from biogas may also qualify for Renewable Identification Number (RIN) credits as part of the U.S. EPA Renewable Fuel Standard 2, which could add additional value to these types of projects.

- Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012) directed the CPUC to adopt natural gas constituent standards (in consultation with ARB and the Office of Environmental Health and Hazard Assessment). The legislation is also designed to streamline and standardize customer pipeline access rules, and encourage the development of statewide policies and programs to promote all sources of biomethane production and distribution. It also directs the CEC to identify constraints to the use and interconnection of biomethane and offer solutions in its Integrated Energy Policy Report. The CPUC has adopted natural gas constituent standards and created a program to offset a portion of gas

producers' costs of connecting to utility pipelines by providing up to $1.5 million per biomethane project, up to a cap of $40 million total.

- Pursuant to Assembly Bill 1257 (Bocanegra, Chapter 749, Statutes of 2013), the CEC has released a report identifying strategies for maximizing the benefits obtained from natural gas as an energy source.[101] The report examines strategies and recommendations regarding natural gas, including low emission resources such as biogas and biomethane; the use of natural gas as a transportation fuel; centralized and distributed electricity generation; cooking, cooling, and space heating; engine and appliance applications; its role in the development of zero net energy buildings; and GHG emissions associated with the natural gas system. The report also examines infrastructure and storage needs and pipeline and system reliability concerns.

- ARB's Cap-and-Trade Program will reduce demand of fossil fuels and provide incentives to accelerate efficiency and clean energy. Compliance Offset Protocols under the Cap-and-Trade Program provide methods to quantify, report, and credit GHG emission reductions from sectors not covered by the Cap-and-Trade Program. The Offset Protocols include a livestock protocol, rice cultivation protocol, and mine methane capture protocol.[102] The livestock protocol credits operators who voluntarily install manure biogas capture and destruction technologies. The rice protocol allows compliance offset credits to be issued for emission reductions achieved by switching to rice cultivation practices that reduce methane emissions. The mine methane capture protocol incentivizes capturing methane that would otherwise be vented into the atmosphere from active and abandoned mines.

A broad array of these and other state programs reducing dependence on fossil fuels are also already working to reduce methane emissions, especially from the oil and gas sector. Ultimately, fugitive methane emissions in the oil and gas sector are a function of our demand for these products. As state policies continue pushing our evolution away from conventional oil and natural gas, they will also help to reduce emissions of methane from the production and distribution of fossil fuels. In particular, efforts to improve efficiency or electrify appliances, buildings, and vehicles will not only reduce energy use and CO_2 emissions, but also serve to reduce or avoid fugitive methane

[101] *AB 1257 Natural Gas Act Report: Strategies to Maximize the Benefits Obtained from Natural Gas as an Energy Source*, California Energy Commission, September 2015. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=15-IEPR-04

[102] As is discussed in more length in the CEQA document accompanying this document, the livestock offset protocol would likely cease accepting new projects for offset credits after the effective date of substantive regulations controlling agricultural methane from dairies; however, existing projects could continue generating credits throughout their crediting periods. ARB expects this continued funding stream, along with increased focus on regulatory and incentive measures in this area, to mean many projects now receiving offsets to continue functioning at the end of the crediting period; this, along with new regulations, will produce significant net reductions in methane even if some offset projects cease to function. This transition from offset protocols towards regulations has long been ARB policy.

emissions from the production, and potentially transmission and distribution, of oil and natural gas.

The State has strong targets to reduce the use of natural gas and petroleum by 2030, and several studies show that California must virtually eliminate the use of all fossil fuels to meet its 2050 climate targets. Notably, Governor Brown has called for reducing on-road petroleum use by up to 50 percent by 2030, and Senate Bill 350 (De León, Chapter 547, Statutes of 2015) requires the State to procure 50 percent of its electricity from renewable resources by 2030 and double the rate of natural gas and electricity efficiency savings. ARB's draft 2016 Mobile Source Strategy describes actions to achieve the State's air quality and climate targets from the transportation sector, and cut petroleum use by 50 percent by 2030. The State's Low Carbon Fuel Standard is sending a clear signal to the market that is leading to investment and use of a broad spectrum of cleaner transportation fuels in California including electricity, biogas, as well as biodiesel and renewable diesel, all of which are displacing petroleum. Further, the State's Cap-and-Trade program encourages efficiency and use of non-fossil energy sources across all sectors of the economy, and various programs provide billions of dollars in incentives to support energy efficiency throughout the State.

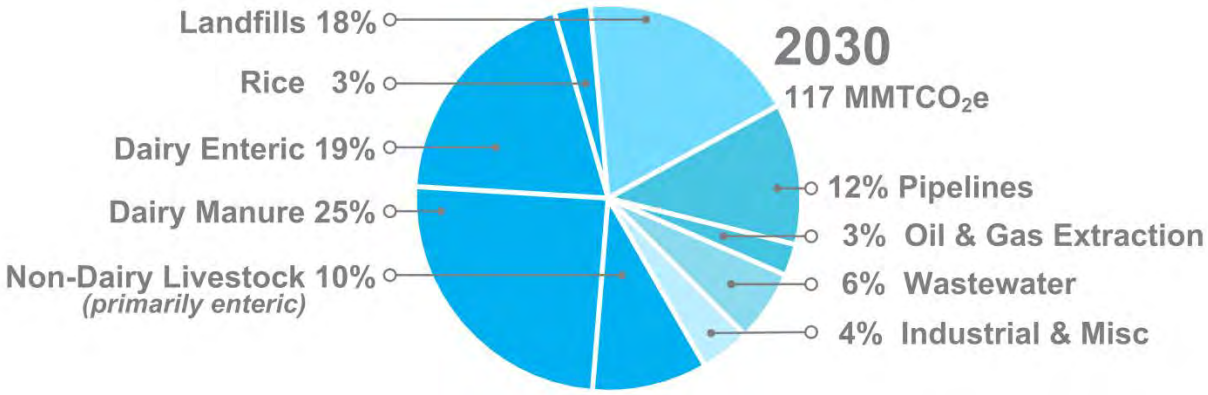
Effectively implementing these actions and programs will significantly cut demand for fossil fuels and associated CO_2 emissions on trajectories we need, while further reducing methane emissions from oil and gas systems. As State agencies implement and refine these programs and plans, they will seek opportunities to better align them with these objectives. Additionally, State agencies will support research to inform appropriate approaches to continue its transition away from fossil fuels.

Further, several efforts are underway at the CEC and ARB to improve emissions monitoring to help identify sources of fugitive methane emissions and reduce them. For example, the CEC provided research funding for operation of a mobile leak detection platform. In 2016, ARB will release a Request for Proposal (RFP) to collect emissions data from oil production wastewater ponds. Results from this contract are expected in 2018, and if they indicate that these ponds are significant sources of methane, ARB may initiate a regulatory process to reduce those methane emissions. Additionally, ARB and NASA's Jet Propulsion Laboratory are collaborating to identify large "hot spot" methane sources through a systematic survey of high methane emitters throughout California. This project will use aerial and ground measurement to survey oil and gas fields and infrastructures, dairies, feedlots, digesters, landfills, rice fields, and wastewater treatment facilities to provide a greater understanding of methane sources. Finally, ARB is actively participating in the Megacities Carbon Project being conducted in the South Coast Air Basin, which is developing and testing methods for monitoring various GHG emissions to link monitored concentrations to emission activity. These efforts will help identify significant fugitive methane sources in California and improve leak detection.

Collectively, these measures will help to keep methane emissions in California fairly steady through 2030. However, the science-based pathway to limiting global warming

below 2°C—including meeting the Governor's goal to reduce GHG emissions by 40 percent below 1990 levels by 2030—requires further reducing methane emissions in California. Significant opportunity remains to further reduce methane emissions from the major sources in the State (Figure 7). Doing so will require overcoming various economic and institutional barriers, but will provide a wide range of economic and environmental benefits throughout the State, especially where they are most needed.

Figure 7: California's 2030 Methane Emission Sources with Existing Measures*



*Using 20-year GWP

B. Recommended Actions to Further Reduce Methane Emissions

California can reduce methane emissions by 40 percent below current levels through a collaborative and mixed approach that combines incentives, public and private investment and partnerships, systematic planning, and regulatory efforts. California's strategy to reduce methane emissions reflects and supports the variety of approaches and options available to achieve the goal in the most efficient, cost-effective, and environmentally-sensitive manner. This Proposed Strategy promotes and encourages opportunities for industry innovation, the efficient use of existing infrastructure and facilities, and supports the development of integrated systems across various sectors to handle, process, and reuse waste materials and captured methane. For example, significant anaerobic digestion and composting infrastructure capacity needs to be established, and appropriate market opportunities developed for compost and captured methane, before the State can fully use existing organic waste streams for beneficial purposes. State agencies will work with industry and other stakeholders to support and accelerate new project development and activities to maximize methane emission reduction at existing facilities. The State will also work with communities and regional stakeholders to plan and develop integrated infrastructure systems and markets to reduce wastes and associated emissions in the most environmentally-sensitive manner. By investing early and committing to the immediate resolution of issues that hinder progress, California can make significant progress in the near-term, and capture associated benefits.

There are a host of activities underway at the State and Federal level, and by gas utilities, to reduce methane emissions from the natural gas system. In particular,

regulations are being developed to reduce fugitive methane emissions from the oil and gas production, processing and storage sector, and from the natural gas transmission and distribution system. By effectively implementing these policies, and supporting them with continued and improved emissions monitoring, California can match the goals of the Obama Administration to reduce methane emissions from the oil and gas sector by 40-45 percent by 2025. The State will aim to extend successful approaches to reduce emissions from the oil and gas sector to other sectors, and overall, to reduce fugitive methane emissions from all sources by similar levels by 2030.

Table 6, below, describes emission reductions by sector to reduce methane emissions by 40 percent below current levels by 2030. The expected emission reductions for each sector are: 75 percent reduction of dairy manure methane from 2013 levels by 2030; 25 percent reduction of enteric fermentation methane by 2030; 90 percent diversion of organic waste by 2025; 40 percent reduction of wastewater and other industrial sources methane by 2030; and 45 percent reduction of oil and gas methane by 2030.

Table 6: Proposed New Methane Emission Reduction Measures and Estimated Emission Reductions ($MMTCO_2e$)[1]

Measure Name	2030 Annual Emission Reductions	2030 Annual Emissions
2030 BAU[2]		**117**
Dairy Manure	21	
Dairy and Livestock Enteric Fermentation	5	
Landfill	5	
Wastewater, industrial and Other Miscellaneous Sources	7	
Oil and Gas Sector	8	
2030 BAU with new measures		**71**

[1] Using 20-year GWPs from the 4th Assessment report of the IPCC
[2] "Business As Usual" (BAU) forecasted inventory includes reductions from implementation of current regulations

1. Dairy Manure

California's dairy and livestock industries account for roughly half of the State's total methane emissions and about five percent of the State's overall GHG emissions. About half of the emissions from the State's 5.5 million total beef and dairy cows come from enteric fermentation (mostly belching), and the other half from manure management practices, primarily lagoon storage of flushed manure from milking cows.

California has the most dairy cows in the country and the highest aggregated dairy methane emissions. The State also has higher per-milking cow methane emissions than most of the rest of the United States, due to the widespread use of flush water lagoon systems for collecting and storing manure. Milk production feed efficiency at California dairies, however, is among the best in the world; California dairy cows produce low enteric fermentation emissions per gallon of milk. So if dairy farms in California were to manage manure in a way to further reduce methane emissions, a gallon of California milk might be the least GHG intensive in the world.

Dairy methane emissions may be significantly reduced by switching from flush water lagoon systems without methane capture to solid-scrape (i.e. slurry) or dry manure management practices. Anaerobic digesters can also be installed to capture and utilize manure methane, and can be used with flush water lagoon systems, dry, or solid-scrape manure collection practices. The use of manure systems such as vacuum or scrape also allows for easier transport and storage of manure off-site or to centralized digester systems, which can improve economies of scale, biogas production efficiencies, and nutrient management on the dairy. Dairy manure can also be mixed with other organic materials diverted from landfills or at wastewater treatment plants to improve digester performance and economics, with centralized digesters playing a key role in helping California meet its organic diversion and bioenergy goals.

Dairies with flush water lagoon systems typically flood irrigate dairy feed crops, such as corn silage and alfalfa, to dilute and disperse nutrients from manure in the lagoon. This practice can lead to soil and groundwater contamination despite being subject to regulation by regional water quality control boards, including the Dairy General Order in the Central Valley. Solid-scrape manure management may lead to air quality challenges, however, which need to be fully considered. Ultimately, the optimal mix of technologies and manure management practices to reduce methane emissions, protect air and water quality, and support dairy economics will depend on dairy-specific factors and vary across the State.

In some instances, pasture-based dairy management may be an option, as well, but there are tradeoffs that limit its applicability. In a pasture system, manure is left in the field and decomposes aerobically (versus anaerobically in a lagoon), which avoids methane emissions. Many organic milk producers rely on pasture systems for much of their operations, and it is a fairly common practice in other states and at smaller dairies in coastal and northern parts of California. However, for larger dairies and those in the Central Valley, pasture would require using significantly more irrigated land and may also pose feed production issues and animal welfare concerns due to heat exposure. Pasture dairy operations may still face potential nutrient management and groundwater

issues, and still must maintain some capacity to store liquid coming from milking parlor operations (chilling milk, cleaning facilities, etc.) for the required 100 year stormwater retention. Milk production and feed efficiencies are lower in pasture-based systems, requiring more cows and higher enteric fermentation emissions per unit of milk, and pasture-based systems limit the ability to manage manure as a valuable organic waste resource. Pasture-based systems are a viable option that is appropriate in some cases, but likely challenging to implement at many existing, larger dairies in the Central Valley.

Captured biogas from dairy manure can be used to power farm trucks and equipment, injected into natural gas pipelines, used as a transportation fuel, or used to generate on-site renewable electricity and heat. However, tapping into this resource in California has been complicated in the past due to air quality constraints, especially in the Central Valley and Southern California. Utilizing newer and clean technologies can help to overcome air quality permitting issues that have previously hindered project development. In particular, technologies or strategies that reduce or eliminate criteria pollutant and toxic emissions should be encouraged in both incentive and regulatory programs, particularly in areas with severe or extreme air pollution. For example, using ARB-certified distributed generation technologies, such as microturbines or fuel cells, can significantly cut NO_x emissions compared to internal combustion engines. Injecting biogas into the natural gas pipeline can avoid most new combustion or associated emissions altogether. As part of an integrated strategy that includes replacing diesel trucks and equipment with certified ultra-low NO_x vehicles or equipment, fueling vehicles with dairy-derived biogas could help to reduce criteria pollution in impacted air basins.

California will aim to reduce methane emissions from dairy manure management by at least 20 percent in 2020, 50 percent in 2025, and 75 percent in 2030. If dairy cow populations don't grow in California, in line with current forecasts, these reductions would reduce overall methane emissions from the dairy industry by more than 40 percent in 2030. Through this Proposed Strategy and related efforts, we can quickly and effectively reduce methane emissions from the State's largest source, while creating economic value in farming communities. While barriers remain to building out necessary infrastructure in the State, if the market were fully enabled, anaerobic digestion at California dairies could lead to billions of dollars of investment and thousands of new jobs, concentrated in the Central Valley (see Chapter VIII). Working together, State agencies, dairy farmers, and other stakeholders can achieve this level of reduction through a combination of financial incentives, infrastructure deployment, market development and regulatory actions.

These targets can be achieved by capturing or avoiding methane currently emitted from lagoons or other anaerobically stored manure at a relatively small fraction of the State's dairies. For example, dairy manure emissions can be reduced by 75 percent by capturing or avoiding the methane generated by about 60 percent of the State's milking cows (1.05 million) on about 30-35 percent of the State's dairies (about 500 dairies).[103]

[103] California has over 1,400 dairies, with approximately 1,000 having more than 500 milking cows which might be suitable for methane capture or abatement (refer to Chapter VIII for a discussion on potential manure methane mitigation options and cost estimates).

The 2020 and 2025 targets could be met by capturing or avoiding methane generated by about 15 percent and 40 percent of the State's milking cows, respectively.

Depending on the strategies pursued to reduce emissions, individual dairies may be able to reduce emissions profitably, and the industry as a whole may be able to meet these targets at little or no net cost (see Chapter VIII). However, revenues in some cases are highly dependent on uncertain environmental credit and energy markets, as well as the ability to interconnect to natural gas pipeline systems, where economic and institutional barriers remain. If regulations impose costs on the industry that cannot be recouped, a result could be emissions leakage, if some dairies relocate outside of California or herd sizes grow elsewhere. This could include places where milk production efficiencies are lower and associated enteric fermentation emissions are higher and could increase mobile source emissions from heavy duty vehicles associated with transport of dairy products to established processing facilities and distribution centers.

Accordingly, the State will encourage and support near-term actions by dairies to reduce emissions through market support and financial incentives. At the same time, ARB will initiate a rulemaking process to develop regulations for dairy manure management in California. This coordinated approach will aim to develop a competitive, low-carbon dairy industry in California and avoid emissions leakage. Specifically, California will take the following steps to significantly cut methane emissions from manure management at dairies:

Accelerate Project Development and Emission Reductions at Dairies

The State will support the industry to accelerate project development and help the industry reduce emissions before regulatory requirements take effect. In particular, the State will work to support improved manure management practices through financial incentives, collaboration to overcome barriers, and other market support.

Continued State funding or incentives should support initial infrastructure investments to convert dairies away from flushwater management systems and support market opportunities for the use of captured or produced biomethane. CDFA estimates that at least $100 million will be needed for each of the next five years to support the development of necessary manure management infrastructure in the form of grants, loans, or other incentive payments. The economic analysis in Chapter VIII suggests that this level of funding could significantly accelerate project development by reducing capital costs and economic risks. Different types of funding mechanisms and level of support may be appropriate for different types of projects.

ARB and CDFA staff will establish a working group with other relevant agencies and stakeholders to focus specifically on solutions to barriers to dairy manure projects. The group will aim to ensure and accelerate market and institutional progress. It may cover several topics, including: project finance, permit coordination, CEQA, feed-in tariffs, simplified interconnection procedures and contracts, credits under the LCFS, increasing the market value of manure products, and uniform biogas pipeline standards. This group will be coordinated with similar working group efforts related to anaerobic digestion, composting, energy, healthy soils, and water. Additionally, State agencies will coordinate activities with federal agencies, including the U.S. Department of Agriculture and U.S. Department of Energy, to align common efforts and attract federal investment to California. Further, ARB will work with State and Regional water quality agencies to ensure opportunities for conservation and water quality efforts are developed jointly and with the air districts to ensure opportunities for air quality efforts are developed jointly.

In many cases, converting to scrape systems or installing anaerobic digesters at dairies may not yet be cost-effective, if the only marketable product is energy. However, if compost or other soil amendment products and environmental credits can be monetized from these projects, as well, they may offer attractive rates of return for farmers and investors.[104] Markets for these other products need further support, however, before they can offer reliable returns to help finance projects. CalRecycle, CDFA, and other agencies are working together to support healthy soils through composting and building markets for soil amendment products in the State. Enabling pipeline injection of biomethane and minimizing associated costs will help get dairy biogas into the transportation sector and allow for the generation of LCFS and RIN credits, which could provide an especially valuable revenue stream.[105] The State will continue to support these efforts.

Develop Regulations to Ensure Emission Reductions

While the State will encourage early emission reduction actions by dairies through market support and financial incentives, regulations will be necessary to ensure manure management practices lead to lasting emission reductions. In 2017, and in coordination with CDFA and local air quality and water quality agencies, ARB will initiate a rulemaking process to reduce manure methane emissions from the dairy industry in-line with the objectives in this Proposed Strategy. The regulatory process will include

[104] For example, one report estimates that the average internal rate of return for dairy digester projects in the U.S. that only capture value from energy production would be about 8 percent in a mid-valuation scenario, but would increase to 38 percent if value can be captured from soil amendments and markets for environmental credits.
Informa Economics (2013) National Market Value of Anaerobic Digester Products, Prepared for the Innovation Center for U.S. Dairy, February.
[105] Under the LCFS, ARB recently approved a dairy digester fuel pathway with a carbon intensity of -276 gCO_2e/MJ. http://www.arb.ca.gov/fuels/lcfs/2a2b/apps/calbio-sum-122115.pdf
At credit prices of $100/MT, these credits could be worth about $5 per diesel gallon equivalent.

consideration of available financial incentives, market support, and the potential for emissions leakage in identifying appropriate timelines and requirements for the industry.

The rulemaking will also include requirements for mandatory reporting and recordkeeping of parameters affecting GHG emissions at California dairy farms. Reported information will be used to refine inventory quantification, evaluate policy effectiveness, and aid in future policy planning and regulatory development. ARB will work with other State agencies and industry groups to improve outreach on new reporting requirements, as well as merge and streamline reporting activities with current forms and requirements to avoid duplicative reporting wherever feasible.

Regulatory requirements to achieve large emission reductions from the industry will affect incentives for dairy methane reduction projects, such as the availability and amount of credits under the Cap-and-Trade program and LCFS. Once a regulation is in place, credits for avoided methane emissions under the LCFS or the Cap-and-Trade Programs would not be available for new projects as the reductions would not be additional to regulation or business-as-usual. However, projects in place before the regulation takes effect would still be able to generate credits for avoided methane emissions for their current crediting period, which is ten years of operation. For new projects after a regulation takes effect, credits under the LCFS would still be available, but would only consider the displacement of petroleum fuel. ARB will clarify the impact of potential regulations on LCFS credits before finalizing a regulation, and will make appropriate adjustments to the Cap-and-Trade Program to ensure only reductions that meet the AB32 offset criteria are credited. Sufficient lead time will be provided before regulatory requirements take affect to allow the market to react.

Research the Reduction Potential of Manure Management Practices

While the need and potential to reduce methane emissions from dairy manure is clear, some potentially effective strategies are still in the development stage. In particular, the use of solid separators and converting flush systems to dry manure management systems could be potentially low cost methods to reduce methane emissions. However, little data exists to quantify costs and benefits associated with these practices. Additionally, some uncertainty remains regarding cross-media impacts and accounting of various dairy manure management practices. ARB and CDFA will continue to support research to eliminate information gaps and improve understanding of potential manure management practices and their associated methane reduction benefits, as well as potential air quality or water quality impacts.

2. Dairy and Livestock Enteric Fermentation

Methane is also produced by the microorganisms involved in the digestive processes in the stomachs of dairy cows and other ruminants, such as sheep, goats, buffalo and cattle. This process is referred to as enteric fermentation. These emissions account for 29 percent of California's methane inventory, making it is essential to develop strategies to reduce emissions from these sources to meet State GHG emission reduction targets.

Strategies that have been investigated to reduce enteric fermentation include increasing production efficiencies to reduce the amount of methane produced for a given amount of product, breeding animals for lower methane production, gut microbial interventions, and changes to nutrition and animal management. Further research is needed to fully evaluate the viability of these strategies to California; and to assess their associated costs and co-benefits, potential impacts on animal productivity, on animal and human health, other environmental impacts, and GHG and air toxic emissions associated with feed lifecycles. Strategies to produce more easily digestible feed that lowers enteric fermentation might increase emissions associated with GHG-intensive feed production and transport. Therefore, regionally-specific lifecycle emission assessments of enteric fermentation emission reduction strategies would need to be used to account for any unintended emission increases in other sectors.

The dairy industry in California and the U.S. has been working to increase efficiencies associated with their operations and product. A broad coalition of the national dairy industry set GHG sustainability targets for 2020. The targets include reducing the GHG intensity of fluid milk by 25 percent,[106] and enteric fermentation emissions by 25 percent.[107] If a 25 percent reduction in enteric fermentation emissions from California's dairy cows were achieved by 2030, it would reduce the State's methane emissions by 5 $MMTCO_2e$ (based on a 20-year GWP).

This Proposed Strategy sets those levels as a goal for reducing methane emissions from enteric fermentation in California. Combined with the goals for manure management, this would bring emissions for the dairy industry down by 40 percent below current levels in 2030. By continuing historic annual improvements in milk production efficiency and progressing toward their established voluntary targets, the industry may meet this goal independently. Additionally, various studies are pointing to new feed supplements that have the potential to reduce enteric fermentation emissions 20-30 percent without affecting milk production.[108,109]

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[106] http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2013/04/0076.xml&printable=true&contentidonly=true

[107] Innovation Center for U.S. Dairy (2008) U.S. Dairy Sustainability Initiative: A Roadmap to Reduce Greenhouse Gas Emissions and Increase Business Value, December. http://www.usdairy.com/~/media/usd/public/roadmaptoreduceghgemissions.pdf.pdf

[108] Hristov et al (2015) An inhibitor persistently decreased enteric methane emission from dairy cows with no negative effect on milk production, *Proceedings of the National Academy of Sciences,* 112**(34)**:10663-10668. www.pnas.org/cgi/doi/10.1073/pnas.1515515112

[109] Moate et al (2014) Grape marc reduces methane emissions when fed to dairy cows, *Journal of Dairy Science,* 97**(8)**:5073-5087. http://dx.doi.org/10.3168/jds.2013-7588

Research Mitigation Strategies for Enteric Fermentation

Federal and State agencies, industry, and academia will support research through available funding mechanisms (e.g. ARB's annual research program, Greenhouse Gas Reduction Fund), and continue to monitor progress to develop strategies that can help to reduce enteric fermentation emissions from dairy cows and livestock in the California context. Once mitigation strategies have been successfully evaluated, long-term emission reduction potential and goals can be established on a broader scale. As ARB develops an emission reduction regulation for manure management, staff will continue to evaluate the latest science of enteric fermentation and identify the best approach to addressing these emissions.

3. Landfills

Landfilling organic materials leads to the anaerobic breakdown of these materials into methane, which can work its way out of the landfill as a fugitive emission. Organic waste constitutes more than 40 percent of California's waste stream, and as with dairy manure, a holistic approach is needed to effectively divert and manage it. This means not only keeping organics out of landfills, either through source reduction or diversion, but also improving the infrastructure for diverting and/or recycling organics, including minimizing and salvaging edible food wastes, composting, anaerobic digestion and other novel processes for energy recovery. In particular, California must have enough in-state composting and in-vessel digestion or other organics processing and recycling capacity to maximize the benefits from this waste stream and effectively minimize the spreading of unprocessed organic waste on open lands, which can have adverse environmental impacts. It also means having markets for this material that are robust and resilient whether as food recovery or waste avoidance, compost , soil amendments, mulch for erosion control, transportation fuels, energy, or other uses. The State can accelerate progress by providing more consistent financial and institutional support for these efforts, and taking steps to align tipping fees and financial incentives in the sector with its organics diversion goals.

Diverting organic wastes can provide a variety of environmental and economic benefits. Food rescue or recovery is the practice of utilizing edible foods that would otherwise go to waste from restaurants, grocery stores, dining facilities and produce markets and distributing it to local food programs. Food recovered from farms, which would otherwise be plowed under, is typically gathered by volunteers. The main benefit of food rescue programs is that they provide healthy foods to those in need, but they also reduce organic waste disposal. Food wastes that may not be easily utilized for human consumption may alternatively be used as animal feed. Composting returns nutrients to the soil, builds soil organic matter, improves water holding capacity, increases carbon sequestration in the landscape, and avoids the use of fossil fuel-intense inorganic fertilizers. Anaerobic digestion can support the State's efforts to obtain at least 50 percent of its electricity from renewable resources, aid in reducing the carbon intensity of transportation fuels, and displace fossil natural gas consumption. As described in Chapter II, eliminating the disposal of organics in landfills as part of a broad

effort to put California's organic waste streams to beneficial use can generate thousands of jobs and provide billions of dollars in value, much of it concentrated in the Central Valley and other rural areas.

Eliminating the disposal of organics in landfills would align California with a growing range of efforts to do so in other states and countries. In California, San Francisco and Alameda County require that food waste be separated and kept out of the landfill, and both Los Angeles and San Francisco, along with other cities, have plans in place to become zero-waste.

The State has already established its intent to phase out the disposal of organics from landfills. Existing law sets a goal of diverting 75 percent of solid waste from landfills by 2020 and provides other measures and requirements to support diverting organics from landfills. California will build on that intent and progress, with market and institutional support, and divert 90 percent of organics from landfills by 2025, effectively eliminating the disposal of organics in landfills.[110] Due to the multi-year timeframe required to breakdown landfilled organic material, emission reductions from organics diversion accumulate over time. These actions would reduce landfill emissions by 5 $MMTCO_2e$ in 2030,[111] increasing to 21 $MMTCO_2e$ by 2050 (using a 20-year GWP).

Still, waste-in-place will continue to emit methane for decades to come. California has a Landfill Regulation in place that requires owners and operators of certain uncontrolled municipal solid waste landfills to install gas collection and control systems. This effort has improved management of landfills in California and reduced methane emissions. There may be additional opportunities to employ best practices and further reduce methane emissions from landfills over time.

However, quantifying emissions from landfills is difficult, due to their area-wide nature and several landfill-specific factors (size, age, materials deposited, local atmospheric conditions, soils, landfill cover, and gas collection system). In the GHG inventory, and its climate programs, ARB assumes a methane capture efficiency of 75 percent at landfills. This conforms with common practice nationally. In its Landfill Regulation, ARB estimated that the landfill regulation may increase the collection efficiency at regulated landfills to 80-85 percent.

Estimates of methane collection efficiency at landfills, both with and without gas collection systems, vary widely. In the U.S. EPA landfill database, the weighted

[110] Specifics of this measure will be developed during the regulatory process. For the sake of calculating emission reductions in this plan, it is estimated that 75 percent of organics will be diverted from landfills by 2020 and 90 percent will be diverted by 2025 (this would amount to an 80 percent reduction below current levels).

[111] Methane emission reductions from landfills (Table 6) are calculated assuming regulated landfills achieve methane capture efficiencies of 80 percent by 2030 and 85 percent by 2050, and that the State effectively eliminates organic disposal at landfills by 2025 by meeting the organics diversion targets identified in this Proposed Strategy.

average of collection efficiencies at California landfills is 78 percent.[112] However, this data is self-reported and the emission estimation method does not incorporate emission changes due to California's regulation. Additionally, various studies suggest that California's methane inventory is underestimating methane emissions in the State. The source(s) of potential incremental methane emissions has not been identified. Continuing evaluation of major sources of methane in the State is necessary, and this includes landfill emissions.

The State will support research to improve understanding of emissions from landfills and engage stakeholders in potential opportunities to further control them. Once more is understood about emissions from California's diverse set of landfills, ARB may update the assumptions regarding collection efficiency used in its inventory and various programs and consider whether additional actions, including a "phase 2" of the landfill regulation, would deliver further cost-effective GHG emission reductions.

Uncertainty around landfill emissions does not suggest that the existing Landfill Regulation is not reducing emissions or that steps to divert organics from landfills should be delayed. To the contrary, what is certain is that best management practices at landfills reduce methane emissions, diverting organics from landfills can provide a wide range of economic and environmental benefits in California, and that doing so is the only reliable way to avoid methane emissions from landfills on a lasting basis.

The State will take the following actions to reduce methane emissions from landfills in California:

Require Organics Diversion from Landfills

ARB, in conjunction with CalRecycle, will develop a regulation by 2018 to effectively eliminate the disposal of organics in landfills by 2025. Under this proposed regulation, the agencies will explore and prioritize opportunities to recover organic materials through local food waste prevention and rescue programs, which could account for 10 percent food waste reduction by 2020 and 20 percent reduction by 2025 in California. Food waste prevention includes activities such as education regarding food preparation and storage, refining food purchasing practices, and software that can help inform food ordering and menu selections. Rescue includes local organizations such as homeless shelters, food banks and community kitchens that provide food for people in need. Material that cannot be effectively recovered would be diverted to organics recycling facilities to make useful products,

[112] The average collection efficiency at California landfills in 2013, according to EPA's database is 76 percent. When weighted by methane generation, the average is 78 percent. http://www3.epa.gov/airtoxics/landfill/landflpg.html

including compost, fuel or energy. These facilities may be developed at existing landfills, other waste management sites, or at new stand-alone sites. Organic wastes could also be diverted to regional wastewater treatment plants or dairies for co-digestion with wastewater sludge, biosolids, or manure. Local governments must play an important role in diverting organics both as land use and permitting authorities for recycling facilities and as partners in implementing diversion requirements. The State will work with its local partners to develop helpful tools such as programmatic EIRs or guidance documents. Community engagement in the planning and environmental review processes is critical, both for understanding and mitigating potential negative health and environmental impacts and for understanding the positive economic and health and environmental benefits afforded by such projects.

Align Financial Incentives with Organics Diversion

Eliminating organics disposal in landfill will require additional infrastructure capacity to process and reuse diverted organic waste from landfills—through composting (including chipping and grinding), anaerobic digestion, or other methods. Continued, increased State funding is critical to building this necessary infrastructure. An increase in California's Integrated Waste Management Fee is also needed to support the establishment of food rescue programs, discourage the landfilling of organic waste and other recyclables, and provide funding to support organics recycling infrastructure. CalRecycle estimates that State support of at least $100 million per year for five years, in the form of grants, loans, or incentive payments, will be needed to leverage private sector financing and local rate structure changes to support the development of necessary organic infrastructure and help to foster markets.

Collaborate to Overcome Barriers

State agencies will collaborate to resolve existing constraints in the permitting process and provide clear standards and compliance pathways for all public health and environmental goals. The beneficial use of methane produced at organic waste processing facilities faces many of the same obstacles described for dairy manure or wastewater treatment, and a common workshop or work group effort to address barriers to beneficial use of organic waste streams may be useful. Also, appropriate standards should be developed to guide the direct application of organic materials on land and ensure this activity does not pose a threat to human or environmental health.

Foster Recovery Programs and Markets

CalRecycle will work collaboratively with other agencies and departments to help establish food rescue programs and to identify, develop, and expand markets for the use of compost, mulch, and renewable fuels and energy. CalRecycle and CDFA will continue their efforts to incentivize the use of compost on agricultural lands in support of the Healthy Soils Initiative, including developing best management practices for agricultural use. They will also work with the State Water Resources Control Board to evaluate potential mechanisms to account for the use of compost and its impacts on

nitrogen budgets in the Irrigated Lands Program. CalRecycle will continue to work towards strengthening State procurement requirements relative to compost and mulch. Finally, building on the existing use of mulch and compost as a water conservation practice that is essential for climate adaptation with respect to drought, State agencies will support research to quantify water conservation and other potential benefits and consider developing mechanisms to account for and value them.

Improve Understanding of Landfill Emissions

ARB and CalRecycle will support research to improve understanding of emissions from California landfills and identify opportunities to further reduce emissions from existing waste-in-place. ARB will consider the latest science and whether adjustments to emissions accounting in the inventory or other programs is warranted. Based on this information, ARB, in collaboration with CalRecycle, may consider additional actions to further reduce and capture methane emissions from landfills in the future.

4. Wastewater Treatment and other Miscellaneous Sources

Wastewater treatment, industrial operations, rice cultivation, septic tanks, and other sources of methane account for about nine percent of the State's methane inventory.

Wastewater treatment plants provide a promising complementary opportunity to help divert a portion of organic wastes from landfills and create useful byproducts such as electricity, biofuels and soil amendments. Wastewater treatment plants are designed to remove contaminants from wastewater, primarily from household sewage, but with infrastructure improvements could increase acceptance of food waste and fats, oils, and grease (FOG) for co-digestion. Anaerobic digestion is a typical part of the wastewater treatment process employed at most of the larger plants, with many plants capturing the methane they currently generate for on-site heating or electricity needs.

Many of these plants may have spare capacity, and can potentially take in additional sources of organic waste for anaerobic digestion. Existing or new digesters at these facilities can be designed to co-digest materials such as food waste and FOG from residential, commercial, or industrial facilities. Many of the largest plants are ideally located close to population centers and could potentially obtain and process significant amounts of food and other suitable waste streams within the region. The State proposes to take the following actions to evaluate this opportunity.

Develop Regional Opportunities to Co-Digest Waste

ARB will work with CalRecycle, the State Water Resources Control Board, Regional Water Quality Control Boards, and others to determine opportunities to support the co-digestion of food-related waste streams at existing and new digester facilities, including wastewater treatment plants.

Align Financial Incentives with Methane Capture and Reuse at Wastewater Treatment Facilities

A program that relies on financial incentives and/or regulatory actions could be implemented to ensure that new and existing wastewater treatment plants in California fully implement methane capture systems (ideally to produce on-site renewable electricity, transportation fuel, or pipeline biogas), and maximize digestion of regional organic materials. The potential actions would need to be tailored to each wastewater treatment plant based on size or capacity, and other factors such as potential for co-digestion expansion, proximity of organic waste streams, and regional air quality standards and rules. The Water Boards could develop permit terms and other regulatory tools to support the program while achieving water supply, water quality, and related co-benefits.

Collaborate to Overcome Barriers

Many wastewater treatment plants are permitted to burn digester biogas through flaring and are classified as industrial facilities. Capturing the biogas to produce electricity, such as through a combined heat and power (CHP) system may result in re-classifying the facility's purpose as "electricity generation" and subject the plant to more onerous emission compliance and abatement equipment rules. In addition, the beneficial use of methane generated at wastewater treatment facilities faces many of the same hurdles faced by dairy digesters and organic waste composting facilities. Support for technologies and strategies to capture biogas to generate electricity, supplement natural gas pipeline fuel, or for use as a transportation fuel, is needed to overcome some of these barriers and may open up more valuable fuel and credit markets. ARB will work with other relevant State and local agencies to identify and remove financial and regulatory barriers that hinder the productive use of waste streams processed at wastewater treatment plants.

5. Oil and Gas

California has a large oil and gas industry with more than 50,000 oil and 1,500 gas wells, including off-shore platforms. The majority of the oil wells are located in Southern California with most of the gas fields located in Northern California. An extensive network of oil and gas pipelines within the State transport California's crude oil from import terminals and on- and off-shore oil fields to refineries, and distributes finished fuels to more than 70 product terminals throughout the State.

California also has about 215,000 miles of natural gas transmission and distribution pipelines; 22 compressor stations; and 25,000 metering and regulating stations (M&R) stations. Natural gas is currently California's largest source of fuel for electricity generation, and supplies most of the energy used for industrial operations. Natural gas is also a primary source of energy used for residential and commercial space heating and cooking, and represents the primary source of GHG emissions from the residential and commercial sectors.

Much of the equipment in the oil and gas industry has been regulated for decades by the local air districts. The districts have rules and regulations to limit VOC and NO_x emissions because they are precursors of ground-level ozone. Many of the VOC controls also reduce methane as a co-benefit. In 2015, U.S. EPA proposed additional federal measures that could address methane primarily at new oil and natural gas sources, with coverage at some existing sources. Additional actions to reduce methane from the oil and gas sector should also reduce VOC and toxic air contaminant emissions, although those co-benefits have not yet been estimated.

California has an emerging, comprehensive framework in place to reduce methane emissions from oil and gas infrastructure. Effectively implementing this framework can reduce methane emissions from oil and gas systems by 40-45 percent in 2025, matching federal commitments.[113] Additional opportunities may emerge to further reduce emissions from infrastructure and will be considered when they do. But further reducing methane emissions from the oil and gas sector will ultimately require reducing in-state demand. A rapid decline for demand for oil and natural gas is also necessary to meet the State's 2030 and 2050 climate targets, more broadly.

About 90 percent of California's natural gas comes from out of State, and ultimately, action by other jurisdictions is needed to minimize leaks associated with our natural gas use. The Obama administration has taken steps to address oil and gas sector methane emissions, especially at the point of production, but more may need to be done to reduce emissions from pipelines and other equipment out-of-state. There may be steps that California agencies or utilities can take to ensure that infrastructure supplying gas to the state has minimal leakage, and to ensure that natural gas is providing environmental benefits compared to use of other fossil fuels in the State.

The State's framework on oil and gas methane emissions includes the following elements:

Adopt and Implement a Greenhouse Gas Emission Standards For Crude Oil and Natural Gas Facilities Regulation

ARB is currently working with local air districts and other stakeholders to develop a regulation for Board consideration by mid-2016. The proposed regulation, still being developed, will likely require:

[113] For the purposes of calculating emission reductions in 2030, Table 6 assumes a 45 percent reduction below current levels by 2030.

- Vapor collection on uncontrolled oil and water separators and storage tanks with emissions above a set methane standard;
- Vapor collection on all uncontrolled well stimulation circulation tanks;
- Leak Detection and Repair (LDAR) on components, such as valves, flanges, and connectors, currently not covered by local air district rules, as well as from soil at underground natural gas storage well sites;
- Vapor collection of large reciprocating compressors' vent gas, or require repair of the compressor when it is leaking above a set emission flow rate;
- Vapor collection of centrifugal compressor vent gas, or replacement of higher emitting "wet seals" with lower emitting "dry seals";
- "No bleed" pneumatic devices and pumps; and
- More frequent methane monitoring at underground natural gas storage facilities.

This regulation would uniformly expand some local regulations to all air districts and include additional infrastructure components (such as valves, flanges, and seals) that are not currently covered by local district programs. ARB staff is investigating ways to ensure that any combustion-based controls will not interfere with efforts to achieve and maintain compliance with ambient air quality standards in cases where methane and VOC emissions cannot be sent into existing sales lines, fuel lines, or reinjection wells, and are instead captured by installing new vapor collection on existing storage tanks, with the collected vapors being sent to a low-NOx incinerator that will replace an existing flare.

Improve Monitoring and Standards to Detect and Minimize Emissions

ARB and DOGGR are working together to ensure that both above and below ground monitoring of storage facilities is improved. As mentioned above, ARB is considering improved above-ground methane monitoring of underground storage facilities in its upcoming Oil and Gas Production, Processing, and Storage Regulation. In January 2016, DOGGR released notice of an emergency regulatory action to implement protective standards specifically designed to ensure that operators of underground gas storage facilities are properly minimizing risks and taking all appropriate steps to prevent uncontrolled releases, blowouts, and other infrastructure-related accidents. The emergency regulations will ensure that operators of existing underground gas storage facilities monitor for and report leaks to DOGGR, function test all safety valve systems, perform inspections of wellheads and surrounding area and equipment, develop risk management plans that require verification of mechanical integrity and corrosion assessment and monitoring, and provide DOGGR with complete project data and risk assessment results. Immediate implementation of these standards will ensure that underground gas storage facilities are properly operated, minimizing the potential that an incident such as the gas leak at the Aliso Canyon Natural Gas Storage Facility does

not recur.[114] ARB and DOGGR will coordinate on the monitoring provisions to ensure consistency and comprehensiveness while limiting duplication.

Additionally, Assembly Bill 1496 (Thurmond, Statues of 2015, Chapter 604) requires ARB, in consultation with scientific experts and other state, local, and federal agencies, to undertake monitoring and measurements of high-emission methane "hot spots" and conduct lifecycle GHG emission analysis for natural gas produced in and imported into California. Pursuant to this bill, ARB will continue its efforts related to hot spots monitoring and lifecycle greenhouse gas accounting for fuels, and will host a scientific workshop to collect the best available knowledge on these topics. ARB will update relevant policies and programs to incorporate any new information gathered as a result of these efforts.

Effectively Implement SB 1371 to Reduce Emissions from Pipelines

Senate Bill 1371 (Leno, Chapter 525, Statutes of 2014) directs the CPUC, in consultation with ARB, to adopt rules and procedures to minimize natural gas leaks from CPUC-regulated intrastate transmission and distribution gas pipelines and facilities. Among other requirements, SB 1371 directs the CPUC to adopt rules and procedures that provide for the maximum technologically feasible and cost-effective avoidance, reduction, and repair of leaks and leaking components. In January 2015, the CPUC launched a rulemaking proceeding (R.15-01-008) to carry out the intent of SB 1371. Under this proceeding, CPUC published a report that identifies new gas leak detection technologies that can be used to optimize methane reductions from transmission, distribution and storage processes. CPUC also required utility companies and gas suppliers to report natural gas emission data and best leak management practices by May 15, 2015. In June 2015, CPUC conducted a prehearing conference to discuss the draft scoping memo of relevant topics to be deliberated during the 24-month timeframe of the proceeding.

ARB continues to actively participate in the proceeding and will lead efforts to analyze collected utility emission data, develop quantification protocols, and identify potential mitigation strategies. In particular, ARB will focus on the emission reduction potential of the proceeding in keeping with the objectives of AB 32 as they pertain to:

- Comparing the data collected under SB 1371 with the Mandatory Reporting Regulation;

[114] Preliminary estimates suggest the incident resulted in about 8 $MMTCO_2e$ (AR5 20-year GWP) of methane emissions, an approximately 20 percent increase in statewide methane emissions for the duration of the leak (October 23, 2015–February 17, 2016). Governor Brown's January 2016 Aliso Canyon Proclamation directs the ARB to develop a mitigation plan for the leaked methane emissions by March 31, 2016. It can be accessed at: http://www.arb.ca.gov/research/aliso_canyon/arb_aliso_canyon_methane_leak_climate_impacts_mitigation_program.pdf

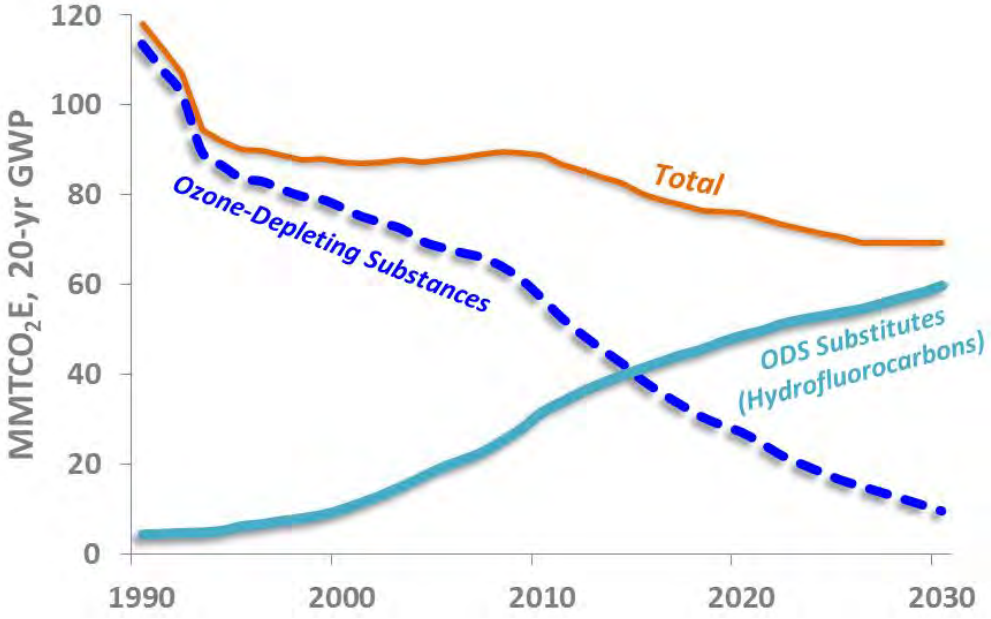
- Analyzing emission data to determine potential mitigation strategies. For example, the proceeding may require the replacement of older pipelines or pipelines constructed of a certain material;
- Identifying any remaining data gaps;
- Establishing procedures for the development and use of metrics to quantify emissions; and
- Reviewing and evaluating the effectiveness of existing practices for the operation, maintenance, repair, and replacement of natural gas pipeline facilities to determine the potential to reduce methane leaks and where alternative practices may be required.

The final decision on potential rules and procedures by the CPUC, including ratemaking and financial incentives to minimize gas leaks, is anticipated in the Fall of 2017. Upon evaluation of the industry's compliance with the decision, ARB will determine whether additional regulatory actions or incentives are required to further reduce methane emissions from this source.

VI. Reducing HFC Emissions

Hydrofluorocarbons (HFCs) are the fastest-growing source of GHG emissions both globally and in California. HFCs are fluorinated gases (F-gases), which also include the ozone-depleting substances (ODS) that are being phased out under the Montreal Protocol. HFCs currently comprise four percent of all GHG emissions in California, although annual HFC emissions are expected to increase 60 percent under business-as-usual by 2030 as HFCs continue to replace ODS (Figure 8).

Figure 8: Emission Trends of ODS and ODS substitutes (hydrofluorocarbons) – (as ODS are phased out, HFCs increase)

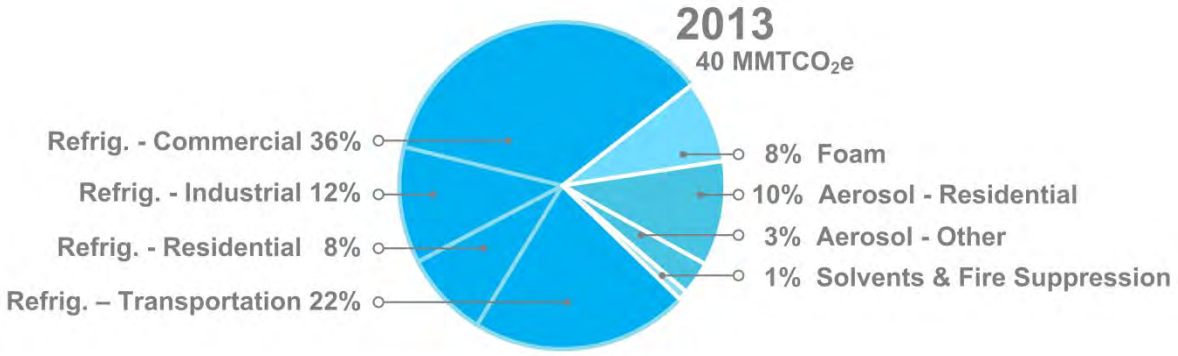


The majority of HFC emissions come from fugitive emissions of refrigerants used in refrigeration and air-conditioning (AC) systems. The largest uses of HFCs are in commercial and industrial refrigeration and air-conditioning, which comprise 48 percent of HFC emissions. More than half of refrigeration and air-conditioning equipment currently uses HCFC-22, a high-GWP ODS which is scheduled for a complete phase-out of new production and import in the U.S. by 2020. The HCFC-22 refrigerant is being replaced with HFCs that have higher GWPs, thus increasing the GHG impact of refrigerants. We expect that in anticipation of the HCFC-22 phase-out by 2020, most owners of equipment using HCFC-22 will either replace the equipment by 2020, or at a minimum replace the HCFC-22 refrigerant in the same equipment (retrofit) with a high-GWP HFC refrigerant. A window of opportunity exists in the next five years to accelerate the transition of refrigeration and air-conditioning equipment to lower-GWP refrigerants, before another generation of equipment is locked into using higher-GWP refrigerants over their average lifetimes of 15 to 20 years.

HFC emissions from transportation are largely from mobile vehicle air-conditioning (MVAC), and as California and the U.S. EPA implement the MVAC credits programs

under their light-duty vehicle GHG emission standards, and the MVAC leakage standards under their heavy-duty vehicle GHG emission standards, the share of HFC emissions from the transportation sector will decline. Aerosol propellants (industrial, consumer, and medical dose inhalers) comprise 13 percent of HFC emissions, and insulating foam expansion agents contribute another eight percent of HFC emissions. Solvents and fire suppressant emissions contribute one percent of all HFC emissions. Figure 9 shows the emissions sectors that contribute to California's overall HFC emissions. (ODS emissions are not shown because they are being completely phased out under the Montreal Protocol and are not included in the AB 32 GHG emission reduction targets.)

Figure 9: California 2013 Hydrofluorocarbons (HFCs) Emission Sources*



*Using 20-year GWP

This Draft Proposal identifies measures that can reduce HFC emissions by 40 percent in California by 2030. They represent a reasonable path forward for California, but the State's approach on HFCs could be affected by a potential international agreement that may be reached in 2016 to phase down the use of HFCs globally.

A. Progress to Date

California is among the world's leaders in reducing HFCs and other F-gas emissions. Measures adopted under AB 32 have reduced emissions from a variety of sources. The State's Cap-and-Trade offset protocol for ozone depleting substances incentivizes the capture and destruction of ODS refrigerants and foam expansion agents. The biggest reductions of high-GWP F-gases are coming from ARB's Refrigerant Management Program, which requires facilities with refrigeration systems to inspect and repair leaks, maintain service records, and in some cases, report refrigerant use. The Refrigerant Management Program has helped change industry practices to become more proactive in preventing refrigerant leaks, which has helped businesses save money by avoiding system repairs and downtime as well as the cost of replacement refrigerant. Other measures already in place include low-GWP requirements for consumer product aerosol propellants and a self-sealing valve requirement for small cans of automotive refrigerants purchased by "do-it-yourself" mechanics.

California's efforts to reduce emissions of F-gases are part of a broader set of national and international commitments. World leaders have agreed to work together and

through the Montreal Protocol to phase down the production of HFCs. The U.S. EPA can impose federal bans on F-gases under the Significant New Alternatives Policy (SNAP) Program. In July 2015, the U.S. EPA adopted future bans on specific HFCs with very high GWPs used in new commercial refrigeration systems, the manufacture of polyurethane foam, and new light-duty motor vehicle air-conditioning systems.[115] In many cases, these national bans copied programs that were first demonstrated in California.

The U.S. national bans are expected to decrease HFC emissions in California by ten percent annually below business as usual by 2025. The European Union (EU) has adopted the world's leading F-gas regulation that will phase down the production and import of HFCs by almost 80 percent from 2014 levels by 2030.[116,117]

Additionally, in response to President Obama's Climate Action Plan, in September 2014, and again in October 2015, the White House announced private sector commitments and executive actions to reduce emissions of hydrofluorocarbons (HFCs).[118,119] U.S. industry is leading the way by investing billions of dollars to develop and deploy the next generation of HFC alternatives that are safer for the environment. These investments span the entire HFC supply chain— from where the chemicals are produced, to where they are used in manufacturing, to where consumers see them in stores.

Further private sector commitments were made in February 2016, when both the Air Conditioning Heating & Refrigeration Institute (AHRI) and the Association of Home Appliance Manufacturers (AHAM) made voluntary commitments to phase down the use of high-GWP HFCs in new equipment.[120,121]

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[115] Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes Under the Significant New Alternatives Policy Program; Final Rule. Federal Register. Volume 80, Number 138, Monday, July 20, 2015. Part II. Environmental Protection Agency. 40 CFR Part 82. http://www.epa.gov/ozone/snap/regulations.html

[116] Velders et al (2014) "Growth of climate change commitments from HFC banks and emissions", G. J. M. Velders, S. Solomon, and J. S. Daniel. *Atmospheric Chemistry and Physics*, 14, 4563–4572, 2014. doi:10.5194/acp-14-4563-2014. www.atmos-chem-phys.net/14/4563/2014/.

[117] EC (2014) European Commission (EC), April 16, 2006 "Regulation (EU) No 517/2014 of the European Parliament and of the Council on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006". http://ec.europa.eu/clima/policies/f-gas/legislation/documentation_en.htm

[118] Fact Sheet: Obama Administration Partners with Private Sector on New Commitments to Slash Emissions of Potent Greenhouse Gases and Catalyze Global HFC Phase Down. September 16, 2014: http://www.igsd.org/documents/20140916HFCFactSheet.pdf

[119] Fact Sheet: Obama Administration and Private-Sector Leaders Announce Ambitious Commitments and Robust Progress to Address Potent Greenhouse Gases. October 15, 2015. https://www.whitehouse.gov/the-press-office/2015/10/15/fact-sheet-obama-administration-and-private-sector-leaders-announce.

[120] AHRI and Natural Resources Defense Council (NRDC) February 1, 2016 petition to U.S. EPA Significant New Alternatives Policy (SNAP) Program to remove high-GWP HFCs from the list of

In March 2016, the U.S. EPA proposed additional bans on high-GWP HFCs in new retail food refrigeration, cold storage, chillers used for air-conditioning, and household refrigerator-freezers.[122] The proposal had not been adopted as of April 2016.

Substantial progress has also been made to safely use natural refrigerants (such as CO_2, ammonia (NH_3), and hydrocarbons (HCs), with GWPs at or near zero) all over the world, especially in Europe and Asia. The refrigeration and air-conditioning industry is looking closely at which applications suit which natural refrigerants. Reports summarizing the progress made in North America show nearly 300,000 pieces of light commercial equipment using CO_2 or hydrocarbons, more than 250 stores using CO_2 systems, and over 250 "next-generation" small-charge ammonia systems in industrial installations. Large companies investing in natural refrigerants include end users, and a wide range of equipment manufacturers.

In addition to the natural refrigerants, a new generation of fluorinated refrigerants known as hydrofluoro-olefins (HFOs) have been developed that are non-ODS and have GWP values less than five. HFOs can be used in pure form for some cooling applications, such as motor vehicle AC, and are also used in blends with HFCs for other cooling applications, such as commercial and industrial refrigeration. Initial results indicate that the newest generation of fluorinated refrigerants perform as well as the high-GWP HFCs they replace.

These State and national efforts will lead to significant reductions in HFC emissions in California through 2030, compared to where they would be otherwise. Still, HFC emissions in California are expected to grow by more than 60 percent without additional action (Figure 10).

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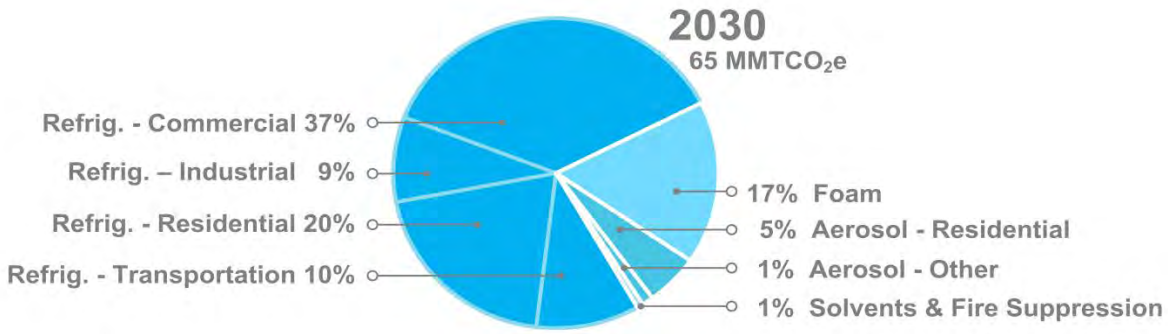
acceptable substitutes in new air-cooled and water-cooled chillers using centrifugal, screw, scroll, and all other compressor types.

[121] "Home Appliance Industry Sets Goal to Eliminate Use of HFC Refrigerants", Press Release February 9, 2016 from Association of Home Appliance Manufacturers (AHAM). http://www.prnewswire.com/news-releases/home-appliance-industry-sets-goal-to-eliminate-use-of-hfc-refrigerants-300217501.html.

[122] Fact Sheet. Proposed Rule - Protection of Stratospheric Ozone: New Listings of Substitutes; Changes of Listing Status; Reinterpretation of Unacceptability for Closed Cell Foam Products under the Significant New Alternatives Policy Program; and Revision of Clean Air Act Section 608's Venting Prohibition for Propane. U.S. EPA, March 29, 2016. https://www.epa.gov/snap/snap-regulations

Figure 10: California's 2030 HFC Emission Sources with Existing Measures*



*Using 20-year GWP

B. Recommended Actions to Further Reduce HFC Emissions

The State supports strong, national, and international actions to reduce HFC emissions. The U.S. EPA has already taken a number of steps to prohibit the use of new high-GWP HFCs in consumer product aerosol propellants, polyurethane insulating foam, and light-duty mobile vehicle air-conditioning. An international agreement could be reached in 2016 to phase down the production and use of HFCs under the Montreal Protocol. The proposed Montreal Protocol HFC phase down amendments, if adopted, will reduce HFC emissions significantly by 2050.

However, if additional measures can be applied in California to achieve further GHG emission reductions in the near-term and at low cost, California will consider them to support the State's 2020 and 2030 GHG targets. Specifically, as effective alternatives become available, ARB will consider developing bans on the use of high-GWP refrigerants in sectors and applications where lower-GWP alternates are feasible and readily available. All refrigerants and substitutes to high-GWP F-gases must first be approved by the U.S. EPA's SNAP Program to ensure the alternatives meet health and safety criteria. The approval process is designed to minimize the risk of using newer alternatives to F-gases by identifying substitutes that offer lower overall risks to human health and the environment.

Also, in the absence of a sufficiently rigorous international agreement by the end of 2016, ARB will evaluate the feasibility of a phasedown for California that aligns with similar efforts and stringency levels in Australia, Canada, the EU, and Japan.

Even with a strong international agreement to phase down the use of HFCs, additional opportunities remain to reduce their emissions in California in the near-term and through 2030 at low cost. Early action, ahead of some of the phase down schedules being proposed internationally, can avoid locking-in the use of high-GWP refrigerants in new or retrofitted systems in the coming years

For example, the State should consider developing an incentive program to encourage the use of low-GWP refrigerants, which could lead to very low-cost emission reductions and could be implemented while further regulations are considered or developed. This

would provide long-term avoided emissions by countering the current trend of replacing HCFC-22, the most common refrigerant for both refrigeration and air-conditioning, with higher-GWP HFCs. This trend is accelerating in the U.S. in response to the 2020 phase-out of HCFC-22 under the Montreal Protocol.

In light of ongoing international discussions, this Draft Proposal describes a set of potential measures that can reduce HFC emissions by 40 percent in California by 2030 (see Table 7). This set of measures has been designed to minimize regulatory requirements and achieve fast and assured emission reductions.

Table 7: Proposed New HFC Emission Reduction Measures and Estimated Emission Reductions ($MMTCO_2e$)[1]

Measure Name	2030 Annual Emission Reductions	2030 Annual Emissions
2030 BAU[2]		**65**
Financial Incentive for Low-GWP Refrigeration Early Adoption	2	
HFC Supply Phasedown	19	
Sales ban of very-high GWP refrigerants	5	
Prohibition on new equipment with high-GWP Refrigerants	15	
2030 BAU with new measures		**24**

[1]Using 20-year GWPs from the 4th Assessment report of the IPCC
[2]"Business as Usual" (BAU) forecasted inventory includes reductions from implementation of current ARB and U.S. EPA regulations

Incentive Programs

In his 2016-2017 Proposed Budget, Governor Brown includes $20 million for a financial incentive program to defray the potential added cost of installing new low-GWP refrigeration equipment or converting existing high-GWP systems to lower-GWP options. This program could provide immediate and ongoing emission reductions. A loan or grant program would support qualifying facilities that take action to reduce emissions prior to any national or state requirements to do so.

Data reported under the existing Refrigerant Management Program indicates that more than 2,400 facilities with large commercial refrigeration systems in California currently use HCFC-22 refrigerant. This refrigerant has not been allowed in new equipment since January 2010, and all new production and import will cease by January 1, 2020. Therefore, these facilities must either buy increasingly scarce recycled HCFC-22 to maintain their systems, or replace or retrofit their existing systems with another refrigerant within five years.

Although lower-GWP options are currently available and can be cost effective, in most cases with improved energy efficiency, there are two main barriers to more widespread adoption of low-GWP commercial refrigeration: 1) potentially higher up-front costs, and 2) lack of familiarity with low-GWP refrigeration. The incentive program could remove the added initial cost barrier and build familiarity with low-GWP refrigeration systems to help them scale throughout the sector.

One of the advantages of an incentive program is that it could fund early adoption of low-GWP technologies, with substantial long-term effects on avoided emissions. The incentive program would "lock in" early and permanent GHG reductions prior to any mandatory measures.

Phasedown in Supply of HFCs

An HFC phasedown allows industry the flexibility to make market-based decisions on when and where to continue using high-GWP HFCs before transitioning to lower-GWP options. The EU has recently adopted a supply phasedown, at the top level of supply for both production and import (first arrival of virgin refrigerant). The EU model identified the existing market based on past production and import and aims to reduce it 79 percent by 2030. Broad-based national or international agreements are the most effective phasedown approaches, minimizing the possibility of simply displacing emissions to other locations.

In the international arena, countries met in Dubai in November 2015 to discuss an HFC phasedown amendment to the Montreal Protocol. The meeting did not result in a specific phase-down agreement, but the outcome was viewed as positive by most participants, with countries agreeing to a series of meetings in 2016 designed to reach an international phase-down. If a national or international HFC phasedown agreement cannot be reached in 2016, ARB may pursue a California HFC phasedown schedule that will help meet the State GHG emission reduction goals. California would seek a partnership with the EU, Canada, Japan, and Australia, all of which are currently pursuing their own separate HFC phasedown programs.

Phasedown programs offer several advantages over other regulatory approaches, such as fees or fixed limits on the maximum GWP of HFCs allowed. A broad-based phasedown program significantly reduces the number of regulated entities compared to downstream regulation, causes minimum disruption to industry, and guarantees emission reductions. Industry stakeholders generally favor a phasedown approach as a technically feasible, fair, and cost-effective means of reducing HFC emissions, while allowing them flexibility in transitioning to low-GWP alternates.

Prohibition on the Sale of New Refrigerant with Very-High GWPs

This measure would prohibit the sale or distribution of refrigerants with 100-year GWP values of 2500 or greater, beginning January 1, 2020. Refrigerants that are certified reclaimed or recycled would be exempt from the sales ban.

In July 2015, the U.S. EPA adopted a ban on using refrigerants with a very-high 100-year GWP of 2500 or greater in new and retrofitted refrigeration systems at retail food facilities beginning in the second half of 2016. Several refrigerants are currently available with a 100-year GWP of less than 1500 that can be used in existing equipment designed for higher-GWP refrigerants.

A sales ban on very high-GWP refrigerants is enforceable and provides immediate reductions. Such a ban facilitates a much faster transition from very high-GWP refrigerants to lower-GWP alternatives in existing equipment (thus avoiding the ongoing high-GWP emissions from equipment that typically lasts for 15 years or longer).

High-GWP Refrigerant Prohibitions in New Stationary Systems

This measure would prohibit the use of high-GWP refrigerants in new commercial, industrial, and residential stationary refrigeration and air-conditioning equipment, as follows:

Stationary Refrigeration or Stationary Air-Conditioning Sector	**Refrigerants Prohibited in New Equipment with a 100-year GWP Value:**	**Proposed Start Date**
Non-residential refrigeration	150 or greater	January 1, 2020
Air-conditioning (non-residential and residential)	750 or greater	January 1, 2021
Residential refrigerator-freezers	150 or greater	January 1, 2021

Certain exceptions could be made to any maximum GWP limit if a low-GWP refrigerant is not technically feasible in a specific application. GWP limits may be subject to change as additional low-GWP refrigerants become available. For example, low and medium-pressure chillers used for air-conditioning may be able to use refrigerants with a GWP less than 150.

Low-GWP commercial refrigeration using ammonia is already extensively used in food processing and cold storage. Additionally, more than 250 retail food stores in the U.S. have begun using CO_2 as the primary or secondary refrigerant. In Europe, CO_2 refrigeration is used in more than 5,200 retail food stores, and generally is cost neutral compared to HFC refrigeration systems. In the hotter climate zones of California, using 100 percent CO_2 refrigeration may not be as energy-efficient as HFC refrigerants, although newly demonstrated adiabatic cooling technology has promise to neutralize energy efficiency concerns. Alternatively, manufacturers are currently developing blends of HFC refrigerants combined with a new class of very-low GWP synthetic refrigerants known as hydrofluoro-olefins (HFOs). The HFO-HFC blends have 100-year GWPs between 88 and 1400, and their use would reduce GHGs in these systems by

more than 75 percent compared to business as usual.[123] Hybrid refrigeration such as secondary loop and cascade systems, using a small HFC central charge and a larger CO_2 charge, experience no energy penalty, even in hotter climates.

With respect to air-conditioning, in September 2014, the Air-Conditioning Heating & Refrigeration Institute (AHRI), an industry association representing 90 percent of U.S. air-conditioning manufacturing and 70 percent of the global industry, made a commitment through the White House Council on Environmental Quality to spend $5 billion over the next ten years to develop low-GWP options for refrigeration and air-conditioning. Many commercially available lower-GWP air-conditioning options are expected by 2020. In order to comply with the EU F-gas regulation that went into effect January 1, 2015, manufacturers are already developing air-conditioning systems that use refrigerants with a 100-year GWP of less than 750. Large chillers used primarily for office building air-conditioning are already commercially available that use an HFO refrigerant with a GWP of one.

Current fire and appliance codes do not allow the use of hydrocarbon refrigerants, which are flammable, unless the system is below a small charge size threshold of 150 grams for commercial refrigerators, and 57 grams for household refrigerators. Experience in Europe and other jurisdictions demonstrates that these codes can be designed to allow for the use of these refrigerants while ensuring safety, where current limits are 150 grams for household refrigerators and up to 1.5 kg for commercial uses. More work is required to update the safety codes in the U.S. before slightly flammable refrigerants can be used in more applications while maintaining safety.

A prohibition, or ban on the use of high-GWP HFCs in new equipment would result in certainty of reductions in applications where alternatives are readily available. By requiring equipment manufacturers to sell only ARB-compliant equipment in California, the enforcement focus is on the manufacturers and is not placed on the end-user.

Additional measures that may be more effectively addressed at the Federal level include prohibitions on high-GWP HFCs in the following sectors: consumer product aerosol propellants, insulation spray foam, heavy-duty motor vehicle air-conditioning, transport refrigeration units (TRUs), and refrigerated shipping containers. ARB will continue to work with the U.S. EPA on reducing HFC emissions from these sectors, and may pursue state-level measures if progress is not made on the Federal level.

[123] HFOs are hydrofluoro-olefins, an emerging class of F-gas with very low GWPs of 1-5, but which are classified as slightly flammable (A2L). By blending HFOs with HFCs, refrigerant blends which are non-flammable have been created and U.S. EPA SNAP-approved for certain applications.

C. Sulfuryl Fluoride

Sulfuryl fluoride (SO_2F_2) is a pesticide fumigant and one of the most common replacements for methyl bromide, an ozone-depleting substance whose use is being phased out. Sulfuryl fluoride is regulated by the California Department of Pesticide Regulation (DPR), and was listed as a toxic air contaminant (TAC) in 2006. As a pesticide and TAC, sulfuryl fluoride's use is strictly controlled. In December 2015, DPR submitted a report to the Legislature, which provided an update on adopted control measures for sulfuryl fluoride,[124] as required by AB 304 (Williams, Chapter 584, Statutes of 2013). DPR plans to develop additional mitigation measures by September 2016, to address unacceptable exposures of sulfuryl fluoride to bystanders and residents. Sulfuryl fluoride is not registered for use as a field soil fumigant and is not used on agricultural fields.

Until 2009, sulfuryl fluoride was believed to have a negligible GWP. Further research concluded that SO_2F_2 has a 20-year GWP of 6840, with a lifetime of several decades. According to the DPR, 3 million pounds of sulfuryl fluoride were used in California in 2013 (most recent data available).[125] Its main use is as a structural pest control fumigant to kill drywood termites in homes and buildings, accounting for 82 percent of all usage in 2013. Sulfuryl fluoride is also a common fumigant for dried fruits, nuts, and other agricultural commodities that must be kept pest-free during storage prior to shipping (15 percent of all usage in 2013). The remaining three percent of sulfuryl fluoride application was for other fumigation uses. A complete listing of sulfuryl fluoride usage in California by commodity is listed in Appendix A.

Because sulfuryl fluoride was not identified as a high-GWP gas by the time AB 32 was enacted, it was not initially included as a part of ARB's statewide GHG inventory. However, the annual usage of sulfuryl fluoride is inventoried by DPR as a highly-regulated pesticide and ARB uses this data to track emissions. In 2013, the 3 million pounds of SO_2F_2 usage was equivalent to 9.4 $MMTCO_2E$ emissions (using 20-year GWP values), or approximately 20 percent of all F-gas emissions.

Identifying less toxic or lower-GWP alternatives to sulfuryl fluoride remains problematic. Methyl bromide (CH_3Br), with a 20-year GWP of 17, was the pesticide fumigant of choice for many applications until its use was almost completely phased-out by the Montreal Protocol because of its ozone-depleting potential. Currently, sulfuryl fluoride is the only fumigant registered for treating structural pests in California. Termites or other wood-destroying pests are detected in over 250,000 California homes each year, with the cost of control and repair of damage from dry-wood termites in California exceeding $300 million annually (with 80 percent of fumigations occurring in Southern California).

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[124] Report to the Legislature Required by AB 3014 (2013) Food & Agricultural Code Section 140124(c)(2)(A): Update on the Adoption of Control Measures for the Toxic Air Contaminant Sulfuryl Fluoride. Report submitted by the California Department of Pesticide Regulation to the California Legislature, December 22, 2015.

[125] Summary of Pesticide Use Report Data 2013 - Indexed by Commodity, California. California Department of Pesticide Regulation, May 2015. Available at: http://www.cdpr.ca.gov/docs/pur/pur13rep/13_pur.htm.

For agricultural commodity fumigation storage (primarily dried fruits and nuts), methyl bromide is still used on a limited basis through special use exemptions, although its use is decreasing annually. An alternative fumigant, phosphine (PH_3), with a GWP of 0, is also used as an alternative to methyl bromide and sulfuryl fluoride. However, reported insect tolerance to phosphine has limited its widespread usage.[126] Non-chemical commodity treatment has been studied since 1995, including irradiation, and controlling the atmosphere to "suffocate" insects in either low-oxygen or high carbon dioxide environments.[127] Chemical treatment remains dominant due to cost and feasibility issues of non-chemical alternatives.

The effectiveness of less toxic (and lower-GWP) alternatives to sulfuryl fluoride in structural fumigation for drywood termites is the subject of much research, opinion, and disagreement. Structural fumigation generally includes tenting the entire structure and treating it to kill termites, or more rarely, wood-boring beetles and other pests living in the structure. While many termite control companies only use sulfuryl fluoride, many others have begun using alternative termite control methods, including orange oil, structure heating or extreme cooling, microwaves, and electricity. Additional research is required before sulfuryl fluoride mitigation measures can be proposed. ARB will continue working with the DPR to assess mitigation measures to sulfuryl fluoride emissions. Additional discussion on potential research of sulfuryl fluoride mitigation is included in Appendix B.

[126] Phosphine Fumigation of Stored Agricultural Commodity - Programmatic Environmental Assessment. November 2013. United States Agency for International Development (USAID), prepared under USAID's Global Environmental Management Support (GEMS) project. Available at: http://www.usaidgems.org/documents/fumigationpea/fumigationpeafeb24_2014.pdf.

[127] Alternatives to Methyl Bromide: Research Needs for California - Report of the Methyl Bromide Research Task Force To The Department of Pesticide Regulation and The California Department of Food and Agriculture. September, 1995. Available at: http://www.cdpr.ca.gov/docs/emon/methbrom/mb4chg.htm.

VII. Achieving Success

Successfully implementing a strategy to reduce SLCP emissions will require integrated planning to achieve multiple objectives, coordination and collaboration among agencies at all levels of government, and focused investments and market support.

A. Integrate and Coordinate Planning

The SLCP Reduction Strategy fits within a wide range of ongoing planning efforts throughout the State to advance economic and environmental priorities. Integrated planning to achieve multiple objectives requires coordination among planning agencies and across sectors, systems, and government jurisdictions. Development of a strategy to reduce emissions of SLCPs is being closely coordinated with other relevant planning efforts. For example, this Proposed Strategy acknowledges that further reductions in black carbon from California's freight system will be realized through strategies identified in the California Sustainable Freight Action Plan. That plan is currently being developed by ARB and other state agencies, and will accelerate emission reductions and implementation of zero and near-zero technology in California's freight transport system. Also, ARB staff and local air districts will develop additional strategies through the upcoming SIPs process, which is expected to reduce black carbon emissions from both mobile and non-mobile sources.

State Plans that will Assist the State in Meeting SLCP Emission Reduction Goals
CalRecycle AB 341 Report to the Legislature
California Sustainable Freight Action Plan
Additional Scoping Plan Updates
2016 California State Implementation Plan
Auction Proceeds Investment Plan
Caltrans Strategic Management Plan for 2015-2020
Funding Plan for Low Carbon Transportation Investments and the Air Quality Improvement Program
Mobile Source Strategy
ARB Annual Research Plan
Climate Change Research Plan for California
California Water Action Plan
CEC Electric Program Investment Charge Program
Annual Investment Plan for Alternative and Renewable Fuels and Vehicle Technology Program
DWR Climate Action Plan
Bioenergy Action Plan
Forest Carbon Plan
Healthy Soils Initiative

The 2014 Scoping Plan Update identified the important role of SLCPs to reduce climate change impacts and provided suggested recommended actions for further emission reductions. Those recommendations were evaluated and expanded upon in this Proposed Strategy.

The ARB is embarking on the next update to the Scoping Plan to describe how the State can meet the Governor's goal of reducing total GHG emissions by 40 percent by 2030. This SLCP strategy is a forerunner to the Scoping Plan, providing justification for accelerated action on SLCP. The next Scoping

Plan will augment the strategies presented in this document with measures focused on CO2, providing a balanced portfolio of near-term and long-term measures.

Other concurrent planning efforts in the State could also identify additional activities that may serve to reduce SLCP emissions. For example, CEC's Integrated Energy Policy Report, the Healthy Soils Initiative, and the Forest Carbon Plan are all ongoing efforts that intersect with many of the concepts described in this Draft Report. ARB will collaborate with other agencies developing those plans to identify and prioritize activities to reduce SLCP emissions that would also support other State priorities and integrated planning efforts. Climate action planning efforts by city, county, and other local government entities will also play a key role in reducing SLCP emissions, especially if these action plans begin to incorporate SLCP emission inventories and mitigation actions.

B. Enable Local and Regional Leadership

State policy is most effective with the support, engagement, and complementary actions of regional and local efforts. As the State shifts its climate-protection focus to the long-term and increases its efforts to reduce SLCP emissions, regional and local governments and agencies will play an increasingly important role in achieving California's GHG goals. The efforts of regional agencies, such as air districts, water districts, and municipal solid waste authorities, to incorporate GHG emission reduction strategies into their respective jurisdictions increases the State's leverage to further reduce SLCP emissions from various sources.

Local air districts have a key role to play in reducing regional and local sources of SLCP emissions, because air pollution reduction strategies employed by air districts often also reduce GHG emissions. City and county governments also play a pivotal role in reducing emissions of SLCPs. Many GHG emission reduction strategies identified by cities and counties in their local Sustainability or Climate Action Plans directly correlate to strategies necessary for SLCP emission reductions, such as improved waste management (increased recycling and composting), use of alternative and renewable fuels, and simply reducing vehicle miles traveled. These local government Climate Action Plans encourage, and sometimes mandate at the local level, actions taken by households and businesses within a community. Often times, these actions involve behavior change by individuals, which leads to increased conservation and sustainability, ultimately driving both community-scale GHG and SLCP emission reductions.

Below are examples of local and regional government efforts that are helping the State reduce SLCP emissions.

Methane

In California, agriculture and landfills are the primary sources of methane emissions. Aside from air district rules to reduce methane emissions at landfills, upstream efforts by

cities, counties, and regional agencies to both reduce and divert food waste and other organic materials from the waste stream have the potential to greatly reduce landfill-related methane emissions. Additionally, local municipalities and solid waste agencies are working collaboratively with air districts to foster renewable fuel opportunities, such as waste-to-energy and waste-to-fuel projects. For example, through its leadership role with Clean Cities, the Sacramento Metropolitan Air Quality Management District is working closely with numerous partners to build awareness and increase separation and diversion of organic waste to a local anaerobic digester.

Local agencies also play a role in utilizing methane beneficially at wastewater treatment plants. Many local agencies own and operate wastewater treatment facilities and are implementing strategies for on-site energy production. Local strategies to improve management and utilization of organic waste throughout the State may also have the ability to help reduce methane emissions throughout the agricultural sectors. Wastewater treatment plants offer a tremendous opportunity to divert organics from landfills and utilize them for producing energy, transportation fuel, and soil amendments. Many treatment plants are located near population centers and could potentially utilize significant amounts of food and other organic waste streams that come from cities and towns. Collaboration amongst local and regional agencies, such as solid waste management and wastewater agencies, is the key to success.

Black Carbon

Local air districts have worked with ARB to develop programs to comply with federal air quality standards for PM (that will also reduce black carbon), such as mandatory and voluntary rules to restrict residential wood-burning in fireplaces and wood stoves, along with incentive programs to switch to cleaner burning devices. In fact, in October 2015, the Bay Area Air Quality Management District adopted a new rule banning all wood burning devices in new construction. Districts have also enacted rules regulating commercial cooking and smoke management programs addressing agricultural, forest and rangeland burning operations, which have reduced black carbon and PM emissions.

In addition to air district efforts, metropolitan planning organizations, in coordination with city and county governments, can be credited with efforts to reduce vehicle emissions, and ultimately on-road related emissions, particularly through their Sustainable Community Strategy planning and implementation efforts. Local governments have stepped up by beginning with their own fleets. For example, in Sonoma County, the Board directed County staff to reduce emissions from the County's on-road fleet by 20 percent by 2010.

Local efforts to reduce diesel particulate matter, such as farm and construction equipment rules and incentive programs by air districts, play a significant role in the reduction of black carbon emissions such as the San Joaquin Valley Air Pollution Control District's program to replace diesel agricultural irrigation pump engines with electric motors. In addition, efforts by local port authorities, such as the San Pedro Bay Standards, have resulted in the establishment of more aggressive targets to reduce black carbon emissions, health risks, and further improve air quality, particularly for those in nearby disadvantaged communities.

HFCs and other F-gases

Local air districts can play an instrumental role in aiding the reduction of HFC emissions, including developing regulations to require low-GWP replacements. For example, the South Coast Air Quality Management District has three regulations to reduce refrigerant emissions from stationary air conditioning and refrigeration systems and motor vehicle servicing, as well as restrictions on CFCs and halons from sterilization, fumigation, and fire extinguishing equipment. In addition, many local governments are also tracking emissions of refrigerants, and some have adopted policies to reduce refrigerant emissions from city-owned air conditioning units, vehicles, and refrigerators.

C. Investments

Investments in financial incentives and direct funding are critical components for successful implementation of SLCP emission reduction strategies. Many existing State funding programs work in tandem to reduce emissions from GHGs (including SLCPs), criteria pollutants, and toxic air contaminants, and are helping foster the transition to a clean energy economy. In particular, State law (Senate Bill 535, De León, Chapter 830, Statutes of 2012) requires focused investment in communities disproportionately impacted by pollution. Many of these communities, especially in the Central Valley, along freight corridors, and in rural parts of the State, stand to benefit from dedicated action and investment to reduce emissions of SLCPs.

Although California has a number of existing incentive programs, the pool of funds is limited and it is critical to target public investments in ways that encourage system-wide solutions to produce deep and lasting public benefits. Significant investments of private capital, supported by targeted, priority investments of public funding, are necessary to scale deployment and to maximize benefits. Public investments can help incentivize

early action to accelerate market transition to cleaner technologies, which can then be supported by regulatory measures. The State must coordinate funding sources such as the California Climate Investments, supported by the Greenhouse Gas Reduction Fund (GGRF), Alternative and Renewable Fuel and Vehicle Technology Program (AB 118), Electric Program Investment Charge (EPIC) Program, Carl Moyer Program, Air Quality Improvement Program, and Proposition 39 to expand investments in California's clean economy and further reductions in SLCPs and other GHG emissions. Current activities and funding allocations for a few of these programs are described herein.

The GGRF is an important part of California's overall climate investment efforts to advance the goals of AB 32 (Nunez, Chapter 488, Statutes of 2006) and target investment in disadvantaged communities. To guide the investment of Cap-and-Trade auction proceeds, the Department of Finance, in consultation with the Air Resources Board and other State agencies, is required to submit a triennial Investment Plan to the Legislature. The Investment Plan identifies priority investments that will help California achieve its GHG emission reduction goals while realizing additional health, economic, and environmental benefits. The Investment Plan is required to identify near-term and long-term greenhouse gas emission reduction goals and targets, analyze gaps in current State funding for meeting these goals, and identify priority investments that facilitate GHG emission reduction. The second Investment Plan for Fiscal Years 2016-17 through 2018-19 was submitted to the Legislature in January 2016. The Second Investment Plan identifies potential State investment priorities to help achieve GHG emission reduction goals, benefit disadvantaged communities, and yield valuable co-benefits within the Transportation & Sustainable Communities, Clean Energy & Energy Efficiency, and the Natural Resources and Waste Diversion categories. The priorities identified in the Second Investment Plan would reduce a range of GHGs, including short-lived climate pollutant emissions. The Second Investment Plan informed Governor Brown's 2016-2017 Proposed Budget, which includes $215 million of Cap-and-Trade expenditures specifically targeting SLCP emission reductions. These include $40 million for black carbon residential woodsmoke reductions, $20 million for HFC reductions from refrigerants, $100 million for waste diversion, $20 million for Healthy Soils, and $35 million for dairy digester development.

A critical piece of the State's investment strategy, which is overseen by ARB and focused on clean transportation incentives, is the Low Carbon Transportation Investments and the Air Quality Improvement Program (AQIP). Consistent with the First Investment Plan, these programs have identified zero-emission passenger transportation and low-carbon freight transport as investment priorities, which reduce criteria pollutant and toxic emissions with concurrent reductions in GHG emissions, including black carbon. ARB has focused AQIP investments on technology advancing projects that support long-term air quality and climate change goals in addition to providing immediate emission benefits. In recent years, funding has included rebates for zero and near-zero emission passenger vehicles through the Clean Vehicle Rebate Project (CVRP), vouchers for hybrid and zero-emission trucks and buses through the Hybrid and Zero-Emission truck and Bus Voucher Incentive Program (HVIP), and the

Truck Loan Assistance Program for small business truck owners in need of truck replacements or retrofits.

The CEC administers an additional key GHG reduction investment program for the transportation sector – the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). Funds that are collected from vehicle and vessel registration fees, vehicle identification plates, and vehicle smog fees provide up to $100 million per year for projects that will transform California's fuel and vehicles to help attain the State's climate change policies. Investments in alternative fuel production and infrastructure, and vehicle projects can contribute to SLCP emission reductions through reduced diesel consumption, capture and use of biogas from waste management activities as a transportation fuel, demonstration and early commercialization of advanced technology trucks that utilize biogas, and avoided fugitive methane emissions from fossil fuel production and distribution operations.

Another CEC-administered program, the Electric Program Investment Charge (EPIC) Program, supports investments in clean technologies and strategies to improve the State's electricity systems. The program provides opportunities to support SLCP emission reductions from reduced or avoided fugitive methane emissions stemming from fossil fuel production and distribution via investments such as improved energy efficiency technologies in building, industrial, agricultural and water sectors; demand response; distributed renewable generation; electric vehicle infrastructure; demonstration of biomass-to-energy conversion systems; advanced energy storage interconnection systems; and vehicle-to-grid power transfer for electric vehicles.

CDFA administers the Dairy Digester Research and Development Program. This incentive-based program supports digester development in California and can provide grants for research and demonstration projects that improve scientific and technical understanding of technologies and practices that reduce methane and other greenhouse gases emissions on dairies. CalRecycle administers greenhouse gas reduction grant and loan programs that include incentives for infrastructure supporting organics diversion.

These programs represent just a portion of opportunities that exist at the federal, State, and local levels to incentivize SLCP and GHG emission reductions. The availability of dedicated and long-lasting funding sources is critical to help meet AB 32 objectives and help provide certainty and additional partnership opportunities at the national, State, regional, and local levels for further investing in projects that have the potential to reduce emissions of SLCPs.

D. Coordinate with Subnational, Federal, and International Partners

California is working with a set of national and subnational partners throughout the world to fight air pollution and climate change. This includes signatories to the Under 2 MOU, as well as others in Mexico, China, India, the U.S., Canada, and elsewhere.

Many of the efforts underway through these collaborations will help reduce emissions of black carbon from the transportation sector and emissions of other SLCPs.

At the 2014 United Nations (UN) Climate Summit, ARB became the first state-level entity to sign onto action statements of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants. At the 2014 UN Conference of Parties in Lima, California co-sponsored an event with Mexico on SLCPs and their role in an international framework to contribute to national commitments to reduce emissions. At UN climate meetings in New York and Paris in 2015, Governor Brown presented the targets described in this Proposed Strategy, and suggested that action on SLCPs may be the most important and most immediate need to address climate change. The State continues to be committed to acting both bilaterally and multilaterally to cooperate with other jurisdictions to cut SLCP emissions, and will explore additional opportunities to further reduce air pollution, greenhouse gas, and SLCP emissions through partnerships.

Building on leadership around SLCPs can provide an important example for action in other countries and jurisdictions, and is one of the most significant opportunities to accelerate international progress to fight climate change. California is in a unique position to serve as a model for action for other countries and jurisdictions to accelerate their progress to reduce emissions of both SLCPs and CO_2, based on the State's demonstrated leadership on air quality and climate change, commitments to set stringent, science-based targets to reduce emissions of both CO_2 and SLCPs, and integrated planning efforts, like this one, to develop a comprehensive policy framework to achieve those goals.

As we have done for decades already, California's actions on SLCPs can demonstrate win-win opportunities for both the most developed countries, where reducing SLCP emissions is an important element of broad efforts to cut GHG emissions, as well as for the least developed countries, where SLCP emission reductions have tremendous benefits for air quality and human health.

Ultimately, each state, region, or country has its own mix of SLCP sources, needs, and opportunities to reduce emissions. Coordinated planning to meet scientific-based emission targets, like this Proposed Strategy does, is important to successfully reducing emissions and maximizing local and global benefits.

California will share this planning effort with others, and encourage them to adopt specific SLCP emission reduction targets and plans to achieve them. A few already have; President Obama has set specific targets to cut methane emissions from the oil and gas sector, Mexico has included targets to cut black carbon emissions in its Intended Nationally Determined Contribution to the United Nations Framework Convention on Climate Change, Europe and other countries have taken steps to phase down the use of HFCs, Australia and Brazil are working to reduce methane from agriculture, and Norway has developed an SLCP action plan of its own.[128] These types

[128] NEA (2014) Summary of Proposed Action Plan for Norwegian Emissions of Short lived Climate Forcers, Norwegian Environment Agency, March.

of commitments and planning efforts need to be adopted more broadly. By developing a comprehensive plan to achieve necessary SLCP emission reductions in an effective and beneficial way, California can foster broader action beyond its borders and demonstrate effective processes and strategies to address climate change.

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http://www.miljodirektoratet.no/en/Publications/2014/March-2014/Summary-of-proposed-action-plan-for-Norwegian-emissions-of-shortlived-climate-forcers/

VIII. Evaluations

This chapter discusses the economic, public health, and environmental justice evaluations of the proposed new measures in this Proposed Strategy. It also discusses the environmental analysis that was prepared for the Proposed Strategy. It should be noted that to the extent that any of the proposals in the Proposed Strategy result in regulatory action, each proposed regulation will be subject to its own public process with workshops, opportunities for stakeholder discussion, consideration of environmental justice, and legally required analyses of the economic and environmental impacts.

A. Economic Assessment of Measures in the Proposed Strategy

This section presents the economic analyses for the new measures identified in this Proposed Strategy. Supporting documentation for this analysis is presented in Appendix D. Activities already underway separately—including development of the California State Implementation Plan to meet federal health-based air quality standards, the California Sustainable Freight Action Plan, the 2030 Target Scoping Plan, and implementation of Senate Bill 1371 (Leno, Chapter 525, Statutes of 2014)—will have important impacts on SLCP emissions in California, but are not evaluated here. Also, economic impacts associated with improved forest management to reduce black carbon emissions from wildfires and address additional State goals for forest management are not considered here, as many of those goals and potential actions to are currently under development through separate planning processes. As described in Chapter IV, improving forest management in California requires a significant financial commitment, on the order of $500 million to $1 billion annually, which can complement efforts to put organic waste resources to beneficial use in California, as described in this section for the dairy and waste sectors.

The analyses presented here consider direct economic costs associated with new technologies and management strategies that can help to reduce SLCP emissions. They also consider direct economic benefits in the form of savings as a result of efficiency improvements, or revenue from marketable products. This analysis does not include a macroeconomic analysis at the statewide level, nor does it include a monetary accounting of societal benefits, such as the value of reducing exposure to fine particulate pollution or reducing the impacts of climate change.

While there are potentially significant market opportunities associated with some of the proposed measures, including putting organics to beneficial use, there are also substantial costs and funding needs. These include costs to increase market penetration of existing technologies and research and development of innovative advanced technology. Initial analyses and various literature sources suggest that SLCP emissions from several sources, including those identified in this Proposed Strategy, can be reduced at low, and sometimes negative, lifetime costs.

Long-term regulatory signals can play a vital role in facilitating low cost SLCP emission reductions. The Low Carbon Fuel Standard (LCFS) and the federal Renewable Fuel

Standard (RFS) incentivize the use of renewable natural gas as a transportation fuel, creating large revenue potential within the dairy manure and organic diversion measures. These programs in particular can help support cost-effective projects to reduce methane from the dairy and waste sectors. Without the LCFS and RFS programs, additional sources for financial incentives and funding may be needed.

The measures laid out in this Proposed Strategy are transformative, leading to uncertainty in the potential costs and revenue of proposed measures as well as the ultimate pathway to compliance. There is a wide range of potential costs and savings, uncertainty in how the strategies will be met, and uncertainty in some cases for how costs in literature translate in the California context. In conjunction with State agencies, ARB will continue to work closely with stakeholders and manufacturers to evaluate the feasibility and costs of existing and developing technologies to determine the best approaches to meeting the targets in the Proposed Strategy.

The measures included in the Proposed Strategy will also strengthen California's environment and the economy by developing infrastructure, generating cost savings, and creating jobs. Measures that reduce methane emissions through waste digestion will have a large impact on the California economy, including disadvantaged communities.

The dairy manure measure has the potential to create jobs in California's Central Valley. These jobs include construction jobs to build digesters and farm and waste management jobs to operate and maintain the facilities. In this analysis, it is assumed that the construction of an anaerobic digester for a 2,000 head dairy farm can result in 25 to 60 construction jobs and 2 to 5 full-time farm jobs.[129] As the dairy manure measure is estimated to impact 1.05 million dairy cows, many in the San Joaquin Valley, the measure could result in over 30,000 construction jobs and 2,500 permanent jobs potentially providing employment opportunities in disadvantaged communities.

Diverting organic waste can also result in increased employment, providing an estimated 2 jobs per 1,000 tons of diverted organic material.[130] In 2030, this could result in 32,000 jobs in waste management and garbage collecting, food recovery and distribution. As demonstrated in the CalRecycle funded Food to Share project, food waste prevention programs not only produce emission reductions, but employment and nutritious meals to California's most vulnerable populations.[131]

The proposed measures will also build on and support existing California efforts related to climate change and air quality. Measures will support infrastructure, research, development, and deployment of advanced technologies that will help achieve

[129] Sample of industry information relied upon for the estimate: http://www.gundersenenvision.org/renewable-energy/turning-cow-waste-into-energy-middleton and http://www.usda.gov/oce/reports/energy/Biogas_Opportunities_Roadmap_8-1-14.pdf.
[130] http://www.calrecycle.ca.gov/publications/Documents/1463%5C20131463.pdf
[131] More information available at: http://greenlining.org/wp-content/uploads/2015/10/CAClimateInvestmentsCaseStudies.pdf.

California's near- and long-term climate and air quality goals. Encouraging the collection of methane gas from waste streams, for example, can provide renewable fuel to reduce the carbon footprint of the transportation sector. Plans that stand to benefit from proposed SLCP measures include the 2030 Target Scoping Plan Update, the California State Implementation Plan, and California's Sustainable Freight Action Plan.

The 2030 Target Scoping Plan, expected to be finalized in 2016, will include a detailed macroeconomic assessment of ARB's complete climate change strategy, including those contained in the final SLCP Strategy. While this Proposed Strategy begins to explore the costs and benefits of proposed measures, detailed economic analyses will allow for a comprehensive assessment of the impact of California's climate strategy on Californians, businesses, and the California economy.

All proposed regulatory SLCP strategies will also be subject to the economic requirements of the Administrative Procedures Act (APA) as part of the public regulatory process. Prior to finalization, regulatory measures will be analyzed in a public process including an Economic Impact Statement, Economic Impact Assessment, and a Standardized Regulatory Impact Assessment for major regulations. Therefore, there will be many opportunities to assess the economic impact of measures in the Proposed Strategy.

The costs, savings, and potential revenue streams of the five measures are assessed in the following sections, 1 through 5. Collectively, implementing these measures would require several billion dollars of investment in clean technologies and strategies that would lead to significant reductions in SLCP emissions. Potential revenues and efficiency gains could also be significant - potentially outweighing the costs of some measures. In other cases, there may be net costs, but associated SLCP emission reductions may come at relatively low cost or provide other environmental and health benefits. While uncertainties remain – especially for costs and revenues associated with some strategies that utilize either emerging technologies or those that haven't been widely deployed already in California – these measures can help to significantly cut SLCP emissions in California at reasonable cost. With ongoing, targeted financial and market support, coordinated with regulatory development and other economic and environmental priorities where appropriate, California can meet the targets identified in the Proposed Strategy plan while delivering a broad range of benefits.

1. Residential Wood Combustion Black Carbon Emission Reductions

Residential wood combustion (RWC) constitutes 15 percent of California's non-forestry back carbon (BC) emissions, and is projected to be the largest individual source of BC by 2030. This Strategy recommends a 3.0 MMTCO2e (20-yr GWP) reduction in RWC BC emissions by 2030 to meet the SLCP BC emission reduction target.

There are a variety of ways to reduce RWC emissions, and multiple air districts have already put measures in place. Past incentive programs to replace old polluting wood-burning devices with the cleanest EPA-certified devices have been popular and

effective. However, rural districts that rely most heavily on RWC for their primary source of heat are largely located outside of regions that provide incentives. Additionally, past incentive programs have not acquired sufficient funding to achieve the substantial emission reductions proposed in this strategy.

The cost share of this strategy between homeowners and governmental incentives primarily depends on the incentive amount provided per device, and total costs depend on the emission reduction achieved per device. Both of these factors will vary by region and by household, thus incentives funding and homeowners share of costs are calculated as a range. The cost to replace a device can range between $3,000 and $5,000.[132] Purchase and installation of woodstoves was assumed to cost $4,000 while gas devices were assumed to cost $4,500. Incentives typically cover a portion of the cost, from $1,000[133] up to the full installation price.[134] In many rural areas that rely heavily on wood combustion as a source of heat will require nearly full coverage of the installation price to spur voluntary participation; therefore, the incentive range was assumed to be $1,000 to $4,500.

The BC emission reduction per household depends on how much wood is burnt per year, the density and moisture content of the wood, the old device type, and the new device type. Emissions were calculated for two replacement cases. The "wood to wood" case assumes conversion of non-certified woodstove to EPA certified wood stove.[135] The "wood to gas" case assumes conversion of non-certified woodstove to gas device. An incentives program may contain a mixture of different replacement types and these two cases are used to bound potential reductions and costs. Other parameters used in emission reduction calculations were provided by the US EPA residential wood combustion replacement calculator, which includes California-specific data when available (Table 8).[136] The calculator was updated to account for replacement with cleaner EPA certified wood burning devices that will be required by 2020.

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[132] USEPA (2014). How to Implement a Wood-Burning Appliance Change out Program. Available at: http://www.epa.gov/sites/production/files/201508/documents/howtoimplementawoodstovechangeout.pdf

[133] SJVAPCD (2016). Burn Cleaner Program. http://valleyair.org/grants/burncleaner.htm

[134] http://www.epa.gov/sites/production/files/201508/documents/howtoimplementawoodstovechangeout.pdf

[135] Specifically, a woodstove that meets the U.S. EPA 2020 new source performance standard (2.0 grams particulate matter per hour) USEPA (2015). Fact Sheet: Summary of Requirements for Woodstoves and Pellet Stoves. Available at: http://www.epa.gov/residential-wood-heaters/fact-sheet-summary-requirements-woodstoves-and-pellet-stoves

[136] USEPA (2009). Burn Wise Additional Resources - Emission Calculator. http://www.epa.gov/burnwise/burn-wise-additional-resources.

Table 8: Emission Summary

Parameter	Wood to Wood	Wood to Gas
Cords wood burnt per year[137]	1.5	1.5
Wood Density (tons/cord)[138]	1.04	1.04
$PM_{2.5}$ Emissions Reduction per device (tons/yr)[139]	0.0218	0.0245
BC Speciation (fraction of $PM_{2.5}$)[140]	0.125	0.125
BC Reduction per device per year (MTCO2e, 20-yr GWP)	7.9	8.9
BC Emissions Target 2030 (MTCO2e, 20-yr GWP)	3,000,000	3,000,000
Number of average replacements needed to meet target	379,000	337,000

The cost of incentives was calculated by multiplying the number of replacements needed to meet the target (Table 8) by the range of incentives that could be provided, from $1,000 to the full cost of replacement.[141] The cost to homeowners was calculated as the total replacement cost, minus the portion covered by incentives. The "low incentives" case in Table 9 is a scenario where only $1,000 in incentives is paid, and homeowners pay a portion of the replacement. In the "high incentives" case, incentives cover 100 percent of replacement costs and homeowners pay no money out of pocket. Costs to oversee and administer the incentives program were assumed to be similar in either case, because a similar number of devices are replaced (Table 8), and were calculated as 10 percent of the lower incentive value.[142] Educational and outreach costs were estimated at 1 percent of the lower incentives value. Education and outreach includes education about the health effects of wood smoke and educating residents about proper use of their new devices to minimize emissions and maximize the lifetime of the equipment. Studies indicate that education and outreach are vital components of RWC replacement programs.[143] A summary of costs can be found in Table 9. The results in Table 9 show that the total costs for either a low incentives or high incentives case would be the same, but the distribution of costs between incentives and homeowner responsibility is different. These scenarios represent extremes use to bound the range of possible costs; actual program implementation may lie between the low and high incentives cases presented in Table 9.

[137] Based on average California Climate, from USEPA Emission Calculator.
[138] Average California wood density, from USEPA Emission Calculator.
[139] Results are from USEPA Emission Calculator for wood to gas conversion. This result assumes approximately 100% reduction in PM.
[140] ARB (2015). 2015 Edition Black Carbon Technical Support Document. Available at: http://www.arb.ca.gov/cc/inventory/slcp/slcp.htm
[141] $4,000 for woodstove installation and $4,500 for gas devices.
[142] http://www.epa.gov/sites/production/files/201508/documents/howtoimplementawoodstovechangeout.pdf
[143] http://www.epa.gov/sites/production/files/201508/documents/howtoimplementawoodstovechangeout.pdf

Table 9: Range of Costs (Million Dollars)[144]

Cost	Low Incentives	High Incentives
Incentives	$340	$1,500
Oversight and Administration	$34	$34
Cost to Homeowners	$1,180	$0
Education and Outreach	$3.4	$3.4
Total Cost	**$1,557**	**$1,537**

Savings associated with this plan include reduced wood use in more efficient devices or any savings (or cost) to convert from wood fuel to natural gas. US EPA estimates that EPA-certified devices burn a third less wood for the same heat output.[145] Table 10 summarizes the range of potential savings depending on the conversion scenario.

Wood to wood total savings were calculated using the average annual amount of wood burnt (Table 8), the fraction of residents who pay for wood,[146] the cost of a cord of wood, and the assumption that a third less wood is used by the replaced devices. This analysis assumes 20 percent of wood is gathered for free, and would not provide a savings to the resident. The cost of a cord of wood will vary from approximately $100 to $480 depending on location and type of wood[147]. This analysis uses the midpoint value of $290 per cord. Reducing annual wood consumption from 1.5 to 1 cord per year would save the average resident $145 per year. Approximately 379,000 wood to wood conversions (Table 9) would result in savings of approximately 44 million dollars per year to consumers receiving incentives to replace their inefficient wood stove.

Wood to gas savings can be calculated assuming 1.5 cords of wood are not purchased (Table 8), the cost of wood is $290 a cord, and that the heat-equivalent amount of natural gas must be purchased, and assuming 337,000 devices are replaced (Table 9). The price of natural gas was assumed to be $11.51 per thousand standard cubic feet.[148] The savings from not purchasing wood is nearly in balance with the additional cost of purchasing natural gas using these assumptions (Table 10).

[144] Low incentives are $1,000 and high incentives cover 100 percent of device purchase and installation costs ($4,000-$4,500 depending on the device). Under the high incentive there is no out of pocket expense to homeowners.
[145] http://www.epa.gov/sites/production/files/201508/documents/howtoimplementawoodstovechangeout.pdf
[146] A portion of residents who rely on residential wood combustion for heat gather wood from local lands at no cost.
[147] CDFA (2010). California Department of Food and Agriculture News Release. Available at https://www.cdfa.ca.gov/egov/Press_Releases/Press_Release.asp?PRnum=10-074
[148] EIA (2015). California 2014 price of natural gas delivered to residential customers. Available at https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SCA_a.htm.

Table 10: Savings Associated with Residential Wood Stove Conversion (Million Dollars)

Conversion Scenario	Savings on Purchase of Wood	Increased Cost for Natural Gas	Net Fuel Savings
100 % Wood to Wood	$44	$0	$44
100 % Wood to Gas	$117	$109	$8

2. Methane Emission Reductions from Dairy Manure

As noted in Chapter V, emissions from dairy manure can be reduced by 75 percent by capturing or avoiding methane produced by about 1.05 million of the State's 1.4 million milking cows whose manure is managed anaerobically. Achieving these targets for the industry could lead to significant GHG emission reductions – 22 $MMTCO_2e$ annually by 2030, and 168 $MMTCO_2e$ cumulatively through 2030 (8 $MMTCO_2e$ and 58 $MMTCO_2$, respectively, using a 100-year GWP).

Several options exist to reduce methane emissions from manure management in California. Five strategies were considered in this analysis, which are described in further detail in Appendix D:

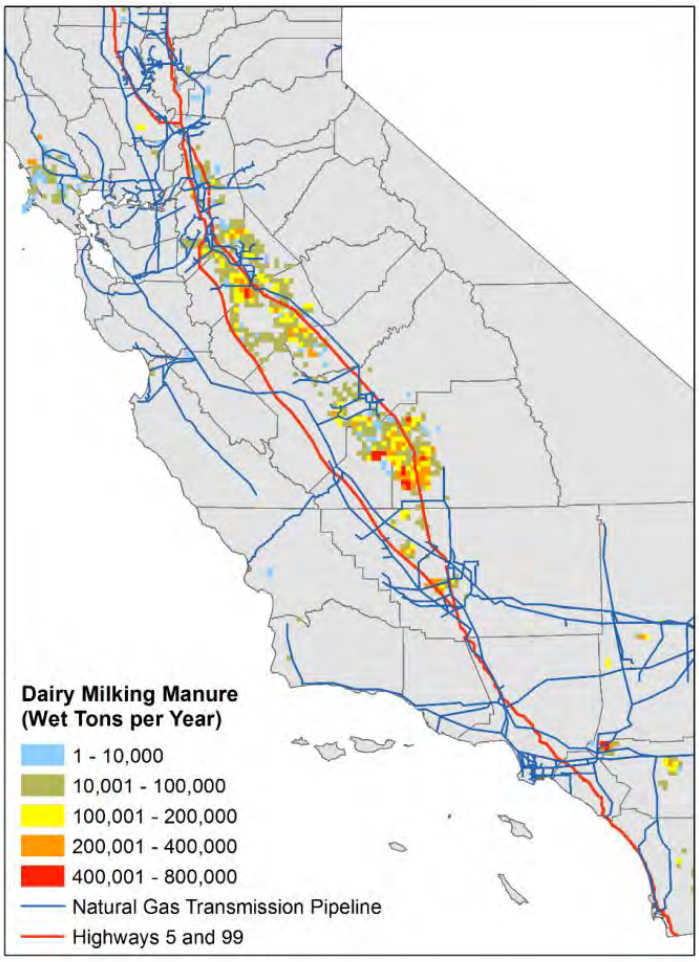
1. Scrape conversion and onsite manure digestion producing pipeline-injected renewable natural gas vehicle fuel
2. Scrape conversion and transport of manure offsite for centralized digestion producing pipeline injected renewable natural gas as a vehicle fuel
3. Scrape conversion, collection and open solar drying of manure onsite
4. Scrape conversion and onsite manure digestion for onsite production of renewable electricity
5. Conversion of dairy operations to pasture-based management

These represent example pathways that could be important to a sector-wide approach to reduce emissions, but they are not meant to rule out other solutions. The cost and efficacy of some options, such as solids separation, are not yet known with certainty and could not be included in this analysis. Solids separation and other potential mitigation methods deserve additional study of both emission reduction potential and economic feasibility.

The strategies considered here aim to balance cost and feasibility, while prioritizing economic and environmental benefits. Specifically, they aim to address water quality issues on dairies by including conversion to scrape systems, maximize renewable natural gas production by utilizing above ground tank/plug flow digesters, and avoid increases in criteria pollutant emissions (most notably oxides of nitrogen, or NOx) and maximize potential revenues by prioritizing pipeline injection of renewable natural gas. Prioritizing these goals adds costs compared to a pathway that focuses on methane mitigation only, but deliver important environmental, health and potential economic benefits.

ARB conducted a Geographic Information System (GIS) analysis of dairies throughout the State to inform the scenario development. GIS informed estimates related to the number of dairies that could feasibly inject renewable natural gas into the pipeline, associated costs, availability and costs associated with "clustering" dairies to centralize digestion and pipeline injection, and opportunities for converting to pasture-based operations. Figure 11 provides a spatial analysis of manure from milking cows in California.

Figure 11: Location of Manure from Milking Cows in California



The analysis was informed by direct consultation with CDFA, academic researchers at UC Davis and elsewhere, project developers, and stakeholders. In particular, as part of developing this Proposed Strategy, ARB supported research at UC Davis to inform cost and performance estimates for dry scrape conversions, anaerobic digesters, and other

pathways.[149] Additional research was also used to inform the cost and performance parameters assumed for this analysis, which are detailed in Appendix D.[150]

Potential revenues from energy or electricity sales and environmental credits were included. For the value of energy and credits, the current or estimated average value through 2030 was used. No revenue was included for soil amendment products that could be potentially generated from these pathways, and provide value,[151] because their market potential remains uncertain at this time. The LCFS, Cap-and-Trade, and federal Renewable Fuel Standard program are all assumed to be in place through at least 2030. Cap-and-trade offsets are not available for projects built after a regulation takes effect, assumed here to be in 2025, and the carbon intensity for LCFS accounting is assumed to increase for new projects from -276 gCO_2e/MJ to +13 gCO_2e/MJ at that point, as well.

The first two strategies produce biomethane that is injected into the pipeline and used as transportation fuel. They receive revenue for energy sales at the price of wholesale natural gas ($3.46/Mscf), as well as LCFS credits ($100/MT) and cellulosic RIN credits ($1.85/RIN)[152] from the federal Renewable Fuel Standard program. In the first strategy, digesters are developed onsite at each dairy, while the second captures economies of scale by utilizing centralized digesters, biogas upgrading, and pipeline injection points for "clustered" dairies. The third pathway mitigates manure methane emissions by converting from flush management to scrape systems, but is assumed to generate no revenue. This represents a low cost option, but low value, as well. In the fourth strategy, manure is digested onsite to produce electricity using microturbines (to limit NOx emissions). This pathway receives revenue from electricity sales ($0.126/kWh) and Cap-and-Trade offsets ($13/$MTCO_2e$). Finally, in the fifth strategy, dairies convert to pasture-based operations. No revenue is assumed from this pathway.

Costs and revenues for these strategies, normalized to a dairy with 2,000 milking cows, are summarized in Table 11. The table includes the net present value for each over a 10-year time horizon, assuming a 10 year loan on capital at 7 percent interest, and a 5 percent discount rate.

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[149] Kaffka, S. et al (2016) Evaluation of Dairy Manure Management Practices for Greenhouse Gas Emissions Mitigation in California, Final Technical Report to the State of California Air Resources Board, February.

[150] In particular: Sustainable Conservation (2015) Combating Climate Change: Dairies Key in Reducing Methane, July: http://www.suscon.org/blog/2015/07/combating-climate-change-dairies-key-in-reducing-methane/.

[151] Soil amendment products from dairy digesters could provide greater potential revenues than energy sales from the digesters, potentially as much as $300 per cow per year in California.
Informa Economics (2013) National Market Value of Anaerobic Digester Products, Prepared for Innovation Center for U.S. Dairy, February.

[152] The assumed cellulosic RIN credit value of $1.85 includes a D5 RIN ($0.85), cellulosic waiver credit ($0.90) and value from the Blenders Tax Credit ($0.10 per D5 RIN).

Table 11: Economic Analysis for Projects at a Representative Dairy with 2,000 Milking cows Over 10-year Accounting Period[153]

	Strategy				
	1 Onsite Digestion to Fuel	2 Central Digestion to Fuel	3 Scrape Only	4 Onsite Digestion to Electricity	5 Convert to Pasture
Capital (million dollars)	$5.4	$3.3	$1.6	$5.8	$5.0
O&M (million dollars)	$3.5	$2.4	$0.4	$3.5	$2.8
Revenue (million dollars)	$11.3	$11.3	--	$3.6	--
NPV (million dollars)	$2.5	$5.5	–$2.1	–$5.7	–$7.8
$/MT CO_2e (20-yr GWP)	–$5.8	–$13.0	$4.9	$13.5	$18.2
$/MT CO_2e (100-yr GWP)	–$16.6	–$37.6	$14.2	$38.8	$52.5
Breakeven Upfront Grant (million dollars)	--	--	$1.9	$5.3	$7.1

Based on the assumptions used here, projects that generate transportation fuel and can capture LCFS credits can generate a positive return (strategies 1 and 2). These pathways may also contribute to regional air quality benefits, as part of an integrated approach to utilize renewable fuel in low-NOx engines. But revenue for these strategies, and the resulting project economics (as measured by net present value), are highly dependent on the value of LCFS and RIN credits. As shown in Table 12, the net present value can fluctuate by several million dollars, depending on the value of these revenue streams. Without these programs, these projects would have net present values similar to strategies 4 and 5.

Table 12: Net Present Value for Strategies Producing Transportation Fuel, as a Function of LCFS and RIN Credit Prices (Million Dollars)

		Strategy 1: Onsite Digestion to Vehicle Fuel					Strategy 2: Centralized Digestion to Vehicle Fuel				
		LCFS Credit Price					LCFS Credit Price				
		$0	**$50**	**$100**	**$150**	**$200**	**$0**	**$50**	**$100**	**$150**	**$200**
Cellulosic RIN Credit Price	**$0.00**	-$8.2	-$5.0	-$1.7	$1.6	$4.8	-$5.1	-$1.9	$1.4	$4.7	$7.9
	$0.50	-$7.1	-$3.8	-$0.6	$2.7	$6.0	-$4.0	-$0.7	$2.5	$5.8	$9.0
	$1.00	-$6.0	-$2.7	$0.5	$3.8	$7.1	-$2.9	$0.4	$3.6	$6.9	$10.2
	$1.85	-$4.1	-$0.8	$2.5	$5.7	$9.0	-$1.0	$2.3	$5.5	$8.8	$12.1
	$2.50	-$2.6	$0.6	$3.9	$7.2	$10.4	$0.5	$3.7	$7.0	$10.3	$13.5
	$3.00	-$1.5	$1.8	$5.0	$8.3	$11.6	$1.6	$4.9	$8.1	$11.4	$14.6
	$3.50	-$0.4	$2.9	$6.1	$9.4	$12.7	$2.7	$6.0	$9.2	$12.5	$15.8
	$4.00	$0.7	$4.0	$7.3	$10.5	$13.8	$3.8	$7.1	$10.4	$13.6	$16.9

[153]Summation may not be exact due to rounding. Capital costs amortized over 10 years with 7% interest. Discount rate is 5%. Costs normalized to representative 2,000 cow dairy.

Other types of dairy projects may not generate positive returns without additional support and/or other potential revenue streams, such as for soil amendments. The third strategy requires the lowest capital outlay among strategies considered in this analysis, but it is not assumed to generate any revenue, leading to a net present value loss of about $2.1 million over 10 years. Still, this pathway represents fairly low cost emission reductions ($4.9/MT using a 20-year GWP) and could break even with an upfront grant, or its equivalent, of about $1.9 million.

The fourth strategy provides revenue streams that are more stable than for the transportation fuel pathways in strategies 1 and 2, but they are also significantly lower, and the project economics are less favorable. The net present value of this project over ten years is -$5.7 million, and an upfront grant of $5.3 million would be needed to break even. Note, however, that if electricity generated from biogas is used to charge electric vehicles, biogas used to generate electricity can be credited with cellulosic RIN credits, which could add another valuable revenue stream. In this case, RIN credits would more than double revenue and add more than $4 million in net present value over 10 years. That type of project, based on the assumptions here, would still represent a net loss of $1.6 million over ten years, but it could break even with an upfront grant of $1.5 million. Costs of emission reductions over 10 years would fall to $4/MT$CO_2$e using a 20-year GWP ($11/MTCO_2e using a 100-year GWP).

Converting to pasture-based systems is assumed to have relatively high costs and no revenue, leading to a pathway with a net present value of -$7.8 million over 10 years. Three-quarters of the estimated capital cost and over 90 percent of the estimated operating costs come from irrigation, so if dairies were to convert to pasture in areas where less irrigation may be needed (perhaps in northern parts of the State), they might be able to significantly cut costs associated with reducing methane from their operations. In general, little information is available on the economics associated with converting to pasture, and additional research and potential demonstration projects could help to evaluate the viability of this strategy to reduce dairy methane emissions in California.

Costs and Revenues for Sector-Wide Scenarios to Meet Proposed Targets

These individual pathways were combined into three industry-wide scenarios (Table 13) for reducing methane emissions from manure management at California dairies by 20 percent in 2020, 50 percent in 2025 and 75 percent by 2030:

- Scenario A: All strategy 3 (scrape to manure collection and drying)
- Scenario B: Mixed approach (including all five strategies)
- Scenario C: All strategy 2 (centralized digestion and pipeline injection)

Table 13: Mix of Strategies in Scenarios:
Number of Milking cows Covered by Projects in 2030

Strategy	A	B	C
(1) Scrape conversion and onsite manure digestion producing pipeline-injected renewable natural gas vehicle fuel		350,000	
(2) Scrape conversion transport of manure offsite for centralized digestion producing pipeline injected renewable natural gas as a vehicle fuel		300,000	1,050,000
(3) Scrape conversion, collection and open solar drying of manure onsite	1,050,000	200,000	
(4) Scrape conversion and onsite manure digestion for onsite production of renewable electricity		150,000	
(5) Conversion of dairy operations to pasture-based management		50,000	
Total	**1,050,000**	**1,050,000**	**1,050,000**

Results for the scenarios are summarized in Table 14. Scenario A represents a low cost, zero revenue case where a sufficient number of dairies transition to scrape operations to reduce methane emissions from manure management by 75 percent by 2030. This could have potential benefits, as described in Chapter V, for nutrient management and water quality on the farm. There could also be potential revenue (along with added costs) if manure were composted and sold, which is not considered here. The sector-wide, net present value through 2030 for this scenario is -$636 million, which represents emission reductions of about $4/MTCO$_2$e using a 20-year GWP ($11/MTCO$_2$e using 100-year GWP).

Table 14: Economic Analysis for Sector-Wide Scenarios Through 2030 (Million Dollars)[154]

	Scenario		
	A	**B**	**C**
Capital	$493	$1,235	$995
O&M	$142	$837	$788
Revenue	$0	$2,157	$3,237
Net Present Value $100 LCFS Credit **$1.85 RIN Credit**	–$636	$84	$1,454
$/MT CO2e (20-yr GWP)	$3.8	–$0.5	–$8.7
$/MT CO2e (100-yr GWP)	$10.9	–$1.5	–$24.9
Net Present Value **$40 LCFS Credit** **$1.00 RIN Credit**	–$636	–$926	–$176

Scenario B includes a mix of all five strategies. Collectively, with LCFS credits assumed to be valued at $100/MT and RINs at $1.85, this scenario meets the targets in this Proposed Strategy with a positive net present value of $84 million through 2030. If the portion of milking cows in this scenario utilizing Strategy 4 were to use generated electricity for transportation fuel to capture RIN credits, it would increase revenues and net present value by about $200 million. Again, revenues are highly dependent on LCFS and RIN credit values. If LCFS credits were $40/MT and RINS were $1.00, the net present value of this scenario would fall by about $1 billion, to -$926 million (and -$823 million if the electricity is used as transportation fuel).

The value of LCFS and RIN credits is even more noticeable in Scenario C, where all emission reductions are achieved through centralized digestion that generates renewable natural gas for transportation fuel and LCFS credits. If instead of the assumptions used here, LCFS and RIN credits were valued at $40/MT and $1.00, respectively, the net present value would fall by $1.6 billion, and the scenario would have a net loss of $176 million through 2030.

Altogether, this analysis suggests that the dairy industry in California can significantly cut methane emissions and deliver low-cost GHG reductions. There are important uncertainties associated with project costs and potential revenues, however, which may limit project development without targeted support. And the State may wish to support

[154] Summation may not be exact due to rounding. Capital costs amortized over 10 years with 7% interest. Discount rate is 5%. In Scenarios B and C, beginning in 2025, regulation eliminates availability of C&T offsets for new electricity generating projects (Strategy 4) and for those that have been operating for 10 years. For projects producing transportation fuel (Strategy 1 and 2), beginning in 2025, the carbon intensity for LCFS credits for new projects and those that have been operating for 10 years increases from -276 to 13 gCO_2e/MJ. The impact of regulation on existing projects under the LCFS has not been determined, and this simply an assumption used for the sake of this analysis.

some higher cost strategies, including conversions to scrape or pasture-based systems, for other environmental reasons.

A mix of grants, especially for projects with lower revenues, and other mechanisms for pathways with higher revenues may be appropriate. This funding could come from federal sources, California's Greenhouse Gas Reduction Fund (GGRF), utility programs, the programs included in this analysis, or other sources. Limited federal grant funding is currently available, and more should be pursued. In his proposed 2016-17 Budget,[155] Governor Brown has proposed committing $55 million in GGRF funding for climate smart agriculture, including dairy digesters and healthy soils. And under a rulemaking by the CPUC pursuant to Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012), California's natural gas utilities will offset half of renewable natural gas interconnection costs, up to $1.5 million per project and $40 million Statewide.

These programs provide a strong starting point for supporting the industry in reducing methane emissions and achieving the targets and benefits identified here. They should be built upon and bolstered. A financial working group may be helpful in recommending ways to leverage private sector investment and significantly scale efforts to rapidly cut methane emissions in California. Through careful investments and structured market-based incentives, project development may be accelerated to achieve emission reductions more quickly than the targets identified in this Proposed Strategy, and ahead of potential regulation of the industry.

3. Methane Emission Reductions from Diversion of Landfill Organic Waste

As noted in Chapter V, diverting organic materials from landfills can reduce landfill emissions by 5 $MMTCO_2e$ in 2030, increasing to 21 $MMTCO_2e$ by 2050 (using a 20-year GWP). Achieving these methane reduction targets requires optimized use and disposal of methane generating organic materials. To that end, the Proposed Strategy recommends reducing organics deposited to landfills by 90 percent by 2025, consistent with AB341. This ambitious target requires putting organic materials to the highest feasible use and developing infrastructure and markets to optimize the economic and environmental value of California's waste streams across sources.

When considering waste diversion options it is essential to balance environmental and economic benefits with any potential impacts on criteria pollutant emissions and ecosystem and human health, especially in disadvantaged communities. Avoiding organic waste generation entirely is the best option to reduce emissions, protect health, and minimize costs. However, once generated, there are many options for creating environmental and economic benefit through the appropriate utilization organic waste. Organics can be diverted to waste facilities with existing excess capacity, including composting facilities, stand-alone anaerobic digesters (AD), and wastewater treatment anaerobic digesters. New facilities can be also built in optimized locations.

[155] http://www.ebudget.ca.gov/2016-17/BudgetSummary/BSS/BSS.html

In this analysis three scenarios were considered that can achieve the organic diversion target outlined in the Proposed Strategy. The three scenarios are based on projected waste data and potential diversion outlined in Appendix D. The only difference between the scenarios is the waste utilization of grass and leaves. The three scenarios evaluate the costs and revenues for utilizing food waste and grass and leaves in three pathways:

1. New anaerobic digestion facilities
2. Existing excess capacity at wastewater treatment anaerobic digestion facilities
3. New compost facilities

The actual future utilization of food waste and grass and leaves will most likely be some mix of these options. Since it is not possible to predict the exact mix of utilization pathways, these three scenarios were developed to bound potential costs and revenues. The scenarios considered here aim to balance cost and feasibility, while prioritizing economic and environmental benefits. To this end, the analysis focuses on the capture and pipeline injection of renewable natural gas from diverted organic waste. Using renewable natural gas as a transportation fuel can result in significant potential revenue streams and reduce criteria pollutant emissions from the transportation sector. Prioritizing the use of biomethane as a transportation fuel may increase costs relative to scenarios that focus solely on methane mitigation. However, important environmental, health, and economic benefits may be realized by prioritizing pipeline injection of renewable natural gas.

Within scenario 1, food waste and a portion of grasses and leaves are handled through new centralized AD facilities and the resulting methane is pipeline injected. New AD facilities are assumed to accept 100,000 tons per year of organic waste. The costs of scenario 1 include facility construction and permitting, operating and maintenance (O&M), waste and digestate processing and transportation, and the costs associated with pipeline injection of renewable natural gas. These include pipeline, interconnection, and biogas upgrading costs. Potential revenue streams include tipping fees, the sale of biogas, LCFS credits, and RIN credits, as outlined in Appendix D.

Scenario 2 assumes that food waste is diverted to wastewater treatment facilities with existing excess capacity. The analysis assumes that, with modification, existing wastewater treatment facilities can accept 50,000 tons of organic material per year on average by 2030, with some facilities accepting more or less depending on size. Costs for this scenario include upgrading and permitting costs that may be required for facilities to accept food waste, waste and biosolid processing and transportation, O&M, as well as the costs associated with pipeline injection of renewable natural gas. Potential revenue streams include tipping fees, sale of biogas, LCFS credits, and RINs.

Scenario 3 assumes that all food waste and grasses and leaves are composted at new facilities with a throughput of 100,000 tons per year. Costs within the scenario include facility construction, O&M, and transportation of organic materials to the compost facility. The only revenue stream included in scenario 3 is the tipping fee, though additional revenue streams could result from the sale of compost.

A principal difference in outcomes from these three scenarios is the number of new facilities needed to achieve the organic diversion targets. Table 15 shows the number of new compost or AD facilities needed for each scenario.[156]

Table 15: Estimated Number of New Facilities

Scenario	Estimated Number of New Compost Facilities to Achieve Target			Estimated Number of New AD Facilities to Achieve Target		
	2020	2025	2030	2020	2025	2030
1. New AD	43	52	54	40	56	58
2. Existing WWTP	50	62	65	-	-	-
3. Compost Only	76	97	102	-	-	-

There is uncertainty regarding the costs, savings, and potential revenue streams associated with organic waste diversion. Social welfare impacts, including those related to health, noise, odor, ecosystem benefit, and water impacts, are not included in this analysis but require additional consideration and analysis prior to the implantation of any organic diversion measure. Additional uncertainty related to existing infrastructure and technology development may also create economic impacts not analyzed in this analysis, which relies on available data from California agencies, academic researchers, and industry to estimate the direct economic impact, including costs, fuel and energy savings, and potential revenue streams, of achieving the organic waste diversion target in the Proposed Strategy.

Net present value calculations were used to estimate the potential profitability of the three scenarios. By calculating the present value of future cost and organic diversion over a 10-year financing period, the net present value calculation provides insight into the feasibility of projects at the facility level, including the need for upfront grants and incentives as well as the significant opportunities and uncertainty surrounding revenue streams based on existing regulations.

Costs and revenues for the three scenarios are summarized in Table 16. The table includes the net present value for each scenario over a 10-year financing period

[156] This analysis assumes existing wastewater treatment facilities can handle 50,000 wet tons of food waste per year, while new AD facilities and compost facilities have a throughput of 100,000 wet tons per year. Additional information regarding the projected organic waste streams by waste , the assumptions surrounding required facilities, and the handling of residuals are presented in Appendix D.

Table 16: Cumulative Estimated Costs and Revenues by Scenario Over 10-Year Accounting Period (Million Dollars)

Scenario 1: New AD	Component	Capital Cost	O&M	Revenue
New AD New Compost	54 Facilities 58 Facilities	$1,200 $600	$2,100 $650	$5,800 $1,200
Total		**$1,800**	**$2,750**	**$7,000**
10-Year Net Present Value		**$2,500**		
Scenario 2: WWTP	**Component**	**Capital Cost**	**O&M**	**Revenue**
New Compost	65 Facilities	$720	$790	$1,500
Existing Wastewater Treatment	118 Facilities	$1,300	$3,700	$5,100
Total		**$2,020**	**$4,490**	**$6,600**
10-Year Net Present Value		**$162**		
Scenario 3: Compost	**Component**	**Capital Cost**	**O&M**	**Revenue**
New Compost	102 Facilities	$1,000	$1,100	$2,100
Total		**$1,000**	**$1,100**	**$2,100**
10-Year Net Present Value		**-$43**		

Table 16 suggests that under Scenario 1 and Scenario 2, organic waste diversion can generate a positive return. These scenarios may also contribute to regional air quality benefits, through reduced transportation emissions. However, revenue for these strategies, and the resulting net present value, is highly dependent on the value of LCFS and RIN credits. As shown in Table 17, for representative wastewater treatment and new AD facilities, the net present value of diverting organic materials – at the facility level – is negative without revenue from LCFS credits and RINs.

Table 17: Net Present Value of Representative Wastewater Treatment and New AD Facility under Varying LCFS Credit Prices and RIN Credit Prices (Million Dollars)

		Wastewater Treatment Facility					New AD Facility				
		LCFS credit price					LCFS credit price				
		$0	$50	$100	$150	$200	$0	$50	$100	$150	$200
Cellulosic RIN credit prices	$0.00	-$17.0	-$12.1	-$7.2	-$2.2	$2.7	-$34.4	-$18.9	-$3.4	$11.9	$27.3
	$0.50	-$8.1	-$3.1	$1.8	$6.7	$11.7	-$14.4	$0.9	$16.4	$31.8	$47.3
	$1.00	$0.9	$5.8	$10.8	$15.7	$20.7	$5.4	$20.9	$36.3	$51.8	$67.2
	$1.85	$16.3	$21.2	$26.1	$31.1	$30.0	$39.3	$54.8	$70.2	$85.6	$101.1
	$2.50	$27.9	$32.9	$37.8	$42.8	$47.8	$65.2	$80.7	$96.1	$116.7	$133.9
	$3.00	$36.9	$41.9	$46.9	$51.8	$56.8	$85.2	$100.6	$116.0	$131.5	$146.9
	$3.50	$46.0	$50.9	$55.9	$60.8	$65.8	$105.1	$120.5	$136.0	$151.4	$166.9
	$4.00	$55.0	$59.9	$64.9	$69.9	$74.8	$125.0	$140.5	$155.9	$171.4	$186.8

State resources could be deployed to supplement financing of biomethane projects through mechanisms such as upfront grants, loan assistance programs, and tax incentives. For example, the illustrative wastewater treatment facility in Table 17 would break even over a 10-year financing period with an upfront grant of $16 million. Looking at LCFS credits and RINs in isolation, without revenue from LCFS credits, this illustrative wastewater treatment facility would break even with a RIN price of $1 over the 10-year financing period. In the absence of revenue from RINs, the facility would breakeven at an LCFS credit price of $173. The US EPA's Renewable Fuel Standard (under which RINs are generated and sold) and California's LCFS program can offset large upfront capital costs that otherwise may prevent project development.

In the absence of revenue from the sale of LCFS credits, a RIN price of $0.87 is required for a representative new AD facility to breakeven over a 10-year financing period. In the absence of RIN credit revenue, an LCFS credit price of $112 is required for that same facility to breakeven over a 10-year financing period. Without revenue from RINs or LCFS credits, an upfront grant of $32 million would be required in order for the illustrative new AD facility to breakeven over a 10-year financing period.

Altogether, this analysis suggests that the diversion of organic waste can result in environmental and economic value to California. There are important uncertainties associated with facility costs and potential revenues, however, which may limit project development without additional support. In the absence of revenue from LCFS credits and RINs, significant financial support, may be required to achieve the target identified in this Proposed Strategy and deliver other environmental benefits. Through careful research, investments, and structured market-based incentives, the State can work with industry to significantly and permanently reduce methane emissions and divert organic waste.

4. Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities Regulation

The Proposed Strategy has a four-pronged approach to methane reductions in the oil and gas sector including regulation of production, processing, and storage facilities and implementation of SB 1371. The process to adopt rules and procedures to minimize natural gas leaks from natural gas pipelines under SB 1371 is just beginning and an analysis of the costs and potential benefits of SB 1371 will be conducted as measures are implemented.

ARB is developing a regulation to address methane from oil and gas production, processing, and storage facilities for Board consideration in 2016. The regulation is anticipated to deliver environmental benefits that include an estimated reduction in GHG emissions through 2030 of about 13.8 $MMTCO_2e$ from oil and gas related emissions in California. In addition, the measure is expected to save about 650 million standard cubic foot (scf) per year of industrial natural gas through reductions of leaks and through vapor recovery systems, the monetized value of which is approximately $2.7 million per year.[157]

While air districts are currently combatting volatile organic compounds (VOC) leaks locally, these rules vary by district and are not addressing any methane only leaks. This measure is designed to expand upon existing local rules, promote statewide uniformity, minimize the administrative burden on local air districts, harmonize state requirements with current and near-future local and federal requirements, and achieve further methane reductions to achieve the goal outlined in this strategy of reducing fugitive methane emissions from all sources in the oil and natural gas sector by 45% by 2030.

The Oil and Gas measure proposes eight main control provisions that are designed to achieve emission reductions in crude oil and natural gas operations. These provisions build upon and in some ways increase existing local air district requirements to monitor, replace, and expand current capital at crude oil and natural gas facilities.
The cost of this measure includes capital costs to: Install Vapor Recovery Units for tanks, well stimulations tanks, and centrifugal compressors; replace rod packing on reciprocating compressors; and change pneumatic devices. In addition, a leak detection and repair program (LDAR) as well as emissions reduction and leak monitoring plans will have ongoing costs in each year beginning in 2018. The amortized[158] capital cost plus the ongoing costs yield an overall cost of the measure of just over $190 million through 2030. These costs are offset by natural gas collection from the reduction in leaks and vapor recovery; these savings amount to savings of almost $33 million through 2030 and persisting thereafter. The costs, cost-savings, and emission reductions are outlined in Table 18 by each provision.

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[157] http://www.energy.ca.gov/2014publications/CEC-200-2014-001/CEC-200-2014-001-SF.pdf. Using a value of $4.10 per Mscf, which is the value of the natural gas prices are based upon wholesale prices that are forecasted by the California Energy Commission using their NAMGas general equilibrium model.
[158] Using a 5% discount rate.

Table 18: Costs and Emissions for Oil and Gas Measure

Segment of Regulation	Total Reductions to 2030 (MTCO2e)	Annual Cost	Annual Savings	Total Cost to 2030	Total Savings to 2030
VRU for Tanks	6,456,000	$4,674,000	$653,000	$56,088,000	$7,836,000
Reciprocating Compressors	804,000	$203,000	$230,000	$2,436,000	$2,760,000
LDAR	2,640,000	$8,902,000	$756,000	$115,726,000	$9,450,000
Pneumatic Devices	3,828,000	$1,153,000	$1,043,000	$13,836,000	$12,516,000
Well Stimulations	60,000	$186,000	$17,000	$2,232,000	$204,000
Centrifugal Compressors	36,000	$4,000	$12,000	$48,000	$144,000
Monitoring Plan	TBD	TBD	TBD	TBD	TBD
Total	**13,824,000**	**$15,122,000**	**$2,711,000**	**$190,366,000**	**$32,910,000**

5. Hydrofluorocarbon (HFC) Emission Reductions

Hydrofluorocarbons (HFCs) are used primarily as refrigerant substitutes to ozone-depleting refrigerants, and although not ozone-depleting, HFCs have high-global warming potentials (GWP) between 500 and 12,000 (20-year GWP values). HFCs currently account for 4 percent of California's GHG emissions, but are expected to double in emissions in the next few decades without additional reduction actions. Four HFC measures are proposed in this strategy to reduce cumulative HFC emissions by 260 $MMTCO_2E$ (20-year GWP) by 2030 to meet the SLCP emission reduction target.

The proposed reduction measures include the following:

- Financial incentive program to install new low-GWP refrigeration and air-conditioning (AC) equipment
- Sales ban on refrigerants with very-high GWPs
- Phasedown in the supply of high-GWP HFCs

- Prohibitions on high-GWP refrigerants in new stationary refrigeration and AC equipment

The cost of strategies to reduce HFCs is highly dependent upon assumptions of the added initial cost of low-GWP equipment, which is estimated to be approximately 10 percent higher than baseline high-GWP equipment, as detailed in Appendix D. The additional initial cost ranges from $500,000 for a large cold storage facility, and $200,000 for a supermarket; to $400 for a residential AC system, and $140 for a residential refrigerator-freezer. In many cases, the added initial cost is offset or reversed through energy savings of low-GWP refrigeration and AC. Additionally, low-GWP refrigerants such as carbon dioxide refrigerant, ammonia, and hydrocarbons are less expensive than HFCs. The main barrier to adoption of low-GWP refrigeration equipment is the added initial cost. For low-GWP AC, the barriers include added initial cost and current building codes that do not allow very slightly flammable low-GWP refrigerants.

Measure costs were derived using the incremental per-unit equipment cost over the number of new units replacing retiring units each year. The total cost savings result from less energy use and less expensive refrigerant over the lifetime of the equipment. The cumulative costs and savings are outlined in Table 19.

The cost and savings from HFC reduction measures were estimated separately for each measure and then summed together to show total estimated cost and total estimated savings from all measures. This approach was used to avoid double-counting emission reductions, cost, and savings from measures that overlap significantly. For example, businesses installing low-GWP refrigeration because of the early adoption incentive program would not be subject to required prohibitions of high-GWP refrigerant in new equipment, and would not be affected by an HFC phasedown. An HFC phasedown could incentivize new equipment to use low-GWP refrigeration and AC, and a prohibition on high-GWP refrigeration and AC would largely overlap with HFC phasedown requirements. Detailed cost and savings for each individual measure are presented in Appendix D.

Table 19: HFC Measure Costs and Savings Through 2030 (Million Dollars)

	Total Cost	Total Savings	Net Cost	Emission Reductions (MMTCO2e)
HFC Reduction Measures	$5,060	($4,850)	$210	260

GHG reductions from direct refrigerant emissions are estimated by modeling equipment sectors using a constant refrigerant charge size and annual leak rate, with the only variable that of the refrigerant's GWP. The reduction per unit per year is the difference between the emissions of the high-GWP equipment and the emissions expected from the new, low-GWP equipment. Indirect GHG emissions from less energy usage were also estimated using the default carbon intensity of California's

electricity from the Cap and Trade Program. Note that the indirect emission reductions account for less than 4 percent of GHG reductions from refrigeration and AC (the carbon intensity of electricity generation used to power cooling equipment is overwhelmed by the very-high GWPs of HFC refrigerants).

B. Public Health Assessment

Short-lived climate pollutants are not only powerful climate forcers but are also harmful air pollutants with many direct and indirect impacts on health. The focused efforts identified in this Proposed Strategy will not only help to limit the impacts of climate change that are already underway, but also reduce local air pollution and produce other co-benefits. The World Health Organization (WHO) describes the direct and indirect impacts of SLCP emissions, on a global level, as follows:[159]

> Since SLCPs contribute to ambient levels of ozone and PM2.5, SCLP [sic] emissions are directly associated with cardiovascular and respiratory diseases, including heart disease, pulmonary disease, respiratory infections and lung cancer. SLCP emissions thus contribute significantly to the more than 7 million premature deaths annually linked to air pollution.
>
> Indirectly, the SLCPs ozone and black carbon reduce plant photosynthesis and growth, thus decreasing agricultural yields, which in turn threatens food security. They also affect weather patterns and the melting of snow and ice, which may harm and endanger health through extreme weather events such as floods.

Furthermore, in its report on *Reducing global health risks through mitigation of short-lived climate pollutants,*[160] the WHO notes that certain efforts to cut emissions of SLCPs may provide other types of health benefits not associated with air pollution. These include improved diets or more opportunities for safe active travel and physical activity. As described in this Proposed Strategy, some strategies to cut emissions of SLCPs in California could have important benefits for water quality, and potentially for water supply in the State, as well.

The measures and goals identified in this Proposed Strategy could deliver many of these types of benefits in California, which might accrue especially in disadvantaged communities (see Section C). As they are further developed and implemented, it will be important to consider a broad array of potential impacts and benefits to ensure that prioritized strategies to cut SLCP emissions also maximize other health benefits. For example, as part of an integrated strategy that includes use of ultra-low-NOx vehicles

[159] World Health Organization, "Reducing global health risks through mitigation of short-lived climate pollutants," accessed April 1, 2016. http://www.who.int/phe/health_topics/outdoorair/climate-reducing-health-risks-faq/en/

[160] WHO (2015) Reducing global health risks through mitigation of short-lived climate pollutants, Summary report for policymakers, World Health Organization, October. http://www.who.int/phe/publications/climate-reducing-health-risks/en/

and renewable natural gas in the transportation sector, converting manure management operations to scrape systems and injecting renewable natural gas into the pipeline can help to improve air quality and water quality near dairies and elsewhere in California. A discussion of the health impacts associated with the measures in this Proposed Strategy is provided below. A more detailed public health impacts analysis will be developed as part of any potential subsequent regulatory process.

Black carbon is a component of fine particulate matter (PM2.5). A large number of studies, particularly epidemiological (population-based) studies, have linked exposure to PM2.5 to a number of adverse health effects, including premature death, hospital admissions for the worsening of chronic cardiovascular and lung diseases, and emergency room visits for asthma.[161,162,163] Diesel particulate matter is a subset of PM2.5, and consists of black carbon particle cores that are coated with a variety of other chemical substances, including over 40 carcinogenic organic compounds, nitrates, sulfates, and heavy metals. To date, no studies have directly investigated potential health effects of black carbon. However, since black carbon particulate matter is a subset of PM2.5, which has been clearly shown to be related to adverse health effects, the scientific community has concluded that diesel and black carbon particulate matter likely have similar adverse effects as PM2.5. As part of its periodic reviews of the national ambient air quality standards, the U.S. EPA draws conclusions as to the strength of the relationship between exposure to air pollution and broad categories of adverse health effects. In its most recent integrated science assessment for the PM standards, it concluded that PM2.5 plays a "causal" role in premature death and cardiovascular effects, and a "likely causal" role in respiratory effects.[164]

As a result of State and local efforts over the past decades to improve air quality, California has significantly cut particulate matter emissions from anthropogenic sources, especially from diesel engines. The result is that black carbon emissions are about 90 percent lower than they were in the 1960s and approximately 5,000 premature deaths are avoided in the State each year. Current NO_x and PM emission standards for on-road and off-road diesel engines that phase in between 2012 and 2020 will lead to significant additional reductions in primary PM2.5 emissions from

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[161] Krewski D., Jerrett M., Burnett R.T., Ma R., Hughes E., Shi Y., Turner M.C., Pope C.A. III, Thurston G., Calle E.E., Thun M.J.. 2009. Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. HEI Research Report 140. Health Effects Institute, Boston, MA. http://www.healtheffects.org/Pubs/RR140-Krewski.pdf

[162] Bell M.L., Ebisu K., Peng R.D., Walker J., Samet J.M., Zeger S.L., Dominici F. 2008. Seasonal and regional short-term effects of fine particles on hospital admissions in 202 U.S. counties, 1999–2005. Am J Epidemiol 168:1301–1310.

[163] Ito, K., G. D. Thurston and R. A. Silverman. 2007. Characterization of PM2.5, gaseous pollutants, and meteorological interactions in the context of time - series health effects models. J Expo Sci Environ Epidemiol. Vol. 17 Suppl 2: S45 - 60.

[164] U.S. EPA. 2009. Integrated Science Assessment for PM. U.S. Environmental Protection Agency, Washington, DC Publication EPA/600/R-08/139F. http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_2007_isa.html

diesel equipment.[165] (NO_X emissions are also projected to decrease, which could reduce ozone and secondary PM.) As a result, the health-related impacts associated with diesel PM2.5 are expected to continue to decrease through 2030.

Residential wood burning (fireplaces and woodstoves) is another important source of black carbon emissions and local air pollution, and its share of the State's black carbon inventory is increasing, as emissions from diesel engines fall. Fireplaces and woodstoves produce PM2.5, carbon monoxide, volatile organic compounds, and hazardous air pollutants. In ARB's black carbon inventory, emissions from these sources are assumed to increase between 2013 and 2030, due to increased residential construction. Actions outlined in this Proposed Strategy, such as restricting residential wood-burning fireplaces and promoting the conversion to cleaner wood-burning stoves, can help reduce these emissions and health-related impacts, which especially impact rural areas.

Methane contributes to global background levels of ozone in the lower atmosphere (troposphere). Global background ozone (tropospheric ozone) concentrations have roughly doubled since preindustrial times, and are projected to continue to increase. Ozone itself is a powerful SLCP as well as a regional ground level air pollutant. Ozone exposure has been linked to increases in emergency room visits for worsening of asthma, hospitalizations due to respiratory disease, and premature death. Additionally, ozone suppresses crop yields; harms ecosystems; and affects evaporation, cloud formation, and precipitation.[166] Thus, reducing methane emissions as part of a broader effort to address climate change can complement local and regional efforts to reduce ground-level ozone.

Strategies to reduce methane emissions from dairy manure management can deliver important health benefits, especially if developed as part of a systematic approach to addressing air quality and water quality. For example, converting operations to pasture-based systems would likely reduce concentrations of and exposure to potentially harmful constituents, such as hydrogen sulfide, ammonia, and particulate matter. One study suggests that ammonia emissions could be 30 percent lower for pasture-based than for confinement systems.[167] It could also improve nutrient management on farms, helping to reduce soil and groundwater contamination. This strategy could be an important element of a sector-wide approach to reducing dairy methane emissions, but may have limited applicability. ARB estimates that about 25

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[165] Primary particles are directly released into the atmosphere by combustion processes (such as soot or black carbon and a large variety of organic carbons). "Secondary" particles also form in the atmosphere from other gaseous pollutants, particularly sulfur dioxide, nitrogen oxides (NO_X), ammonia, and volatile organic compounds (VOCs). The transportation sector is an important source of secondary particulate matter such as ammonium nitrate, especially in the winter.

[166] UNEP and WMO (2011) Integrated Assessment of Black Carbon and Tropospheric Ozone, United Nations Environment Programme and World Meteorological Association. http://www.unep.org/dewa/Portals/67/pdf/BlackCarbon_report.pdf.

[167] Perry, A. (2011) Putting dairy cows out to pasture: An environmental plus, USDA-ARS Agricultural Research Magazine, May-June. http://www.ars.usda.gov/is/AR/2011/may11/cows0511.htm

dairies in the State could convert to pasture-based operations without reducing herd size or procuring new land.

Other strategies could also deliver environmental and health benefits. Converting dairies from flushwater manure management systems to dry manure management systems would also improve nutrient management, thereby helping to improve groundwater quality. It is possible that farms may choose some management strategies which could increase or decrease emissions of pollutants of concern. If emissions increase, measures should be implemented to mitigate the impacts as part of the permitting process.

Strategies that capture or produce methane and utilize it for production of renewable energy and fuels could lead to additional sources of combustion, but as part of a regional approach to utilize low-NO_x vehicles and renewable fuels, can displace diesel combustion and help to improve air quality. If electricity is generated onsite using dairy derived biogas, using microturbines or fuel cells can minimize new emissions of NO_x and PM, minimizing potential local health impacts. To the extent that renewable natural gas is produced and injected into the natural gas pipeline network, or used in low-NO_x engines to displace diesel combustion, air quality impacts can be avoided. Prioritizing pipeline injection and onsite usage in low-NOx vehicles, in addition to a coordinated effort to increase use of low-NO_x vehicles with renewable fuels in areas surrounding dairies and elsewhere can reduce air pollution regionally and statewide. These emission reductions translate directly into health benefits, especially in disadvantaged communities near dairies and along transportation corridors, and in areas of non-attainment for ambient air quality standards.

Diverting organics from landfills to compost facilities and anaerobic digestion facilities, along with implementing food rescue and recovery programs, will significantly reduce the need for further landfill development in California, and may help reduce the lifespan of existing landfills, many of which are located in or near environmental justice communities. Phasing out the landfilling of organic materials will also help reduce future levels of fugitive methane emissions from landfills during their operational and post-closure stages. The number and frequency of heavy vehicle or truck trips to existing landfills, through neighboring communities, could potentially be reduced as organic materials are directed to anaerobic digestion facilities and regional compost facilities. To the extent that truck trips are reduced to and from landfills, they could increase in areas where facilities handling diverted organic waste are located. The net effect on overall truck trips in the State and associated emissions is uncertain, and could potentially increase as a result of changes in organic waste management, depending on how strategies are implemented. Many of the same issues associated landfilling organic waste—potential criteria pollutant emissions, water quality impacts, and odors—could be issues at anaerobic digestion or compost facilities. In many cases, these can be effectively limited with available technologies and management strategies, including limiting trucking emissions by utilizing zero emission vehicles or renewable natural gas in low-NO_x engines associated with these operations.

Food rescue and recovery could deliver additional potential health benefits by utilizing useable food to relieve food insecurity and provide better access to healthy foods. Increasing edible food recovery—especially from large-scale food producers, processors, and users—and safely redirecting food to those in need could increase access to healthy fruits and vegetables and benefit millions of Californians who suffer from food insecurity.

Reducing leaks from the oil and gas sector will also reduce VOC emissions, which contributes to ground level ozone formation and related health impacts. For example, ARB's oil and gas regulation is expected to reduce VOC emissions and toxic air contaminants that are emitted from uncontrolled oil and water storage tanks and released from well stimulation recirculation tanks. The estimated reduction in VOCs from this measure is approximately 3,000 tons per year, or about 8 tons per day, statewide.

The measures identified in this Proposed Strategy for HFCs are unlikely to have noticeable health impacts. HFCs have negligible impacts on smog formation and are exempt from U.S. EPA's definition of volatile organic compounds. At higher concentrations that could result from an accidental release in occupational settings, they might be toxic, and emissions of vapors containing HFCs in the workplace environment should be prevented. But at ambient concentrations, HFCs pose no significant health risk, and efforts described in this Proposed Strategy to phase down their use are not expected to deliver noticeable health benefits. Some potential replacements for HFCs could result in emissions of VOCs and particulate matter, but they would be negligible.

C. Environmental Justice and Disadvantaged Communities

The State of California defines environmental justice in statute as, "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations and policies." (Government Code Section 65040.12). ARB is committed to continuing to strengthen its outreach efforts to ensure that all California communities have the opportunity to participate in its public processes and benefit from the State's climate-related programs, policies, and regulations.

ARB endeavors to integrate environmental justice into all of its programs, policies, and regulations and is taking additional steps to strengthen its work with the environmental justice community. Specifically, every major program, policy, plan or strategy, and rulemaking explicitly discusses environmental justice and promotes the fair treatment of people from all races, cultures, geographic areas, and income levels—especially in disadvantaged communities. As part of the development and implementation of the AB 32 Scoping Plan, ARB convened an Environmental Justice Advisory Committee (EJAC). ARB has briefed the EJAC on this Proposed Strategy development multiple times, and at its April 2016 meeting, the EJAC discussed and made recommendations on this Proposed Strategy. ARB also works extensively with local air districts and

stakeholders during the development and implementation of its programs to respond to concerns about environmental justice.

The EJAC developed the following recommendations for inclusion in this Proposed Strategy:

> (1) Create a declining methane target specific to dairies that would lead to a 40% reduction mandate for dairies by 2030.
> (2) The dairy emission target should include all methane emissions from dairies, not just from manure handling.
> (3) The Proposed Strategy should explicitly say no disposal of food waste to landfills or incinerators.
> (4) Explore synergies with methane reductions from dairies and the management of organic waste, such as wood waste.
> (5) Include Concentrated Animal Feeding Operations (CAFO) in the methane emission reduction goal.
> (6) Mitigate all additional ancillary emissions generated through achieving the methane emission reduction goal.

This Proposed Strategy includes a measure that would create a regulatory program to achieve a 75 percent reduction in methane emissions from dairy manure management by 2030. It also includes a commitment to work to further examine enteric emissions and reduction opportunities. The GHG inventory includes methane emissions associated with CAFO facilities, which are primarily from enteric fermentation and manure management. The organic diversion measure identified in this Proposed Strategy will virtually eliminate organics from landfills, including food waste.

ARB staff has been working with staff from other state agencies to develop an holistic and synergistic approach to reducing methane emissions, and will continue to work with them to implement these measures. ARB staff will continue to consult with environmental justice communities as we implement the measures to ensure minimum impact and maximum benefit to environmental justice communities. Furthermore, the EJAC recommendations will be taken into consideration as specific actions and policies discussed in this Proposed Strategy are developed into regulatory measures.

The California Environmental Protection Agency and pursuant to Senate Bill 535 (De León, Chapter 830, Statutes of 2012), has identified the communities in California that are most disproportionately burdened by pollution for the purposes of expenditure of California Climate Change Investment Funds. Of the 12 indicators of pollution included in its methodology, three are directly related to SLCP emissions (fine particle emissions, diesel particulate emissions, and solid waste sites and facilities), and at least six others (mostly related to water quality and air quality) are at least related to sources of SLCP emissions.

The distribution of these communities aligns with locations of SLCP emission sources, including sources of organic waste streams and dairies in the Central Valley; ports and

freight corridors in the East Bay, Los Angeles area and Inland Empire; and oil production, landfills and other sources of SLCP emissions throughout the State. Many communities in these areas have some of the worst pollution burdens in the State and high rates of poverty and unemployment. Forested and rural communities in the northern part of the State and the Sierra also are stricken with high rates of poverty and unemployment. They are also where many billions of dollars in public and private investment will accrue in the coming years to reduce SLCP and CO_2 emissions and strengthen our agricultural sector, build sustainable freight systems, and grow healthy forests. To the extent new facilities are built to manage organic waste streams in the State, care must be taken to locate, design, and operate them in a manner that protects local air quality.

The integrated strategy to reduce SLCP emissions from agriculture and waste, developed in this Proposed Strategy, can be part of an integrated strategy to improve air and water quality in agriculture regions, such as in the Central Valley. Additionally, the Healthy Soils Initiative will improve California's agriculture economy and support further economic development in these communities. California's commitment to improve the health and management of forests will boost California's forest economy and limit black carbon emissions and many other air pollutants from wildfires.

The measures identified in this Proposed Strategy will be further developed in a formal public process that specifically considers environmental justice concerns. Opportunities for public participation will be provided during the development of each measure, and regulatory language will be made available in easily understood and useful formats, such as program-specific webpages and slide presentations.

D. Environmental Analysis

ARB, as the lead agency for the Proposed Strategy, prepared a Draft Environmental Analysis (EA) in accordance with the requirements of the California Environmental Quality Act (CEQA) and ARB's regulatory program certified by the Secretary of Natural Resources (California Code of Regulation, title 17, sections 60006-60008; California Code of Regulation, title 14, section 15251, subdivision (d)). The resource areas from the CEQA Guidelines Environmental Checklist were used as a framework for a programmatic environmental analysis of the reasonably foreseeable compliance responses resulting from implementation of the proposed measures discussed in the Proposed Strategy. The Draft EA provides an analysis of both the beneficial and adverse impacts and feasible mitigation measures for the reasonably foreseeable compliance responses associated with the proposed measures under each of 17 environmental resource areas. Collectively, the Draft EA concluded implementation of these actions could result in the following short-term and long-term beneficial and adverse impacts : beneficial long-term impacts in reduced greenhouse gas emissions; less than significant impacts to air quality, biological resources, energy demand, geology and soils, greenhouse gases (short-term), hazards and hazardous materials, hydrology and water quality, resources related to land use planning, mineral resources, noise, population and housing, public services, and recreational services; and

potentially significant and unavoidable adverse impacts to aesthetics, agriculture and forest resources, air quality, biological resources, cultural resources, geology and soils, hazards and hazardous materials, hydrology and water quality, resources related to land use planning, noise, transportation/traffic, and utilities and service systems. The potentially significant and unavoidable adverse impacts are primarily related to short-term construction-related activities, which explains why some resource areas are identified above as having both less-than-significant impacts and potentially significant impacts. Please refer to the Draft EA in Appendix C for further details.

ARB will prepare written responses to all comments received on the Draft EA, which will be presented to the Board for consideration along with the Final EA.

IX. Next Steps

This Proposed Strategy and an accompanying draft Environmental Analysis (EA), was released for public comment. Staff will provide an update to the Board on the Proposed Strategy in May 2016. In fall 2016, staff will present the final proposed SLCP Reduction Strategy, the final EA, and written responses to comments received on the EA to the Board for consideration.

To the extent that the proposals in the SLCP Reduction Strategy result in regulatory action, each proposed regulation will be subject to its own public process with workshops, opportunities for stakeholder discussion, consideration of environmental justice, and legally required analyses of the economic and environmental impacts.

While this Proposed Strategy is intended to be comprehensive, it is not exhaustive. We will continue to pursue new cost-effective programs and measures as technology and research on SLCP emission sources and potential mitigation measures advances. Effectively implementing this Proposed Strategy will require working with local, regional, federal and international partners, and diligently investing time and money to overcome market barriers that hinder progress. The extent to which we do so will drive results, which can include a wide range of significant economic and environmental benefits for California broadly, and many of the State's most disadvantaged communities, specifically.

Green Bags for Yard Waste

Curbside Yardwaste Collection

Curbside yard waste collection is available to Town of Truckee residents only.

Participation in the curbside yard waste program requires residents to purchase approved green bags (4 mil thick) from area retailers. Set out up to four bags for weekly collection. Bags must be tied and weigh no more than 40 pounds each for collection to occur. Bags that are over weight, untied or stacked in a pile will be left at the curb. Bags are collected year round. Please make sure green bags are easily accessible by trash collection personnel.

The Town of Truckee discourages leaving more than four bags at curbside at a time. More than four bags left on the curbside are unsightly and pose a fire danger.

Purchase Approved Green Bags:

In order to participate, residents must purchase approved green bags from Mountain Hardware, Tahoe Supply Company, Truckee Tahoe Lumber Company, The Office Boss or the Tahoe Donner HOA Clubhouse.

Look for the "Sold Here" Poster...

Retailer Locations:

- Mountain Hardware -11320 Donner Pass Road
- The Office Boss- Safeway Center and Airport Business Center
- Tahoe Supply Company -10939 A Industrial Way (near the Pioneer Commerce Center)
- Truckee Tahoe Lumber Company - 10242 Church Street
- Tahoe Donner HOA Clubhouse - 11509 Northwoods Blvd

Accepted Items:

Pine Needles
Pine Cones

Lawn Trimmings
Garden Waste
Brush
Small Twigs & Branches
Wood Chips & Bark

NO: Large Limbs or Branches; Food Waste; Pet Waste; Rocks/Dirt.

Tap Menu Button

Food Composting

What can I compost? Lots of items!

Now available to all of our Napa County (NCRWS) and City of Napa (NRWS) customers! All food scraps and compostable materials go in the brown compost cart…see below for details.

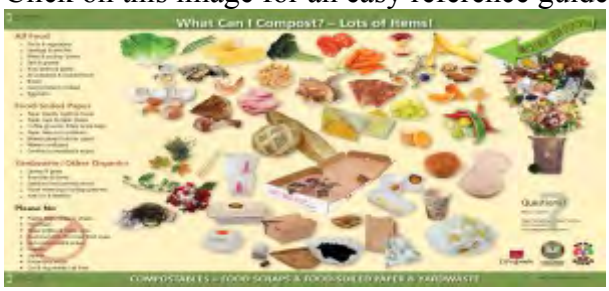
Click here to sign up and get tips for a successful commercial composting program. Residential food composting info is available here.

Food Composting Program – acceptable items:

ALL FOOD	SOILED PAPER
• Fruits & vegetables (pits & shells too) • Seafood, including shellfish • Meat & bones • Solid fats & grease • Rice, beans, grains & pasta • Bread • Dairy products/cheese • Eggshells and eggs • All prepared, cooked & spoiled foods • Pet food	• Napkins, paper towels, tissues & other soiled paper • Paper cups and plates • Coffee grounds & filters • Tea bags & loose tea • Waxed paper, butcher paper & waxed cardboard • Paper take-out boxes & containers • Greasy pizza boxes & paper bags • Certified compostable cleaning wipes
YARD TRIMMINGS/OTHER ORGANICS	**Not Accepted**
• Leaves & grass • Branches, stems and other plant debris • Flowers & floral trimmings • Holiday greenery • Sawdust, chopsticks, toothpicks, wooden crates & other clean wood items under 36″	Please No: • Plastic bags/wrap, straws or other plastic items • Styrofoam • Glass • Metal

• Natural cork • Cotton balls/cotton swaps with paper stems • Hair, fur & feathers (non-synthetic) • Manure & animal bedding	• Aluminum foil/foil-lined food wrap • Liquids • Cat & dog waste/cat litter • Hazardous waste

Click on this image for an easy reference guide w/ pictures:



Privacy Statement | Contact

How you can support the ban on food in the garbage

Did you know that food scraps make up 40 per cent of the garbage going to our landfill? Discarded food in the landfill creates greenhouse gases.

Recycling our food scraps reduces the amount of garbage we produce, cuts down on global warming pollution, and creates compost soil for local gardens and farms.

Get resources to start recycling your food scraps now

As of January 1, 2015, both the City of Vancouver and Metro Vancouver regional district banned food scraps from disposal as garbage.

That means all food scraps – raw and cooked food, plate scrapings, leftovers, expired food, meat, bones, and dairy products – need to be recycled.

Get tips to start recycling your food scraps for your type of property, below.

Live in a house or duplex?

Recycle food scraps in your Green Bin

Find out what goes in your Green Bin and what to keep out.

Live in a multi-unit residential building?

Recycle food scraps in your Green Bin

Does your building get City Green Bin pickup? Learn what goes in your Green Bin and what to keep out.

Manage a multi-unit residential building?

Start a food scraps collection program with the City or a private hauler

Do we already collect your building's garbage? We may also be able to collect your food scraps, too. Phone 3-1-1 to inquire. Otherwise, hire a private waste service provider using our helpful tips and directory.

Consider on-site organics management systems

Composting food scraps at your building or business can save you money on disposal fees and create compost for landscaping. Find out if on-site organics management systems suit your needs.

Run a business?

Find a hauler

Tips on how to find a garbage, recycling, or food scraps hauler for your business.

Consider on-site organics management systems

Composting food scraps at your building or business can save you money on disposal fees and create compost for landscaping. Find out if on-site organics management systems suit your needs.

Get resources for your restaurant and grocery store

For help designing, starting, and maintaining a food scraps recycling program at your restaurant, read the "Closing the Loop" guide, case studies, and other tips on the Metro Vancouver Organics Ban website.

Learn more about the ban

Visit Metro Vancouver's Organics Ban website

Watch a video on the ban

MV Update_Organics Ban

In French, Japanese, Mandarin, Punjabi, Tagalog, and Korean

Regulations

On October 14, 2014, Council enacted two bylaws that require all City of Vancouver business licence-holders, property owners, and occupants to recycle their food scraps starting January 1, 2015.

- Read Bylaw #11091 (amendment to the Licence Bylaw) (30 KB)
- Read Bylaw #11092 (amendments to the Solid Waste Bylaw) (25 KB)

Climate Change and Solid Waste Management

Organics

Organic Materials Management and Climate Change

California disposes approximately 30 million tons of waste in landfills each year, of which approximately 30 percent is compostable organic materials, 30 percent is construction and demolition debris, and nearly 20 percent is paper (see the 2008 Waste Characterization Study). Greenhouse gas emissions resulting from the decomposition of organic wastes in landfills have been identified as a source of emissions contributing to global climate change. Anaerobic decomposition of organic materials in landfills produces methane (CH_4), a greenhouse gas with global warming potential approximately 25 times higher than carbon dioxide (CO_2). Landfills emit the majority of man-made methane emissions in California. Reducing the amount of organic materials sent to landfills and increasing the production of compost and mulch are part of the AB 32 Scoping Plan.

In accordance with Assembly Bill 341 (Chapter 476, Statutes of 2011), CalRecycle is leading California's ambitious drive toward a 75 percent reduction in the amount of waste going to landfills by the year 2020. This will be achieved through source reduction, recycling, and composting. Attaining this goal will require diverting up to 22 million tons of waste from California landfills annually.

In order to meet these goals, infrastructure must be developed to manage organic wastes and increase the production and markets for compost. Additionally, expanding anaerobic digestion infrastructure will provide organic materials managers the opportunity to earn credits for producing low carbon fuels and renewable electricity.

Three Main Drivers

1. **Infrastructure:** CalRecycle fosters a regulatory and permitting environment necessary to build the 21st Century Organics Infrastructure.
2. **Scientific Research and Technology Evaluation:** CalRecycle funds and supports research to answer scientific questions pertaining to waste management and climate change.
3. **Improve Economic Incentives for Organics Diversion and Markets for finished compost products:** Historically, this has focused on promoting the value of compost. More recently, this includes leveraging the Low Carbon Fuel and Renewable Portfolio standards to provide additional incentives for anaerobic digestion.

Infrastructure

To meet the goals of AB 341, it is estimated that California will need to double the size of the current organics materials management infrastructure. CalRecycle has identified barriers and corresponding solutions to help facilitate the construction and safe operation of this next-generation infrastructure:

- Programmatic Environmental Impact Report (EIR) for anaerobic digestion facilities: This document will assist potential developers of projects to build and operate anaerobic digesters for the treatment of organic wastes.
- Guidance Document: for California Environmental Quality Act Review of Municipal Organic Waste Anaerobic Digester Facilities in California.
- Third Assessment of California Compost and Mulch Producing Infrastructure: The 2010 update to CalRecycle's efforts to measure the capacity of the organics infrastructure also focuses on management practices and market conditions.
- Organics Regulations: The current regulations covering compostable materials handling operations have been in place for 10 years. CalRecycle is now in the process of updating those rules.

- Organics Roadmap: Developed to address organic materials diversion and CalRecycle's Strategic Directive 6.1, which called for diverting 50 percent of the organics in the waste stream into more productive uses by 2020.

Scientific Research and Technology Evaluation

CalRecycle funds and supports research to answer important scientific questions and to ensure program initiatives are based on the best available science. CalRecycle collaborates with other agencies to ensure shared research priorities receive prompt attention.

- **Compost-Greenhouse Gas Research.** CalRecycle funded a multi-year contract with UC Davis to research the greenhouse gas impacts of compost production and use. Multiple emissions measurement techniques have been used to measure methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) emissions from a series of compost piles at a commercial compost facility in Northern California. The project includes additional field research to measure the impact of compost application on N_2O emissions from intensively farmed lands—one of the largest N_2O sources in California—as well as laboratory incubations checking the impact of compost on soil CH_4 and N_2O emissions for multiple soil types and different chemical fertilizer applications. The research will conclude in April 2014.
- **Other compost emissions research.** Over the past decade, CalRecycle has funded or participated in numerous projects investigating emissions of criteria pollutants and greenhouse gases from composting piles. Most recently, CalRecycle teamed up with the San Joaquin Valleywide Air Pollution Study Agency, the Association of Compost Producers, the City of Bakersfield, Harvest Power, O2 Compost, and emissions consultant Chuck Schmidt to investigate the impacts of a commercial-scale composting system reducing criteria pollutant and greenhouse gas emissions from composting processes by employing electric conveyors for pile construction, solar-powered blowers to aerate piles, and a one-foot-thick biofilter layer to reduce emissions.
- **Evaluate Compost as a Landfill Cover.** CalRecycle studied the feasibility of placing a biocover of compost over the surface of a landfill to control escaping methane.
- **In-Situ Anaerobic Digester:** This CalRecycle-funded study tested an innovative concept for building anaerobic digestion and compost cells at the Yolo County Central Landfill near Woodland, CA.

Markets: Improve Economic Incentives for Organics Diversion and Markets for finished compost products

Composting and anaerobic digestion compete with low-cost landfilling and direct land application for feedstocks, reducing operators' ability to pay for infrastructure development, product marketing, and other essentials. CalRecycle works to find ways to monetize the inherent value of advanced organics handling facilities.

- **Low Carbon Fuel Standard (LCFS) for High-Solids Anaerobic Digestion:** CalRecycle staff assisted the Air Resources Board with the development of the Low Carbon Fuel Standard High Solids Anaerobic Digestion (HSAD) Pathway, which resulted in one of the lowest carbon intensities of any LCFS fuel pathway developed to date. Additionally, CalRecycle staff is currently working with ARB staff to develop a LCFS pathway for Low Solids Anaerobic Digestion (LSAD).
- The **Agriculture Working Group for the Climate Action Team** coordinates efforts aimed at protecting and developing resources related to California's agricultural economy and ensures the state's ability to mitigate and adapt to climate change impacts on agriculture resources (land, livestock, water, food, and fiber) while supporting implementation of greenhouse gas emission reduction programs. CalRecycle is a participating member of this team.
- **Help Caltrans develop compost specifications and best management practices** (PDF, 185 KB): California has more than 16,000 miles of state highways. Increasing the use of compost along those roads can help establish plants and reduce erosion after road construction or rehabilitation, and can reduce the need for and the cost of irrigating highway vegetation.
- Landscaping: CalRecycle is working with the Climate Action Team's Land Use Subgroup to reduce greenhouse gases by developing "Watershed-Friendly" Landscaping Guidelines for adoption and customization for local climates and conditions. The guidelines will conserve water, reduce green waste, reduce air pollution, and protect water quality. Examples of existing landscape guidelines customized for local climates and conditions include Bay-Friendly Landscaping and River-Friendly Landscape Guidelines.
- **Compost Specifications for Agriculture:** CalRecycle worked with researchers to develop a range of parameters

for finished compost products that will help ensure success when used by growers of specific, high-value crops, including avocados, blueberries, grapes, lettuce, strawberries, and tomatoes. Final report not yet available.

Last updated: July 17, 2013
Climate Change: http://www.calrecycle.ca.gov/Climate/
Contact: climatechange@calrecycle.ca.gov

3Degrees

CARBON OFFSET PROPOSAL

You're about to do something great.

CLIENT: California Clean Energy Committee

DATE: 4/28/2016

Your purchase of carbon offsets makes a real difference:

+ Improve your environmental footprint
+ Channel funds directly to greenhouse gas reduction projects
+ Demonstrate sustainability leadership

Your annual purchase of 1,000 verified carbon offsets will lower your carbon footprint and have environmental impact similar to:

growing 25,642 trees per year for 10 years

or...

taking 211 cars off the road for 1 year

or...

not using 2,326 barrels of oil

Why us?

We offer you a way to be part of innovative projects that have a positive environmental impact, inspire stakeholders, and promote your brand. It's why we keep winning the EPA's Green Power Supplier of the Year award and why our customers vote us their favorite in industry surveys year after year.

CARBON OFFSET OPTIONS (1 YEAR)

Pricing shown is indicative and can be firmed upon request.

Volume	*Project type*	*Name/Location*	*Verification*	Green-e Climate CERTIFIED	*Cost/MT*	*Total cost*
1,000	U.S. Forestry	RPH Ranch, CA	CAR Conservation Based Forest Mgnm		$ 8.50	$ 8,500.00

Prices include a discount for upfront payment in full by check or wire transfer and are valid for seven days. Standard delivery.

We ensure all Green-e® Climate reporting requirements are met by providing specific information about the projects you support, including the project name, location, along with the vintage year of the offsets and GHG project standard.

Contact: **BRIAN HARVEY**

+1 415 659 8865 *bharvey@3degreesinc.com*

SEE THE NEXT PAGE FOR MORE ON WHY US

3Degrees

CARBON OFFSET PROPOSAL

We're with you every step of the way.

CLIENT: California Clean Energy Committee

DATE: 4/28/2016

HIGH-QUALITY PRODUCTS

When you buy carbon offsets from us, we tell you exactly which project you're supporting, upon delivery. We're committed to transparency and we know the project information will be meaningful and inspiring to your stakeholders.

Certified B Corporation bcorporation.net

As a Certified B Corporation, we are part of a growing community that seeks to build a new sector of the economy—an economy in which the goal is not to be the best in the world, but to be the best for the world.

EXTRAORDINARY SERVICE

Full-service means we deliver what you need when you need it. As one of the nation's most experienced renewable energy firms, we're expert at tailoring our products and services to align with your values and your budget. Whatever your company needs, we are with you every step of the way—writing RFPs, providing guidance on greenhouse gas reporting, and drafting award nominations are just a few of the myriad ways we support our clients.

MARKETING & COMMUNICATIONS SUPPORT

Our team of designers and marketers help tell the story of your carbon offset commitment. Our success is measured by the success of your program, and we will help you to spread the news.

Some of the work we've done for our clients includes:

- lunchroom and promotional posters
- custom web and social media assets
- certificates suitable for framing
- engagment webinars
- infographics
- content for annual reports, newsletters and blog posts

3Degrees leadership:

- DOE/EPA Green Power Supplier of the Year
- Best for the World for Worker Impact, B Lab
- #1 REC Trading Company in North America, *Environmental Finance*
- Inc. 5000 list of America's Fastest Growing Private Companies

Our clients include:

Adobe

Boston Properties VOSS

Contact: **BRIAN HARVEY**

+1 415 659 8865 *bharvey@3degreesinc.com*

Carbon offset

From Wikipedia, the free encyclopedia

A carbon offset is a reduction in emissions of carbon dioxide or greenhouse gases made in order to compensate for or to offset an emission made elsewhere.[1][2][3][4]

Carbon offsets are measured in metric tons of carbon dioxide-equivalent (CO_2e) and may represent six primary categories of greenhouse gases:[5] carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and sulfur hexafluoride (SF_6).[6] One carbon offset represents the reduction of one metric ton of carbon dioxide or its equivalent in other greenhouse gases.

There are two markets for carbon offsets. In the larger, compliance market, companies, governments, or other entities buy carbon offsets in order to comply with caps on the total amount of carbon dioxide they are allowed to emit. This market exists in order to achieve compliance with obligations of Annex 1 Parties under the Kyoto Protocol, and of liable entities under the EU Emission Trading Scheme. In 2006, about $5.5 billion of carbon offsets were purchased in the compliance market, representing about 1.6 billion metric tons of CO_2e reductions.[7]

In the much smaller, voluntary market, individuals, companies, or governments purchase carbon offsets to mitigate their own greenhouse gas emissions from transportation, electricity use, and other sources. For example, an individual might purchase carbon offsets to compensate for the greenhouse gas emissions caused by personal air travel. Many companies (see list[8]) offer carbon offsets as an up-sell during the sales process so that customers can mitigate the emissions related with their product or service purchase (such as offsetting emissions related to a vacation flight, car rental, hotel stay, consumer good, etc.). In 2008, about $705 million of carbon offsets were purchased in the voluntary market, representing about 123.4 million metric tons of CO_2e reductions.[9] Some fuel suppliers in the UK offer fuel which has been carbon offset such as Fuel dyes.

Offsets are typically achieved through financial support of projects that reduce the emission of greenhouse gases in the short- or long-term. The most common project type is renewable energy,[10] such as wind farms, biomass energy, or hydroelectric dams. Others include energy efficiency projects, the destruction of industrial pollutants or agricultural byproducts, destruction of landfill methane, and forestry projects.[11] Some of the most popular carbon offset projects from a corporate perspective are energy efficiency and wind turbine projects.[12]

Carbon offsetting has gained some appeal and momentum mainly among consumers in western countries who have become aware and concerned about the potentially negative environmental effects of energy-intensive lifestyles and economies. The Kyoto Protocol has sanctioned offsets as a way for governments and private companies to earn carbon credits that can be traded on a marketplace. The protocol established the Clean Development Mechanism (CDM), which validates and measures projects to ensure they produce authentic benefits and are genuinely "additional" activities that would not otherwise have been undertaken. Organizations that are unable to meet their emissions quota can offset their emissions by buying CDM-approved Certified Emissions Reductions. Emissions from burning fuel, such as red diesel, has pushed one UK fuel supplier to create a carbon offset fuel named Carbon Offset Red Diesel.

Offsets may be cheaper or more convenient alternatives to reducing one's own fossil-fuel consumption. However, some critics object to carbon offsets, and question the benefits of certain types of offsets.[13] Due diligence is recommended to help businesses in the assessment and identification of "good quality" offsets to ensure offsetting provides the desired additional environmental benefits, and to avoid reputational risk associated with poor quality offsets.[14]

Offsets are viewed as an important policy tool to maintain stable economies. One of the hidden dangers of climate change policy is unequal prices of carbon in the economy, which can cause economic collateral damage if production flows to regions or industries that have a lower price of carbon—unless carbon can be purchased from that area, which offsets effectively permit, equalizing the price.[15]

Contents

Wind turbines near Aalborg, Denmark. Renewable energy projects are the most common source of carbon offsets.

Definitions

The World Resources Institute defines a carbon offset as "a unit of carbon dioxide-equivalent (CO_2e) that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere".[1]

The Collins English Dictionary defines a carbon offset as "a compensatory measure made by an individual or company for carbon emissions, usually through sponsoring activities or projects which increase carbon dioxide absorption, such as tree planting".[2]

The Environment Protection Authority of Victoria (Australia) defines a carbon offset as: "a monetary investment in a project or activity elsewhere that abates greenhouse gas (GHG) emissions or sequesters carbon from the atmosphere that is used to compensate for GHG emissions from your own activities. Offsets can be bought by a business or individual in the voluntary market (or within a trading scheme), a carbon offset usually represents one tonne of CO_2-e".[3]

The Stockholm Environment Institute defines a carbon offset as "a credit for negating or diminishing the impact of emitting a ton of carbon dioxide by paying someone else to absorb or avoid the release of a ton of CO_2 elsewhere".[16]

The University of Oxford Environmental Change Institute defines a carbon offset as "mechanism whereby individuals and corporations pay for reductions elsewhere in order to offset their own emissions".[4]

The Encyclopædia Britannica defines a carbon offset as "any activity that compensates for the emission of carbon dioxide (CO_2) or other greenhouse gases (measured in carbon dioxide equivalents [CO_2e]) by providing for an emission reduction elsewhere."[17]

A carbon offset is a greenhouse gas (GHG) reduction that is used to counterbalance, or offset, a GHG emission. They are sometimes also referred to as carbon credits, VERs, or CERs.[18]

A carbon offset occurs when an individual or organization emits a given amount of GHG emissions but invests in measures that remove the equivalent volume of GHG emissions from the atmosphere or prevent the emissions from taking place at all. Carbon offsets are a financial instrument that represents this reduction in GHG emissions.[18]

Features

Carbon offsets have several common features:

- Vintage. The vintage is the year in which the carbon reduction takes place.[19]
- Source. The source refers to the project or technology used in offsetting the carbon emissions.

Projects can include land-use, methane, biomass, renewable energy and industrial energy efficiency. Projects may also have secondary benefits (co-benefits). For example, projects that reduce agricultural greenhouse gas emissions may improve water quality by reducing fertilizer usage.[20]

- Certification regime. The certification regime describes the systems and procedures that are used to certify and register carbon offsets. Different methodologies are used for measuring and verifying emissions reductions, depending on project type, size and location.[21] For example, the CDM uses another.[22] In the voluntary market, a variety of industry standards exist. These include the Voluntary Carbon Standard and the CDM Gold Standard that are implemented to provide third-party verification of carbon offset projects.[14] There are some additional standards for the validation of co-benefits, including the CCBS, issued by the Climate, Community & Biodiversity Alliance and the Social Carbon Standard,[23] issued by Ecologica Institute.

Carbon offset markets

Global market

In 2009, 8.2 billion metric tons of carbon dioxide equivalent changed hands worldwide, up 68 per cent from 2008, according to the study by carbon-market research firm Point Carbon, of Washington and Oslo. But at EUR94 billion, or about $135 billion, the market's value was nearly unchanged compared with 2008, with world carbon prices averaging EUR11.40 a ton, down about 40 per cent from the previous year, according to the study.[24] The World Bank's "State and Trends of the Carbon Market 2010"[25] put the overall value of the market at $144 billion, but found that a significant part of this figure resulted from manipulation of a VAT loophole.[26]

· 90% of voluntary offset volumes were contracted by the private sector – where corporate social responsibility and industry leadership were primary motivations for offset purchases.[27]

· Offset buyers' desire to positively impact the climate resilience of their supply chain or sphere of influence was evident in our data which identifies a strong relationship between buyers' business sectors and the project categories from which they contract offsets.[27]

E.U. market

The global carbon market is dominated by the European Union, where companies that emit greenhouse gases are required to cut their emissions or buy pollution allowances or carbon credits from the market, under the European Union Emission Trading Scheme (EU ETS). Europe, which has seen volatile carbon prices due to fluctuations in energy prices and supply and demand, will continue to dominate the global carbon market for another few years, as the U.S. and China—the world's top polluters—have yet to establish mandatory emission-reduction policies.

U.S. market

On the whole, the U.S. market remains primarily a voluntary market, but multiple cap and trade regimes are either fully implemented or near-imminent at the regional level. The first mandatory, market-based cap-and-trade program to cut CO_2 in the U.S., called the Regional Greenhouse Gas Initiative (RGGI), kicked into gear in Northeastern states in 2009, growing nearly tenfold to $2.5 billion, according to Point Carbon

(http://www.pointcarbon.com). Western Climate Initiative (WCI)—a regional cap-and-trade program including seven western states (California notably among them) and four Canadian provinces—has established a regional target for reducing heat-trapping emissions of 15 percent below 2005 levels by 2020. A component of California's own Global Warming Solutions Act of 2006, kicked off in early 2013, requires high-emissions industries to purchase carbon credits to cover emissions in excess of 25,000 CO2 metric tons.

Voluntary market

Participants

A wide range of participants are involved in the voluntary market, including providers of different types of offsets, developers of quality assurance mechanisms, third party verifiers, and consumers who purchase offsets from domestic or international providers. Suppliers include for-profit companies, governments, charitable non-governmental organizations, colleges and universities, and other groups.[28]

Motivations

According to industry analyst Ecosystem Marketplace, the voluntary markets present the opportunity for citizen consumer action, as well as an alternative source of carbon finance and an incubator for carbon market innovation. In their survey of voluntary markets, data has shown that "Corporate Social Responsibility" and "Public Relations/Branding" are clearly in first place among motivations for voluntary offset purchases, with evidence indicating that companies seek to offset emissions "for goodwill, both of the general public and their investors".

In addition, regarding market composition, research indicates: "Though many analysts perceive pre-compliance buying as a dominant driving force in the voluntary market, the results of our survey have repeatedly indicated that precompliance motives (as indicated by 'investment/resale and 'anticipation of regulation') remain secondary to those of the pure voluntary market (companies/individuals offsetting their emissions)."[29]

Pre-compliance & trading

The other main category of buyers on the voluntary markets are those engaged in pre-compliance and/or trading. Those purchasing offsets for pre-compliance purposes are doing so with the expectation, or as a hedge against the possibility, of future mandatory cap and trade regulations. As a mandatory cap would sharply increase the price of offsets, firms—especially those with large carbon footprints and the corresponding financial exposure to regulation—make the decision to acquire offsets in advance at what are expected to be lower prices.

The trading market in offsets in general resembles the trade in other commodities markets, with financial professionals including hedge funds and desks at major investment banks, taking positions in the hopes of buying cheap and selling dear, with their motivation typically short or medium term financial gain.

Retail

Multiple players in the retail market have offerings that enable consumers and businesses to calculate their carbon footprint, most commonly through a web-based interface including a calculator or questionnaire, and sell them offsets in the amount of that footprint.[30] In addition many companies selling products and services, especially carbon-intensive ones such as airline travel,[31][32] offer options to bundle a proportional offsetting amount of carbon credits with each transaction.

Suppliers of voluntary offsets operate under both nonprofit and social enterprise models, or a blended approach sometimes referred to as triple bottom line. Other suppliers include broader environmentally focused organizations with website subsections or initiatives that enable retail voluntary offset purchases by members, and government created projects.

Features of companies that voluntarily offset emissions

Companies that voluntarily offset their own emissions tend to be of relatively low carbon intensity, as they can offset a significant proportion of their emissions at relatively low cost.[33] Voluntary offsetting is particularly common in the financial sector. 61 per cent of financial companies in the FTSE 100 offset at least a portion of their 2009 emissions. Twenty-two per cent of financial companies in the FTSE 100 considered their entire 2009 operations to be carbon neutral.[10]

Sources of carbon offsets

The CDM identifies over 200 types of projects suitable for generating carbon offsets, which are grouped into broad categories. These project types include renewable energy, methane abatement, energy efficiency, reforestation and fuel switching.[11]

Renewable energy

Renewable energy offsets commonly include wind power, solar power, hydroelectric power and biofuel. Some of these offsets are used to reduce the cost differential between renewable and conventional energy production, increasing the commercial viability of a choice to use renewable energy sources.

Renewable Energy Credits (RECs) are also sometimes treated as carbon offsets, although the concepts are distinct. Whereas a carbon offset represents a reduction in greenhouse gas emissions, a REC represents a quantity of energy produced from renewable sources. To convert RECs into offsets, the clean energy must be translated into carbon reductions, typically by assuming that the clean energy is displacing an equivalent amount of conventionally produced electricity from the local grid. This is known as an indirect offset (because the reduction doesn't take place at the project site itself, but rather at an external site), and some controversy surrounds the question of whether they truly lead to "additional" emission reductions and who should get credit for any reductions that may occur.[34][35] Intel corporation is the largest purchaser of renewable power in the US.[36]

Methane collection and combustion

Some offset projects consist of the combustion or containment of methane generated by farm animals (by use of an anaerobic digester),[37] landfills[38] or other industrial waste. Methane has a global warming potential (GWP) 23 times that of CO_2; when combusted, each molecule of methane is converted to one molecule of CO_2, thus reducing the global warming effect by 96%.

An example of a project using an anaerobic digester can be found in Chile where in December 2000, the largest pork production company in Chile, initiated a voluntary process to implement advanced waste management systems (anaerobic and aerobic digestion of hog manure), in order to reduce greenhouse gas (GHG) emissions.[39]

Energy efficiency

While carbon offsets that fund renewable energy projects help lower the carbon intensity of energy supply, energy conservation projects seek to reduce the overall demand for energy. Carbon offsets in this category fund projects of several types:

Chicago Climate Justice activists protesting cap and trade legislation in front of Chicago Climate Exchange building in Chicago Loop

1. Cogeneration plants generate both electricity and heat from the same power source, thus improving upon the energy efficiency of most power plants, which waste the energy generated as heat.
2. Fuel efficiency projects replace a combustion device with one using less fuel per unit of energy provided. Assuming energy demand does not change, this reduces the carbon dioxide emitted.
3. Energy-efficient buildings reduce the amount of energy wasted in buildings through efficient heating, cooling or lighting systems. In particular, the replacement of incandescent light bulbs with compact fluorescent lamps can have a drastic effect on energy consumption. New buildings can also be constructed using less carbon-intensive input materials.

Destruction of industrial pollutants

Industrial pollutants such as hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) have a GWP many thousands of times greater than carbon dioxide by volume.[40] Because these pollutants are easily captured and destroyed at their source, they present a large and low-cost source of carbon offsets. As a category, HFCs, PFCs, and N_2O reductions represent 71 per cent of offsets issued under the CDM.[11]

Land use, land-use change and forestry

Land use, land-use change and forestry (LULUCF) projects focus on natural carbon sinks such as forests and soil. Deforestation, particularly in Brazil, Indonesia and parts of Africa, account for about 20 per cent of greenhouse gas emissions.[41] Deforestation can be avoided either by paying directly for forest preservation, or by using offset funds to provide substitutes for forest-based products. There is a class of mechanisms referred to as REDD schemes (Reducing emissions from deforestation and forest degradation), which may be included in a post-Kyoto agreement. REDD credits provide carbon offsets for the protection of forests, and provide a possible mechanism to allow funding from developed nations to assist in the protection of native forests in developing nations.

Almost half of the world's people burn wood (or fiber or dung) for their cooking and heating needs. Fuel-efficient cook stoves can reduce fuel wood consumption by 30 to 50%, though the warming of the earth due to decreases in particulate matter (i.e. smoke) from such fuel-efficient stoves has not been addressed. There are a number of different types of LULUCF projects:

- Avoided deforestation is the protection of existing forests.
- Reforestation is the process of restoring forests on land that was once forested.
- Afforestation is the process of creating forests on land that was previously unforested, typically for longer than a generation.

- Soil management projects attempt to preserve or increase the amount of carbon sequestered in soil.

Purchase of carbon allowances from emissions trading schemes

Voluntary purchasers can offset their carbon emissions by purchasing carbon allowances from legally mandated cap-and-trade programs such as the Regional Greenhouse Gas Initiative or the European Emissions Trading Scheme. By purchasing the allowances that power plants, oil refineries, and industrial facilities need to hold to comply with a cap, voluntary purchases tighten the cap and force additional emissions reductions.

Voluntary purchases can also be made through small-scale and sometimes uncertified schemes such as those offered at South African based Promoting Access to Carbon Equity Centre (PACE),[42] which nevertheless offer clear services such as poverty alleviation in the form of renewable energy development. Also, as "easy carbon credits are coming to an end",[43] these projects have the potential to develop projects that are either too small or too complicated to benefit from legally mandated cap-and-trade programs.

Links with emission trading schemes

Once it has been accredited by the UNFCCC a carbon offset project can be used as carbon credit and linked with official emission trading schemes, such as the European Union Emission Trading Scheme[44] or Kyoto Protocol, as Certified Emission Reductions. European emission allowances for the 2008–2012 second phase were selling for between 21 and 24 Euros per metric ton of CO_2 as of July 2007.

The voluntary Chicago Climate Exchange also includes a carbon offset scheme that allows offset project developers to sell emissions reductions to CCX members who have voluntarily agreed to meet emissions reduction targets.

The Western Climate Initiative, a regional greenhouse gas reduction initiative by states and provinces along the western rim of North America, includes an offset scheme. Likewise, the Regional Greenhouse Gas Initiative, a similar program in the northeastern U.S., includes an offset program. A credit mechanism that uses offsets may be incorporated in proposed schemes such as the Australian Carbon Exchange.

Other

A UK offset provider set up a carbon offsetting scheme that set up a secondary market for treadle pumps in developing countries. These pumps are used by farmers, using human power, in place of diesel pumps.[45] However, given that treadle pumps are best suited to pumping shallow water, while diesel pumps are usually used to pump water from deep boreholes, it is not clear that the treadle pumps are actually achieving real emissions reductions. Other companies have explored and rejected treadle pumps as a viable carbon offsetting approach due to these concerns.

Carbon retirement

Carbon retirement involves retiring allowances from emission trading schemes as a method for offsetting carbon emissions. Under schemes such as the European Union Emission Trading Scheme, EU Emission Allowances (EUAs), which represent the right to release carbon dioxide into the atmosphere, are issued to

all the largest polluters. The theory is that by buying these allowances and permanently removing them, the price of EUAs increases and provides an incentive for industrial companies to reduce their emissions.[46]

Accounting for and verifying reductions

Due to their indirect nature, many types of offset are difficult to verify. Some providers obtain independent certification that their offsets are accurately measured, to distance themselves from potentially fraudulent competitors. The credibility of the various certification providers is often questioned. Certified offsets may be purchased from commercial or non-profit organizations for US$5.50–30 per tonne of CO_2,[47] due to fluctuations of market price. Annual carbon dioxide emissions in developed countries range from 6 to 23 tons per capita.

Accounting systems differ on precisely what constitutes a valid offset for voluntary reduction systems and for mandatory reduction systems. However formal standards for quantification exist based on collaboration between emitters, regulators, environmentalists and project developers. These standards include the Voluntary Carbon Standard, Green-e Climate, Chicago Climate Exchange and the CDM Gold Standard, the latter of which expands upon the requirements for the Clean Development Mechanism of the Kyoto Protocol.

Accounting of offsets may address the following basic areas:

- Baseline and Measurement—What emissions would occur in the absence of a proposed project? And how are the emissions that occur after the project is performed going to be measured?
- Additionality—Would the project occur anyway without the investment raised by selling carbon offset credits? There are two common reasons why a project may lack additionality: (a) if it is intrinsically financially worthwhile due to energy cost savings, and (b) if it had to be performed due to environmental laws or regulations.
- Permanence—Are some benefits of the reductions reversible? (for example, trees may be harvested to burn the wood, and does growing trees for fuel wood decrease the need for fossil fuel?) If woodlands are increasing in area or density, then carbon is being sequestered. After roughly 50 years, newly planted forests will reach maturity and remove carbon dioxide more slowly.
- Leakage—Does implementing the project cause higher emissions outside the project boundary?

Co-benefits

Overall, carbon offsets improve the environment by reducing the amount of greenhouse gases in the earth's atmosphere. Offset projects often also lead to a number of co-benefits such as better air and water quality, and healthier communities.[48]

While the primary goal of carbon offsets is to reduce global carbon emissions, many offset projects also claim to lead to improvements in the quality of life for a local population. These additional improvements are termed co-benefits, and may be considered when evaluating and comparing carbon offset projects. Some possible co-benefits from a project that replaces wood-burning stoves with ovens using a less carbon-intensive fuel include:

- Lower non–greenhouse gas pollution (smoke, ash, and chemicals), which improves health in the home.
- Better preservation of forests, which are an important habitat for wildlife.

In a recent survey conducted by EcoSecurities, Conservation International, CCBA and ClimateBiz, of the 120 corporates surveyed more than 77 per cent rated community and environmental benefits as the prime motivator for purchasing carbon offsets.[49]

Carbon offset projects can also negatively affect quality of life. For example, people who earn their livelihoods from collecting firewood and selling it to households could become unemployed if firewood is no longer used. A paper from the Overseas Development Institute offers some indicators to be used in assessing the potential developmental impacts of voluntary carbon offset schemes:[50]

- What potential does the project have for income generation?
- What effects might a project have on future changes in land use and could conflicts arise from this?
- Can small-scale producers engage in the scheme?
- What are the 'add on' benefits to the country—for example, will it assist capacity-building in local institutions?[51]

Putting a price on carbon encourages innovation by providing funding for new ways to reduce greenhouse gases in many sectors. Carbon reduction goals drive the demand for offsets and carbon trading, encouraging the development of this new industry and offering opportunities for different sectors to develop and use innovative new technologies.[48]

Carbon offset projects also provide savings – energy efficiency measures may reduce fuel or electricity consumption, leading to a potential reduction in maintenance and operating costs.[48]

Quality assurance schemes

Quality Assurance Standard for Carbon Offsetting (QAS)

In an effort to inform and safeguard business and household consumers purchasing Carbon Offsets, in 2009,[52] the UK Government has launched a scheme for regulating Carbon offset products.[53] DEFRA have created the "Approved Carbon Offsetting" brand to use as an endorsement on offsets[54] approved by the UK government. The Scheme sets standards for best practice in offsetting. Approved offsets have to demonstrate the following criteria:

- Accurate calculation of emissions to be offset
- Use of good quality carbon credits i.e. initially those that are Kyoto compliant
- Cancellation of carbon credits within a year of the consumers purchase of the offset
- Clear and transparent pricing of the offset
- Provision of information about the role of offsetting in tackling climate change and advice on how a consumer can reduce his or her carbon footprint

The first company to qualify for the scheme was Clear, followed by Carbon Footprint, Carbon Passport, Pure, British Airways and Carbon Retirement Ltd.

On 20 May 2011 the Department of Energy and Climate Change announced that the Quality Assurance Scheme would close on 30 June 2011.[55] The stated purpose of the Quality Assurance Scheme was 'to provide a straightforward route for those wishing to offset their emissions to identify quality offsets'.[55]

Critics of the closure therefore argued that without the scheme, businesses and individuals would struggle to identify quality carbon offsets.[56]

In 2012 the scheme was relaunched as the Quality Assurance Standard (QAS).[57] The QAS is now run independently by Quality Assurance Standard Ltd which is a company limited by guarantee based in the United Kingdom. The Quality Assurance Standard is a comprehensive independent audit system for carbon offsets. Approved offsets are checked against a 40-point checklist[58] to ensure they meet the very highest standards in the world.

On 17 July 2012, the first organisations were approved as meeting the new QAS.

Australian Government National Carbon Offset Program

The Australian government is currently in a consultation period on the regulation of Carbon Offsets.[59] On 20 December 2013, the Australian Government released the Emissions Reduction Fund Green Paper outlining its preferred design options for the Emissions Reduction Fund: a carbon buy-back model. The Government invites public comment and written submissions on the Green Paper by 5pm on Friday 21 February 2014.[60]

Controversies

Project-offsetting

Less than 30 pence in every pound spent on some carbon offset schemes goes directly to projects designed to reduce emissions.[61] The figures reported by the BBC[62] and based on UN data reported that typically 28p goes to the set up and maintenance costs of an environmental project. 34p goes to the company that takes on the risk that the project may fail. The project's investors take 19p, with smaller amounts of money being distributed between organisations involved in brokering and auditing the carbon credits. In that respect carbon Offsets are similar to most consumer products, with only a fraction of sale prices going to the off-shore producers, the rest being shared between investors and distributors who bring it to the markets, who themselves need to pay their employees and service providers such as advertising agencies most of the time located in expensive areas.

Indulgence controversy

Some activists disagree with the principle of carbon offsets, likening them to Roman Catholic indulgences, a way for the guilty to pay for absolution rather than changing their behavior. George Monbiot, an English environmentalist and writer, says that carbon offsets are an excuse for business as usual with regard to pollution.[63][64] Proponents hold that the indulgence analogy is flawed because they claim carbon offsets actually reduce carbon emissions, changing the business as usual, and therefore address the root cause of climate change.[65] Proponents of offsets claim that third-party certified carbon offsets are leading to increased investment in renewable energy, energy efficiency, methane biodigesters and reforestation and avoided deforestation projects, and claim that these alleged effects are the intended goal of carbon offsets. On October 16, 2009 responsibletravel.com, once a strong voice in favour of carbon offsetting, announced

that it would stop offering carbon offsetting to its clients, stating that "too often offsets are being used by the tourism industry in developed countries to justify growth plans on the basis that money will be donated to projects in developing countries. Global reduction targets will not be met this way".[66]

On 4 February 2010, travel networking site Vida Loca Travel announced that they would donate 5 per cent of profits to International Medical Corps, as they feel that international aid can be more effective at cutting global warming in the long term than carbon offsetting, citing the work of economist Jeffrey Sachs.[67]

Effectiveness of tree-planting offsets

Some environmentalists have questioned the effectiveness of tree-planting projects for carbon offset purposes.[68] Critics point to the following issues with tree planting projects:

- Timing. Trees reach maturity over a course of many decades. Project developers and offset retailers typically pay for the project and sell the promised reductions up-front, a practice known as "forward selling".
- Permanence. It is difficult to guarantee the permanence of the forests, which may be susceptible to clearing, burning, or mismanagement. The well-publicized instance of the "Coldplay forest", in which a forestry project supported by the British band Coldplay resulted in a grove of dead mango trees, illustrates the difficulties of guaranteeing the permanence of tree-planting offsets.[69] When discussing "tree offsets, forest campaigner Jutta Kill of European environmental group FERN, clarified the physical reality that "Carbon in trees is temporary: Trees can easily release carbon into the atmosphere through fire, disease, climatic changes, natural decay and timber harvesting."[70]
- Monocultures and invasive species. In an effort to cut costs, some tree-planting projects introduce fast-growing invasive species that end up damaging native forests and reducing biodiversity. For example, in Ecuador, the Dutch FACE Foundation has an offset project in the Andean Páramo involving 220 square kilometres of eucalyptus and pine planted. The NGO Acción Ecológica criticized the project for destroying a valuable Páramo ecosystem by introducing exotic tree species, causing the release of much soil carbon into the atmosphere, and harming local communities who had entered into contracts with the FACE Foundation to plant the trees.[71] However, some certification standards, such as the Climate Community and Biodiversity Standard require multiple species plantings.
- Methane. A recent study has claimed that plants are a significant source of methane, a potent greenhouse gas, raising the possibility that trees and other terrestrial plants may be significant contributors to global methane levels in the atmosphere.[72] However, this claim has been disputed recently by findings in another study.[73]
- The albedo effect. Another study suggested that "high latitude forests probably have a net warming effect on the Earth's climate", because their absorption of sunlight creates a warming effect that balances out their absorption of carbon dioxide.[74]
- Necessity. Corporate tree-planting is not a new idea; farming operations have been used by companies making paper from trees for a long time. If farmed trees are replanted, and the products made from them are placed into landfills rather than recycled, a very safe, efficient, economical and time-proven method of geological sequestration of greenhouse carbon is the result of the paper product use cycle. This only holds if the paper in the land fill is not decomposted. In most landfills, this is the case and leads to the fact that more than half of the greenhouse gas emissions from the life cycle of paper products occur from landfill methane emissions.

Indigenous land rights issues

Tree-planting projects can cause conflicts with indigenous people who are displaced or otherwise find their use of forest resources curtailed. For example, a World Rainforest Movement report[75] documents land disputes and human rights abuses at Mount Elgon. In March 2002, a few days before receiving Forest Stewardship Council certification for a project near Mount Elgon, the Uganda Wildlife Authority evicted more than 300 families from the area and destroyed their homes and crops. That the project was taking place in an area of on-going land conflict and alleged human rights abuses did not make it into project report. A 2011 report by Oxfam International describes a case where over 20,000 farmers in Uganda were displaced for a FSC-certified plantation to offset carbon by London-based New Forests Company[76]

Additionality and lack of regulation in the voluntary market

Several certification standards exist, offering variations for measuring emissions baseline, reductions, additionality, and other key criteria. However, no single standard governs the industry, and some offset providers have been criticized on the grounds that carbon reduction claims are exaggerated or misleading. Problems include:[77][78][79]

- Widespread instances of people and organizations buying worthless credits that do not yield any reductions in carbon emissions.
- Industrial companies profiting from doing very little – or from gaining carbon credits on the basis of efficiency gains from which they have already benefited substantially.
- Brokers providing services of questionable or no value.
- A shortage of verification, making it difficult for buyers to assess the true value of carbon credits.

Perverse incentives

Because offsets provide a revenue stream for the reduction of some types of emissions, they can in some cases provide incentives to emit more, so that emitting entities can later get credit for reducing emissions from an artificially high baseline. This is especially the case for offsets with a high profit margin. For example, one Chinese company generated $500 million in carbon offsets by installing a $5 million incinerator to burn the HFCs produced by the manufacture of refrigerants. The huge profits provided incentive to create new factories or expand existing factories solely for the purpose of increasing production of HFCs and then destroying the resultant pollutants to generate offsets. Not only is this outcome environmentally undesirable, it undermines other offset projects by causing offset prices to collapse.[80][81] The practice had become so common that offset credits are now no longer awarded for new plants to destroy HFC-23.[82]

In Nigeria oil companies flare off 40 per cent of the natural gas found. The Agip Oil Company plans to build plants to generate electricity from this gas and thus claim 1.5 million offset credits a year. United States company Pan Ocean Oil Corporation has also applied for credits in exchange for processing its own waste gas in Nigeria. Oilwatch.org's Michael Karikpo calls this "outrageous", as flaring is illegal in Nigeria, adding that "It's like a criminal demanding money to stop committing crimes".[82]

Other negative impacts from offset projects

Although many carbon offset projects tout their environmental co-benefits, some are accused of having negative secondary effects. Point Carbon has reported on an inconsistent approach with regard to some hydro-electric projects as carbon offsets; some countries in the EU are not allowing large projects into the EU ETS, because of their environmental impacts, even though they have been individually approved by the UNFCCC and World Commission on Dams.[83] It is difficult to assess the exact results of carbon offsets given the fact that they are a relatively new form of carbon reduction, and it is possible that some carbon offset purchases are made in an attempt to increase positive business public relations rather than to help solve the issue of greenhouse gas emissions.[84]

Offset projects may also have negative social impacts, for example when local residents are evicted to enable a National Park to be marketed as a carbon offset.[85]

See also

- Carbon credit
- Carbon negative
- Carbon neutral
- Carbon retirement
- Carbon tax
- Ecosystem Marketplace
- Emissions trading
- Live Earth Pledge
- Mitigation of global warming
- Personal carbon trading
- Plantations and natural forest loss
- Renewable Energy Certificate (United States)
- Weighted average cost of carbon
- Zero carbon

References

1. Goodward, Jenna; Kelly, Alexia (August 2010). "Bottom Line on Offsets". World Resources Institute. Retrieved 2010-09-08.
2. "Carbon offset". Collins English Dictionary - Complete & Unabridged 11th Edition. Retrieved September 21, 2012 from CollinsDictionary.com.
3. "Climate change glossary EPA Victoria". Environment Protection Authority Victoria. 2008-09-02. Retrieved 2010-08-28.
4. ECI (2008-04-07). "Carbon Offsets". University of Oxford Environmental Change Institute. Retrieved 2010-09-08.
5. "Working Group I: The Scientific Basis". Intergovernmental Panel on Climate Change. 2001. Retrieved 2010-02-22.
6. Friend, G. (2009). The Truth about Green Business. Upper Saddle River, NJ: FT Press.
7. "State and Trends of the Carbon Market" (PDF). World Bank. 2007.
8. "Brands and Carbon Offsets". Carbon Offsets Daily. 2008-08-01.
9. Ecosystem Marketplace, New Energy Finance State, of the Voluntary Carbon Markets 2009 (http://ecosystemmarketplace.com/documents/cms_documents/StateOfTheVoluntaryCarbonMarkets_2009.pdf)
10. "Carbon Retirement report: The state of voluntary carbon offsetting in the FTSE 100". 2011-04-18. Retrieved 2011-05-24.
11. "UNEP Risoe CDM/JI Pipeline Analysis and Database". UNEP Risoe Centre. 2010-02-01. Retrieved 2010-02-22.

12. EcoSecurities, ClimateBiz, Carbon Offsetting Trends Survey 2008 (http://www.ecosecurities.com/Standalone/Carbon_Offsetting_Trends_Survey_2008/default.aspx)
13. Gillenwater, Michael; Derik Broekhoff; Mark Trexler; Jasmine Hyman; Rob Fowler (2007). "Policing the voluntary carbon market". Nature Reports Climate Change 6 (711): 85–87. doi:10.1038/climate.2007.58.
14. "Developing a robust carbon offsetting strategy". United Kingdom: Carbon Trust. November 2006. Retrieved 14 August 2012.
15. "Interview: Neal Dikeman Co-founder of Carbonflow on web technology's role in addressing climate change". Carbon Offsets Daily. 2009-07-27.
16. "Carbon offset". Glossary: Carbon Offset Research & Education (CORE). Stockholm Environment Institute. Retrieved 2010-09-03.
17. Selin, Noelle. "carbon offset -- Britannica Online Encyclopedia". Encyclopædia Britannica Inc. Retrieved 26 June 2012.
18. "Carbon Offsetting". offsestters. Retrieved 27 October 2014.
19. "ICE". Retrieved 6 August 2015.
20. United States Environmental Protection Agency, Carbon Sequestration in Agriculture and Forestry (http://www.epa.gov/sequestration/water_quality.html)
21. United Nations Framework Convention on Climate Change. "CDM: Methodologies". Retrieved 6 August 2015.
22. United Nations Framework Convention on Climate Change. "CDM: How To ...". Retrieved 6 August 2015.
23. "Social Carbon profile on database of market governance mechanisms". United Kingdom. Retrieved 9 May 2014.
24. Sweet, Cassandra (2010-01-06). "UPDATE: Global Carbon Trading Up In 2009, Though Prices Lower". The Wall Street Journal. Archived from the original on May 24, 2012. Retrieved 2010-03-03.
25. "State and Trends of the Carbon Market 2010". World Bank Group. Retrieved 2010-08-26.
26. Reyes, Oscar (2010-07-20). "Carbon market "growth" is mainly fraudulent, World Bank report shows". Carbon Trade Watch. Retrieved 2010-08-26 .]
27. "2013 Voluntary Carbon Markets Report". Ecosystem Marketplace. Retrieved 27 October 2014.
28. GAO Study, Voluntary Carbon Markets (http://www.gao.gov/new.items/d081048.pdf)
29. New Carbon Finance 2009 State Of Voluntary Carbon Markets (http://www.ecosystemmarketplace.com/documents/cms_documents/StateOfTheVoluntaryCarbonMarkets_2009.pdf)
30. For a list of commercial offset retailers, refer to "Carbon Directory". Carbon Catalog. 2010-10-04. Retrieved 2010-10-04.
31. "Customer Carbon Fund". Retrieved 6 August 2015.
32. "United Airlines - Airline Tickets, Travel Deals and Flights on united.com". Retrieved 6 August 2015.
33. Smith, Tierney (2011-04-18). "Only 0.1 per cent of FTSE 100 emissions are offset". Climate Action. Retrieved 2011-05-25.
34. Gillenwater, Michael (2008). "Redefining RECs—Part 1: Untangling attributes and offsets". Energy Policy 36 (6): 2109. doi:10.1016/j.enpol.2008.02.036.
35. Gillenwater, Michael (2008). "Redefining RECs (Part 2): Untangling certificates and emission markets". Energy Policy 36 (6): 2120. doi:10.1016/j.enpol.2008.02.019.
36. E. Curry, B. Guyon, C. Sheridan, and B. Donnellan, "Developing an Sustainable IT Capability: Lessons From Intel's Journey" (http://www.edwardcurry.org/publications/MISQE_SustainableIT_Intel_2012.pdf), MIS Quarterly Executive, vol. 11, no. 2, pp. 61–74, 2012.
37. "Haubenschild Dairy Farm Digester". Retrieved 6 August 2015.
38. EPA Draft Offset Protocol (http://www.epa.gov/climateleaders/docs/ClimateLeaders_DraftLandfillOffsetProtocol.pdf) [pdf]
39. "dcarbon8.com". Retrieved 6 August 2015.
40. "F-gases Emissions - Climate Change - US EPA". Retrieved 6 August 2015.
41. "Deforestation". Mongabay.com. Retrieved 6 August 2015.
42. [1] (http://www.carbon.org.za/) Carbon Equity Centre (PACE)
43. [2] (http://www.altenergymag.com/news_detail.php?pr_id=5079) The latest analysis from New Carbon Finance confirms that many of the low hanging fruit of cheap carbon credits in the developing world have now been harvested. Further opportunities for reducing emissions will require more effort, spurring investments in renewable energy and energy efficiency. Submitted on 07/29/08, 10:26 AM

44. [3] (http://unfccc.int/files/meetings/sb22/application/pdf/agenda_round_table_24_may.pdf) Round-Table Discussion on Policies and Measures-Source-UNFCCC Official Website
45. Hopkirk, James (2007-01-04). "Carbon-offsetting: All credit to them". The Independent (London). Retrieved 2010-02-23.
46. http://www.carbonretirement.com/content/how-it-works Carbon Retirement website
47. "Carbon Emissions Offset Directory". EcoBusinessLinks. 2007. Retrieved 2007.
48. Pacific Carbon Trust. "What are the benefits of offsets?". Pacific Carbon Trust. Retrieved 27 October 2014.
49. EcoSecurities, Conservation International, CCBA, ClimateBiz, Forest Carbon Offsetting Trends 2009 Survey (http://www.ecosecurities.com/Standalone/Forest_Carbon_Offsetting_Trends_Survey_2009/default.aspx)
50. "Can standards for voluntary carbon offsets ensure development benefits?". Overseas Development Institute. 2007. Retrieved 2007.
51. "Making Voluntary Carbon Markets work better for the Poor: the case of Forestry Offsets". Overseas Development Institute. 2006. Retrieved 2007.
52. DECC to close carbon offset accreditation scheme: http://www.greenwisebusiness.co.uk/news/decc-to-close-carbon-offset-accreditation-scheme-2356.aspx
53. The UK Government's Quality Assurance Scheme for Carbon Offsetting (http://offsetting.defra.gov.uk/) UK Government DEFRA, 9 February 2009
54. List of DEFRA QAS approved Offsets (http://offsetting.defra.gov.uk/cms/approved-offsets/) UK Government DEFRA, 9 February 2009
55. "Closure of the Quality Assurance Scheme for Carbon Offsetting". Department of Energy and Climate Change. 2011-05-20. Retrieved 2011-05-25.
56. Will Nichols (2011-05-23). "Cancellation of offset assurance scheme could leave businesses in the dark". businessGreen. Retrieved 2011-05-25.
57. QAS: http://qascarbonneutral.com
58. 40 Point Check List: http://qascarbonoffsetting.com/qas-40-point-carbon-offset-checklist/
59. Australian Government National Carbon Offset (http://www.climatechange.gov.au/nav/carbon_offset.html) Australian Government, 9 February 2009
60. http://www.environment.gov.au/system/files/resourc 3042-4cd8-99a3-040705fead3b/files/erf-green-paper_1.pdf
61. "Carbon Retirement report: The efficiency of carbon offsetting through the CDM". 2009-12-07. Retrieved 2011-05-24.
62. Kahya, Damian (2009-12-07). "30% of carbon offsets' spent on reducing emissions". BBC News. Retrieved 2010-09-01.
63. Monbiot, George (2006-10-19). "Selling Indulgences". Monbiot.com. Retrieved 2010-08-10. "The trade in carbon offsets is an excuse for business as usual."
64. Kaste, Martin (2006-11-28). "Carbon Offset Business Takes Root". National Public Radio. "It's a bit like the sale of indulgences prior to the Reformation -that as long as you hand over your money, your sins are deemed to have been canceled out and you are no longer unclean in the eyes of God."
65. Roberts, David (2007-07-11). "An observation on the offset debate—Many offset critics appear to be shadowboxing". Grist. Retrieved 2010-03-02.
66. "responsibletravel.com removes 'dangerously distracting' carbon offset offering from its site" (Press release). www.responsibletravel.com. 2009-10-16. Retrieved 2010-04-30.
67. "How can international aid help to reduce global warming?". Vida Loca Travel Charity Pledge. Vida Loca Travel Ltd. 2010. Retrieved 2010-08-11.
68. "The Problems with Offsets from Tree Planting". David Suzuki Foundation. 2009. Retrieved 2010-02-23.
69. Dhillon, Amrit; Harnden, Toby (2006-04-30). "How Coldplay's green hopes died in the arid soil of India". Telegraph (London). Retrieved 2010-02-23.
70. Jutta Kill (July 2006). "10 things you should know about tree 'offsets' ". New Internationalist. Retrieved 21 March 2010.
71. Acción Ecológica Ecuador (May 2005). "Carbon Sink Plantations in the Ecuadorian Andes: Impacts of the Dutch FACE-PROFAFOR monoculture tree plantations project on indigenous and peasant communities" (PDF). World Rainforest Movement. Retrieved 2007.
72. Keppler F, Hamilton JT, Brass M, Röckmann T. (2006). "Methane emissions from terrestrial plants under aerobic conditions". Nature 439 (7073): 187–191. Bibcode:2006Natur.439..187K. doi:10.1038/nature04420. PMID 16407949.

73. Dueck TA; et al. (2007). "No evidence for substantial aerobic methane emission by terrestrial plants: a 13C-labelling approach". New Phytologist 175 (1): 29–35. doi:10.1111/j.1469-8137.2007.02103.x. PMID 17547664.
74. Climate Effects of Global Land Cover Change (https://e-reports-ext.llnl.gov/pdf/324200.pdf)
75. Chris Lang; Timothy Byakola (December 2006). "A funny place to store carbon: UWA-FACE Foundation's tree planting project in Mount Elgon National Park, Uganda" (PDF). World Rainforest Movement. Retrieved 2007.
76. http://www.redd-monitor.org/wordpress/wp-content/uploads/2011/09/cs-new-forest-company-uganda-plantations-220911-en.pdf.
77. Harvey, Fiona; Fidler, Stephen (2007-04-25). "Industry caught in carbon 'smokescreen' ". Financial Times.
78. Other periodicals that have covered these issues include the Christian Science Monitor [4] (http://www.csmonitor.com/2007/0110/p13s02-sten.html), The Guardian [5] (http://www.guardian.co.uk/environment/2007/jun/16/climatechange.climatechange), Mother Jones [6] (http://www.motherjones.com/commentary/columns/2007/05/practical_values.html), and The New York Times [7] (http://www.nytimes.com/2007/04/29/weekinreview/29revkin.html?ex=1335499200&en=d9e2407e4f1a20f0&ei=5124).
79. Schapiro, Mark (February 2010). "Conning the Climate: Inside the Carbon-trading Shell Game" (PDF). Harper's Magazine (New York). pp. 31–39. Retrieved 9 April 2012.
80. Concerns about CDM projects based on decomposition of HFC-23 emissions from 22 HCFC production sites (http://cdm.unfccc.int/public_inputs/inputam0001/Comment_AM0001_Schwank_081004.pdf,)
81. Bradsher, Keith (2006-12-21). "Outsize Profits, and Questions, in Effort to Cut Warming Gases". The New York Times.
82. Mukerjee, Madhussree (2009). "A Mechanism of Hot Air". Scientific American (June): 9–10.
83. ECX bans CERs from big hydro projects over EU eligibility uncertainty (http://www.rivernet.org/prs07_04.htm#091007) Point Carbon via River News, 9 October 2007
84. Schmidt, Charles (2009). "Carbon Offsets: Growing Pains in a Growing Market.". Environmental Health Perspectives 11 (2): 62–68. doi:10.1289/ehp.117-a62.
85. CounterPunch, 9 September 2009, Double Jeopardy: Carbon Offsets and Human Rights Abuses (http://www.counterpunch.org/checker09092009.html)

External links

- Carbon Management (https://www.dmoz.org/Science/Environment/Global_Change/Carbon_Management) at DMOZ

Categories: Carbon finance | Renewable energy

California Environmental Protection Agency
Air Resources Board

This page last reviewed December 2, 2015

Compliance Offset Protocol U.S. Forest Offset Projects

Adopted November 14, 2014

This page describes the ARB Compliance Offset Protocol for U.S. Forest Projects adopted November 14, 2014 (2014 Forest Protocol) and all supporting documents for project implementation. The calculations for estimating volume and converting biomass to CO_2e vary by project location. Forest projects may be located anywhere in the lower 48 states. Forest land in Alaska, Hawaii, and the U.S. Territories are not eligible at this time. Projects listed under the 2014 Forest Protocol located in California, Oregon, and Washington should refer to Table 1. Projects listed under the 2014 Forest Protocol located within the other 45 contiguous states should refer to Table 2.

Projects listed under the June 25, 2015 Compliance Offset Protocol for U.S. Forest Projects should refer to that version's U.S. Forest Offset Projects webpage. New!

Projects listed under the October 20, 2011 Compliance Offset Protocol for U.S. Forest Projects should refer to that version's U.S. Forest Offset Projects webpage.

Skip to: Approved Growth and Yield Models

Skip to: Guidance in the form of Frequently Asked Questions

Skip to: Guidance for U.S. Forest Projects Transitioning from Early Action to Compliance

Skip to: Compliance Offset Program Forms to obtain forest offset project listing forms and forest Offset Project Data Report forms

Introduction

The Forest Protocol provides requirements and methods for quantifying the net climate benefits of activities that sequester carbon on forestland. The protocol provides offset project eligibility rules; methods to calculate an offset project's net effects on greenhouse gas (GHG) emissions and removals of CO_2 from the atmosphere (removals); procedures for assessing the risk that carbon sequestered by a project may be reversed (i.e. released back to the atmosphere); and approaches for long-term project monitoring and reporting. The protocol is designed to ensure that the net GHG reductions and GHG removal enhancements caused by an offset project are accounted for in a complete, consistent, transparent, accurate, and conservative manner and may therefore be reported as the basis for issuing ARB or registry offset credits.

Offset Project Operators or Authorized Project Designees must use the 2011 Forest Protocol for

projects listed no later than midnight December 31, 2014 to quantify and report GHG reductions and GHG removal enhancements. For projects listed on or after January 1, 2015, Offset Project Operators or Authorized Project Designees must use the 2014 Forest Protocol to quantify and report GHG reductions and GHG removal enhancements.

The protocol provides eligibility rules, methods to quantify GHG reductions, project-monitoring instructions, and procedures for reporting Offset Project Data Reports. Additionally, all offset projects must submit to independent verification by ARB-accredited verification bodies. Requirements for verification bodies to verify Offset Project Data Reports are provided in the Cap-and-Trade Regulation.

ARB Video: "California's forest offset protocol" (CAFR5011--Yurok project)

ARB Video: "Forest offset project benefits tribes and state" (CAFR5028--Round Valley project)

U.S. Forest Protocol Resources

Compliance Offset Protocol U.S. Forest Projects (Forest Offset Protocol) (PDF - 1.15MB)

Table 1: Documents for Projects Located in California, Oregon, and Washington	Description
Instructions	The Forest Protocol requires estimates of total above-ground and below-ground biomass. Offset Project Operators (OPOs)/Authorized Project Designees (APDs) with projects located in California, Oregon, and Washington should use these instructions to convert biomass to tons of CO_2e emissions or removal enhancements.
Supersection Maps: • Entire U.S.A. Overview • Northwestern U.S. Map • Southwestern U.S. Map • GIS Supersection Shapefiles (compressed zip file 9.08 MB)	 Step 1: Supersection maps identify the appropriate Supersection and Assessment Area corresponding to the project's location. An OPO/APD must first determine the geographic Supersection within which the Project Area is located by reviewing the Supersection maps. A GIS shapefile of the Supersection may be downloaded to map the project boundaries for reporting purposes.
Assessment Area Data File • Assessment Area Data File	Step 2: After the OPO/APD identifies the correct Supersection for its Project Area, the OPO/APD must consult the Assessment Area Data File to identify the Assessment Area that best corresponds to the project, based on the dominant vegetation present in the "forest type" category within the spreadsheet. The Assessment Area Data File provides information that must be used as inputs to meet Protocol requirements. Click here for more details on the categories contained in the Assessment Area Data File.

Volume Estimation and Biomass Equations - Projects Located in California, Oregon, and Washington • Volume Estimation for Species in Projects Located in CA, OR, WA (Updated: 09/19/2014) • Biomass Equations for Species in Projects Located in CA, OR, WA (Updated: 09/19/2014)	Step 3a: The OPO/APD must find and use references and coefficients associated with each species in a Project Area for projects located in CA, OR, and WA. The volume equation references and coefficients in this document must be used in conjunction with the biomass equations provided for CA, OR, and WA (referenced in Step 3b). Step 3b: The OPO/APD must use the biomass equations presented in this document for projects located in CA, OR, and WA. Biomass equations have been obtained from the U.S. Forest Service FIA National Program. These biomass equations must be used in conjunction with the volume equation references and coefficients by species for projects located in CA, OR, and WA (referenced in Step 3a).
Estimating Carbon in Wood Products • Regional Mill Efficiency Data • Table C.1 - Specific Gravity and Wood Density by Forest Type for CA, OR, and WA (COP, page 97) • "Wood Products Generated" worksheet within Assessment Area Data File	Step 4: For projects that include harvesting, the OPO/APD must estimate the carbon stored in harvested wood products. The following documents are needed to estimate carbon in harvested wood products: Step 4a: Regional Mill Efficiency Data The OPO/APD must identify the mill efficiency factor and use that factor as an input to estimate carbon in harvested wood delivered to mills. Step 4b: Table C.1 Specific Gravity and Wood Density by Forest Type for CA, OR, and WA The OPO/APD must check Table C.1 (duplicate of table on page 97 of the Protocol), which provides gravity and wood density factors by forest type. Once the forest type is identified, these factors are used as an input to help determine the carbon in harvested wood delivered to mills. Step 4c: Wood Product Classes The OPO/APD will need to estimate the average carbon stored over 100 years in in-use wood products. The OPO/APD may do this using the Supersection default values in the “Wood Products Generated” worksheet within the Assessment Area Data File or by obtaining a verified report from the mill(s) where the Project Area’s logs are sold indicating the product categories the mill(s) sold for the year in question.

Table 2: Documents for Projects Located Within the Other 45	Description

Contiguous States (Outside California, Oregon, and Washington)	
Instructions	The Forest Protocol requires estimates of total above-ground and below-ground biomass. Offset Project Operators (OPOs)/Authorized Project Designees (APDs) with projects located in all approved states except California, Oregon, and Washington (lower 45 states) should use these instructions to estimate volume and convert biomass to tons of CO2e emissions or removal enhancements. The Protocol requires use of specific volume equations found in "Methods and Equations for Estimating Aboveground Volume, Biomass, and Carbon for Trees in the U.S. Forest Inventory, 2010" . Coefficients are found in the regional Coefficients Database associated with the Woodall document. OPOs/APDs must estimate biomass using the Component Ratio Method (CRM); the CRM is applicable to all states except California, Oregon, and Washington.
Supersection Maps • Overview Map of U.S.A. • Southwest U.S. • Northwest U.S. • North Central U.S. • Northeast U.S. • Southeast U.S. • GIS Supersection Shapefiles (compressed zip file 9.08 MB)	 Step 1: An OPO/APD must first determine the geographic Supersection within which the project area is located by reviewing the Supersection maps in this table. Supersection maps identify the appropriate Supersection and Assessment Area corresponding to the project's location. A GIS shapefile of the Supersection may be downloaded to map the project boundaries for reporting purposes.
Assessment Area Data File • Assessment Area Data File	Step 2: After the OPO/APD identifies the correct Supersection for its Project Area, the OPO/APD must consult the Assessment Area Data File to identify the Assessment Area that best corresponds to the project, based on the dominant vegetation present in the 'forest type' category within the document. The Assessment Area Data File provides information that must be used as inputs to meet Protocol requirements. Click here for more details on the categories contained in the Assessment Area Data File.
Volume Estimation and Biomass Equations - Projects Located Outside of California, Oregon, and Washington • A. Methods and Equations for Estimating Aboveground Volume, Biomass, and Carbon for Trees in the U.S. Forest Inventory, 2010	Step 3a: The "Methods and Equations for Estimating Aboveground Volume, Biomass, and Carbon for Trees in the U.S. Forest Inventory, 2010" document provides cubic foot gross and sound volume models for the 45 states by region and species[1]. The OPO/APD will need the accompanying "Coefficients Database" to determine the correct coefficients to

(Woodall et al.)

- B. Coefficients Database (folder containing three documents)
- C. Accounting for density reduction and structural loss in standing dead trees: Implications for forest biomass and carbon stock estimates in the United States (Domke et al.)

**Density reduction factors by decay class are found Differences Between Standing and Downed Dead Tree Wood Density Reduction Factors: A Comparison Across Decay Classes and Tree Species (Harmon et al.)

- D. Biomass Estimation Component Ratio Method
- E. Biomass Coefficients for Use with Component Ratio Method

use for gross and/or sound volume.

Step 3b: Use the Coefficients Database to find the appropriate coefficients by project location and species. Coefficients for the same species may be different in two different locations. Gross cubic foot volume (VOLCFGRS) must be converted to sound cubic foot volume (VOLCFSND) by subtracting rotten and missing cull volume.

Step 3c: The standing dead tree carbon pool must be adjusted for density reduction and structural loss using the approach established in "Accounting for density reduction and structural loss in standing dead trees: Implications for forest biomass and carbon stock estimates in the United States." General guidance for using the Domke method is found here.

Decay class, density reductions factors (DRFs), and structural loss adjustment (SLA) factors are necessary to complete calculations for standing dead trees. Decay class and DRFs are found in Appendix B of "Differences Between Standing and Downed Dead Tree Wood Density Reduction Factors: A Comparison Across Decay Classes and Tree Species" under the column labeled "SD." Where species are not found or missing DRFs (in Appendix B), OPOs/APDs must identify a value by appropriate decay class from within the same genus (from Appendix D). If this is not possible, use the hardwood/softwood default values found in Table 6 of Harmon (2011). OPOs/APDs should always cite the source of the DRF and column within the source for ease of verification..

SLA factors can be found in Table 2 of Domke (2011) for decay classes 1-5 for top, bark, bole, stump and roots. These SLA factors are applicable to all species.

Biomass is then calculated for individual tree components following the Component Ratio Method.

Step 3d: The "Biomass Estimation Component Ratio Method" document is an excerpt from the FIA Database User's Manual[2] and should be used to calculate biomass for all projects outside California, Oregon, and Washington. It provides a nationally consistent method of estimating tree biomass, called the Component Ratio Method (CRM)[3]. The CRM involves calculating the dry weight of individual components before estimating the total above-ground or below-ground biomass. The tables in this document describe the equations used to estimate

	various components of tree biomass (stem wood, top and branches, bark, stump, course roots). Most components are estimated through a series of ratio equations[4]. The “Biomass Coefficients for Use with the Component Ratio Method” document must be used in conjunction with the document in Step 3a. It provides the coefficients for common species that are necessary to estimate biomass using the Component Ratio Method.
Estimating Carbon in Wood Products • Regional Mill Efficiency Data • USFS Wood Handbook • "Wood Products Generated" worksheet within Assessment Area Data File	Step 4a: For projects that include harvesting, the OPO/APD must estimate the carbon stored in harvested wood products. The following documents are needed to estimate carbon in harvested wood products: Step 4b: Regional Mill Efficiency Data The OPO/APD must identify the mill efficiency factor and use that factor as an input to estimate carbon in harvested wood delivered to mills. Step 4c: USFS Wood Handbook This handbook provides gravity and wood density factors by forest type; these factors are used as input to determine the carbon in harvested wood delivered to mills. Step 4d: Wood Product Classes The OPO/APD will need to estimate the average carbon stored over 100 years in in-use wood products. The OPO/APD may do this using the Supersection default values in the “Wood Products Generated” worksheet within the Assessment Area Data File or by obtaining a verified report from the mill(s) where the Project Area’s logs are sold indicating the product categories the mill(s) sold for the year in question.

Footnotes

[1] Cubic foot volume calculations are necessary for trees with diameters greater than or equal to 5 inches. Trees with diameters less than 5 inches do not require cubic foot volume calculations to estimate biomass using the Component Ratio Method. Biomass for trees less than 5 inches in DBH is calculated with DBH only following Appendix J of the "Draft Forest Inventory Analysis Database Description and Users Manual, Version 4.0, Revision 2.

[2] Appendix J. December 2009. Draft Forest Inventory Analysis Database Description and Users Manual, Version 4.0, Revision 2.

[3] Heath et al. 2009.

[4] Jenkins et al. 2003.

References

Bailey, R. G.; Avers, P. E.; King, T.; McNab, W. H., eds. 1994. Ecoregions and subregions of the United States (map). Washington, DC: USDA Forest Service. 1:7,500,000. With supplementary

table of map unit descriptions, compiled and edited by W. H. McNab and R. G. Bailey.

Forest Inventory and Analysis Database 6.0. 2009. Appendix J. In: DRAFT FIA Database Description and Users Manual for Phase 2, version 4.0, revision 2. U.S. Department of Agriculture, Forest Service.

Harmon, Mark E.; Woodall, Christopher W.; Fasth, Becky; Sexton, Jay; Yatkov, Misha. 2011. Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

Heath, Linda S.; Hansen, Mark; Smith, James E.; Miles, Patrick D.; Smith, Brad W. 2009. Investigation into calculating tree biomass and carbon in the FIADB using a biomass expansion factor approach. In: McWilliams, Will; Moisen, Gretchen; Czaplewski, Ray, comps. 2009. 2008 Forest Inventory and Analysis (FIA) Symposium; October 21-23, 2008; Park City, UT. Proc. RMRS-P-56CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 26 p.

Jenkins, Jennifer C.; Chojnacky, David C.; Heath, Linda S.; Birdsey, Richard A. 2003. National scale biomass estimators for United States tree species. Forest Science. 49: 12-35.

McNab, W.H.; Cleland, D.T.; Freeouf, J.A.; Keys, Jr., J.E.; Nowacki, G.J.; Carpenter, C.A., comps. 2007. Description of ecological subregions: sections of the conterminous United States [CD-ROM]. Gen. Tech. Report WO-76B. Washington, DC: U.S. Department of Agriculture, Forest Service. 80 p.

U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis National Core Field Guide (October 2010)

Woodall, Christopher W.; Heath, Linda S.; Domke, Grant M.; Nichols, Michael C. 2011. Methods and equations for estimating aboveground volume, biomass, and carbon for trees in the U.S. forest inventory, 2010. Gen. Tech. Rep. NRS-88. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 30 p.

Resource Materials for Projects in All Locations

Resources for Offset Project Operators

- Definition of “Forest Owner” (Section 2.2 of the Protocol)
- Approved Growth and Yield Models
- Guidance in the form of Frequently Asked Questions
- Guidance Request for Offset Project Operators/Authorized Project Designees
- Woodall Guidance (Coming Soon!)

Resources for Verifiers

- Guidance for Verifying Forest Carbon Inventories
- Verification of Forest Carbon Project Plots Using Sequential Statistical Methods - A Microsoft Excel application to be used by verifiers as part of the verification sequential sampling (Coming soon!)
- Guidance in the form of Frequently Asked Questions
- Guidance Request for Verifiers

References for U.S. Forest Protocol

- Appraisals
  - Uniform Standards of Professional Appraisal Practice 2008-2009 Edition
  - Internal Revenue Code, Section 170(f)(11)(E)(ii)

- U.S. Forest Service Forest Inventory and Analysis (FIA) Background Reference Information
  - PNW-FIA Integrated Database version 2.0
  - PNW-FIA Integrated Database Table Structure
  - Appendix J. Biomass Estimation in the FIA Database

- Journal Articles
  - Cairns et al. Root biomass allocation in the world's upland forest. Oecologia (1997) 111:1-11.
  - Harmon, Mark E.; Woodall, Christopher W.; Fasth, Becky; Sexton, Jay; Yatkov, Misha. 2011. Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.
  - Prisley, Stephen P. and Mortimer, Michael J. 2004. A synthesis of literature on evaluation of models for policy applications, with implications for forest carbon accounting. Forest Ecology and Management 198 (2004) 89–103

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Download Free Quantum GIS (QGIS)

Download Explorer GIS (Coming soon!)

For questions or comments regarding the U.S. Forest Protocol please contact

Barbara Bamberger at 916-324-2303 or e-mail bbamberg@arb.ca.gov.

California Environmental Protection Agency

AIR RESOURCES BOARD

Compliance Offset Protocol
U.S. Forest Projects

Adopted: November 14, 2014

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Abbreviations and Acronyms

ARB	Air Resources Board
C	Carbon
CAR	Climate Action Reserve
CH_4	Methane
CO_2	Carbon dioxide
FIA	Forest Inventory and Analysis Program of the U.S. Forest Service
GHG	Greenhouse gas
lb	Pound
IFM	Improved Forest Management
N_2O	Nitrous oxide
Regulation	Cap-and-Trade Regulation, title 17, California Code of Regulations, sections 95800 et seq.
SSR	GHG Sources, GHG Sinks, and GHG Reservoirs
USFS	United States Forest Service

1 Introduction

The Compliance Offset Protocol U.S. Forest Projects (Forest Offset Protocol) provides requirements and methods for quantifying the net climate benefits of activities that sequester carbon on forestland. The protocol provides offset project eligibility rules; methods to calculate an offset project's net effects on greenhouse gas (GHG) emissions and removals of CO_2 from the atmosphere (removals); procedures for assessing the risk that carbon sequestered by a project may be reversed (i.e. released back to the atmosphere); and approaches for long term project monitoring and reporting. The goal of this protocol is to ensure that the net GHG reductions and GHG removal enhancements caused by an offset project are accounted for in a complete, consistent, transparent, accurate, and conservative manner and may therefore be reported as the basis for issuing ARB or registry offset credits. The protocol is built off of The Climate Action Reserve's Forest Project Protocol Version 3.2.[1]

Offset Project Operators or Authorized Project Designees must use this protocol to quantify and report GHG reductions and GHG removal enhancements. The protocol provides eligibility rules, methods to quantify GHG reductions, project-monitoring instructions, and procedures for reporting Offset Project Data Reports. Additionally, all offset projects must submit to independent verification by ARB-accredited verification bodies. Requirements for verification bodies to verify Offset Project Data Reports are provided in the Cap-and-Trade Regulation (Regulation).

AB 32 exempts quantification methodologies from the Administrative Procedure Act (APA)[2]; however those elements of the protocol are still regulatory. The exemption allows future updates to the quantification methodologies to be made through a public review and Board adoption process but without the need for rulemaking documents. Each protocol identifies sections that are considered to be quantification methodologies and exempt from APA requirements. Any changes to the non-quantification elements of the offset protocols would be considered a regulatory update subject to the full regulatory development process. Those sections that are considered to be quantification methodologies are clearly indicated in the title of the chapter or subchapter if only a portion of that chapter is considered part of the quantification methodology.

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[1] Climate Action Reserve (CAR 2010) Forest Project Project Protocol Version 3.2. August 31, 2010. http://www.climateactionreserve.org/wpcontent/uploads/2009/03/Forest_Project_Protocol_Version_3.2.pdft/ (accessed September 9, 2010)

[2] Health and Safety Code section 38571.

1.1 About Forests, Carbon Dioxide, and Climate Change

Forests have the capacity to both emit and sequester carbon dioxide (CO_2), a leading greenhouse gas that contributes to climate change. Trees, through the process of photosynthesis, naturally absorb CO_2 from the atmosphere and store the gas as carbon in their biomass, i.e. trunk (bole), leaves, branches, and roots. Carbon is also stored in the soils that support the forest, as well as the understory plants and litter on the forest floor. Wood products that are harvested from forests can also provide long term storage of carbon.

When trees are disturbed, through events like fire, disease, pests or harvest, some of their stored carbon may oxidize or decay over time releasing CO_2 into the atmosphere. The quantity and rate of CO_2 that is emitted may vary, depending on the particular circumstances of the disturbance. Forests function as reservoirs in storing CO_2. Depending on how forests are managed or impacted by natural events, they can be a net source of emissions, resulting in a decrease to the reservoir, or a net sink, resulting in an increase of CO_2 to the reservoir. In other words, forests may have a net negative or net positive impact on the climate.

Through sustainable management and protection, forests can also play a positive and significant role to help address global climate change. The Forest Offset Protocol is designed to address the forest sector's unique capacity to sequester, store, and emit CO_2 and to facilitate the positive role that forests can play to address climate change.

2 Forest Project Definitions and Requirements

For the purposes of this protocol, a Forest Project is a planned set of activities designed to increase removals of CO_2 from the atmosphere, or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving forest carbon stocks.

A glossary of terms related to Forest Projects is provided in Section 11 of this protocol. Throughout the protocol, important defined terms are capitalized (e.g. "Reforestation Project"). For terms not defined in Section 11, the definitions in the Regulation apply.

2.1 Project Types

The following types of Forest Project activities are eligible:

2.1.1 Reforestation

A Reforestation Project involves restoring tree cover on land that is not at optimal stocking levels and has minimal short-term (30-years) commercial opportunities. A Reforestation Project is only eligible if it can fully satisfy the eligibility rules in the Regulation and:

1. The project involves tree planting or removal of impediments to natural reforestation, on land that:
    a. Has had less than 10 percent tree canopy cover for a minimum of 10 years; or
    b. Has been subject to a Significant Disturbance that has removed at least 20 percent of the land's above-ground live biomass in trees.
2. No rotational harvesting of reforested trees or any harvesting of pre-existing carbon in live trees occurs during the first 30 years after offset project commencement unless such harvesting is needed to prevent or reduce an imminent threat of disease. Such harvesting may only occur if the Offset Project Operator or Authorized Project Designee provides a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the harvesting is necessary to prevent or mitigate disease.
3. The tree planting, or removal of impediments to natural reforestation, does not follow a commercial harvest of healthy live trees that has occurred in the Project Area within the past 10 years, or since the occurrence of a Significant Disturbance, whichever period is shorter.
4. The offset project does *not* employ broadcast fertilization.
5. The offset project does not take place on land that was part of a previously listed and verified Forest Project, unless the previous Forest Project was terminated due to an Unintentional Reversal (see Section 7) or is an early action offset project transitioning to this protocol according to the provisions of the Regulation and this protocol.
6. If the offset project was an offset project in a voluntary offset program, the offset project can demonstrate it has met all legal and contractual requirements to allow it to terminate its project relationship with the voluntary offset program and be listed using this compliance offset protocol.

Reforestation Projects on both private and public lands, excluding federal lands that are not included in the categories of land listed in section 3.6 of this protocol, are eligible.

2.1.2 Improved Forest Management

An Improved Forest Management Project involves management activities that maintain or increase carbon stocks on forested land relative to baseline levels of carbon stocks, as defined

in Section 6.2 of this protocol. An Improved Forest Management Project is only eligible if it can fully satisfy the eligibility rules in the Regulation and:

1. The offset project takes place on land that has greater than 10 percent tree canopy cover.
2. The offset project employs natural forest management practices, as defined in Section 3.8.2 of this protocol.
3. The offset project does *not* employ broadcast fertilization.
4. The offset project does not take place on land that was part of a previously listed and verified Forest Project, unless the previous Forest Project was terminated due to an Unintentional Reversal (see Section 7) or is an early action offset project transitioning to this protocol according to the provisions of the Regulation and this protocol.
5. If the offset project was an offset project in a voluntary offset program, the offset project can demonstrate it has met all legal and contractual requirements to allow it to terminate its project relationship with the voluntary offset program and be listed using this compliance offset protocol.

Eligible management activities may include, but are not limited to:

- Increasing the overall age of the forest by increasing rotation ages.
- Increasing the forest productivity by thinning, diseased, and suppressed trees.
- Managing competing brush and short-lived forest species.
- Increasing the stocking of trees on understocked areas.
- Maintaining stocks at a high level.

Improved Forest Management Projects on both private and public lands, excluding federal lands that are not included in the categories of land listed in section 3.6 of this protocol, are eligible.

2.1.3 Avoided Conversion

An Avoided Conversion Project involves preventing the conversion of forestland to a non-forest land use by dedicating the land to continuous forest cover through a Qualified Conservation Easement or transfer to public ownership, excluding transfer to federal ownership. An Avoided Conversion Project is only eligible if it can fully satisfy the eligibility rules in the Regulation and:

1. It can be demonstrated that there is a significant threat of conversion of project land to a non-forest land use by following the requirements for establishing the project's baseline in Section 6.3 of this protocol.
2. The offset project does *not* employ broadcast fertilization.
3. The offset project does not take place on land that was part of a previously listed and verified Forest Project, unless the previous Forest Project was terminated due to an Unintentional Reversal (see Section 7) or is an early action offset project transitioning to this protocol according to the provisions of the Regulation and this protocol.
4. If the offset project was an offset project in a voluntary offset program, the offset project can demonstrate it has met all legal and contractual requirements to allow it to terminate its project relationship with the voluntary offset program and be listed using this compliance offset protocol.

An Avoided Conversion Project may involve tree planting and harvesting as part of the project activity.

Avoided Conversion Projects are eligible only on lands that are privately owned prior to offset project commencement.

2.2 Forest Owners

A Forest Owner is the owner of any interest in the real (as opposed to personal) property involved in a Forest Project, excluding government agency third party beneficiaries of conservation easements. Generally, a Forest Owner is the owner in fee of the real property involved in a Forest Project. In some cases, one entity may own the land while another entity may have an interest in the trees or the timber on the property, in which case all entities or individuals with interest in the real property are collectively considered Forest Owners, however, a single Forest Owner must be identified as the Offset Project Operator.

The Offset Project Operator is responsible for undertaking, listing, and verifying a Forest Project, however, all Forest Owner(s) are ultimately responsible for all Forest Project commitments. The Offset Project Operator may identify an Authorized Project Designee pursuant to §95974 of the Regulation, to assist or consult with implementation of the Forest Project. All information submitted to ARB or an Offset Project Registry shall reference the Offset Project Operator and all Forest Owner(s) who are ultimately responsible for the accuracy and completeness of the information submitted.

3 Eligibility Rules and Other Requirements

In addition to the definitions and requirements described in Section 2, Forest Projects must meet several other criteria and conditions to be eligible for listing, and must adhere to requirements in the Regulation and requirements related to duration and crediting periods.

3.1 Additionality

ARB and registry offsets credits must be generated by projects that yield surplus GHG emission reductions or removal enhancements that exceed any GHG reductions or removals otherwise required by law or regulation, or any GHG reduction or removal that would otherwise occur in a conservative Business-As-Usual Scenario. Forest Projects must satisfy the following to be considered additional:

1. Forest Projects must achieve GHG reductions or GHG removal enhancements above and beyond any GHG reductions or GHG removal enhancements that would result from compliance with any federal, state, or local law, regulation or ordinance. Forest Projects must also achieve GHG reductions and GHG removal enhancements above and beyond any GHG reductions or GHG removal enhancements that would result from compliance with any court order or other legally binding mandates, including management plans (such as Timber Harvest Plans) that are required for government agency approval of harvest activities. Legally binding mandates also include conservation easements or deed restrictions, except where such conservation easements have been enacted in support of the Forest Project, as described in Section 3.5. This requirement is assessed through the Legal Requirement Test in 3.1.1.
2. Forest Projects must achieve GHG reductions or GHG removal enhancements above and beyond any GHG reductions or GHG removal enhancements that would result from engaging in Business-As-Usual activities, as defined by the Regulation and the requirements described and assessed through the Performance Test in Section 3.1.2.

3.1.1 Legal Requirement Test

To meet additionality requirements, the following legal requirement test must be met, specific to each type of Forest Project.

3.1.1.1 Reforestation Projects

Reforestation Project activities cannot be legally required (as defined in 3.1 above) at the time of offset project commencement. Modeling of the Forest Project's baseline carbon stocks must reflect all legal constraints, as required in Section 6.1 of this protocol.

3.1.1.2 Improved Forest Management Projects

Improved Forest Management Project activities (defined as management activities intended to maintain or increase carbon stocks relative to baseline levels) cannot be legally required (as defined in 3.1 above) at the time of offset project commencement. Modeling of the Forest Project's baseline carbon stocks must reflect all legal constraints, as required in Section 6.2 of this protocol.

3.1.1.3 Avoided Conversion Projects

Avoided Conversion Project activities cannot be legally required (as defined in 3.1 above) at the time of offset project commencement. Modeling of the Forest Project's baseline carbon stocks must reflect all legal constraints, as required in Section 6.3 of this protocol.

Official documentation must be submitted demonstrating that the type of anticipated land use conversion is legally permissible. Such documentation must fall into at least one of the following categories:

1. Documentation indicating that the current land use policies, including zoning and general plan ordinances, and other local and state statutes and regulations, permit the anticipated type of conversion.
2. Documentation indicating that the Forest Owner(s) obtained all necessary approvals from the governing county to convert the Project Area to the proposed type of non-forest land use (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.).
3. Documentation indicating that similarly situated forestlands within the project's Assessment Area were recently able to obtain all necessary approvals from the governing county, state, or other governing agency to convert to a non-forest land use (including, for instance, certificates of compliance, subdivision approvals, timber conversion permits, other rezoning, major or minor use permits, etc.).

3.1.2 Performance Test

The Performance Test is satisfied if the following requirements are met, depending on the type of Forest Project.

3.1.2.1 Reforestation Projects

A Reforestation Project that occurs on land that has had less than 10 percent tree canopy cover for at least 10 years automatically satisfies the Performance Test.

A Reforestation Project that occurs on land that has undergone a Significant Disturbance satisfies the Performance Test if:

1. The Forest Project corresponds to a scenario in Appendix E, Table E.1, indicating that it is "eligible" (as determined by the requirements and methods in Appendix E); or
2. The Forest Project occurs on a type of land for which the Forest Owner has not historically engaged in or allowed timber harvesting. (Examples of such land include municipal or state parks.)

3.1.2.2 Improved Forest Management Projects

An Improved Forest Management Project automatically satisfies the Performance Test. Project activities are considered additional to the extent they produce GHG reductions and/or GHG removal enhancements in excess of those that would have occurred under a conservative Business-As-Usual Scenario, as defined by the baseline estimation requirements in Section 6.2.1.

3.1.2.3 Avoided Conversion Projects

An Avoided Conversion Project satisfies the Performance Test if a real estate appraisal for the Project Area (as defined in Section 4) is submitted indicating the following:

1. *The Project Area is suitable for conversion*. The appraisal must clearly identify the highest value alternative land use for the Project Area and indicate how the physical characteristics of the Project Area are suitable for the alternative land use.
    a. At a minimum, where conversion to commercial, residential, or agricultural land uses is anticipated, the appraisal must indicate that the slope of Project Area land does not exceed 40 percent.

    b. Where conversion to agricultural land use is anticipated, the appraisal must provide:
        i. Evidence of soil suitability for the type of expected agricultural land use.
        ii. Evidence of water availability for the type of expected agricultural land use.
    c. Where conversion to mining land use is anticipated, the appraisal must provide evidence of the extent and amount of mineral resources existing in the Project Area, and the commercial viability of mineral extraction.
    d. The appraisal must identify specific portions of the Project Area suitable for the identified alternative land use. For example, an appraisal that identified a golf course as an alternative land use must specify the approximate acres suitable for fairways, greens, clubhouses, and outbuildings.
2. *The alternative land use for the Project Area has a higher market value than forestland*. The appraisal for the property must demonstrate that the fair market value of the anticipated alternative land use for the Project Area is at least 40 percent greater than the value of the current forested land use.

Where conversion to residential, commercial, or recreational land uses is anticipated, the appraisal must also describe the following information:

1. The proximity of the Project Area to metropolitan areas.
2. The proximity of the Project Area to grocery and fuel services and accessibility of those services.
3. Population growth within 180 miles of the Project Area.

The appraisal must be conducted in accordance with the Uniform Standards of Professional Appraisal Practice[3] and the appraiser must meet the qualification standards outlined in Internal Revenue Code, Section 170 (f)(11)(E)(ii).[4]

3.2 Offset Project Commencement

The date of offset project commencement for a Forest Project is the date on which an activity is first implemented that will lead to increased GHG reductions or GHG removal enhancements relative to the Forest Project's baseline. The following actions identify offset project commencement for each project type:

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[3] Uniform Standards of Professional Appraisal Practice. http://www.uspap.org/2010USPAP/toc.htm. (Accessed October 1, 2010).

[4] Section 170 (f)(11)(E)(ii) of the Internal Revenue Code defines a qualified appraiser as
"an individual who -
(I) has earned an appraisal designation from a recognized professional appraiser organization or has otherwise met minimum education and experience requirements set forth in regulations prescribed by the Secretary,
(II) regularly performs appraisals for which the individual receives compensation, and
(III) meets such other requirements as may be prescribed by the Secretary in regulations or other guidance."

- For a Reforestation Project, the action is the planting of trees, the removal of impediments to natural regeneration, or site preparation for the planting of trees, whichever comes first.
- For an Improved Forest Management Project, the action is initiating forest management activities that increase sequestration and/or decrease emissions relative to the baseline, or transferring the Project Area to public ownership.
- For an Avoided Conversion Project, the action is committing the Project Area to continued forest management and protection through recording a conservation easement with a provision to maintain the Project Area in forest cover or transferring the Project Area to public ownership.

An Improved Forest Management project's offset project commencement date must be linked to a discrete, verifiable action that delineates a change in practice relative to the Forest Project's baseline. Any one of the following actions denotes an Improved Forest Management project's offset project commencement date:

- Recordation of a conservation easement on the Project Area. The date the easement was recorded is the Forest Project's offset project commencement date.
- Transferring of property ownership (to a public or private entity). The offset project commencement date is the date of property transfer.
- Submitting the offset project listing information specified in Section 9.1.1. Offset project commencement is the date of submittal of listing information, provided that the offset project completes verification within 30 months of being submitted. If the offset project does not meet this deadline, the listing information must be resubmitted under the latest version of the protocol.

Adequate documentation denoting the offset project commencement date must include where applicable, deeds of trust, title reports, conservation easement documentation, dated forest management plans, and/or other relevant contracts or agreements.

3.3 Project Crediting Period

The crediting period for offset projects using this protocol is 25 years. This means that after a successful initial verification, a Forest Project will be eligible to receive Offset Credits for GHG reductions and/or removals quantified using this protocol, and verified by ARB-approved verification bodies, for a period of 25 years following the offset project's commencement date. A project may be renewed for subsequent crediting periods, subject to approval at that time and use of the quantification methods in the most recent approved version of the Forest Offset Protocol at the time of renewal.

The baseline for any Forest Project under this version of the Forest Offset Protocol is valid for the duration of the Project Life following a successful initial verification where the offset project receives a Positive Verification Statement.

3.4 Project Life and Minimum Time Commitment

Project Life is defined as the period of time between offset project commencement and a period of 100 years following the issuance of any ARB or registry offset credit for GHG reductions or GHG removal enhancements achieved by the offset project. Forest Projects must continue to monitor, verify and report offset project data for a period of 100 years following any ARB or registry offset credit issuance. For example, if ARB or registry offset credits are issued to a

Forest Project in year 25 following offset project commencement, monitoring and verification activities must be maintained until year 125.

There are three possible exceptions to this minimum time commitment:

1. A Forest Project automatically terminates if a Significant Disturbance occurs leading to an Unintentional Reversal that reduces the Forest Project's Standing Live Carbon Stocks below the Forest Project's baseline Standing Live Carbon Stocks. If this occurs, the requirements of section 95983(d) of the Regulation shall apply.
2. A Forest Project automatically terminates if Project Lands or timber rights are sold to an entity that does not elect to take over the Forest Project responsibilities and commitments. Such a termination will require a quantity of ARB Offset Credits to be retired, as specified under 'Retiring Compliance Instruments Following Project Termination,' below.
3. A Forest Project may be voluntarily terminated prior to the end of its minimum time commitment if the required quantities of Compliance Instruments are retired, as specified under 'Retiring Compliance Instruments Following Project Termination,' below.

Retiring Compliance Instruments Following Project Termination

If a Forest Project is terminated for any reason except an unintentional reversal, the Forest Owner must replace any ARB Offset Credits that have previously been issued based on the requirements in the Regulation and the following provisions:

a. For a Reforestation or Avoided Conversion Project, a quantity of Compliance Instruments equal to the total number of ARB Offset Credits issued, and where applicable, all Early Action Offset Credits issued pursuant to section 95990(i) of the Regulation, to the project over the preceding 100 years must be retired.
b. For an Improved Forest Management Project, a quantity of Compliance Instruments equal to the total number of ARB Offset Credits issued, and where applicable, all Early Action Offset Credits issued pursuant to section 95990(i) of the Regulation, to the project over the preceding 100 years, multiplied by the appropriate compensation rate indicated in Table 3.1 must be retired.

Table 3.1. Compensation Rate for Terminated Improved Forest Management Projects

Number of years that have elapsed between offset project commencement and the date of termination	Compensation Rate
0-5	1.40
6-10	1.20
11-20	1.15
21-25	1.10
31-50	1.05
>50	1.00

3.5 Use of Qualified Conservation Easements

For Avoided Conversion Projects on private land, the Forest Owner must record a Qualified Conservation Easement against the offset project's property in order for the Forest Project to be eligible. Any Forest Project that records a Qualified Conservation Easement may reduce its risk

rating and required contribution to the Forest Buffer Account in Appendix D. To be "qualified" for purposes of ARB's compliance offset program, the conservation easement must:

a. Be granted by the owner of the fee to a qualified holder of a conservation easement in accordance with the conservation easement enabling statute of the state in which the project is located;
b. Be perpetual in duration;
c. Expressly acknowledge that ARB is a third party beneficiary of the conservation easement with the right to enforce all obligations under the easement and all other rights and remedies conveyed to the holder of the easement. These rights include standing as an interested party in any proceeding affecting the easement.

Qualified Conservation Easements must be recorded no earlier than one year before the offset project's commencement date. If a Qualified Conservation Easement was recorded more than one year prior to the offset project commencement date, the limits imposed by the easement on forest management activities must be considered a legal mandate for the purpose of satisfying the legal requirement test for additionality (Section 3.1.1) and in determining the Forest Project's baseline (Section 6).

As indicated in Section 3.2, an offset project commencement date must be linked to a discrete, verifiable action. The recordation of a conservation easement may be used to denote the commencement date of pre-existing projects between December 31, 2006 and December 31, 2010. Any previously recorded conservation easement may only be considered a Qualified Conservation Easement if it was recorded within one year prior to the identified project commencement date. Any previously recorded conservation easement must still meet, or be modified to meet, all of the requirements of this section (i.e. expressly acknowledging ARB as a third-party beneficiary) in order to be considered "qualified."

The conservation easement may be amended to exclude ARB as a third party beneficiary upon termination of the Forest Project or once all legal requirements for monitoring and verification of carbon stocks under this Compliance Offset Protocol have been met.

3.6 Project Location

All Forest Projects must be located in the United States of America. Reforestation Projects and Improved Forest Management Projects may be located on private land, or on state or municipal public land. Avoided Conversion Projects must be implemented on private land, unless the land is transferred to public ownership as part of the project.

All Forest Projects on public lands must be approved by the government agency or agencies responsible for management activities on the land. This approval must include an explicit approval of the Forest Project's baseline, as determined in Section 6 and must involve any public vetting processes necessary to evaluate management and policy decisions concerning the project activity. Offset projects on federal lands that are not included in the categories of land in the following paragraph are not eligible at this time.

Forest Projects situated on the following categories of land are only eligible under this protocol if they meet the requirements of this protocol and the Regulation, including the waiver of sovereign immunity requirements of section 95975(l) in the Regulation:

1. Land that is owned by, or subject to an ownership or possessory interest of a Tribe;
2. Land that is "Indian lands" of a Tribe, as defined by 25 U.S.C. §81(a)(1); or

3. Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands.

The Forest Offset Protocol contains data tables, equations, and benchmark data applicable to projects located in the United States. The methods required by this protocol for estimating baseline carbon stocks for Forest Projects cannot currently be applied outside the United States, as they rely on U.S.-specific data sets and models. Forest Projects in Alaska and Hawaii are not eligible at this time due to lack of region-specific data.

3.7 Regulatory Compliance

As stated in the Regulation, Project Lands must fulfill all applicable local, regional and national requirements on environment impact assessments that apply based on the offset project location. Offset projects must also meet any other local, regional, and national requirements that might apply.

Each time the Forest Project is verified, the Offset Project Operator or Authorized Project Designee must attest that the Forest Owner and Project Lands are in compliance with all applicable laws and regulations. The Offset Project Operator or Authorized Project Designee are required to disclose in writing to the verifier any and all instances of non-compliance associated with the Project Lands with any legal requirement. If a verifier finds that an offset project is in a state of non-compliance with any environmental law or regulation, then ARB or registry offset credits will not be issued for GHG reductions or GHG removal enhancements that occurred during any reporting period of non-compliance.

3.8 Sustainable Harvesting and Natural Forest Management Practices

Forest Projects can create long-term climate benefits as well as provide other environmental benefits, including the sustaining of natural ecosystem processes. This protocol requires eligible offset projects to employ both sustainable long-term harvesting practices and Natural Forest Management practices over time, as described below. Any non-conformance with the sustainable harvesting and Natural Forest Management requirements in this section will result in an adverse offset verification statement during the reporting periods that the Forest Project was out of conformance.

3.8.1 Sustainable Harvesting Practices

At the time commercial harvesting is either planned or initiated within the Project Area, the Offset Project Operator or Authorized Project Designee must demonstrate that the Forest Owner(s) employs and demonstrates sustainable long-term harvesting practices on all of its forest landholdings, including the Project Area, using one of the following options:

1. The Forest Owner must be certified under the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System certification programs. Regardless of the program, the terms of certification must require adherence to and verification of harvest levels which can be permanently sustained over time.
2. The Forest Owner must adhere to a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency.
3. The Forest Owner must employ uneven-aged silvicultural practices (if harvesting occurs) and must maintain canopy cover averaging at least 40 percent across the entire forestland owned by the Forest Owner in the same Assessment Areas covered by the Project Area, as measured on any 20 acres within the Forest Owner's landholdings

found in any of these Assessment Areas, including land within and outside of the Project Area (areas impacted by Significant Disturbance may be excluded from this test).

Forest Owners who acquire new forest landholdings within their entity have up to 5 years to incorporate such acquisitions under their certification or management plan, whether or not such land is contiguous with the Project Area.

3.8.2 Natural Forest Management

All Forest Projects must promote and maintain a diversity of native species and utilize management practices that promote and maintain native forests comprised of multiple ages and mixed native species within the Project Area and at multiple landscape scales ("Natural Forest Management").

All Forest Projects are required to establish and/or maintain forest types that are native to the Project Area. For the purposes of this protocol, native forests are defined as those forests occurring naturally in an area, as neither a direct nor indirect consequence of human activity post-dating European settlement.

The Forest Offset Protocol Resources section of ARB's webpage provides required references by Assessment Area for the definition of native forests (see Appendix F). If a state/regional reference is unavailable or inadequate, documentation from a state botanist or other qualified independent resource, recognized as expert by academic, private and government organizations, must be submitted indicating that the project promotes and maintains native forests per the definition above. Where supported by scientific peer-reviewed research, the planting of native species outside of their current distribution is allowed as an adaptation strategy due to climate change. Such planting must be done in accordance with a state or federally approved adaptation plan, or a local plan that has gone through a transparent public review process. A written statement must be submitted from the government agency in charge of forestry regulation in the state where the project is located stipulating that the planting of native trees outside their current range is appropriate as an adaptation to climate change.

The following requirements shall apply to all Forest Projects regardless of the silvicultural or regeneration methods that are used to manage or maintain the forest:

1. Forest Projects must maintain or increase standing live carbon stocks over the project life, as described in Section 3.8.3.
2. Forest Projects must show verified progress (verified at scheduled site-visits) towards native tree species composition and distribution consistent with the forest type and forest soils native to the Assessment Area.
3. Forest Projects must manage the distribution of habitat/age classes and structural elements to support functional habitat for locally native plant and wildlife species naturally occurring in the Project Area, as specified in

Table 3.2 and Section 3.8.4 below.

Forest Projects that initially engage in Natural Forest Management must continue to do so for as long as monitoring and verification of the Forest Project are required by this protocol (i.e. for the duration of the Project Life). Forest Projects that do not initially meet Natural Forest Management criteria but can demonstrate progress towards meeting these criteria at the times identified in

Table 3.2 are still eligible.

The evaluation criteria provided in

Table 3.2 shall be used to determine if the Forest Project meets the criteria for engaging in Natural Forest Management. The following evaluation must be completed and verified at a Forest Project's first verification and at all subsequent verifications. Forest Project carbon stock inventories (requirements for which are contained in Appendix A) should be used as the basis of these assessments where applicable.

Table 3.2. Evaluation criteria to test if a Forest Project meets the requirement for the establishment and maintenance of native species and natural forest management

Criteria	When Assessed	Results of not passing criteria	Application Rules
Native Species			
Project consists of at least 95% native species based on the sum of carbon in the standing live carbon pool. The assessment shall be conducted using estimates of stems per acre for Reforestation Projects and basal area per acre for Improved Forest Management and Avoided Conversion Projects.	Assessed at initial verification from inventory data	Forest Project is not eligible unless demonstrated that management will achieve this goal over the project life.	Applies to all project types throughout the project life
	Assessment during verification site visits must demonstrate continuous progress toward goal. This criterion must be met within 25 years.	Project is not in conformance with protocol requirements.	
Composition of Native Species			
Improved Forest Management and Avoided Conversion Projects Where the Project Area naturally consists of a mixed species distribution, no single species' prevalence, measured as the percent of the basal area of all live trees in the Project Area, exceeds the percentage value of standing live carbon shown under the heading 'Species Diversity Index' (incorporated by reference, October 10, 2010) in the Forest Offset Protocol Resources section of ARB's website. Where the Project Area does not naturally consist of a mixed species distribution, a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the project area does not naturally consist of a mixed species distribution must be submitted. **Reforestation** To the extent seed is available, and/or physical site characteristics permit, Reforestation Projects that involve planting of seedlings must plant a mixture of species such that no single species' prevalence, measured as the percent of all live tree stems in the Project Area, exceeds the percentage value shown under the heading 'Species Diversity Index' (incorporated by reference, October 10, 2010) in the Assessment Area table in the Forest Offset Protocol Resources section of ARB's website. Where seed is unavailable, the Reforestation Project is based on natural regeneration, or physical site characteristics are limiting, a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that seed is unavailable, the	Species composition is assessed at project initiation from inventory data.	Project is not eligible, unless it is demonstrated that management activities will enable this goal to be achieved over the project life.	Applies to all project types throughout the project life Some project sites may not be capable of meeting the requirement. In these cases, a written statement from the government agency in charge of forestry regulation in the state where the project is located must be submitted as described under "Criteria"
	Species composition is assessed at initial verification from inventory data. Project must show continuous progress toward criteria. These criteria must be met within 25 years.	Project is not in conformance with protocol requirements.	

Reforestation Project is based on natural regeneration, or physical site characteristics are limiting must be submitted.			
Distribution of Age Classes/Sustainable Management			
All forest landholdings owned or controlled by the Forest Owner are currently under one of the following: 1. Third party certification under the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System, whose certification standards require adherence to and verification of harvest levels which can be permanently sustained over time, or 2. Operating under a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency, or 3. The Forest Owner must employ uneven-aged silvicultural practices and canopy retention averaging at least 40 percent across the forest, as measured on any 20 acres within the entire forestland owned by the Forest Owner, including land within and outside of the Project Area. (Areas impacted by Significant Disturbance may be excluded from this test.)	Condition shall be met at all times during project and is assessed during each verification.	Project is not in conformance with protocol requirements.	Applies to all project types at first regeneration harvest
On a watershed scale up to 10,000 acres (or the project area, whichever is smaller), all projects must maintain, or make progress toward maintaining, no more than 40 percent of their forested acres in ages less than 20 years. (Areas impacted by Significant Disturbance may be excluded from this test.)	Age classes (if even age management is used) are assessed at project initiation and each verification site visit.	NA	
	Project must show continuous progress toward criteria. This criterion must be met within 25 years.	Project is not in conformance with protocol requirements.	
Structural Elements (Standing and Lying Dead Wood)			
Lying dead wood must be retained in sufficient quantities, as described below. **For portions of the Project Area that have not recently undergone salvage harvesting:** If a verifier determines that the quantity of lying dead wood is commensurate with recruitment from standing dead trees (i.e. there is no evidence that lying dead wood has been actively removed), the project must maintain (or demonstrate ongoing progress toward) an average of at least: ▪ one (1) metric ton of carbon (C) per acre; or ▪ 1% of standing live carbon stocks, in *standing* dead wood, whichever is higher, If a verifier determines that the quantity of lying dead wood is **not** commensurate with recruitment from standing dead trees (i.e. it appears lying dead wood has been actively removed), the project must maintain (or demonstrate ongoing progress toward)	Assessed during project at each verification audit.	Project is not in conformance with protocol requirements.	Applies to all project types throughout the project life

an average of at least: ▪ two (2) metric tons of carbon (C) per acre; or ▪ 1% of standing live carbon stocks, in *standing* dead wood, whichever is higher, Standing dead wood may be evenly or unevenly distributed throughout the portion of the Project Area unaffected by salvage harvesting, as long as the appropriate minimum average tonnage per acre requirement is met. **For portions of the Project Area that have undergone salvage harvesting within the previous year:*** If a verifier determines that the quantity of lying dead wood following salvage harvest is commensurate with recruitment from standing dead trees, the project must maintain (or demonstrate ongoing progress toward) an average of at least two (2) metric tons of carbon (C) per acre in *standing* dead wood, If a verifier determines that the quantity of lying dead wood following harvest is **not** commensurate with recruitment from standing dead trees, the project must maintain (or demonstrate ongoing progress toward) an average of at least four (4) metric tons of carbon (C) per acre in *standing* dead wood, Standing dead wood may be evenly or unevenly distributed throughout the portion of the Project Area subject to salvage harvesting, as long as the appropriate minimum average tonnage per acre requirement is met. This requirement must be met for a period of 30 years following the salvage harvest. After 30 years, the portion of the Project Area subject to salvage harvesting must meet the requirements for portions that have not recently undergone salvage harvesting (described above).			

3.8.3 Promotion of the Onsite Standing Live Carbon Stocks

In an effort to promote and maintain the environmental benefits of Forest Projects, the standing live carbon stocks within the Project Area must be maintained and/or increased during the Project Life. Therefore, except as specified below, ARB or registry offset credits will not be issued for quantified GHG reductions and GHG removal enhancements achieved by a Forest Project if a Forest Project's Offset Project Data Reports – over any 10-year consecutive period – indicate a decrease in the standing live carbon stocks.

Exceptions are allowed where reductions in standing live carbon stocks are important for maintaining and enhancing forest health, environmental co-benefits, or the long-term security of all carbon stocks; where reductions are due to non-harvest disturbances; or where reductions are required by law. Note that these exceptions in no way change or affect the requirements related to compensating for reversals, as detailed in Section 7.3.

Forest Projects whose standing live carbon stocks have decreased over a 10-year period are not in conformance with protocol requirements, except if the decrease in standing live carbon stocks is due to one of the following causes:

1. The decrease is demonstrably necessary to substantially improve the Project Area's resistance to wildfire, insect, or disease risks. The actions that will be taken to reduce the risks must be documented. The techniques used to improve resistance must be supported by relevant published peer reviewed research.
2. The decrease is associated with a planned balancing of age classes (regeneration, sub-merchantable, and merchantable) and is detailed in a long-term management plan that demonstrates harvest levels can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency. In this case, documentation must be submitted at the time of the Forest Project's Listing, indicating that a balancing of age classes, resulting in a decrease in the standing live carbon stocks, is planned at the initiation of the Forest Project (Figure 3.1). At no time over the Project Life shall the Forest Project's inventory of standing live carbon stocks fall below the Forest Project's baseline standing live carbon stocks, or 20 percent less than the Forest Project's standing live carbon stocks at the project's initiation, whichever is higher. Over any consecutive 10-year period, average standing live carbon stocks must be maintained at or above the standing live carbon stocks at the initiation of the project.

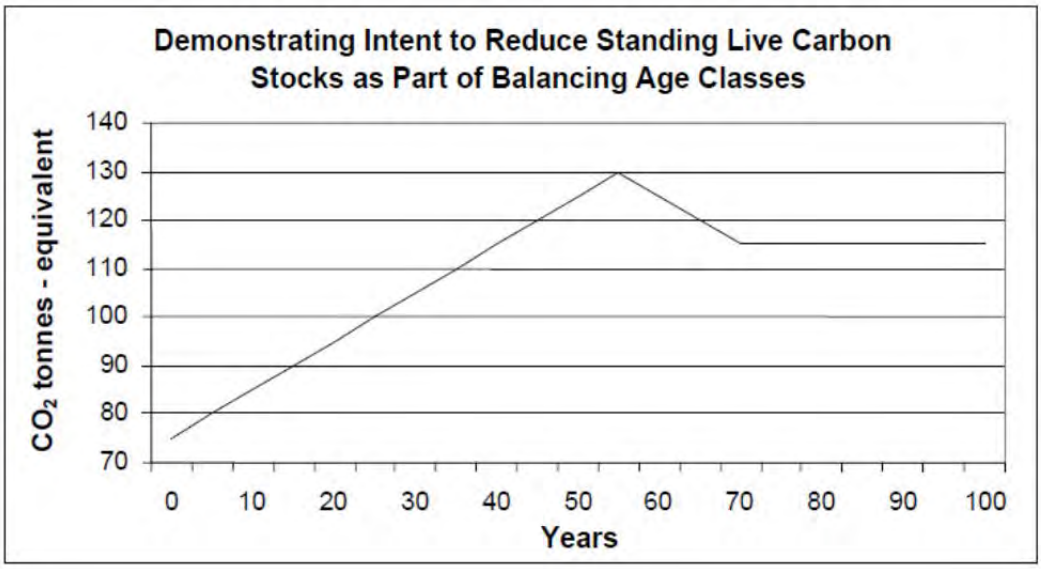


Figure 3.1. Example of Reducing Standing Live Carbon Stocks as Part of Balancing Age Classes

3. The decrease is part of normal silviculture cycles for forest ownerships less than 1,000 acres. Inventory fluctuations are a normal part of silvicultural activities. Periodic harvest may remove more biomass than the biomass growth over the past several years. At no time during the Project Life shall the Forest Project's inventory of standing live carbon stocks fall below the Forest Project's baseline standing live carbon stocks, or 20 percent less than the Forest Project's standing live carbon stocks at the project's initiation, whichever is higher. Over any consecutive 10-year period, average standing live carbon stocks must be maintained at or above the standing live carbon stocks at the initiation of the project. Documentation submitted at the time the Forest Project is Listed must indicate that fluctuations in the Forest Project's standing live carbon stocks are an anticipated silvicultural activity and that the overall trend will be for standing live carbon stocks to increase or stay the same over the life of the offset project (Figure 3.2).

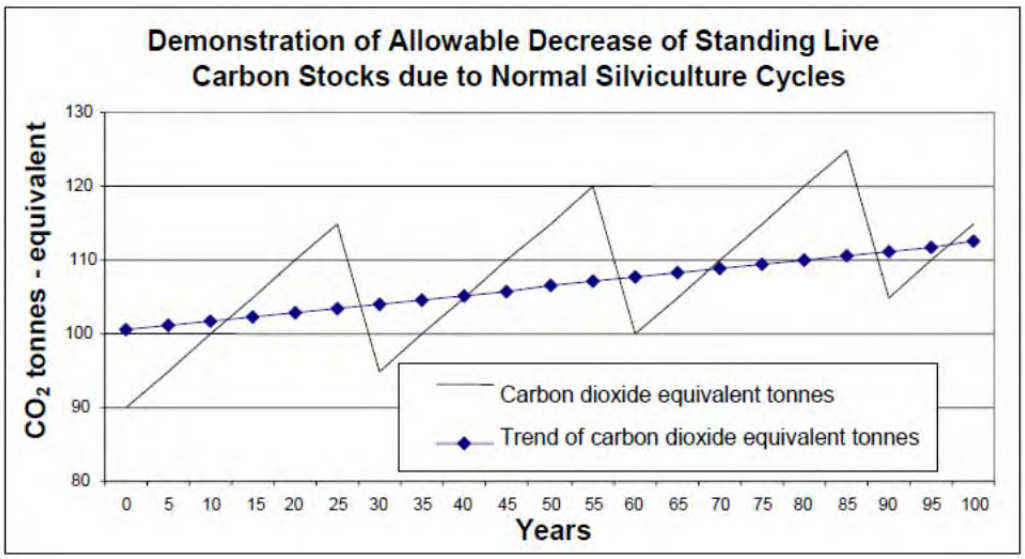


Figure 3.2. Example of Allowable Decrease of Standing Live Carbon Stocks due to Normal Silviculture Cycles

4. The decrease is due to an unintentional reversal such as wildfire, disease, flooding, wind-throw, insect infestation, or landslides.
5. The decrease in standing live carbon stocks occurs after the final crediting period (during the required 100 year monitoring period) as long as the residual live carbon stocks are maintained at a level that assures all credited standing live carbon stocks are permanently maintained.

3.8.4 Balancing Age and Habitat Classes

A variety of silvicultural practices may be employed in the Project Area during the course of a Forest Project though the protocol does not endorse any particular practice. To ensure environmental integrity, Forest Projects must meet a minimum set of standards in the use of any such practices.

For offset projects that employ even-aged management practices, harvesting must be limited to stands no greater than 40 acres. Stands adjacent to recently harvested stands must not be harvested using an even-aged harvest until the average age of the adjacent stand is at least 5-years old, or the average height in the adjacent stand is at least 5 feet. On a watershed scale up to 10,000 acres, all projects must maintain, or make progress toward maintaining, no more than 40 percent of their forested acres in ages less than 20 years. Areas impacted by a Significant Disturbance are exempt from this test until 20 years after reforestation of such areas.

The protocol does not override a landowner's obligation to abide by applicable laws and regulations, including any governing forest practice rules that may be more stringent. Regardless of the silvicultural practice employed, landowners must fulfill their commitment under the protocol to permanently maintain or increase onsite standing live carbon stocks (i.e. the carbon in live trees within the Project Area) as specified in Section 3.8.3.

4 Identifying the Project Area

The geographic boundaries defining the Project Area must be described in detail at the time a Forest Project is Listed. The boundaries must be defined using a map, or maps, that display public and private roads, major watercourses (4th order or greater), topography, towns, and either public land survey townships, ranges, and sections or latitude and longitude. The maps must be of adequate resolution to clearly identify the required features. The Project Area can be contiguous or separated into tracts. The Project Area may also extend across multiple Assessment Areas within an Ecosection or Supersection (see Appendix F) and across no more than two adjacent Ecosections or Supersections.

For Improved Forest Management Projects, the geographic boundaries may be defined such that non-forested areas, or areas not under forest management, are excluded from the Project Area.

For Reforestation Projects, the Project Area must be on land that has had less than 10 percent tree canopy cover for a minimum of ten years, or that have been subject to a Significant Disturbance that resulted in at least 20 percent of the carbon stocks being emitted. A Reforestation Project may defer finalizing the boundaries of the Project Area until the second full verification provided: (1) all lands included in the Project Area were initially included in the Project Area during listing, and (2) the Reforestation Project has elected to defer its initial inventory until the second full verification. This allows Reforestation Projects to initially identify a larger Project Area during project listing that may be revised prior to the completion of the forest inventory and the issuance of any ARB or registry offset credits.

For Avoided Conversion Projects, the Project Area is defined through the required appraisal process. The Project Area must be determined following the boundary definitions in Table 4.1 based on the type of anticipated conversion. All lands in the Project Area must be covered by the Qualified Conservation Easement or transferred to public ownership as part of the program.

Table 4.1. Project Area Definition for Avoided Conversion Projects

Conversion Type	Project Area Definition
Residential	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in residential development.
Agricultural Conversion or Mining	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in agricultural production or mining.
Golf Course	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' as a golf course. This is to include forested areas within 200' of fairways, greens, and buildings.
Commercial Buildings	The boundary of the parcel or parcels that have been appraised as having a 'higher and better use' in commercial buildings. This is to include forested areas with 200' of suitable building sites.

5 Offset Project Boundary

The Offset Project Boundary defines all the GHG emission sources, GHG sinks, and GHG reservoirs (SSR's) that must be accounted for in quantifying a Forest Project's GHG reductions and GHG removal enhancements (Section 6). The Offset Project Boundary encompasses all the GHG emission SSRs that may be significantly affected by Forest Project activities, such as forest carbon stocks and harvested wood products. For accounting purposes, the GHG sources, GHG sinks, and GHG reservoirs included in the Offset Project Boundary are organized according to whether they are predominantly associated with a Forest Project's "Primary Effect" (i.e. the Forest Project's intended changes in carbon stocks, GHG emissions, or GHG removal enhancements) or its "Secondary Effects" (i.e. unintended changes in carbon stocks, GHG emissions, or GHG removal enhancements caused by the Forest Project). Secondary effects may include increases in mobile combustion CO_2 emissions associated with site preparation, as well as increased CO_2 emissions caused by the shifting of harvesting activities from the Project Area to other forestlands (referred to as "Leakage"). Offset projects are required to account for Secondary Effects following the methods described in Section 6.

The following tables provide a comprehensive list of the SSRs that may be affected by a Forest Project, and indicate which SSRs must be included in the Offset Project Boundary for each type of Forest Project. If a SSR is designated as a "reservoir/pool," this means that GHG reductions and GHG removal enhancements are accounted for by quantifying changes in carbon stock levels. For SSRs designated as GHG sources or GHG sinks, GHG reductions and GHG removal enhancements are accounted for by quantifying changes in GHG emission or GHG removal enhancement rates, as described in the tables.

5.1 Reforestation Projects

Table 5.1. Offset Project Boundary – Reforestation Projects

SSR	Description	Type	Gas	Included or Excluded?	Quantification Method
Primary Effect Sources, Sinks, and Reservoirs					
RF-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by field measurements and updating forest carbon inventory
RF-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
RF-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
RF-4	Lying dead wood carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
RF-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
RF-6	Soil carbon	Reservoir / Pool	CO_2	*Included/excluded: Soil carbon must be included in the Offset Project Boundary if any of the following occur: ▪ Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds (or is expected to exceed from the baseline characterization and modeling) 25 percent of the Project Area over the Project Life, or ▪ Mechanical site preparation activities are not conducted on contours.	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
RF-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	Included	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
RF-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	Excluded when project harvesting exceeds baseline Included when project harvesting is below baseline	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes

Secondary Effect Sources, Sinks, and Reservoirs					
RF-9	Biological emissions from site preparation activities	Source	CO_2	*Included: Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSRs #RF-2 and #RF-6)
RF-10	Mobile combustion emissions from site preparation activities	Source	CO_2	Included	**Baseline:** N/A **Project:** Estimated using default emission factors
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-11	Mobile combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-12	Stationary combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	Included	**Baseline:** N/A **Project:** Estimated using default land-use conversion factors for non-project land
RF-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
RF-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A

			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
RF-17	Biological emissions from decomposition of forest products	Source	CO_2	Included	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #RF-7) and landfills (SSR #RF-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #RF-7) and landfills (SSR #RF-8)
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A

5.2 Improved Forest Management Projects

Table 5.2. Offset Project Boundary – Improved Forest Management Projects

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
Primary Effect Sources, Sinks, and Reservoirs					
IFM-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by field measurements and updating forest carbon inventory
IFM-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
IFM-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
IFM-4	Lying dead wood carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
IFM-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	Excluded	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
IFM-6	Soil carbon	Reservoir / Pool	CO_2	*Included/ Excluded Soil carbon must be included in the Offset Project Boundary, if any of the following activities occur: ▪ Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds (or is expected to exceed from the baseline characterization and modeling) 25 percent of the Project Area over the Project Life, or ▪ Mechanical site preparation activities are not conducted on contours.	**Baseline:** Modeled based on initial field inventory measurements **Project:** Measured by updating forest carbon inventory
IFM-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	Included	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
IFM-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	Excluded when project harvesting exceeds baseline Included when project harvesting is below baseline	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes

Secondary Effect Sources, Sinks, and Reservoirs					
IFM-9	Biological emissions from site preparation activities	Source	CO_2	*Included Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR #IFM-6, where applicable)
IFM-10	Mobile combustion emissions from site preparation activities	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
IFM-11	Mobile combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A .
IFM-12	Stationary combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
IFM-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
IFM-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	Included / Excluded	**Baseline:** N/A **Project:** Estimated using a default 20% “leakage” factor applied to the difference in harvest volume relative to baseline
IFM-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A

			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
IFM-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
IFM-17	Biological emissions from decomposition of forest products	Source	CO_2	*Included	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #IFM-7) and landfills (SSR #IFM-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #IFM-7) and landfills (SSR #IFM-8)
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A

5.3 Avoided Conversion Projects

Table 5.3. Offset Project Boundary – Avoided Conversion Projects

SSR	Description	Type*	Gas	Included or Excluded?	Quantification Method
Primary Effect Sources, Sinks, and Reservoirs					
AC-1	Standing live carbon (carbon in all portions of living trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by field measurements and updating forest carbon inventory
AC-2	Shrubs and herbaceous understory carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
AC-3	Standing dead carbon (carbon in all portions of dead, standing trees)	Reservoir / Pool	CO_2	Included	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by updating forest carbon inventory
AC-4	Lying dead wood carbon	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
AC-5	Litter and duff carbon (carbon in dead plant material)	Reservoir / Pool	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
AC-6	Soil carbon	Reservoir / Pool	CO_2	*Included/ Excluded Soil carbon must be included in the Offset Project Boundary, if any of the following activities occur: ▪ Site preparation activities involve deep ripping, furrowing, or plowing where soil disturbance exceeds (or is expected to exceed from the baseline characterization and modeling) 25 percent of the Project Area over the Project Life, or ▪ Mechanical site preparation activities are not conducted on contours	**Baseline:** Modeled based on initial field inventory measurements and expected land-use conversion rates **Project:** Measured by updating forest carbon inventory
AC-7	Carbon in in-use forest products	Reservoir / Pool	CO_2	Included	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes
AC-8	Forest product carbon in landfills	Reservoir / Pool	CO_2	Excluded when project harvesting exceeds baseline Included when project harvesting is below baseline	**Baseline:** Estimated from modeled harvesting volumes **Project:** Estimated from measured harvesting volumes

Secondary Effect Sources, Sinks, and Reservoirs					
AC-9	Biological emissions from site preparation activities	Source	CO_2	*Included Biological emissions from site preparation are not quantified separately, but rather are captured by measuring changes in included carbon reservoirs	**Baseline:** N/A **Project:** Quantified based on measured carbon stock changes in included reservoirs (SSR #AC-6, where applicable)
AC-10	Mobile combustion emissions from site preparation activities	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-11	Mobile combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-12	Stationary combustion emissions from ongoing project operation & maintenance	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-13	Biological emissions from clearing of forestland outside the Project Area	Source	CO_2	Included	**Baseline:** N/A **Project:** Estimated using default forestland conversion factors
AC-14	Biological emissions/ removals from changes in harvesting on forestland outside the Project Area	Source / Sink	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
AC-15	Combustion emissions from production, transportation, and disposal of forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A

			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-16	Combustion emissions from production, transportation, and disposal of alternative materials to forest products	Source	CO_2	Excluded	**Baseline:** N/A **Project:** N/A
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A
AC-17	Biological emissions from decomposition of forest products	Source	CO_2	Included	**Baseline:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #AC-7) and landfills (SSR #AC-8) **Project:** Quantified as a component of calculating carbon stored for 100 years in wood products (SSR #AC-7) and landfills (SSR #AC-8)
			CH_4	Excluded	**Baseline:** N/A **Project:** N/A
			N_2O	Excluded	**Baseline:** N/A **Project:** N/A Decomposition of forest is not expected to be a significant source of N_2O emissions.

6 Quantifying Net GHG Reductions and GHG Removal Enhancements

This section provides requirements and methods for quantifying a Forest Project's net GHG reductions and GHG removal enhancements.

Quantification Methodology:
For each type of Forest Project, quantification proceeds in seven steps:

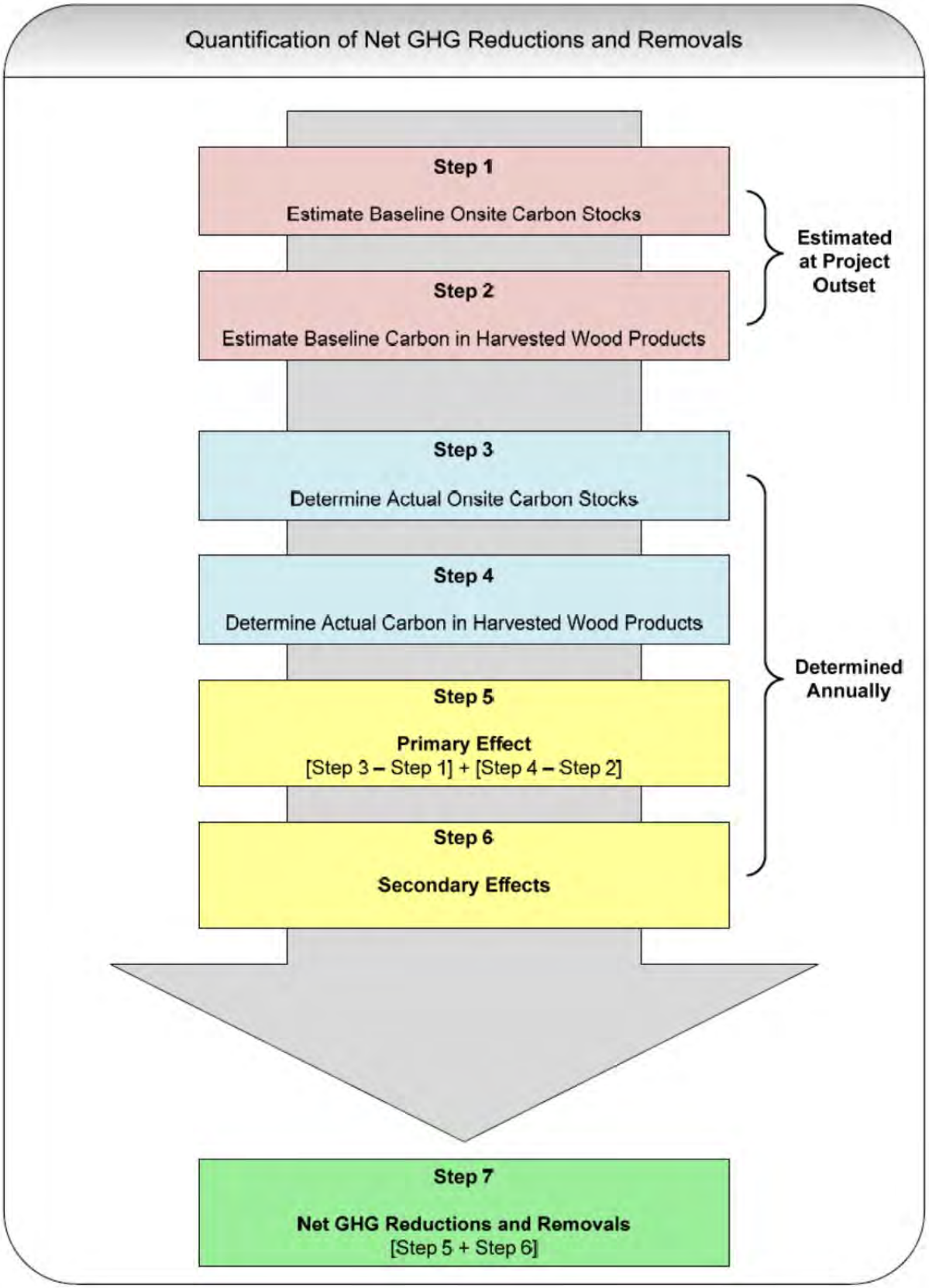
1. **Estimating baseline onsite carbon stocks.** The baseline is an estimate of what would have occurred in the absence of a Forest Project. To establish baseline onsite carbon stocks, the carbon stock changes in each of the Forest Project's required onsite carbon pools (identified in Sections 5.1 to 5.3) must be modeled over 100 years. Modeling must be based on inventoried carbon stocks at the time of the Forest Project's offset project commencement (or when first inventoried as is allowed for Reforestation Projects), following the applicable requirements in this section. Onsite carbon stocks are inventoried following the requirements in Appendix A; modeling of onsite carbon stocks over time must be conducted following the requirements in this section and the requirements and methods in Appendix B. Baseline onsite carbon stocks are estimated over 100 years at the time of the Forest Project's commencement.
2. **Estimating baseline carbon in harvested wood products.** In conjunction with modeling baseline onsite carbon stocks, a forecast of any harvesting that would have occurred in the baseline must be developed and converted to an average annual harvesting volume. From this, the amount of carbon that would have been transferred each year (on average) to long-term storage in wood products can be determined. Baseline harvesting is forecasted following the requirements in this section and carbon stored in wood products must be calculated following the requirements and methods in Appendix C.
3. **Determining actual onsite carbon stocks.** Each year, the Forest Project's actual onsite carbon stocks must be determined. This must be done by updating the Forest Project's forest carbon inventory for the current year, following the requirements and methods in this section and in Appendices A and B. The estimate of actual onsite carbon stocks must be adjusted by an appropriate confidence deduction, as described in Appendix A, Section A.4.
4. **Determining actual carbon in harvested wood products.** Each year, any harvesting in the Project Area must be reported and from this, the amount of carbon transferred to long-term storage in wood products must be calculated following the requirements and methods in Appendix C.
5. **Calculating the offset project's Primary Effect.** Each year, the actual change in GHG emissions or GHG removal enhancements associated with the Forest Project's intended ("Primary") effect must be quantified, as defined in Section 5. For any given year, the Primary Effect is calculated by:
    a. Taking the difference between actual onsite carbon stocks for the current year and actual onsite carbon stocks for the prior year
    b. Subtracting from (a) the difference between baseline onsite carbon stocks for the current year and baseline onsite carbon stocks for the prior year
    c. Adding to (b) the calculated difference between actual and baseline carbon in harvested wood products for the current year (see Equation 6.1.)
6. **Quantifying the offset project's Secondary Effects.** Each year, the actual change in GHG emissions or GHG removal enhancements associated with the Forest Project's unintended ("Secondary") effects must be quantified as defined in Section 5.

Requirements and methods for quantifying Secondary Effects are provided below for each type of Forest Project. Secondary Effects will almost always be negative (i.e. they will reflect an increase in GHG emissions caused by the offset project).

7. **Calculating total net GHG reductions and GHG removal enhancements.** For each year, total net GHG reductions and GHG removal enhancements are calculated by summing a Forest Project's Primary and Secondary Effects. If the result is positive, then the Forest Project has generated GHG reductions and/or GHG removal enhancements in the current year. If the result is negative, this indicates a reversal has occurred except as specified below (see Section 7).

Requirements for how to perform quantification steps 1 to 4 for each Forest Project type are presented in the remainder of this section. The required formula for quantifying annual net GHG reductions and GHG removal enhancements is presented in Equation 6.1. Net GHG reductions and GHG removal enhancements must be quantified and reported in units of carbon dioxide-equivalent (CO_2e) metric tons.

A reversal occurs only if: (1) total net GHG reductions and GHG removal enhancements for the year are negative; and (2) ARB or registry offset credits have previously been issued to the Forest Project. If calculated GHG reductions and GHG removal enhancements are negative and no ARB or registry offset credits have been issued to the project since its commencement date then the result should be treated as a "negative carryover" to GHG reduction calculations in subsequent years (variable N_{y-1} in Equation 6.1). This may happen, for example, because the confidence deduction applied to actual onsite carbon stocks can result in actual values being less than baseline values in a Forest Project's initial years.


Quantification of Net GHG Reductions and Removals
Step 1
Estimate Baseline Onsite Carbon Stocks
Step 2
Estimate Baseline Carbon in Harvested Wood Products
Estimated at Project Outset
Step 3
Determine Actual Onsite Carbon Stocks
Step 4
Determine Actual Carbon in Harvested Wood Products
Step 5
Primary Effect
[Step 3 – Step 1] + [Step 4 – Step 2]
Step 6
Secondary Effects
Determined Annually
Step 7
Net GHG Reductions and Removals
[Step 5 + Step 6]

Quantification Methodology

Equation 6.1.

$$QR_y = [(\Delta AC_{onsite} - \Delta BC_{onsite}) + (AC_{wp,\,y} - BC_{wp,\,y}) * 0.80 + SE_y] * (1 - ACD) + N_{y-1}$$

Where,

QR_y = Quantified GHG reductions and GHG removal enhancements for year y

ΔAC_{onsite} = $(AC_{onsite,\,y})(1 - CD_y) - (AC_{onsite,\,y-1})(1 - CD_{y-1})$

Where,

$AC_{onsite,\,y}$ = Actual onsite carbon (CO_2e) as inventoried for year y

$AC_{onsite,\,y-1}$ = Actual onsite carbon (CO_2e) as inventoried for year y-1 (if y is the first year of the offset project, then the value for $AC_{onsite,\,y-1}$ will be zero)

CD_y = Appropriate confidence deduction for year y, as determined in Appendix A, Section A.4.

CD_{y-1} = Appropriate confidence deduction for year y-1, as determined in Appendix A, Section A.4.

ΔBC_{onsite} = $BC_{onsite,\,y} - BC_{onsite,\,y-1}$

Where,

$BC_{onsite,\,y}$ = Baseline onsite carbon (CO_2e) as estimated for year y

$BC_{onsite,\,y-1}$ = Baseline onsite carbon (CO_2e) as estimated for year y-1 (if y is the first year of the offset project, then the value for $BC_{onsite,\,y-1}$ will be zero) [5]

$AC_{wp,\,y}$ = Actual carbon in wood products produced in year y that is projected to remain stored for at least 100 years (i.e. $WP_{total,\,y}$ derived for actual harvest volumes following the requirements and methods in Appendix C)

$BC_{wp,y}$ = Averaged annual baseline carbon in wood products that would have remained stored for at least 100 years (i.e. $WP_{total,\,y}$ derived for baseline harvest volumes following the requirements and methods in Appendix C)

SE_y = Secondary Effect GHG emissions caused by the project activity in year y

ACD = Avoided Conversion Project discount factor, determined in Section 6.3.1

N_{y-1} = Any negative carryover from the prior year (occurs when total quantified GHG reductions are negative prior to the issuance of any ARB offset credits for the project)

Note: The net change in carbon in harvested wood products, ($AC_{wp,y} - BC_{wp,y}$), is multiplied by 80 percent in Equation 6.1 to reflect market responses to changes in wood product production. The general assumption in this protocol is that for every ton of reduced harvesting caused by a

[5] For Improved Forest Management projects, where baseline onsite carbon stocks are averaged across all years, the value for ΔBC_{onsite} will be zero in all years except the first year of the project.

Forest Project, the market will compensate with an increase in harvesting of 0.2 tons on other lands (see Section 6.2.6).

6.1 Reforestation Projects

6.1.1 Estimating Baseline Onsite Carbon Stocks

Quantification Methodology

To estimate baseline carbon stocks for a Reforestation Project:

1. Provide a qualitative characterization of the likely vegetative conditions and activities that would have occurred without the project, taking into consideration any laws, statutes, regulations, or other legal mandates that would encourage or require reforestation on the Project Area. The qualitative assessment shall include an assessment of the commercial value of trees within the Project Area over the next 30 years. The qualitative assessment must be used as the basis for modeling baseline carbon stocks (Step 3).
2. Inventory the carbon stocks in each of the Forest Project's required carbon pools, following the requirements in Appendix A of this protocol.[6] For carbon pools that will be affected by site preparation, the inventory must be conducted prior to any site preparation activities. For those carbon pools that are affected by site preparation, provide an estimate of initial carbon stocks using one of the following alternatives:
    - Measuring carbon stocks using 20 sample plots located in the portion of the Project Area containing the greatest amount of biomass in the pool that will be affected.
    - Stratifying (classifying) the Project Area into similar densities and measuring stocks within the affected carbon pools using 20 sample plots per density class.
    - Measuring the affected carbon stocks based on a grid system across the Project Area.

For other carbon stocks, the inventory may be deferred, as described below.

3. Once a full inventory is obtained, perform a computer simulation that models the carbon stocks for 100 years following the forest project's commencement date, based on the qualitative characterization of what would have occurred without the offset project. The modeling must follow the requirements and methods for modeling contained in Appendix B, Section B.3, incorporating any conditions and constraints specified in the qualitative characterization of the baseline (Step 1, above). The computer simulation must model the expected growth in carbon stocks associated with pre-existing trees in the Project Area (i.e. those not planted as part of the Forest Project).

Deferral of Initial Inventory for Carbon Stocks Not Affected by Site Preparation

The inventory of carbon stocks that are not affected by site preparation may be deferred until a Reforestation Project's second verification. At the time of the second verification, an estimated inventory of the all required carbon stocks at the time of the Forest Project's offset project commencement date must prepared by:

1. Assuming standing dead carbon stocks at the time of the Forest Project's offset project commencement date were equal to the standing dead carbon stocks measured and verified at the second verification.

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[6] Initial carbon stocks could be zero if the Project Area has no quantifiable forest cover or required carbon pools.

2. Using an approved growth model or a stand table projection methodology, as described in Appendix B, Section B.1, to derive an estimate of standing live carbon stocks in pre-existing trees (i.e. those not planted as part of the Forest Project) at the time of the Forest Project's offset project commencement date. The approved growth model or stand table projection used for the estimate must produce a result within 5 percent of current inventory data for pre-existing trees.

If the inventory of these carbon pools is deferred, the timing of the second verification is at the discretion of the Offset Project Operator or Authorized Project Designee (but must occur within 12 years of the initial verification). Reforestation Projects for which an initial inventory is deferred are not eligible to receive ARB or registry offset credits until after the second verification.

6.1.2 Estimating Baseline Carbon in Harvested Wood Products

Quantification Methodology

If harvesting of the pre-existing trees would be expected to occur in the baseline, the following steps must be performed:

1. Use a model (see Appendix B) to determine the *average* amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year of the baseline over 100 years. The result will be a uniform estimate of harvested carbon in each year of the baseline. This estimate is determined at offset project commencement using the same volume models and biomass equations used to calculate biomass in live trees and estimate baseline onsite carbon stocks; this will not change over the course of the offset project crediting period.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.1.3 Determining Actual Onsite Carbon Stocks

Quantification Methodology

Actual carbon stocks for Reforestation Projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Approved growth models and requirements and methods for projecting forest inventory plot data using models are provided in Appendix B.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the requirements and methods in Appendix A. Section A.4.

6.1.4 Determining Actual Carbon in Harvested Wood Products

Quantification Methodology

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.1.3).

2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.1.5 Quantifying Secondary Effects

Quantification Methodology

For Reforestation Projects, significant Secondary Effects can arise from two sources:

1. One-time combustion emissions associated with machinery used in site preparation; and
2. The shifting of cropland or grazing activities to forestland outside the Project Area (which may be both a market and/or physical response to the project activity), which is accounted for over the Project Life.

To quantify combustion emissions associated with site preparation, use the appropriate standard emission factor from Table 6.1 corresponding to the level of brush cover on the Project Area, multiplied by the number of acres in the Project Area (Equation 6.2).

Mobile combustion emissions must be added to Secondary Effect emissions (SE_y in Equation 6.1) in the first year of an offset project. If this results in a negative amount for total net quantified GHG reductions and GHG removal enhancements in year one (QR_1), the negative amount must be carried over into future years (N_{y-1} in Equation 6.1) until sufficient GHG reductions and GHG removal enhancements are accrued to achieve a positive balance. Negative GHG reductions and GHG removal enhancements due to site preparation emissions are *not* considered a reversal (Section 7.1).

Equation 6.2. Combustion Emissions Associated with Site Preparation

$$\mathbf{MC_y = (-1) \times (EF_{mc} \times PA)}$$

Where,

MC_y = Secondary Effect CO_2e emissions due to mobile combustion from site preparation

EF_{mc} = Mobile combustion emission factor from Table 6.1

PA = The size of the Project Area, in acres

Table 6.1. Mobile Combustion Emissions for Reforestation Projects

SITE PREP - REFORESTATION PROJECTS Emissions Associated with Mobile Combustion		
Average Metric Tons CO_2e per Acre		
Light	Medium	Heavy
0-25% Brush Cover	>25-50% Dense Brush Cover	>50% Brush Cover, Stump Removal
0.090	0.202	0.429

To quantify GHG emissions from the shifting of cropland and grazing activities each year, determine the appropriate “leakage” risk percentage for the project following the decision tree in Figure 6.3. The leakage risk percentage is only determined once, at offset project

commencement. Each year, this percentage must be applied to the net increase in onsite carbon stocks to determine the annual Secondary Effects due to shifting of cropland or grazing activities (Equation 6.3).

Equation 6.3. Emissions from Shifting Cropland and Grazing Activities

$$\mathbf{AS_y = (-1) \times L \times (\Delta\, AC_{onsite} - \Delta\, BC_{onsite})}$$

Where,

AS_y	=	Secondary Effect CO_2e emissions due to shifting of cropland or grazing activities
L	=	Leakage risk percentage, as determined from Figure 6.3
$\Delta\, AC_{onsite}$	=	Annual difference in actual onsite carbon (CO_2e) as defined in Equation 6.1.
$\Delta\, BC_{onsite}$	=	Annual difference in baseline onsite carbon (CO_2e) as defined in Equation 6.1.

Total Secondary Effect emissions for Reforestation Projects are calculated as follows (Equation 6.4). The value for Secondary Effect emissions will always be negative or zero.

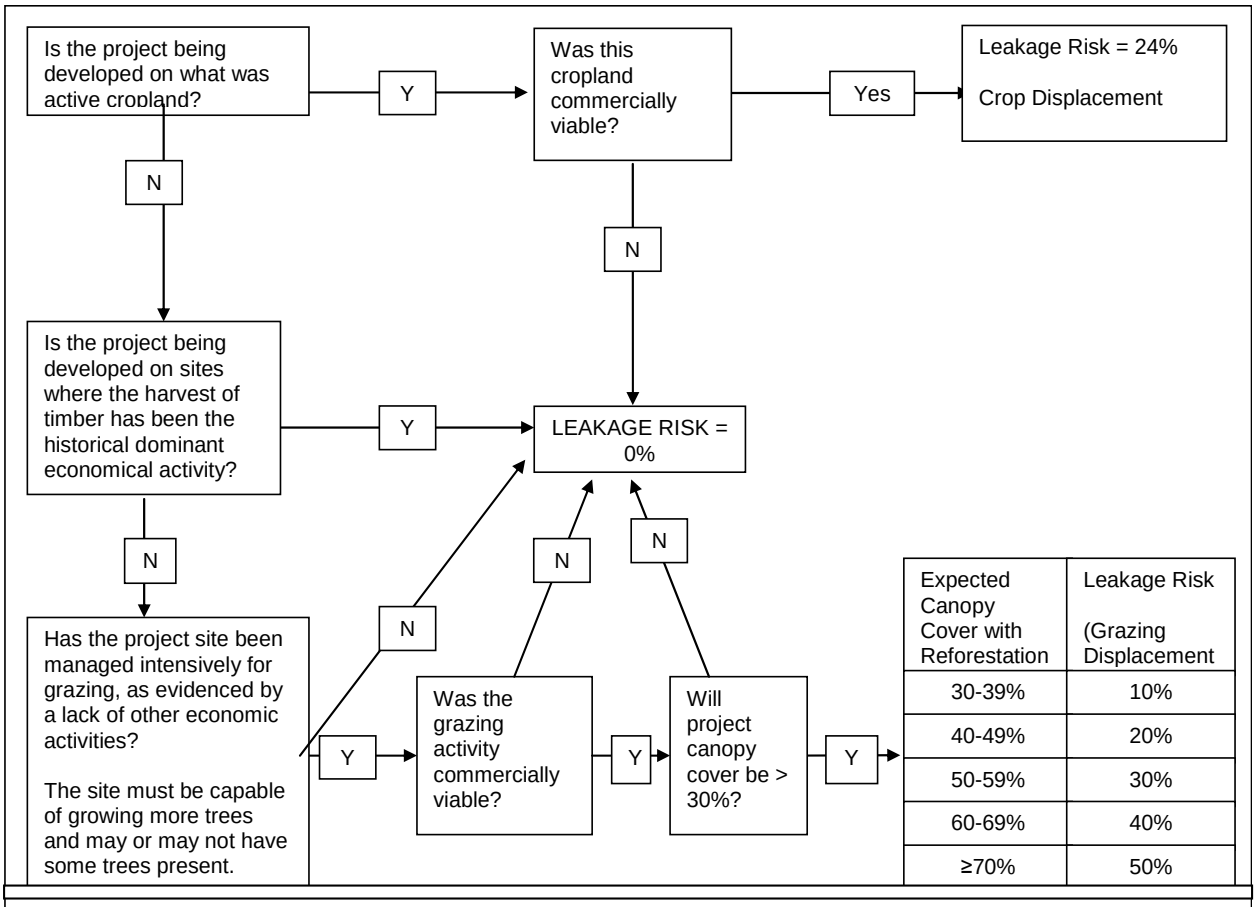
Equation 6.4. Total Secondary Effect Emissions

$$\mathbf{SE_y = MIN[(AS_y + MC_y), 0]}$$

Where,

SE_y	=	Secondary Effect GHG emissions caused by the project activity in year y (Equation 6.1)
MIN	=	The lowest value in the set of values being evaluated.
AS_y	=	Secondary Effect CO_2e emissions due to shifting of cropland or grazing activities
MC_y	=	Secondary Effect CO_2e emissions due to mobile combustion from site preparation*

*Only occurs in year 1.



Expected Canopy Cover with Reforestation	Leakage Risk (Grazing Displacement
30-39%	10%
40-49%	20%
50-59%	30%
60-69%	40%
≥70%	50%

Assumptions:

- Leakage risk for cropland displacement is based on a default rate developed by Murray et al (*Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture,* USEPA, 2005). Rates are regionally dependent so this would need to be adjusted if projects are occurring outside of CA.
- If canopy cover associated with the reforestation project in < 30%, grazing activity will not be affected.
- With increasing canopy cover, competition among grazers increases and, therefore, total grazing on the project land decreases and is displaced.
- Demand for crops is inelastic.
- "Commercially viable" is defined here as profitable either without subsidies or with a reliable, long-termed sustained form of subsidies. The assessment of commercially viable shall be determined by analysis of comparable practices within the assessment area on comparable conditions (slope, soils, access to markets, etc.). For grazing, if the level of grazing activity has been equal to, or less than, .5 Animal Unit Months (AUMs) per acre, the grazing activity is not commercially viable.

Figure 6.3. Activity Shifting ("Leakage") Risk Assessment for Reforestation Projects

6.2 Improved Forest Management Projects

Improved Forest Management Projects that take place on private land – or on land that is transferred to public ownership at the time the project is initiated – must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.2.1. Improved Forest Management Projects that take place on land that was publicly owned prior to the offset project commencement date must estimate baseline onsite carbon stocks following the requirements and procedures in Section 6.2.2. Requirements for determining baseline carbon in harvested wood products, determining actual onsite carbon stocks, determining actual carbon in harvested wood products, and quantifying Secondary Effects are the same for all Improved Forest Management Projects.

6.2.1 Estimating Baseline Onsite Carbon Stocks – Private Lands

Quantification Methodology

The baseline approach for Improved Forest Management Projects on private lands applies a standardized set of assumptions to offset project-specific conditions. A key assumption is that baseline carbon stocks will depend on how a project's initial standing live carbon stocks per acre (ICS) compare to "Common Practice," (CP) defined as the average standing live carbon stocks per acre on similar lands within the Forest Project's Assessment Area. In addition, for cases where ICS is below CP, baseline carbon stocks must be adjusted to reflect management practice on the Forest Owner's other landholdings in instances where Project Area carbon stocks are more than 20 percent below the carbon stocks on land within the same logical management unit. Finally, the baseline must be modeled to reflect all legal and financial constraints affecting the Project Area.

The following steps must be followed to estimate baseline carbon stocks:

1. Determine the Common Practice level of above-ground standing live carbon stocks applicable to the Project Area.
2. Determine if the Project Area's initial above-ground standing live carbon stocks are above or below Common Practice.
3. Estimate baseline above-ground standing live carbon stocks, taking into account financial and legal constraints on harvesting in the Project Area, as well as the minimum baseline level applicable to the Project Area, as defined in the requirements for step 3, below. The minimum baseline level will depend on whether initial above-ground standing live carbon stocks are above or below Common Practice.
4. Determine the baseline carbon stocks over 100 years for all required carbon pools in the Project Area.

For all calculations in this section, all values for "carbon stocks" should be expressed in metric tons of CO_2-equivalent.

Step 1 – Determine the Common Practice Carbon Stocks for the Project's Assessment Area

As defined in this protocol, Common Practice (CP) refers to the average stocks of above-ground standing live carbon per acre associated with the Assessment Area(s) covered by the Project Area. Common Practice is used as a reference point for baseline estimation. To determine a value for Common Practice, see Appendix F and the Assessment Area Data File document available in the Forest Offset Protocol Resources section of ARB's website.

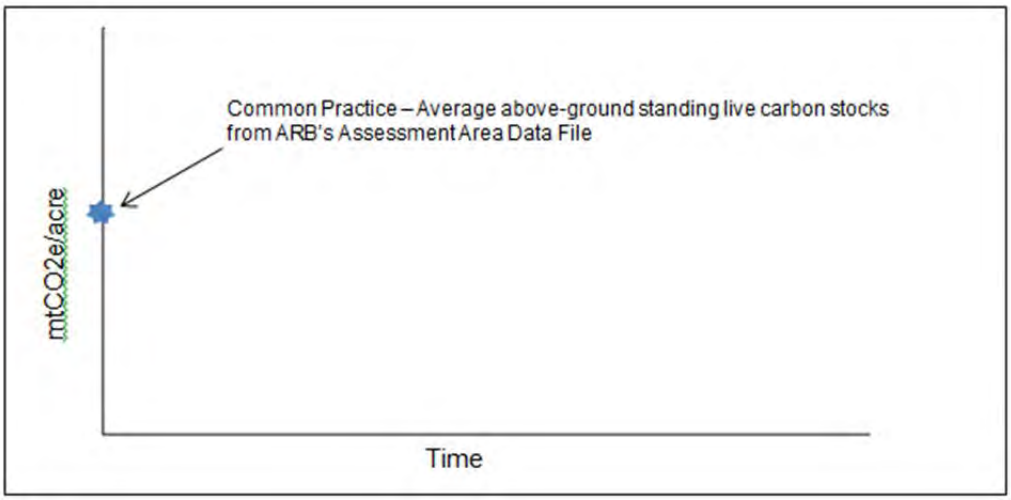


Figure 6.4. Common Practice as a Reference Point for Baseline Estimation

Step 2 – Determine if Initial Above-Ground Standing Live Carbon Stocks Are Above or Below Common Practice

To determine if initial above-ground standing live carbon stocks per acre (ICS), expressed in $MTCO_2$-e, are above or below Common Practice, perform the following steps:

1. From the initial forest carbon inventory for the Project Area (conducted following the requirements in Appendix A), identify the total metric tons of CO_2e contained in *above-ground* standing live carbon stocks.
2. Divide this amount by the number of acres in the Project Area.
3. Compare the result with the Common Practice value identified in Step 1.

Step 3 – Determine Baseline Above-Ground Standing Live Carbon Stocks

The above-ground standing live carbon stocks component of the baseline must be determined by: (1) Modeling above-ground standing live carbon stocks through a series of growth and harvesting scenarios over 100 years; and (2) averaging the model results over the 100-year timeframe, so that the above-ground standing live carbon stocks component of the baseline is expressed as a single (average) annual value for above-ground standing live carbon stocks per acre. The modeling must be performed following the requirements and methods in Appendix B and must meet the following conditions:

1. Growth and harvesting scenarios must reflect all legal constraints, following the requirements in Section 6.2.1.2;
2. Growth and harvesting scenarios must reflect any financial constraints, following the requirements in Section 6.2.1.3; and

3. The averaged model results, expressed as above-ground standing live carbon stocks per acre, must not fall below the minimum baseline level (MBL).
   a. If initial above-ground standing live carbon stocks are above Common Practice, the MBL must be determined using the formula in Equation 6.5.
   b. If initial above-ground standing live carbon stocks are equal to or below Common Practice, then MBL must be determined using the formula in Equation 6.6.

Graphical examples are provided in Figure 6.5 and Figure 6.6.

Figure 6.5 shows ICS as a data point on the graph and the 100-year modeled above-ground standing live carbon stocks before averaging.

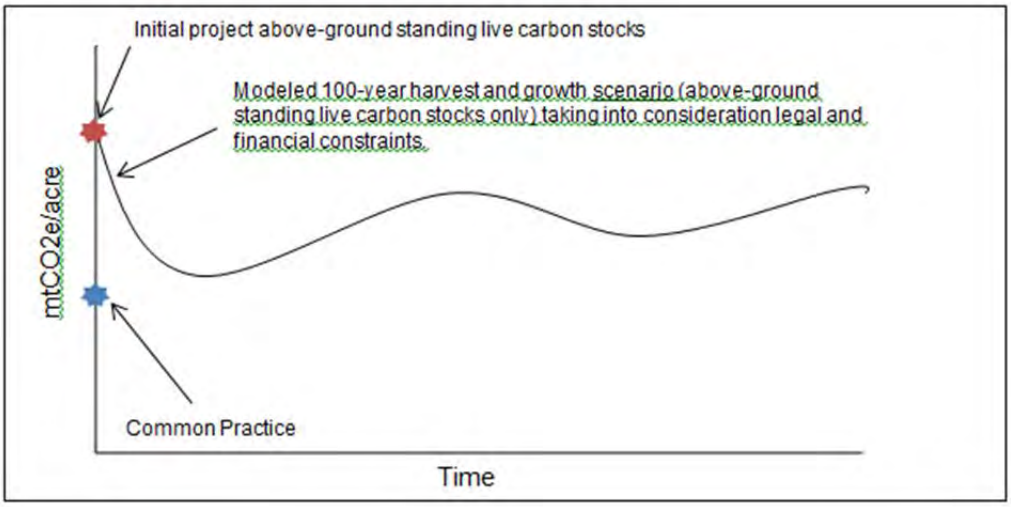


Figure 6.5. Initial Carbon Stocks and 100-year Modeled Above-Ground Standing Live Carbon Stocks Where Initial Stocks Are Above Common Practice

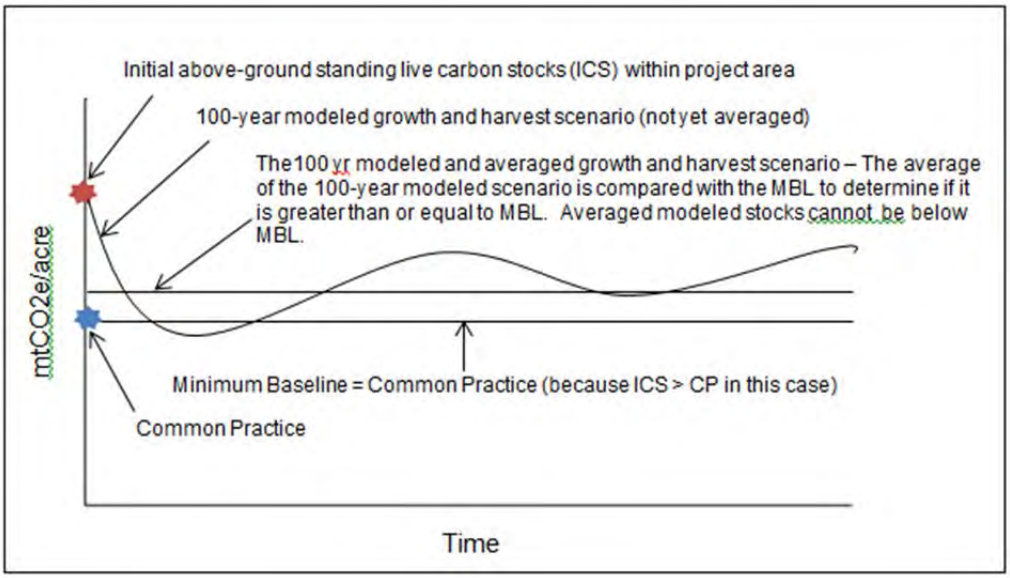


Figure 6.6. Averaging the 100-Year Modeled Above-Ground Standing Live Carbon Stocks Where Initial Stocks are Above Common Practice for Comparison to the MBL.

Equation 6.5. Determining the Minimum Baseline Level Where Initial Stocks Are Above Common Practice

MBL = CP

Where,

MBL	=	Minimum baseline level (above-ground standing live carbon stocks)
CP	=	Common Practice (as determined in Step 1)

Equation 6.6. Determining the Minimum Baseline Level Where Initial Stocks Are Equal to or Below Common Practice

MBL = MAX (MAX (HSR, ICS), MIN (CP, WCS))

Where,

MAX	=	The highest value in the set of values being evaluated.
MIN	=	The lowest value in the set of values being evaluated.
MBL	=	Minimum baseline level (above-ground standing live carbon stocks)
HSR	=	The "High Stocking Reference" for the Project Area. The High Stocking Reference is defined as 80 percent of the highest value for above-ground standing live carbon stocks per acre within the Project Area during the preceding 10-year period. To determine the High Stocking Reference, the Offset Project Operator or Authorized Project Designee must document changes in the Project Area's above-ground standing live carbon stocks over the preceding 10 years. Figure 6.7 presents a graphical portrayal of a High Stocking Reference determination.
CP	=	Common Practice (as determined in Step 1)
ICS	=	Initial above-ground standing live carbon stocks per acre within the Project Area (as determined in Step 2)
WCS	=	The weighted average above-ground standing live carbon stocks per acre for all Forest Owner (and affiliate) landholdings within the same logical management unit as the Project Area. See Section 6.2.1.1 for requirements and methods for calculating WCS.

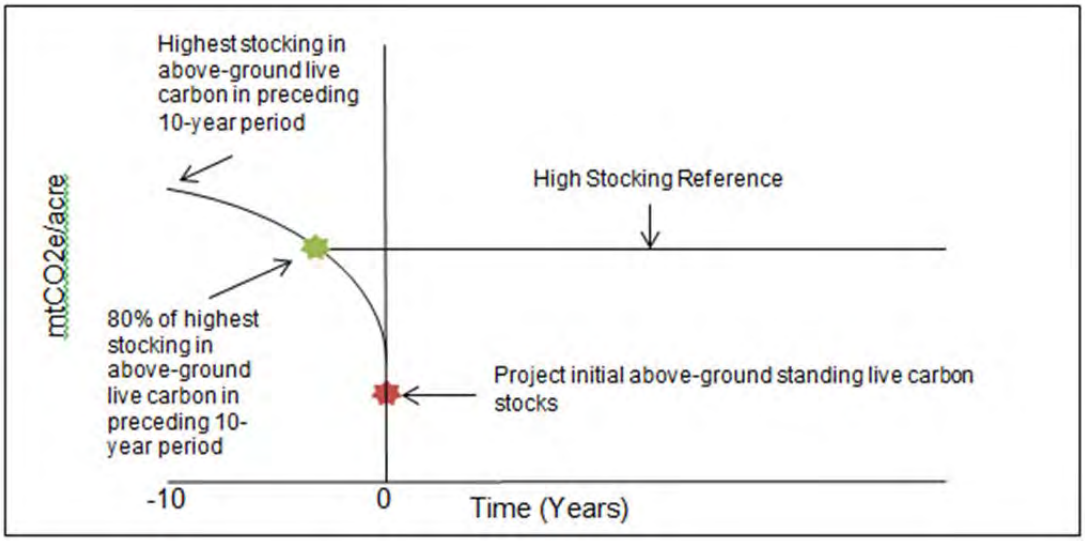


Figure 6.7. Determining a Project Area's High Stocking Reference
Note: It is possible for the High Stocking Reference to be higher than Common Practice, even where initial above-ground standing live-tree carbon stocks for the project are below Common Practice.

Step 4 – Determine the Baseline for All Carbon Pools

Once the baseline for above-ground standing live carbon stocks has been determined, perform the following steps:

1. Estimate separate baselines for all other required onsite carbon pools identified for the offset project. This includes above and below-ground standing live carbon stocks, above and below ground standing dead carbon stocks, and soil carbon stocks where applicable. These carbon stocks must be modeled or estimated following the requirements and methods in Appendix A and Appendix B.
2. Average the modeled results of each individual carbon pool, so that a single annual averaged value for each carbon pool results.
3. Sum the average annual value of above-ground standing live carbon stocks with the average annual value of all other carbon stocks to produce a final baseline for all onsite carbon pools (see Figure 6.8).

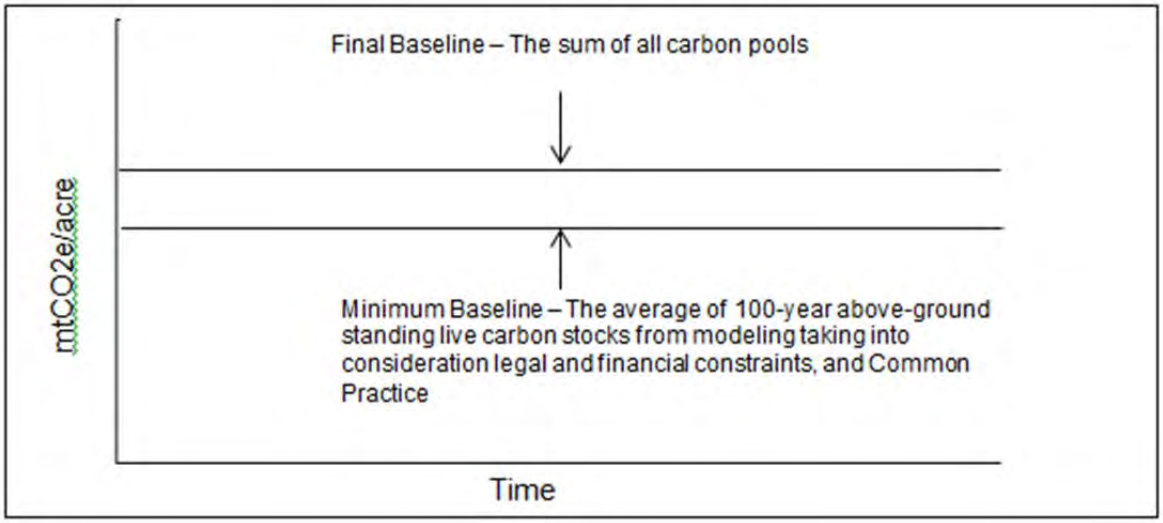


Figure 6.8. Final Baseline Incorporating All Required Onsite Carbon Stocks

6.2.1.1 Determining Weighted Average Carbon Stocks (WCS) on Lands in the Same Logical Management Unit as the Project Area

Quantification Methodology
Determining the minimum baseline level (MBL) for an Improved Forest Management project requires a comparison to carbon stocking levels on other lands within the same logical management unit (LMU) as the Project Area. The carbon stocking level within the LMU (expressed as the weighted average above-ground standing live carbon stocks per acre for all lands in the same LMU) is used as a parameter (WCS) for determining the MBL in Equation 6.6.

A “logical management unit” or “LMU” is defined as all land that the Forest Owner and its affiliate(s) (as defined below) either own in fee or hold timber rights on, and which it or they manage as an explicitly defined planning subunit. LMUs are generally characterized by unique biological, geographical, and/or geological conditions, are generally delimited by watershed boundaries and/or elevational zones, and contain unique road networks. In addition, an LMU must:

- Be a sustainable planning subunit as demonstrated by inventory reports and growth and harvest projections for the LMU or;
- Where even aged management is utilized, have a uniform distribution (by area) of 10-year age classes that extend to the normal rotation age (variation of any 10-year age class not to exceed 20%) or;
- Where uneven aged management is utilized, have between 33% and 66% of the forested stands exceeding the retention standards identified in the growth and harvest projections by a minimum of 25% (basal area).

An “affiliate” is defined as any person or entity that, directly or indirectly, through one or more intermediaries, controls or is controlled by or is under common control with the Forest Owner, including any general or limited partnership in which the Forest Owner is a partner and any limited liability company in which the Forest Owner is a member. For the purposes of this definition, "control" means the possession, direct or indirect, of the power to direct or cause the direction of the management and policies of a person, whether through the ownership of voting securities, by contract or otherwise, and “person” means an individual or a general partnership,

limited partnership, corporation, professional corporation, limited liability company, limited liability partnership, joint venture, trust, business trust, cooperative or association or any other legally-recognized entity.

If an explicit, existing LMU containing the Project Area cannot be identified, the LMU must be defined by identifying all lands where the Forest Owner and its affiliate(s) (as defined above) either own in fee or hold timber rights within the same Assessment Area(s) covered by the Project Area. Assessment Areas covered by the Project Area are identified in Step 1, above, using the information in Appendix F.

To calculate WCS, estimate the above-ground standing live carbon stocks per acre for the entire LMU containing the Project Area (including the Project Area itself). This can be done using either existing inventory data, or a stratified vegetation-type analysis.

6.2.1.1.1 Calculating WCS Using Inventory Data

Quantification Methodology

If sufficient inventory data for LMU lands exist to quantify above-ground standing live carbon stocks for the entire LMU, then the formula in Equation 6.7 must be used to calculate WCS.

Equation 6.7. Formula for WCS Using Inventory Data

$$If\ \left|\left(1-\frac{ECS}{ICS}\right)\right| \leq 0.2, then\ WCS = ICS$$

$$If\ \left|\left(1-\frac{ECS}{ICS}\right)\right| > 0.2, then\ WCS = \frac{ICS \cdot PA + ECS \cdot EA}{PA + EA}$$

Where,

WCS = The weighted average above-ground standing live carbon stocks per acre within the LMU containing the Project Area

ICS = Initial above-ground standing live carbon stocks per acre within the Project Area

PA = Size of the Project Area in acres

ECS = Above-ground standing live carbon stocks per acre within the LMU *but excluding the Project Area* (EA), as determined from existing inventory data

EA = Size of the LMU in acres, e*xcluding the Project Area*

6.2.1.1.2 Calculating WCS Using Stratified Vegetation-Type Analysis

Quantification Methodology

If sufficient inventory data is not available for the LMU, a stratified vegetation-type analysis must be used to calculate WCS. To conduct this analysis, all landholdings within the LMU – including the Project Area – must be divided into vegetation types and size class/canopy cover categories as delimited in Table 6.2 with a resolution for classification no greater than 40 acres. Each vegetation class has a “carbon rating” provided in Table 6.2. WCS must be calculated using the ratio of average carbon stocking on LMU lands relative to carbon stocking on Project Area lands

(referred to as the “stratified carbon weighting factor” or SWF). The required formulas are specified in Equation 6.8 and Equation 6.9.

Equation 6.8. Formula for WCS Using Stratified Vegetation-Type Analysis

$$If\ |(1 - SWF)| \leq 0.2, then\ WCS = ICS$$

$$If\ |(1 - SWF)| > 0.2, then\ WCS = \frac{(ICS \cdot PA) + (SWF \cdot ICS \cdot EA)}{PA + EA}$$

Where,

WCS = The weighted average above-ground standing live carbon stocks per acre within the LMU containing the Project Area

ICS = Initial above-ground standing live carbon stocks per acre within the Project Area

PA = Size of the Project Area in acres

SWF = The stratified carbon weighting factor for the LMU (from Equation 6.9 below)

EA = Size of the LMU in acres, e*xcluding the Project Area*

Equation 6.9. Formula for LMU Stratified Carbon Weighting Factor (SWF)

$$SWF = \frac{\sum_i (EA_i \cdot CR_i)}{\sum_i EA_i} \div \frac{\sum_i (PA_i \cdot CR_i)}{\sum_i PA_i}$$

Where,

SWF = The stratified carbon weighting factor for the LMU

PA_i = Acres of the Project Area in forest vegetation type *i* (from Table 6.2)

EA_i = Acres of the LMU, e*xcluding the Project Area,* in forest vegetation type *i* (from Table 6.2)

CR_i = Carbon rating for forest vegetation type *i* (from Table 6.2)

Table 6.2. Vegetation Classes for Stratification

Forest Vegetation Description	Average Diameter (Breast Height)	Average Canopy Cover	Carbon Rating (metric tons CO_2e/acre)
Brush	0"	NA	0
Regeneration	3"	NA	0.5
Pole-sized trees	6" - 12"	< 33%	2
Pole-sized trees	6" - 12"	33% - 66%	4
Pole-sized trees	6" - 12"	>66%	6

Small Sawlogs	12" - 20"	< 33%	4
Small Sawlogs	12" - 20"	33% - 66%	8
Small Sawlogs	12" - 20"	>66%	12
Large Sawlogs	20" - 36"	< 33%	8
Large Sawlogs	20" - 36"	33% - 66%	16
Large Sawlogs	20" - 36"	>66%	24
Very Large Trees	>36"	< 33%	16
Very Large Trees	>36"	33% - 66%	32
Very Large Trees	>36"	>66%	48

6.2.1.2 Consideration of Legal Constraints

In modeling the baseline for standing live carbon stocks, all legal constraints that could affect baseline growth and harvesting scenarios must be incorporated. The standing live carbon stock baseline must represent a growth and harvesting regime that fulfills all legal requirements. Voluntary agreements that can be rescinded, such as rental contracts and forest certifications, are not legal constraints. Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs) that are in place more than one year prior to the offset project commencement date shall be modeled as legal constraints. HCPs and SHAs that are approved after the date one year prior to the offset project commencement date are not considered legal constraints for the purpose of baseline modeling and may be disregarded from the baseline modeling.

Legal constraints include all laws, regulations, and legally-binding commitments applicable to the Project Area at the time of offset project commencement that could affect standing live carbon stocks. Legal constraints include:

1. Federal, state, or local government regulations that are required and might reasonably be anticipated to influence carbon stocking over time including, but not limited to:
    a. Zones with harvest restrictions (e.g. buffers, streamside protection zones, wildlife protection zones)
    b. Harvest adjacency restrictions
    c. Minimum stocking standards
2. Forest practice rules, or applicable Best Management Practices established by federal, state, or local government that relate to forest management.
3. Other legally binding requirements affecting carbon stocks including, but not limited to, covenants, conditions and restrictions, and other title restrictions in place prior to or at the time of project initiation, including pre-existing conservation easements, Habitat Conservation Plans, Safe Harbor Agreements, and deed restrictions, excepting an encumbrance that was put in place and/or recorded less than one year prior to the offset project commencement date, as defined in Section 3.5.

For forest projects located in California, the baseline must be modeled to reflect all silvicultural treatments associated with any submitted, active, or approved timber harvest plans (THPs) at the time of offset project commencement that would affect harvesting and management within the Project Area during the Project Life. All legally enforceable silvicultural and operational provisions of a THP – including those operational provisions designed to meet California Forest Practice Rules requirements for achieving Maximum Sustained Production of High Quality Wood Products [14 CCR 913.11 (933.11, 953.11)] – are considered legal constraints and must be reflected in baseline modeling for as long as the THP will remain active. For portions of the

Project Area not subject to THPs (or over time periods for which THPs will not be active), baseline carbon stocks must be modeled by taking into account any applicable requirements of the California Forest Practice Rules and all other applicable laws, regulations, and legally binding commitments that could affect onsite carbon stocks. On a case-by-case basis, the California Department of Forestry and Fire Protection (Cal FIRE) may assist in identifying minimum carbon stocking levels that would be effectively required under California Forest Practice Rules.

6.2.1.3 Consideration of Financial Constraints

In modeling the baseline for standing live carbon stocks, financial constraints that could affect baseline growth and harvesting scenarios must be included. It must be demonstrated that the growth and harvesting regime assumed for the baseline is financially feasible through one of the following means:

1. A financial analysis of the anticipated growth and harvesting regime that captures all relevant costs and returns, taking into consideration all legal, physical, and biological constraints. Cost and revenue variables in the financial analysis may be based on regional norms or on documented costs and returns for the Project Area or other properties in the Forest Project's Assessment Area.
2. Providing evidence that activities similar to the proposed baseline growth and harvesting regime have taken place on other properties within the Forest Project's Assessment Area within the past 15 years. The evidence must demonstrate that harvesting activities have taken place on at least one other comparable site with:
    a. Slopes that do not exceed slopes in the Project Area by more than 10 percent
    b. An equivalent zoning class to the Project Area
    c. Comparable species composition to the Project Area (i.e. within 20 percent of project species composition based on trees per acre)

6.2.2 Estimating Baseline Onsite Carbon Stocks – Public Lands

Quantification Methodology

For Improved Forest Management Projects on lands owned or controlled by public agencies, the baseline must be estimated by:

1. Conducting an initial forest carbon inventory for the Project Area
2. Projecting future changes to Project Area forest carbon stocks by:
    a. Extrapolating from historical trends
    b. Anticipating how current public policy will affect onsite carbon stocks

The method that results in the highest estimated carbon stock levels must be used to determine the baseline.

To extrapolate from historical trends:

- For Project Areas that have a ten-year history of declining carbon stocks, the baseline must be defined by the average of the carbon stocks over the past ten years and considered static for the project life (i.e. the same level of carbon stocks is assumed in every year).
- For Project Areas that demonstrate an increasing inventory of carbon stocks over the past ten years, the growth trajectory of the baseline shall continue until the forest (under the baseline stocks) achieves a stand composition consistent with comparable forested areas that have been relatively free of harvest over the past 60 years.

To anticipate how current public policy will affect onsite carbon stocks, the baseline must be modeled over 100 years following the requirements and methods in Appendix B incorporating constraints imposed by all applicable statutes, regulations, policies, plans and Activity-Based Funding.

6.2.3 Estimating Baseline Carbon in Harvested Wood Products

Quantification Methodology

To estimate the amount of baseline carbon transferred to long-term storage in wood products each year, the following steps must be performed:

1. Determine the *average* amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year of the baseline over 100 years. The result will be a uniform estimate of harvested carbon in each year of the baseline. This estimate is determined at offset project commencement, using the same volume models and biomass equations used to calculate biomass in live trees and estimate baseline onsite carbon stocks; this will not change over the course of the project life.
    a. For offset projects on private lands, the amount of harvested carbon must be derived from the growth and harvesting regime used to develop the baseline for onsite carbon stocks in Section 6.2.1.
    b. For offset projects on public lands, the amount of harvested carbon must be derived from the growth and harvesting regime assumed in the baseline for onsite carbon stocks derived in Section 6.2.2.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.2.4 Determining Actual Onsite Carbon Stocks

Quantification Methodology

Actual carbon stocks for Improved Forest Management projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Approved growth models and requirements and methods for projecting forest inventory plot data using models are provided in Appendix B.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the requirements and methods in Appendix A, Section A.4.

6.2.5 Determining Actual Carbon in Harvested Wood Products

Quantification Methodology

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.2.4).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.2.6 Quantifying Secondary Effects

Quantification Methodology

For Improved Forest Management Projects, significant Secondary Effects can occur if a project reduces harvesting in the Project Area, resulting in an increase in harvesting on other properties. Equation 6.10 must be used to estimate Secondary Effects for Improved Forest Management projects:

Equation 6.10. Secondary Effects Emissions

$$If \sum_{n=1}^{y} (AC_{hv,n} - BC_{hv,n}) \geq 0, then \;\; SE_y = 0$$

$$If \sum_{n=1}^{y} (AC_{hv,n} - BC_{hv,n}) < 0, then \; SE_y = (AC_{hv,y} - BC_{hv,y}) \times 20\%$$

Where,

SE_y	=	Estimated annual Secondary Effects (used in Equation 6.1.)
$AC_{hv,\,n}$	=	Actual amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons
$BC_{hv,\,n}$	=	Estimated average baseline amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons, as determined in Step 1 of Section 6.2.3
Y	=	The current year or reporting period

6.3 Avoided Conversion Projects

6.3.1 Estimating Baseline Onsite Carbon Stocks

Quantification Methodology

The baseline for Avoided Conversion Projects is a projection of onsite forest carbon stock losses that would have occurred over time due to the conversion of the Project Area to a non-forest land use. Estimating the baseline for Avoided Conversion Projects involves two steps:

1. Characterizing and projecting the baseline; and
2. Discount for the uncertainty of conversion probability.

Step 1 - Characterizing and Projecting the Baseline

The project baseline must be characterized by:

1. Clearly specifying an alternative highest-value land use for the Project Area, as identified by an appraisal (required in Section 3.1.2.3).
2. Estimating the rate of conversion and removal of onsite carbon stocks, taking into consideration any laws, statutes, regulations, or other legal mandates that affect land use conversion or removal of onsite carbon stocks. The rate of conversion and removal of onsite carbon stocks must be estimated by either:
    a. Referencing planning documentation for the Project Area (e.g. construction documents or plans) that specifies the timeframe of the conversion and intended removal of forest cover on the Project Area; or

b. In the absence of specific documentation, identifying default Total Conversion Impact and Annual Conversion values from Table 6.3.

3. Using a model to project changes in onsite carbon stocks over 100 years, reflecting the rate of conversion estimated in (2). The simulation must model changes in onsite carbon stocks for all required carbon pools, as identified in Section 5.3.

Table 6.3. Default Avoided Conversion

Type of Conversion Identified in Appraisal	**Total Conversion Impact** This is the assumed total effect over time of the conversion activity. (The total conversion impact is amortized over a 10-year period to determine the annual conversion in the next column.)	**Annual Conversion** This is the assumed annual conversion activity. The percentages below are multiplied by the initial onsite carbon stocks for the project on an annual basis for the first 10 years of the project.
Residential	Estimate using the following formula: TC = min(100, (P*3 / PA)*100) *Where:* TC = % total conversion (TC cannot exceed 100%) PA = the Project Area (acres) identified in the appraisal P = the number of unique parcels that would be formed on the project area as identified in the appraisal *Each parcel is assumed to deforest 3 acres of forest vegetation.	Estimate using the following formula: AC = TC / 10 *Where:* AC = % annualized conversion TC = % total conversion
Mining and agricultural conversion, including pasture or crops	90%	9.0%
Golf course	80%	8.0%
Commercial and Industrial buildings	95%	9.5%

The baseline modeling must apply the identified rate of conversion over time to estimate changes in onsite carbon stocks, beginning with the Project Area's initial onsite carbon stocks at the time of offset project commencement.

If the projected conversion rate does not result in a complete removal of onsite forest carbon stocks, the baseline projection should account for any residual forest carbon value as a steady condition for the balance of a 100-year projection.

Step 2 - Discount for Uncertainty of Conversion Probability

If the fair market value of the anticipated alternative land use for the Project Area (as determined by the appraisal required in Section 3.1.2.3) is *not more than 80 percent greater* than the value of the current forested land use, then a discount must be applied each year to the offset project's quantified GHG reductions and GHG removal enhancements. If quantified GHG reductions and GHG removal enhancements for the year are positive (i.e. $[(\Delta AC_{onsite} - \Delta BC_{onsite}) + (AC_{wp,\,y} - BC_{wp,\,y}) * 0.80 + SE_y] > 0$ within Equation 6.1) then use the following formula (Equation 6.11) to calculate the appropriate Avoided Conversion Discount factor, ACD. If quantified GHG reductions and removals for the year are negative, then ACD must equal zero.

Equation 6.11. Avoided Conversion Discount Factor

If $0.4 < ((VA / VP) - 1) < 0.8$, **then** $ACD = [0.80 - ((VA / VP) - 1)] \times 2.5$
If $((VA / VP) - 1) \geq 0.8$, **then** $ACD = 0$
If $((VA / VP) - 1) \leq 0.4$, **then** $ACD = 1$

Where,

ACD	=	The Avoided Conversion Project discount factor (used in Equation 6.1).
VA	=	The appraised fair market value of the anticipated alternative land use for the Project Area
VP	=	The appraised fair market value of the current forested land use for the Project Area

6.3.2 Estimating Baseline Carbon in Harvested Wood Products

Quantification Methodology

Harvesting is assumed to occur in the baseline over time as the Project Area is converted to another land use. To estimate the baseline carbon transferred to long-term storage in harvested wood products each year:

1. Determine the amount of carbon in standing live carbon stocks (prior to delivery to a mill) that would have been harvested in each year of the baseline, consistent with the rate of reduction in baseline standing live carbon stocks determined in Section 6.3.1. This projection is determined at offset project commencement, using the same volume models and biomass equations used to calculate biomass in live trees and estimate baseline onsite carbon stocks; this will not change over the course of the offset project life.
2. On an annual basis, determine the amount of harvested carbon that would have remained stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.3.3 Determining Actual Onsite Carbon Stocks

Quantification Methodology

Actual carbon stocks for Avoided Conversion Projects must be determined by updating the Project Area's forest carbon inventory. This is done by:

1. Incorporating any new forest inventory data obtained during the previous year into the inventory estimate. Any plots sampled during the previous year must be incorporated into the inventory estimate.
2. Using an approved model to "grow" (project forward) prior-year data from existing forest inventory plots to the current reporting year. Approved growth models are identified in Appendix B. Methods for projecting forest inventory plot data using models is also provided in Appendix B.
3. Updating the forest inventory estimate for harvests and/or disturbances that have occurred during the previous year.
4. Applying an appropriate confidence deduction for the inventory based on its statistical uncertainty, following the requirements and methods in Appendix A, Section A.4.

6.3.4 Determining Actual Carbon in Harvested Wood Products

Quantification Methodology

Perform the following steps to determine actual carbon in harvested wood products:

1. Determine the actual amount of carbon in standing live carbon stocks (prior to delivery to a mill) harvested in the current year (based on harvest volumes determined in Section 6.3.3).
2. Determine the amount of actual harvested carbon that will remain stored in wood products, averaged over 100 years, following the requirements and methods in Appendix C.

6.3.5 Quantifying Secondary Effects

Quantification Methodology

Significant Secondary Effects for Avoided Conversion projects can arise if the type of land use conversion that would have happened on the Project Area is shifted to other forest land.

To quantify Secondary Effects for Avoided Conversion projects, use Equation 6.12.

The value for Secondary Effect emissions will always be negative or zero.

Equation 6.12. Secondary Effects Emissions

$$\mathbf{SE_y = MIN[(-0.036 \times (\Delta AC_{onsite} - \Delta BC_{onsite}), 0]}$$

Where,

SE_y	=	Secondary Effect GHG emissions caused by the project activity in year y (Equation 6.1)
MIN	=	The lowest value in the set of values being evaluated.
-0.036	=	Conversion displacement risk value, assumed to be 3.6% for all forest lands
ΔAC_{onsite}	=	Annual difference in actual onsite carbon (CO_2e) as defined in Equation 6.1
ΔBC_{onsite}	=	Annual difference in baseline onsite carbon (CO_2e) as defined in Equation 6.1

7 Ensuring the Permanence of Credited GHG Reductions and GHG Removal Enhancements

The Regulation requires that credited GHG reductions and GHG removal enhancements be "permanent." Permanence of Forest project GHG reductions and removals is addressed through three mechanisms:

1. The requirement for all offset projects to monitor onsite carbon stocks, submit annual Offset Project Data Reports, and undergo third-party verification of those reports with site visits at least every six years for the duration of the Project Life.
2. The regulatory obligation for all intentional reversals of GHG reductions and GHG removal enhancements to be compensated for through retirement of other Compliance Instruments.
3. The maintenance of a Forest Buffer Account by ARB to provide insurance against reversals of GHG reductions and GHG removal enhancements due to unintentional causes (including natural disturbances such a fires, pest infestations, or disease outbreaks).

GHG reductions and GHG removal enhancements can be "reversed" if the stored carbon associated with them is released (back) to the atmosphere. Many biological and non-biological agents, both natural and human-induced, can cause reversals. Some of these agents cannot completely be controlled and may therefore result in an unintentional reversal, such as natural agents like fire, insects, and wind. Other agents can be controlled such as the human activities like land conversion and over-harvesting. Under this protocol, reversals due to controllable agents are considered intentional as defined in the Regulation. The Offset Project Operator or Authorized Project Designee is required to identify and quantify the risk of reversals from different agents based on offset project-specific circumstances. The resulting risk rating determines the quantity of ARB offset credits that the project must contribute to the Forest Buffer Account to insure against unintentional reversals.

7.1 Identifying a Reversal

The Offset Project Operator or Authorized Project Designee must demonstrate, through annual reporting and periodic verification, that stocks associated with credited GHG reductions and GHG removal enhancements are maintained for a period of time considered to be permanent. For purposes of this protocol 100 years is considered permanent. If the quantified GHG reductions and GHG removal enhancements (i.e. QR_y in Equation 6.1) in a given year are negative, and ARB offset credits were issued to the Forest Project in any previous year, it is considered a reversal, regardless of the cause of the decrease. Planned thinning or harvesting activities, for example, may cause a reversal if they result in a negative value for QR_y.

7.2 Insuring Against Reversals

Unintentional reversals are insured against by contributing a percentage of ARB offset credits to a Forest Buffer Account. The amount of the contribution is based on a project-specific risk evaluation.

7.2.1 About the Forest Buffer Account

A Forest Buffer Account is a holding account for ARB offset credits issued to Forest Project, which is administered by ARB. All Forest Projects must contribute a percentage of ARB offset credits to the Forest Buffer Account any time ARB offset credits are issued by ARB for verified GHG reductions and GHG removal enhancements. Each Forest Project's contribution is determined by a project-specific risk rating, as described in Section 7.2.2. If a Forest Project experiences an unintentional reversal of credited GHG reductions and GHG removal enhancements (as defined in Section 7.3), ARB offset credits from the Forest Buffer Account will be retired in an amount equal to the total amount of carbon that was reversed (measured in metric tons of CO_2-equivalent) according to the process identified in the Regulation. A Forest Buffer Account therefore acts as a general insurance mechanism against unintentional reversals for ARB offset credits issued to Forest Projects.

7.2.2 Contributions to the Forest Buffer Account

ARB offset credits will be contributed to the Forest Buffer Account pursuant to the Regulation based on the reversal risk rating for a project as determined by the requirements and methods in Appendix D. The risk rating must be determined prior to listing, and recalculated in every year the project undergoes verification. Forest Owners who record a Qualified Conservation Easement in conjunction with implementing a Forest Project will receive a lower risk rating (see Appendix D).

7.3 Compensating for Reversals

The Regulation defines reversals and establishes how reversals will be compensated.

7.3.1 Unintentional Reversals

The Regulation defines unintentional reversals. Requirements for compensating unintentional reversals are set forth in the Regulation.

7.3.2 Intentional Reversals

The Regulation defines intentional reversals. Requirements for intentional reversals are set forth in the Regulation.

7.4 Disposition of Forest Projects after a Reversal

Provisions related to the disposition of a Forest Project after a reversal are set forth in the Regulation. These provisions dictate under what circumstances a Forest Project that undergoes an intentional or unintentional reversal would be terminated and under what circumstances the Forest Project may continue without termination.

8 Offset Project Monitoring

General requirements for monitoring, reporting, and record retention are provided in the Regulation. The Offset Project Operator or Authorized Project Designee must conduct monitoring activities and submit Offset Project Data Reports in accordance with the Regulation and this protocol. Monitoring is required for a period of 100 years following the final issuance of any ARB or registry offset credits to an offset project.

For Forest Projects, monitoring activities consist primarily of updating a project's forest carbon inventory. ARB requires a complete inventory of carbon stocks to be reported each year. This complete inventory must be maintained and updated throughout the Project Life.

8.1 Forest Carbon Inventory Program

Prior to a Forest Project's first verification, a documented forest carbon inventory program, including an inventory monitoring plan and a modeling plan, must be established detailing the specific methods that will be used to update the project's forest carbon inventory on an annual basis. The forest carbon inventory program must adhere to the requirements and methods in Appendices A and B, which establish the equations for computing biomass and limits to which computer models can be used in the inventory update process.

8.2 Annual Monitoring Requirements

The Offset Project Operator or Authorized Project Designee is required to report the Forest Project's onsite carbon stocks each year in an Offset Project Data Report. The Offset Project Data Report must include an estimate of carbon stocks in all required carbon pools. The estimate must reflect the appropriate confidence deduction as determined by the steps in Appendix A, Section A.4. Annual onsite carbon stock estimates are computed from inventory data. Inventory data are updated annually by:

1. Incorporating any new forest inventory data obtained during the previous year.
2. Modeling growth in sample plots using approved growth models and stand table projection methods (see Appendix B regarding growth models and stand table projections).
3. Updating the forest inventory data for harvests and/or disturbances that have occurred during the previous year.

Specific methods used to update the forest inventory must follow the inventory methodologies approved at the time the project is initially verified. Modifications to inventory methodologies must be approved in advance by a third-party verification body and by ARB, and documented in the change log.

9 Reporting Requirements

This section provides supplemental requirements for reporting in addition to requirements contained in the Regulation. Offset Project Data Reports must be submitted at the conclusion of every Reporting Period.

9.1 Offset Project Documentation

In order for the offset project to be Listed, all of the information specified in the Project Listing Requirements in Section 9.1.1 must be submitted, along with any additional information specified in the Regulation. Reporting deadlines and record retention requirements are contained in the Regulation.

All reports that reference carbon stocks must be submitted with the oversight of a Professional Forester. If the offset project is located in a jurisdiction without a Professional Forester law or regulation, then a Professional Forester must either have the Certified Forester credentials managed by the Society of American Foresters, or other valid professional forester license or credential approved by a government agency in a different jurisdiction.

9.1.1 Offset Project Listing Requirements

The listing information in this section must be submitted by the Offset Project Operator or Authorized Project Designee prior to the Listing of the offset project. This information is also submitted as part of the first Offset Project Data Report, and is subject to verification at the initial offset project verification. The following listing information must be submitted no later than the date at which the Offset Project Operator or Authorized Project Designee submits the first Offset Project Data Report:

9.1.1.1 All Offset Projects[7]

1. Offset project name.
2. Offset project contact information, including name, phone number, address, and email address for:
   a. Offset Project Operator
   b. Authorized Project Designee (if applicable);
3. Whether the Offset Project Operator is the owner in fee for the project area.
   a. If yes, provide documentation (e.g. deed of trust, title report) showing the Offset Project Operator's ownership interest in the property and its interest in the trees and standing timber on the property.
   b. If no, explain how the entity identified as the Offset Project Operator has the right to undertake and list the project and provide documentation supporting the explanation.
4. Offset project type (reforestation, improved forest management, or avoided conversion).
5. A description of the management activities that will lead to increased carbon stocks in the Project Area, compared to the baseline.

[7] Reforestation projects as qualified in section 6.1 can defer the items that are marked with an asterisk until the second site-visit verification.

6. Indicate if the offset project occurs on public or private lands, and further specify if the offset project occurs on any of the following categories of land:
   a. Land that is owned by, or subject to an ownership or possessory interest of a Tribe;
   b. Land that is “Indian lands” of a Tribe, as defined by 25 U.S.C. §81(a)(1); or
   c. Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands.
7. Offset project commencement date, with an explanation and justification of the commencement date.
   a. Specify the action(s) that identify the offset project commencement date.
8. A statement as to whether any GHG reductions or GHG removal enhancements associated with the Project Lands have ever been listed or registered with, or otherwise claimed by, another registry or program, or sold to a third party prior to listing, including;
   a. Have any lands within the Project Area ever been listed or registered with an offset project registry or program in the past?
   b. Have greenhouse gas emission reductions or removal enhancements associated with lands within the Project Area been credited or claimed for the purpose of greenhouse gas mitigation or reduction goals, whether in a voluntary or regulatory context?
   c. If yes, identify the registry or program (include vintages and reporting period).
9. A statement as to whether the project is being implemented and conducted as the result of any law, statute, regulation, court order, or other legally binding mandate? If yes, explain.
10. Declaration that the offset project does *not* employ broadcast fertilization.
11. If the Forest Project is located on public land, a description and copies of the documentation demonstrating explicit approval of the offset project’s management activities and baseline including any public vetting processes necessary to evaluate management and policy decisions concerning the offset project.
12. If the Forest Project is located on the following categories of land, a description and copies of documentation demonstrating that the land within the Project Area is owned by a tribe or private entities:
    a. Land that is owned by, or subject to an ownership or possessory interest of a Tribe;
    b. Land that is “Indian lands” of a Tribe, as defined by 25 U.S.C. §81(a)(1); or
    c. Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands.
13. If commercial harvesting is either planned or ongoing within the Project Area, a description of how the Forest Owner satisfies one of the three requirements for employing and demonstrating sustainable long-term harvesting practices on all of its forest landholdings (refer to Section 3.8.1).
14. A description of how the offset project meets (or will meet) the definition of “Natural Forest Management” (refer to Section 3.8.2), including:
    a. Composition of native species;
    b. Distribution of age classes / sustainable management;
    c. Structural elements (standing and lying dead wood);
15. Descriptions and maps of the Project Area boundaries that include:
    a. Governing jurisdictions, and latitude/longitude coordinates
    b. Public and private roads (map)
    c. Towns (map)

d. Major watercourses (4th order or greater), water bodies, and watershed description (map)
e. Topography (map)
f. Townships, ranges, and sections or latitude and longitude (map)
g. Existing land cover and land use (description with optional map)
h. Forest vegetation types (description with optional map)
i. Site classes (description with optional map)
j. Land pressures and climate zone/classification (description with optional map)
k. Historical land uses, current zoning, and projected land use within project area and surrounding areas (description with optional map)
l. A georeferecned shape file (or other electronic file that can be read in a geographic information system) that clearly identifies the project area and boundaries. This file may constitute the required map if it includes the required map information listed above.

16. Identify what assessment area or areas contain lands within the Project Area.
    a. Include how many acres of project lands fall within each assessment area.
    b. Include a value for total project area acreage.
17. General description of the forest conditions within the Project Area:
    a. Species (tree) composition;
    b. Age class distribution;
    c. Management history;
18. Indicate whether the project will employ a Qualified Conservation Easement.
    a. If yes, include the date the Qualified Conservation Easement was or will be recorded, the terms that affect forest management within the easement, and provide a copy of the Qualified Conservation Easement to ARB.
19. *A description of the inventory methodology for each of the carbon pools included in the Forest Project's Offset Project Boundary. The inventory methodology must describe the information required in Appendix A.3.
20. *A description of the calculation methodologies for determining metric tons per acre for each of the carbon pools included in the Offset Project Data Report.
21. *A modeling plan, following the requirements and methods in Appendix B, Section B.3.
22. *A diagram of the final baseline incorporating all required carbon stocks.
23. *A summary of the inventory of carbon stocks for each carbon pool.
24. *A summary of inventory confidence statistics.
25. *A description and estimate of the Forest Project's baseline onsite carbon stocks. Baseline onsite carbon stocks must be portrayed in a graph depicting time in the x-axis and metric tons CO2-equivalent in the y-axis. The graph should be supported with written characterizations that explain any annual changes in baseline carbon stocks over time.
26. *An estimate of carbon that will be stored long-term in harvested wood products in the baseline.
27. *Calculation of the offset project's reversal risk rating and contribution to the Forest Buffer Account.

9.1.1.2 Reforestation Projects

In addition to the information in Section 9.1.1.1, the following information must be provided for Reforestation projects:

1. An explanation of how the Project Lands, at the time of offset project commencement, meets the eligibility requirements of a) less than 10 percent tree canopy cover for a minimum of 10 years; or b) subject to a significant disturbance that has removed at least 20 percent of the land's above-ground live biomass. The explanation should include why the forest was out of forest cover or a description of the disturbance if a natural significant disturbance occurred.
2. For a Reforestation Project that occurs on land that has undergone a recent Significant Disturbance, indicate the eligibility scenario pertaining to the project site as identified in Appendix E, or a description of how the Forest Project occurs on a type of land for which the Forest Owner has not historically engaged in or allowed timber harvesting.
3. A qualitative characterization of baseline conditions, including an assessment of the likely vegetative conditions and activities that would have occurred in the absence of the project, taking into consideration any laws, statutes, regulations, or other legal mandates that would encourage or require reforestation on the Project Area. The qualitative assessment shall include an assessment of the commercial value of trees within the project area over the next 30 years.
4. List any laws, statutes, regulations or other legal mandates that would encourage or require reforestation on the project area.

9.1.1.3 Improved Forest Management Projects on Private Lands

In addition to the information in Section 9.1.1.1, the following information must be provided for Improved Forest Management projects on private lands:

1. Documentation that the Project Area has greater than 10 percent tree canopy cover.
2. A determination of how the Forest Project's initial standing live carbon stocks compare to Common Practice, as required in Section 6.2.1.
3. If the Forest Project's initial standing live carbon stocks are below Common Practice, a determination of the "High Stocking Reference" for the Project Area. To determine the High Stocking Reference, changes in the Project Area's live-tree carbon stocks over the preceding 10 years must be documented.
    a. Include an affidavit testifying that the inventory depicted over the past 10 years is reasonably accurate.
    b. Include a summary of volume harvested over the past 10 years.
4. Documentation of any and all legal constraints affecting forest management activities on the Project Area. The documentation of legal constraints must include:
    a. A description of each constraint (refer to Section 6.2.1.2).
    b. A narrative that describes the effect of the constraint on forest management
    c. A description of the modeling techniques used to simulate the effects of the constraint.
5. A demonstration that the growth and harvesting regime assumed for the baseline is financially feasible following the requirements of Section 6.2.1.3.

9.1.1.4 Improved Forest Management Projects on Public Lands

In addition to the information in Section 9.1.1.1, the following information must be provided for Improved Forest Management projects on public lands:

1. Documentation demonstrating that the offset project takes place on land that has greater than 10 percent tree canopy cover.

2. A projection of future changes to Project Area forest carbon stocks by extrapolating from historical trends; and anticipating how current public policy will affect onsite carbon stocks per the requirements of Section 6.2.2.
3. An explanation of how current public policy will affect onsite carbon stocks and how the baseline modeling incorporates constraints imposed by all applicable statutes, regulations, policies plans and Activity-Based Funding.

9.1.1.5 Avoided Conversion Projects

In addition to the information in Section 9.1.1.1, the following information must be provided for Avoided Conversion projects:

1. Documentation demonstrating the planned or completed dedicating of the land in the Project Area to continuous forest cover through a Qualified Conservation Easement or transfer to public ownership.
2. Documentation demonstrating that the type of anticipated land use conversion is legally permissible per the requirements of Section 3.1.1.3.
3. A description of how the Project Area was determined, following the requirements in Section 4.
4. A full copy of the appraisal that was prepared for the Project Area per the requirements of Section 3.2.1.3.
5. A description of the highest value alternative land use identified in the appraisal.
6. An estimate the rate of conversion and removal of onsite carbon stocks per the requirements in Section 6.3.1.
7. A comparison of the fair market value of the anticipated alternative land use for the Project Area with the value of the current forested land use, and the calculation of an appropriate uncertainty discount (following the requirements in Section 6.3.1).
8. Where the anticipated alternative land use is commercial, residential or agricultural use, indicate the maximum slope of the project area.
9. Where the anticipated alternative land use is mining, describe the extent of mineral resources existing in the Project Area.
10. Where the anticipated alternative land use is commercial, residential or recreational use, indicate:
    a. The proximity of the Project Area to metropolitan areas;
    b. The proximity of the Project Area to grocery and fuel services and accessibility of those services;
    c. Population growth (people per year) within 180 miles of the Project Area.

9.2 Offset Project Data Report

Offset Project Operators or Authorized Project Designees must submit an Offset Project Data Report each year according to the reporting schedule in the Regulation. The listing information in Section 9.1.1 must be included in the initial Offset Project Data Report, and is subject to verifier review during the initial verifications. All Offset Project Data Reports must include the information in section 9.2.1.

9.2.1 Annual Reporting

An Offset Project Data Report must be prepared for each reporting period during the Project Life. Offset Project Data Reports must be provided to verification bodies whenever a Forest Project undergoes verification. Offset Project Data Reports must contain an annual update of the project's forest carbon inventory (Section 8.2). Each report must also contain the following information. Reforestation Projects, as qualified in Section 6.1, can defer the items that are

marked with an asterisk until submitting the offset project data report that will undergo the second verification.

1. Offset project name
2. Offset project contact information, including name, phone number, address, and email address for:
    a. Offset Project Operator
    b. Authorized Project Designee (if applicable);
3. Reporting Period.
4. A statement as to whether the Forest Project and associated Project Lands have met and been in compliance with all local, state, or federal regulatory requirements during the reporting period. If not, an explanation of the non-compliance must be provided.
5. A statement as to whether all the information submitted for project Listing is still accurate. If not provided updates to the relevant listing information.
6. An updated estimate of the reporting period's carbon stocks in all required carbon pools.
7. *The appropriate confidence deduction for the forest carbon inventory following the requirements and methods in Appendix A, Section A.4)
8. *An explanation of any decrease over any 10-year consecutive period in the standing live carbon pool.
9. Any changes in the status of the Forest Owner including, if applicable per Section 3.8.1, the acquisition of new forest landholdings.
10. A description of how the project meets (or will meet) the definition of "Natural Forest Management" (refer to Section 3.8.2), including progress on criteria that have not been fully met in previous years.
11. *An estimate of reporting-year harvest volumes and associated carbon in harvested wood products.
12. *Estimated mill efficiency, as determined following the method in Appendix C, Section C.2.
13. The baseline carbon stock estimates for all required carbon pools for the reporting period, as determined following the requirements in Section 6 and approved at the time of the project's registration.
14. An estimate of Secondary Effects, following calculation steps and/or factors provided in Section 6 and approved at the time of the offset project listing.
15. The uncertainty discount for avoided conversion projects, as determined following the requirements of Section 6.3 and approved at offset project listing. (After the initial verification, the uncertainty discount does not change.)
16. A calculation of total net GHG reductions and GHG removal enhancements (QR_y) for the reporting period, following the requirements in Section 6.
17. If a reversal has occurred during the previous reporting period, the report must include a written description and explanation of the reversal, whether the reversal has been classified as intentional or unintentional, and the status of compensation for the reversal.
18. *The offset project's reversal risk rating, as determined following the requirements in Section 7 and Appendix D.
19. *A calculation of the offset project's Forest Buffer Account contribution.
20. For the initial Offset Project Data Report: Projections of baseline and actual harvesting volumes from the Project Area over 100 years.

9.2.2 Additional Reporting for Verification Years

Forest Projects must be verified at least every six years. If verification is less frequent than annual, Offset Project Data Reports must include the following additional information on aggregated GHG emission reductions or removal enhancements since the last verification:

1. Annual estimates of carbon stocks for all required carbon pools reported during each year since the last verification.
2. Confidence deduction for the forest carbon inventory applied for each year since the last verification for the project, if applicable.
3. Baseline carbon stock estimates for all required carbon pools reported during each year since the last verification.
4. Estimate of Secondary Effects reported during each year since the last verification.
5. If a reversal has occurred during the previous six years, the report must provide a written description and explanation of the reversal, whether the reversal has been classified as intentional or unintentional, and the status of compensation for the reversal.
6. Calculation of the offset project's Forest Buffer Account contribution for each year since the last verification.
7. Calculation of total net GHG reductions and GHG removal enhancements (QR_y) reported for each reporting period since the last verification.

9.3 Reporting and Verification Cycle

Upon completion of a reporting period, the Offset Project Operator or Authorized Project Designee must annually submit an Offset Project Data Report according to the schedule specified in the Regulation for each reporting period. Reporting periods are defined in the Regulation. Offset Project Data Reports must be verified (including a site visit) by an ARB-accredited verification body according to the schedule and requirements in the Regulation and Section 10.

A Forest Project is considered automatically terminated (see Section 3.4) if the Offset Project Operator or Authorized Project Designee chooses not to report data and undergo verification at required intervals.

Reforestation Projects for which an initial inventory is deferred are not eligible to receive ARB or registry offset credits until after the second verification.

10 Verification

10.1 Regulatory Verification Requirements

Offset Project Data Reports must be verified in accordance with the regulatory verification requirements in Subarticle 13 of the Regulation and this protocol. Failure to conform to any requirements in this protocol or the Regulation, as applicable, will result in an adverse verification statement. Forest Projects are not eligible to receive a qualified positive offset verification statement.

10.2 Additional Verification Requirements

In addition to the offset project verification requirements in the Regulation, verification of Offset Project Data Reports for Forest Projects must include the following:

10.2.1 Initial Verification

During the initial full verification, the following is required:

1. A detailed review of all required Listing Information during the initial verification.
    a. Include a thorough review of documentation and maps to verify the acreage of the Project Area enrolled in a Forest Project.

10.2.2 Full Verification

During every full verification, including the initial verification, the following is required of the offset verifier:

1. A detailed review of the forest carbon inventory, including:
    a. Inventory methodology and sampling design;
    b. Inventory update processes;
    c. Measurement of sample plots and sample plot locations;
    d. Lifetime and updating of sample plots, as applicable;
    e. Stratification methods, if applicable;
    f. Biomass equations and calculations;
    g. Incorporation of growth and harvest modeling and data;
    h. Documentation of inventory methods and procedures, including procedures for data quality assurance and quality control.
2. Identification and re-measurement of a selection of sample plots, along with a comparison with inventory data to have reasonable assurance that sample plots are measured accurately using the methods required in this section.

    The following paragraphs use specific terms that may not always have the same meanings in varying contexts. For the purposes of this verification the following terms and definitions apply:

- Stand: An individual unit or polygon that is relatively homogeneous in terms of the carbon stocking within its borders. For live and dead trees, the determination of stand boundaries is usually based on forest vegetation attributes, such as species, size (age), and density characteristics. For soils, the determination of soil stand boundaries is made on similar soil types.
- Stratum: A group of stands that contain a similar attribute, such as vegetation or soils attributes.
- Strata: Plural of stratum. The set of different groupings for a specific attribute, such as vegetation or soil

The offset verifier will sample plots consistent with the objectives of a random, risk-based and efficient approach. In doing so, the offset verifier may weight the probability of selecting strata and plots based on appropriate criteria such as carbon stocking, access difficulty, and vegetation heterogeneity. Verifiers may choose to sample project plots within strata with a cluster design. The selection of a stratum may use probability proportional to carbon stocks or probability proportional to error risk.

The verification procedures described below must be applied independently for each applicable carbon pool or applicable combination of pools that is included in the Offset Project Boundary:

- Standing live and dead trees;
- Soil;
- Lying dead wood; and
- Shrubs and herbaceous understory

Sequential statistical methods are used to minimize the verification effort when verification and project sample data agree. Sequential approaches have stopping rules rather than fixed sample sizes. With each successive plot, or series of plots, analyzed by the offset verifier, a stopping rule indicate to the offset verifier a) to continue to the next plot(s) since the results do not indicate either a bias or an agreement and further testing is required, b) stop as the testing indicates bias, or c) stop as the testing indicates agreement. When a stopping rule is met then the result is evaluated. Verification of sample plots is successful after a minimum number of successive plots in a sequence indicate agreement. Where the stopping rules indicate the presence of a bias, additional verification plots may be collected after that time if it is felt that random chance may have caused the test to fail and a convergence towards agreement is expected with additional samples. For effective application of the sequential statistics in the field, the determination of when the stopping rule is met is determined at the end of each sampling day, which will include the full set of plots measured in that day.

Stands of a given stratum must be independently selected using a random selection design. Plots, or clusters, must be independently selected within a stand using a random or systematic design. No more than 6 plots or clusters can be assigned to a stand, unless the groups of plots required for verification exceed the number of stands that exist for the offset project. If the offset project is not stratified for each applicable pool, the offset verifier shall allocate the plots or clusters on a randomized basis. If the offset verifier uses a cluster design, the mean of the cluster accounts for one observation (plot). Plots may be measured and assessed one at a time or in reasonable batches that correspond to logistical realities such as crew-days of effort. Verification sampling may be conducted using clustering or systematic approaches to facilitate efficiency.

When the project area has been stratified for the purposes of estimating the Forest Project's inventory based on common characteristics for each carbon pool, the offset verifier shall select three strata for each applicable carbon pool based on the offset verifier's evaluation of risk. Consideration of risk should be based on the overall importance of a given stratum to the project's total stocks and the presumption that any given stratum is inaccurately measured. The selection of stands to verify within a given stratum must be random. The minimum number of sample plots varies by project size and number of strata verified (Table 10.1).

Table 10.1. Minimum number of sample plots in sequence, as a function of project size.

Test	Number of Strata Verified	Project Acres				
		<100	100 - 500	501 - 5,000	5,000 - 10,000	> 10,000
Paired/Unpaired	3	2	3	4	5	6
	2	4	6	8	10	12
	1	8	12	16	20	24

There are two possible statistical procedures that can be applied to the stratum-level verifications. A paired test can be applied when plot locations can be found and it is statistically appropriate (i.e. plot measurements can be replicated) to use a paired test. An unpaired test can be applied when plots cannot be relocated. The range of acceptable error (δ, delta) is fixed at 10 percent.

Assigning Risk to Strata: The offset verifier must determine for each applicable pool or combination of pools if the Offset Project Operator or Authorized Project Designee has stratified the project area into strata that reflect common characteristics that influence carbon stocks. The offset verifier may presume risk exists in the highest stocked strata, strata that are unique or difficult to access due to topographical, vegetative, or other physical barrier, strata that represent a large portion of the project's inventory due to the area they represent, or any other risk perceived by the offset verifier. The determination of risk must be applied to the stratum as a unit and not individual stands of a given stratum.

Selecting Strata based on Risk: Based on the assessment of risk, the offset verifier will query, or request that the Offset Project Operator or Authorized Project Designee query, the set of stands that are associated with the strata selected. The queried stands must have an identifier which can be based on the Offset Project Operator or Authorized Project Designee's identification convention or one assigned by the offset verifier. Three strata must be selected, or the maximum number of strata stratified by the Offset Project Operator or Authorized Project Designee for each pool. Table 10.2 displays an example of ordered strata for standing live and dead trees selected by stratum with random numbers assignments.

Table 10.2. Stands selected by vegetation strata and risk class with random number assignments.

Stand Number	Stratum (from Forest Owner or Verifier)	Risk Class	Order of Random Selection
2	Dense Intermediate Conifers	High Stocking	5
3	Dense Intermediate Conifers	High Stocking	3
4	Dense Intermediate Conifers	High Stocking	1
8	Dense Intermediate Conifers	High Stocking	8
9	Dense Intermediate Conifers	High Stocking	2
10	Dense Intermediate Conifers	High Stocking	1
15	Dense Intermediate Conifers	High Stocking	4
18	Dense Intermediate Conifers	High Stocking	7
Stand Number	**Stratum (from Forest Owner or Verifier)**	**Risk Class**	**Order of Random Selection**
8	Dense Mature Conifers	High Stocking	4
9	Dense Mature Conifers	High Stocking	3
10	Dense Mature Conifers	High Stocking	5
15	Dense Mature Conifers	High Stocking	2
18	Dense Mature Conifers	High Stocking	1
Stand Number	**Stratum (from Forest Owner or Verifier)**	**Risk Class**	**Order of Random Selection**
13	Medium Dense Mature Riparian	Difficult Access	2
14	Medium Dense Mature Riparian	Difficult Access	1
17	Medium Dense Mature Riparian	Difficult Access	3

Planning and Implementing Field Verification Sampling: The selected stands shall be mapped and labeled with the random number to assist in developing a strategy to perform field sampling activities. Up to 6 plots or clusters may be re-measured in a stand (if plots are monumented) or installed (if plots are not monumented) in each stand. If the project area has not been stratified or there are less than 3 strata, the offset verifier shall locate the plots or clusters using a random process of their own design. For efficiency, it is acceptable for the offset verifier to relocate to a new area at the beginning of a day without having completed all the plots in the previous day.

Determination if the Stopping Rules have been met: The offset verifier must determine if the stopping rules have been met for each stratum after the measurement of each plot, unless the offset verifier determines it is appropriate to defer the determination until no later than the end of each day of sampling. The offset verifier must conduct the appropriate calculation for a paired or unpaired test. It is required that the offset verifier apply the random order selection in the sampling process. For efficiency purposes, the offset verifier may skip the random order on a temporal basis as long as the sequential analysis includes the ordered set of stands. This may provide significant efficiencies when selected stands and/or plots are in close geographic proximity and it is hypothesized that the stopping rules will require the full number of plots. An example is displayed in Table 10.3.

Table 10.3. The table displays a sampling schedule planned by the offset verifier and the verification results. In this example, the sequential sampling is conditionally satisfied after Day 3 but requires the full set of randomly selected stands to be sampled up to the point of satisfying the sequential statistics, which is met after sampling Stand 3 on Day 4.

Stand	Stratum (from Forest Owner)	Risk Class	Order of Random Selection	Sampling Schedule (Planned)	Verification Effort	Verification Results
4	Dense Intermediate Conifers	High Stocking	1	Day 3	Day 1	Inconclusive. Stand 9 sampled. Sequential sampling criteria not satisfied - More plots are needed
9	Dense Intermediate Conifers	High Stocking	2	Day 1	Day 2	Inconclusive. Stand 15 sampled. Sequential sampling criteria not satisfied - More plots are needed
3	Dense Intermediate Conifers	High Stocking	3	Day 4	Day 3	Inconclusive. Stand 4 sampled. Sequential sampling criteria satisfied but stand order must be satisfied. Stand 3 must be sampled.
15	Dense Intermediate Conifers	High Stocking	4	Day 2	Day 4	Conclusive. Stand 3 sampled. Sequential sampling criteria is met and adherence to random selection is maintained
2	Dense Intermediate Conifers	High Stocking	5	Day 6	Further Verification Effort not Necessary	
10	Dense Intermediate Conifers	High Stocking	6	Day 5		
18	Dense Intermediate Conifers	High Stocking	7	Day 7		
8	Dense Intermediate Conifers	High Stocking	8	Day 8		

Paired Plots: The statistical test is based on a comparison of the offset verifier's measurements of plots within a selected stratum, calculated as CO_2-equivalent compared to the Offset Project Operator's or Authorized Project Designee's measurements of plots, which may include any adjustments for growth. The offset verifier must use α=0.05 and β=0.20 to control for error. The null hypothesis (H_0) is that the verifier's plots and project plots are equal.

1) Sample and measure at least the minimum number of plots required in Table 10.1.

2) If $n \geq ((Z_\alpha + Z_\beta)^2 \times S_n^2) / D^2$ then stop and evaluate. Otherwise take another sample.

   n = Number of verification plots measured
   $Z_\alpha = \alpha/2\%\ N(0,1) = 1.645$
   $Z_\beta = \beta/2\%\ N(0,1) = 0.8416$
   S_n^2 = sample variance of the differences
   $D = \delta \times$ project average estimate

3) If stopped, then evaluate.

   If $\bar{X}_N \leq K$ then accept H_0,
   If $\bar{X}_N > K$ then reject H_0.

   $\bar{X}_N$ = sample mean of the differences,
   N = total number of plots measured,
   $K = (Z_\alpha \times D) / (Z_\alpha + Z_\beta)$.

4) If H_0 was rejected then additional samples may be taken as long as the offset verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

Unpaired Plots: The statistical test is based on comparing the average $CO_{2-}e$ estimates for each stratum from the verifier plots to the Offset Project Operator's or Authorized Project Designee's plots.

The offset verifier must use α=0.05 to control for error; the β is not specified because the method is constructing a confidence interval not a test. The null hypothesis (H_0) is that the verification and stratum averages are equal. The following procedure is appropriate for the unpaired test.

1) Sample and measure at least the minimum number of plots required in Table 10.1. Calculate n as the sum of the number of plots from both the stratum and the verification.

2) Calculate the following:

   $T_n = \bar{X}_p - \bar{X}_n$ where,
   $\bar{X}_p$ = stratum mean,
   $\bar{X}_n$ = verification mean after sample n.
   S_n^2 = sample variance of the verification plots,
   S_P^2 = sample variance of the stratum plots,
   D = δ × stratum average estimate.
   a = the percentile from a standard normal distribution for one half of alpha; is equal to 1.96 for α=0.05

3) If $n \geq (a^2/D^2) \times (S_n^2 + S_P^2)$, then stop and evaluate. (Note: $n = n = n_P + n_V$). Otherwise take another sample.

4) If stopped, then evaluate. Construct a confidence interval $T_n \pm D$.
   If the confidence interval includes zero then accept H_0,
   Otherwise reject H_0.

5) If H_0 was rejected then additional samples may be taken until as long as the verifier is of the opinion that there is a chance that H_0 may be accepted based on the variability and trend observed.

If the stopping rule in step (3) above cannot be attained within 100 plots then apply a standard unpaired t-test comparison using alpha of 0.05 and beta of 0.80.

3. Application of appropriate confidence deductions, if applicable.

4. Review reversal risk rating calculation.
5. Review of conformance with natural forest management and sustainable harvesting requirements.

10.2.3 Less-Intensive Verification

Less intensive verification refers to offset verification services that may be provided in interim years between full verifications. In the case of Forest Projects, full verification is required once every six years. Less intensive verification services may be provided in interim years between full verification at the discretion of the Offset Project Operator or Authorized Project Designee, subject to the concurrence of the accredited verification body that conducted the last full verification. Less intensive verification is not allowed if (1) there have been significant changes in methodologies or updates to the forest carbon inventory program, or (2) there has been a change in verification body since the previous verification.

Less intensive verification of an Offset Project Data Report only requires data checks and document reviews of an Offset Project Data Report based on the analysis and risk assessment in the most current sampling plan developed as part of the most recent full offset verification services. A site visit is not required. This level of verification may only be used if the verification team can provide findings with a reasonable level of assurance.

During less intensive verification of Forest Projects, the verification team must:

- Conduct data checks and carefully review data and calculations contained within the Offset Project Data Report, and
- At a minimum, review documentation supporting the data and calculations in the Offset Project Data Report, including the data used to update the forest carbon inventory and any new sample plot measurements, updates in growth and yield models, timber harvest plans and other regulatory documentation related to timber harvest, documentation of timber sales.

10.2.4 Verification of Multiple Reporting Years

If verification is less frequently than annual, the verification team must separately review and evaluate each reporting period of reported data specified in Section 9.2.2.

1. Each reporting period of quantified GHG reductions or GHG removal enhancements (QR_y) is separately evaluated for offset material misstatement.

10.2.5 Verification Team

Each verification team must include the following:

1. At least one Professional Forester that takes an active role in reviewing the forest carbon inventory program and conducting the site visit.
2. At least one individual with demonstrated competence in forest biometrics through:
    a. A master's degree in statistics or forest biometrics, or another closely related science that includes 12 semester or 16 quarter hours of forest biometrics, sampling design and/or statistics coursework; or

    b. University coursework that includes 12 semester or 16 quarter hours of forest biometrics, sampling design and/or statistics coursework, and at least two years of experience sampling, developing, implementing and analyzing forest biomass or carbon inventories
3. At least one individual with demonstrated knowledge of and competence in the use of forest growth and yield models, and demonstrated experience working with the model used in the forest carbon inventory being verified. Such experience should include university or other professional coursework, and/or project experience demonstrating competency in the use of the model.
4. An ARB-accredited Forest Offset Project Specialist.

An explanation demonstrating that the verification team includes individuals with the required experience and expertise must be included in the Notice of Verification Services submittal. The required experience and expertise may be demonstrated by a single individual, or by a combination of individuals.

10.2.6 Minimum Required Verification Schedule

Except as allowed for the second verification of Reforestation Projects, ARB requires that an ARB-accredited third-party verification body review and assess all reported data and information for a Forest Project and conduct a site visit at least once every six years. Verification is also required anytime new confidence deductions and/or reversal risk ratings are established. This requirement is consistent with Title 17, Cal. Code Regs. section 95977.1(b)(3)(D) and does not impose an additional visit requirement.

For Reforestation Projects, the second verification may be deferred up to 12 years at the discretion of the Offset Project Operator or Authorized Project Designee.

11 Glossary of Terms[8]

Above-Ground Live Biomass	The total mass of biomass in live trees including the stem, branches, and leaves or needles, brush and other woody live plants above ground.
Activity-Based Funding	The budget line items that are dedicated to agency accomplishments in vegetation management, including pre-commercial thinning, commercial thinning, harvest, hazard tree removal, hazardous fuel reductions, and other management activities designed to achieve forest sustainability health objectives.
Additional	Additional is defined in the Regulation. Under this protocol, GHG reductions or removals from Forest Projects are demonstrated to be addition when they pass a legal requirement test and a performance test, as described in Section 3.1, and by achieving GHG reductions and removals quantified against an approved baseline, determined according to the requirements in Section 6.
Allometric Equation	An equation that utilizes the genotypical relationship among tree components to estimate characteristics of one tree component from another. Allometric equations allow the below ground root volume to be estimated using the above-ground bole volume.
Assessment Area	A distinct forest community within geographically identified ecoregions that consists of common regulatory and political boundaries that affect forest management. The size of an Assessment Area is determined by efforts to achieve optimal statistical confidence across multiple scales using U.S. Forest Service Forest Inventory and Analysis Program (FIA) plots for biomass. Maps of the Assessment Areas and the associated data may be found on ARB's website.
Avoided Conversion Project	A type of Forest Project consisting of specific actions that prevent the conversion of privately owned forestland to a non-forest land use by dedicating the land to continuous forest cover through a conservation easement or transfer to public ownership.
Best Management Practices	Management practices determined by a state or designated planning agency to be the most effective and practicable means (including

[8] For terms not defined in this section, the definitions in the Regulation apply.

	technological, economic, and institutional considerations) of controlling point and nonpoint source pollutants at levels compatible with environmental quality goals.
Biological Emissions	For the purposes of the Forest Offset Protocol, biological emissions are GHG emissions that are released directly from forest biomass, both live and dead, including forest soils. For Forest Projects, biological emissions are deemed to occur when the reported tonnage of onsite carbon stocks, relative to baseline levels, declines from one year to the next.
Biomass	Biomass is defined in the Regulation.
Bole	A trunk or main stem of a tree.
Broadcast Fertilization	A fertilizer application technique where fertilizer is spread across the soil surface.
Carbon Pool	A greenhouse gas reservoir.
Common Practice	The average stocks of the standing live carbon pool from within the Forest Project's Assessment Area, derived from FIA plots on all private lands within the defined Assessment Area.
Even-Aged Management	Management where the trees in individual forest stands have only small differences in their ages (a single age class). By convention, the spread of ages does not differ by more than 20 percent of the intended rotation.
FIA	USDA Forest Service Forest Inventory and Analysis program. FIA is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems. FIA has been in operation under various names (Forest Survey, Forest Inventory and Analysis) for 70 years.
Forest Buffer Account	Forest Buffer Account is defined in the Regulation as a holding account for Forest Project ARB offset credits administered by ARB. It is used as a general insurance mechanism against unintentional reversals for all forest offset projects listed under a Compliance Offset Protocol.
Forest Management	The commercial or noncommercial growing and harvesting of forests.
Forest Owner	A Forest Owner is defined in the Regulation as the owner of any interest in the real (as opposed

	to personal) property involved in a forest offset project. Generally, a Forest Owner is the owner in fee of the real property involved in a forest offset project. In some cases, one entity may be the owner in fee while another entity may have an interest in the trees or the timber on the property, in which case all entities or individuals with interest in the real property are collectively considered the Forest Owners, however, a single Forest Owner must be identified as the Offset Project Operator.
Forest Project	A planned set of activities designed to increase removals of CO_2 from the atmosphere, or reduce or prevent emissions of CO_2 to the atmosphere, through increasing and/or conserving forest carbon stocks.
Forestland	Land that supports, or can support, at least 10 percent tree canopy cover and that allows for management of one or more forest resources, including timber, fish and wildlife, biodiversity, water quality, recreation, aesthetics and other public benefits.
GHG Removal Enhancement	GHG removal enhancement is defined in the Regulation. GHG removal enhancements are calculated as gains in carbon stocks over time relative to a Forest Project's baseline.
Greenhouse Gas (GHG) Reservoir	Greenhouse Gas Reservoir is defined in the Regulation. For Forest Projects, GHG reservoirs may include above-ground or below-ground biomass or harvested wood products, among others.
Improved Forest Management Project	A type of Forest Project involving management activities that increase carbon stocks on forested land relative to baseline levels of carbon stocks.
Listed	A Forest Project is considered "listed" when an the Offset Project Operator or Authorized Project Designee is registered with ARB or an approved offset project registry, submits all required documentation for project listing in the Regulation and this protocol, and the project has been approved by ARB or an approved offset project registry for listing.
Litter	Any piece(s) of dead woody material from a tree, e.g. dead boles, limbs, and large root masses, on the ground in forest stands that is smaller than material identified as lying dead wood.
Lying Dead Wood	Any piece(s) of dead woody material from a tree,

	e.g. dead boles, limbs, and large root masses, on the ground in forest stands. Lying dead wood is all dead tree material with a minimum average diameter of 5” and a minimum length of 8’. Anything not meeting the measurement criteria for lying dead wood will be considered litter. Stumps are not considered lying dead wood.
Metric ton (MT) or “ton”	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1023 short tons.
Native Forest	For the purposes of this protocol native forests shall be defined as those occurring naturally in an area, as neither a direct nor indirect consequence of human activity post-dating European settlement.
Natural Forest Management	Forest management practices that promote and maintain native forests comprised of multiple ages and mixed native species at multiple landscape scales. The application of this definition, its principles, detailed definition, and implementation are discussed further in the Section 3.8.2.
Non-Forest Cover	Land with a tree canopy cover of less than 10 percent.
Non-Forest Land Use	An area managed for residential, commercial, or agricultural uses other than for the production of timber and other forest products, or for the maintenance of woody vegetation for such indirect benefits as protection of catchment areas, wildlife habitat, or recreation.
Non-Harvest Disturbance	Reduction in forest cover that is not a direct result of harvest, such as wildfire and insect disturbances.
Onsite Carbon Stocks	Carbon Stock as defined in the Regulation means “the quantity of carbon contained in an identified GHG reservoir.” For Forest Projects onsite carbon stocks include the carbon stocks in the required carbon pools indicated in Table A.1 within the Project Area.
Primary Effect	The Forest Project’s intended changes in carbon stocks, GHG emissions, or GHG removals.
Professional Forester	A professional engaged in the science and profession of forestry. For forest projects that occur in a jurisdiction that has professional forester licensing laws and regulations, a Professional Forester must be credentialed in

	that jurisdiction. Where a jurisdiction does not have a professional forester law or regulation, then a Professional Forester is defined as either having the Certified Forester credentials managed by the Society of American Foresters, or other valid professional forester license or credential approved by a government agency in a different jurisdiction.
Project Area	The area inscribed by the geographic boundaries of a Forest Project, as defined following the requirements in Section 4 of this protocol. Also, the property associated with this area.
Project Life	Refers to the duration of a Forest Project and its associated monitoring and verification activities, as defined in Section 3.4.
Public Lands	Lands that are owned by a public governmental body such as a municipality, county, state, or country.
Qualified Conservation Easement	A qualified conservation easement must explicitly refer to the requirements of the regulation and this protocol and apply to current and all subsequent Forest Owners for the full duration of the Forest Project's minimum time commitment, as defined in Section 3.4 of this protocol.
Reforestation Project	A type of Forest Project involving the restoration of tree cover on land that currently has no, or minimal, tree cover.
Reversal	A reversal as defined in the Regulation. Under this protocol, a reversal is deemed to have occurred if the quantified GHG reductions and removal enhancements in a given year are negative and offset credits were issued to the Forest Project in any previous year, regardless of the cause of the decrease.
Secondary Effects	Unintended changes in carbon stocks, GHG emissions, or GHG removals caused by the Forest Project.
Significant Disturbance	Any natural impact that results in a loss of at least 20 percent of the above-ground live biomass that is not the result of intentional or grossly negligent acts of the Forest Owner.
Standing Dead Carbon Stocks	The carbon in standing dead trees. Standing dead trees include the stem, branches, roots, or section thereof, regardless of species, with a minimum diameter at breast height of five inches and a minimum height of 15 feet. Stumps are not

	considered standing dead stocks.
Standing Live Carbon Stocks	The carbon in the live tree biomass. Live trees include the stem, branches, roots, and leaves or needles of all live biomass, regardless of species, with a minimum diameter at breast height of five inches and a minimum height of 15 feet.
Stocks (or Carbon Stocks)	The quantity of carbon contained in an identified GHG reservoir (or carbon pool).
Submitted	A Forest Project is “submitted” when all of the appropriate forms have been uploaded and submitted.
Tree	A woody perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown with the capacity to attain a minimum diameter at breast height of 5 inches and a minimum height of 15 feet with no branches within 3 feet from the ground at maturity.
Unintentional Reversal	An unintentional reversal as defined in the Regulation is any reversal not due to the Forest Owner’s negligence, gross negligence or willful intent, including wildfires or disease that are not the result of the Forest Owner's negligence, gross negligence or willful intent.
Uneven-Aged Management	Management that leads to forest stand conditions where the trees differ markedly in their ages, with trees of three or more distinct age classes either mixed or in small groups.

Appendix A Developing an Inventory of Forest Project Carbon Stocks

Quantification Methodology

This appendix provides requirements for quantifying a Forest Project's forest carbon stocks. It explains how to identify the required forest carbon pools measured in a Forest Project, as well as the steps necessary for quantifying the existing carbon stocks in the selected pools within the Project Area. Carbon inventory information serves two purposes:

1. It is used as the basis for modeling and estimating carbon stocks in a Forest Project's baseline (following the requirements of Section 6).
2. It is used to quantify actual carbon stocks during the course of a project.

This appendix explains the essential steps and requirements for completing a carbon inventory for all required onsite carbon pools associated with a Forest Project.

A.1 Provide Background Information on Forest Area

To begin the inventory process, develop a general description of the activities and land use patterns that influence carbon stocks in the Project Area, including all the information required in Section 9.1.1.1. This information will help inform the initial design of the forest inventory, as well as the estimations of carbon stocks. This information will be reviewed during verification.

A.2 Measure Carbon Pools in the Project Area

Forest carbon pools are broadly grouped into the following categories:

1. Living biomass
2. Onsite dead biomass
3. Soil (per Tables 5.1-5.3)

Values for some of these categories of carbon will be determined through direct sampling. Table A.1 indicates the categories with their associated carbon pools and identifies which pools must be quantified for all offset projects versus those are excluded depending on the project. It also shows how the value for the pool is determined.

Table A.1. Requirements of carbon pool categories and determination of value for pool

Category	Carbon Pool	Improved Forest Management	Reforestation	Avoided Conversion	Determination of Value
Living biomass	Standing Live	Required	Required*	Required	Sampled in Project
	Shrubs and Herbaceous Understory	Excluded	Required	Excluded	Sampled in Project
Onsite dead biomass	Standing Dead	Required	Required	Required	Sampled in Project
Soil	Soil**	Required/ Excluded**	Required/ Excluded**	Required/ Excluded**	Sampled in project

* Pre-existing trees must be distinguished from planted trees. Since pre-existing and new trees are easy to distinguish for several decades after tree planting, pre-existing trees do not need to be inventoried until the offset project first seeks verification of GHG reductions and GHG removal enhancements.
** Soil carbon is not anticipated to change significantly as a result of most Forest Project activities. Soil carbon is excluded except when specified in Section 5.

A.3 Developing Onsite Forest Carbon Inventories

To develop estimates of carbon stocks in the carbon pools identified in Table A.1, a forest inventory must first be conducted. Standard forest inventories require the establishment of sample plots and provide inventory estimates in terms of cubic or board foot volume. These measurements are based on the species, trunk or bole diameter, form and height of the tree.

Each Offset Project Operator or Authorized Project Designee must develop and document a forest carbon inventory methodology. The inventory method must be capable of quantifying carbon stocks for required carbon pools to a high degree of accuracy. A complete inventory methodology must include:

1. A description of the Offset Project Boundary, including a list of all carbon pools included in the Offset Project Boundary.
2. For each carbon pool, include a detailed description of the inventory sampling methodology used to quantify that carbon pool, with references clearly documented. This documentation must include:
    a. Standard procedures for the collecting of field measurements. These procedures must be detailed enough so that any qualified forester would be able to accurately repeat the previous measurements. These procedures must include a description of the types of sample plots, location of plots, and frequency for updating or replacing sample plots as well as the forest carbon inventory as a whole;
    b. Standard procedures for where and how to measure parameters used in volume models and biomass equations and the associated calculations (such as dbh and height, including for irregular trees), how to classify dead wood, and for any other aspects of sampling where a consistent method needs to be documented; and
    c. Stratification rules (pre and post sampling), if applicable, that include a map of vegetation strata, results of stratification (area by strata), tools for application

(such as GIS, aerial photos), and a discussion of how boundaries were determined.

3. Documentation of all analytic methods including volume models and biomass equations used to translate field measurements into volume or biomass carbon estimates;
4. A documented quality assurance / quality control (QA/QC) plan including procedures for internal review to ensure that standard operating procedures are being followed. The QA/QC plan must include procedures for assessing and ensuring the quality of collection, transfer and archiving of field data; procedures for data entry and analysis, and data maintenance and archiving; and any other relevant procedures to ensure quality and consistency in the collection and maintenance of data used to compile the offset project data reports.
5. Description of data management systems and processes, including the collection, storage, and analysis of inventory and all related analytical methods used to translate field measurements into volume and/or biomass estimates.
6. A change log documenting any changes in the inventory methods, volume models, or biomass equations used to calculate carbon stocks.
7. Standard procedures for updating the forest carbon inventory, including documented procedures to account for:
    a. Harvest;
    b. Growth;
    c. Disturbance;
    d. Incorporating new inventory and plot data, and retiring older sample plots;
    e. Modeling, as allowed under Appendix B; and
    f. Application of appropriate confidence deduction.
8. Identification and description of known or potential disease(s) that may affect the health of the project's inventory, specifically above-ground standing live and dead trees.

Inventory methods and sampling procedures, once established, must be consistent over the life of the project. Any changes to inventory methods or calculations must be documented and justified in the change log.

Allometric Equations for Volume, Biomass, and Carbon Mass Estimates

The volume models and biomass equations in the Forest Offset Protocol Resources section of ARB's webpage must be used for biomass and carbon mass estimations using the bole diameter and total height for live trees and sound standing dead trees for trees ≥ 5 inches in diameter at breast height. Estimates of standing dead tree (for non-sound trees) biomass must be computed in terms of cubic volume and subsequently converted to biomass/carbon mass estimates.

Projects must adjust for decay and structural loss in standing dead trees at the tree-level by incorporating density reduction factors and structural loss adjustments using the Domke et al.(2011) reference on the Forest Offset Protocol Resources section of ARB's webpage for projects located in the 45 states using the Component Ratio Method (all states except Washington, Oregon, and California). For projects in Washington, Oregon and California, use Harmon et al. (2011) density factors by decay class to estimate density in standing dead carbon stocks.

Sample Plots

Any plot data used for deriving the forest carbon inventory estimates must have been sampled within the last 12 years. The scheduling of plot sampling may occur in one time period or be distributed over several time periods. Either approach is acceptable so long as an inventory of the entire Project Area (its required carbon pools and corresponding sample plots) is completed within 12-year intervals.

Steps for Developing a Complete Forest Carbon Inventory

The steps that follow provide more detail on establishing and maintaining a complete inventory and estimating carbon stocks. Results must be summarized in a table when submitting required data in an Offset Project Data Report (see Section 9).

Step 1 – Developing Inventory Methodology and Sample Plots

The Offset Project Operator or Authorized Project Designee must develop and describe a methodology to sample for biomass or volume of all required carbon pools. If a pre-existing forest inventory is used to develop a forest carbon inventory, all steps here must be followed to ensure the existing inventory meets the requirements of this protocol.

Sampling methodology and measurement standards should be consistent throughout the duration of the Forest Project. If new methodologies are adopted, they must achieve an equal or greater accuracy relative to the original sampling design. All sampling methodologies and measurement standards must be statistically sound and must be approved during verification.

Stratification is not required, but it may simplify verification. Temporary flagging of plot center, as is customary to allow for check cruising, is required to ensure ongoing inventory quality and allow for offset verifiers to visit plots when verifying inventory procedures. If permanent plots are used, which are statistically efficient for stock change estimates, permanent plot monumenting must be sufficient for relocation. Plot centers should be referenced on maps, preferably with GPS coordinates. The methodologies utilized must be documented and made available for verification and public review. The design of the sampling methodology and measurement standards must incorporate the requirements in the following table. All tree species within the Project Area must be measured regardless of the merchantability of the trees.

Table A.2. Minimum required sampling criteria for estimated pools

Carbon Pool	Name of Requirement	Description of Requirement
Standing Live Carbon Stocks (above-ground portion)	Diameter (breast height) Measurements	The minimum diameter (at breast height) must be stated in the methodology, and this minimum diameter must not be greater than 5 inches (inventory must include all trees 5 inches and greater in diameter).
	Height Measurements	Height must be measured as per the inputs required by the volume models and/or biomass equations for each species and/or for subsequent updates to the inventory upon re-measurement. If the project's growth and yield model imputes heights utilizing the model's own data points (but accepts measured height) height measurements collected in the field or derived from field inventory must be used in the model. In interim years when inventory data is modeled, DBH and height estimate outputs from the model may be used as the basis for carbon calculations. A portion of heights may be estimated as long as the height estimate methodology and overall inventory method employed results in an inventory that is capable of being quantified at the plot level to a high degree of accuracy, designed such that any qualified forester would be able to accurately repeat the previous measurements, whereby the verifier reviews the inventory sampling methodology and agrees that all sampling methodology and measurement standards are statistically sound. All height and field measurements within a project area are subject to passing sequential sampling and verification.
	Deductions for Missing Biomass	Standing live trees may have cavities, broken tops, or other deformities that reduce biomass in the trees. Inventory methodology must include a standardized approach and description of how deductions are estimated to account for missing biomass.
	Measurement Tools	Description of tools used for height measurement, diameter measurement, and plot measurement.
	Measurement Standards	The methodology shall include a set of standards for tree and plot size measurements.
	Plot Layout	A description of plot layout.
	Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be included in the sampling design.
	Allometric Equation used for Estimating Biomass	The methodology must include a description of the allometric equation used to estimate the whole tree biomass (bole, branches, and leaves) from bole diameter measurements. The use of functions other than those provided in the protocol will need to be approved by ARB and the verification body.
Standing Live Carbon Stocks (below-ground portion)	Plot-level Allometric Equation used for Estimating Biomass	Apply model (Cairns, Brown, Helmer, & Baumgardner, 1997) to estimate below-ground biomass density for projects located in California, Oregon, and Washington. This model equation is based on above-ground biomass density in tons per hectare. For projects in the other 45 states apply the component ration methods. The use of a function other than that provided in the protocol will need to be approved by ARB and the verification body.

Herbaceous Understory	Sampling Methodology	The sampling methodology prepared by Brown, Shoch, Pearson, & Delaney (2004). Alternative methodologies need to be reviewed and approved by ARB and the verification body.
Standing Dead Tree Carbon Stocks (above-ground)	Diameter (breast height) and top Diameter Measurements	The minimum diameter (at breast height) must be stated in the methodology, and this diameter must not be greater than 5 inches. The minimum height of standing dead trees is 15'. The method must include how volume is derived where a total height does not exist (i.e. where the tree is broken).
	Deductions for Missing Biomass	Standing dead trees may have cavities, broken tops, or other deformities that reduce biomass in the trees. Inventory methodology must include a standardized approach and description of how deductions are estimated to account for missing biomass. For projects in California, Oregon, and Washington, adjustments for decay and structural loss must be incorporated in the sampling design and reflected in the project inventory accounting methodology, using Harmon et al. (2011) density factors by decay class. For projects in the other 45 states, adjustments for decay and structural loss must be incorporated in the sampling design and reflected in the project inventory accounting methodology using Domke et al (2011) decay and structural loss adjustment factors.
	Measurement Standards	The methodology shall include a set of standards for height and diameter measurements.
	Plot Layout	A description of plot layout (may be the same layout as for live tree biomass).
	Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be included in the sampling design.
Standing Dead Tree Carbon Stocks (below-ground portion)	Plot-level Allometric Equation used for Estimating Biomass	Apply model (Cairns, Brown, Helmer, & Baumgardner, 1997) to estimate below-ground biomass density for projects located in California, Oregon, and Washington. This model equation is based on above-ground biomass density in tons per hectare. For projects in the other 45 states apply the component ration methods. The use of a function other than that provided in the protocol will need to be approved by ARB and the verification body.

Step 2 – Estimating Carbon in Live Trees from Sample Plots

Standing live tree carbon estimates are required for all offset projects. The standing live tree estimate includes carbon in all portions of the tree, including the bole, stump, bark, branches, leaves, and roots. The Offset Project Operator or Authorized Project Designee is responsible for determining appropriate methodologies for sampling to determine standing live tree carbon stocks. The estimate of above-ground live tree biomass must be combined with the estimates of biomass from other carbon pools to determine a mean estimate of the included pools derived from sampling, along with a summary that describes the statistical confidence of the estimate. All biomass estimates must be converted to carbon estimates. The derived estimate of biomass must be multiplied by 0.5 to calculate the mass (kg) in carbon. This product must be multiplied by 0.001 tons/kg to convert the mass to metric tons of carbon.

Approved volume models and biomass equations are available in the Forest Offset Protocol Resources section of ARB's website.

Step 3 – Estimating Carbon Standing Dead Tree Carbon from Sample Plots

An inventory of carbon stocks in standing dead trees is required for all Forest Projects. The Offset Project Operator or Authorized Project Designee must provide a sampling methodology for standing dead tree carbon as part of an overall sampling strategy (discussed in Step 1). Sound dead trees can be computed using the equations provided for standing live carbon in Step 2. The estimate of standing dead tree carbon for highly decayed trees (broken tops, missing branches, etc.) must be calculated first volumetrically and subsequently converted to biomass and carbon tons.

For those trees where volume is computed, the volume will need to be converted to biomass density by applying conversion factors based on decay class. The methodology developed must include a description of the calculation techniques used to determine biomass density by decay class (i.e., decay classes 2-5). The estimate of biomass density must be computed in terms of metric tons of carbon on a per acre basis.

- For states using the Component Ratio Method (all states in the contiguous U.S. except California, Oregon and Washington), estimates of trees in advanced stages of decay are obtained by estimating gross and sound volume from tree and site-level variables, converting sound volume to biomass, converting biomass in each tree component to carbon, and incorporating density reduction factors and structural loss adjustments using the steps in the Domke et al. (2011) (Steps 3-16) paper on the Forest Offset Protocol Resources section of ARB's webpage.
- For projects in California, Oregon and Washington, estimates of trees in advanced stages of decay are obtained by estimating gross volume using the required volume models on the ARB Forest Offset Protocol Resources section of ARB's webpage, converting to sound volume, and then applying density factors by decay class from Harmon el al. (2011) to estimate density in standing dead trees.

Step 4– Estimate Carbon in Shrubs and Herbaceous Understory from Sample Plots

Any methodology developed for measuring carbon in shrubs must be reviewed during verification. The most applicable biomass estimation methods may be used, including photo series, the estimation functions from published papers, direct sampling, or combinations of approaches.

Step 5 – Estimate of Carbon Tons in Soil

Changes in total soil carbon are a challenge to measure over short timeframes, as this pool changes slowly and is usually dependent on the rate of biomass input relative to soil decomposition. The sampling methodology and protocols for deriving carbon estimates in soil must be developed as part of an overall sampling strategy (discussed in Step 2). Use the soil sampling methodology prepared by Brown, Shoch, Pearson, & Delaney (2004).

Step 6 – Sum Carbon Pools

The metric tons of carbon in each carbon pool, as derived from the preceding steps, must be entered in tables A.3(a) and A.3(b). For the purpose of quantifying GHG reductions and GHG removal enhancements, all numbers must be converted to metric tons of CO_2-equivalent by multiplying by 3.664.

Table A.3(a). Summarizing Carbon Pools and Calculating Total Metric Ton of CO_2e per Carbon Pool

Carbon Pool	Source	Gross CO_2-equivalent Tons per Acre
Step 2 Standing Live Carbon Stocks	From sampling results of trees.	
Steps 3 Standing Dead Carbon Stocks	From sampling results of standing dead biomass.	
Step 4 Shrubs and Herbaceous Understory	From sampling results of shrubs and herbaceous understory.	
Step 5 Soil	From sampling results of soil.	
Sum of CO_2-equivalent Tons from Required Pools		

Table A.3(b) requires the Offset Project Operator or Authorized Project Designee to identify the metric tons CO_2e by stratum and identify the percentage of carbon each stratum represents in relation to the total project area. This table provides valuable information to the offset verifiers as they identify areas of risk when planning their site visit.

Table A.4(b). Summarizing Total Metric Ton of CO_2e by Carbon Pool and Stratum

Carbon Pool: (e.g. above ground standing live)

Strata	No. of Plots	Carbon (CO_2e /acre)			Total Acres	CO_2e Total	CO_2e by Percentage of Total
		Average	Std. Dev.	Std. Error			
Total							

A.4 Applying a Confidence Deduction

Any forest carbon inventory estimate will be subject to statistical uncertainty. Where statistical confidence is low, there is a higher risk of overestimating a project's actual carbon stocks and therefore a higher risk of over-quantifying GHG reductions and GHG removal enhancements. To help ensure that estimates of GHG reductions and GHG removal enhancements are conservative, a confidence deduction must be applied each year to the inventory of actual onsite carbon stocks. A confidence deduction is *not* applied to the forest carbon inventory when it is used to model baseline carbon stocks.

To determine the appropriate confidence deduction, perform the following:

1. Compute the standard error of the inventory estimate (based on the carbon in all carbon pools included in the forest carbon inventory).
2. Multiply the standard error by 1.645.

3. Divide the result in (2) by the total inventory estimate and multiply by 100. This establishes the sampling error (expressed as a percentage of the mean inventory estimate from field sampling) for a 90 percent confidence interval.
4. Consult Table A.4 to identify the percent confidence deduction that must be applied to the inventory estimate for the purpose of calculating GHG reductions and removals (i.e. variable CD_y in Equation 6.1 in Section 6).

Table A.4. Forest carbon inventory confidence deductions based on level of confidence in the estimate derived from field sampling.

Sampling Error (% of Inventory Estimate)	Confidence Deduction
0 to 5.0%	0%
5.1 to 19.9%	(Sampling Error – 5.0%) to the nearest 1/10th percentage
20% or greater	100%

The confidence deduction must be updated each time the offset project is subject to verification, but must remain unchanged between verifications. If increased sampling over time results in a lower confidence deduction at the time of verification, the lower deduction must be applied to inventory estimates in the most recent reporting period subject to verification at that time. ARB or registry offset credits may be issued in the most recent reporting period for any verified increase in quantified GHG reductions and GHG removal enhancements associated with the new (lower) confidence deduction. Conversely, if a loss of qualified sampling plots results in a higher confidence deduction, this higher deduction is applied to the inventory estimates in the most recent reporting period subject to verification at that time. Any resulting decrease in quantified GHG reductions and GHG removal enhancements from prior years as a result of the increased confidence deduction will be treated as an intentional reversal, and must be compensated pursuant to the Regulation.

Appendix B Modeling Carbon Stocks

Quantification Methodology

This protocol requires the use of certain empirical-based models to estimate the baseline carbon stocks and project stocks of selected carbon pools within the Project Area. These models may also be used to supplement assessments of actual changes in carbon stocks resulting from the Forest Project.

B.1 About Models and Their Eligibility for Use with Forest Projects

Empirical-based models are used for estimating existing values where direct sampling is not possible or cost-effective. They are also used to forecast the estimations derived from direct sampling into the future. Field measurements provide the basis for inferring value through the use of these models.

The models that simulate growth projections have two basic functions in the development and management of a forest project. Models project the results of direct sampling through simulated forest management activity. These models, often referred to as growth and yield simulation models, may project information regarding tree growth, harvesting, and mortality over time – values that must ultimately be converted into carbon in an additional step. Other models may combine steps and estimate tree growth and mortality, as well as changes in other carbon pools and conversions to carbon, to create estimated projections of carbon stocks over time.

Models are also used to assist in updating inventory plots so that the plots can represent a reporting year subsequent to their actual sample date. The model simulates the diameter and height increment of sampled trees for the length of time between their sampled date and the reporting year. The limit to the use of models for updating plot data is described in Appendix A.

The following growth models have been approved (versions publicly available prior to January 1, 2015):

- CACTOS: California Conifer Timber Output Simulator
- CRYPTOS: Cooperative Redwood Yield and Timber Output Simulator
- FVS: Forest Vegetation Simulator
- SPS: Stand Projection System
- FPS: Forest Projection System
- FREIGHTS: Forest Resource Inventory, Growth, and Harvest Tracking System
- CRYPTOS Emulator
- FORSEE

Inventory plot data may be updated for estimating diameter and height growth by incorporating data obtained from sample plots, as in a stand table projection. To qualify for this method:

- The Project Area shall be stratified into even-age management and uneven-age management.
- Diameter increment shall be based on the average annual increment of a minimum of 20 samples of radial growth for diameter increment for each 8” DBH (diameter at breast height) class, beginning at 0 – 8” DBH for each management (even-age or uneven-age) type. The average annual increment shall be added for each year according to the plot’s sample date.
- Height increment shall be based on regression curves for each management type (even-age or uneven-age) developed from height measurements from the same trees from

which the diameter increment data was obtained. The estimated height shall be determined using the regression estimators for the ‘grown’ diameters as described above.

B.2 Using models to forecast carbon stocks

The use of simulation models is required for estimating a Forest Project’s baseline carbon stocks. Models may also be required to forecast actual carbon stocks expected under the Forest Project (e.g. in conjunction with determining expected harvesting volumes or in updating forest carbon inventories).

Inventory information from Appendix A must be incorporated into the simulation models to project carbon stocks over time. If a model has the ability to convert biomass to carbon, it must include all the carbon pools required by this protocol.

Projected baseline and actual carbon stocks must be portrayed in a graph depicting time in the x-axis and carbon tons in the y-axis. Baseline carbon stocks must be projected forward from the date of the Forest Project’s offset project commencement. The graph should be supported with written characterizations that explain any annual changes in baseline carbon stocks over time. A reference point depicting the initial above-ground standing live carbon stocks must be included in the graph. These characterizations must be consistent with the baseline analysis required in Section 6.

B.3 Modeling Requirements

A modeling plan must be prepared that addresses all required forecasting or updating of baseline and actual carbon stocks for the Forest Project. The modeling plan shall contain the following elements:

1. A description of all silviculture methods modeled. The description of each silviculture method will include:
    a. A description of the trees retained (by species groups if appropriate) at harvest.
    b. The harvest frequency (years between harvests).
    c. Regeneration assumptions.
2. A list of all legal constraints that affect management activities on the Project Area. This list must identify and describe the constraint and discuss the silviculture methods that will be modeled to ensure the constraint is respected.
3. A description of the site indexes used for each species and an explanation of the source of the site index values used.
4. A description of the model used and an explanation of how the model was calibrated for local use, if applicable.

Modeling outputs must include:

1. Periodic harvest, inventory, and growth estimates for the entire Project Area presented as total carbon tons and carbon tons per acre.
2. Harvest yield streams on modeled stands, averaged by silviculture method and constraints, which must include the period over which the harvest occurred and the estimated volume of wood removed.

Appendix C Estimating Carbon in Wood Products

Quantification Methodology

Wood products may constitute a reservoir for storing carbon over the long term. Projects that increase wood product production can receive credit for the resulting incremental carbon storage. By the same token, projects that reduce wood product production must account for the incremental *reduction* in stored wood product carbon. As indicated in Section 7, GHG reductions and GHG removal enhancements must be effectively "permanent," meaning that sequestered carbon associated with GHG reductions and removals must remain stored for at least 100 years. Wood product carbon is estimated by calculating the average amount of carbon that is likely to remain stored in wood products over a 100-year period.

The processes described here are adapted from the 1605(b) methodology (U.S. Department of Energy, 2007) for accounting for the long-term storage of wood products. Please see Smith, Heath, Skog, & Birdsey (2006) for a more detailed description since the 1605(b) procedure was adapted from this publication.

The average amount of carbon remaining sequestered in wood products over the 100-year period is determined by calculating the amount of carbon delivered to the mills, the portion of carbon that is converted to wood products, and the wood product classes manufactured by the mill. An estimate of the average carbon remaining in wood products over the 100-year period is the basis of baseline and annual reporting of harvested wood products.

Project reporting of harvested wood products occurs on an annual basis. Wood product classes reported for a given reporting year apply both to the project and the baseline case. The volume of logs delivered to the mill in the baseline case remains static throughout the project life. However, the mill efficiencies and the wood product classes identified in a reporting period are applied to the baseline harvested wood products the same way they apply to the project harvested wood products. This is meant to provide the best comparison of project activity to baseline activity. The annual reporting of carbon in trees harvested for wood products is based on the relative proportion of volume in trees harvested for wood products and volume delivered to the mill(s) in the baseline case.

Because of the significant uncertainties associated with predicting wood product carbon storage over 100 years, the accounting requirements in this appendix are designed to err on the side of conservativeness. This means the calculations are designed to reduce the risk of overestimating the GHG reductions and GHG removal enhancements achieved by a Forest Project. One of the largest sources of uncertainty is predicting the amount of wood product carbon likely to be stored in landfills. To accommodate this uncertainty, and ensure that Forest Project GHG reductions and GHG removal enhancements are accounted for conservatively:

1. Landfill carbon storage is *excluded* from calculations of wood-product carbon in years where a Forest Project's actual harvesting volumes exceed estimated baseline harvesting volumes, as determined in Section 6.
2. Landfill carbon storage is *included* in calculations of wood-product carbon in years where a Forest Project's actual harvesting volumes are below estimated baseline harvesting volumes, as determined in Section 6.

Accounting for wood product carbon must be applied only to actual or baseline volumes of wood harvested from within the Project Area. Trees harvested outside of the Project Area are not part of the Forest Project and must be excluded from any calculations.

There are six steps required to account for the harvesting of trees and to determine carbon stored in wood products:

1. Accounting for CO_2e associated with trees harvested (whole tree including below ground).
2. Determining the amount of carbon in trees harvested that is delivered to mills (bole without bark).
3. Accounting for mill efficiencies.
4. Estimating average carbon storage over 100 years in in-use wood products.
5. Estimating average carbon storage over 100 years in wood products in landfills (when applicable).
6. Summing the results to determine total average carbon storage over 100 years.

C.1 Determine the Amount of Carbon in Harvested Wood Delivered to Mills

The following steps must be followed to determine the amount of carbon in harvested wood if the biomass model does not provide metric tons carbon in the bole, without bark. If it does, skip to step C.2.

1. Determine the amount of wood harvested (actual or baseline) that will be delivered to mills, by volume (cubic feet) or by green weight (lbs.), and by species for the current year (y). In all cases, harvested wood volumes and/or weights must exclude bark.
    a. Baseline harvested wood volumes and species are derived from modeling a baseline harvesting scenario, following the requirements in Section 6.
    b. Actual harvested wood volumes and species must be based on verified third-party scaling reports, where available. Where not available, documentation must be provided to support the quantity of wood volume harvested.

2. If a volume measurement is used, multiply the cubic foot volume by the appropriate wood density factor by species, depending on the project location. Use Smith et al. (2006) for projects located in the Pacific Northwest (examples in Table C.1) or from the USFS Wood Handbook for projects located in other regions.[9] Both references are provided on the Forest Offset Protocol Resources section of ARB's website. This results in pounds of biomass with zero moisture content.

3. If a weight measurement is used, subtract the water weight based on the moisture content of the wood. This results in pounds of biomass with zero moisture content.

4. Multiply the dry weight values by 0.5 pounds of carbon/pound of wood to compute the total carbon weight.

5. Divide the carbon weight by 2,204.6 pounds/metric ton to convert to metric tons of carbon. This value is used in the next step, accounting for mill efficiencies.

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[9] The Wood Handbook (USFS, 2010) contains specific gravities for tree species in other regions. Multiply the specific gravity by the density of water (62.43 lbs/ft^3) to get wood density.

Table C.1 Examples of Specific gravity and Wood Density of green softwoods and hardwoods by forest type for the Pacific Northwest

Forest Type	Specific Gravity of Softwoods	Specific Gravity of Hardwoods	Wood Density of Softwoods (lbs/ft^3)	Wood Density of Hardwoods (lbs/ft^3)
Mixed conifer	0.394	0.521	24.59	32.51
Douglas-fir	0.429	0.483	26.77	30.14
Fir-spruce-hemlock	0.372	0.510	23.21	31.82
Ponderosa pine	0.380	0.510	23.71	31.82
Redwood	0.376	0.449	23.46	28.02

Reference: Table 4. Factors to calculate carbon in growing stock volume: softwood fraction, sawtimber-size fraction, and specific gravity by region and forest type group. Smith et al. 2006, adapted from a USDA Forest Service General Technical Report NE-343.

C.2 Account for Mill Efficiencies

Multiply the total carbon weight (metric tons of carbon) for each species derived in step C.1 by the mill efficiency identified for the project's mill location(s) in the Regional Mill Efficiency Database, found on the Forest Offset Protocol Resources section of ARB's website. If wood products classes cannot be assessed at the species level, carbon weight may be aggregated. This is the total carbon transferred into wood products. The remainder (sawdust and other byproducts) of the harvested carbon is considered to be immediately emitted to the atmosphere for accounting purposes in this protocol.

C.3 Estimate the Average Carbon Storage Over 100 Years in In-Use Wood Products

The amount of carbon that will remain stored in in-use wood products for at least 100 years depends on the rate at which wood products either decay or are sent to landfills. Decay rates depend on the type of wood product that is produced. Thus, in order to account for the decomposition of harvested wood over time, a decay rate is applied to wood products according to their product class. To approximate the climate benefits of carbon storage, this protocol accounts for the average amount of carbon stored over 100 years. Thus, decay rates for each wood product class have been converted into "average storage factors" in Table C.2 below.

<u>Steps to Estimate Average Carbon Storage Over 100 Years in In-Use Wood Products</u>

To determine the average carbon storage in in-use wood products over 100 years, the first step is to determine what percentage of a Project Area's harvest will end up in each wood product class for each species (Columns A-G in Table C.2). This must be done by either:

- Obtaining a verified report from the mill(s) where the Project Area's logs are sold indicating the product categories the mill(s) sold for the year in question; or

- If a verified report cannot be obtained, looking up default wood product classes for the project's Assessment Area, as given in the most current Assessment Area Data File found on the Forest Offset Protocol Resources section of ARB's website.

If breakdowns for wood product classes are not available from either of these sources, classify all wood products as "miscellaneous."

Once the breakdown of in-use wood product categories is determined, use Table C.2 to estimate the average amount of carbon stored in in-use wood products over 100 years:

1. Assign a percentage to each product class for each species (columns A-G) according to mill data or default values for the project.
2. Multiply the total carbon transferred into wood products (determined in Section C.2) by the percentages in each column and insert the resulting values into boxes 2A through 2G.
3. Multiply the values in 2A through 2G by the 100-year average storage factor and insert the results into boxes 4A through 4G.
4. Use Equation C.1 to calculate the average carbon stored in in-use wood products over 100 years (in units of CO_2-equivalent metric tons).

Equation C.1. Average Carbon Stored in In-Use Wood Products

$$\mathbf{WP_{in\text{-}use,\,y} = \sum(\text{Table C.2, Row 4}) \times 3.664}$$

Where,

$WP_{in\text{-}use,\,y}$ = Average carbon stored in in-use wood products over 100 years from wood harvested in year y (actual or baseline)

Table C.2. Worksheet to Estimate Long-Term Carbon Storage In In-Use Wood Products

Rows		A	B	C	D	E	F	G
	Wood Product Class	Softwood Lumber	Hardwood lumber	Softwood Plywood	Oriented Strandboard	Non Structural Panels	Miscellaneous Products	Paper
1	**% in each class**	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
2	**Metric tons C in each class**	(2A)	(2B)	(2C)	(2D)	(2E)	(2F)	(2G)
3	**100-year average storage factor (in-use)**	0.463	0.250	0.484	0.582	0.380	0.176	0.058
4	**Average C stored in in-use wood products (metric tons)**	(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

C.4 Estimate the Average Carbon Storage Over 100 Years for Wood Products in Landfills

Wood product carbon in landfills is only calculated for years in which a Forest Project's actual harvesting volumes are below estimated baseline harvesting levels, as determined in Section 6. To determine the appropriate value for average landfill carbon storage, perform the following steps:

Step 1 – Calculate the average carbon storage over 100 years for wood products in landfills

Use Table C.3 to estimate the average amount of wood product carbon stored in landfills over 100 years:

1. Assign a percentage to each product class for each species (columns A-G) according to mill data or default values for the project (as determined in Section C.3).
2. Multiply the total carbon transferred into wood products for each species (determined in Section C.2) by the percentages in each column and insert the resulting values into boxes 2A through 2G.
3. Multiply the values in 2A-2G by the 100-year average storage factor for landfill carbon and insert the results into boxes 4A through 4G.

Table C.3. Worksheet to Estimate Long-Term Carbon Storage in Wood Products in Landfills

Rows		A	B	C	D	E	F	G
	Wood Product Class	Softwood Lumber	Hardwood lumber	Softwood Plywood	Oriented Strandboard	Non Structural Panels	Miscellaneous Products	Paper
1	**% in each class**	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
2	**Metric tons C in each class**	(2A)	(2B)	(2C)	(2D)	(2E)	(2F)	(2G)
3	**100-year average storage factor (landfills)**	0.298	0.414	0.287	0.233	0.344	0.454	0.178
4	**Average C stored in landfills (metric tons)**	(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)

Step 2 – Determine the appropriate value to use for wood product carbon in landfills

Use Equation C.2. Average Wood Product Carbon Stored in Landfills to determine the appropriate value for the average wood product carbon stored in landfills over 100 years (in units of CO_2-equivalent metric tons).

Equation C.2. Average Wood Product Carbon Stored in Landfills

$$If \sum_{n=1}^{y}(AC_{hv,n} - BC_{hv,n}) < 0, then\, WP_{landfill,y} = \sum(Table\ \ \mathrm{C3}, Row\, 4) \times 3.66\underline{47}$$

$$If \sum_{n=1}^{y}(AC_{hv,n} - BC_{hv,n}) > 0, then\ \ WP_{landfill,y} = 0$$

Where,

$WP_{landfill,\ y}$	=	Average carbon stored in wood products in landfills over 100 years from wood harvested in the current year/reporting period (actual or baseline)
$AC_{hv,\ n}$	=	Actual amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons
$BC_{hv,\ n}$	=	Estimated average baseline amount of onsite carbon harvested in reporting period n (prior to delivery to a mill), expressed in CO_2-equivalent tons
y	=	The current year or reporting period

C.5 Determine Total Average Carbon Storage in Wood Products Over 100 Years

The total average carbon storage in wood products over 100 years for a given harvest volume (as determined in Section C.1) must be calculated and reported as follows (Equation C.3). The value derived for WP_{total} must be used for actual and baseline wood product carbon estimates ($AC_{wp,y}$ or $BC_{wp,y}$ in Equation 6.1) as appropriate, following the guidance in Section 6.

Equation C.3. Total Average Carbon Stored in Wood Products

$$WPtotal, y = \sum_{k} WP_{in-use,y} + \sum_{k} WP_{landfill,y}$$

Where,

$WP_{total,\ y}$	=	Average carbon stored over 100 years from wood harvested in year y (actual or baseline)
$WP_{in\text{-}use,\ y}$	=	Average carbon stored in in-use wood products over 100 years from wood harvested in year y (actual or baseline)
$WP_{landfill,\ y}$	=	Average carbon stored in wood products in landfills over 100 years from wood harvested in year y (actual or baseline)
K	=	Species harvested

Appendix D Determination of a Forest Project's Reversal Risk Rating

A reversal risk rating must be determined for the Forest Project using the worksheets in this section. The worksheets are designed to identify and quantify the specific types of risks that may lead to a reversal, based on project-specific factors.

This risk assessment must be updated every time the Forest Project undergoes a verification site visit. Therefore, a Forest Project's risk profile and its assessment are dynamic. If estimated risk values and associated mitigation measures are updated as improvements in quantifying risks or changes in risks are determined, any adjustments to the risk ratings will affect only current and future year contributions to the Forest Buffer Account.

Risks that may lead to reversals are classified into the categories identified in Table D.4.

Table D.4. Forest Project Risk Types

Risk Category	Risk Type	Description	How managed in this protocol
Financial	Financial Failure Leading to Bankruptcy	Financial failure can lead to bankruptcy and/or alternative management decisions to generate income that result in reversals through over-harvesting or conversion	Default Risk
Management	Illegal Harvesting	Loss of project stocks due to timber theft	Default by Area
	Conversion to Non-Forest Uses	Alternative land uses are exercised at project carbon expense	Default Risk
	Over-Harvesting	Exercising timber value at expense of project carbon	Default Risk
Social	Social Risks	Changing government policies, regulations, and general economic conditions	Default Risk
Natural Disturbance	Wildfire	Loss of project carbon through wildfire	Default Risk
	Disease/Insects	Loss of project carbon through disease and/or insects	Default Risk
	Other Episodic Catastrophic Events	Loss of project carbon from wind, snow and ice, or flooding events	Default Risk

D.1 Financial Risk

Financial failure of an organization resulting in bankruptcy can lead to dissolution of agreements and forest management activities to recover losses that result in reversals. Forest Projects that employ a Qualified Conservation Easement, or that occur on public lands, have lower risk.

Table D.5. Financial Risk Identification

Applies to all projects		
Identification of Risk	**Contribution to Reversal Risk Rating**	
Default Financial Risk	**Forest Project not on public lands or without a Qualified Conservation Easement**	**Forest Project on public lands or with a Qualified Conservation Easement**
	5%	1%

D.2 Management Risk

Management failure is the risk of management activities that directly or indirectly could lead to a reversal. Forest Projects that occur on public lands, or employ a Qualified Conservation Easement are exempt from this risk category.

Management Risk I – Illegal Removals of Forest Biomass

Illegal logging occurs when biomass is removed either by trespass or outside of a planned set of management activities that are controlled by regulation. Illegal logging is exacerbated by lack of controls and enforcement activities.

Table D.6. Risk of Illegal Removals of Forest Biomass

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
United States Default Harvesting Risk	0%

Management Risk II – Conversion of Project Area to Alternative Land Uses

High values for development of housing and/or agriculture may compete with timber and carbon values and lead to a change in land use that affects carbon stocks. The risk of conversion of any Project Area to other non-forest uses is related to the probability of alternative uses, which are affected by many variables, including population growth, topography, proximity to provisions and metropolitan areas, availability of water and power, and quality of access to the Project Area.

Table D.7. Risk of Conversion to Alternative Land Use

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement that explicitly encumbers all development rights	0%
Without Qualified Conservation Easement	2%

Management Risk III – Over-Harvesting

Favorable timber values, among other reasons, may motivate an Offset Project Operator or Authorized Project Designee to realize timber values at the expense of managing carbon stocks for which ARB or registry offset credits have been issued. Additionally, reversals can occur as the result of harvest associated with fuels treatments.

Table D.8. Risk of Over-Harvesting

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
With Qualified Conservation Easement that explicitly encumbers timber harvesting associated with project stocks	0%
Without Qualified Conservation Easement	2%

D.3 Social Risk

Social risks exist due to changing government policies, regulations, and general economic conditions. The risks of social or political actions leading to reversals are low, but could be significant.

Table D.9. Social Risk Identification

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
United States Default Social Risk	2%

D.4 Natural Disturbance Risk

Natural disturbances can pose a significant risk to the permanence of the GHG reductions and GHG removal enhancements. Natural disturbance risks are only partially controllable by

management activities. Management activities that improve resiliency to wildfire, insects, and disease can reduce these risks. Management activities that shift harvesting practices from live sequestering trees to trees that have succumbed to natural disturbances reduce or negate the reversal depending on the size and location of the disturbance.

Natural Disturbance Risk I – Wildfire

A wildfire has the potential to cause significant reversals, especially in certain carbon pools. These risks can be reduced by certain techniques including reducing surface fuel loads, removing ladder fuels, adding fuel breaks, and reducing stand density. However, these techniques cannot reduce emission risk to zero because all landowners will not undertake fuel treatments, nor can they prevent wildfire from occurring.

Table D.10. Natural Disturbance Risk I – Wildfire

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
United States Default Fire Risk	4%
If fuel treatments have been implemented for the Project Area, reduce the value above by the appropriate Y% as indicated below.*	(4%) x Y%

* Depending on the level of fuel treatments, the Y% is set as follows:
- high level of fuel treatments = 50%,
- medium level of fuel treatments = 66.3%,
- low level of fuel treatments = 82.6%,
- no fuel treatments = 100%.

Natural Disturbance Risk II - Disease or Insect Outbreak

A disease or insect outbreak has the potential to cause a reversal, especially in certain carbon pools.

Table D.11. Natural Disturbance Risk II – Disease or Insect Outbreak

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
Default Risk Contribution from Disease or Insect Outbreak	3%

Natural Disturbance Risk III - Other Episodic Catastrophic Events

A major wind-throw event (hurricane, tornado, high wind event) has the potential to cause a reversal, especially in certain carbon pools.

Table D.12. Natural Disturbance Risk III – Other Episodic Catastrophic Events.

Applies to all projects	
Identification of Risk	**Contribution to Reversal Risk Rating**
Default Risk Contribution from Other Catastrophic Events	3%

D.5 Summarizing the Risk Analysis and Contribution to Buffer Account

Use table D.10 to summarize the Forest Project's reversal risk rating. As indicated above, projects that employ a Qualified Conservation Easement, or that occur on public lands, are exempt from certain risk categories. Such Qualified Conservation Easements must clearly identify the goals and objectives of the Forest Project according to the terms of this protocol.

Table D.13. Project Contribution to the Buffer Account Based on Risk.

Risk Category	**Contribution from Risk Descriptions Above**		
	Source	Forest Project without a Qualified Conservation Easement and/or Public Ownership	Forest Projects with a Qualified Conservation Easement and/or Public Ownership
Financial Failure	Default Risk	5%	1%
Illegal Forest Biomass Removal	Default Risk	0%	0%
Conversion	Default Risk	2%	0%
Over-Harvesting	Default Risk	2%	0%
Social	Default Risk	2%	2%
Wildfire	Calculated Risk from worksheet	X%	X%
Disease or Insect Outbreak	Calculated Risk from worksheet	3%	3%
Other Catastrophic Events	Calculated Risk from worksheet	3%	3%

Completing the Risk Rating Analysis:

The Forest Project's reversal risk rating is calculated as follows:

$$100\% - \left(\begin{array}{l} (1 - FinancialFailure\%) \times (1 - IllegalForestBiomassRemoval\%) \times (1 - Conversion\%) \\ \times (1 - OverHarvesting\%) \times (1 - SocialRisk\%) \times (1 - Wildfire\%) \times (1 - Disease/InsectOutbreak\%) \\ \times (1 - OtherCatastrophicEvents\%) \end{array} \right)$$

Appendix E Reforestation Project Eligibility

This appendix presents a standardized approach to determine whether reforestation activities on lands that have undergone a Significant Disturbance are likely to be "business as usual," and therefore not eligible for registration based on the net present value for the timber expected to be produced from reforestation. A reforestation project is considered "business as usual" if the net present value for expected timber is $0 or more according to the criteria in Table E.1.

To determine whether a reforestation project is eligible, perform the following steps:

1. Identify whether site preparation costs[10] are High or Low:
    a. Site preparation costs are High if:
        i. Competing species management (including mechanical removal and/or use of herbicides) has been or will be conducted on 50 percent or more of the Project Area; or
        ii. Soil ripping has occurred on more than 50 percent of the Project Area.
    b. Site preparation costs are Low for all other projects.
2. Identify the value of harvested products (High, Medium, Low, or Very Low) corresponding to the project's Assessment Area, from the lookup table in the Forest Offset Protocol Resources section of ARB's website.
3. Identify the standard Rotation Age for the project's Assessment Area, from the lookup table in the Forest Offset Protocol Resources section of ARB's website.
4. Identify the site class category for the Project Area. The category must be consistent with the stated site productivity in the project's submission form. Projects with mixed site classes must round to the nearest site class category based on a weighted average.
    a. Site Classes I and II are classified as 'Higher'.
    b. Site Classes III, IV, and V are classified as 'Lower'.
5. Determine whether the Forest Project is "eligible" or "not eligible" according to the identified site preparation costs, value of harvested products, rotation age, and site class, as indicated in Table E.1.

[10] All Forest Projects are assumed to have similar costs related to the cost of seedlings and planting; site preparation costs, however, can vary depending on circumstances.

Table E.1. Determination of Reforestation Project Eligibility

Site Preparation Costs	Value of Harvested Products	Rotation Age (Length)	Site Class	Eligibility	Scenario #
High Site Preparation	High	Short, Medium, Long	Higher	Not Eligible	1
			Lower	Not Eligible	2
		Extremely Long	Higher	Eligible	3
			Lower	Eligible	4
	Medium	Short, Medium	Higher	Not Eligible	5
			Lower	Not Eligible	6
		Long	Higher	Not Eligible	7
			Lower	Eligible	8
		Extremely Long	Higher	Eligible	9
			Lower	Eligible	10
	Low	Short	Higher	Not Eligible	11
			Lower	Eligible	12
		Medium, Long, Extremely Long	Higher	Eligible	13
			Lower	Eligible	14
	Very Low	Short, Medium, Long, Extremely Long	Higher	Eligible	15
			Lower	Eligible	16
Low Site Preparation	High	Short, Medium	Higher	Not Eligible	17
			Lower	Not Eligible	18
		Long, Extremely Long	Higher	Not Eligible	19
			Lower	Eligible	20
	Medium	Short, Medium	Higher	Not Eligible	21
			Lower	Not Eligible	22
		Long	Higher	Not Eligible	23
			Lower	Eligible	24
		Extremely Long	Higher	Eligible	25
			Lower	Eligible	26
	Low	Short	Higher	Not Eligible	27
			Lower	Not Eligible	28
		Medium	Higher	Not Eligible	29
			Lower	Eligible	30
		Long, Extremely Long	Higher	Eligible	31
			Lower	Eligible	32
	Very Low	Medium, Long, Extremely Long	Higher	Eligible	33
			Lower	Eligible	34
		Short	Higher	Not Eligible	35
			Lower	Not Eligible	36

Appendix F Determining a Value for Common Practice

Quantification Methodology

Forest Assessment Areas Introduction
Assessment areas are used to provide standardized regional data for offset project development. An assessment area is generally defined as a forest vegetation community that shares common environmental, economical, and regulatory attributes. The Forest Offset Protocol Resources section of ARB's website provides data, by assessment area, necessary to calibrate and/or implement project accounting, including:

- Common Practice – The average carbon stocks (metric tons) of the above ground portion of live trees on private lands. The average carbon stock is the result of the suite of management activities within the assessment area. The common practice value is a factor in the determination of a project's baseline, which governs the extent to which improved forest management projects can receive credit for avoided emissions. (See Section 6.2.)
- Species Diversity Index – The maximum amount of any one native species allowed within a project by percentage. (See Section 3.8.2.)
- The rotation length commonly used in the assessment area and the value of harvest for incorporating in a financial test for reforestation projects (see Appendix E).
- The regional mill efficiency used for calculating wood products (see Appendix C).
- The wood product classes generated for calculating wood products values (see Appendix C).

Defining Assessment Areas

The U.S. Forest Service Forest Inventory and Analysis Program (FIA) is the basis for development of assessment areas. The FIA program collects data on U.S. forests using an extensive array of coordinated sample plots throughout the nation. Together the plots comprise a national inventory system designed to assess the state of U.S. forests on an ongoing basis. The hierarchical and spatial nature of FIA data make it possible to group sample field plots by geographical location. FIA plots are assigned an attribute referred to as 'forest type' that identifies the dominant vegetation present at the plot. Forest Types were combined into forest communities following a process described further below.

Ecosections are spatial units and can be mapped. The geographical units that contain assessment areas are based on individual ecosections or combined ecosections (called supersections). Supersections were created in order to stratify the plots into high site class and low site class (where possible) and to increase the statistical reliability of the common practice estimates derived for each assessment area. The combination of ecosections into supersections only occurred where adjacent ecosections share similar environmental, economic, and regulatory attributes. Ecosections are combined into supersections if:

1. The ecosections are adjacent to each other.
2. They share a similar distribution of plots by forest types, which indicates that the ecosections share similar climate, elevation, and other environmental variables.
3. The economics of forest management are similar between the ecosections. The criteria considered to determine economic commonality between ecosections include forest product

generation, transportation networks, forest product mill types, and wood products markets. This was based on professional knowledge of regional timber markets.

4. Regulations between ecosections are relatively homogeneous across ecosection boundaries. Ecosections are not combined into supersections in cases where forest practice regulations between adjoining administrative units are known to be markedly different.

The Forest Service computed the statistics for the combined forest types aggregated at the supersection level and disaggregated at the ecosection level. The statistics are reported on a per acre basis and include board foot volume, basal area (square feet), above ground carbon tons, and the sampling error. Ecosections were not combined into supersections if the aggregation changed average standing carbon stocks of any assessment areas by more than 10%, indicating that there are environmental, economic or regulatory differences affecting the forest stocks within these communities.

The aggregation of forest types into forest communities that define assessment areas is based on the natural forest communities found within the ecosections rather than the presence of a single dominant species as in plantation management. As an example, the Northwest Coast Range contains many forest holdings of intensively managed Douglas-fir forests, yet the natural forest community contains many other species such as western hemlock, Sitka spruce, and red alder, among others. The plots used to define the assessment area, as well as the common practice statistic, are the entire set of plots found in the natural forest community. No effort is made to isolate assessment areas based on the existence of plantations. Successional stage, including the presence of shade tolerance species, and management influence on species prevalence is not a basis for stratifying distinct communities. The Forest Offset Protocol Resources data on ARB's webpage displays the associations of forest species (forest types) and assessment areas for all of the ecosections and supersections.

Determining a Value for Common Practice

The following requirements and methods provide step by step instructions for determining the appropriate Common Practice value for an Improved Forest Management project based on its geographic location and boundaries.

1. **Determine the Geographic Ecosection(s) or Supersection(s) Within Which the Project Area is Located**

   The Offset Project Operator or Authorized Project Designee must determine the geographic Ecosection(s) or Supersection within which the Project Area is located by consulting maps of Supersections. These maps can be downloaded from the Forest Offset Protocol Resources section of ARB's website in either a .pdf format or a Geographical Information System (GIS) shapefile.

2. **Determine the Acreage of the Project Area That Falls Within Each Assessment Area Contained in the Ecosection(s) or Supersection(s)**

   Ecosections and Supersections may consist of one or many Assessment Areas. Assessment Areas are groupings of tree species that are commonly found in association with each other, as in a vegetation community. Assessment Areas are not mapped since the geographic locations of forest communities vary based on highly resolute environmental variables. To determine which Assessment Areas are included within the

Project Area, compare the tree species in the Project Area to the species list associated with each Assessment Area in the project's Ecosection(s) or Supersection(s) (identified in Step 1). Tree species information must be looked up using the most current Assessment Area Data File from the Forest Offset Protocol Resources section of ARB's website. The minimum mapping resolution for vegetation communities is 20 acres. Therefore, any contiguous area 20 acres or greater within the Project Area that consists of a separate vegetation community must be independently mapped.

3. **Where Necessary, Stratify Project Area Acres According to Whether They Are High or Low Site Class**

   The Assessment Area Data File on the Forest Offset Protocol Resources section of ARB's website provides data for each Assessment Area by high, low, or all site classes. For Assessment Areas where data are attributed for high and low site classes, the Offset Project Operator or Authorized Project Designee must further stratify the Project Area and identify the acreage that falls within each site class.

   The computation of the statistics in the Assessment Area Data File (on a per acre basis) for board foot volume, basal area (square feet), and CO_2 equivalent was done for high and low site classes wherever the FIA plots were available in adequate quantity. The board foot volume and basal area statistics are presented only to elucidate comparisons to the Common Practice (CO_2 equivalent) statistic. Board foot volume and basal area statistics are not used for other purposes in the protocol.

For stratification purposes, a "high" site class refers to U.S. Forest Service FIA assigned site class productivity codes I-III. A "low" site class refers to U.S. Forest Service FIA assigned site class productivity codes IV-VII. Forest owner(s), Offset Project Operators, or Authorized Project Designees must determine the portion of the Project Area that is in each site class for each Assessment Area using either soils data from a state or federal agency, direct site class data from a state or federal agency, attestation from a state forester, or through field analysis. Whatever method is used, documentation of the analysis must be provided to the verifier at the project's initial verification.

For the purpose of establishing common practice values, ARB uses FIA's definition of site class. FIA defines site class as the potential growth in cubic feet/acre/year of the species on forestland and is based on the culmination of mean annual increment of fully stocked natural stands. For plots that fall outside FIA's National Information Management System (NIMS), which is a federal system developed to process and store annual inventory data, site class productivity class designation is determined using site trees or from other sources. For data processed by NIMS, site class is assigned based on the site trees available for the plot, or, if no valid site trees are available, a default value is either estimated or predicted; the following provides the site class productivity code breakdown by cubic feet/acre/year.

Site Class	Basal Area Cubic feet /acre/year
1	225+
2	165-224
3	120-164
4	85-119
5	50-84

6	20-49
7	0-19

4. Identify the Common Practice Statistic Associated with Each Assessment Area and Site Class Stratum

For each Assessment Area and Site Class within the Project Area, identify the appropriate Common Practice statistic from Assessment Area Data File. The value displayed in the Assessment Area Data File indicates CO_2 equivalent metric tons per acre in the above ground portion (bole, bark, top and branches) of live trees.

If data for an Assessment Area are provided for both high and low site classes, and a Offset Project Operator or Authorized Project Designee is unable or unwilling to stratify the Project Area into site classes using an acceptable method described above, then the high site-class Common Practice statistic must be used for all acres within the Assessment Area.

5. Determine a Value for Common Practice for the Entire Project Area

Determine a single Common Practice value for the entire Project Area by calculating the average of the Common Practice statistics for each Assessment Area and site class, weighted by the number of acres of each Assessment Area and site class within the Project Area. See Table F1 for an example.

Table F1. Example of Common Practice Statistic Calculation

Ecosection(s) /Supersection(s)	Assessment Area	Site Class	Acres	Common Practice (Metric Tons CO2-e)
Name the Ecosection(s)/Supersection(s) the project is found within.	*Identify the Assessment Areas the project is in. If the project is in more than one site class for an Assessment Area, enter the Assessment Area twice*	*Enter the Site Class Value*	*Acres for each Assessment Area-Site Class Combination*	*Enter the Value from the most current Assessment Area Data File*
Adirondacks & Green Mountains	Adirondacks & Green Mountains Northeast Conifers	High	1,000	91.8
Adirondacks & Green Mountains	Adirondacks & Green Mountains Northeast Conifers	Low	100	84.4
Adirondacks & Green Mountains	Adirondacks & Green Mountains Northern Hardwood	High	50	102.8
Total Acres / Weighted Average Common Practice			**1,150**	**91.6**

Appendix G References

Brown, S., D. Shoch, T. Pearson, and M. Delaney. 2004. Methods for Measuring and Monitoring Forestry Carbon Projects in California. Winrock International, for the California Energy Commission, PIER Energy-Related Environmental Research. 500-04-072F

Cairns MA, Brown, S Helmer EH et al. (1997) Root biomass allocation in the world's upland forest. Oecologia, 111, 1-11.

Domke et al. 2011 Accounting for density reduction and structural loss in standing dead trees: Implications for forest biomass and carbon stock estimates in the United States. Carbon Balance and Management 2011 6:14 http://www.treesearch.fs.fed.us/

Harmon, Mark E.; Woodall, Christopher W.; Fasth, Becky; Sexton, Jay; Yatkov, Misha. 2011. Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

Miles, Patrick D; Smith, W. Brad. 2009. Specific gravity and other properties of wood and bark for 156 tree species found in North America. Res. Note NRS-38. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 35 p.

Smith et al. 2006. Appendix Section 1: Methods for Calculating Forest Ecosystem and Harvested Carbon, with Standard Estimates for Forest Types of the United States The material presented in Appendix Section 1 is adapted from a USDA Forest Service General Technical Report NE-343.

NewForests
FOREST CARBON PARTNERS

New Forests Registers Forest Carbon Offset Project at Hanes Ranch in Mendocino County, California

SAN FRANCISCO, CALIFORNIA (August 27, 2014) – New Forests announced today the regulatory approval of the Hanes Ranch Forest Carbon Project, which was developed under the California Compliance Offset Protocol – U.S. Forest Projects, a standard adopted by the California Air Resources Board for use in the California cap and trade program. The California Air Resources Board ("ARB") approved issuance of over 86,000 ARB offset credits to the Hanes Ranch Forest Carbon Project. ARB offset credits can be used for compliance in the California greenhouse gas emissions trading program.

The project encompasses 2,500 acres of Coastal Redwood, Douglas-Fir, and mixed hardwood forest held by the Hanes family, which has managed forests and rangeland in the region since the nineteenth century. Hanes Ranch includes miles of the salmon-bearing Garcia River and Rancheria Creek. By registering the Improved Forest Management project and selling carbon offsets in the California cap and trade system, Hanes Ranch has made a legal commitment to maintain current forest carbon stocks on the project area. The project enables the Hanes family to manage the forest for both increased carbon sequestration and sustainable timber production. The project will generate significant revenue for Hanes Ranch, assisting the family in their multi-generational commitment to forest stewardship.

Through its Forest Carbon Partners, L.P. investment fund, forestry investment manager New Forests has provided offset project finance and managed all aspects of project development and offset credit sales for the project. The Hanes Ranch project is one of six forest carbon offset projects currently under development by New Forests for the California carbon market. SCS Global Services provided offset verification services for the project. The project was registered with the American Carbon Registry, an offset project registry approved by the State of California.

"With the successful registration of the Hanes Ranch Forest Carbon Project, New Forests is continuing a track record of delivering real financial and environmental benefits to forest landowners in California and across the nation through the California carbon market," said Brian Shillinglaw, Associate Director, New Forests Inc. "The California carbon market creates a strong market price signal for sustainable forestry, forest conservation and improved wildlife habitat on both industrial and non-industrial timberlands throughout the United States."

About Forest Carbon Partners and New Forests
Forest Carbon Partners, L.P. is a leading supplier of forest carbon offsets to the California cap and trade system. An investment vehicle managed by New Forests Inc. of San Francisco, Forest Carbon Partners offers forest carbon offset project finance and development services to private forest landowners nationwide. The fund manages all aspects of project evaluation, development, registration, and credit sales, delivering improved timberland revenue to landowners and a reliable supply of high-quality offsets to California compliance buyers. New Forests Inc. is a wholly-owned subsidiary of New Forests Pty Limited of Sydney, Australia. The New Forests group (www.newforests.com.au) manages investments in sustainable forestry and associated environmental markets for institutional investors. The company has offices in Sydney, Singapore and San Francisco and currently manages more than AU$2.3 billion in funds and assets and over 1,000,000 acres of land in Australia, the United States and Asia.

Media Contacts:

New Forests Inc. (San Francisco)
Brian Shillinglaw
T: +1 415 321 3305
M: +1 415 987 4182
bhillinglaw@newforests-us.com

New Forests Pty Limited (Singapore)
MaryKate Hanlon
T: +65 3152 2012
M: +65 9661 2799
mhanlon@newforests.com.au









AMTRAK® SUSTAINABILITY REPORT 2013

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ABOUT AMTRAK

PRESIDENT'S MESSAGE

Welcome to Amtrak's 2013 Sustainability Report. I'm excited to share our progress.

Amtrak provides an energy efficient transportation option for travelers. Compared to cars, train travel produces 30% fewer greenhouse gas emissions on a per passenger mile basis, and 11% fewer emissions than airplanes. We are continuously working to improve our operation – from our trains to our yards and stations – by reducing fuel and energy consumption, which also reduces emissions and saves money. We have made significant progress on fuel and energy reduction through efforts such as lighting upgrades, but we know we have room for even greater improvement.

Amtrak established our first comprehensive corporate Sustainability Policy in July 2013. Our Policy laid the groundwork to incorporate the three pillars of sustainability — environmental, economic and social considerations — into our business decision-making processes. This Sustainability Report is intended to provide an honest and transparent assessment of Amtrak's initiatives, successes and challenges in the field of sustainability. The Policy is the cornerstone of our Sustainability Program, which also includes external sustainability commitments, including the American Public Transportation Association Sustainability Commitment and annual climate change reporting through the Carbon Disclosure Project.

> "With a focus on environmental, economic, and social factors within the organization, the Sustainability Program is part of a strategy that will help Amtrak continue to evolve into the kind of organization that makes the most efficient use of resources, is a good neighbor in the communities we serve, and continues to provide a smart choice for the travelling public."

Amtrak's three main strategic goals are Safety and Security, Customer Service, and Financial Excellence. The Sustainability Program supports each of these goals. With a focus on environmental, economic, and social factors within the organization, the Sustainability Program is part of a strategy that will help Amtrak continue to evolve into the kind of organization that makes the most efficient use of resources, is a good neighbor in the communities we serve, and continues to provide a smart choice for the travelling public.

I hope you will find this report both informative and useful. As we continue to work toward a more sustainable organization, we value input and feedback from you, our stakeholders.

Joseph Boardman

ABOUT THIS REPORT

This Sustainability Report represents Amtrak's first comprehensive public disclosure regarding our corporation's sustainability initiatives. In the following pages, you will read about Amtrak's route to a more sustainable future, beginning with our adoption of a corporate-wide Sustainability Policy in 2013, and the integration of the principles of sustainability into our existing environmental management structure. In 2013, we also completed our first materiality assessment with an internal group of environmental professionals, and held sustainability workshops with small groups from various departments to facilitate discussion with Amtrak employees about our policy, program, and goals.

In the past we have published environmental reports, but this comprehensive Sustainability Report is organized around the triple bottom line structure of environmental, social, and economic aspects of our operations, and represents a significant progression from our past reporting. This report is an initial step in our efforts to progress toward reporting in conformance with the internationally recognized and widely accepted G4 Sustainability Reporting Guidelines developed by the Global Reporting Initiative (GRI). We acknowledge that this report will not fully meet the criteria put forth in the G4 Guidelines, but it will lay the groundwork for a more complete account of our efforts in future years.

As part of Amtrak's strategic planning effort, four corporate goals were set for the 2013 fiscal year (FY) to reduce our environmental impacts and improve operating efficiency. These goals relate to reductions in electricity usage, locomotive diesel fuel conservation, and reductions in greenhouse gas emissions, as well as a focus on our facilities' environmental compliance. We exceeded our fuel reduction target and achieved an average environmental audit score above our goal in FY 2013. We did not meet our goal for reducing electricity usage at our largest 15 facilities, but achieved a smaller reduction. Finally, we met one part of our intensity-based GHG reduction goal and were close to meeting the second part. Based on these results, we recognize that we have more work to do as a corporation, and we are committed to setting specific and measurable goals to continually benchmark our progress in future years.

OUR FOUR ENERGY AND ENVIRONMENTAL GOALS :

ELECTRICITY
Reduce electricity use at our 15 largest facilities by 1%

LOCOMOTIVE DIESEL FUEL
Reduce revenue train diesel fuel use by 1%

GREENHOUSE GAS EMISSIONS
Reduce Greenhouse Gas (GHG) emissions intensity by 1%

ENVIRONMENTAL MANAGEMENT PERFORMANCE
Achieve an average environmental audit score of 83

Learn more on Page 12

We continue to invest in projects that promote interconnectivity and accessibility in the communities in which we operate, making significant strides through the Amtrak Accessible Stations Development Project (ASDP), and extending our "Thruway Service" Program. In 2013, we established pilot programs for passengers to bring bicycles aboard our trains, and we continued to create a culture of rail safety in the communities we serve through our Operation Lifesaver Program. We have also expanded our Safety and Security focus by creating the Emergency Preparedness and Corporate Security Department, which will utilize a security risk management strategy to address threats and vulnerabilities associated with natural hazards and acts of terrorism. Finally, to encourage our employees to live healthy and balanced lives, we continued our Safe-2-Safer injury reduction initiative and expanded our Employee Wellness Programs.

From a financial standpoint, in 2013 we invested in projects that provide significant cost savings along with positive environmental and social benefits. These included capital projects that provide energy savings, such as the replacement of a chiller plant in one of our largest stations and the purchase of new GenSet Switcher locomotives which achieve significant fuel savings. We know that integrating sustainability into our financial decisions will provide long lasting value to our stakeholders while enhancing our operational efficiency. At Amtrak, we are committed to investing in programs and technology that will advance rail transportation in North America for decades to come.

We want to ensure that we report on our progress and challenges each year. We recognize that these efforts represent just the beginning of Amtrak's journey. We hope that you will join us for the ride, and we invite you to contact us at AskEnvironmental@amtrak.com should you have any comments, questions, or suggestions related to this report or to our operations.

ORGANIZATIONAL PROFILE: OUR BUSINESS

The National Railroad Passenger Corporation (Amtrak) manages a network of long-distance, corridor, and high-speed passenger rail services. Amtrak offers passengers a safe, reliable, and fuel-efficient alternative to automobile and air travel, thereby helping to reduce highway congestion and the demand for passenger vehicle fuel in North America.

Headquartered in Washington, DC, Amtrak unites multiple modes of transportation, connects communities, and continues to set ridership records each year. In FY 2013 (October 1, 2012 – September 30, 2013) more than 31 million passengers traveled with us, setting our 10th ridership record in the past 11 years. Amtrak operates more than 300 daily intercity trains along more than 21,000 route miles, serving over 500 destinations in 46 states as well as the District of Columbia and three Canadian provinces. Amtrak's total revenues in FY 2013 reached a record $2.9 billion.

Amtrak is organized into three Business Lines within our Operations Department. These Business Lines include the Northeast Corridor Operations (NEC), Long Distance Services, and State Supported Corridors. Amtrak's NEC is the busiest railroad in North America, with more than 2,200 regional, long distance, and commuter trains operating along the Washington, DC to Boston, MA route every day. On the NEC, Amtrak offers passengers multiple service levels including first class, business class, and coach. We also offer passengers North America's only high speed rail service (up to 150 mph) aboard the Acela Express.

Nationally, Amtrak operates 15 long distance trains. In many cases, these long distance trains provide communities with their only alternative transportation option for intercity passengers. State Supported Corridor trains operating outside of the NEC are the fastest-growing component of our rail system, with 18 state partnerships and 13 commuter agency agreements in place during 2013. Examples of these partnerships include routes in California, the Pacific Northwest, the metropolitan region surrounding Chicago's Union Station, and connections from peripheral communities to our Northeast Regional trains.

Outside of the electrified NEC, Amtrak trains are powered by diesel locomotives and operate on track owned by host railroads. Along with operating passenger service on these routes, Amtrak owns and/or maintains 759 miles of right-of-way, 17 tunnels, and more than 1,000 bridges. Approximately half of Amtrak's property is located along the NEC, though other large tracts of property are located in Pennsylvania, Michigan, and Indiana. Amtrak customers are likely most familiar with the 105 station facilities that the corporation owns or operates, but behind the scenes Amtrak also operates maintenance and repair facilities to provide maintenance and overhaul services to over 2,600 passenger cars and locomotives.

Throughout this extensive network of tracks, train yards, maintenance, and passenger facilities, Amtrak works proactively to meet or exceed federal, state, and local environmental requirements. Amtrak's Environmental Policy – which came into effect in 2001 – clearly states our environmental commitment, which is based on the principles of compliance, leadership, and stewardship. In working to connect communities and provide efficient and cost effective transportation, Amtrak strives to go beyond basic environmental compliance to operate in a manner that contributes to the well-being of our communities and our planet. As a way to formalize these goals, Amtrak implemented a corporate-wide Sustainability Policy in 2013.

SUSTAINABILITY POLICY

Amtrak's Executive Committee approved the company's first Sustainability Policy in July 2013.

The Policy defines sustainability for Amtrak to mean "operating in a way that creates long-term value by balancing the needs of the organization with the needs of future generations through consideration of environmental, economic, and social factors". With the Policy as its foundation, Amtrak continues to develop a corporate-wide Sustainability Program, integrating sustainability practices throughout our operations in a transparent and measureable way.

Amtrak was actively pursuing sustainability commitments well before the adoption of this corporate-wide Sustainability Policy. These external commitments have helped to pave the way for the development of our Sustainability Policy and continue to shape our corporate Sustainability Program.

2003
Amtrak became a charter member of the Chicago Climate Exchange, a program that required an aggressive commitment to reducing greenhouse gas (GHG) emissions from locomotive diesel fuel.

2009
Amtrak joined The Climate Registry (TCR).

Amtrak signed the American Public Transportation Association (APTA) Sustainability Commitment, which requires signatories to develop a baseline inventory of GHG emissions, water and energy usage, waste generation, recycling rates, and air emissions of criteria pollutants.

2011
Amtrak submitted its first comprehensive greenhouse gas inventory to TCR.

2013
Amtrak achieved the Bronze level of the APTA Sustainability Commitment by completing a sustainability inventory, implementing environmental initiatives, and establishing goals for the reduction of fuel use in locomotives and electricity use at our facilities.

Amtrak transitioned from reporting GHG data through TCR to reporting GHG data as well as climate change strategy and initiatives through the Carbon Disclosure Project (CDP).

CORE ELEMENTS OF THE AMTRAK SUSTAINABILITY POLICY

The core elements of the Amtrak Sustainability Policy are:

- To incorporate environmental, economic, and social sustainability considerations into Amtrak business decision-making processes and operations;
- To assist Amtrak in achieving the goals outlined in our Strategic Plan;
- To provide the foundation for the Amtrak Sustainability Program; and
- To provide guidelines for recognizing Amtrak departments for their sustainability initiatives and achievements.

The Policy provides structure for the governance and implementation of the Program and details the committees that are responsible for overseeing the Policy and the various elements of the Program. The day-to-day implementation of the Program is led by Amtrak's Environment and Sustainability Group.

GOVERNANCE STRUCTURE

ENVIRONMENT AND SUSTAINABILITY MANAGEMENT SYSTEM

Following the adoption of our corporate Sustainability Policy, the Environmental Executive Oversight Committee (EEOC) approved using the Amtrak Environmental Management System (EMS) as the framework for governing and advancing Amtrak's corporate Sustainability Policy and Program.

As of October 1, 2013, the management system formally became the Environment and Sustainability Management System (ESMS). The governing committees were renamed, with the EEOC becoming the Environment and Sustainability Oversight Committee (ESOC), and the EMS Steering Committee becoming the Environment and Sustainability Management System (ESMS) Steering Committee. The ESOC is led by Amtrak's Chief Legal Officer and Chief Operating Officer, and the committee is composed of the General Managers of the operating business lines and department heads of various departments within Amtrak.

The ESOC oversees the efforts of the multi-departmental ESMS Steering Committee, which guides the implementation of the ESMS and the Sustainability Program. The ESMS Steering Committee members work within their departments and business lines to incorporate sustainability into business decision-making processes and operations.

Amtrak's Environmental Group was renamed the Environment and Sustainability Group, and now has responsibility for leading, managing and reporting on Amtrak's environmental and sustainability programs The Group's mission is to maintain Amtrak in compliance with federal, state and local environmental legal and regulatory requirements, and advance operationally sound and sustainable business solutions for the company.

The Environment and Sustainability Group serves three main functions:

1 **Environment and Sustainability Management System (ESMS)**
The ESMS supports environmental compliance by developing and delivering environmental procedures and training to Amtrak personnel across the corporation. This includes communications, compliance guidance, regulatory reports, and field operations management to support business operations. The ESMS integrates environmental, economic, and social sustainability considerations into Amtrak business decision-making processes and operations and strategic planning. The Environmental Compliance Audit Program (which is managed independently within the Amtrak Law Department) provides systematic review of regulatory compliance and ensures conformance with ESMS procedures and goals.

2 **Sustainability Program**
The Program works with departments across the organization to identify sustainable business solutions and initiatives in support of Amtrak's strategic goals, assists with the implementation of new sustainability initiatives and targets, tracks performance against targets, and reports publicly on metrics (including greenhouse gas emissions).

3 **Environmental Project Management**
The Environment and Sustainability Group provides project management for operating and capital projects, including remediation of environmental contamination on Amtrak properties, and environmental risk reduction projects at Amtrak facilities.

ETHICS AND INTEGRITY

As part of Amtrak's commitment to ethics and integrity, all employees are required to follow the Amtrak Standards of Excellence which mandate the highest professional standards. The cornerstones of these Standards include honesty, trust, and respect; legal compliance; ethical conduct; and socially and environmentally responsible conduct. The Standards of Excellence also remind employees of their duty to promptly report any actual or suspected misconduct. Failure to fulfill this duty by our employees is a violation of Amtrak's Code of Ethics and may result in disciplinary measures and termination of employment.

Amtrak has implemented a non-retaliation policy which prohibits retaliation against an employee for raising a concern and/or reporting actual or suspected misconduct in good faith. There are also multiple avenues through which ethics concerns can be reported confidentially by employees, including the Amtrak Ethics Information Hotline, the Chief Legal Officer, and the Amtrak Office of the Inspector General.

STAKEHOLDER ENGAGEMENT AND MATERIALITY ANALYSIS

Amtrak has identified employees, passengers, communities served by Amtrak, Congress, State partners, and the general public as key stakeholders that influence our operations.

Since adopting our Sustainability Policy, we have focused on internal stakeholder engagement through a series of employee workshops. We continue to communicate and engage with external stakeholders through a variety of outlets including social media, press releases, Earth Day events, and marketing materials, as well as through project-specific community engagement.

Beginning in November of 2013, the Environment and Sustainability Group began holding employee engagement workshops that focused on familiarizing individual departments and business lines with the Amtrak Sustainability Policy and the company's sustainability goals and objectives. The workshops also enabled us to gather data on current initiatives throughout the corporation that fall under the umbrella of sustainability to better inform our tracking and reporting on these initiatives. Each workshop was tailored to the particular group or department to engage employees in discussion around what the concept of sustainability means in the context of their professional duties and responsibilities.

In September 2013, Amtrak conducted a sustainability materiality assessment workshop facilitated by an independent consultant with expertise in the GRI G4 Reporting Guidelines. This internal materiality assessment was conducted as part of a staff workshop held by the Environment and Sustainability Group, and was attended by Amtrak environmental professionals and the environmental counsel. The GRI-focused materiality assessment involved the identification and discussion of environmental, social, and economic issues that are material to Amtrak across the entire value chain. For Amtrak, material issues are those that have the potential to significantly impact our core business performance as well as those that are considered important to key stakeholders.

This initial materiality assessment highlighted the following issues as being material:

- Operational energy efficiency
- Employee safety
- Operational safety
- Passenger and public safety
- Improving the customer experience
- Government relations
- Financial accountability

This materiality process will be further informed by the enterprise risk management initiative that Amtrak began in 2013 (see discussion in the Economic section of this Report). This is an enterprise-wide initiative to identify all objectives and risks relevant to Amtrak's business. The process requires evaluating climate change, environmental, sustainability, energy, and other related risks that bear on Amtrak's business objectives.

Building on the results of the September 2013 materiality assessment and our enterprise risk management initiative, the Environment and Sustainability Group will explore the most appropriate methods to further broaden and strengthen our materiality process to include a greater representation of internal and external stakeholders. In future years, we will continue to formalize our approach to assessing materiality through stakeholder engagement and will refine our Sustainability Program accordingly.

ENVIRONMENT

Amtrak's Environmental Policy describes the corporation's commitment to full compliance with all applicable environmental laws and regulations and the adoption of practices that increase efficiency, reduce environmental impacts, and promote the sustainable use of resources. Our Environmental Policy is based on the principles of compliance, leadership, stewardship, and a commitment to continuous improvement.

ENERGY AND ENVIRONMENTAL GOALS

With the development of the corporation's first five-year Strategic Plan in 2011, Amtrak established Corporate energy and environmental goals and performance measures focused on electricity and fuel consumption and environmental management.

In addition to their environmental sustainability benefits, these goals are directly related to our corporate-wide strategic goal of Financial Excellence in that they contribute to reducing operating costs and improving operating efficiencies. The goals are established on a fiscal year basis to align with financial and operating goals. Each year, we review these goals and performance measures and adapt them to better reflect the current operations and capabilities of our organization. Amtrak's FY 2013 electricity, fuel, and environmental goals, and our progress against these goals, are summarized in Table 1.

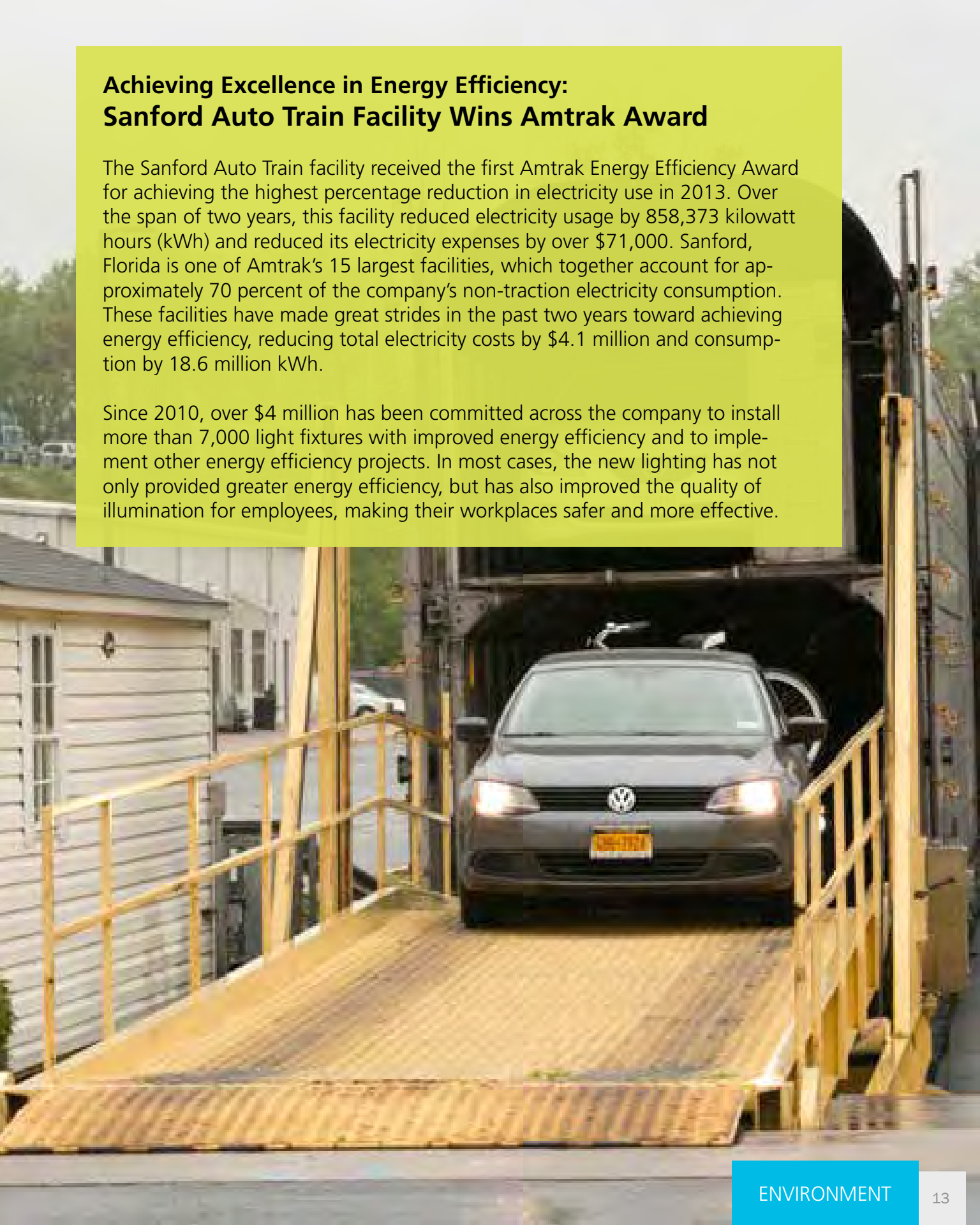
Table 1: Performance against Amtrak FY 2013 Sustainability Goals

Goal	Achieved	Not Achieved	Notes
Electricity: reduce electricity use at our 15 largest facilities by 1% annually		✗ Achieved a 0.76% reduction from FY 2012	Supports corporate energy efficiency and climate-related objectives and our strategic goal of Financial Excellence.
Locomotive Diesel Fuel: reduce revenue train diesel fuel use by 1% annually	✓ Achieved a 1.11% reduction from FY 2012		Revenue trains are defined as locomotives that move passengers and generate income. Diesel locomotive fuel is the largest contributor to Amtrak's GHG emissions and is a major operating cost.
Greenhouse Gas Emissions: reduce Greenhouse Gas (GHG) emissions intensity by 1% annually	✓ GHGs per million seat miles decreased by 1.36% from FY 2012	✗ GHGs per million passenger miles decreased by 0.39% from FY 2012	Our 2011 emissions profile is used as the baseline for this goal. Our GHG emissions are calculated based on the actual use of locomotive diesel fuel as well as the purchase, estimated purchase, or estimated use of other forms of energy, fuel, and refrigerants. Intensity measures are derived by dividing total GHG emissions by seat miles (a measure of carrying capacity equal to the number of seats available multiplied by the number of miles traveled) and passenger miles (a statistical unit denoting one mile traveled by one passenger, used in measuring the volume of passenger traffic).
Environmental Management Performance: achieve an average environmental audit score of 83 for FY 2013	✓ Achieved an average audit score of 84.9, up 10.55% from FY 2012		Incorporating sound environmental management practices into our operations ensures responsible management of environmental risks, reduces our environmental footprint, and reduces the potential for penalties and fines for non-compliance.

Achieving Excellence in Energy Efficiency:
Sanford Auto Train Facility Wins Amtrak Award

The Sanford Auto Train facility received the first Amtrak Energy Efficiency Award for achieving the highest percentage reduction in electricity use in 2013. Over the span of two years, this facility reduced electricity usage by 858,373 kilowatt hours (kWh) and reduced its electricity expenses by over $71,000. Sanford, Florida is one of Amtrak's 15 largest facilities, which together account for approximately 70 percent of the company's non-traction electricity consumption. These facilities have made great strides in the past two years toward achieving energy efficiency, reducing total electricity costs by $4.1 million and consumption by 18.6 million kWh.

Since 2010, over $4 million has been committed across the company to install more than 7,000 light fixtures with improved energy efficiency and to implement other energy efficiency projects. In most cases, the new lighting has not only provided greater energy efficiency, but has also improved the quality of illumination for employees, making their workplaces safer and more effective.



PERFORMANCE AGAINST AMTRAK FY 2013 SUSTAINABILITY GOALS

In FY 2013, total electricity consumption at Amtrak's largest 15 facilities decreased by 0.76 percent from the previous fiscal year. This decrease is slightly below our one percent reduction goal. The facility results are attributable to a variety of individual projects including the installation of energy-efficient lighting, and upgrades to heating, ventilation and air conditioning (HVAC) systems. The decrease was small because several sites experienced increased electricity usage due to the colder winter temperatures and increased use of 480V standby power compared to FY 2012. However, due to facility projects over the past two years, the overall reduction in electricity use from FY 2011 to FY 2013 was 4.72 percent for the 15 largest facilities.

Amtrak reduced locomotive diesel fuel use in revenue-generating trains by 1.11 percent from FY 2012 to FY 2013, exceeding the goal of a one percent reduction. Initiatives to reduce usage of locomotive diesel fuel included the implementation of a campaign that focused on shutting down diesel locomotives when they are out of service for one hour or more; the use of Automatic Engine Stop-Start technology; and the use of ground power to "plug in" trains when power is needed at stations and other layover locations, rather than the traditional practice of relying on diesel locomotives to provide this power.

Amtrak GHG emissions per seat mile decreased by 1.36 percent from FY 2012 to FY 2013, exceeding the one percent reduction goal, whereas GHG emissions per passenger mile decreased by 0.39 percent over the same period, short of the one percent goal. It is likely the severe winter experienced in the Eastern and Midwestern United States in 2013 contributed to higher than normal emissions from natural gas and other fuel sources. However, the energy efficiency and fuel conservation projects implemented over the past few years have helped reduce total GHG emissions by reducing overall energy and fuel use.

EMISSIONS PROFILE

In 2009, as part of an effort to calculate, define, and better understand our carbon footprint, Amtrak joined The Climate Registry (TCR). Amtrak committed to the organization's comprehensive standards for calculating and reporting GHG emissions using TCR's General Reporting Protocol (GRP).

The 2010 calendar year GHG Inventory was Amtrak's first official inventory completed and made available to the public. In 2013, Amtrak began reporting our GHG inventory and information about our climate initiatives to the Carbon Disclosure Project (CDP), while continuing to adhere to TCR's GRP for the preparation of the inventory. CDP requires that participating organizations report on direct and indirect emissions.

Each year, Amtrak's GHG inventory undergoes a third-party verification process to ensure accuracy. Table 2 includes highlights from the emissions data submitted in Amtrak's 2013 CDP report.

Table 2: Summary of 2013 GHG Emissions

Emissions Source Category and Intensity	2013 Result	Units
Direct GHG Emissions (Scope 1)	725,714	metric tons CO_2e
Indirect GHG Emissions (Scope 2)	373,948	metric tons CO_2e
Total Scope 1 and 2 Emissions	1,099,662	metric tons CO_2e
Other Indirect GHG Emissions (Scope 3)*	31,526	metric tons CO_2e
GHG Emissions Intensity	93.22	metric tons CO_2e/million passenger miles
	161.48	metric tons CO_2e/million seat miles

* Amtrak's Scope 3 emissions include emissions from line loss of electricity and natural gas during transmission and distribution.

Amtrak's GHG inventory is developed annually using six different "facility groups". A description of the emission sources from each group is included in Table 3. The inventory represents a comprehensive accounting of emissions throughout the entirety of Amtrak's operations.

Table 3: Description of Amtrak Facility Groups

Emissions Source Category and Intensity	2013 Result
Rolling Stock	Includes diesel / electric locomotives and passenger cars.
Highway Vehicles	Includes leased General Services Administration highway vehicles and all other highway vehicles owned or leased by Amtrak.
Right of Way	Includes all switches, switch heaters, signals, crossings, lights, towers, and any other device on the Right of Way.
	Includes paralleling / switching equipment and substations that are part of the catenary system in the electrified NEC.
	Includes moveable bridges along the NEC.
Small Stations	Includes stations owned by Amtrak or where Amtrak has a presence as a lessee, and where minor or no maintenance occurs.
Single Stationary Facilities	Includes major facilities grouped into five categories: rail yards, mechanical maintenance facilities, maintenance-of-way bases, back shops, and large stations.
Administrative Working Space	Includes all office space not attached to a yard, station, or other Amtrak facility.

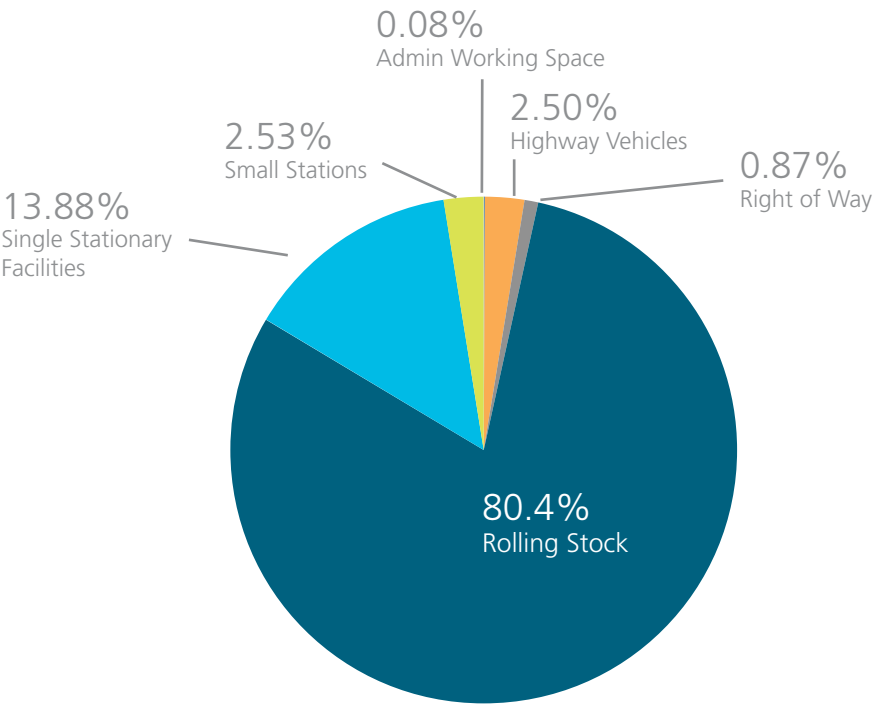


Figure 1: Facility Group Contributions to GHG Emissions for 2013

Figure 1 shows the approximate percentage that each facility group contributes to the overall total Scope 1 and 2 GHG emissions for 2013. The operation of rolling stock, including locomotives and passenger cars, is by far the largest contributor to Amtrak's Scope 1 and 2 emissions (approximately 80 percent). The largest sources of emissions are diesel and electric locomotives, contributing approximately 60 percent and 20 percent to Amtrak's total GHG emissions, respectively.

In addition to GHG information, Amtrak also reports energy consumption by fuel and energy type through CDP. Furthermore, as a part of its GHG inventory, Amtrak estimates emissions from ozone depleting substances (ODS). Amtrak uses various ODS throughout its operations; however, the most common refrigerants used are R22, R134a, and R11. Table 4 includes data for energy consumption by type converted to megawatt hours (MWh) for comparison purposes.

Table 4: Energy Consumption by Type

Energy Type	Total MWh for 2013
Diesel Fuel and Heating Oil	2,518,633
Gasoline	90,763
Propane	2,310
Kerosene	1,381
Vehicle CNG	0.76
Biodiesel	3.83
E85	229
Natural Gas	132,602
Electricity	845,981
Steam	21,672

As noted above, Amtrak's largest source of emissions is from diesel fuel and results from the combustion of fuel in the engines of our locomotives. Table 5 provides estimates for emissions of criteria pollutants and hydrocarbons from Amtrak's diesel locomotives.

Table 5: Air Emissions of Criteria Pollutants and Hydrocarbons

Emission Type	Total Emissions (metric tons)
PM_{10}	425.51
Hydrocarbons	700.54
NO_X	13,680.12
Carbon Monoxide	1,714.50
SO_2	33.53

ENERGY, FUEL AND CLIMATE

SUMMARY OF METRICS

As a signatory of the APTA Sustainability Commitment, Amtrak reports on a number of metrics, including GHG emissions, energy consumption, and environmental management performance. These metrics help us to better understand our performance on a year-over-year basis and provide useful data for establishing energy and environmental goals. Table 6 outlines key metrics and provides a comparison between 2012 and 2013 data. We are reporting these metrics on a calendar year basis (except where noted) to align with our third-party verified GHG inventory reporting for 2013.

Table 6: Key Energy and Environmental Metrics and Year-over-Year Results

Metric	2012 Result	2013 Result	Annual Change
Total Electricity Consumption (kWh)	874,087,557	845,981,306	-3.2%
Electricity - Traction (Electric Locomotives) (kWh)	549,318,720	525,127,185	-4.4%
Electricity - Non-Traction (Facilities) (kWh)	324,768,837	320,854,121	-1.2%
Total Locomotive Diesel Fuel (gallons)*	63,952,812	63,872,590	-0.13%
Total GHG Emissions (metric tons CO_2e)	1,086,286	1,099,662	1.23%
Metric Tons GHGs/million passenger miles	159.93	161.48	0.97%
Metric Tons GHGs/million seat miles	94.07	93.22	-0.90%
Environmental Audit Score**	76.8	84.9	+8.1

**For the purpose of calculating GHG emissions, Total Locomotive Diesel Fuel includes diesel fuel used by revenue trains, as well as that used in yard (switcher) locomotives and other work equipment, as well as locomotive diesel fuel purchased from host railroads.*

*** Annual environmental audit performance is reported on a fiscal year (FY) basis. These data represent FY 2012 and FY 2013.*

In 2013, Amtrak began reporting our overall strategy, risks, opportunities, and financial implications related to climate change to the CDP. The process for disclosing information to the CDP requires discussion among various departments and groups within the corporation that are responsible for activities that affect climate change (primarily GHG emissions). Our inaugural CDP response addresses Amtrak's climate change impact as well as our preparedness for the impacts of climate change on our infrastructure and operations.

Since more than 90% of Amtrak's GHG emissions come from diesel and electric locomotives and the energy used at stationary facilities, our GHG reduction initiatives have historically focused on fuel and energy conservation. These efforts have been led by leaders from all of our internal groups and departments to ensure broad participation across our organization as we seek to build a culture of energy and GHG conservation.

With regard to electricity consumption reduction initiatives, our Utilities Management Group oversaw several significant lighting upgrade projects in 2013 including:

- Installation of approximately 1700 energy efficient fixtures, including several pilot programs using LED technology;
- Installation of lighting sensor controls for 500 fixtures which turn off lights when an area is not being used by employees; and
- Removal of 200 fixtures in areas that were determined to be over-lit.

These energy efficiency projects will realize a cumulative projected yearly reduction of 3,000,000 kWh and cost savings of $285,000, with a payback period of less than two years. Further lighting efficiency projects are planned at additional facilities across the Amtrak network in 2014 and beyond.

3,000,000
kWh

Cumulative projected yearly reduction

$285,000

Cumulative cost savings

2013 LIGHTING UPGRADE PROJECTS

Smarter, Cheaper, and Cooler by a Mile: Keeping Passengers Cool and Saving Energy at Penn Station New York

New York's Penn Station is Amtrak's busiest and the nation's largest passenger train station, serving more than three quarters of a million passengers per day on multiple railroads – including Amtrak, MTA, and NJ Transit. It takes a lot of power to keep this massive landmark cool enough to beat the New York City summer heat, which requires an efficient and powerful chiller plant. In 2013, Amtrak finished installing a new chiller plant which greatly improved New York's Penn Station cooling system. This project replaced an old chiller plant that was first installed when Penn Station was rebuilt in 1963. After 50 years of service, the plant was no longer efficiently meeting the cooling needs of the station. The new plant saves more than 760,000 kilowatt hours (kWh) of electricity per year, with estimated annual savings of $122,000 due to various controls and system improvements that increase efficiency and reduce energy use.

The main function of the chiller plant is to cool the nearly three quarters of a million people who pass through Penn Station every day. The plant supplies chilled water to about 170 air-handling units, including everything from office air conditioning systems to Penn Station's air compressors. The air compressors are important to the operation of track switches, and the chilled water helps remove humidity from the compressed air supply to the switches, preventing corrosion and potential frozen switches in the winter months. With a more reliable system that ultimately helps keep track switches operating and trains coming in and out of Penn Station, these chillers are contributing to Amtrak's social and environmental sustainability.

The new plant incorporates a number of sophisticated design and engineering features that enhance operational efficiency, reliability and safety, energy efficiency, performance monitoring, and both commuter and employee comfort, all contributing to Amtrak's social, environmental, and economic sustainability. In addition to saving on operating costs, Amtrak was able to capitalize on an incentive program offered by the New York State Energy Research and Development Authority for this energy reduction project. One of the many environmental benefits associated with this new chiller plant is its utilization of refrigerants with lower Global Warming Potentials as compared to the older, less efficient system.

Out with the old...

In with the new!
Chiller Plant at Penn Station, New York

RETRO-COMMISSIONING OF CHICAGO UNION STATION'S HVAC SYSTEM

1,169,017 kWh

Cumulative projected yearly reduction

$126,948

Cumulative cost savings

CHANGES TO THE HVAC SYSTEM

Other energy reduction projects completed in 2013 include a retro-commissioning of Chicago Union Station's HVAC system that involved the installation of high efficiency controls and motors. Three compressed air audits were also completed at this facility, resulting in the repair of 120 leaks. The changes to the HVAC system in Chicago Union Station will result in a projected usage reduction of 1,169,017 kWh and cost savings of $126,948 annually, with a project payback period of one year. The repaired leaks resulting from the compressed air audits are projected to realize a reduction of 1,000,000 kWh in electricity and an annual cost savings of $165,000.

Amtrak's Fuel Management Group leads our efforts in reducing our transportation-related fossil fuel consumption and GHG emissions. Reductions in transportation-related consumption were realized by shutting down locomotives when they were out of service for an hour or more when the temperature was above 40° F. In 2013, Amtrak focused on the use of Automatic Engine Stop Start technology in our locomotives, and increasing the use of ground power by trains at layover locations and in maintenance facilities rather than relying on their diesel engines to supply power.

1,000,000 kWh

Cumulative projected yearly reduction

$165,000

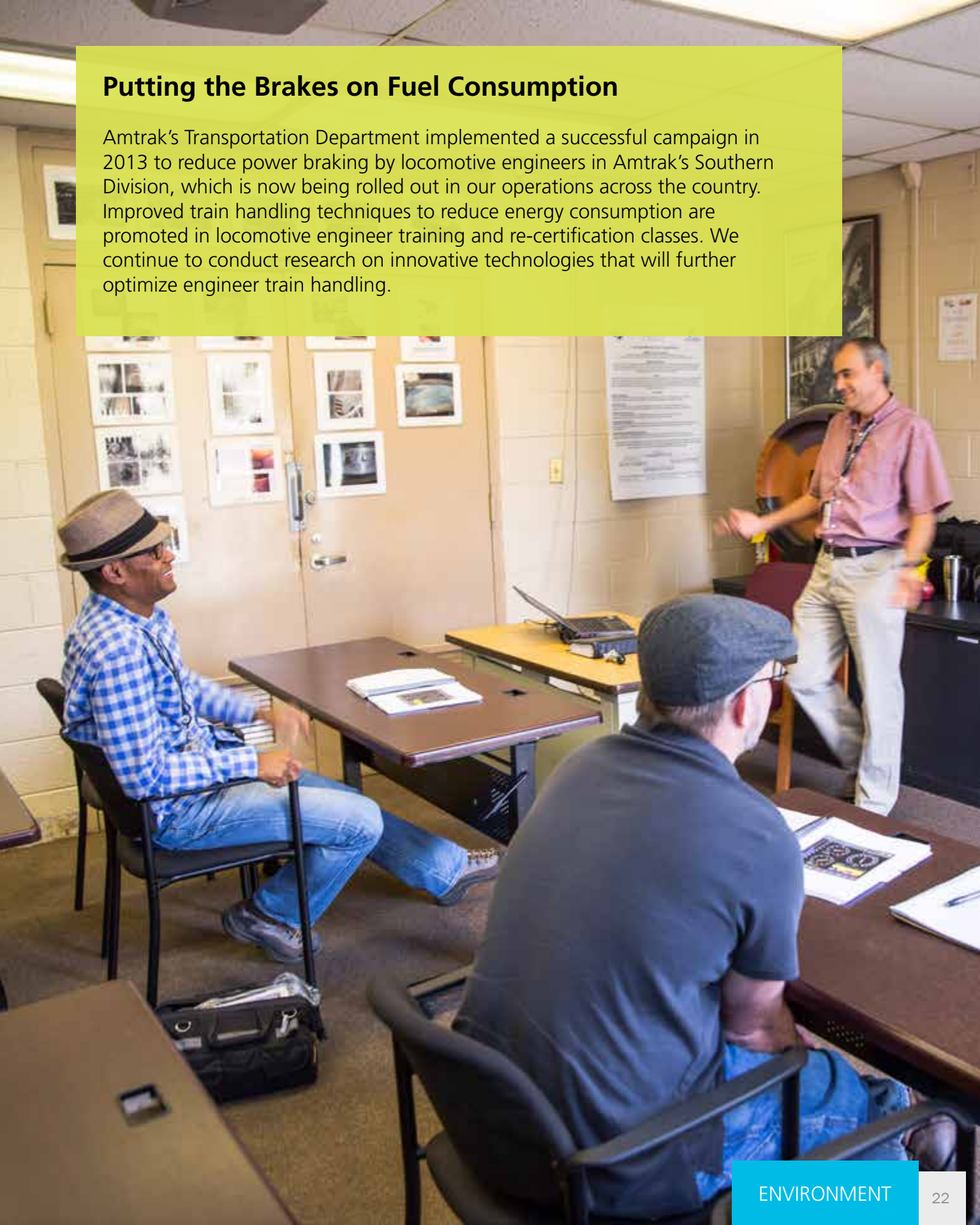
Cumulative cost savings

REPAIRED LEAKS

RETRO-COMMISSIONING OF CHICAGO UNION STATION'S HVAC SYSTEM

Putting the Brakes on Fuel Consumption

Amtrak's Transportation Department implemented a successful campaign in 2013 to reduce power braking by locomotive engineers in Amtrak's Southern Division, which is now being rolled out in our operations across the country. Improved train handling techniques to reduce energy consumption are promoted in locomotive engineer training and re-certification classes. We continue to conduct research on innovative technologies that will further optimize engineer train handling.

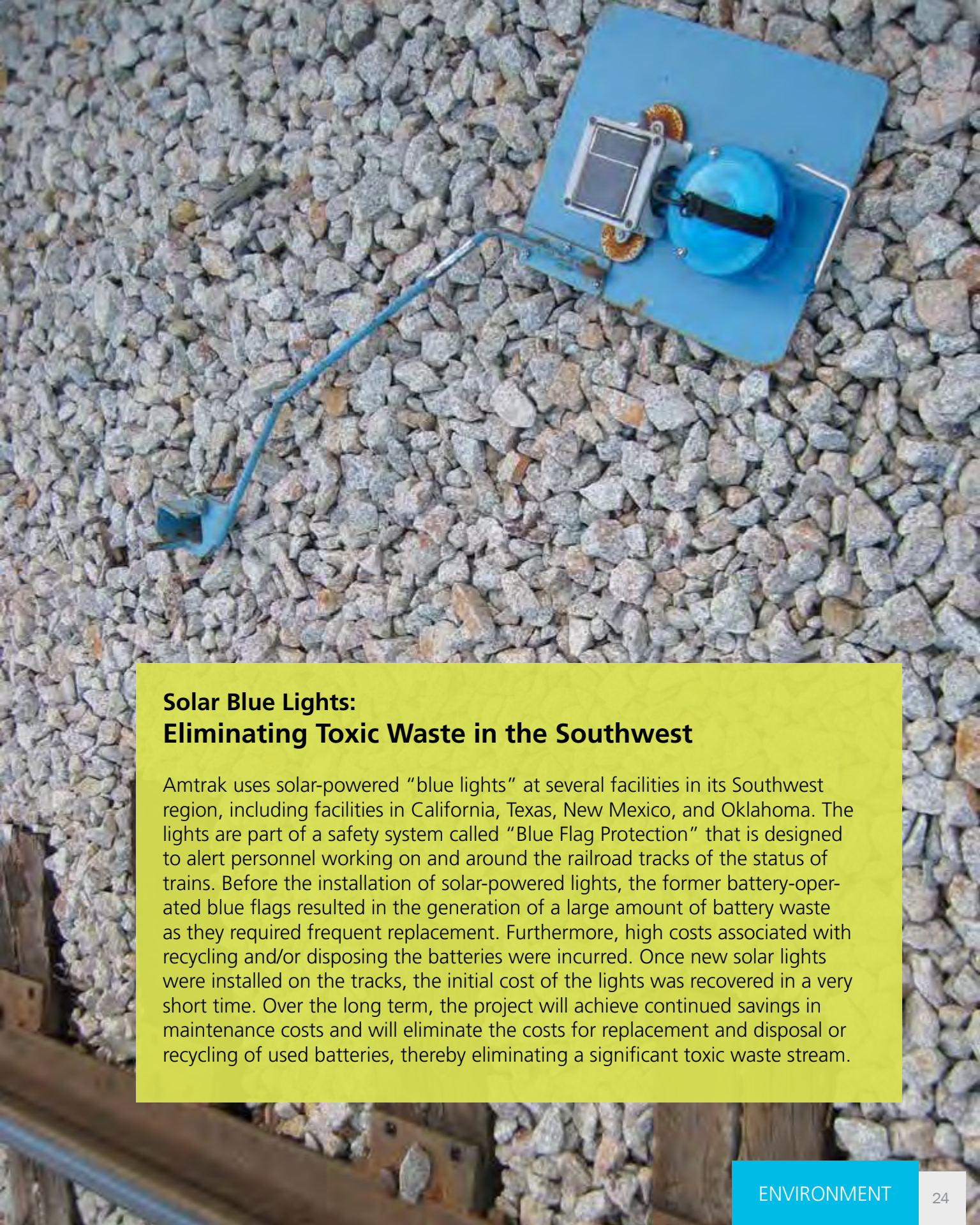


New GenSet locomotive at Amtrak's Chicago Yard

Over the past several years, the Environment and Sustainability Group has worked closely with the Mechanical Department to obtain grants for the procurement of energy-efficient GenSet locomotives to replace older diesel locomotives at our rail yards in urban areas. In 2013, GenSet locomotives were in operation at Amtrak yards in Los Angeles and Oakland, California, and two GenSets were delivered to Chicago, Illinois. Unlike older locomotives that have one large engine that idles continuously when in service, each GenSet has two smaller, independently-controlled engines that shut down when not needed. This engine configuration helps lower fuel consumption requirements. In 2014, we expect to put into service two GenSet locomotives at our Chicago, Illinois rail yard, and two locomotives at the Washington, DC yard will be refurbished to have their engines replaced with GenSets. Compared to the typical older locomotive engines in service at Washington Union Station, the new GenSet engines will require approximately 50% less fuel and will significantly reduce pollutant emissions.

Amtrak's infrastructure in the NEC suffered significant impacts from Superstorm Sandy in 2012. In the wake of this extreme storm, Amtrak began developing a climate change strategy to strengthen resilience and reduce the effects of climate change on our infrastructure and railroad operations. For example, Amtrak began evaluating our current design standards to account for sea-level rise. A rise in sea-level will increase the likelihood of flooding to critical Amtrak infrastructure including track beds, substations, and stations which may lead to increased operational costs and service disruptions. Additionally, as part of its mission to manage and plan Amtrak's infrastructure needs in the NEC territory, Amtrak has recognized the need to evaluate methodologies to assess climate-related impacts, risks, and opportunities in planning for infrastructure improvements.

Amtrak launched two risk-focused initiatives in 2013, as described in the Economic section of this report. Both of these initiatives are enterprise-wide and include all objectives and risks relevant to Amtrak, including strategic, operational, financial, and compliance-related risks. We consider climate change, environmental, sustainability, energy, and other related risks to be relevant for each category of objectives, and we will assess and manage these risks as part of these processes.



Solar Blue Lights:
Eliminating Toxic Waste in the Southwest

Amtrak uses solar-powered "blue lights" at several facilities in its Southwest region, including facilities in California, Texas, New Mexico, and Oklahoma. The lights are part of a safety system called "Blue Flag Protection" that is designed to alert personnel working on and around the railroad tracks of the status of trains. Before the installation of solar-powered lights, the former battery-operated blue flags resulted in the generation of a large amount of battery waste as they required frequent replacement. Furthermore, high costs associated with recycling and/or disposing the batteries were incurred. Once new solar lights were installed on the tracks, the initial cost of the lights was recovered in a very short time. Over the long term, the project will achieve continued savings in maintenance costs and will eliminate the costs for replacement and disposal or recycling of used batteries, thereby eliminating a significant toxic waste stream.

WASTE REDUCTION AND RECYCLING

WE RECYCLE

At Amtrak, we strive not only to reduce waste, but also to recycle wherever possible. Like many corporations, we generate both industrial materials and municipal-type wastes. These two very distinct waste streams require different approaches in how we manage and track data and require the establishment of different goals.

Amtrak mechanical and engineering maintenance facilities recycle industrial materials generated through train repair and upgrades, track repair and routine maintenance. These materials include steel parts such as wheels and axles, scrap steel, other metals (such as brass and aluminum), used oil, and other materials such as polycarbonate windows and mattress foam. The amount of materials generated depends on the volume of maintenance work and capital improvements undertaken in a given year. Amtrak has established vendor contracts for recycling of these materials and tracks the quantities recycled each year. Our goal is to continue to identify recycling opportunities for additional materials, such as the seats from train cars when they reach the end of their useful lives and can no longer be refurbished.

Municipal-type materials are handled differently than industrial materials for recycling. The amount of these materials, such as beverage containers and all types of paper, is hard to predict since much of it is generated by our passengers. The waste removed from our trains is handled at our stationary facilities (stations and maintenance yards) along with the municipal-type wastes generated at those facilities. These waste streams and

recycling quantities are tracked on a facility-specific basis and are reflected in the facility totals. The vendor contracts for pickup of municipal wastes have typically been established on a local basis. Amtrak does not currently possess a mechanism for centralized tracking of these waste streams; however, we are exploring the means to do so.

Our corporate goal for municipal waste streams for 2013 was to centralize data collection and establish a reliable baseline for municipal solid waste amounts and recycling rates. This will allow us to set performance improvement targets and track waste diversion rates for our onboard recycling program and the recycling that occurs at our offices, stations, and maintenance facilities. To begin the process of centralizing data to better manage these waste streams, Amtrak contracted with a national firm in August 2012 to manage, report, and optimize all waste accounts for municipal materials. This is the same data management service that has been used to manage Amtrak's other utility accounts (e.g. electricity, natural gas, and steam) since 2007.

During the first year of the data centralization program (2013), a total of 101 waste accounts were entered into the waste management tracking system. These accounts cover all of Amtrak's largest owned and operated facilities. We estimate that these accounts comprise 85 to 90 percent of the municipal waste materials that our facilities generate. Additional accounts will be added in future years, as we increase our understanding of our waste diversion rates at a national level. The first full year of data will be used to establish baseline metrics for municipal solid waste amounts with the goal of accounting for the amount disposed and the amount recycled.

Table 7 highlights the industrial and municipal-type materials that were recycled in 2012 and 2013.

Table 7: Industrial and Municipal Materials Recycled

INDUSTRIAL MATERIALS TOTALS - TONS EXCEPT WHERE NOTED		
	CY 2012	**CY 2013**
Steel Parts and Equipment	2,621	2,409
Scrap Metal / Steel	2,532	2,435
Cable / Wire	55	35
Other metals (copper, brass, aluminum)	257	160
Batteries (lead-acid)	84	85
Mattress Foam	6	7.6
Windows	24	11.2
Plastic Drums	6	8.5
Wood Scrap / Pallets	72	92
Used Oil - gallons	186,614	206,061
All Industrial Materials Recycled - tons (excludes used oil)	5,657	5,242
MUNICIPAL MATERIALS		
	CY2012	**CY2013**
Commingled materials*	1,454	1,406
Office paper	467	538
Mixed paper**	127	137
Cardboard	188	1,717
All Municipal Materials Recycled - tons	2,236	3,798

*Commingled materials include mixed plastic, aluminum, glass, paper, and cardboard collected at Amtrak facilities and through our onboard recycling program.

**Mixed paper includes all types of paper collected as a mixed stream, excluding office paper that is collected separately.

Engineering Department at Penn Station New York Minimizes Solder Waste:

Moving from hazardous waste disposal off-site to total closed-loop in-house recycling

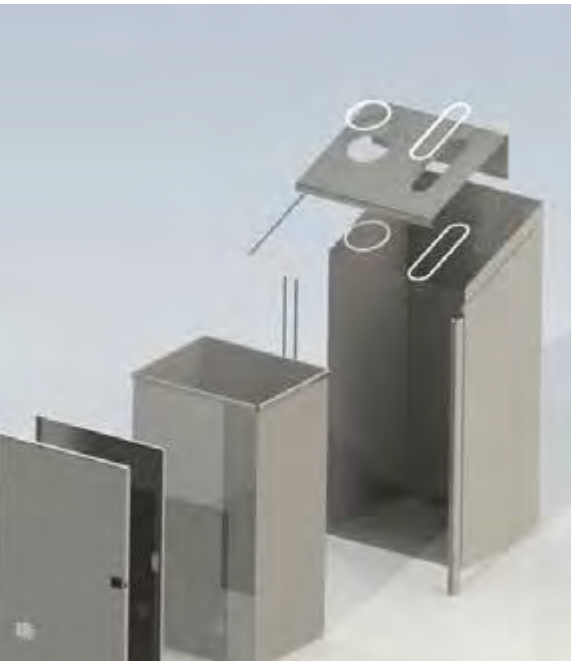
Amtrak's Engineering Department at our Penn Station New York rail yard fabricated a "Lead Soldering Station" that was put into operation in 2013. Prior to the implementation of this station, lead solder drippings (slag) produced from facility operations had to be handled as hazardous waste when collected from wood and concrete surfaces. This hazardous waste had to be containerized and disposed of through a hazardous waste hauler.

The design of the new soldering station at Penn Station ensures that all slag remains on a new stainless steel bench top or drops to a catch tray which allows for its collection and reuse. This system allows Amtrak to eliminate this waste stream in our Engineering division by recycling the material for reuse in-house. The innovative thinking behind this measure has reduced the production, transportation and disposal of hazardous waste at Penn Station, resulting in cost savings as well as reduced environmental compliance risk by eliminating one of the facility's Hazardous Waste Satellite Accumulation Areas. This enhancement helps Amtrak in achieving its Financial Excellence strategic goal and improves the safety of our employees that work in and around our rail yards by reducing their exposure to hazardous waste.

In addition to the environmental benefits associated with this innovation, the solder table makes use of clamps to hold work pieces during soldering, allowing employees to use both hands. This provides a safer work environment and minimizes the amount of solder used, improving both efficiency and productivity.

ONBOARD RECYCLING PROGRAM

Passengers sometimes ask, "Why don't I see more recycling containers aboard Amtrak trains?" Most Amtrak passenger cars have been in service for many years. Traditional passenger car designs included only one or two waste receptacles in each car, and typically lacked any form of dedicated recycling containers. In order to raise our capacity for waste management onboard our passenger cars, we are in the midst of a multi-year effort to meet our goal of providing a recycling receptacle in every Amtrak passenger car. This continues our evolution toward improving onboard waste diversion. Between 2008 and 2010, an existing trash can was relabeled for recycling in every café and dining car in the Amtrak fleet, so that all trains with food service provide for recycling of food and beverage containers.



Superliner Passenger Car Recycling Container

In 2013, we completed the design and installation procedures for new recycling containers to be installed in each Superliner I passenger car. Superliner cars are bi-level cars in long distance service on several Amtrak routes throughout the country. We evaluated vendors and in-house capabilities and determined that Amtrak's Beech Grove, Indiana Mechanical shop could build the containers quickly and cost-effectively. The Amtrak Mechanical Department also determined that they could utilize their field locations to install the containers as trains come through frequently for routine maintenance. This will greatly shorten the installation time for the whole fleet of Superliners from four years (the typical overhaul cycle) to less than two years. By the end of 2014, passengers in all areas that we serve should see these new containers in service in our passenger cars. Furthermore, our design engineers are already at work on design and planning the installation of recycling containers for the other types of passenger cars in the Amtrak fleet.

Single-Use Styrofoam ice chests packaged for delivery to a recycling facility.

Recycling and Source Reduction Project on Long Distance Trains

Until recently, Styrofoam ice chests were used in the sleeping cars of Amtrak long distance trains to provide fresh ice to passengers during their trip. Due to food safety regulations, these ice chests were single-use containers that had to be disposed of at the end of each trip and could not be reused. The Amtrak Environment and Sustainability Group identified a recycling center to recycle the Styrofoam, and worked with other Amtrak departments to develop a long-term solution that would be more economical and more sustainable. This internal collaboration has enabled us to develop a new procedure for delivering ice from the food service car aboard trains that will eliminate the use of Styrofoam ice chests on all Amtrak long distance routes.

ENVIRONMENTAL COMPLIANCE

Amtrak had no significant fines or non-monetary sanctions for non-compliance with environmental laws and regulations in 2013.

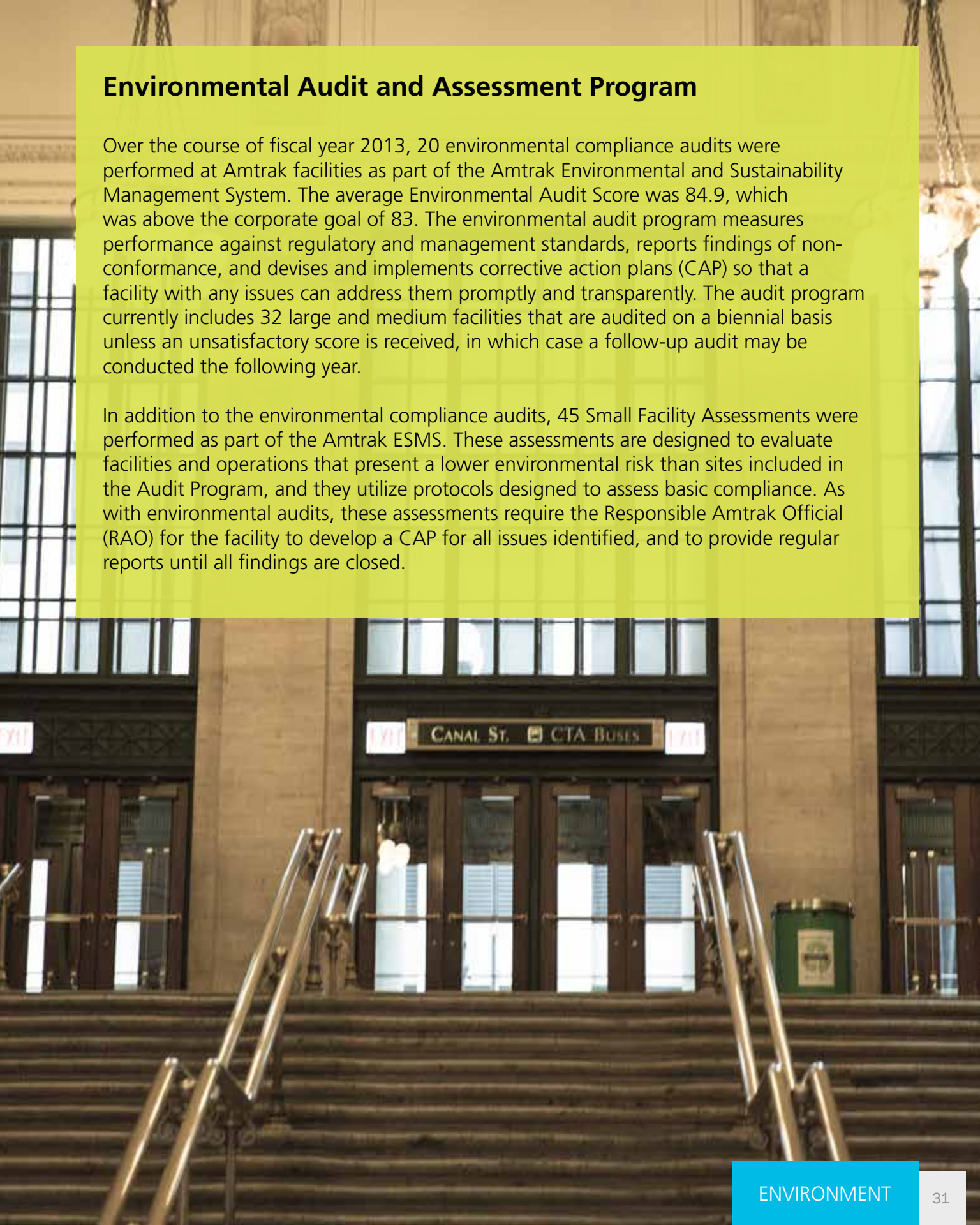
In 2013, Amtrak recorded a total of 81 environmental incidents involving a spill of operational fluids, including equipment leaks and accidental spills. All spills were cleaned up and remediated as necessary by Amtrak employees or an environmental contractor managed by Amtrak, and residual materials were disposed of in accordance with environmental regulations. Of these spills, 43 were reported to federal, state, or local environmental agencies based on regulatory reporting thresholds. There were only two spills greater than 100 gallons, while 72 percent of spills were of volumes below 25 gallons.

The Environment and Sustainability Group tracks each spill from initial report to final cleanup, allowing us to appropriately manage these events and look for opportunities to reduce the risk of spills in the future. Of the 81 incidents that occurred in 2013, the majority (62) were spills of petroleum products. Eight were spills of non-petroleum oils, and 11 were spills of non-oily materials such as industrial wastewater, sewage, and battery acid. Amtrak routinely trains operating employees on proper material handling techniques as well as spill cleanup procedures in order to reduce spill incidents and impacts.

Environmental Audit and Assessment Program

Over the course of fiscal year 2013, 20 environmental compliance audits were performed at Amtrak facilities as part of the Amtrak Environmental and Sustainability Management System. The average Environmental Audit Score was 84.9, which was above the corporate goal of 83. The environmental audit program measures performance against regulatory and management standards, reports findings of non-conformance, and devises and implements corrective action plans (CAP) so that a facility with any issues can address them promptly and transparently. The audit program currently includes 32 large and medium facilities that are audited on a biennial basis unless an unsatisfactory score is received, in which case a follow-up audit may be conducted the following year.

In addition to the environmental compliance audits, 45 Small Facility Assessments were performed as part of the Amtrak ESMS. These assessments are designed to evaluate facilities and operations that present a lower environmental risk than sites included in the Audit Program, and they utilize protocols designed to assess basic compliance. As with environmental audits, these assessments require the Responsible Amtrak Official (RAO) for the facility to develop a CAP for all issues identified, and to provide regular reports until all findings are closed.



Environmental Improvements to Trainwash Facility in Hialeah, Florida

In 2013, Amtrak completed repairs and upgrades to the Hialeah trainwash facility. This trainwash is subject to Florida Department of Environmental Protection regulations for stormwater and wastewater discharges. Upgrades included extending the length of the wash water containment pad to contain the sprayed wash water and prevent wash water "carryout" from the blower area onto unpaved ground, reducing the risk of contaminants from the washing operation entering the soil or contaminating groundwater.

BEFORE
Trainwash at Amtrak facility in Hialeah, Florida

AFTER
Trainwash at Amtrak facility in Hialeah, Florida

SOCIAL

EMPLOYEES AND EMPLOYEE PROGRAMS

WORKFORCE COMPOSITION

To maintain and operate the nation's intercity passenger rail network, Amtrak employs more than 20,000 people in a variety of roles.

We are committed to being an equal opportunity employer, and we adhere to all labor and employment laws in the jurisdictions in which we operate. Information on our workforce demographics is shown in Table 8.

Table 8: Workforce Composition

WORKFORCE COMPOSITION BY EMPLOYMENT TYPE		
Employment Type	**Employees**	**Employee %**
Union	17,864	76.10%
Management	2,948	12.13%
Contractor	2,761	11.76%
Grand Total	23,473	100%
WORKFORCE COMPOSITION BY VETERAN STATUS		
Veteran Status	**Employees**	**Employee %**
Non-Veteran	19,591	83.46%
Undisclosed	2,991	12.74%
Veteran	891	3.80%
Grand Total	23,473	100%
Gender	**Employees**	**Employee %**
Male	17,923	76.36%
Female	5,225	22.26%
Unspecified	325	1.38%
Grand Total	23,473	100%
WORKFORCE COMPOSITION BY GENDER AND EMPLOYMENT TYPE		
Gender	**Employees**	**Employee %**
Male	17,923	76.36%
Union	13,821	58.88%
Contractor	2111	8.99%
Employee	1991	8.48%
Female	5,225	22.26%
Union	4,043	17.22%
Employee	857	3.65%
Contractor	325	1.38%
Unspecified	325	1.38%
Contractor	325	1.38%
Grand Total	23,473	100%

Amtrak has 12 labor unions and they all support Amtrak's Safe-to-Safer initiative. More information about the Safe-to-Safer program can be found in the Safety and Security section of this report.

The Amtrak Employee Wellness Program

The Amtrak Employee Wellness Program continued to engage employees in 2013 by offering confidential onsite biometric screenings and online health assessments, hosting flu shot clinics, and offering an incentive program that awards gift cards for staff participation. The Wellness Program organized a "Keep Walking" challenge that distributed pedometers to employees, enabling them to keep track of the number of steps that they walk and providing rankings through electronic reporting software. This initiative challenged employees to meet a corporate-wide goal for steps logged and promoted the creation of employee teams that fostered a sense of camaraderie.

Association of American Railroads Environmental Awards

The Association of American Railroads Environmental Awards provide recognition to an individual railroad employee who has demonstrated outstanding performance in the areas of environmental awareness and responsibility during the award year. In 2013, Sandra Yan of Amtrak's New England Division was the Amtrak Nominee for the Professional Environmental Excellence Award in recognition of her exemplary performance in advancing sustainable solutions and creatively and tenaciously ensuring environmental compliance. Also in 2013, Renee Strolis, the Director of Fuel Management, was Amtrak's nominee for the John H. Chafee Environmental Excellence Award for her role in leading Amtrak's fuel management and fuel reduction initiatives.

Renee A. Strolis, Amtrak nominee for AAR Chafee Award for environmental excellence.

Promoting Healthy Food Choices through a Farm Share Program in Philadelphia

Employees at our Philadelphia 30th Street Station and their families enjoyed fresh fruits and vegetables delivered right to the station in 2013 by signing up for a local Farm Share program through Amtrak. The Delaware Valley Farm Share is a program of Common Market, a distributor of sustainable food from local family farms. Their mission is to strengthen regional farms while making local produce accessible to communities and the institutions that serve them, including schools, hospitals, universities, grocery stores, and workplaces. The 30th Street Station Farm Share site was coordinated by a local Amtrak employee, who made sure that all the participants received their delivery every other week during summer and fall. Many of the Amtrak participants enjoyed the summer produce so much that they signed on for the winter share, which included squash and pumpkins, honey, and even locally made flour and bread.

SAFETY AND SECURITY

2013 was the fourth year of Amtrak's Safe-2-Safer program. Safe-2-Safer is a multiyear risk-reduction approach to safety and security that aims to reduce injuries by creating a more collaborative environment and to bridge gaps between departments, as well as labor and management across the company. This behavior-based program complements our existing safety programs by fostering training, coaching, and greater accountability for supervisors, and broader employee engagement through peer-to-peer feedback. In 2013, the program had an overall employee contact rate of 55 percent with a total of 96,145 peer-to-peer safety observations performed by employees.

The Amtrak Police Department (APD) provides law enforcement support and security throughout Amtrak operations. In 2013, the APD continued working to improve employee safety and security awareness by designing and distributing numerous print publications that describe methods for determining suspicious activity and crime, and provide employee safety tips.

In April, the APD distributed information to all Amtrak employees to raise awareness of human trafficking, which included the delivery of a web-based human trafficking training program for our staff. The APD also participated in the Blue Campaign, a US Department of Homeland Security (DHS) campaign to end human trafficking, and attended a stakeholder event of the DHS Council on Combatting Violence Against Women in Washington, DC. Amtrak's Police Department continues to be an active partner in supporting the DHS in its efforts to end human trafficking.

We also worked with multiple federal, state, local, rail, and transit agencies in 2013 to conduct nine Operation RAILSAFE deployments, which are exercises designed as simulations for counterterrorism and incident response capabilities at passenger stations and along the right of way.

On October 16, 2013, the APD launched the "Txt-a-Tip" program, a new method for passengers and employees to report suspicious activity, crime, or emergencies via SMS text messaging. This initiative is part of a continued effort by Amtrak to provide additional communication options, particularly for passengers and employees who are deaf or may have hearing loss, allowing easy and efficient communication of emergency information to the APD.

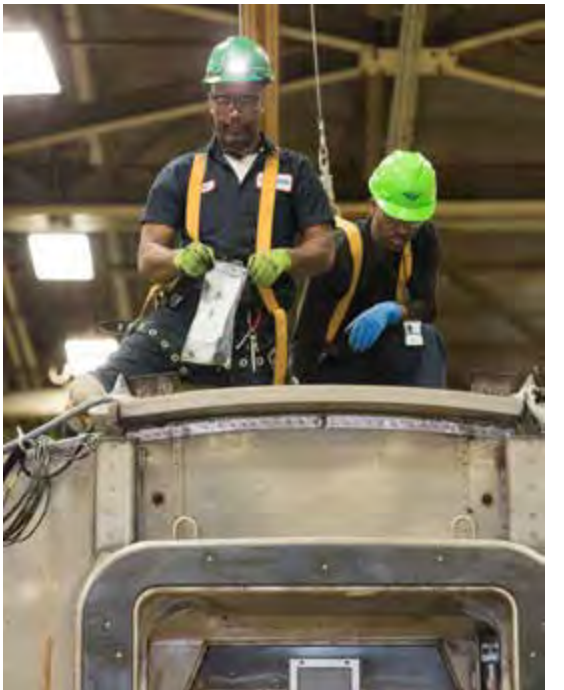
In 2013 the newly formed Amtrak Emergency Preparedness and Corporate Security Department also began implementing a security risk management strategy to address threats and vulnerabilities associated with natural hazards and acts of terrorism. This includes a framework for video surveillance of rail assets, installing secure videoconferencing systems, and developing training programs for security awareness. The group also considered ways to integrate this strategic goal into Amtrak operations in the upcoming year.

OPERATION LIFESAVER

The Operation Lifesaver (OL) program started in 1972 when the average number of collisions at U.S. highway-rail grade crossings had risen above 12,000 incidents annually. Today, OL's network of authorized volunteer speakers and trained instructors offers free rail safety education programs in fifty states. The organization delivers presentations to more than one million people each year including school groups, driver education classes, community audiences, professional drivers, law enforcement officers, and emergency responders. The goal of the organization is to promote education, enforcement, and engineering to end collisions, deaths, and injuries at highway-rail grade crossings and on rail properties nationwide.

Amtrak has a long history of participating in OL and has helped to deliver its safety message to thousands of people through special railroad events, internal and external training activities, and presentations conducted by Amtrak employees. To date, nearly 100 Amtrak employees have been trained as OL presenters or volunteers. Together, they have helped spread the word about trespassing and grade crossing safety to dozens of civic organizations, first responder classes, transportation groups, and school age children nationwide.

Amtrak consistently contributes funding to Operation Lifesaver to sustain and support its short and long term projects and programs. Amtrak has also partnered with OL for major national events such as National Train Day to promote rail safety. OL volunteers and state coordinators are provided free travel on Amtrak trains to attend OL events, meetings and conferences where safety strategies are developed and implemented. Amtrak has created a dedicated position of Operational Lifesaver Specialist to act as a liaison between all partners and outside stakeholders committed to reducing the number of grade crossing and trespasser incidents.



STATION INITIATIVES

In 2013, Amtrak participated as a partner and/or stakeholder in the design and construction of new stations and improvements to existing stations in ways that incorporate sustainability criteria in multiple communities.

Designs for new facilities incorporate many green building elements that will qualify projects for the US Green Building Council's Leadership in Energy and Environmental Design (LEED) ratings, whether or not the project sponsor seeks LEED certification. LEED is a green building certification program that recognizes best-in-class building strategies and practices. To receive LEED certification, building projects must satisfy prerequisites and earn points to achieve different levels of certification. Amtrak developed criteria for externally sponsored design-build projects that incorporate requirements for sustainability. The Review Requirements for Design-Build Projects was issued for the New York State Department of Transportation's 2013 procurement for design-build services for our new Rochester, New York Station. The new ARTIC Station in Anaheim, California, designed for LEED Platinum certification (the highest LEED designation that can be achieved) was under construction in 2013 for scheduled completion in the fall of 2014.

Seattle King Street Station waiting room before renovations

The 2013 re-opening of the central waiting room and Compass Room entrance of the City of Seattle's King Street Station completed a five-year project whose improvements include seismic strengthening upgrades and features that use renewable energy, reduce operating costs, and lower the building's overall carbon footprint. King Street Station is expected to receive LEED Platinum certification. Amtrak's Facilities Development team incorporated additional recommendations for sustainable design in the update to the Amtrak Station Program and Planning Guidelines issued on May 1, 2013.

Seattle King Street Station waiting room following renovations

EARTH DAY PROGRAMS

Amtrak has committed to sharing our journey to sustainability with our employees, passengers, and members of local communities. The APD headed efforts to develop environmental awareness by leading a cross-functional team to conceptualize, plan, and deliver Earth Day events at Philadelphia 30th Street Station and Washington Union Station in April 2013. The APD coordinated participation of environmental organizations in both events by fostering partnerships between Amtrak, the Environmental Protection Agency, Earth Day Network, and numerous other local organizations. These environmental fairs offered an opportunity to represent Amtrak among a group of government and non-government agencies and small businesses that participated in these events to share environmental educational material and promote environmental programs or products.

ACCESSIBILITY AND CONNECTIVITY

Building on our current base of services, networks and features, we will be enhancing accessibility and connectivity through 2014 and beyond.

Tables 9 through 11 provide information on enhancements completed or in progress in 2013. In future years we will report on annual improvements that we make to improve accessibility and connectivity for our passengers.

Table 9: Design Work Completed in Fiscal Year 2013

DESIGNS THAT PROGRESSED	
Count	**Station**
1	Staunton, VA
2	Prince, WV
Total	2
DESIGNS COMPLETED	
Count	**Station**
1	Ontario, CA
2	Palm Springs, CA
3	Victorville, CA
4	Sanford, FL
5	Gainesville, GA
6	Savannah, GA
7	Alliance, OH
8	Bryan, OH
9	Camden, SC
10	Lorton, VA
Total	10

Table 10: Construction Work Completed in Fiscal Year 2013

CONSTRUCTION THAT PROGRESSED	
Count	**Station**
1	Dyer, IN
2	Amsterdam, NY (station interior only)
3	Port Kent, NY
4	Ticonderoga, NY
5	Whitehall, NY
6	Randolph, VT
7	St. Albans, VT
8	Waterbury, VT
Total	8
CONSTRUCTION SUBSTANTIALLY COMPLETED	
Count	**Station**
1	Guadalupe, CA
2	Lompoc-Surf, CA
3	Needles, CA
4	Redding, CA
5	San Luis Obispo, Ca
6	Stockton, CA
7	Renssalear, IN
Total	7

Table 11: Contracts Awarded for Station Improvements in Fiscal Year 2013

Count	Station
1	Dyer, IN
2	Rensselaer, IN
3	Amsterdam, NY (station interior only)
4	Port Kent, NY
5	Ticonderoga, NY
6	Whitehall, NY
7	Randolph, VT
8	St. Albans, VT
9	Waterbury, VT
Total	9

AMTRAK - ACCESSIBLE FOR ALL

In 1990, Congress passed the Americans with Disabilities Act (ADA), which required intercity rail stations to be accessible to persons with disabilities. Amtrak is proud to serve as an important mode of travel for people with disabilities. Working with other station stakeholders, we are committed to ensuring that stations are accessible to all of our passengers.

In February 2009, as required by the Passenger Rail Investment and Improvement Act of 2008, Amtrak provided a plan to Congress to achieve ADA compliance by September 30, 2015. ADA compliance includes updating restrooms, ticket windows, water fountains, signage, entry doors, egress pathways, and Passenger Information Display Systems (PIDS) that provide visual and audio announcements. Outdoors, ADA compliance extends to the design of platforms, PIDS, signage, parking stalls and accessible routes to include curb cuts, ramps, and doorway widths.

Ultimately, accessibility improvements benefit all Amtrak passengers by eliminating barriers to travel. Improvements such as level boarding have made it easier for persons with wheeled mobility devices to board the train, along with the elderly, families with children, and passengers with heavy bags. Ongoing work to remove barriers to travel in the parking lot, in and around the station, and on the platform will help ensure that America's intercity passenger rail system is accessible to everyone.

AMTRAK THRUWAY SERVICE EXTENDS THE REACH OF OUR RAIL NETWORK

As the United States' intercity passenger rail service provider, Amtrak connects more than 500 destinations in 46 states and three Canadian provinces. Amtrak "Thruway Service" extends the reach of our transportation network to destinations not directly served by intercity rail, giving passengers greater connectivity and more travel options. Most connections are operated by intercity buses, but some routes are operated by vans, taxis, commuter (regional) trains, and ferries. In most cases the connection to the Thruway Service is provided at Amtrak stations.

The arrangements for these co-modal services vary by route. Amtrak does not operate buses directly, but contracts for services on its behalf or enters into ticketing agreements with other operating companies. In some cases, Amtrak provides a "dedicated" bus connection, meaning that the bus route is contracted by Amtrak to be used on its behalf exclusively for connecting to and from Amtrak trains. In other cases, the connecting Thruway Service is with another carrier, where Amtrak passengers are carried over typical scheduled line service. Many of the Thruway routes are supported by state governments, often to improve access to intercity transportation in rural areas and to increase ridership on trains that are financially supported by the state.

In a few instances, bus service also offers supplemental frequencies to rail service, allowing more departure options for a given itinerary than could be achieved using just passenger rail.

AMTRAK AIRPORT CONNECTIONS

Amtrak intercity trains provide direct connections to several airports in the United States. Along the densely populated Northeast Corridor, Amtrak serves the BWI Thurgood Marshall Airport Station (serving Baltimore and Washington DC) and the Newark Liberty International Airport Station (serving the New York metropolitan area). Both airport stations are also served by frequent commuter train services. Additionally, the corporation has agreements that allow airline passengers at Newark airport to connect with Amtrak trains between Newark and Philadelphia (approximately 80 miles apart), reducing the need for short-haul feeder flights.

Outside the Northeast Corridor, Amtrak has airport stations in Milwaukee, Wisconsin, and Burbank, California. Many other airports have local rail connections to intercity trains. Travelers can reach the airport by connecting from intercity trains to local transit providers. Given that several Amtrak routes pass through rural areas with limited transportation alternatives, the connectivity provided by the intercity train to a metropolitan airport is often the only public transportation access to an airport for a significant portion of the population.

New bicycle storage

BIKES ON BOARD

In an effort to improve Customer Service and connect multiple modes of transportation, in 2013 Amtrak staff created a prototype to allow customers to store bicycles more easily in the baggage cars of our trains. Previously, bicycles were required to be stored in bicycle boxes, which incurred additional costs for customers traveling with bicycles and made the bikes more difficult for passengers to load. The new prototype allows the bicycles to be stored securely and wheeled easily onto the train.

Contractor installs length of steel conduit along a railroad bridge to carry new signal, power, and communication cables over a waterway.

Amtrak personnel install a manhole to provide access to newly installed buried cables.

Amtrak personnel install a manhole to provide access to newly installed buried cables.

Expanding Access

New Haven-Hartford-Springfield Rail Corridor Improvements

Beginning with the replacement of existing signals, communications, and electric power infrastructure, Amtrak initiated a multi-year project to improve rail infrastructure along the New Haven-Hartford-Springfield corridor with the goals of increasing both the speed and frequency of rail service along this 62-mile corridor that connects New Haven, Connecticut and Springfield, Massachusetts.

Funded by the State of Connecticut through a grant from the Federal Railroad Administration's High-Speed Intercity Passenger Rail Program, the project will include the replacement or restoration of approximately 35 miles of track which will be realigned to support speeds of up to 110 miles per hour, the repair or replacement of numerous bridges and culverts, improvements to existing stations, and the construction of new stations. Aligned with Amtrak's strategic goals of Customer Focus, Financial Excellence, and Safety and Security, this work will introduce commuter rail service along the corridor and support enhanced Amtrak intercity passenger rail service.

ECONOMIC

ECONOMIC PERFORMANCE PROFILE

Amtrak reports its financial performance through Monthly Performance Reports and through its annual consolidated financial statements which are released on a fiscal year basis.

These reports may be found on Amtrak's public website, www.Amtrak.com under the Reports and Documents tab.

Our Monthly Performance Reports document a number of key performance metrics, including ridership totals, revenue and expenses per seat mile, customer satisfaction index, and on-time performance, among others. The Monthly Performance Reports also track other indicators of Amtrak performance including seat miles, passenger miles, load factor, diesel gallons per train mile, and equipment in service (locomotive fleet and passenger fleet).

ORGANIZATIONAL EXCELLENCE: BUSINESS REORGANIZATION

In FY 2013, Amtrak completed a significant reorganization of our operating structure. This reorganization involved the creation of three Business Lines — new operating organizations tailored to deliver services to the customers of our major service offerings with a strong focus on enhancing financial and operational performance and greater customer service by creating greater accountability for activities that impact our patrons. During 2013, to further the goals established in the Amtrak Strategic Plan, we formed three new Business Lines to manage Amtrak's operation, entitled the Northeast Corridor, State Supported Corridors, and Long Distance Business Lines.

This new structure for our organization was designed to dissolve organizational silos with the goal of driving stronger communication, collaboration, and a unified purpose across disciplines in support of the customers of our three train operating businesses. The overarching success of Amtrak will be driven by accountability of the individuals and teams that make up and support these primary business lines.

Going forward, each business line will be required to create a plan with clear objectives, responsibilities and performance metrics that will guide its operation. Throughout FY 2013, extensive planning and development efforts were undertaken to ensure that these three Business Lines would be fully positioned to commence service beginning in FY 2014, which for Amtrak began on October 1, 2013.

The three new train operations business lines join the existing Northeast Corridor Infrastructure and Investment Development Business Line (NECIID), which was created in FY 2012. NECIID manages and plans Amtrak's infrastructure needs in the NEC territory from Boston, MA to Washington, DC. The NECIID organization continued to advance NEC network planning, conceptual design, and development activities, together with managing commercial partnerships, infrastructure access and funding, and financing strategies to support the future needs of Amtrak's NEC infrastructure. Through extensive dialogue with our primary customers that use Amtrak's NEC assets (the Northeastern states served by the NEC and related commuter rail operators) and the Northeast Corridor Operations Advisory Commission, NECIID has led Amtrak's ongoing participation in the Commission's efforts to negotiate appropriate cost allocation formulae for commuter and Amtrak uses of NEC shared infrastructure in accordance with Section 212 of the Passenger Rail Investment and Improvement Act (2008).

NECIID is also leading Amtrak's efforts on major Master Planning initiatives addressing the long-term needs and opportunities related to Amtrak's major stations along the NEC, including Washington, DC Union Station, Philadelphia 30th Street Station, Baltimore Penn Station, and the New York Penn Station complex. These programs will result in significantly enhanced facilities to improve railroad operations, enhance the experience of our traveling public, and create greater economic value for Amtrak.

ENTERPRISE RISK MANAGEMENT

Amtrak launched two related initiatives in 2013. The first calls for the development and implementation of an Enterprise Risk Management process. The second calls for the establishment of a Management Control Framework.

Both are enterprise-wide initiatives and include all objectives relevant to Amtrak's business, including strategic, operational, financial, and compliance objectives. The process requires evaluating climate change, environmental, sustainability, energy, and other related risks in relation to Amtrak's business objectives. The Enterprise Risk Management and Management Control Framework processes have significantly improved our risk management capabilities and will provide a foundation upon which the company can evaluate alternative controls and techniques over time to optimize operations in a manner that also contributes to the reduction of our carbon footprint.

PHOTOGRAPHY

APPENDIX A

GLOSSARY

THE CLIMATE REGISTRY (TCR): A nonprofit organization that is a collaboration among North American states, provinces, territories, and Native Sovereign Nations that sets consistent and transparent standards to calculate, verify, and publicly report greenhouse gas emissions into a single registry.

THE CARBON DISCLOSURE PROJECT (CDP): An independent nonprofit organization that holds the largest collection of self-reported corporate climate change, water, and forest-risk data. For more information, visit www.cdp.net.

CARBON DIOXIDE EQUIVALENT (CO_2e): A term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact.

ENVIRONMENTAL MANAGEMENT SYSTEM (EMS): A system that enables the management of an organization's environmental programs in a comprehensive, systematic, planned and documented manner. An EMS can be used to support organizational efforts to meet targets for controlling environmental impacts of its activities.

GENERAL REPORTING PROTOCOL (GRP): Outlines the policies of The Climate Registry and the required reporting calculation methodologies for the majority of greenhouse gas emissions sources.

GLOBAL REPORTING INITIATIVE (GRI): Organization promoting the use of sustainability reporting as a way for organizations to become more sustainable and contribute to sustainable development. The GRI pioneered and developed a comprehensive sustainability reporting framework that is widely used around the world. The current GRI framework is known as the 'G4' Guidelines.

GLOBAL WARMING POTENTIAL (GWP): The relative measure of the warming effect that a particular greenhouse gas will have on the atmosphere. Global warming potential values represent the heat trapped by a mass of the greenhouse gas in question with the heat trapped by a similar mass of carbon dioxide.

GREENHOUSE GAS (GHG): Atmospheric gases that absorb and emit radiation, which is the process that leads to the greenhouse effect that heats the surface of the Earth. Carbon dioxide (CO_2) is an example.

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED): A green building rating and certification program which was developed by and administered by the US Green Building Council.

NITROGEN OXIDES (NO_X): Significant components of air pollution that are generated during the combustion of fuel sources including natural gas and vehicle fuel.

OZONE DEPLETING SUBSTANCES (ODS): Substances responsible for man-made chemical ozone depletion that are commonly used in refrigeration systems. Many are also greenhouse gases.

PARTICULATE MATTER (PM_{10}): Complex mixture of microscopic solid and/or liquid matter suspended in the Earth's atmosphere. Common pollutants contained in particulate matter include acids, organic chemicals, metals, and soil or dust particles.

PASSENGER MILES (PM): A statistical unit denoting one mile traveled by one passenger used in measuring the volume of passenger traffic.

SCOPE 1 EMISSIONS: All direct greenhouse gas emissions, including emissions from stationary and mobile combustion.

SCOPE 2 EMISSIONS: Indirect GHG emissions from the consumption of purchased or acquired electricity, heat, or steam.

SEAT MILES (SM): A measure of carrying capacity equal to the number of seats available multiplied by the number of miles traveled.

SULFUR DIOXIDE (SO_2): A significant component of air pollution that is generated during the combustion of fuel sources including natural gas and vehicle fuel. Sulfur dioxide emissions are a precursor to acid rain.

CORPORATE CONTACT INFORMATION

Amtrak
60 Massachusetts Avenue, N.E.
Washington, D.C. 20002
Amtrak.com

CORPORATE SOCIAL RESPONSIBILITY CONTACT INFORMATION

Celia Ann H. Pfleckl, PMP
Senior Sustainability Manager
CeliaAnn.Pfleckl@amtrak.com

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2 00P	0	Dp	Chicago, IL–Union Station (CT)	●♿QT	Ar	2 50P
R2 34P	28		Naperville, IL (METRA/BN Line)	●♿QT		D1 53P
3 44P	104		Princeton, IL	○		D12 33P
4 38P	162		Galesburg, IL -S. Seminary St. 77	●♿QT		D11 41A
5 25P	205		Burlington, IA	○♿		10 36A
5 59P	233		Mount Pleasant, IA	●♿		9 54A
6 53P	279		Ottumwa, IA	●♿		9 09A
8 09P	359		Osceola, IA (Des Moines)	○♿QT		7 40A
8 41P	392		Creston, IA	○♿		7 04A
10 55P	500	Ar	Omaha, NE	●♿	Dp	5 14A
11 05P		Dp			Ar	4 59A
12 08A	555	Ar	Lincoln, NE	●♿	Dp	3 26A
12 14A		Dp			Ar	3 20A
1 47A	652		Hastings, NE (Grand Island)	●♿		1 42A
2 34A	706		Holdrege, NE	○♿		12 54A
3 43A	783		McCook, NE (CT)	○♿		11 49P
5 05A	960		Fort Morgan, CO (Sterling) (MT)	○♿		8 25P
7 15A	1038	Ar	Denver, CO–Union Station	●♿	Dp	7 10P
8 05A		Dp	Colorado Springs, Raton, Vail, Salida, Gunnison—see back		Ar	6 38P
10 07A	1100		Fraser-Winter Park, CO	○♿		3 50P
10 37A	1113		Granby, CO (Rocky Mt. Nat'l. Park)	○♿		3 12P
1 53P	1223		Glenwood Springs, CO (Aspen)	●♿		12 10P
4 10P	1311		Grand Junction, CO	●♿		10 23A
5 58P	1417		Green River, UT	○♿		7 59A
7 20P	1488		Helper, UT (Price)	○♿		6 37A
9 26P	1563		Provo, UT	○♿		4 35A
11 05P	1608	Ar	Salt Lake City, UT (MT)	●♿	Dp	3 30A
11 30P		Dp	Ogden, Boise, Las Vegas —see back		Ar	3 05A
3 03A	1871		Elko, NV (PT)	○♿		9 31P
5 40A	2013		Winnemucca, NV	○♿		7 08P
8 36A	2202		Reno, NV	●♿QT		4 06P
9 37A	2237		Truckee, CA (Lake Tahoe)	○♿		2 38P
11 48A	2301		Colfax, CA	○♿		12 21P
12 57P	2336		Roseville, CA	○♿QT		11 35A
D2 13P	2353		Sacramento, CA	●♿QT		11 09A
D2 44P	2367		Davis, CA	●♿QT		10 36A
D3 26P	2411		Martinez, CA (San Joaquin Trains)	●♿QT		9 54A
D3 59P	2430		Richmond, CA	○♿QT		9 22A
4 10P	2438	Ar	Emeryville, CA (PT) San Francisco—see back	●♿QT	Dp	9 10A

Shading Key

Overnight train	Thruway and connecting services

Connecting Local Services

Metropolitan Denver

At Denver Union Station, the Regional Transportation District (RTD) offers frequent light rail and bus service:

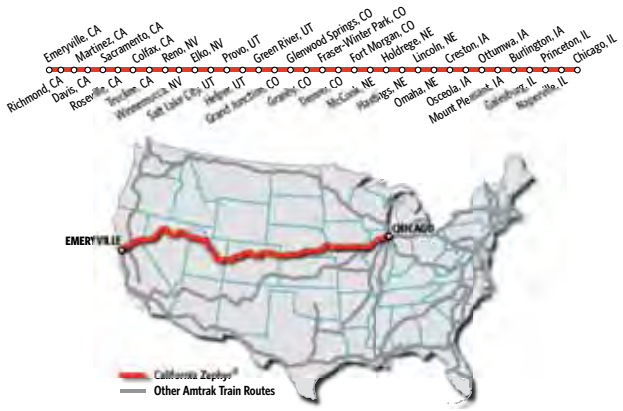
- Western/Southern suburbs via light rail,
- Boulder/Longmont/Northern suburbs via express coach service,
- Denver International Airport via SkyRide express coach service,
- Free shuttles connect Union Station along the 16th Street Pedestrian Mall to the Civic Center Station.

Call (303) 299-6000 or check www.rtd-denver.com for more information.

Salt Lake City and Environs

The Utah Transit Authority (UTA) serves Utah County, Salt Lake City, Ogden, Provo and intermediate stops with FrontRunner commuter rail, bus routes, ski buses and four TRAX light rail lines. Call 801-RIDE-UTA (743-3882) or visit www.rideuta.com.

CALIFORNIA ZEPHYR ROUTE MAP and SYMBOLS



A	Time Symbol for A.M.	QT	Quik-Trak self-serve ticketing kiosk
P	Time Symbol for P.M.	○	Unstaffed station
D	Stops only to discharge passengers; train may leave before time shown.	●	Staffed ticket office; may or may not be open for all train departures
R	Stops only to receive passengers.	♿	Station wheelchair accessible; no barriers between station and train
CT	Central time	♿	Station wheelchair accessible; not all station facilities accessible
MT	Mountain time		
PT	Pacific time		
🚌	Bus stop		

Service on the California Zephyr®

R **Coaches: Reservations required.**

Sleeping cars: Superliner sleeping accommodations.
- Amtrak Metropolitan Lounge available in Chicago for Sleeping car passengers.

Dining: Full meal service.

Sightseer Lounge: Sandwiches, snacks and beverages.
On Board Guide Program: California State Railroad Museum narrators provide historical and sightseeing commentary between Reno and Sacramento. Program and schedule is subject to change.

Checked baggage at select stations.

36 Direct transfer between train and bus at Amtrak station for connecting passengers only.

77 Executive Transportation operates Thruway van service from Springfield, IL for connections from Train 22 to Trains 3 and 5 at Galesburg, IL and from Galesburg, IL for connections from Trains 4 and 6 to Train 21 at Springfield, IL. Passengers with disabilities must provide advance notification of needs. For additional information call (217) 523-5466.

All Amtrak services and stations are non-smoking.

Trails and Rails Program: In cooperation with the National Park Service, volunteer rangers provide on board narratives between May and September on selected days on parts of this route. Visit nps.gov/trailsandrails and amtraktoparks.com.

Scenic Highlights

- One of the most popular scenic trains
- Rocky Mountains/Moffat Tunnel
- Colorado's Gore, Byers and Glenwood Canyons
- California's historic Donner Pass and High Sierra

Thruway Bus Connections

Denver • Colorado Springs • Raton *(Greyhound Lines)*

5	6	Connecting Train Number					6
8305	8306	Thruway Number					8406
Daily	Daily	Mile	▼	Days of Operation	Symbol	▲	Daily
				Denver, CO (MT)			
	12 20A	0	Dp	–Greyhound Station	○	Ar	6 15P
7 30P	12 01A		Dp	–Union Station	●♿	Ar	6 05P
8 55P	1 50A	70	Ar	Colorado Springs, CO	○	Dp	4 40P
10 00P	2 50A	112	Ar	Pueblo, CO	○	Dp	3 50P
	5 15A	218	Ar	Raton, NM –Amtrak Sta.(MT)	○	Dp	1 35P

Denver • Vail *(Greyhound Lines)*

8805	Thruway Number					8706
Daily	Mile	▼	Days of Operation	Symbol	▲	Daily
			Denver, CO (MT)			
12 15P	0	Dp	–Greyhound Station	○	Ar	
	0	Dp	–Union Station	●♿	Ar	6 10P
2 00P	71	Ar	Frisco, CO	○	Dp	4 30P
2 35P	100	Ar	Vail, CO (MT)	○	Dp	3 55P

Denver • Salida • Gunnison • Alamosa

(Black Hills Stages–en route transfers may be necessary)

5	Connecting Train Number					6
8605	Thruway Number					8606
Daily	Mile	▼	Days of Operation	Symbol	▲	Daily
2 00P	0	Dp	Denver, CO–Greyhound Sta. (MT)	○	Ar	11 15A
2 10P	0	Dp	–Union Station	●♿	Ar	11 05A
2 50P	39	Ar	Pine Junction, CO	○	Dp	10 20A
3 55P	85		Fairplay, CO	○		9 10A
4 45P	120		Buena Vista, CO	○		8 30A
5 05P	144		Salida, CO	○		7 50A
5 30P	149		Poncha Springs, CO	○		7 40A
6 50P	209		Gunnison, CO–Bus Station	○		6 20A
6 55P	210		–Western State University	○		6 15A
6 50P	226	Ar	Alamosa, CO (MT)	○	Dp	6 20A

Salt Lake City • Las Vegas *(Greyhound Lines)*

8453	Thruway Number					8458	8456
Daily	Mile	▼	Days of Operation	Symbol	▲	Daily	Daily
8 30A	0	Dp	Salt Lake City, UT (MT) –Greyhound Station	○	Ar	6 50A	5 05P
9 25A	45	Ar	Provo, UT	○	Dp	5 55A	4 10P
2 25P	304	Ar	St. George, UT (MT)	○	Dp	1 10A	11 30A
3 40P	422	Ar	Las Vegas, NV (PT) –Greyhound Station	○	Dp	10 00P	7 55A

Boise • Twin Falls • Ogden • Salt Lake City *(Greyhound Lines)*

6		Connecting Train Number						5
8447	8441	Thruway Number					8446	8440
Daily	Daily	Mile	▼	Days of Operation	Symbol	▲	Daily	Daily
10 20A	11 15P	0	Dp	Boise, ID (MT) –Greyhound Station	○	Ar	7 00A	7 45P
1 10P	1 35A	128		Twin Falls, ID –Oasis Stop N Go	○		4 40A	5 00P
4 55P	5 20A	316		Ogden, UT –Greyhound Station	○		12 50A	1 10P
5 40P	6 05A	353	Ar	Salt Lake City, UT (MT) –Greyhound Station	○	Dp	12 05A	12 15P

Emeryville • San Francisco

5005	Mile	▼	Thruway Number	Symbol	▲	5006
36 4 25P	0	Dp	Emeryville, CA–Amtrak Station (PT)	●♿ or	Ar	8 25A
			San Francisco, CA			
D5 10P	2	Ar	–Financial District, Hyatt Regency	○♿		R7 20A
D5 00P	9		–Transbay Temporary Terminal	●♿		R7 50A
D5 25P	10		–Fisherman's Wharf, Pier 39	○♿		R7 30A
D5 40P	11		–S.F. Shopping Ctr., 835 Market St.	○♿		R7 10A
5 50P	13	Ar	–Caltrain Sta., 4th & Townsend Sts.	○♿	Dp	7 00A

See other side for Shading Key, Route Map and Symbols.

PLACER COUNTY
TRANSPORTATION
PLANNING AGENCY

PLACER COUNTY
REGIONAL TRANSPORTATION PLAN
2010 - 2035

Final – September 2010

Prepared by

Placer County Transportation Planning Agency
299 Nevada Street
Auburn, CA 95603
530.823.4030
530.823.4036 (fax)
http://www.pctpa.net

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DOCUMENT AVAILABILITY

To review a copy of the 2035 RTP please visit PCTPA offices located at:

Placer County Transportation Planning Agency
299 Nevada Street, Auburn, California 95603

To download a copy of the 2035 RTP or select chapters of the document please visit the PCTPA website at:

http://www.pctpa.net/

To request a hard copy of the 2035 RTP please contact:

David M. Melko
Senior Transportation Planner
Phone: (530) 823-4090
E-mail: **dmelko@pctpa.net**

- ⇨ Please consider the environment before requesting a hard copy.

ACKNOWLEDGEMENTS

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Sue Sholtis ..... Executive Assistant

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Prepared by the

Placer County Transportation Planning Agency

in cooperation with the

California Department of Transportation

and the

Sacramento Area Council of Governments

TRANSPORTATION PLANNING ACRONYMS & DEFINITIONS

The following is a list of common acronyms used in transportation planning. Each acronym is accompanied by a brief definition.

AB **Assembly Bill**
Legislation that originates in the California assembly.

ADA **Americans with Disabilities Act**
Federal act that requires equal accessibility for persons with disabilities. It mostly comes into play with transit issues.

ADT **Average Daily Traffic**
Unit of measurement for the average amount of traffic that travels daily on a specific roadway(s).

ALUC **Airport Land Use Commission**
The designated body that deals with the compatibility of land use around airports to ensure the safety of the public while maintaining the integrity of the airport. PCTPA is the ALUC for Placer County.

ALUCP **Airport Land Use Compatibility Plan**
The plan that governs how jurisdictions will deal with land use around airports.

APCD **Air Pollution Control District**
The designated agency that deals with air quality requirements for both stationary source and mobile source (transportation-based) pollution. The Placer County Air Pollution Control District is the APCD for our area.

ARB **Air Resources Board (California)**
California agency responsible for protecting the State's air.

BTA **Bicycle Transportation Account**
A competitive annual state funding program for bicycle and pedestrian projects.

CAAA **Clean Air Act Amendments**
The federal law that sets air quality standards for the nation, including procedures for meeting these standards and penalties for non compliance.

CALTRANS **California Department of Transportation**
The California Department of Transportation (Caltrans) is primarily responsible for the planning, design, construction, maintenance, and operation of the State's transportation system.

CASP **California Aviation System Plan**
The California Aviation System Plan (CASP) is prepared by Caltrans every five years as required by the Public Utilities Code. The CASP integrates regional aviation system planning on a statewide basis.

CCAA **California Clean Air Act**
The State law that sets air quality standards for California, including procedures for meeting these standards and penalties for non compliance.

CEQA **California Environmental Quality Act**
The law that requires an assessment of the environmental impact of specified governmental actions, including procedures for making determinations.

CIP **Capital Improvement Program**
Jurisdictions and agencies prepare a Capital Improvement Program (CIP) which forecasts capital improvement needs, revenues and expenditures over a period of time varying from two to up to ten years.

CMA **Congestion Management Agency**
Under Proposition 111, passed in 1990, each county with an urbanized population of 50,000 or more was required to designate a CMA to perform specified duties to better integrate transportation, land use, and air quality. These duties were subsequently made voluntary, although PCTPA continues to administer a Transportation Demand Management program. PCTPA retains the designation as the CMA for Placer County.

CMAQ **Congestion Mitigation and Air Quality**
A funding program provided under Federal transportation legislation that targets a certain portion of Federal transportation dollars to projects that reduce congestion and/or improve air quality. PCTPA programs these funds through SACOG.

CMP **Congestion Management Program**
Under Proposition 111, passed in 1990, each county with an urbanized population of 50,000 or more was required to designate a CMA and adopt a program for integrating transportation, land use, and air quality decisions made by local jurisdictions. The CMP requirement was later made voluntary, although PCTPA continues to assist with transportation control measures.

CO **Carbon Monoxide**
A colorless, odorless, poisonous gas emitted by vehicle combustion.

CTC **California Transportation Commission**
A nine-member board, appointed by the Governor, that governs the State Transportation Improvement Program and other specified transportation funding programs.

CTSA **Consolidated Transportation Service Agency**
A designation conferred by the Regional Transportation Planning Agency on a transit provider to coordinate and consolidate the efforts of the county's paratransit providers. The CTSA is eligible to receive Transportation Development Act funding.

DOT **Department of Transportation**
The federal department responsible for transportation programs established by Congress.

EIR **Environmental Impact Report**
An environmental document prepared to comply with the California Environmental Quality Act that provides an assessment of the environmental impacts of a proposed governmental action, as well as mitigation measures and findings.

EIS **Environmental Impact Statement**
An environmental report that documents the actions and processes implemented to comply with the National Environmental Protection Act. The Environmental Impact Statement (EIS) is required for any project involving federal funding.

EPA **Environmental Protection Agency**
The federal agency responsible for environmental protection and environmental programs established by Congress.

FHWA **Federal Highway Administration**
The federal agency charged with overseeing compliance with federal requirements for highway projects. The FHWA also acts as a conduit to other federal agencies, such as US Fish & Wildlife, Army Corps of Engineers, and US Environmental Protection Agency, on transportation related permits, air quality conformity, and environmental documents.

FSP **Freeway Service Patrol**
A Freeway Service Patrol (FSP) is an umbrella term for a variety of programs implemented by government agencies, typically state Highway Patrols or Departments of Transportation, to reduce traffic congestion and improve highway safety by having specially marked and equipped vehicles patrol designated sections of roadway and provide incident management and motorist assistance.

FTA **Federal Transit Administration**
The federal agency charged with overseeing compliance with requirements for federally funded transit projects.

FY **Fiscal Year**
Begins July 1 of each year and ends June 30 the following year.

HCP **Habitat Conservation Plan**
Regional planning mechanism designed to protect an area's unique ecological assets, while clearing regulatory obstacles toward continued economic growth and development.

HOV **High Occupancy Vehicle**
A passenger vehicle with 2 or more occupants sometimes referred to as a carpool.

IIP **Interregional Improvement Program**
A programming document prepared by the Caltrans District that designates the projects and amounts to be funded by the county's share of Interregional Choice funding. Every two years, the Caltrans ITIP, along with the RTIPs from California's 58 counties, are adopted into the State Transportation Improvement Program (STIP).

ITIP **Interregional Transportation Improvement Program**
The portion of the State Transportation Improvement Program that is controlled by Caltrans. ITIP funds are used by Caltrans to fund and construct projects of statewide importance on the state highway system.

ITS **Intelligent Transportation Systems**
Refers to techniques that use technology to improve transportation safety and mobility. Techniques may include changeable message signs to alert drivers of upcoming problems, sensors to detect ice on pavement, traffic monitoring cameras, and so on.

LOS **Level of Service**
A letter designation indicating the level of traffic congestion on a particular roadway or intersection, with "A" being free-flowing and "F" being gridlock.

LTF **Local Transportation Fund**
A funding source provided under the Transportation Development Act and administered by the regional transportation planning agency, for jurisdictions to operate local transit systems. The LTF is funded by 1/4% of the statewide sales tax, returned to the county of origin.

MPO **Metropolitan Planning Organization**
A federally designated agency that provides transportation planning and programming and other duties as specified for federal programs for a metropolitan area, as designated in the federal census. The Sacramento Area Council of Governments is the MPO for the six county Sacramento area.

MTP **Metropolitan Transportation Plan**
A federally required transportation planning document which inventories existing transportation systems, forecasts needs, and designates a funding-constrained list of projects for a 20 year horizon. This document is prepared by the Sacramento Area Council of Governments.

MTIP **Metropolitan Transportation Improvement Program**
A federally required document which lists federally funded and "regionally significant" transportation projects over a four year horizon. This document is then used to demonstrate air quality conformity, which is required for a transportation project to proceed.

NEPA **National Environmental Protection Act**
The federal law which outlines the processes required to determine the environmental impact of federal projects.

NHS **National Highway System**
The National Highway System consists of 163,000 miles of interstate highways and major primary roads.

OWP **Overall Work Program**
The document PCTPA prepares each year to outline the work the agency will be undertaking, including the specific activities, products, time lines, and budgets.

PA & ED **Project Approval and Environmental Document**
Project Approval and Environmental Document (PA&ED) include commitments between partners that apply to the PA&ED phase of the project covered by an agreement.

PDT **Project Development Team**
A Project Development Team (PDT) is an interdisciplinary team composed of key members of the project team and selected external stakeholders.

PMP **Pavement Management Program**
A Pavement Management Program (PMP) is a maintenance plan for streets.

PS&E **Plans, Specifications and Estimate**
This component includes all work to develop contract plans, specifications engineer's estimate, and contract bid documents, allocation of funds, contract award, and contract approval. In addition, environmental commitments must be resolved.

PSR **Project Study Report**
Project Study Reports (PSRs) are engineering reports whose purpose is to document agreement on the scope, schedule, and estimated cost of a project so that it can be considered for inclusion in a future programming document such as the STIP. PSRs are prepared for State highway projects. PSRs are also used by Caltrans for certain projects funded under the State Highway Operation and Protection Program (SHOPP) and for certain locally funded projects on the State highway system.

RCRC **Regional Council of Rural Counties**
An organization of rural counties that share information, and advocate for rural issues at the state level.

RCTF **Rural Counties Task Force**
A group of regional transportation planning agencies from rural counties that share information on rural transportation issues, and represent the rural perspective on policy issues with Caltrans and the California Transportation Commission.

RFP **Request for Proposal**
A Request for Proposal (RFP) is an early stage in a procurement process, issuing an invitation for suppliers, often through a bidding process, to submit a proposal on a specific commodity or service.

RIP **Regional Improvement Program**
Regional Improvement Program, funded through 75% of new STIP funding and subdivided by formula into county shares.

R-O-W **Right-of-Way**
Right-of-way is a strip of land granted for a transportation facility. It can also refer to legally granted access for a public throughway.

RSTP **Regional Surface Transportation Program**
One of the funding programs included in the federal transportation legislation. RSTP funds are the most flexible funding pot, and can be used for most transportation purposes.

RTIP **Regional Transportation Improvement Program**
A programming document adopted by the regional transportation planning agency (RTPA) that designates the projects and amounts to be funded by the county's share of Regional Choice funding. Every two years, the RTIPs from California's 58 counties, along with Caltrans ITIP, are adopted into the State Transportation Improvement Program (STIP).

RTP **Regional Transportation Plan**
A state required transportation planning document that inventories existing transportation systems, forecasts needs, and designates a funding-constrained list of projects for a 20 year horizon. This document is prepared by PCTPA.

RTPA **Regional Transportation Planning Agency**
A state designation for the countywide agency charged with certain tasks under California law, including administration of the Transportation Development Act, adoption of the Regional Transportation Improvement Program, and adoption of the Regional Transportation Plan.

SACOG **Sacramento Area Council of Governments**
The Metropolitan Planning Organization for the Sacramento region, SACOG also acts as the RTPA for Sacramento, Yolo, Sutter, and Yuba Counties.

SAFE **Service Authority for Freeway Emergencies**
A Service Authority for Freeway Emergencies administers a freeway callbox program.

SAFETEA-LU **Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users**
The successor legislation to TEA-21, SAFETEA-LU covers the years 2004 - 2009. While funding levels increased, programs from TEA-21 remained essentially unchanged.

SECAT **Sacramento Emergency Clean Air and Transportation Program**
A $70 million program that combines $20 million of Congestion Mitigation and Air Quality funds with $50 million from the Traffic Congestion Relief Program to fund projects to repower older diesel engines with low polluting ones.

SHOPP **State Highway Operation Protection Program**
A program created by state legislature, which includes projects needed to maintain the integrity of the state highway system, primarily associated with safety and rehabilitation without increasing roadway capacity. The SHOPP is a four -year program of projects, approved by the CTC separately from the STIP cycle.

SIP **State Implementation Plan**
A State Implementation Plan (SIP) is the framework for the state's program to protect the air. It is not a single plan, but an accumulated record of a number of air pollution documents showing what the state has done, is doing, or plans to do to assure compliance with federal National Ambient Air Quality Standards (NAAQS) for "criteria" pollutants.

SOV **Single Occupancy Vehicle**
A vehicle with a driver only, and no additional passengers.

SRTP **Short Range Transit Plan**
A document that assesses the existing conditions for a transit system, projects short term (usually five year) demand, and outlines a plan for meeting those needs. While PCTPA usually develops these plans, they are adopted by the jurisdiction's governing board.

SSTAC **Social Service Transportation Advisory Council**
An appointed committee which advises the PCTPA Board on the Unmet Transit Needs process, as required under the Transportation Development Act.

STA **State Transit Assistance**
A funding source provided under the Transportation Development Act. Revenues come through the state budget process.

STIP **State Transportation Improvement Program**
The programming document that is adopted every two years by the California Transportation Commission to designate the projects, schedule, and funding amount for the state's portion of the federal gas tax funds. Placer projects are included in the STIP via PCTPA's adopted Regional Transportation Improvement Program.

TAC **Technical Advisory Committee**
Public works and planning staff from each of the jurisdictions, Caltrans, and the Placer County Air Pollution Control District staff make up PCTPA's Technical Advisory Committee, which reviews and advises staff on issues before the Board.

TART **Tahoe Area Regional Transit**
The transit provider for the Tahoe area, including Truckee.

TCM **Transportation Control Measure**
Essentially interchangeable with Transportation Demand Management (TDM) and Transportation Systems Management (TSM), these describe techniques to reduce congestion and air quality problems by encouraging people to use alternative transportation or carpool. Some techniques include increased transit frequency, carpool match listing programs, or providing bike maps to employers.

TDA **Transportation Development Act**
Passed in 1971, the TDA requires every county to provide transit service to its residents, based on criteria of unmet transit needs that are reasonable to meet. The required transit service is funded by 1/4% of the state's sales tax, returned to the Regional Transportation Planning Agency in the county of origin.

TDM **Transportation Demand Management**
Strategies designed to reduce vehicular demand upon the existing transportation system.

TEA **Transportation Enhancement Activities**
One of the funding programs included in the federal transportation legislation (see ISTEA and TEA-21). TEA funds are targeted to provide enhancements over and above those normally provided for transportation projects, such as streetscape improvements, additional landscaping, or transportation museums.

TMA **Transportation Management Association**
A private non-profit association, usually made up of large employers, to develop and encourage use of TCMs. The Truckee/North Tahoe Transportation Management Association is the only TMA currently operating in Placer County.

TRO **Trip Reduction Ordinance**
An ordinance specifying requirements for employers to encourage their employees to use alternative transportation. Local jurisdictions were required to adopt these ordinances as part of Proposition 111, which passed in 1990, but compliance was later made voluntary.

TRPA **Tahoe Regional Planning Agency**
Amongst its many functions, TRPA is also the Regional Transportation Planning Agency and Metropolitan Planning Organization for the Tahoe Basin, including a portion of Placer County.

TSM **Transportation System Management**
Strategies designed to improve the efficiency and effectiveness of the existing transportation system.

VMT **Vehicle Miles Traveled**
Unit of measurement of how far a vehicle or vehicles have traveled in a day, month or year.

YTD **Year-to-Date**
Year-To-Date (YTD) represents the period starting January 1 of the current year and ending today.

ZEV **Zero Emission Vehicle**
A vehicle that produces no tailpipe pollutants. Electric vehicles and fuel cell vehicles are considered ZEVs.

EXECUTIVE SUMMARY

The **2035 Regional Transportation Plan (RTP) for Placer County** has been developed by the Placer County Transportation Planning Agency (PCTPA) to document the policy direction, actions, and funding recommendations that are intended to meet the short and long range needs of Placer County's transportation systems over the next twenty years. This document is designed to guide the systematic development of a balanced, comprehensive, multi-modal transportation system for the current and future needs of Placer County.

The 2035 RTP includes projects that PCTPA anticipates can reasonably be funded within the twenty year time frame. Also included is a list of projects that could be implemented if additional funds were to become available. While funding at all levels is constrained, the transportation needs of Placer County will continue to increase as a result of anticipated growth in population, employment, and housing.

These conditions represent a significant challenge for Placer County jurisdictions to coordinate projects impacting land use, transportation, and air quality. In particular, the roadway projects proposed for construction during the span of this plan are critically important to reduce congestion. In the same way, alternative transportation modes, such as transit, rail, bicycling, walking, and transportation systems management, are being expected to play a role in reducing congestion and improving air quality.

CHAPTERS OF THE 2035 RTP

Chapter 1 Introduction describes the purpose of the RTP; provides an overview of the plan requirements; and describes the process to update the RTP.

Chapter 2 Organizational Setting describes PCTPA's organization and its different roles and responsibilities; the roles and responsibilities of other transportation agencies; and the relationship of these various roles and responsibilities to the development of the RTP.

Chapter 3 Physical & Socio-Economic Setting describes the location, population, employment, housing of Placer County, as well as demographic projections.

Chapter 4 Regional Transportation Issues & Challenges introduces the various transportation modes and their interrelationships, and to discuss the key regional transportation issues and environmental challenges currently facing Placer County and the greater Sacramento metropolitan area.

Chapter 5 Policy Element details the goals, objectives, policies, and performance measures that guided the development of the 2035 RTP. The RTP defines the goals of the transportation system and sets priorities for project implementation within the context of six regional planning principles:

- Support well-planned growth and land use patterns;
- Improve environmental quality through better stewardship of the transportation system;

- Fit within financially constrained budget by delivering cost-effective projects that are feasible to construct and maintain;
- Improve economic vitality by efficiently connecting people to jobs and delivering goods and services to markets;
- Improve access and mobility opportunities for all people to jobs, services and housing; and
- Provide real, viable travel choices for all people within a diverse county.

The RTP contains the following overall goals that provide the framework for the action and financial elements. The overall goals of the RTP are listed below.

1. Maintain and upgrade a safe, efficient, and convenient countywide roadway system that meets the travel needs of people and goods through and within the region.

2. Provide effective, convenient, regionally and locally coordinated transit service that connects residential areas with employment centers, serves key activity centers and facilities, and offers a viable option to the drive-alone commute.

3. Improve the availability and convenience of passenger rail service.

4. Promote general and commercial aviation facilities and services that complement the countywide transportation system.

5. Provide for the safe and efficient movement of goods through, within, and into Placer County.

6. Promote a safe, convenient, and efficient non-motorized transportation system, for bicyclists, pedestrians, and users of low speed vehicles, which is part of a balanced overall transportation system.

7. Provide an economical solution to the negative impacts of single-occupant vehicle travel through the use of alternative transportation methods.

8. Promote a transportation system that integrates and facilitates recreational travel and uses, both motorized and non-motorized.

9. By integrating land, air, and transportation planning, build and maintain the most efficient and effective transportation system possible while achieving the highest possible environmental quality standards.

10. Secure maximum available funding; pursue new sources of funds for maintenance, expansion, and improvement of transportation facilities and services; and educate the public about the need for funding for transportation projects.

11. Incorporate all-inclusive public outreach efforts as part of the planning process, and encourage input from all interested groups and persons.

The RTP contains ten specific goals, each with supporting policies and objectives, for roadways, public transit, rail transportation, aviation, goods movement, non-motorized transportation, transportation systems management (TSM), recreation, integrated land use, air quality, and transportation planning, and funding. There are no specific goals defined for Safety and for Intelligent Transportation Systems (ITS). Rather, Safety and ITS are addressed within the goals, objectives and policies of the other subject areas of the Policy Element. Performance measures are also identified and apply to the entire RTP in order to assess priorities for implementation.

Chapter 6 Action Element provides a discussion of each transportation mode including both a short and long range action plan. A list of specific projects, both funded and unfunded is also provided for each mode. Short and long range action plans for each mode are listed below.

Regional Roadway Action Plan

Short Range

1. Continually develop and implement innovative approaches to delivering projects (as shown in Table 6.1-3 as quickly and cost effectively as possible. *(PCTPA, project sponsors)*

2. Identify and pursue additional funding sources, as appropriate. *(PCTPA, Caltrans, jurisdictions)*

3. Obtain funding for and construct regionally significant roadway projects shown in Figures 6.1c through 6.1e. *(PCTPA, SPRTA, Caltrans, jurisdictions)*

4. Identify deficiencies and/or future congestion impacts on the regional road network. *(PCTPA, Caltrans, jurisdictions)*

5. Maintain street and highway system, including vegetation management. *(Caltrans, jurisdictions)*

6. Identify and implement operational improvements on local streets and roads. *(Jurisdictions)*

7. Implement capacity increasing strategies that encourage the use of alternative modes, such as High Occupancy Vehicle (HOV) lanes. *(PCTPA, Caltrans, jurisdictions)*

8. Develop parallel capacity to I-80 and SR65 to reduce congestion and reliance on I-80 and SR65 for local trip purposes. *(PCTPA, SPRTA, jurisdictions)*

9. Consider the concept of complete streets when developing and implementing local roadway improvement projects. *(Jurisdictions)*

10. Improve select rural roads to an urban standard that serve new Blueprint development on the urban edge. *(Jurisdictions)*

11. Continue to participate in the Caltrans system planning and corridor planning processes. *(PCTPA, jurisdictions, Caltrans)*

12. Consider access management strategies along older retail corridors to improve economic performance. *(Jurisdictions, transit operators, Caltrans)*

13. Maintain pavement conditions at a good or better Pavement Condition Index. *(Jurisdictions, Caltrans)*

Long Range

1. Construct the Placer Parkway, in phases, connecting from SR65 to SR70/99. *(PCTPA, SPRTA, Caltrans, jurisdictions, other state/federal agencies)*

2. Continue to implement the actions called for in the short range action plan. (*PCTPA, Caltrans, jurisdictions, other state/federal agencies)*

Public Transit Action Plan

Short Range

1. Continue to maximize available Federal Transit Administration (FTA) funds through the Section 5311 (rural transit), Section 5307 (urban transit), and other FTA discretionary programs. *(PCTPA, transit operators)*

2. Continue to maximize available State funds through the State Transit Assistance, bond programs, and other related funding programs. *(PCTPA, transit operators, CTSA)*

3. Update the short range transit plans for Auburn, Lincoln, Roseville, Placer County, and the Western Placer CTSA. *(PCTPA, jurisdictions, transit operators, CTSA)*

4. Monitor transit services regularly and make adjustments to routes and schedules to improve operational efficiency and on-time performance, and maintain a discipline of cost recovery, including meeting fare box recovery ratios as outlined in the Transportation Development Act and productivity standards established in the adopted Short Range Transit Plans. *(PCTPA, transit operators, CTSA)*

5. Conduct an independent performance audit every three years of the activities of each of the five transit operators under PCTPA jurisdiction that it allocates LTF (funds). *(PCTPA, transit operators, CTSA)*

6. Conduct an independent financial audit annually of the TDA funds allocated to each jurisdiction to determine compliance with statutes, rules and regulations of TDA and the allocation instructions of PCTPA. *(PCTPA, jurisdictions, transit operators, CTSA)*

7. Continue to obtain public input on public transportation systems by holding annual unmet transit needs workshops and hearings. Implement expanded services to respond to needs that are reasonable to meet. *(PCTPA, transit operators, jurisdictions, CTSA)*

8. Continue active participation in local and regional coordinating groups (e.g., SACOG Transit Coordinating Committee, Transit Operators Working Group, Best Step Transportation Collaborative). *(PCTPA, transit operators, CTSA)*

9. Work with public transit operators and social service transportation providers to improve or increase transit services to rural areas of Placer County. *(PCTPA, transit operators, CTSA)*

10. Implement and/or modify paratransit services to continually meet the requirements of the Americans with Disabilities Act. *(PCTPA, transit operators)*

11. Continue to coordinate and consolidate social service transportation whenever possible. *(PCTPA, CTSA, social service agencies)*

12. Implement the recommendations outlined in the South Placer Regional Dial-a-Ride Study to avoid duplication and coordinate respective Dial-a-Ride services. *(PCTPA, transit operators, CTSA)*

13. Encourage the transit operators to work cooperatively to optimize service delivery, offer complementary services and fare media to improve ease of connectivity among transit systems. *(PCTPA, transit operators, CTSA)*

14. Implement a discounted College Transit Pass Program in partnership with local colleges, universities, trade and technical schools to increase student awareness and use of Placer County public transit services. *(PCTPA, transit operators, Sierra Community College District, California State University Sacramento, other local colleges, universities, trade and technical schools)*

Long Range

1. Continue to update the short range transit plans for the transit operators with continued emphasis on meeting the transit needs of the growing and changing population, public education, enhancing the convenience of regional travel, offering alternatives to the automobile, and improving connections between various modes of travel. *(PCTPA, transit operators, CTSA, jurisdictions)*

2. Pursue the recommendations outlined for Scenario 2 in the Transit Master Plan in the development of future transit services in Placer County through the year 2035, with a

focus on coordination and integration opportunities. *(PCTPA, transit operators, CTSA, jurisdictions)*

Passenger Rail Action Plan

Short and Long Range

1. Seek funding through Caltrans to implement the CCJPA Business Plan and Capital Improvement Program, as continuously updated. *(PCTPA, CCJPA, Caltrans, jurisdictions)*

2. Continue to partner with CCJPA to bring additional Capitol Corridor passenger rail service to western Placer County. *(PCTPA, CCJPA, Caltrans, jurisdictions, UPRR)*

3. Continue to partner with CCJPA to promote destination and rail travel to / from Placer County. *(PCTPA and CCJPA)*

4. Encourage expansion of the Capitol Corridor service to Colfax, Soda Springs, Truckee, and Reno/Sparks. *(PCTPA, CCJPA, Nevada County Transportation Commission, Caltrans, Washoe County Regional Transportation Commission, jurisdictions, UPRR)*

5. Support Capitol Corridor program / project applications for high-speed rail and other funding opportunities from the Federal Railroad Administration (FRA). *(PCTPA, CCJPA, jurisdictions, federal representatives)*

6. Support the allocation of Proposition 1A high speed rail bond funding and other intercity rail funding to the Capitol Corridor from the California Transportation Commission. *(PCTPA and jurisdictions)*

7. Pursue implementation of regional rail service between Auburn and Oakland. *(PCTPA, Regional Transit, Yolo County Transportation District, CCJPA, Solano Transportation Authority, Contra Costa Transportation Authority, Caltrans, UPRR)*

8. Continue to explore the feasibility of rail service between Marysville and Sacramento with stops in Lincoln and Roseville. *(PCTPA, Caltrans, Yuba County, jurisdictions, UPRR)*

9. Consider implementing new safety / quiet zones at at-grade rail crossings to eliminate train horn noise provided that the crossing accident rate meets Federal Railroad Administration (FRA) standards and supplemental or alternative safety measures are in place in accordance with the FRA Final Train Horn and Quiet Zone Rule (effective June 2005). *(PCTPA, jurisdictions, CCJPA, CPUC, Caltrans, FRA, UPRR)*

10. Continue to evaluate capital improvement requirements and amenities at passenger rail stations. *(PCTPA, jurisdictions, CCJPA, CPUC, Caltrans, FRA, UPRR)*

Aviation Action Plan

Short Range

1. Continue efforts to avoid conflicts over noise issues. *(PCTPA, jurisdictions, airport operators, vicinity property owners)*

2. Continue to protect airspace and runway approaches. *(PCTPA, FAA, jurisdictions, airport operator, vicinity property owners)*

3. Promote compatible land uses that are consistent with the Placer County Airport Land Use Compatibility Plan. *(PCTPA, airport operators, jurisdictions, Caltrans)*

4. Continue to upgrade navigational equipment as needed. *(Jurisdictions, airport operators)*

5. Promote public awareness of airport services and benefits for business, recreation and goods movement use. *(PCTPA, jurisdictions, airport operators)*

6. Maintain and improve existing airport facilities in accordance with adopted airport master plans, as updated. *(Jurisdictions, airport operators)*

7. Assist operators of public use airports in pursuing funding sources. *(PCTPA, airport operators)*

8. Explore opportunities to improve passenger and cargo airport ground access to relieve potential bottlenecks around airports through local road and intersection improvements. *(PCTPA, jurisdictions)*

9. Promote the development of general aviation airport security for functional areas such as personnel, aircraft, airports/facilities, surveillance, security plans and communications, and specialty operations. *(Caltrans Division of Aeronautics, jurisdictions)*

10. Participate in SACOG's development of the McClellan Field ALUCP update to ensure that any potential impacts from ongoing operations at McClellan Field to Placer jurisdictions are minimized, and update the Placer County ALUCP, as necessary. *(PCTPA, jurisdictions, SACOG, Sacramento County)*

11. Participate in Caltrans Division of Aeronautics regional and statewide aviation planning efforts. *(PCTPA, airport operators)*

12. Work cooperatively with NCTC to address Truckee-Tahoe Airport ALUCP coordination issues. *(PCTPA, NCTC)*

13. Encourage Placer County to initiate the State-mandated requirement to update its General Plan and supporting planning documents to be consistent with the Placer County ALUCP. *(PCTPA, Placer County)*

14. Prepare a comprehensive update of the Placer County ALUCP, once the Caltrans Division of Aeronautics State Handbook update is completed, and review the ALUCP every five years and update as needed. *(PCTPA, jurisdictions, airport operators, Caltrans Division of Aeronautics, Sacramento County, SACOG)*

Long Range

1. Continue to implement the actions outlined in the short range action plan. *(PCTPA, jurisdictions, airport operators, Caltrans, FAA)*

2. Encourage more flexible use of airport revenues for off-airport ground access projects. *(PCTPA, airport operators, jurisdictions, Caltrans, FAA)*

Goods Movement Action Plan

Short Range

1. Identify obstacles that prevent or impede goods movement. *(PCTPA, jurisdictions, industry).*

2. Encourage industry to maximize use of rail and air for the transportation of goods. *(PCTPA, jurisdictions)*

3. Support the development of grade separation projects where necessary. *(PCTPA, jurisdictions, Caltrans)*

4. Support the designation of hazardous waste routes by federal and state regulators. *(PCTPA, jurisdictions)*

5. Designate a subregional or countywide backbone truck route system. *(PCTPA, jurisdictions, Caltrans)*

6. Maintain a balanced freight transportation system to provide for the safe and efficient movement of goods. *(PCTPA, jurisdictions, Caltrans)*

7. Support local development of truck parking strategies. *(PCTPA, jurisdiction, industry)*

8. Specially designate roads that connect key agricultural producers with processing facilities and the regional road network. *(PCTPA, jurisdictions, agricultural industry)*

9. Act as a resource to local jurisdictions for interrelationship of industrial and wholesale land use and transportation planning. *(PCTPA)*

Long Range

1. Continue to implement the actions outlined in the short-range action plan. *(PCTPA, Caltrans, jurisdictions, industry)*

2. Continue to support accelerating truck and rail modernization, with cleaner technologies, in order to reduce current and long-term impacts of the goods movement system on public health and air quality. *(PCTPA, SACOG, APCDs, jurisdiction and industry)*

3. Coordinate goods movement plans and projects. *(PCTPA, Caltrans, jurisdictions, SACOG)*

Non-Motorized and Low-Speed Transportation Action Plan

Short Range

1. Identify issues and problems pertaining to non-motorized and low-speed transportation. *(PCTPA, jurisdictions)*

2. Develop policies for the allocation of funds and processing of claims for non-motorized and low-speed projects. *(PCTPA, jurisdictions)*

3. Promote non-motorized and low-speed transportation as a viable transportation control measure for the mitigation of air quality and congestion problems. *(PCTPA, jurisdictions, PCAPCD, SACOG)*

4. Ensure that jurisdictions have current Bikeway Master Plans that comply with state requirements. *(PCTPA, jurisdictions, Caltrans)*

5. Work with jurisdictions and Caltrans to connect the urbanized centers of the region through non-motorized and low-speed transportation facilities, with an emphasis on closing gaps. *(PCTPA, jurisdictions, Caltrans)*

6. Work with PCTPA jurisdictions to encourage the development of support facilities, such as secure bicycle parking or storage lockers, shower and changing space, appropriate signage, and adequate lighting, at new commercial and industrial sites, transit centers, park-and-ride lots, and all transit buses. *(PCTPA, jurisdictions, Caltrans, transit operators)*

7. Encourage PCTPA jurisdictions to evaluate the feasibility of installing Class II bike lanes as part of street overlay and maintenance projects. *(PCTPA, jurisdictions)*

8. Pursue new revenue sources for non-motorized and low-speed transportation development. *(PCTPA, jurisdictions)*

9. Review existing abandoned railroad corridors for possible conversion to non-motorized and low-speed transportation facilities. *(PCTPA, jurisdictions)*

10. Promote the beneficial aspects of non-motorized and low-speed transportation through Spare the Air, Bike-to-Work Month, and other similar programs. *(PCTPA, jurisdictions, Caltrans)*

11. Expand the use of the Safe Routes to Schools program, conduct bicycling and walking audits, in an effort to make bicycling, walking and crossing the street safer enroute to and from school. *(Jurisdictions, school districts, Caltrans, local law enforcement, CHP, PCTPA)*

12. Encourage jurisdictions to identify and upgrade intersections that have sub-standard or are missing pedestrian crosswalks and curb cuts. *(Jurisdictions, Caltrans)*

Long Range

1. Continue to implement the actions outlined in the short range action plan. *(PCTPA, jurisdictions)*

Transportation System Management (TSM) Action Plan

Short and Long Range

1. Work cooperatively with neighboring jurisdictions to implement ITS improvements that would support TSM efforts in the region. *(PCTPA, SACOG, TRPA, NCTC, EDCTC, Sierra County, Caltrans)*

2. Continue to work cooperatively with SACOG, SMAQMD, and the City of Roseville on implementation and enhancement of regional rideshare programs that encourage the use of alternative modes of transportation. *(SACOG, SMAQMD, PCTPA, City of Roseville, local employers)*

3. Continue to work cooperatively with area school districts on outreach to children in educating them about the benefits realized through the use of alternative transportation. *(PCTPA, school districts, transit operators)*

4. Promote alternative modes of transportation to help meet the transportation needs of rural agricultural workers in Placer County. *(PCTPA, transit operators, agricultural industry, Placer County Farm Bureau, Placer County Agricultural Commissioner, Placer County Agriculture Department, Caltrans, SACOG)*

5. Implement traffic flow improvements on regionally significant roadways. *(PCTPA, jurisdictions, Caltrans)*

6. Improve and expand public transportation systems (bus and rail) as feasible, to maintain existing and increase new ridership. *(PCTPA, CCJPA, transit operators)*

7. Develop and expand facilities to support the use of alternative transportation such as pedestrian and bicycle facilities, park-and-ride lots, and intermodal transfer stations. *(PCTPA, CCJPA, jurisdictions, Caltrans)*

8. Increase the awareness to media, employers and the general public of alternative transportation options in Placer County through outreach, educational and incentive programs. *(PCTPA, jurisdictions, transit operators)*

9. Encourage SACOG to develop a periodic regional survey of traveler choices, which would monitor trends in traveler choices related to external influences and the impact of public policy programs. *(SACOG, jurisdictions, transit operators, PCTPA, Caltrans)*

10. Promote a transportation system which minimizes the dependency of long-distance, single-occupant vehicle trips and vehicle miles traveled in Placer County toward achieving SACOG's 10 percent regional trip reduction goal. *(SACOG, jurisdictions, transit operators, PCTPA, Caltrans)*

Transportation Safety & Security Action Plan

Short and Long Range

1. Reduce accident rates to below the statewide average or better through implementation of safety improvements and measures. *(PCTPA, jurisdictions, transit operators, Caltrans)*

2. Encourage jurisdictions to develop a systematic approach to identify and review existing or potential high incident accident locations, including rural areas to prevent animal-vehicle collisions. *(Jurisdictions, transit operators, CCJPA, Caltrans, CHP, PCTPA and SACOG)*

3. Prioritize projects that implement preventative and routine maintenance and address safety standards. *(Jurisdictions, transit operators, CCJPA, Caltrans, PCTPA and SACOG)*

4. Prioritize infrastructure in need of replacement, relocation or upgrade to meet current safety and design standards, including implementation of safety measures, enforcement,

and educational activities. *(Jurisdictions, transit operators, CCJPA, Caltrans, CHP, PCTPA and SACOG)*

5. Continue to participate in the SHSP planning process and various interagency coordination efforts to exchange information on ongoing safety activities and best practices, as well as identify training opportunities, and exercise capabilities. *(Jurisdictions, transit operators, CCJPA, Caltrans, CHP, PCTPA and SACOG)*

6. Encourage a regional approach to maximize public outreach and education and related enforcement initiatives that target high risk behavior issues and that improve safe driving practices. *(Jurisdictions, CCJPA, Caltrans, CHP, PCTPA and SACOG)*

7. Encourage jurisdictions and transportation agencies to continue to coordinate with the Placer County OES and CAL FIRE on emergency preparedness activities. *(Jurisdictions, transit operators, Caltrans, CHP, Placer County OES,CAL FIRE, PCTPA)*

8. Encourage the preparation of transportation security assessments, and emergency preparedness plans, including continuity of operations, business resumption and recovery. *(Jurisdictions, transit operators, CCJPA, Caltrans, CHP, PCTPA and SACOG)*

9. Improve the security preparedness of transportation facilities. *(Jurisdictions, transit operators, CCJPA, Caltrans, CHP, PCTPA and SACOG)*

Intelligent Transportation Systems (ITS) Action Plan

Short Range

1. Maximize the operating efficiency of the existing surface transportation system by incorporating ITS strategies where feasible. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, SACOG, Caltrans)*

2. Improve the safety of travel into, through, and out of the Tahoe Gateway Region. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, Caltrans)*

3. Ensure that accurate and reliable traveler information regarding traffic and weather conditions is available to those entering the region as well as those traveling within the region. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, SACOG, Caltrans)*

4. Provide more effective and convenient transit services. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, transit operators, SACOG)*

5. Ensure efficient commercial vehicle operations into, through and out of the Tahoe Gateway Region. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, Caltrans)*

6. Ensure the long-term viability of ITS in the Tahoe Gateway Region. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, Caltrans, FHWA)*

7. Maintain an ITS program that is compatible and supported by National ITS efforts. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, SACOG, Caltrans, FHWA)*

8. Coordinate with communication utilities to include rural broadband, where possible, as part of the implementation of jurisdiction ITS projects. *(PCTPA, jurisdictions, communication utilities)*

Long Range

1. Continue implementation (deployment, operations, and maintenance) of the Tahoe Gateway Counties ITS. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, Caltrans, SACOG, FHWA)*

2. Continue implementation (deployment, operations, and maintenance) of the Sacramento Region ITS. *(PCTPA, El Dorado County, Sacramento County, Sutter County, Yolo County, Yuba County, jurisdictions, Caltrans, SACOG, FHWA)*

3. Continue regional ITS management via each member County, neighboring regions, and other agencies, organizations, and individuals. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, Caltrans, SACOG, FHWA)*

4. Mainstream or incorporate ITS technologies into the planning process as stand-alone projects and/or as part of larger transportation projects. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, Caltrans, SACOG, FHWA)*

5. Ensure that the Regional ITS Architecture Maintenance Plan continues to be implemented. *(PCTPA, El Dorado County, Nevada County, Sierra County, jurisdictions, Caltrans, SACOG, FHWA)*

Recreational Travel Action Plan

Short and Long Range

1. Promote and use intelligent transportation systems (ITS) to improve recreational travel. *(PCTPA, jurisdictions, Caltrans, SACOG, TRPA, FHWA)*

2. Work with SACOG and other regional partners to implement and expand the 511 traveler information system (electronic information system) so it can be used to provide accurate and timely information on roads, traffic, transit, and alternative routes. *(SACOG, Caltrans, PCTPA, transit operators)*

3. Provide education and marketing of alternatives to the personal automobile. *(PCTPA, employers, resorts, TNT TMA, transit operators, United Auburn Indian Community of the Auburn Rancheria)*

4. Identify public infrastructure in need of expansion, as well as maintenance and repair to support tourism and recreation. *(PCTPA, jurisdictions, Caltrans, transit operators)*

5. Expand the availability of alternative transportation options (transit, rail, bike, pedestrian, airport shuttles) to driving the personal (private or rental) automobile. *(Transit operators, PCTPA, jurisdictions, Capitol Corridor, employers, resorts, United Auburn Indian Community of the Auburn Rancheria)*

6. Provide coordinated feeder transit services to parks and attractions. *(Transit operators, resorts, employers, Caltrans, United Auburn Indian Community of the Auburn Rancheria)*

7. Coordinate transportation planning with the tourism and resort industry to cooperatively develop, recommend, and implement transportation-related programs for improving recreational travel. *(Resorts, employers, Caltrans, TNT TMA, transit operators, United Auburn Indian Community of the Auburn Rancheria)*

8. Identify opportunities for joint projects and activities to maximize the effectiveness of limited funding opportunities. *(PCTPA, jurisdictions, Caltrans, SACOG, TNT TMA, resorts, employers, United Auburn Indian Community of the Auburn Rancheria)*

9. Work with primary marketing organizations to develop travel guides, way finding signage and to designate tourism routes. *(PCTPA, jurisdictions, Caltrans, SACOG, TNT TMA, resort, business and merchant associations, visitors bureau, chambers of commerce's, recreation providers, United Auburn Indian Community of the Auburn Rancheria)*

Integrated Land Use, Air Quality, & Transportation Action Plan

Short Range

1. Continue to coordinate with jurisdictions and agencies inside and outside of Placer County to help establish county-wide transportation priorities, implement studies and projects in cooperation with other counties, facilitate joint transportation projects, and anticipate impacts on Placer County from governmental decisions. (*PCTPA, jurisdictions, SACOG, Caltrans, PCAPCD, CCJPA, Nevada County, Sacramento County, El Dorado County, Yuba County, Sutter County*)

2. Review local general and specific plans, and land use entitlement applications for consistency with airport land use plans. (*PCTPA, jurisdictions*)

3. Seek grant funding to support transportation projects that benefit the environment, housing, sustainable communities, air quality, or reduced traffic congestion. (*PCTPA, jurisdictions, PCAPCD, Caltrans*)

4. Continue to participate in the SACOG regional Blueprint planning efforts. (*PCTPA, jurisdictions, SACOG*)

5. Develop guidelines and/or implement policies to prioritize transportation projects that have air quality benefits, while providing cost effective movement of people and goods. (*PCTPA, PCAPCD*)

6. Provide support for projects consistent with Placer County's Ozone Reduction Ordinance, and also lead to reduced Greenhouse Gas emissions. (*PCTPA, PCAPCD*)

7. Encourage jurisdictions to develop transportation corridors that complement Blueprint planned growth patterns, infill development, economic development programs, and requirements of infrastructure to support planned land uses. (*PCTPA, jurisdictions*)

8. Encourage jurisdictions to review and assess the impact of new development proposals consistency with Blueprint principles, and the impact on local circulation plans and transit system demand and supply. (*PCTPA, jurisdictions, transit operators*)

9. Continue active participation in local and regional coordinating groups as well as statewide forums to maximize opportunities for transportation improvements in Placer County. (*PCTPA*)

10. Provide written support for development projects which may increase residential and employment densities near existing transit and rail stations, as well as future rail stations that may emerge as a result of expansion of the Capitol Corridor service to Colfax, Soda Springs, Truckee, and Reno/Sparks. (*PCTPA*)

11. Plan for new/expanded facilities such as pedestrian and bicycle facilities, park-and-ride lots, and intermodal transfer stations where development projects will provide increased residential and/or employment densities. (*PCTPA, jurisdictions, Caltrans, CCJPA*)

12. Encourage thorough examination, context sensitive design, and mitigation of environmental impacts when planning and constructing transportation improvements through or near established residential communities. *(PCTPA, jurisdictions)*

13. Encourage jurisdictions to avoid or minimize impacts of transportation projects and programs on special-status plant populations, special-status fish and wildlife species and habitat, riparian and woodland communities, and waters of the United States. (*PCTPA, jurisdictions, Caltrans)*

14. Work with jurisdictions to include the needs of all transportation users in the planning, design, construction and maintenance of roadway (complete streets) and transit facilities where feasible. *(PCTPA, jurisdictions, transit operators, Caltrans)*

15. Encourage jurisdictions to consider multi-modal transportation facility proximity when siting educational, social service, and major employment and commercial facilities. *(PCTPA, jurisdictions, transit operators)*

16. Provide information and support services to jurisdictions regarding the countywide transportation impacts of local land use decisions. *(PCTPA, jurisdictions, transit operators, Caltrans))*

17. Where possible, support jurisdictions' efforts to maintain their adopted Level of Service (LOS) on local streets and roads in accordance with the applicable General Plan Circulation Element. *(PCTPA, jurisdictions)*

18. Encourage jurisdictions to require land uses which produce significant trip generation to be served by roadways with adequate capacity and design standards to provide safe usage for all modes of travel. *(PCTPA, jurisdictions, Caltrans)*

19. Encourage jurisdictions to include transit-oriented development Blueprint principles in designing neighborhoods and communities to reduce vehicle miles traveled (VMT) and to deal with more short trips.*(PCTPA, jurisdictions, transit operators, Caltrans)*

Long Range

1. Integrate land, air, and transportation planning, in order to build and maintain the most efficient and effective transportation system possible while achieving the highest possible environmental quality standards. (*PCTPA, jurisdictions, SACOG, PCAPCD, SMAQMD*)

2. Continue to coordinate with SACOG, the Placer County Air Pollution Control District, and the Sacramento Metropolitan Air Quality Management District to ensure transportation projects meet all applicable budgets for air quality conformity standards. (*PCTPA, PCAPCD, SMAQMD, SACOG*)

3. Encourage the use of general plan designations, zoning controls, access management, acquisition, development easements, and development agreements to help secure and protect future right of way for essential transportation corridors. (*PCTPA, jurisdictions*)

4. Coordinate and arrange for regional workshops focused on the incorporation of "smart growth" and transportation project planning. *(SACOG, PCTPA, jurisdictions, Caltrans)*

Chapter 7 Air Quality Element describes federal and State air quality related law, the roles of air quality regulators, and the impact of these laws on the RTP. This chapter describes the required determination that must be made by the Sacramento Area Council of Governments that the RTP conforms to federal air quality regulations. This chapter also provides short and long range action plans, shown below, and a list of specific air quality related projects.

Air Quality Action Plan

Short Range and Long Range

1. Solicit the input of the Placer County Air Pollution Control District on all transportation plans, programs and projects. *(PCTPA, jurisdictions, Caltrans, PCAPCD)*

2. Prioritize and recommend transportation projects that minimize vehicle emissions while providing cost effective movement of people and goods. *(PCTPA, jurisdictions, PCAPCD, SACOG)*

3. Continue to promote projects that can be demonstrated to reduce air pollution and greenhouse gases, maintain clean air and better public health, through programs and strategies, to green the transportation system. *(PCTPA, jurisdictions, PCAPCD, SACOG)*

4. Work with the Placer County Air Pollution Control District in developing plans that meet the standards of the California Clean Air Act and the Federal Clean Air Act Amendments, and also lead to reduced greenhouse gas emissions. *(PCTPA, jurisdictions, PCAPCD, SACOG)*

5. Work with the Sacramento Area Council of Governments to evaluate the impacts of transportation plans and programs on the timely attainment of ambient air quality standards; regional greenhouse gas emission reduction targets; and health risks of sensitive receptors from exposure to mobile source air toxics. *(PCTPA, jurisdictions, PCAPCD, SACOG)*

6. Ensure transportation planning efforts comply with SB375 and AB32. *(PCTPA, jurisdictions, transit operators, PCAPCD, Caltrans, SACOG)*

7. Participate in SACOG efforts to develop a Regional Climate Action Plan. *(PCTPA, jurisdictions, PCAPCD, SACOG)*

8. Expand the use of alternative fuels to reduce impacts on air quality and GHG emissions. *(PCTPA, jurisdictions, PCAPCD, SACOG)*

9. Encourage jurisdictions and Caltrans to develop a green construction policy, the recycling of construction debris to the maximum extent feasible, and to use the minimum feasible amount of GHG emitting materials in the construction of transportation projects. *(PCTPA, jurisdictions, Caltrans, PCAPCD, SACOG)*

10. Encourage jurisdictions and Caltrans to mainstream energy efficiency in transportation projects, using energy efficient lighting technology in traffic signals, crosswalk lights, street lighting, railroad crossing lights, and parking lot lights. *(PCTPA, jurisdictions, Caltrans, PCAPCD, SACOG)*

11. Encourage jurisdictions and Caltrans to use lighter colored pavement with increased reflectivity in pavement rehabilitation projects, to reduce the urban heat island effect. *(PCTPA, jurisdictions, Caltrans, PCAPCD, SACOG)*

12. Encourage jurisdictions and Caltrans to protect, preserve, and incorporate trees and natural landscaping into transportation projects to provide shade, buffer winds, encourage people to walk, and to sequester CO2. *(PCTPA, jurisdictions, Caltrans, PCAPCD, SACOG)*

Chapter 8 Financial Element assesses the financial issues associated with implementing the transportation projects and programs that implement the goals, objectives, and policies contained in the 2035 RTP. This chapter also examines current and potential funding sources; identifies transportation improvements that would be implemented under various financial "availability" scenarios; and provides a summary of estimated revenues considered to be reasonably available to fund the implementation of the RTP. Several actions are identified below to further support the objectives and policies contained within the Policy Element.

Financial Element Action Plan

Short and Long Range

1. Promote funding of transportation projects identified in the RTP's Action Element consistent with the provisions included in the Plan's Policy Element. *(PCTPA, jurisdictions, transit operators, Caltrans)*

2. Maximize the use of federal and state transportation funding sources. *(PCTPA, jurisdictions, transit operators, Caltrans)*

3. Make the most efficient use of federal, state, regional and local transportation revenues and allocations in the programming and delivering projects. *(PCTPA, jurisdictions, Caltrans, SACOG)*

4. Encourage multi-agency packaging of projects for federal and State funding programs, where a regional strategy may improve chances of funding success. *(PCTPA, jurisdictions, Caltrans, SACOG)*

5. Assist local jurisdictions to identify and obtain federal and state grant funding. *(PCTPA)*

6. Develop and update the Regional Transportation Improvement Program, the Metropolitan Improvement Program, and the Project Delivery Plan. *(PCTPA, jurisdictions, Caltrans, SACOG)*

Chapter 9 Environmental Considerations summarizes environmental considerations in the developing the 2035 RTP, including prior CEQA reviews and alternatives previously considered. SAFETEA-LU requires that the RTP include an environmental mitigation program that links transportation planning to the environment. This chapter serves this purpose. This chapter also

discusses program and project level activities that may potentially affect the environment; the recommended strategies needed to mitigate any resultant impacts, and summarizes potential growth related impacts of the Plan. Further, air quality documentation requirements to demonstrate the RTP's conformity to the SIP is described.

PUBLIC INVOLVEMENT IN 2035 RTP DEVELOPMENT

PCTPA actively solicits the participation of the general public as part of its ongoing transportation planning work program. The reader should refer to Appendix A for a description of PCTPA's Community Information and Participation Program and to Appendix B documenting the milestones and identifying the stakeholders contacted during the Interagency and Public Involvement Process for the 2035.

Once a draft RTP and the environmental document are produced, general public involvement is solicited through the public workshop and public hearing process. In addition, citizen comments are encouraged and accepted at any point during the plan development process. The draft RTP and environmental documentation are made available at county libraries, at jurisdiction offices, on the PCTPA web page, and at PCTPA offices. In accordance with state law, a noticed public hearing takes place prior to plan adoption by the PCTPA Board of Directors. The public hearing for the RTP is advertised in newspapers of general circulation at least 30 days prior to the hearing date. The environmental documentation is also made available for public review in accordance with the California Environmental Quality Act (CEQA) and noticed prior to public hearing. The number of days required for notification depends upon the type of environmental documentation required.

CHAPTER 1
INTRODUCTION

The 2035 Regional Transportation Plan (RTP) was developed under the direction of the Placer County Transportation Planning Agency (PCTPA). This chapter describes the purpose of the RTP; provides an overview of the plan requirements; and describes the process to update the RTP.

The 2035 RTP is designed to be a blueprint for the systematic development of a balanced, comprehensive, multi-modal transportation system, including but not limited to, regional roadways, public transit, passenger rail, aviation, goods movement, non-motorized facilities, transportation systems management, transportation safety and security, and intelligent transportation systems. In addition, the RTP is action oriented and pragmatic, considering both the short-term and long-term time periods.

This RTP is developed to fulfill the state requirements of AB 402 (Government Code Title 7, Chapter 2.5, Sections 65080-65082), the specific guidance of the California Transportation Commission (CTC), including the recently updated 2010 Regional Transportation Plan Guidelines, as well as federal planning requirements, and the California Environmental Quality Act.

1.1 Regional Transportation Plan Purpose

Regional Transportation Plans are developed to provide a clear vision of the regional transportation goals, objectives, policies and strategies. This vision must be realistic and be within fiscal constraints. In addition to providing a vision, the RTPs have many specific functions, including:

- Providing an assessment of the current modes of transportation and the potential of new travel options within the region including Lake Tahoe (north and west shores).
- Predicting the future needs for travel and goods movement;
- Identifying and documenting specific actions necessary to address the region's mobility and accessibility needs;
- Identifying needed transportation improvements, in sufficient detail, to serve as a foundation for the:
    - Development of the Federal Transportation Improvement Program (FTIP), the Regional Transportation Improvement Program (RTIP) and the Interregional Transportation Improvement Program (ITIP);
    - Facilitation of the National Environmental Protection Act (NEPA)/404 integration process decisions;
    - Identification of project purpose and needs;

  - Development of an estimate of emissions impacts for demonstrating conformity with the air quality standards identified in the State Implementation Plan (SIP).
- Promoting consistency between the California Transportation Plan, the regional transportation plan and other transportation plans developed by cities, counties, districts, private organizations, tribal governments, and state and federal agencies in responding to statewide and interregional transportation issues and needs;
- Providing a forum for:
  - Participation and cooperation
  - Facilitation of partnerships that reconcile transportation issues which transcend regional boundaries; and
- Involving the public, federal, state and local agencies, as well as local elected officials, early in the transportation planning process so as to include them in discussions and decisions on the social, economic, air quality and environmental issues related to transportation.

1.2 Need for the 2035 RTP

The 2035 RTP is intended to address the many transportation needs within Placer County, including and not limited to:

- Insufficient resources within Placer County to meet all of maintenance, preservation, and improvement needs of the transportation system;
- Increasing amount of traffic congestion;
- Insufficient supply of non-motorized facilities;
- Limited public transit service and inadequate pedestrian and bicycle access to transit services;
- Improvement of regional and inter-regional goods movement via rail, truck, and air to accommodate future growth and to reach intended destinations with limited delay;
- Existing street designs that do not safely accommodate all forms of travel; and
- Insufficient Intelligent Transportation Systems (ITS) and transportation system and demand management strategies that would improve system operation.

The 2035 RTP is needed to provide a comprehensive strategy to approach the many transportation issues and environmental challenges faced by Placer County as population, employment and housing continues to grow and the urbanized area expands over the next two decades. These issues and challenges are discussed further in Chapter 4.0.

1.3 Regional Transportation Plan Requirements

REQUIRED ELEMENTS

Government Code Section 65080 states that Regional Transportation Plans shall include the following components:

A ***policy element*** that identifies the mobility goals, objectives, and policies of the region. This element outlines the process for implementation of the Regional Transportation Plan to guide decision-makers.

An ***action element*** that identifies programs and actions to implement the RTP in accordance with the goals, objectives, and policies set forth in the policy element. The institutional and legal actions needed to implement the RTP and action plans are also discussed in this section, followed by a detailed assessment of all transportation modes. It is within the action element that priorities for regional transportation programs are established. In addition, the RTP is required to include a short-range (approximately five years) and a long-range action plan (approximately 20 years), identifying a list of specific projects to be implemented over these timeframes. To qualify for federal or state funding, projects nominated by jurisdictions and transportation agencies must be included in or be consistent with the RTP.

A ***financial element*** that summarizes the cost of implementing the projects in the RTP considering a financially constrained environment. All anticipated transportation funding revenues are compared with the anticipated costs of the transportation programs identified in the action element. If shortfalls are identified, strategies are identified to fund the otherwise unfunded projects.

REQUIRED DOCUMENTATION

Environmental documentation is required under the California Environmental Quality Act (CEQA). The environmental documentation states whether there will be an environmental impact of the plan and, if so, what that impact will be. Depending upon the scope of the plan and the local environment, environmental documentation may be a negative declaration, a mitigated negative declaration, or a full, supplemental or subsequent environmental impact report (EIR).

1.4 Regional Transportation Plan Process

2035 RTP UPDATE PROCESS

PCTPA is the Regional Transportation Planning Agency (RTPA) for Placer County, except for that portion of the County within the Tahoe Regional Planning Agency (TRPA). One of the fundamental responsibilities which results from this designation is the preparation of the county's RTP.

Under the terms of a Memorandum of Understanding between PCTPA and SACOG, entered into in 1993 and affirmed in 2001 and 2005, PCTPA submits the Regional Transportation Plan for inclusion into the SACOG Metropolitan Transportation Plan. This process is important to both the SACOG MTP and the PCTPA RTP, as it allows for a locally developed RTP to be included in the regional air quality conformity process. This locally developed RTP process includes a local consensus of policies, projects, programs and funding decisions which then become an integral part of the regional MTP.

The 2035 RTP is an update of the Placer County 2027 RTP, adopted by the PCTPA in September 2005. The 2027 RTP served as the transportation blueprint for the Placer County portion of the SACOG 2035 Metropolitan Transportation Plan (MTP). The 2027 RTP projects were refined as part of the development of the 2035 MTP. A small number of new projects have been added to the original 2027 RTP project list. The 2035 MTP was adopted by SACOG in March 2008. The 2035 RTP conforms to the Placer County portion of the 2035 MTP, and brings the two plans into consistency. The 2035 RTP short-term program is also consistent with the Placer County portion of the Metropolitan Transportation Improvement Program (MTIP). Further, the 2035 RTP is consistent with the goals of the existing California Transportation Plan.

The 2035 RTP, pending review by SACOG will serve as the transportation blueprint for the Placer County portion of the Metropolitan Transportation Plan update.

RTP AMENDMENT PROCESS

Revisions to a project's cost, scope, funding, and schedule can occur as part of the overall project development process. Projects included in the RTP short-term element are typically programmed in the SACOG MTIP. Any changes to RTP projects programmed in the MTIP can also be considered an amendment to PCTPA's RTP. It should be noted that projects with federal funds may be moved within the four year period of the MTIP without necessitating an amendment. Development of SACOG's MTP will also lead to refinement of projects submitted as part of PCTPA's RTP. Any changes to RTP projects included in the MTP can also be considered an amendment to PCTPA's RTP.

There may also be other changes proposed besides revisions to projects that require an amendment to the RTP; for example in regard to plan policies. An amendment to the RTP in this regard would require an evaluation demonstrating that the amendment is consistent with the goals, objectives and policies of the plan; that the amendment maintains financial constraint; that the amendment meets the air quality conformity requirements inherent to the adopted plan; and that there is an opportunity for review and comment by the public of the proposed amendment.

RTP CONSULTATION, COORDINATION, AND APPROVALS

As the designated Regional Transportation Planning Agency (RTPA) for Placer County, PCTPA is responsible for the preparation and adoption of the 2035 RTP. PCTPA is also the lead agency for the environmental review of the 2035 RTP, pursuant to the State Guidelines for Implementation of the California Environmental Quality Act (CEQA), Section 15050.

Although adoption of the RTP itself will not require permits or other regulatory approvals of resource or trustee agencies, separate future, environmental review, permits and approvals may ultimately be required by project lead agencies to implement transportation system improvements identified in the 2035 RTP.

Review of the RTP is part of the consultation process required under federal planning regulations and State RTP guidelines, and is consistent with the community involvement procedures described in PCTPA Community Information and Participation Program shown in Appendix A. The RTP was circulated for 45 days to give all affected parties an opportunity to comment. All comments received have been addressed in the document.

Agency Consultation and Coordination

PCTPA has engaged in continuous consultation and coordination with the following agencies in the development of the RTP, including the individual projects and programs shown in the Action Element:

- California Department of Transportation (Caltrans) District 03;
- Sacramento Area Council of Governments (SACOG);
- PCTPA member jurisdictions, including:
  - *Placer County*
  - *City of Auburn*
  - *City of Colfax*
  - *City of Lincoln*
  - *City of Rocklin*
  - *City of Roseville*
  - *Town of Loomis*
- South Placer Regional Transportation Authority;
- Capitol Corridor Joint Powers Authority; and
- Other responsible transportation agencies.

Stakeholder Groups Consulted

Various stakeholder groups, including public agencies, private industry, business organizations, tribal governments, environmental groups, and the general public were formally and informally consulted during the preparation of the 2035 RTP. These stakeholder groups are identified in Appendix B. Each stakeholder group received a copy of a Notice of Availability of the 2035 RTP.

Many of the projects shown in the RTP's Action Element are federally funded and are therefore included within SACOG's MTP and MTIP. As the metropolitan transportation planning agency for the six-county Sacramento region, SACOG is responsible for federal programming and addressing federal planning requirements. Consultation and coordination with various public agencies and stakeholder groups regarding these projects follows the procedures outlined in SACOG's Public Participation Plan.

CHAPTER 2
ORGANIZATIONAL SETTING

The Placer County Transportation Planning Agency (PCTPA) has a number of different roles and responsibilities in the transportation activities of Placer County. This chapter describes PCTPA's organization and its different roles and responsibilities; the roles and responsibilities of other transportation agencies; and the relationship of these various roles and responsibilities to the development of the RTP.

2.1 Regional Transportation Planning Agency (RTPA) Designation

As a result of the passage of the Transportation Development Act (TDA) in 1971, each county must have a regional transportation planning agency (RTPA) to administer transit funding. Pursuant to Title 7.91 of the California Government Code, Title 7.91, Section 67910, PCTPA was created as a local area planning agency in 1975 to provide regional transportation planning for the area of Placer County exclusive of the Lake Tahoe Basin. Further, California Government Code Section 29532.1(c) identifies PCTPA as the designated regional transportation planning agency for Placer County, exclusive of the Lake Tahoe Basin. Previous to this designation, PCTPA operated under the name of the Placer County Transportation Commission (PCTC) and operated as a local county transportation commission as specified under Section 29532(c) of the Government Code.

State Transportation Planning and Programming

PCTPA has executed a memorandum of understanding and Master Fund Transfer Agreement with the Caltrans on January 1, 2005 identifying the responsibilities of PCTPA as the RTPA and providing the administrative structure to implement these responsibilities.

As an RTPA with an urbanized population over 50,000, PCTPA is responsible for preparing the county's RTP. PCTPA's jurisdiction, which represents the area covered by the RTP, is shown in Figure 1.2a. PCTPA is also responsible for preparing a Regional Transportation Improvement Program (RTIP) pursuant to Section 65080 of the Government Code. Under SB 45, RTPAs are responsible for the selection of RTIP projects, to be funded with the county's share of STIP funds. This responsibility requires that PCTPA monitor projects included in the county's RTIP, and that they are completed on schedule and within budgetary constraints.

Under AB 1012, agencies are also held responsible for ensuring State and Federal funding is spent promptly and projects delivered within specified time limits. This requirement is backed up by "use it or lose it" timely use of funds deadlines. Some of the major projects subject to these provisions are the Regional Surface Transportation Program (RSTP) and Congestion Mitigation and Air Quality (CMAQ) programs. Proposition 1B Corridor Mobility Improvement

Account (CMIA) funding carries additional provisions that require funded projects to be under construction no later than 2011.

Federal Transportation Planning and Programming

Federal statutes require adherence to eight planning objectives in the development of regional transportation plans:

- Support economic vitality of the region;
- Increase the safety of the transportation system;
- Increase the security of the transportation system;
- Increase the accessibility and mobility options for people and freight;
- Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns;
- Enhance integration and connectivity of the transportation system among modes for people and freight;
- Promote efficient system management and operations; and
- Emphasize preservation of the existing transportation system.

All of these federal objectives coincide with the adopted goals in this RTP, and are considered in defining the policies and reflected in the actions for the plan.

PCTPA executed a memorandum of understanding (MOU) with Caltrans and the Sacramento Council of Governments (SACOG) in April 2001 to govern federal transportation planning and programming in Placer County. This agreement integrates the PCTPA Regional Transportation Plan (RTP) and RTIP within the SACOG process.

Pursuant to this agreement, PCTPA receives a “fair share” allocation of both federal urbanized Surface Transportation Program (STP) funds and Congestion Air Quality Mitigation Improvement Program funds (CMAQ). PCTPA nominates projects for these funds, and SACOG has agreed to select these nominated projects unless they fail to meet a federal requirement. SACOG cannot add projects to the PCTPA nominations.

PCTPA submits the state mandated RTP, developed pursuant to Section 65080.5 of the Government Code, to SACOG for inclusion in the federal Metropolitan Transportation Plan. As part of this agreement, SACOG conducts a federal air quality conformity test on the Placer County transportation program and plan.

PCTPA receives an allocation of federal STP funds for Placer County. Pursuant to Section 182.6 of the Streets and Highways Code, PCTPA can exchange the non-urbanized funds for State gas tax funds. PCTPA allocates these exchange funds to jurisdiction projects based upon an MOU signed by all Placer jurisdictions approved in November 1994. The STP funding exchange

formula and allocation was updated to reflect TEA 21 and approved by the PCTPA Board in January 1999. The exchange formula and allocation is updated annually as appropriate.

Federal Aid Project Administration

PCTPA executed a Local Agency - State Agreement for Federal Aid Projects (Agreement 03-6158) with the State of California in March 1994, which was reauthorized in January 2004. The execution of this agreement qualifies PCTPA to administer federally funded projects.

Local Transportation Fund Administration

As the transportation planning agency, PCTPA allocates the Local Transportation Fund (LTF) to Placer County public transportation agencies pursuant to Section 29532 of the Government Code. The administration of these funds includes the establishment of a Social Service Transportation Advisory Council, the implementation of a citizen participation process appropriate for Placer County, annual recommendations for productivity improvements for transit operators, the performance of an annual fiscal audit of all LTF claimants, the implementation of a triennial performance audit of all LTF claimants, and the preparation of an annual unmet transit needs determination.

PCTPA receives an allocation of LTF funds for the administration of the LTF fund pursuant to Section 99233.1 of the Public Utilities Code and for transportation planning pursuant to Section 99233.2 of the Public Utilities Code and Section 6646 of the Government Code.

It is the responsibility of PCTPA to establish rules and regulations to provide for administration and allocation of the LTF and State Transit Assistance (STA) Funds in accordance with applicable sections of the Government Code, Public Utilities Code and Administrative Code included within the Transportation Development Act. It is also the responsibility of PCTPA to adhere to the applicable rules and regulations promulgated by the Secretary of the Business, Transportation and Housing Agency of the State of California as addressed in the Transportation Development Act, Title 3, Division 3, Chapter 2, Article II, Section 29535.

RTP Consistency

The RTP is consistent with the 2035 MTP, transportation plans of adjacent regions, short range transit plans, human services transportation plan, the air quality State Implementation Plan (SIP), local general plans, airport plans, and regional plans for intelligent transportation systems (ITS).

The RTP is also consistent with other statewide plans and regulations, including: the 2030 California Transportation Plan, a statewide document with policies that should be followed in all regional transportation plans; the California Environmental Quality Act (CEQA) through the development of an environmental document describing impacts and mitigation; and the California Clean Air Act, a state regulation that specifies air quality management strategies that must be adopted.

The RTP must conform to the federal Clean Air Act, which requires demonstration that emissions from transportation activities in the plan decline steadily until the 2019 deadline by which federal clean air standards must be reached in the Sacramento region.

The RTP addresses interregional transportation, such as Amtrak stations, freight railyards, and airports, but does not include planning for those systems, which are owned and operated by other entities. A discussion of interregional transportation can be found within Chapter 6.

Relationship of RTPA and RTP

As the RTPA for Placer County, PCTPA has prepared and/or updated the Regional Transportation Plan for Placer County every two to four years since 1978. Prior to 1978, Caltrans prepared the RTP for the county. PCTPA is responsible for developing and adopting a plan that conforms to the most recent version of the California Transportation Commission's *Regional Transportation Plan Guidelines*, in order to ensure that PCTPA and its member jurisdictions continue to receive state and federal transportation planning and construction funds.

2.2 Airport Land Use Commission (ALUC) Designation

Requirements for creation of airport land use commissions (ALUCs) were first established under the California State Aeronautics (Public Utility Code Sections 21670 et seq.) in 1967. The fundamental purpose of ALUCs is to promote land use compatibility around airports. As expressed in the present statutes, the purpose is:

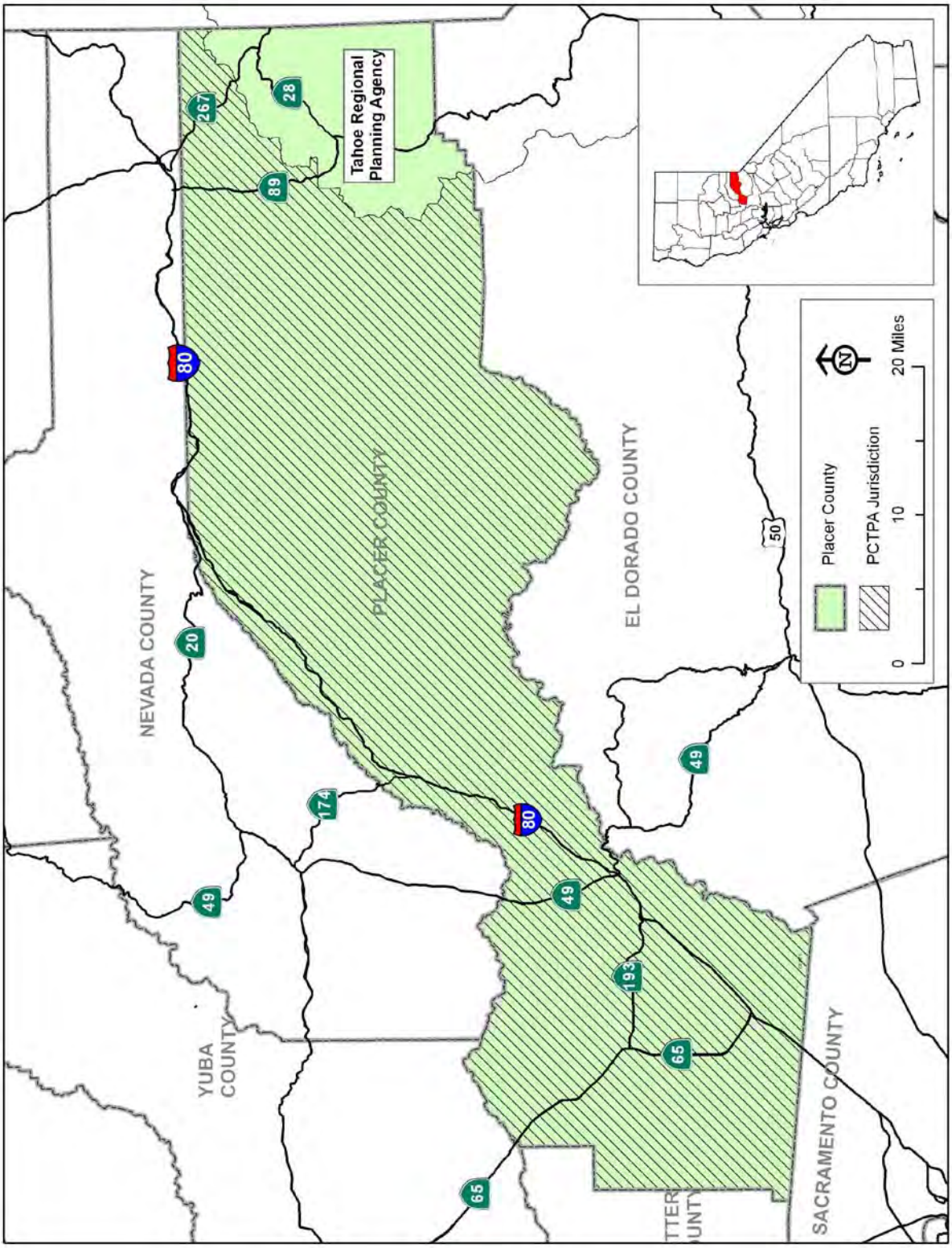
> *To protect public health, safety, and welfare by ensuring the orderly expansion of airports and the adoption of land use measures that minimize the public's exposure to excessive noise and safety hazards within areas around public airports to the extent that these areas are not already devoted to incompatible uses.*

PCTPA was designated the ALUC for the Auburn Municipal, Lincoln Regional, and Blue Canyon airports in January, 1997. As ALUC, PCTPA has two principal powers. PCTPA acts as the hearing body for land use planning for Placer County airports. PCTPA is also responsible for development of airport land use plans for Placer County airports, and must review the plans, regulations, and other actions of local agencies and airport operators for consistency with that plan. The Placer County ALUC (PCTPA Board of Directors) adopted the updated Placer County Airport Land Use Compatibility Plan in October, 2000.

Relationship of ALUC and RTP

The RTP includes an Aviation Action Element, which incorporates capital improvements for each airport according to the local agencies' adopted airport master plans. As the ALUC, PCTPA approves the master plans for each airport. In this way, PCTPA's role as the ALUC is consistent with its transportation planning responsibilities and duties.

Figure 2.1
PCTPA Jurisdiction (Area Covered by RTP)



2.3 Congestion Management Agency (CMA) Designation

In June 1990, the voters of California approved Proposition 111, which increased the tax on gasoline to fund improvements on congested roadways. This proposition amended Government Code Section 65089 to require counties containing urbanized areas with populations of 50,000 or more, such as Placer County, to designate an agency as a Congestion Management Agency (CMA); however, the CMA designation has since been made optional. PCTPA was designated the CMA for Placer County in 1991.

Under SB 437, CMA's have the option as to whether to continue their Congestion Management Program (CMP). PCTPA maintains this effort through an alternative transportation outreach effort in an effort to provide trip reduction programs to those who reside and work in Placer County.

Relationship of CMA and RTP

The purpose of the CMA is to recognize and address the interrelationship between land use, air quality, and transportation, and to maintain transportation mobility by establishing standards that encourage a balance of transportation modes. In Placer County, PCTPA implements an alternative transportation outreach effort, which is discussed in the Transportation Systems Management section of this RTP. This is one of the methods proposed to assist in the effort to improve air quality and make maximum use of existing transportation systems.

2.4 Passenger Rail Administration

PCTPA is a statutorily designated member of the Capitol Corridor Joint Powers Authority (CCJPA), pursuant to Section 140762(b) of the Government Code. Through an interagency agreement with Caltrans, the CCJPA administers the intercity rail service on the San Jose-Colfax corridor.

Relationship of CCJPA and RTP

The RTP Action Element includes a Passenger Rail Chapter, which incorporates regionally significant and passenger rail improvement projects, including services provided by the CCJPA. CCJPA projects are included in the 2035 RTP. Freight rail improvements are identified in the Goods Movement Chapter.

2.5 South Placer Regional Transportation Authority (SPRTA) Administration

PCTPA adopted a Regional Transportation Funding Strategy in August 2000, which included the development of a regional transportation impact fee program and mechanism to implement this impact fee. The South Placer Regional Transportation Authority (SPRTA), formed in January 2002, is the result of that effort. PCTPA was designated as the administrator of the SPRTA under the terms of the Authority's Joint Powers Agreement dated January 22, 2002. As the administrator, PCTPA provides staffing and management of the Authority, and is reimbursed for these services under a staffing agreement.

Relationship of SPRTA and RTP

The RTP includes an Action Element, which incorporates regionally significant and local transportation improvement projects. Several of the regionally significant projects are funded through a regional development impact fee, adopted by SPRTA. PCTPA as the administrator of SPRTA includes these projects in the RTP and the MTP, and programs them in the SACOG MTIP.

2.6 Transportation Sales Tax Authority Administration

PCTPA was designated as the transportation sales tax authority for Placer County by the Placer County Board of Supervisors in August 2006. In the event that a transportation sales tax is proposed for voter approval and is subsequently passed by a 2/3 majority of Placer voters, PCTPA would be designated as the entity to administer the sales tax expenditure plan.

Relationship of Transportation Sales Tax Expenditure Plan and RTP

The RTP includes an Action Element, which incorporates regionally significant and local transportation improvement projects. Several of the projects included in the RTP could be potentially funded via a transportation sales tax. In May 2006, the transportation sales tax was found to be consistent with the description of local fund sources included in the 2027 RTP's financial element.

2.7 Western Placer Consolidated Transportation Services Agency (WPCTSA) Administration

PCTPA was designated as the administrator of the WPCTSA under the terms of the Agency's Joint Powers Agreement approved in October 2008. As such, PCTPA provides staffing and management of the Agency, and is reimbursed for these services under a staffing agreement.

Relationship of WPCTSA and RTP

The RTP includes an Action Element, which incorporates regionally significant and local public transit improvement projects, including services provided by the WPCTSA. WPCTSA projects are included in the RTP, as well as the CTSA short range transit plan, and SACOG's human services transportation plan. PCTPA as the administrator of WPCTSA includes these projects in the RTP and the MTP, and programs them in the SACOG MTIP.

2.8 Other Agencies

PCTPA coordinates with a variety of agencies, including Caltrans, SACOG, and other agencies, as indicated below, regarding various planning activities, transportation programs and specific projects.

MEMBER JURISDICTIONS

Each of the six cities/towns within Placer County, (the Cities of Auburn, Colfax, Lincoln, Rocklin, and Roseville and the Town of Loomis), as well as the County of Placer are members of PCTPA. As members, each of the jurisdictions has direct input into PCTPA's decision-making process, both on a staff and board level. The PCTPA Board of Directors is comprised of nine elected officials, with three members appointed by the Placer County Board of Supervisors and one member each from the incorporated Cities of Auburn, Colfax, Lincoln, Rocklin, Roseville and the Town of Loomis. In addition, the Technical Advisory Committee includes public works and planning staff from each jurisdiction.

<u>Relationship of Member Jurisdictions and RTP</u>

The input provided by the member jurisdictions directly affects the content and direction of the RTP. Each jurisdiction's concerns and perspectives on pertinent transportation issues are sought. Further, jurisdictions recommend projects to be included in the action plan of the RTP. Participation in the development of the RTP is also in the best interests of the jurisdictions. Any project which requires federal or state funding must be included in the RTP in order to be eligible. Many of the goals, objectives, and policies delineated in the RTP are implemented by

the jurisdictions. The participation and agreement of all jurisdictions, therefore, is critical in implementing the RTP.

CALIFORNIA TRANSPORTATION COMMISSION (CTC)

The California Transportation Commission (CTC) is composed of members appointed by the Governor to oversee transportation funding in California. The CTC biennially adopts the State Transportation Improvement Program (STIP). Regional Transportation Improvement Programs (RTIP) from the regions of California, together with the Caltrans Interregional Transportation Improvement Program (ITIP) forms the STIP. The STIP is a five year capital improvement programming document listing all major projects to be funded from State and federal transportation funds allocated by the CTC. Under State law, the CTC may accept or reject a region's RTIP in its entirety but may not reject specific projects in the RTIP. However, the CTC can choose to change the funding schedule for projects in the RTIP.

Relationship of CTC and RTP

PCTPA is responsible for preparing a Regional Transportation Improvement Program (RTIP) pursuant to Section 65080 of the Government Code. Projects in the PCTPA RTIP are included in or are consistent with the adopted RTP. RTIP projects are recommended by PCTPA for consideration by the CTC for inclusion in the STIP. The RTP and RTIP are both consistent with the adopted STIP.

CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

As the State Department of Transportation, Caltrans has numerous roles and responsibilities for planning, programming, constructing, operating, and maintaining the State's transportation system. Virtually all federal and state planning and construction funds are administered through Caltrans to PCTPA and its member jurisdictions. As a result, Caltrans is responsible for monitoring and reviewing the activities of PCTPA to ensure that transportation planning and programming requirements associated with these funding programs are met. The RTP is a cornerstone of these requirements, as local areas plan a comprehensive transportation system which identifies what improvements are most needed and how they will be funded.

California Transportation Plan

Caltrans is also responsible for preparing the California Transportation Plan (CTP). The CTP is a statewide, long range transportation plan for meeting California's future mobility needs. The CTP provides a vision for the State's future transportation system; a fully integrated, multimodal, sustainable transportation system that supports a prosperous economy, a quality environment, and furthers social equity. The CTP offers a policy framework to guide future transportation decisions and investments, better link transportation and land use, improve air quality, and reduce petroleum energy consumption. The CTP also provides guidance for developing RTPs. The CTP is currently being updated for a planning horizon year of 2035. The update is scheduled to be completed in 2010, and is being developed in consultation with regional transportation planning agencies through the Rural Counties Task Force.

Caltrans System Planning Process

Caltrans system planning is a long range (20 years) transportation planning process that evaluates current and future operating conditions and deficiencies on the State's transportation system. The planning process is not financially constrained, and is focused primarily on the State highway system. Caltrans District 3 system planning elements include the:

- District System Management Plan (DSMP), which provides a technical assessment of District transportation needs as well as the identification of problems that will result in planning and funding decisions related to proposed transportation improvements over a twenty year time frame.
- District Mobility Action Plan (DMAP), which describes the District's vision for State highway system development, maintenance, management, and ways to enhance mobility within District 3 over the next 20 years and identifies key strategies, including specific projects and costs.
- Transportation Corridor Concept Report (TCCR), which is a long term planning document for each State Highway Route that identifies how the highway will be improved and managed over a 20-year period so that it maintains a minimum acceptable concept level of service. TCCR's also identify an "ultimate concept," which is a long term vision for the highway beyond the 20-year planning horizon. For routes that have a CSMP, the CSMP serves as the TCCR.
- Transportation System Development Program (TSDP), which consists of a broad list of programmed and planned (financially unconstrained) projects to maintain and improve regional and interregional mobility, including the needed improvements identified in each TCCR and priority congestion relief projects on the heaviest travel corridors. The TSDP identifies three priority congestion projects in Placer County:
    - Reconstruct SR65/I-80 interchange;
    - Add HOV lanes from I-80 to Industrial Boulevard; and
    - Construct the Placer Parkway.
- Corridor System Management Plans (CSMPs), which evaluates existing and projected corridor traffic conditions and outline transportation improvements and management strategies to enhance mobility within the State's most congested corridors associated with the Corridor Mobility Improvement Account. The primary focus is on low-cost, operational improvements, and daily system operational activities. Current CSMP's in Placer County cover three major freeway corridors, I-80, SR65 and SR49.
- 10-Year State Highway Operation and Protection Plan (SHOPP), which summarizes the District's maintenance and system operational needs for the next ten years, including the necessity to address the growing inventory of distressed lane miles.

Most Caltrans projects identified in the District Mobility Action Plan, the Transportation Corridor Concept Reports, the Transportation System Development Program, and the Corridor System Management Plans for District 3 are included in the 2035 RTP.

Relationship of Caltrans and RTP

The RTP is consistent with Caltrans mission to "improve mobility across California;" and specifically, the RTP goals, objectives and policies are consistent with Caltrans goals to: provide a safe transportation system; maximize system performance, mobility, and accessibility; efficiently deliver transportation projects and services; and preserve and enhance California's resources and assets.

Most federal and state programs administered by Caltrans require projects to be identified in a current RTP which meets state and federal guidelines in order for that project to be funded. Without an adopted RTP, Caltrans could not distribute funds to PCTPA and its jurisdictions to build those projects, nor could Caltrans build its own projects within the region. As the owner-operator of the state highway system, Caltrans has a vested interest in ensuring that a complete and conforming RTP is adopted.

Caltrans representatives participate in the development and review of the RTP. The agency is represented on the Technical Advisory Committee. Caltrans' perspective on pertinent transportation issues is sought, and Caltrans recommends projects to be included in the action plan. When the draft RTP is completed, it is sent to Caltrans District 3 and Headquarters for comments. Further, Caltrans Headquarters distributes the draft RTP to the appropriate divisions, such as Mass Transportation, Rail, and Aeronautics, for more specific review. The comments received as a result of the review conducted by the various divisions of Caltrans is then included, as appropriate, in the final RTP.

SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG)

The Sacramento Area Council of Governments (SACOG) is the Regional Transportation Planning Agency for Sacramento, Sutter, Yolo and Yuba counties. In addition, SACOG is the federally designated Metropolitan Planning Organization (MPO) for the Sacramento Metropolitan Area. As a result, SACOG acts as the MPO for those portions of Placer County excluding Lake Tahoe and within the Federal Ozone Non-attainment Area.

Relationship of SACOG and RTP

PCTPA has the responsibility for the development and adoption of the RTP and the RTIP for Placer County. SACOG has the responsibility for the development and adoption of the Metropolitan Transportation Plan (MTP) and the Metropolitan Transportation Improvement Program (MTIP). SACOG also has the responsibility for making findings of conformity required under Section 176 of the Federal Clean Air Act with the designated Federal Ozone Non-attainment Area. Under the terms of a Memorandum of Understanding between PCTPA and SACOG entered into in 1993 and amended in 2001, PCTPA submits the RTP for inclusion into the SACOG MTP. PCTPA also represents the Placer jurisdictions in various federal planning and programming issues. The RTP is designed to be consistent with SACOG's adopted 2035 MTP and the MTIP, as amended.

PLACER COUNTY AIR POLLUTION CONTROL DISTRICT (PCAPCD)

The Placer County Air Pollution Control District (PCAPCD) establishes and implements regulations to achieve air quality standards in Placer County (see Chapter 7 for additional information). The PCAPCD works in concert with the other air pollution control districts in the Sacramento region including Sacramento Metropolitan Air Quality Management District, El Dorado Air Quality Management District, Yolo-Solano Air Quality Management District, and Feather River Air Quality Management District.

PCAPCD also works with PCTPA to fund and implement various programs promoting alternative transportation, such as the annual Spare-the-Air campaign and the SECAT Program. Further, PCAPCD has provided funding for a Freeway Service Patrol program in Placer County.

Relationship of PCAPCD and RTP

PCAPCD participates on PCTPA's Technical Advisory Committee (TAC). The PCAPCD reviews the RTP to ensure the accuracy of information and consistency with air quality plans. The RTP is designed to be consistent with the adopted plans and programs of the PCAPCD as well as the adopted SIP.

OTHER AGENCIES' REGIONAL TRANSPORTATION PLANS

PCTPA also coordinates regional transportation planning activities outside the Sacramento region. These include adjacent RTPAs, such as the El Dorado County Transportation Commission (EDCTC), the Nevada County Transportation Commission (NCTC), and the Tahoe Regional Planning Agency (TRPA).

Relationship of Other Agencies and RTP

PCTPA conducts appropriate consultation and coordination with other RTPAs as part of the RTP planning process and during the normal course of overall work program planning activities. The RTP is designed to be consistent with the adopted RTPs of the adjacent RTPAs.

TRIBAL GOVERNMENTS

PCTPA consults with the United Auburn Indian Community of the Auburn Rancheria on regional transportation planning and project activities within Placer County.

Relationship of Other Agencies and RTP

PCTPA conducts appropriate consultation and coordination with the United Auburn Indian Community as part of the RTP planning process and during the normal course of overall work program planning activities. In addition, many of the projects shown in the RTP's Action Element are federally funded; therefore, consultation and coordination with tribal governments also occurs through SACOG's MTP and MTIP processes.

LOCAL GENERAL PLANS AND CAPITAL IMPROVEMENT PROGRAMS (CIP)

Local jurisdictions prepare circulation elements governing streets and roads and other transportation system improvements for incorporation into their local general plans and capital improvement programs. By State law, circulation elements and capital improvement programs (CIP) must be internally consistent with the land use elements of their general plans in order for the local general plan as a whole to be considered legally adequate. The CIP contains improvements that are needed for implementation of the goals, policies and land uses designated by the general plan for the jurisdiction.

Relationship of Local General Plans and CIP and RTP

Locally significant transportation improvements are proposed for inclusion in the RTP if State of federal funds is used, or if the improvement is considered regionally significant. The RTP is designed to be consistent with jurisdiction's adopted general plans and CIPs.

OTHER PLANS AND PROGRAMS

Transportation planning is conducted by many agencies at all levels of government in Placer County.

Relationship of Other Agencies and RTP

The RTP outlines the region's goals and policies for meeting existing and future transportation needs and provides a foundation for transportation investment decision making. PCTPA conducts appropriate consultation and coordination with agencies as part of the RTP planning process and during the normal course of overall work program planning activities. The RTP is designed to be consistent with the adopted plans and programs of other agencies.

GENERAL PUBLIC

All residents of Placer County are affected by transportation and, as such, are an important component of the transportation planning process. It is the public's needs and actions that determine the effectiveness of transportation plans.

Relationship of General Public and RTP

PCTPA is continuously exploring new methods of reaching out to the general public. PCTPA actively solicits the participation of the general public as part of its ongoing transportation planning work program to ensure the public has the opportunity to participate in the development of plans, projects and programs. The reader should refer to Appendix A for a description of PCTPA's Community Information and Participation Program, and to Appendix B documenting the milestones in the Interagency and Public Involvement Process for the 2035.

Once a draft RTP and the environmental document are produced, general public involvement is solicited through the public workshop and public hearing process. In addition, citizen comments are encouraged and accepted at any point during the plan development process. The draft RTP and environmental documentation are made available at county libraries, at jurisdiction offices, on the PCTPA web page, and at PCTPA offices. In accordance with state law, a noticed public hearing takes place prior to plan adoption by the PCTPA Board of Directors. The public hearing for the RTP is advertised in newspapers of general circulation at least 30 days prior to the hearing date. The environmental documentation is also made available for public review in accordance with the California Environmental Quality Act (CEQA) and noticed prior to public hearing. The number of days required for notification depends upon the type of environmental documentation required.

CHAPTER 3
PHYSICAL & SOCIO-ECONOMIC SETTING

3.1 Physical Setting

To set the framework in which the current and future transportation systems of Placer County function, a complete characterization of the area is needed. This chapter describes the location, population, employment, housing of Placer County, as well as demographic projections.

LOCATION

Placer County is located in the foothills and mountains of the Sierra Nevada, extending eastward from the eastern portion of California's Central Valley. Placer County is bordered by Nevada County to the north, Sutter County to the west, Sacramento and El Dorado Counties to the south and the State of Nevada to the east. A portion of Lake Tahoe is located in Placer County. Placer County contains 1,506 square miles or 898,820 acres, ranging in elevation from 160 feet above sea level to nearly 9,500 feet above sea level. Figure 3.1 shows the location of Placer County in the context of surrounding counties.

Six incorporated cities are located within the political boundary of Placer County. These include the Cities of Auburn, Colfax, Lincoln, Rocklin, Roseville, and the Town of Loomis. Numerous unincorporated communities also dot Placer County, including Foresthill, Granite Bay, Weimar, Newcastle, Meadow Vista, and Sheridan. Refer to Figures 3.2 and 3.3.

Capital improvement projects identified in the RTP are located on state highways, county roads, local streets, and publicly owned rights-of-way.

CLIMATE

The climate of the Sacramento Valley Air Basin portion of Placer County is characterized by hot, dry summers and cool rainy winters. During the winter, the North Pacific storm track intermittently dominates valley weather. Moderate, dry days and cool nights characterize the summer months in Placer County. The temperature during the summer varies between the Valley and High Country areas. Typically, valley temperatures are higher in summer and winter, while mountain temperatures are lower. The rainy season in Placer County occurs between November and April, but excessive rainfall and damaging windstorms are rare. The Sierra Nevada snow fields are a major source of water during the dry summer months. Table 3.1 shows average temperatures and precipitation in Placer County.

Figure 3.1
Placer County Location within California & SACOG Region

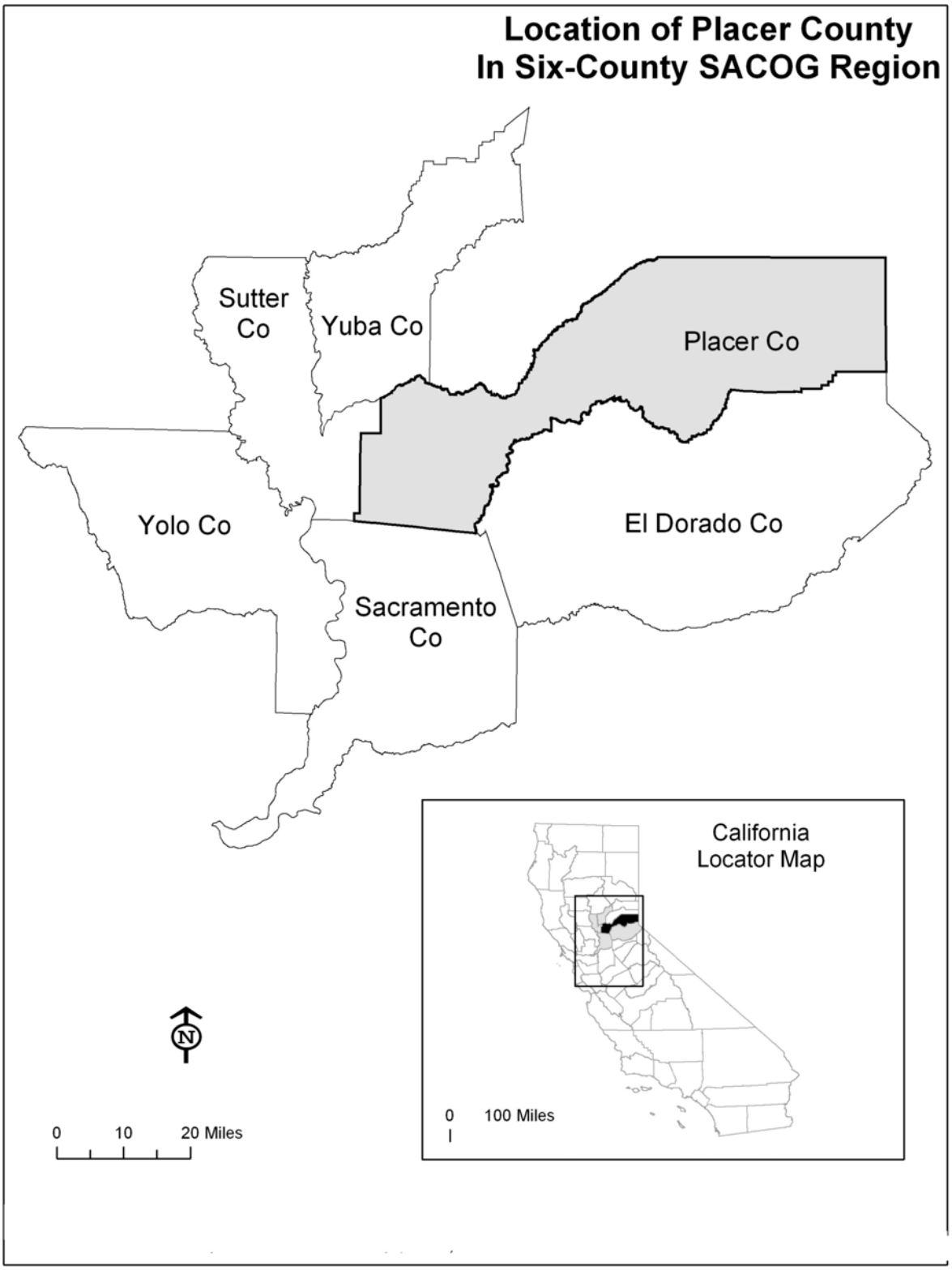


Figure 3.2
Incorporated Cities and Unincorporated Communities in Western Placer County

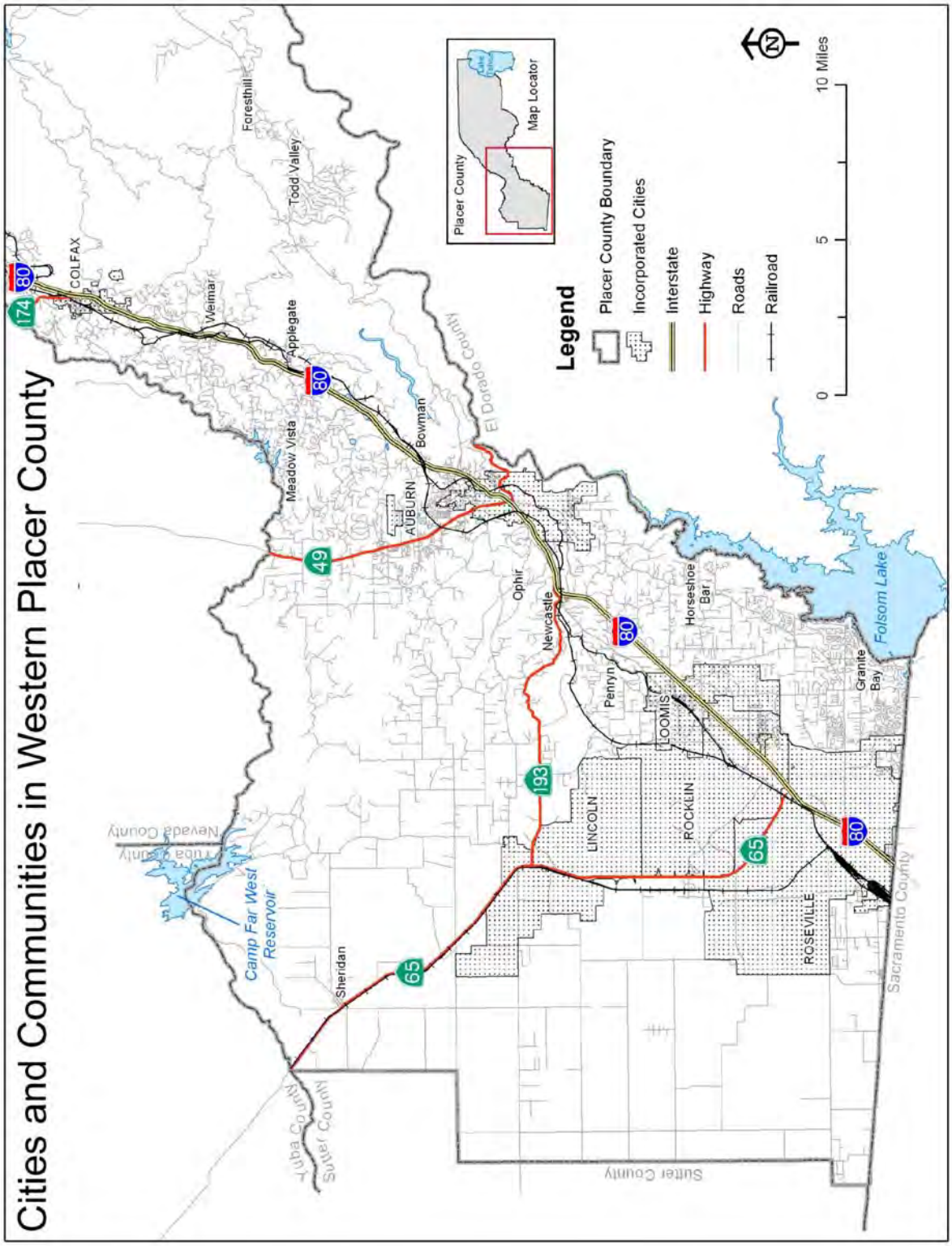


Figure 3.3
Incorporated Cities and Unincorporated Communities in Eastern Placer County

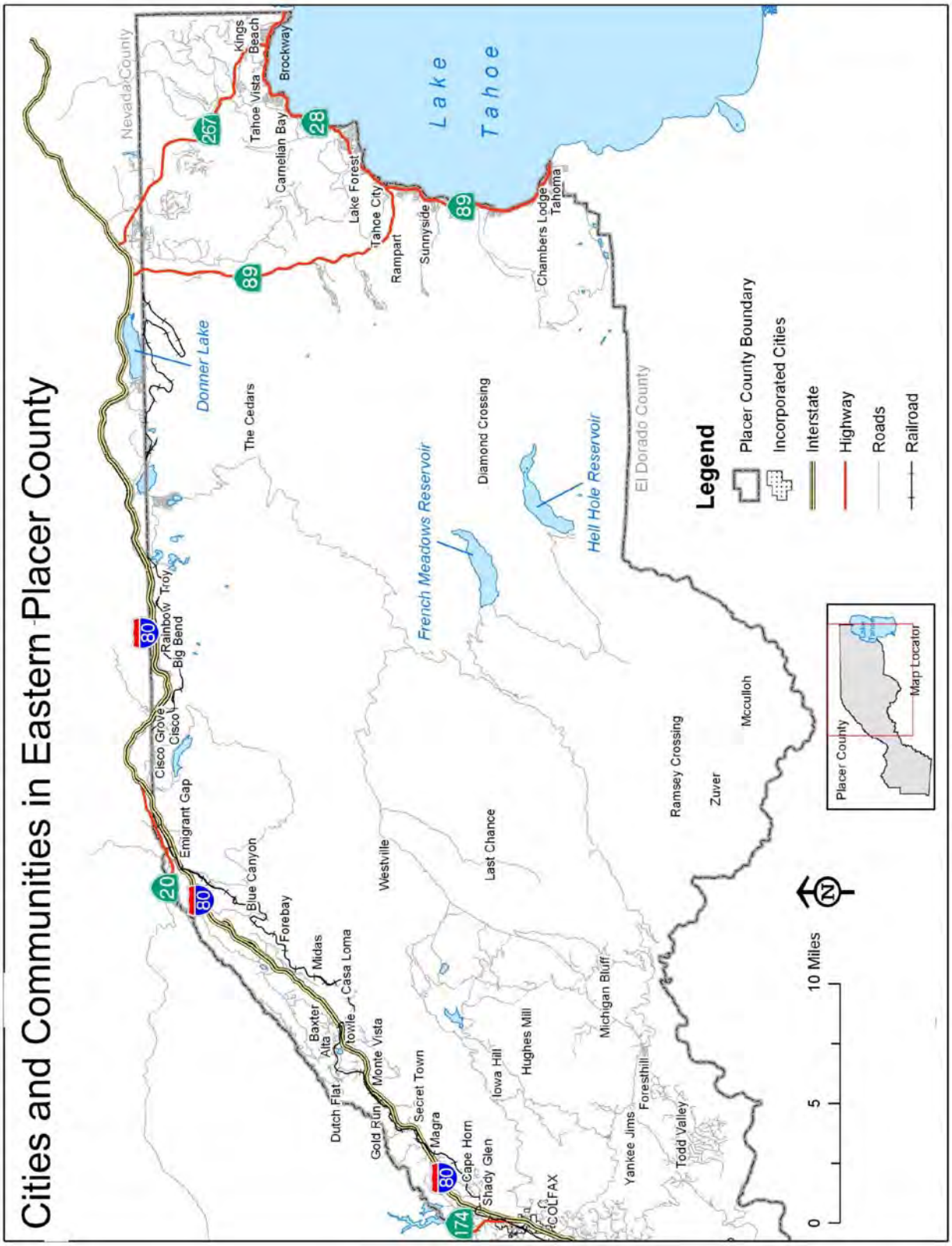


Table 3.1
Temperature and Precipitation in Placer County 1905-2009 Monthly Normal

Area	Average Maximum Temperature	Average Minimum Temperature	Average Total Precipitation	Average Total Snowfall
Rocklin	74.7ºF	45.4ºF	22.8”	0.3”
Auburn	72.4ºF	48.3ºF	34.3”	1.4”
Colfax	70.7ºF	46.2ºF	45.3”	18.9”
Gold Run	67.9 ºF	45.7 ºF	54.1”	15.2”
Iowa Hill	67.3 ºF	46.3 ºF	52.9”	30.6”
Blue Canyon	58.4 ºF	43.0 ºF	67.5”	240.3”
Squaw Valley	57.7 ºF	27.3 ºF	51.0”	246.2”
Tahoe City	56.0ºF	30.5ºF	31.5”	190.4”

Note:
1. Period of monthly climate summary 1/1/1905 to 8/31/2009.

Source:
1. Western Regional Climate Center, December 2009.

CHARACTER

Placer County’s climate, geography, and historical richness contribute to an unusually high quality of life. The geography of the county encompasses the grasslands of the valley, the woodlands of the foothills, the snow-capped Sierra Nevada mountain range, and numerous rivers, lakes, state and national forests, and ski resorts. The Valley Area of Placer County represents rich agricultural lands, recreational amenities, and cultural activities. The world-famous gold Country features well-stocked lakes with tree-lined shores. Lake Tahoe, the internationally acclaimed lake in the High Country, is a place of unparalleled natural beauty and provides opportunities for water skiing, sailing, scuba diving, jet skiing, and fishing.

The comparative solitude of country living and the magnificent mountains provide a perfect retreat from urban life. Placer County offers hiking, biking, camping, snow skiing, snow boarding, horseback riding, fishing, water sports, ice skating, and hunting. In addition to the recreational opportunities, Placer County offers a diverse array of cultural attractions. South Placer is one of the fastest growing business communities in California and commercial activities and shopping opportunities are abundant. The choice of rural, urban and suburban living creates unique lifestyle opportunities for work and play.

3.2 Socio-Economic Setting

Placer County’s economy is diverse and includes a mix of available jobs. The resorts in North Lake Tahoe are the leading employers in that region’s growing tourism industry. In the South Placer area, high tech companies are prominent. A list of current major employers in Placer County can be found in Appendix C. The major employment sectors in Placer County, and their share of total employment at the end of 2008, is listed in Table 3.2 below:

Table 3.2
Employment Distribution by Sector

Employment Sector	Percent in 2008
Construction	9.0%
Financial Activities	7.7%
Information	1.7%
Trade, Transportation, Utilities	20.3%
Natural Resources and Mining	0.1%
Government	14.5%
Educational and Health Services	12.1%
Agriculture	0.1%
Other Services	3.7%
Professional and Business Services	10.8%
Leisure and Hospitality	14.2%
Manufacturing	5.8%

Source:

1. Placer County Industry Employment and Labor Force Annual Average, Employment Development Department, January 2010.

Placer County's job growth has remained relatively strong compared to California, the Bay Area, and the Sacramento area. During the 1980's and 1990's, the county's manufacturing sector grew steadily with expansion of high technology industries. Services, retail trade, and government employment sectors also increased to meet the needs of the county's expanding population base.

During the 2000 decade, the principle sectors that continued to produce jobs in are trade, transportation and utilities, government, leisure and hospitality, education and health services, professional and business services, and construction. The fastest growing sector is currently education and health services. Momentum for employment growth is also in transportation, warehousing, wholesale and retail trade, leisure and professional services. Employment in manufacturing activities has been declining since the mid-1990's. Employment in construction and financial services have declined since 2007 as housing production and homes sales fell precipitously, although construction employment is expected to rebound by 2012. Government still accounts for more than 25 percent of jobs in the Sacramento region.

The county's unemployment rate at the end of 2009 was 11.3 percent compared to a rate of 8.2 percent in December 2008; ranking 16 out of the State's 58 counties. Underemployment, such as furloughs of State workers, is not counted in these unemployment figures.

3.3 Recent Growth Trends 2000 - 2008

Placer County's communities, cultural amenities, economic opportunities, and ideal climate continue to attract new residents, workers, and businesses, creating a dynamic environment in which to plan for and implement transportation improvements. To examine how growth has impacted transportation, it is useful to examine trends that unfolded during the decade between 2000 and 2008. Table 3.3 displays some of the key growth indicators shaping travel behavior in Placer County.

Table 3.3
Summary of Placer County Growth Trends 2000 – 2008

Characteristics	2000	2008	Percent Change
Demographic Characteristics			
Total Population	248,399	332,608	33.9%
Male	121,092	163,949	35.4%
Female	126,507	168,659	33.3%
Median age (years)	38.0	37.8	-0.5%
Under 5 years	15,924	19,905	25.0%
18 years and over	182,641	258,852	41.7%
65 years and over	32,560	49,098	50.8%
Housing Characteristics			
Total Housing Units	107,302	144,813	35.0%
Occupied Housing	93,382	125,967	34.9%
Owner-occupied	68,372	90,424	32.3%
Renter-occupied	25,010	35,543	42.1%
Vacant housing	13,920	18,846	35.4%
Owner-occupied Median Value ($)	$213,900	$469,100	119.3%
Median Monthly Owner Costs with Mortgage	$1,521	$2,449	61.0%
Single Family Building Permits	4,745	1,389	-70.7%
Multi Family Building Permits	133	316	137.6%
Economic Characteristics			
Labor Force (population 16 and over)	123,875	174,030	40.5%
Median Household Income	$57,535	$73,260	27.3%
Median Family Income	$68,858	$86,419	25.5%
Per capita income	$27,963	$35,913	28.4%
Unemployment Rate	3.20%	8.2%	103.1%
Social Characteristics			
Average Household Size	2.63	2.61	-0.8%
Average Family Size	3.06	3.06	0.0%
Speak language other than English at home	24,645	41,754	69.4%
Transportation Characteristics			
Mean travel time to work in minutes	27.0	26.8	-0.7%
30 Minutes or less	81,831	87,087	6.4%
30 minutes or more	39,056	57,097	46.2%
Drove Alone	105,128	125,771	19.6%
Carpooled	14,307	16,589	16.0%

Used Public Transportation	1,452	1,824	25.6%
No Vehicle Available at Home	5,370	1,517	-71.8%
1 Vehicle at Home	31,665	19,707	-37.8%
2 Vehicles at Home	42,015	61,880	47.3%
3 or more Vehicles at Home	23,068	54,713	137.2%

Sources:

1. 2008 and 2006-2008 American Community Survey, Placer County, California,
2. American Fact Finder, U.S. Census Bureau, 2009.
3. Placer County Historical Civilian Labor Force, EDD, January 2010.
4. 2001 Supplementary Survey - Means of Transportation to Work, U.S. Census Bureau, 2002.
5. Tenure of Vehicles Available; and Travel Time for Workers, U.S. Census Bureau, 2002.
6. Historical Data for Building Permits in Placer County, EDD, February 2010.

Table 3.4 summarizes the primary commuting patterns for Placer County workers occurring from 1990 to 2000. In 2000, about 43 percent of Placer County workers commuted within the County's boundaries. About 30 percent commuted to surrounding counties; and surrounding counties contributed about 27 percent of the workers commuting into Placer County.

Table 3.4

Summary of Primary Commuting Patterns in Placer County from 1990 to 2000

Area of Residence	Area of Work Place	1990 Number of Workers	2000 Number of Workers	Percent Increase
Placer County	Placer County	46,601	69,554	49.3%
Placer County	Sacramento County	27,818	35,458	27.5%
Sacramento County	Placer County	15,969	29,788	86.5%
Nevada County	Placer County	3,532	5,215	47.7%
El Dorado County	Placer County	1,838	3,663	99.3%
Placer County	Yolo County	1,413	2,497	76.7%
Placer County	Nevada County	1,072	1,877	75.1%
Yuba County	Placer County	566	1,694	199.3%
Sutter County	Placer County	447	1,487	232.7%
Placer County	Washoe County , NV	989	1,040	5.2%
Placer County	El Dorado County	594	872	46.8%
Placer County / Elsewhere	Elsewhere / Placer County	5628	8260	46.8%
	Total	**106,467**	**161,405**	**51.6%**

Note: 1990 and 2000 US Census data compiled by EDD.

Source:

1. Historical Data for Commuting Patterns in Placer County, California Labor Market Info, EDD, February 2010.

3.4 Growth Assumptions

As the Regional Information Center for the Sacramento area, the Sacramento Area Council of Governments (SACOG) prepared population, housing, and employment forecasts for the

development of the MTP 2035. The SACOG Board of Directors adopted a revised set of forecasts in September 2007 for years 2013, 2018 and 2035. These forecasts are the basis of the growth assumptions for the 2035 RTP update. Appendix D summarizes the process and assumptions used by SACOG to develop the land use allocation for the MTP 2035.

The population, housing, and employment forecasts reflect the growth that is anticipated to occur within Placer County during the twenty-five year horizon of this plan. SACOG develops the regional population, housing, and employment forecasts in consultation with member local jurisdictions, the 2000 census, the State Department of Finance, the State Employment Development Department, and the State Department of Housing and Community Development. The requirements for coordination between SACOG and state agencies have been strengthened by SB375.

SACOG typically updates its growth projections on four-year cycles. The State Department of Finance does not plan to update its official long-range state and county growth forecast (adopted in 2007) until after the 2010 census is completed, anticipated in 2013. The State plans to release amended population and housing projections benchmarked to the 2010 census by June 2011. SACOG's anticipates adoption of a revised set of the regional growth forecasts to occur by December 2011. Estimates will be provided for several near-term years: 2011, 2014, 2017, 2018 and 2025 to address federal Clean Air Act requirements; and 2020 to address state SB375 requirements. The revised growth forecast will include fewer dwelling units and jobs than the 2035 MTP.

POPULATION PROJECTIONS

Population forecasts are household population only and are based on persons per household rates by housing type. Households represent about 95 percent of total housing units, with the average persons per household at 2.62 people. Population forecasts are identified milestone year increments and reflect the net increase and percent growth of each jurisdiction, as shown in Table 3.5.

Table 3.5
Population Projections by Jurisdiction 2005-2035

	2005	2009	2013	2018	2035	Net Increase	% Growth
Auburn	13,942	13,432	16,572	15,438	17,985	4,043	29%
Colfax	3,320	1878	3,530	3,677	4,246	926	28%
Lincoln	29,322	40,060	58,253	56,802	112,209	82,887	283%
Loomis	6,910	6,677	6,809	7,425	8,336	1,426	21%
Rocklin	50,251	54,754	58,599	62,106	69,155	18,904	38%
Roseville	102,215	112,343	139,358	149,683	172,500	70,285	69%
Unincorp.[1]	93,912	97,310	110,647	129,311	186,278	92,366	98%
County Total	299,872	326,454	393,768	424,441	570,709	270,837	90%

Notes:
[1] Population estimates for 2005 and 2005 are household population only and are based on persons per household rates by housing type, using DOF 2009 occupancy rates.
[2] Excludes the unincorporated area of the Tahoe Basin that falls within TRPA planning area.

Sources:

1. SACOG Projections for MTP 2035, Population Growth and Distribution, 2005 – 2035 by Jurisdiction, September 2007.
2. SACOG Forecast Data 2009.
3. Table E-1: City / County Population Estimated January 1, 2008 to January 1, 2009, Department of Finance (DOF).

EMPLOYMENT PROJECTIONS

The employment forecasts were derived from the expected increase in building square footage or acreage factor consistent with each local general plan. SACOG converted the building square footage or acreage factor into employment using calculated holding capacities consistent with those assumed for the local general plans. Employment forecasts are identified in milestone year increments and reflect the net increase and percent growth of each jurisdiction, as shown in Table 3.6.

Table 3.6
Employment Projections by Jurisdiction 2005-2035

	2005	2009	2013	2018	2035	Net Increase	% Growth
Auburn	8,153	7,800	8,259	8,280	8,525	372	5%
Colfax	1,081	900	1,263	1,500	1,925	844	78%
Lincoln	7,994	6,200	17,923	21,950	38,426	30,432	381%
Loomis	3,762	4,000	4,022	4,347	4,822	1,060	28%
Rocklin	15,427	23,800	19,801	21,340	27,297	11,870	77%
Roseville	60,167	48,000	79,805	83,439	100,395	40,228	67%
Unincorp.[1]	34,864	56,300	44,126	46,093	66,062	31,198	90%
County Total	131,448	147,000	175,199	186,949	247,452	116,004	88%

Notes:

[1] Excludes the unincorporated area of the Tahoe Basin that falls within the TRPA planning area.

Sources:
1. SACOG Projections for MTP 2035, Population Growth and Distribution, 2005 – 2035 by Jurisdiction, September 2007.
2. SACOG Forecast Data 2009.
3. Monthly Labor Force Data for Cities and Census Designated Places – December 2009 Preliminary, EDD, January 2010.

HOUSING PROJECTIONS

Housing forecasts are identified in milestone year increments and reflect the net increase and percent growth of each jurisdiction, as shown in Table 3.7. The forecasts assume a five percent vacancy rate, although the current rate is substantially higher due the effects of the recession and mortgage crisis.

Table 3.7
Housing Projections by Jurisdiction 2005-2035

	2005	2009	2013	2018	2035	Net Increase	% Growth
Auburn	6,144	6,034	6,540	6,887	7,872	1,728	28%
Colfax	1,371	820	1,460	1,584	1,813	442	32%
Lincoln	10,506	17,772	23,515	24,840	40,916	30,410	289%
Loomis	2,304	2,462	2,494	2,710	3,223	919	40%
Rocklin	19,658	21,216	22,542	23,891	26,907	7,249	37%
Roseville	42,418	46,230	53,930	59,708	72,735	30,317	71%
Unincorp.[1]	37,410	54,731	45,091	52,697	76,067	38,657	103%
County Total	119,811	149,265	155,572	172,317	229,533	109,722	92%

Notes:

[1] Excludes the unincorporated area of the Tahoe Basin that falls within the TRPA planning area.

Sources:

1. SACOG Projections for MTP 2035, Population Growth and Distribution, 2005 – 2035 by Jurisdiction, September 2007.
2. SACOG Forecast Data 2009.
3. SACOG Population, Housing and Household Estimates 2000 – 2009, May 2009.

JOBS TO HOUSING BALANCE

Jobs/housing balance refers to the relationship of residences to jobs in a given area. Assuming a reasonable match between the affordability of housing and the incomes of jobs in the local area, if the number and proximity of residences is proportionate to the number and proximity of jobs, the majority of the employees would have the opportunity to work and reside in the same area. A well balanced ratio of jobs and housing can contribute to reductions in the number of vehicle trips, less congestion on area roadways and intersections, and lower levels of air pollutant emissions due to employment opportunities in closer proximity to residential areas.

SACOG calculates an area's jobs to housing ratios using total employment divided by total housing units. A ratio greater than 1.0 indicates a jobs rich jurisdiction; likewise, a ratio less than one indicate a housing rich jurisdiction. Jobs to housing ratios are identified for each jurisdiction for 2005 and 2035, as shown in Table 3.8.

Table 3.8
Jobs to Housing Ratios by Jurisdiction 2005-2035

Jurisdiction	2005	2035
Colfax	0.8	1.1
Lincoln	0.8	0.9
Loomis	1.6	1.5
Rocklin	0.8	1.0
Roseville	1.4	1.4
Unincorp.[1]	0.9	0.9
Total	1.1	1.1

Notes: [1] *Excludes the unincorporated area of the Tahoe Basin that falls within the TRPA planning area.*

Source:

1. SACOG Projections for MTP 2035, Population Growth and Distribution, 2005 – 2035 by Jurisdiction.
2. SACOG Forecast Data 2009.

COMPARISON OF 2035 PROJECTIONS TO 2050 BLUEPRINT PREFERRED SCENARIO

Table 3.9 shows the adopted 2035 growth projections as a percentage of the 2050 Blueprint Preferred Scenario growth projections for each jurisdiction.

Table 3.9
2035 Growth as a Percentage of 2050 Blueprint Growth

	Employees	Housing Units
Auburn	28%	50%
Colfax	54%	37%
Lincoln	56%	62%
Loomis	70%	60%
Rocklin	32%	63%
Roseville	46%	80%
Unincorp.[1]	57%	64%
Total	47%	67%

Notes: [1] Excludes the unincorporated area of the Tahoe Basin that falls within the TRPA planning area.

Source:
1. SACOG Projections for MTP 2035, Population Growth and Distribution, 2005 – 2035 by Jurisdiction.
2. SACOG Forecast Data 2009.

3.5 Other Recent Economic Forecasts

Table 3.10 presents the Placer County Economic Forecast as projected through 2035. This forecast is updated annually by Caltrans. This forecast tracks closely to the recent set of projections prepared for SACOG by the Center for Continuing Study of the California Economy In the near-term (through 2015) Placer County is expected to lead growth in the State due to relative affordability and higher production of homes.

Table 3.10
Placer County Economic Forecast 2005 - 2035

Year	Population	Net Migration	Registered Vehicles (1000)	House-holds (1000)	New Homes Permitted	Total Taxable Sales (Billions)	Personal Income (Billions)	Real Per Capita Income (Dollars)	Inflation Rate (Percent Change in CPI)	Employ-ment Total Wage & Salary (1000)	Unemploy-ment Rate (Percent)
2005	313,496	9,554	357.5	120.0	5,294	$7.26	$13.2	$46,783	2.0	137.3	4.3
2009	344,226	3,826	366.5	133.2	1,283	$6.53	$15.7	$45,747	0.8	129.4	11.3
2010	348,565	3,000	365.6	134.0	1,844	$6.64	$16.5	$46,419	2.1	130.6	10.5
2015	386,096	7,417	394.9	148.9	3,895	$8.81	$22.6	$51,436	2.2	151.9	5.7
2020	427,965	7,062	441.7	166.3	3,875	$11.87	$30.1	$55,438	2.1	171.4	5.0
2025	470,050	7,079	492.6	184.2	3,785	$15.78	$38.8	$57,434	2.5	191.5	4.6
2030	510,613	6,916	542.1	201.8	3,735	$20.62	$49.7	$59,423	2.7	211.1	4.5
2035	549,269	6,643	588.9	218.7	3,576	$26.28	$62.1	$60,508	2.7	229.4	4.6

Notes:

1. Caltrans County level forecast project was initiated in 2000 to assist local and regional agencies in their planning and travel forecasting efforts. The project provides near and long-term forecasts for each county and are updated annually; this forecast was conducted from November 2009 through February 2010.
2. The long-term forecast is based on the extrapolation of the near term forecast. The forecast responds to how economic indicators might reasonably grow over time, consistent with reasonable assumptions about population and housing growth and the growth of the U.S. and California economies.

Source: Long-Term Socio-Economic Forecasts by County, Placer County 2010, Office of Transportation Economic, Caltrans, March 2010.

CHAPTER 4
REGIONAL TRANSPORTATION ISSUES & ENVIRONMENTAL CHALLENGES

The purpose of this chapter is to introduce the various transportation modes and their interrelationships, and to discuss the key regional transportation issues and environmental challenges currently facing Placer County and the greater Sacramento metropolitan area. Subsequent chapters will build on this information, identifying overall goals and objectives for the transportation system, then addressing the specific needs and developing an action plan for each transportation mode.

4.1 Modal Issues

Placer County is a growing, dynamic, and diverse community. Population, housing, employment, and other key parameters all show continuous, significant growth. This growth brings increasing demands on our transportation systems to maintain and enhance safety, offer multimodal transportation options, preserve existing resources, reduce congestion, improve air quality, and coordinate efforts both locally and regionally.

HIGHWAYS / STREETS / REGIONAL ROADWAYS

Maintenance and Rehabilitation

As traffic increases, the issue of roadway rehabilitation and maintenance, including vegetation management, becomes increasingly important to ensure safe and effective travel. In particular, investing in the maintenance of the existing infrastructure will be a focus of road projects during the planning period. Roadways, bridges, and the associated infrastructure have a limited life, and funding must be available to maintain and, if needed, rehabilitate these facilities. In addition, rehabilitation projects may be needed to accommodate changes in travel patterns. Interchanges may need to be upgraded to accommodate more and varying types of traffic. Additional paving work may be needed to prevent the faster breakdown of pavement integrity resulting from increased truck traffic. Lanes may need to be added and shoulders may need to be widened or added.

Providing sufficient funding when it is needed to keep up with wear and tear and changes in traffic demands/patterns is crucial. A 1999 survey of the unfunded rehabilitation, maintenance, and operations needs of the existing multi-modal transportation system resulted in a 20-year cost estimate of over $225 million. As maintenance and rehabilitation projects are undertaken, it will be important to include all modes in their design so that pedestrians, bicyclists, drivers, truckers, and transit can move efficiently and safely. These improvements will necessarily be coordinated with land use and air quality decisions and considerations.

Expansion

In order to address the transportation needs associated with existing and projected growth, PCTPA and the local jurisdictions are planning for expansion and construction of the existing roadway systems and new regional connections. These plans, detailed in Chapter 6 – Action Element, focus on regional connectors such as Interstate 80, State Route 65, State Route 49, and the Placer Parkway. These efforts involve regional partnerships with SACOG, Caltrans, the private and public sectors, local jurisdictions, and all users (present and future) of these roadways.

Complete Streets

Governor Schwarzenegger signed Assembly Bill 1358 (AB 1358), the California Complete Streets Act of 2009, into law in September 2008. AB 1358 requires a city or county's general plan to identify how the circulation of all users of the roadway, including motorists, pedestrians, bicyclists, children, seniors, individuals with disabilities, and users of public transportation will be accommodated. Accommodations may include sidewalks, bike lanes, crosswalks, wider shoulders, medians, and bus turnouts, among other complete street type improvements. AB 1358 is also a key strategy to help improve air quality and reduce GHG emissions. Further, integrating complete street improvements into the initial design of a project is more cost-effective than making retrofits later.

PUBLIC TRANSIT

Placer County ranges from sparsely populated rural areas to more densely populated urban areas. With the county's increasing population and enlarging urban areas comes an increasing demand for transit service to more and larger areas. As the emphasis shifts from local bus service to regional services, the creation of multi-jurisdictional agreements for ongoing funding of transit will become even more important. The convenience, comfort, frequency, accessibility, and reliability of transit services will play a key role in encouraging transit use as opposed to drive-alone commuting. In particular, convenience can be provided by designing transit services that are as seamless as possible. Transit can also play a role in mitigating the jobs/housing imbalance by providing tailored commuter services such as that proposed for implementation between Reno and North Tahoe. Bus Rapid Transit services along selected corridors may prove helpful in enhancing convenience and providing a viable alternative to driving.

Other more specific factors also contribute to the need for increased transit:

- The Americans with Disabilities Act requires the expansion of paratransit services to specific areas complementary to fixed-route service.
- Jobs Access programs are expected to have a significant impact on local transit systems as the state enacts policies and programs to require more welfare recipients to get jobs.
- State and federal clean air legislation and transportation demand management principles call for the increased use of transit to offset and reduce automotive vehicle emissions. Commuter bus service to provide quick connections between Auburn, Roseville,

Rocklin, Lincoln and Downtown Sacramento has been a consistent need cited by Placer County citizens in the Unmet Transit Needs process.

- The aging of the population also contributes to the demand for transit and paratransit services, as people become unable to drive themselves.
- As the entire Sacramento region grows, interregional connections between suburban areas such as South Placer and Rancho Cordova will become increasingly important.

PASSENGER RAIL

The Capitol Corridor train service, which currently has its eastern terminus in Auburn, has been experiencing significant growth in ridership. Studies of Regional Rail, a commuter service that would supplement the Capitol Corridor service providing half-hour train frequency during commute periods, and the potential for extension of Capitol Corridor service to Reno are currently underway. Given the anticipated increases in congestion along the Interstate 80 corridor, the Capitol Corridor and Regional Rail train services can potentially play a significant role in removing intercity drivers and commuters from that corridor. Close coordination with Union Pacific Railroad and significant additional funding will be needed in order to procure equipment and construct track improvements required for more frequent trains.

Another possible corridor for rail service may be the segment north from Sacramento to Lincoln and Marysville. This corridor was explored in 1995, and, under current and projected growth conditions, may indeed now be feasible. Such service could potentially relieve the growing congestion on Highway 65.

To be truly effective, rail improvements will need to incorporate convenient access at multimodal stations including adequate park-n-ride capacity, bus/rail transfer capability, secure bike storage, and safe pedestrian/handicapped access.

AVIATION

PCTPA will continue to support the local jurisdictions, which operate airports (Lincoln, Auburn, and Placer County) in their efforts to identify and utilize available funding at the state and federal level for airport infrastructure improvement and expansion as warranted. These projects are typically included in the capital improvement plans for each jurisdiction. Aviation will probably continue to play a key role in moving goods throughout the region and beyond.

PCTPA's other role with regard to aviation will be to continue to function as the Airport Land Use Commission, ensuring that local land use in the vicinity of airports is compatible with airport operations and promote the safety of all concerned.

GOODS MOVEMENT

As population increases along with traffic, the ability to move goods efficiently and safely within and through Placer County will be an ever-increasing challenge. Efficient goods movement is essential for the local and regional economy.

Most goods movement in Placer County is provided by truck transportation. Interstate 80 is one of the most important truck routes in Northern California. In 2002, truck traffic on I-80, as a percentage of Average Annual Daily Traffic, ranged from 5.75% to 18.95% on various segments in Placer County.

With the growth of intermodal container freight at the Port of Oakland, rail is playing an increasing role in ensuring efficient goods movement. This change creates several challenges, including the following:

- Ensuring the safety of at-grade railroad crossings.
- Anticipating longer waits at railroad crossings on key arterials.
- Avoiding conflicts between freight and passenger rail services.
- Promoting freight yard expansions and other capital improvements needed to accommodate this growth.

Regional air freight, utilized extensively by manufacturers in Roseville, Rocklin and Lincoln, is handled either at Sacramento International Airport or at Mather Airport. Because air freight is market-driven, it is impossible to reliably predict the nature and extent of future demand. It will be important to consider the needs of all road users (e.g., residents, truckers, buses, bicyclists) when planning for goods movement.

NON-MOTORIZED AND LOW-SPEED TRANSPORTATION

As mentioned, bicyclists and pedestrians share the use of transportation facilities with motorized vehicles. Non-motorized and low-speed transportation can provide a viable transportation choice when design of new and/or rehabilitated facilities considers their needs for safe travel, direct routes, and off-road options. Non-motorized and low-speed travel, when it is carefully planned for, can be an increasingly used mode. To that end, this plan recommends inclusion of non-motorized and low-speed travel needs in all phases of both land use and transportation planning and design.

TRANSPORTATION SYSTEMS MANAGEMENT (TSM)

PCTPA is the Congestion Management Agency (CMA) for Placer County. As such, staff works with the Placer County Air Pollution Control District (PCAPCD), local agencies, and employers to promote alternatives to drive-alone commuting. As part of these TSM efforts, PCTPA continues to implement its Congestion Management Program (CMP), which offers various sources of information on alternative transportation modes, coordinates public transit marketing campaigns for all of Placer Count's transit operators, and provides cash incentives for those who

carpool, vanpool, bicycle, or ride transit though such programs as a the Guaranteed Ride Home program, Spare the Air, and Bucks for Bikes.

The PCAPCD provides funds collected from vehicle registration fees for projects that improve air quality, including PCTPA's Congestion Management Program (CMP). The PCAPQD has also funded the Freeway Service Patrol in Placer County, which reduces congestion and emission of pollutants by providing assistance to disabled motorists on Interstate 80 between the Placer / Sacramento County line and Sierra College Boulevard. PCTPA and the PCAPQD work in partnership with the Sacramento Metropolitan Air Quality Management District to conduct the Spare the Air campaign, which educates the public about air quality issues and promotes activities and habits that will improve air quality.

In the future, air quality and transportation planning organizations as well as local jurisdictions will need to continue to work together to creatively identify and fund ways to reduce mobile emissions so that the Sacramento region can achieve federal clean air standards. Achievement of these standards will play a key role in allowing important transportation infrastructure improvements to move forward.

RECREATIONAL TRAVEL

The transportation needs of the recreation and tourism industries are increasingly impacting the transportation infrastructure. The natural and cultural resources draw visitors. This increases the need to plan for the unique demands for recreation-oriented travel since there are peak seasons and times of day different from the typical commute patterns. One of the challenges will be to provide a public transportation system that is convenient, flexible, and reliable enough to encourage visitors not to drive to their destination. Linking different modes seamlessly (air, rail, bus, shuttles) is also important for providing transportation to scenic and recreation venues.

INTEGRATED LAND USE, AIR QUALITY, AND TRANSPORTATION PLANNING

One of the prime motivations for the establishment of PCTPA in 1975 was to provide a forum for interjurisdictional coordination on countywide and regional issues. Although not technically a transportation mode, interjurisdictional coordination is a key component of an effective and efficient transportation system, as it is necessary to ensure connectivity of roads, transit, bicycle and pedestrian paths, and other transportation systems between communities.

In a time of scarce governmental resources, coordination is even more important to ensure that those funds that are available are spent in the most efficient and effective manner possible. Intergovernmental coordination furthers this goal by developing county-wide transportation priorities, implementing studies and projects in cooperation with other counties, facilitating joint transportation projects, and anticipating and mitigating impacts of governmental decisions of one jurisdiction onto another.

Coordination both within Placer County and with "outside" jurisdictions in the Sacramento region, and even the Bay Area, will be crucial in the effort to address transportation challenges

along key corridors such as Interstate 80, State Route 49, and State Route 65. Coordination among regional agencies such as Caltrans, SACOG, Placer County Air Pollution Control District (PCAPCD), Sacramento Metropolitan Air Quality Management District (SMAQMD), and others will also play an important role.

Another aspect of coordination is that between transportation and land use planning. The planning agencies and jurisdictions can work together to support and encourage land use patterns that promote alternatives to driving alone while preserving the natural and cultural resources that are so attractive to existing residents, newcomers, and visitors alike. Land use decisions are made quickly – in contrast to transportation projects that may take decades to fund, design, and implement. A continuous dialogue, interdisciplinary approach, and proactive strategy will be needed to keep land use decision-making and transportation investment in sync.

4.2 Regional Transportation Issues

INTER-JURISDICTIONAL COORDINATION

Inter-jurisdictional coordination is a key component of an effective and efficient transportation system. Such coordination is necessary to ensure connectivity of the transportation system and access between communities. Coordination is also critical to addressing transportation-related regional impacts, such as air quality and traffic congestion. In a time of limited funding, coordination becomes even more important to ensure that those funds that are available are spent in the most efficient and effective manner possible. Inter-jurisdictional coordination furthers this goal by developing county-wide transportation priorities, implementing studies and projects in cooperation with other counties, facilitating joint transportation projects, and anticipating and mitigating impacts of governmental decisions of one jurisdiction onto another.

CONGESTION

As Placer County continues to grow, congestion on Interstate 80, state highways, and local roads continues to increase. Commute times become longer, and the capacity of many roadways during peak periods is exceeded, slowing traffic to a crawl. This diverts regional and interregional auto and truck traffic to parallel local roadways that are not equipped to handle the increased traffic volumes.

From the public's perspective, the most noticeable effect of congestion is increased traffic delay. Rush hour traffic no longer occurs during the morning and evening peak periods but extends throughout the day. Truck traffic and recreational travelers are especially sensitive to congestion due to tightly scheduled freight distribution procedures and personal activities.

It is estimated by FHWA that roughly half of the traffic congestion experienced is what is known as recurring congestion – caused by recurring demands that exist virtually every day, where road use exceeds existing capacity. The other half is due to non-recurring congestion – caused by temporary disruptions such as, traffic incidents, work zones, weather and special events.

A mix of strategies will be necessary to address these congestion and capacity issues:

- Improving the availability, reliability, convenience, and frequency of public transportation;
- Increasing the capacity of existing roadways and interchanges;
- Promoting commute alternatives that remove vehicles from the road (e.g., telecommuting, bicycling, transit); and,
- Implementing bypasses that move traffic around congested areas and/or new roadways that connect growing residential areas to jobs.

Successful implementation of these strategies will require significant additional funding, careful coordination with land use changes, and calculation of positive and negative impacts on air quality.

GROWTH

The Placer region continues to face urban growth and contains some of the fastest growing communities in California. Between 1990 and 2000, the Census-defined urbanized area grew significantly eastward from its previous terminus in Rocklin and Granite Bay to include Loomis, Auburn, and the unincorporated North Auburn area. Between 2000 and 2005, Placer County as a whole grew by over 20%. Between 2005 and 2027, the total county-wide population is projected to grow at approximately 2% annually, for an estimated overall growth of more than 44%.

Despite the current slow down in residential growth and the realignment occurring in the Sacramento region's economy, projections show that housing and employment will increase significantly. Between 2005 and 2035, the numbers of households and jobs are each projected to grow by over 85% throughout Placer County. New growth areas are being considered in western Placer County. Along with continuing commercial and industrial growth, these trends indicate that transportation within, into, and out of Placer County will be key issues. Balancing the types and location of housing available with the types and location of available employment will continue to be important factors that play into both land use and transportation planning over the next twenty-five years.

In addition to this RTP, jurisdictions in Placer County are also addressing growth in their communities by updating their general plans to address the long-term future and provide policies and strategies to meet those needs.

Mobility is a major concern for seniors, who are a growing portion of the State's and Placer County's population. By year 2025, the over-65 population in California will increase by 52 percent, greater than the total population growth percentage. Those over 80 years of age, is expected to increase by 62 percent. This means there will be a larger than ever group of people who are dependent on family, friends, or public transportation services for mobility, and who in some cases have serious limited mobility and life activities as a result of this dependence.

TRANSPORTATION PLANNING

The 2035 RTP is a plan intended to continue the vision established in the 2027 RTP and also included in the 2035 MTP. The 2035 RTP will provide a bridge to the next update, due in 2015. The next RTP will follow the development of the next MTP. SACOG adopted the 2035 MTP in March 2008 and anticipates adopting the next MTP by December 2011. A number of regional transportation planning issues will be addressed as part of this MTP update, which is currently underway. These issues will play a significant planning role in the development of policies, projects and program activities for the next RTP. These issues are as follows:

- Update of the regional growth forecast in employment (type), population, and demand for housing through year 2050;
- Update of the regional financial plan due to a slower economy and growth rates, both which affect many of the revenue streams, especially at the state and local level;
- Inclusion of a regional greenhouse gas emission target, provided by the California Air Resources Board (CARB);
- Meeting the requirements of SB375 that the MTP must meet a regional greenhouse emissions target provided by CARB through a Sustainable Communities Strategy (SCS) or through an Alternative Planning Strategy (APS) that meets the target; and
- Meeting the requirements of SB375 that the Regional Housing Needs Allocation process now must be consistent with the MTP for the first eight years of growth under the SCS, which will affect local jurisdiction allocations for market rate and affordable housing.

TRANSPORTATION FUNDING

Funding for transportation projects originates at federal, state, and local levels. Detailed descriptions of these funding sources are provided in the Financial Element and Appendix P of this RTP.

The 2035 RTP begins in a period of revenue uncertainty, declining economic outlook and high unemployment, creates an environment of increasing funding risk. Limited flexibility in transportation funding creates further challenges.

At the federal level, the reauthorization of SAFETEA-LU, a six-year bill for transportation funding, will determine whether the trend of increasing levels of federal funding will continue. In the near term, several transportation projects received a one-time boost through investments made possible by the federal stimulus package, the American Recovery and Reinvestment Act (ARRA) of 2009.

Over the past decade, the shrinking cost effectiveness of the federal and State gasoline tax has put transportation projects, maintenance and operating support at risk.

At the State level, the legislature continues to deal with a general fund deficit at nearly $20 billion, on top of deficits of more than $40 billion in the past two years. State transportation funding has fluctuated wildly over the past several years. Early in the decade, the State raided

transportation funds to balance their budget, which resulted in project programming delays for STIP projects. The passage of Propositions 1A and 1B in 2006 spurred a significant cash influx to transportation, but by 2009 was in jeopardy of shutting down because of continuing state budgetary issues.

The instability of state funding is best summarized in the following quotation from the California Transportation Commission's Annual Report to the Legislature, December, 2004:

> *California's transportation program is in crisis and on the verge of collapse. Where the state once had a transportation program funded almost exclusively from user fees protected by the California Constitution (gasoline taxes and weight fees), we now have a program dependent primarily on motor fuel sales taxes, without constitutional protection. For each of the last 4 years, transportation funds have been taken to close the General Fund deficit. For the last 2 years, the California Transportation Commission has been forced to stop making new allocations to projects from all three of the major components of the state transportation program, the State Transportation Improvement Program (STIP), the State Highway Operation and Protection Program (SHOPP), and the Traffic Congestion Relief Program (TCRP). Cities and counties have not been receiving the state subventions committed to them in statute for local road rehabilitation and repair and state transit assistance.*
>
> *In all, these programs account for about $2.6 billion in state and local transportation projects that should be ready to go to construction this year but will not for lack of funding. Reduced spending on pre-construction work means the delay of billions more in future years. This represents a loss to California's economy in terms of reduced productivity, increased congestion, increased user costs, and increased system operating and maintenance costs. Applying standard economic multipliers, the work not going to construction this year alone will result in the loss of well over 50,000 jobs.*

At the local level many transportation projects substantially depend on development fees. All of the jurisdictions in Placer County implement local impact fees so that new development "pays its way" for additional infrastructure required to accommodate it. PCTPA has taken the lead in developing and implementing the South Placer Regional Transportation Authority (SPRTA), which now collects a transportation mitigation fee on all new development that impacts regional roadways in Roseville, Rocklin, Lincoln, and south Placer County. This effort provided the framework for a regional strategy for funding transportation projects. At the local level, cities and counties may provide funds for transportation projects. These may include dedicated sales taxes, redevelopment funds, general funds, special grants, or other sources.

The housing slowdown has reduced the flow of developer fees in most jurisdictions; thus postponing transportation projects funded with those fees until growth picks up again, as well as diminishing the population growth and traffic for which those projects are needed.

There are many more transportation projects than there are funds available to implement them. Future funding sources for state and local projects will continue to be dependent on the condition of the state budget and the state legislature's development of statewide transportation funding

programs. Innovative approaches to transportation funding and development of new funding sources will also be needed to provide for the multi-modal transportation needs of the residents of Placer County. Some of these possible approaches include: a dedicated sales tax, increased existing taxes such as the gasoline/fuel tax, expansion of developer impact fees, and public/private partnerships.

A funding shortage offers opportunities for those who can deliver projects because scare funds tend to flow to projects ready to be delivered, rather to projects still working on delivery. Delivering projects within estimated cost, scope and schedule will remain a key issue in transportation policy for many years to come.

TRANSPORTATION SAFETY & SECURITY

Ensuring the safety and security of all travelers on all modes is a theme throughout all of the transportation projects in this plan. Safety and security issues will be incorporated from the policy and standards level through to implementation of safety and security improvement projects. Such projects might include rail crossings, addition of shoulders where little or none exist, bikeways, newly designed intersections and interchanges that reduce the potential for car/bicycle collisions, pedestrian and bicycle bridges and walkways, airport improvements, interchange improvements/upgrades, additional transit shelters and benches, signal additions, ITS and/or video surveillance improvements on transit vehicles and at rail stations.

Safety and security projects are a high priority when it comes to transportation. State and federal funding exist for safety and security improvement projects for highway, public transit, passenger rail, safe routes to schools (including bicycle and pedestrian modes), bridge rehabilitation, airport upgrades, and land use plans for airport influence areas. However, the need for safety and security improvement projects will continue to far exceed the funding available.

4.3 Environmental Challenges

AIR QUALITY

One of the primary sources of air pollution in California is vehicle exhaust. As a result, transportation and air quality are closely linked. In fact, the Sacramento region, including Placer County, has been designated as a non-attainment area for air quality standards, which are specified by the California Clean Air Act of 1988 and the federal Clean Air Act Amendments of 1991. PCTPA works closely with the Sacramento Area Council of Governments (SACOG) and the Placer County Air Pollution Control District (PCAPCD) to assess the impact of all transportation projects on air quality in the region. Since 1991, Placer County has been eligible to receive an apportionment of Congestion Mitigation and Air Quality (CMAQ) funds from the federal government for projects designed to reduce congestion and improve air quality. Since that time, PCTPA has approved millions of dollars in CMAQ funds for alternatively-fueled transit buses, transit facilities, bikeways, rail station improvements, and pedestrian safety projects.

CLIMATE CHANGE, GLOBAL WARMING, AND GREENHOUSE GAS EMISSIONS

California leads the nation in an effort to mitigate the impacts of motor vehicle generated Greenhouse Gas (GHG) emissions. One of two recent legislative efforts to achieve this is Assembly Bill 32 (AB 32), signed into law as part of the California Global Warming Solutions Act of 2006. AB 32 requires that by 2020 the state's GHG emissions be reduced to 1990 levels, about a 25 percent reduction under business as usual estimates. The second legislative effort, Senate Bill 375 (SB 375), is more focused on reducing GHG emissions through the regional transportation planning efforts of the Metropolitan Planning Organization (MPO). PCTPA will work closely with SACOG to reduce GHG emissions through the MTP planning process.

CHAPTER 5
POLICY ELEMENT

As part of the planning process, the Regional Transportation Plan establishes goals, objectives, and policies to guide the development and management of the region's transportation systems.

- ***Goals*** are general statements of what we want the future to be like. These statements should reflect the region's needs and priorities.
- ***Objectives*** are specific, quantifiable steps towards the realization of those goals.
- ***Policies*** are statements that provide direction for decisions to help attain these goals and objectives.

The goals and objectives are used as guiding principles to choose among various options for transportation improvements. Therefore, they should be attainable and realistic. In addition, the goals should relate to present conditions and expected changes in those conditions. Performance measures are also identified and apply to the entire RTP in order to assess priorities for implementation.

5.1 Overall Goals

The purpose of the RTP is to guide the long-range planning and development of transportation projects in Placer County.

The process of updating the RTP provides an opportunity to participate in both planning and priority setting. The process allows the community to focus their attention on transportation in the context of the Placer County as well as the entire Sacramento region, building both local and regional coalitions. The longer time frame of twenty years gives the community a chance to step back from day-to-day concerns and deliberate on how to achieve the desired transportation system.

The RTP defines the goals of the transportation system and sets priorities for project implementation within the context of six regional planning principles:

- Support well-planned growth and land use patterns;
- Improve environmental quality through better stewardship of the transportation system;
- Fit within financially constrained budget by delivering cost-effective projects that are feasible to construct and maintain;
- Improve economic vitality by efficiently connecting people to jobs and delivering goods and services to markets;

- Improve access and mobility opportunities for all people to jobs, services and housing; and
- Provide real, viable travel choices for all people within a diverse county.

The RTP contains the following overall goals that provide the framework for the action and financial elements. The overall goals of the RTP are listed below.

1. Maintain and upgrade a safe, efficient, and convenient countywide roadway system that meets the travel needs of people and goods through and within the region.

2. Provide effective, convenient, regionally and locally coordinated transit service that connects residential areas with employment centers, serves key activity centers and facilities, and offers a viable option to the drive-alone commute.

3. Improve the availability and convenience of passenger rail service.

4. Promote general and commercial aviation facilities and services that complement the countywide transportation system.

5. Provide for the safe and efficient movement of goods through, within, and into Placer County.

6. Promote a safe, convenient, and efficient non-motorized transportation system, for bicyclists, pedestrians, and users of low speed vehicles, which is part of a balanced overall transportation system.

7. Provide an economical solution to the negative impacts of single-occupant vehicle travel through the use of alternative transportation methods.

8. Promote a transportation system that integrates and facilitates recreational travel and uses, both motorized and non-motorized.

9. By integrating land, air, and transportation planning, build and maintain the most efficient and effective transportation system possible while achieving the highest possible environmental quality standards.

10. Secure maximum available funding; pursue new sources of funds for maintenance, expansion, and improvement of transportation facilities and services; and educate the public about the need for funding for transportation projects.

11. Incorporate all-inclusive public outreach efforts as part of the planning process, and encourage input from all interested groups and persons.

The RTP contains ten specific goals, each with supporting policies and objectives, for roadways, public transit, rail transportation, aviation, goods movement, non-motorized transportation, transportation systems management (TSM), recreation, integrated land use, air quality, and

transportation planning, and funding. There are no specific goals defined for Safety and for Intelligent Transportation Systems (ITS). Rather, Safety and ITS are addressed within the goals, objectives and policies of the other subject areas of the Policy Element.

5.2 Goals, Objectives & Policies

GOAL 1: HIGHWAYS/STREETS/ROADWAYS

Maintain and upgrade a safe, efficient, and convenient countywide roadway system that meets the travel needs of people and the movement of goods through and within the region.

Objective A: Identify and prioritize improvements to the roadway system.

Policies:

1. Work with Caltrans and local jurisdictions to identify roadways in need of major upgrading to meet standards for safety and design, maximize system efficiency and effectiveness, and plan their improvement through regional planning, corridor system management planning, and capital improvement programming.

2. Encourage jurisdictions to implement pavement management systems that identify and prioritize road maintenance projects.

3. Provide technical support to jurisdictions' local roadway improvement efforts through circulation system analysis, and other transportation studies, as requested.

Objective B: Construct, maintain, and upgrade roadways to meet current safety standards.

Policies:

1. Work in partnership with Caltrans and local jurisdictions to identify and eliminate unsafe conditions on state highways.

2. Prioritize roadway projects, including maintenance and repair, required to maintain safety standards.

3. Maintain roads in the most cost effective manner given available resources.

Objective C: To promote economic development, prioritize roadway maintenance and improvement projects on principal freight and tourist travel routes in Placer County.

Policies:

1. Maintain and improve the Interstate 80 Corridor as one of the major connections for freight distribution to and from destinations east of California.

2. Improve State Route 65 in order to facilitate goods movement and access to jobs.

3. Continue to identify funding for the Placer Parkway, a connector between State Route 65 and State Routes 70 and 99 including access to the Interstate 5 corridor in northern Sacramento County and the Sacramento International Airport.

4. Provide for convenient access, on all modes of travel, to tourist and recreational destinations within Placer County.

5. Incorporate Intelligent Transportation System (ITS) strategies in roadway improvements as economically feasible.

6. Implement capacity-increasing strategies that encourage use of alternative modes, such as HOV lanes, bus rapid transit, and bus-only lanes.

GOAL 2: PUBLIC TRANSIT

Provide effective, convenient, regionally and locally coordinated transit service that connects residential areas with employment centers, serves key activity centers and facilities, and offers a viable option to the drive-alone commute.

Objective A: Provide transit services that fulfill all "unmet transit needs that are reasonable to meet."

Policies:

1. Work with transit operators, social service agencies, the Social Services Transportation Advisory Council, and the general public to identify unmet transit needs.

2. On an annual basis, administer the unmet transit needs process, including hearings and findings, in accordance with the Transportation Development Act.

3. Work with transit operators to implement any transit services identified in the unmet transit needs process.

Objective B: Tailor transit service provisions to the area's population characteristics and special needs.

Policies:

1. Encourage jurisdictions to prioritize fixed route and dial-a-ride transit service within the urbanized area where the greatest operational efficiencies exist.

2. Encourage jurisdictions to develop alternative transit systems in non-urbanized/rural areas where transit needs exist, such as park-and-ride commuter services, lifeline fixed route deviation services, non-emergency medical transport programs, subsidized taxi services, and volunteer transport programs.

3. Encourage jurisdictions to work with transit operators to pursue improvements to transit access whenever opportunities arise.

4. Support transit projects which will serve residents, employees and visitors within the North Lake Tahoe "Resort Triangle" (area bordered by SR28, SR 89, and SR 267) destinations for both commute, recreation and daily trip purposes.

Objective C: Provide a transit system that is responsive to the needs of persons who rely on public transportation.

Policies:

1. Work with transit operators, social service agencies, and the Consolidated Transportation Service Agency to update and implement the Social Service Transportation Action Plan.

2. Assist transit operators in the implementation of the Americans with Disabilities Act.

3. Encourage transit operators to provide discount fares for elderly and disabled groups.

4. Encourage some level of "lifeline" transit service between all communities where feasible.

5. Work with transit operators to assist social service agencies in providing transportation for *Access to Jobs* clients.

6. Work with transit operators to identify and secure funding to implement adopted short range transit plans.

Objective D: Develop and encourage the use of public transit as a viable alternative to the automobile in order to maximize transit ridership.

Policies:

1. Implement and maintain transit services at levels recommended in adopted Short Range and Long Range Transit Master Plan, and update these plans at regular intervals.

2. Work with transit operators and jurisdictions to develop and fund routes that serve key commute corridors.

3. Develop and implement a coordinated marketing program to promote public transit as a viable transportation option, raise public awareness of the various systems, and increase understanding of how to use them.

4. Ensure that transit services continue to meet all state and federal requirements for funding, including those for fare box recovery ratios, while developing fares and pricing that encourage non-riders to give transit a try.

5. Work with transit operators to develop and enforce ridership rules that ensure the safety of passengers and transit employees alike.

6. Develop working relationships with the business and industrial sector of the region to meet the transportation needs of their employees and clients.

Objective E: Coordinate various transportation services to maximize efficiency and convenience and minimize duplication of services.

Policies:

1. Provide convenient, coordinated transit schedules that provide for seamless regional connections both within Placer County and the Sacramento region.

2. Encourage transit operators to develop agreements that maximize convenience and minimize transfers when making trips that involve crossing jurisdictional boundaries.

3. Coordinate public transit schedules and rail passenger schedules to allow passengers to utilize bus service to access rail services.

4. Work with transit operators and other RTPAs in the region to develop and implement a centralized, one-stop consumer access center for transit information and trip planning.

5. Work with social service agencies and the CTSA to utilize available resources and coordinate social service transportation to the extent feasible.

6. Establish and maintain a performance monitoring system which evaluates the effectiveness of transit service as outlined in the Transportation Development Act.

GOAL 3: PASSENGER RAIL

Improve the availability and convenience of passenger rail service.

Objective A: Provide more frequent, convenient, and reliable passenger rail service to and through Placer County.

Policies:

1. Support the Capital Corridor Joint Powers Board's Business Plan to increase the number of intercity passenger trains serving the entire Capital Corridor route, including increased service frequency to Placer County.

2. Support extension of regular Capital Corridor rail service to Reno.

3. Work with the Capital Corridor Joint Powers Board, Amtrak, Union Pacific, and other agencies to improve reliability of trains serving Placer County.

4. Encourage continued implementation of passenger information systems, convenient ticketing systems, and security upgrades on trains and at rail stations.

5. Work with jurisdictions to improve rail station facilities, including bus transfer, parking, lighting, and amenities.

6. Develop and implement regional rail service during peak commute periods between Auburn, Sacramento, and Oakland.

GOAL 4: AVIATION

Promote general and commercial aviation facilities and services that complement the countywide transportation system.

Objective A: Promote the development, operation, and maintenance of a regional system of airports.

Policies:

1. Promote the development of aviation system facilities and services necessary to satisfy user requirements.

2. Recognize and support the role of privately-owned, public use airports in accommodating the county's general and agricultural aviation needs.

3. Participate in Caltrans Division of Aeronautics regional and statewide aviation planning efforts.

Objective B: Update and revise Airport Master Plans as necessary.

Policies:

1. Work with jurisdictions to develop Airport Master Plans for public airports that address current and forecast conditions, and recognize the need for comprehensive, coordinated aviation planning.

Objective C: Promote and secure adequate air passenger, goods movement, and other aviation and air transportation services as part of a multi-modal transportation system.

Policies:

1. Support projects that integrate air transport facilities with other modes of transportation, including street and road access, public transit, and pedestrian and bike paths.

2. Integrate air transportation planning and development with other modes of transportation.

3. Support projects that facilitate goods movement utilizing the regional system of airports.

Objective D: Promote the safe, orderly, and efficient use of airports and ensure compatible development around them via the Placer County Airport Land Use Compatibility Plan (PCALUCP).

Polices:

1. Update, as necessary, the PCALUCP to provide for orderly growth around public use airports and to safeguard public welfare.

2. Encourage local agency general plan consistency with the PCALUCP.

   Review proposed local agency planning documents, regulations, and certain land use actions for consistency with the PCALUCP.

GOAL 5: GOODS MOVEMENT

Provide for the safe and efficient movement of goods through, within, and into Placer County.

Objective A: Promote a balance of roads, rail, airports, and pipelines for the improvement of goods transport.

Policies:

1. Prioritize grade separation projects for railroad crossings which accommodate high traffic volumes and produce frequent delays.

2. Support projects that facilitate multi-modal goods transport to commercial and industrial areas wherever feasible.

3. Support projects that facilitate goods movement utilizing the regional system of airports.

4. Support projects that address the timely and efficient movement of goods and service on local, regional and interregional routes.

Objective B: Mitigate conditions that transporters of goods deem dangerous or unacceptable.

Policies:

1. Prioritize projects that improve site distances, warning signals, pavement quality and other safety features of at-grade rail crossings, which have deteriorated to an unacceptable level.

2. Encourage jurisdictions to provide proper road geometry on roadways intended to accommodate truck traffic.

3. Support projects that bring interchanges on Interstate-80 into compliance with height standards for truck traffic.

4. At at-grade rail crossings, consider implementing new safety / quiet zones to eliminate train horn noise provided that the crossing accident rate meets Federal Railroad Administration (FRA) standards and supplemental or alternative safety measures are in place in accordance with the FRA Final Train Horn and Quiet Zone Rule (effective June 2005).

GOAL 6: NON-MOTORIZED TRANSPORTATION AND LOW-SPEED VEHICLES (PEDESTRIAN, BICYCLE, AND NEVS)

Promote a safe, convenient, and efficient non-motorized transportation system, for bicyclists, pedestrians, and users of low speed vehicles, as part of a balanced overall transportation system.

Objective A: Plan and develop a continuous and easily-accessible non-motorized and low-speed vehicle system within the region.

Policies:

1. Work with jurisdictions to update their Bicycle Master Plans in compliance state standards.

2. Encourage the completion of existing non-motorized systems and facilities (including bikeways and sidewalks), with an emphasis on closing gaps.

3. Consider Class I and II bikeways as preferred linkages in the bicycle facilities network. Use Class III bike routes as connectors only when necessary.

4. Regularly update the Placer County Bike Map.

5. Encourage jurisdictions to develop an implementation plan for accommodating Neighborhood Electric Vehicles (NEV) on appropriate roads.

6. Encourage the development of abandoned railroad right-of-way for non-motorized facilities.

7. Encourage the development of trails to increase access to wilderness and recreational areas of the region.

Objective B: Provide a non-motorized and low-speed vehicle system that emphasizes the safety of people and property.

Policies:

1. Encourage the adoption of bicycle and NEV ordinances.

2. Encourage local jurisdictions to install bicycle safe drain grates.

3. Encourage secure facilities for bicycle and NEV storage at industrial, governmental, commercial, recreational, and educational locations.

4. Require all bicycle facilities funded through the Transportation Development Act to be designed in accordance with the state and federal bikeway design criteria.

Objective C: Integrate non-motorized and low-speed vehicle facilities into a multi-modal transportation system that encourages alternatives to driving alone.

Policies:

1. Improvements to the existing roadway network should consider provisions to properly accommodate bicycles, pedestrians, and NEVs.

2. Priority should be placed on roadway and street designs that avoid collisions between bicycles, autos, NEVs, and pedestrians.

3. Encourage jurisdictions to build complete street improvement projects, which incorporate non-motorized and transit facilities where feasible.

4. Encourage jurisdictions to require developers to incorporated pedestrian, bicycle, and NEV friendly designs in commercial centers and parking lots.

5. Encourage jurisdictions to implement safe bicycle and pedestrian routes to schools.

Objective D: Promote the development of multi-use trails in rural and other areas.

Policies:

1. Support pedestrian/equestrian paths and bicycle trails within open spaces adjacent to creeks, canals, and major traffic corridors.

2. Support regional hiking and equestrian trails that link residential areas.

Objective E: Provide an informational/educational program for motorists, bicyclists, and NEV users that identify the proper role and responsibilities of each in the transportation environment.

Policies:

1. Distribute pamphlets on “rules of the road” for to bicycle shops, schools, and the Department of Motor Vehicles.

2. Encourage the Department of Motor Vehicles to include bicycle and NEV rules and regulations on driver licensing tests.

GOAL 7: TRANSPORTATION SYSTEMS MANAGEMENT (TSM)

Provide an economical solution to the negative impacts of single-occupant vehicle travel through the use of alternative transportation methods.

Objective A: Create a multi-modal transportation network between major residential areas, educational and recreational facilities, and employment centers.

Policies:

1. Consider proximity to major travel origins and destinations in siting of new multi-modal transportation facilities.

2. Encourage jurisdictions to consider multi-modal transportation facility proximity when siting educational, social service, and major employment and commercial facilities.

Objective B: Advance the use of Transportation Demand Management (TDM) in a thorough, cost-effective manner.

Policies:

1. Support the use of public transportation as a transportation control measure to reduce traffic congestion and vehicle emissions.

2. Prepare and distribute transit service information to educational, commercial, recreational, and large employment centers.

3. Work with Caltrans and local jurisdictions to locate and develop park-and-ride lots.

4. Work with the Regional Rideshare Task Force to coordinate ridesharing activities and goals.

5. Provide outreach to media, employers, and the general public to promote awareness of alternative transportation.

6. Continue to organize, coordinate, and publicize alternative transportation events and programs such as Bike Commute Week, Spare the Air, and School Pool.

7. Work toward decreasing the amount of single-occupant vehicle trips and vehicle miles traveled in Placer County toward achieving SACOG's 10 percent trip reduction goal.

Objective C: Promote the use of electronic information transfer systems to reduce work-related, education-related, and personal trips.

Policies:

1. Encourage employers to develop and implement telecommuting programs for their workers.

2. Encourage employers to use teleconferencing to reduce the need for face-to-face meetings.

3. Provide informational resources to businesses and individuals regarding telecommuting, teleconferencing, and satellite work locations.

4. Encourage the use of computer service networks to pay bills, shop, and bank, obtain travel information, and completed other personal business tasks.

5. Encourage the development and use of technological advances that enable students to participate in classroom instruction from their homes.

GOAL 8: RECREATIONAL TRAVEL

Promote a transportation system that integrates and facilitates recreational travel and uses, both motorized and non-motorized.

Objective A: Incorporate access to recreational centers in the transportation infrastructure.

Policies:

1. Consider peak recreational seasons and times when designing facilities for all modes, including transit services, new roadways, bike routes, pedestrian paths, and electronic information systems.

2. Promote the advantages of “leaving your car behind” to travelers, and inform them of alternatives.

3. Consider the transportation needs of employers and employees in the recreation industry when designing transit services.

GOAL 9: INTEGRATED LAND USE, AIR QUALITY & TRANSPORTATION PLANNING

By integrating land, air, and transportation planning, build and maintain the most efficient and effective transportation system possible while achieving the highest possible environmental standards.

Objective A: Provide information and support services to jurisdictions regarding the countywide transportation impacts of local land use decisions.

Policies:

1. Where possible, support jurisdictions' efforts to maintain their adopted Level of Service (LOS) on local streets and roads in accordance with the applicable general plan Circulation Element.

2. Provide comment on the consistency of county and local general and specific plans with airport land use plans.

3. Encourage jurisdictions to require land uses which produce significant trip generation to be served by roadways with adequate capacity and design standards to provide safe usage for all modes of travel.

4. Encourage jurisdictions to protect corridors and rights-of-way, when identified, for future road and transit corridors through the adoption of specific plans and general plans.

5. Encourage jurisdictions to include transit-oriented development Blueprint principles in designing neighborhoods and communities to reduce vehicle miles traveled (VMT) and to deal with more short trips

6. Encourage thorough examination, context sensitive design, and mitigation of transportation impacts when planning and constructing transportation improvements through or near residential communities.

Objective B: Provide transportation infrastructure that meets existing and future needs.

Policies:

1. Encourage jurisdictions to develop roadways and transit investments that complement Blueprint growth patterns, infill development, economic development programs, and requirements of infrastructure to support planned land uses.

2. Encourage jurisdictions to review and assess the impact of new development proposals consistency with Blueprint principles, and the impact on local circulation plans and transit system demand and supply.

3. Encourage jurisdictions to require street patterns for new roadways, especially in commercial, industrial, and high-density residential areas, that take into consideration the requirements of public transit.

4. Explore and analyze opportunities to add additional rail stations and infrastructure, while maintaining and expanding existing rail infrastructure as necessary.

5. Encourage jurisdictions to include the needs of all transportation users in the planning, design, construction, reconstruction, and maintenance of roadway (complete streets), bridge, and transit facilities.

6. Encourage jurisdictions to diversify their transportation energy infrastructure.

Objective C: Ensure that transportation projects do not contribute to increased vehicle emissions.

Policies:

1. Prioritize and recommend transportation projects that minimize vehicle emissions while providing cost effective movement of people and goods.

2. Continue to promote projects that can be demonstrated to reduce air pollution and greenhouse gases, maintain clean air and better public health, through programs and strategies, to green the transportation system.

3. Work with the Placer County Air Pollution Control District in developing plans that meet the standards of the California Clean Air Act and the Federal Clean Air Act Amendments, and also lead to reduced greenhouse gas emissions.

4. Work with the Sacramento Area Council of Governments to evaluate the impacts of each transportation plan and program on the timely attainment of ambient air quality standards, and regional greenhouse gas emission reduction targets.

5. Solicit the input of the Placer County Air Pollution Control District on all transportation plans, programs and projects.

Objective D: Work with local jurisdictions, the Sacramento Area Council of Governments, Caltrans, the California Transportation Commission, and other transportation agencies to develop a regional planning and programming process to ensure that Placer County jurisdictions

have maximum participation and control in the transportation decision-making process.

Policies:

1. Use mechanism such as Memorandums of Understanding and joint powers agreements between jurisdictions to accomplish sound planning and implementation of multi-jurisdictional transportation projects and programs.

2. Facilitate the coordination and implementation of local, county-wide, and regional transportation programs to improve mobility and air quality.

3. Build coalitions with key private sector and community groups to involve the community in developing transportation solutions.

4. Monitor state and federal legislative proposals and provide input regarding their impacts on local and regional transportation programs.

Objective E: Participate in state, multi-county and local transportation efforts to insure coordination of transportation system expansion and improvements.

Policies:

1. Continue to coordinate with local jurisdictions in transportation improvement efforts.

2. Continue to participate in statewide forums such as the Regional Transportation Planning Agencies group, Rural Counties Task Force, California Council of Governments, and the California Association for Coordinated Transportation in order to maximize opportunities for transportation improvements in Placer County.

3. Work with appropriate agencies, including Caltrans and SACOG, to ensure coordination of interjurisdictional transportation corridor projects.

GOAL 10: FUNDING

Secure maximum available funding; pursue new sources of funds for maintenance, expansion, and improvement of transportation facilities and services; and educate the public about the need for funding for transportation projects.

Objective A: Obtain funding of vital transportation needs through all conventional sources.

Policies:

1. Maximize use of federal and state transportation funding sources to achieve RTP policies and objectives, and advocate for full funding of transportation programs, including the State Transportation Improvement Program (STIP).

2. Assist jurisdictions to identify and obtain grant funding.

3. Seek funding for public transportation implemented to serve social service programs from the agencies responsible for the programs.

4. Work with the California Transportation Commission, Caltrans, local jurisdictions, the United Auburn Indian Community, and other regional agencies to maximize allocations of statewide funds, such as State Highway Operation Protection Program and Interregional Transportation Improvement Program, for Placer County projects.

5. Promote the funding of operational improvements that will improve traffic flows and increase the capacity of person trips at relatively low cost.

6. Promote the funding of operational improvements, maintenance, and modernization of public transit services and facilities.

7. Promote funding of maintenance for existing infrastructure as a top priority.

8. Promote funding for transportation investments in non-urbanized/rural areas.

9. Promote the funding of non-motorized projects which are part of a regional or community-wide plan.

10. Promote the funding of non-motorized projects which increase accessibility to recreational, commercial, or educational facilities.

11. Work with State and Federal officials to resist attempts to divert or reduce transportation funding.

12. Manage Federal and State funding so as to simplify, expedite, and maximize project delivery, including working out ways to exchange various types of funds among jurisdictions and projects.

13. Continue to fund some project development to create a shelf list of key ready to implement projects for ad hoc funding opportunities.

Objective B: Develop innovative funding sources for vital transportation needs where conventional funding sources are insufficient to do so.

Policies:

1. Encourage jurisdictions to devise user charges that link the financing of new or expanded facilities and services to the development that creates or increases the need for such.

2. Consider alternative customized transportation fund sources such as development impact fees, establishment of assessment districts, license and vehicle registration fees.

3. Work with the League of California Cities, California State Association of Counties, legislators, transportation groups, and other interested parties to develop new sources of funding for road rehabilitation, maintenance and operation of the existing transportation system and expansion to meet future needs.

4. Consider implementing a local option sales tax for transportation purposes.

5. Initiate a public education and outreach campaign to inform citizens of the need for additional funding for transportation projects.

6. Encourage multi-agency package of projects for federal and State funding programs, where a regional strategy may improve chances of success.

7. Consider using innovative "best-value" implementation methods, such as design-build or design- sequencing for the design and construction of transportation projects.

5.3 Performance Measures

Transportation performance measures consist of a set of objective, measurable criteria used to evaluate the performance and effectiveness of the transportation system, policies, plans, projects, and programs.

Performance measures in the RTP set the context for judging the effectiveness of the plan as a "program," by furthering goals, objectives and policies. The STIP Guidelines identify performance measures to evaluate the effectiveness of specific projects in achieving the RTP's goals, objectives and policies.

PCTPA has developed the following performance criteria to set priorities for implementation of projects included in the RTP:

1. Improve transportation safety throughout the region.

2. Relieve congestion on roadways and continuously improve air quality.

3. Enhance regional integration for all modes, and increase multi-modal travel opportunities.

4. Maintain existing transportation facilities to comply with all applicable standards.

5. Implement transportation projects that preserve natural and cultural resources.

6. Provide opportunities for public participation in all stages and phases of transportation planning and project development and implementation.

Appendix E summarizes year 2005 system performance, establishing a baseline from which future performance trends can be observed and informed decisions can be made regarding transportation investments and project selection.

In evaluating the performance of the RTP, PCTPA will use multiple tools and datasets to quantify information where available. For example, PCTPA uses the data available through the Highway Performance Monitoring System (HPMS) as a monitoring and management tool. PCTPA also uses the transit operator financial audits to monitor fare box recovery; and uses the Triennial Performance Audit process to evaluate the effectiveness, efficiency and economy of transit operations.

In addition, SACOG has recently assembled a Regional Transportation Monitoring Report documenting demographics, growth and transportation data and trends in the Sacramento region from 2002 to 2009. Data compiled in the Monitoring Report include: household income, age, gasoline prices, and transit service; as well as data for key measures of transportation behavior, such as trips by mode, vehicle miles traveled, commute travel times and congestion levels. The Monitoring Report provides a useful understanding of how the transportation system in the region is being used; and what changes and trends are in evidence based on the most credible data sources available to the Sacramento region.

SACOG anticipates the Regional Transportation Monitoring Report will be updated every two years and include county-level breakouts of the data. The county-level breakouts will provide another resource for PCTPA to use to track and monitor the progress of transportation system performance.

CHAPTER 6
ACTION ELEMENT

This chapter serves as an introduction to the Action Element. The Action Element includes sub-elements (Chapters 6.1 through 6.11) and action plans for regional roadways, public transit, aviation, passenger rail, goods movement, non-motorized transportation, transportation systems management, transportation safety and security, intelligent transportation systems, and integrated land, air, and transportation planning.

The Action Element identifies all transportation projects within the financial constraint requirements within the horizon of the Regional Transportation Plan (RTP). The Action Element implements the Policy Element with the anticipated financial resources identified in the Financial Element and conforms to the State Implementation Plan (SIP) for air quality.

The Action Element represents the heart of the RTP. It describes, by mode of transportation, the current conditions, recent planning activities, and priorities. Federal conformity regulations (Title 40 CFR 93.106, Content of Transportation Plans) identify the short-term horizon as a period up to ten years and the long-term horizon as projects or activities 20 years and beyond.

A short-range (pre-2015), a medium-range (2016 – 2024), and long-range (2025 – 2035) action plan are provided for each mode as well as a list of specific projects to be implemented by the various jurisdictions that comprise PCTPA along with Caltrans and other transportation agencies.

The project lists are separated into programmed / funded (or constrained) and planned / unfunded (or unconstrained) projects. Appendix F provides the programmed major projects list; Appendix G provides the planned major projects list.

Programmed funds mean that the funds are budgeted / committed for projects and are included in the SACOG MTIP (as amended), the STIP, and the SHOP. Funded projects can also include projects beyond the four year programming period of the MTIP, which are included in the region's financially constrained 2035 MTP. The programmed / funded (or constrained) list includes those projects that given the assumptions contained in the Financial Element, PCTPA can reasonably expect to fund between now and 2035. Planned projects (or unconstrained) refer to projects for which a specific funding source has not yet been identified. The planned / unfunded (or unconstrained) list includes those projects included in the PCTPA's 2027 RTP and / or SACOG's MTP 2035, including its "vision." Many of the planned projects are still in the conceptual phase; although the list includes many projects that could be implemented if additional funds were to become available.

The short and long range action plans and project lists are consistent with achievement of the goals, objectives, and policies described in Chapter 5, Policy Element. This consistency is illustrated in the table shown in Appendix H, which matches each action plan item in Chapter 6 with the appropriate objective from Chapter 5.

6.1 Regional Roadways

One of the most important components of the overall transportation system in Placer County is the network of roadways that facilitates the movement of people and goods in and through the region. This chapter identifies those roadways that are of regional significance.

REGIONALLY SIGNIFICANT ROADWAYS

With limited resources for the maintenance and improvement of roadways, priority must be given to those roadways that are most important to the overall transportation system. Roadways are determined to be of regional significance if they meet one or more of the following criteria:

- Roadways of statewide significance
- State or interstate highways
- Rural arterials connecting two or more urbanized areas
- Principal roadways connecting Placer County with other regions or counties
- Roadways that provide access to significant recreational, commercial, industrial, or institutional activity centers
- Roadways that are primary emergency evacuation routes for urbanized areas
- Roadways that would be included in the air quality conformity modeling of the regional transportation network.

Based on the above criteria, there are a variety of roadways of regional significance in Placer County, including one interstate, eight state highways and 14 local road segments. These regionally significant roadways are illustrated in Figures 6.1a, Regionally Significant Roads in Western County, and 6.1b, Regionally Significant Roads in Eastern County, and are described below.

Table 6.1-1 provides an inventory of maintained road miles for all rural and urban roads located within Placer County, excluding that portion of the Lake Tahoe Basin outside of PCTPA jurisdiction.

Table 6.1-1
Maintained Road Miles in Placer County

Jurisdiction		Rural	Urban	Total	Percent
Cities:	Auburn	1.59	60.02	61.61	2.7%
	Colfax	11.74	0.00	11.74	0.5%
	Lincoln	157.17	12.30	169.47	7.5%
	Loomis	0.00	33.67	33.67	1.5%
	Rocklin	11.06	132.83	143.89	6.3%
	Roseville	5.53	422.07	427.60	18.8%
County:	Unincorporated	809.92	133.83	943.75	41.5%
Other:	Army Corps of Engineers	5.50	0.00	5.50	0.2%
	State Highway	112.48	41.85	154.33	6.8%
	State Park Service	9.10	0.00	9.10	0.4%
	US Bureau of Reclamation	0.40	0.00	0.40	0.0%
	US Forest Service	310.88	0.00	310.88	13.7%
	Total	1,435.37	836.57	2,271.94	100.0%

Notes:
1. Maintained road miles data is derived from the Highway Performance Monitoring System (HPMS).
2. Road miles for unincorporated Placer County exclude the Tahoe area, based on County GIS data.

Sources:
1. 2008 California Public Road Data, Caltrans, 2009.
2. Phone communication from Jim Rose re: Placer County & Tahoe road miles, Placer County, January 22, 2009.

Significant State Highways

The state highway system is the backbone of the region's roadway system, connecting the major population centers within the county, and connecting the county with the rest of the state. All state highways in Placer County are of regional significance. The state highways in Placer County include:

Interstate 80 (I-80) is a major transcontinental east/west route on the Federal Interstate System that runs in California from its western limits in the San Francisco Bay Area to the eastern California/Nevada Border. It continues eastward outside California toward the northeastern United States and terminates in New Jersey. I-80 is a "High Emphasis" route and has been designated by Caltrans in the Interregional Transportation Strategic Plan as a Gateway for people and freight movement. I-80 is also on the National Highway System (NHS) and the Strategic Highway Network (STRAHNET). The freeway in California is also part of the National Priority Network. I-80 is the predominant commercial and recreational route serving Northern California, the Sacramento Valley, and Southern Oregon. It is a major truck route in California because it is the only all-weather route over the Sierra-Nevada mountain range north of SR58 in Kern County. There is also high seasonal traveler usage from the Bay Area and Sacramento region to the mountain resort communities around Lake Tahoe. In Placer County, I-80 is a six-

lane facility from the Placer / Sacramento County line to the Applegate/Weimar area, where it decreases to 4 lanes to the Nevada County line.

State Route 20 (SR20) is an "ocean to mountains" route which begins at SR 1 near Fort Bragg and ends at I-80 near Emigrant Gap, weaving into Placer County just east of Blue Canyon. SR 20 is predominantly a two-lane conventional facility that serves regional, commercial, agricultural and recreational traffic and interconnects with major routes such as I-5, SR99, SR70, and I-80. SR20 is a "High Emphasis Focus Route."

State Route 28 (SR28) extends 11 miles from SR89 at Tahoe City to Kings Beach, where it intersects SR267, and to the California/Nevada border. This route is a two to four lane conventional highway serving recreational traffic along the North Shore of Lake Tahoe, and is on the Federal Aid Primary (FAP) system. It is located outside of PCTPA's planning area.

State Route 49 (SR49) is a north/south route connecting Auburn with numerous "gold country" communities in the foothills. At the south end is a connection across the American River to El Dorado County, and at the north end is a connection across the Bear River to Nevada County. It is a major arterial for both local and through traffic in these foothill counties. In fact, the portion of SR49 between I-80 in Auburn and SR 20 in Grass Valley is identified as a High-Emphasis Focus Route and as a high-growth rural and recreational route. SR49 is a city street with turn lanes and traffic signals in central Auburn. The segment of SR49 south of I-80 has been relinquished by the State to the City of Auburn.

State Route 65 (SR65) runs north/south connecting I-80 to Lincoln and Marysville. The route currently includes 4-lane freeway segments between I-80 and Industrial Boulevard, just south of Lincoln and between Beale Air Force Base north of Wheatland to SR70 south of Marysville. The remainder of SR65 is a 2-lane highway.

State Route 89 (SR89) in Truckee and unincorporated Placer County serves as a key facility for interregional travel, providing the transition between I-80 and the primary access to the Tahoe Basin's North Shore, as well as Squaw Valley and Alpine Meadows. SR89 also serves as a key "gateway" to the Tahoe Region and to Truckee.

State Route 174 (SR174) extends 13.1 miles northward from I-80 near Colfax in Placer County to SR 20 in the City of Grass Valley in Nevada County. SR174 is largely used by commuters between Auburn and Nevada County as a bypass to avoid congestion on SR49. The route passes through mountainous terrain with grades of up to 8.8 percent. SR174 is on the FAP system and is not on the National Truck Network or Interregional Road System.

Figure 6.1a
Regionally Significant Roads - Western County

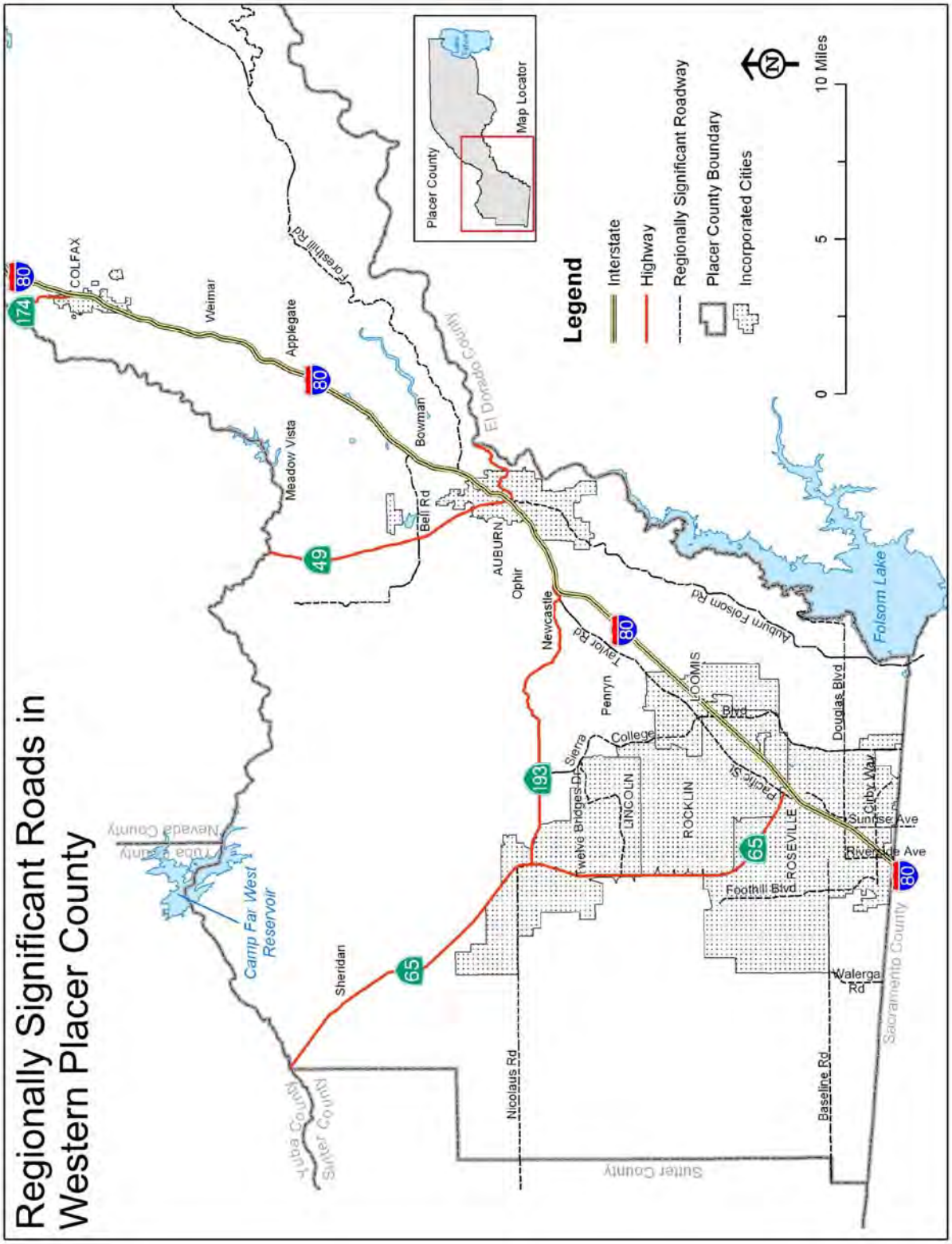
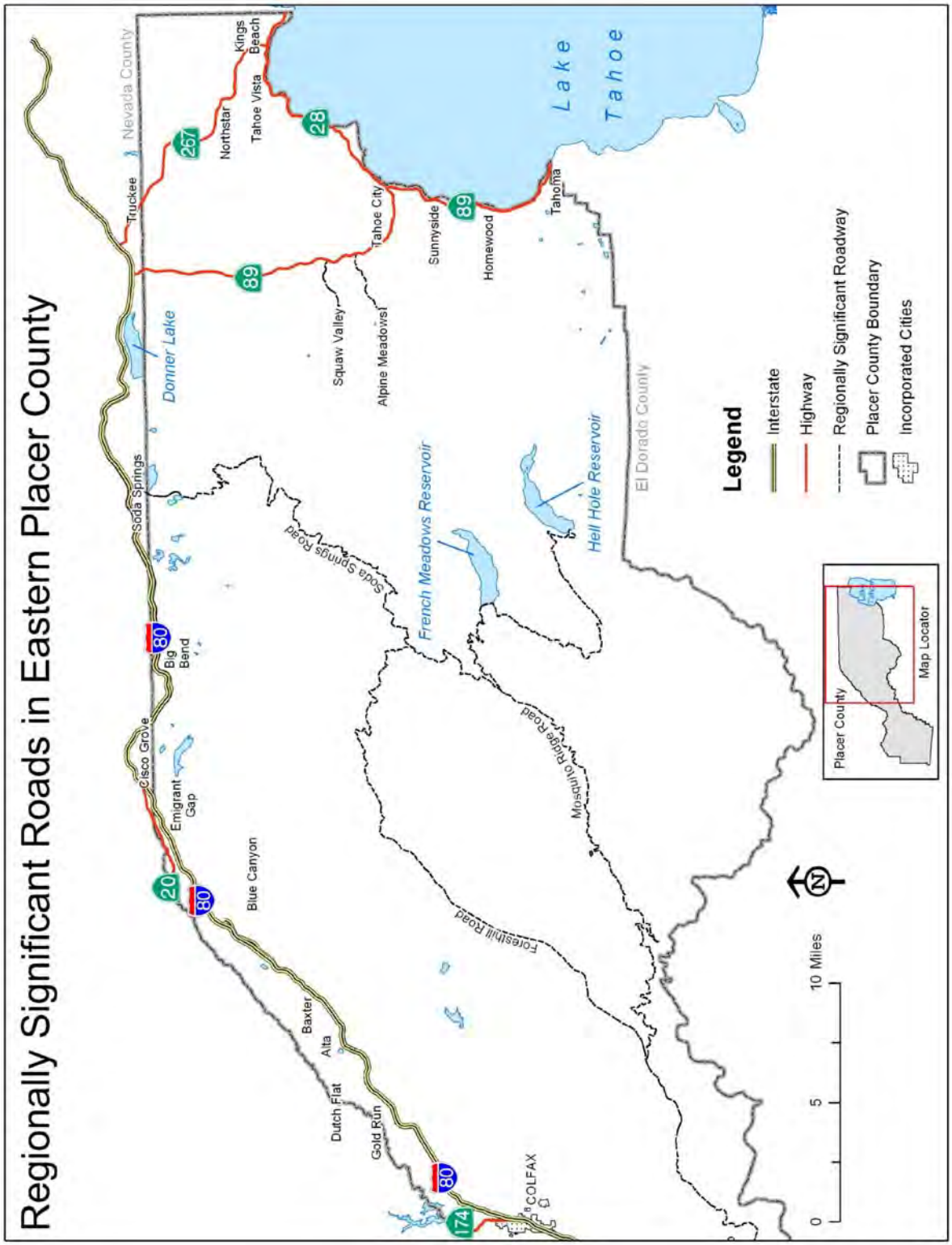


Figure 6.1b
Regionally Significant Roads – Eastern County



State Route 193 (SR193) is a connector road running between Placerville on US Highway 50 and the City of Lincoln on SR65. North of Placerville the route leaves SR49 to serve the communities of Kelsey, Spanish Flat, and Georgetown until connects to the town of Cool and SR49 again. At this point the designation is abandoned in favor of SR49 until it reaches I-80. The road then travels west from Newcastle to the City of Lincoln and the connection to SR65. SR193 serves as a truck route and connector road between I-80 and SR65.

State Route 267 (SR267) is a north-south undivided two-lane conventional highway approximately 13 miles in length that connects I-80 near Truckee in Nevada County to SR28 near Kings Beach. The route is of local and regional significance providing access to residential, industrial, commercial and recreational land uses and serves inter-regional, local commuter, and recreational traffic traveling between the Tahoe Basin, Martis Valley, Truckee and I-80.

Significant Local Roads

Local roads provide comprehensive access to all areas of Placer County, and each is important to those using it. Local streets and roads account for about 80 percent of the total Placer road network and carry about 46 percent of total traffic in 2008.

The RTP, however, seeks to identify those local roads which are of regional significance, connecting population centers with significant recreational, commercial, industrial, or institutional activity centers. These roads often serve as alternate parallel routes to congested freeway corridors. The regionally significant local roads in Placer County include:

Sierra College Boulevard: The segment of Sierra College Boulevard between SR193 and I-80 is a regional transportation route between the Rocklin and Loomis area to Lincoln and the agricultural areas to the north and east. The segment between I-80 and the Sacramento County Line is a regional transportation route connecting I-80 to the easterly portion of Roseville, Granite Bay area and Sacramento County. Sierra College Boulevard also connects Sierra College to I-80 and Roseville and Granite Bay areas. The entire segment between I-80 and Highway 50 serves as a defacto north-south beltway connector.

Pacific Street/Taylor Road: From I-80 to SR193 this segment serves as a major arterial connecting Newcastle and Roseville. Known as Pacific Street within Roseville and Rocklin, it is a two and four lane facility extending through the Town of Loomis where is becomes Taylor Road, connecting to I-80 in Newcastle. This road was previously a portion of the historic Lincoln Highway (Route 40) prior to the establishment of I-80.

Auburn-Folsom Road: From Auburn to Sacramento Line, this is a regional transportation route connecting Auburn to Granite Bay area, City of Folsom and northeastern Sacramento County. It is one of three main routes crossing the American River to Highway 50.

Douglas Boulevard: From Sierra College Boulevard to Folsom Lake, this is a regional transportation route connecting Roseville and I-80 with the community of Granite Bay and the Folsom Lake Recreation Area at Granite Bay.

Sunrise Avenue: From Eureka Road to Sacramento County line, this is a regional transportation route connecting Roseville with Sacramento County.

Cirby Way: From Rocky Ridge Drive to Foothills Boulevard, this is a major arterial connecting southwest Roseville to I-80 via Riverside Avenue and to northwest Roseville via Foothills Boulevard.

Foothills Boulevard: From Cirby Way to north of Blue Oaks Boulevard, this is a major arterial connecting southwest Roseville to northwest and north central Roseville.

Riverside Avenue: From Vernon Street to Interstate 80, this is minor arterial connecting downtown Roseville to I-80.

Baseline Road: From Foothills Boulevard to the Sutter County Line, this is a primary commercial connector and commuting route from Roseville to SR70 and SR99, Sacramento and the Sacramento Airport. At the Placer / Sutter County line, Baseline Road becomes Riego Road.

Walerga Road: From Baseline Road to Placer County Line, this is a primary connector between Roseville and the north area of Sacramento County and serves as a connection to I-80.

Nicolaus Road: From H Street in Lincoln to Sutter County Line, this is a two to four lane arterial serving the Lincoln Regional Airport, a designated "reliever airport" to Sacramento International Airport.

Twelve Bridges Drive: From Sierra College Boulevard to SR65 and Industrial Boulevard, this is a two and four lane arterial approximately four miles in length. This roadway serves the southern portion of Lincoln.

Bell Road: From SR49 to I-80, this is a bypass route for commute traffic heading from I-80 to North Auburn area and Nevada County. Bell Road also serves the Auburn Airport Industrial Area, the Placer County DeWitt Center government complex, and I-80.

Foresthill Road: From I-80 to Foresthill, this is a connector route for the community of Foresthill to Auburn, I-80 and the Sacramento Area. It also provides significant access to recreational opportunities in the Sierras.

REGIONAL ROAD NETWORK AND LEVEL OF SERVICE

Level of service (LOS) is used to express the traffic flow conditions of a road segment in relation to the capacity of the roadway. Level of service generally describes traffic conditions in terms of speed and travel time, volume and capacity, traffic interruptions, and safety. Level of service uses the letters "A" through "F" to describe traffic flow, with "A" being free flow and "F" being gridlock. Table 6.1-2 provides specific descriptions of level of service.

Each jurisdiction establishes level of service standards for roadways within the Circulation Element of their general plan. SACOG uses the level of service standards established in the general plans for the current and future congestion analysis prepared as part of the SACOG Metropolitan Transportation Plan (MTP). Caltrans use concept LOS to reflect the minimum level or quality of operations that is acceptable for each State highway within the 20-year planning horizon.

Table 6.1-2
Level of Service Descriptions

Level of Service	Description
A	Represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream.
B	Stable flow, but the presence of others in the traffic stream begins to be noticeable.
C	Stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by the interactions with others in the traffic stream.
D	Represents high density, but stable flow.
E	Represents operating conditions at or near the capacity level.
F	Represents forced breakdown of flow.

Source: Highway Capacity Manual – Special Report 209, Transportation Research Board, 1985.

Regional Road Network Level of Service Analysis

SACOG uses the SACSIM transportation model to evaluate current and future travel demand conditions on regionally significant roadways in the Sacramento metropolitan area, including Placer County. A description of the SACSIM transportation model is provided in Appendix I.

The purpose of the level of service evaluation is to identify current roadway deficiencies and to identify segments of the regional road network that may become congested in the future as a result of growth during the twenty-year horizon of the Plan. Any current roadway deficiency identified by this analysis may become the basis for a project, while segments of the road network forecast to have a congestion problem in the future may be known and monitored by the appropriate jurisdiction as development occurs.

For those congestion impacts forecast to occur on State Highway routes, PCTPA and Caltrans will be responsible for monitoring the levels of service over time, in addition to any project development. For those congestion impacts forecast to occur on county or city roads, the appropriate local jurisdiction will be responsible for monitoring traffic levels and the development of any corrective project.

Appendix J summarizes current (2008) rural and urban daily vehicle miles of travel (VMT) by road functional classification. Placer County has about 2,384 total maintained road miles, with rural roads comprising 65 percent of the total and urban 35 percent. Not surprisingly, the miles

traveled on these roads is nearly the reverse, with 64 percent of travel occurring on urban roads and 36 percent on rural roads.

Appendix J also summarizes highway congestion data (2008) for state highways in Placer County. Placer County currently experiences 8.3 total congested directional miles. Morning congestion is spread along westbound I-80 and southbound SR65; evening congestion occurs along both eastbound and westbound I-80 south of SR65. Users experienced about 502 daily vehicle hours of delay. Placer County ranks 19th statewide among counties in terms of congestion experienced on state highways.

Appendix K lists current (2007) traffic data and performance measures for several key roadway segments in Placer County. Appendix L lists forecasted traffic data and performance measures for similar key segments.

Placer Parkway Final Tier 1 EIS / Program EIR

The Placer Parkway Final Tier 1 EIS / Program EIR include several mitigation *considerations* that are different from several proposed RTP projects identified in Table 6.1-3. These *considerations* outline "strategies" that go beyond the 2035 horizon of the RTP; mitigating year 2040 LOS impacts on the following road segments:

- Widen Fiddyment (Blue Oaks to Roseville city limits) to six lanes. PLA25130 proposes widening of Fiddyment from two to four lanes from Roseville city limits to Athens Road.
- Widen Whitney Ranch Parkway (SR65 to University Avenue) to eight lanes. PLA25025 proposes constructing a new six lane facility from SR65 to Wildcat Boulevard. The PSR/PR for the SR65/Whitney Ranch Parkway interchange also indicates this segment is to be eight lanes (six lanes plus two auxiliary lanes).
- Widen Valley View Parkway (Sierra College Boulevard to Park Drive) to four lanes. PLA19250 proposes constructing a two lane Valley View Parkway.
- Widen Sierra College Boulevard (Valley View to English Colony Way) to six lanes. PLA19330 proposes widening of Sierra College Boulevard to four lanes from Valley View to Loomis town limits.

REGIONAL ROADWAY NETWORK NEEDS ASSESSMENT

High Priority Regional Road Network Projects

The level of service analysis prepared for the regional road network is only one factor considered in prioritizing the region's project priorities. Other primary and secondary criteria must be considered in establishing the project priorities for the region. Primary criteria include safety

improvements, air quality conformity, eligibility for state and federal funding, and local funding availability. Secondary criteria include project state of readiness and popular and community support.

Based on these criteria, PCTPA has identified several high priority regional roadway projects that are needed in Placer County within the planning period of this Plan. Each of these projects is considered a necessary improvement that will maintain acceptable levels of service and safety on the regional road network. These projects are shown in Figure 6.1c, Regionally Significant Roadway Projects in Western County, and Figure 6.1d, Regionally Significant Roadway Projects in Eastern County.

Examination of the regional project priority list shows that funding is an important determining factor in their implementation. A forecast of future State, federal, and local funding is included in the Financial Element. Obtaining the funding necessary for the high priority regional road network projects will be one of the greatest challenges for long range planning.

Interstate 80 Capacity Increasing Project

The traffic demand on the I-80 freeway corridor impacts the freeway to a point of operational breakdown during the peak periods. This proposed project would consist of adding one lane in each direction on I-80 from the Sacramento / Placer County line to approximately one half mile east of the SR65 connector and the addition of auxiliary lanes. The total cost of this project over three phases is estimated to be $91 million.

PCTPA and SACOG jointly examined the feasibility of implementing a system of High Occupancy Toll (HOT) lanes on the I-80 corridor, between I-5 and SR65 as a pilot project. HOT lanes are based on the strategy of allowing single occupant vehicles to use the extra capacity in a high occupancy vehicle (HOV) lane, and generating revenue through the tolls charged on the single occupant vehicles. The feasibility study was completed in July 2010. The feasibility study concluded that implementation of a HOT lane on I-80 from I-5 to SR 65 will not provide sufficient gross revenue to cover its costs through 2035. Between 2026 to 2035, gross revenues may be able to cover operations and maintenance costs but not capital and financing costs.

Interstate 80 Ongoing Highway Operations Improvements

In addition to using State Highway Operation and Protection Program (SHOPP) funds, Caltrans implements ongoing maintenance and safety improvement projects annually on Interstate 80 throughout Placer County. Spread over a number of projects and phases, the total cost for ongoing highway operational improvements along the entire length of I-80 in Placer County is estimated to be $657 million.

Interstate 80 / Rocklin Road Interchange

In Rocklin, from Rocklin Road onto both westbound and eastbound I-80, the project would involve construction of a combination of loop and flyover ramps to eliminate left-turn movements. The project is estimated to cost about $30 million.

Interstate 80 / Eureka Boulevard Interchange

In Roseville, on Eureka Road at I-80 the project would add a fourth westbound through lane from 500 feet east of North Sunrise to the eastbound I-80 on-ramp. The project also includes widening Miners Ravine Bridge and changing the existing first north bound and southbound through lanes at Sunrise Boulevard and Eureka Boulevard to left turn lanes. The estimated cost of the project is about $10 million.

State Route 65 / Lincoln Bypass

The proposed project is a westerly bypass along SR65 around the City of Lincoln. The project consists of a roughly 12-mile mixed two-and and four-lane facility extending from Industrial Boulevard in Lincoln to just north of Sheridan. The most current estimate prepared by Caltrans puts the total cost for this project at approximately $292 million, including right-of-way, design, and construction, with the second phase from North Ingram Slough to Sheridan at $55 million.

State Route 65 Widening from Industrial to Interstate 80

This project would widen SR65 to six lanes in the rapidly growing area on the border between Rocklin and Roseville, 6.5 miles from the Galleria Boulevard interchange to the Industrial Avenue interchange. This project is estimated to cost about $109 million.

State Route 65 / Interstate 80 Interchange Modifications

This project would improve about three miles of I-80 between Miners Ravine Bridge to approximately 0.2 mile west of Rocklin Road and would improve about two miles of SR65 between the I-80 junction to approximately one mile to the north of Galleria Boulevard. The proposed project improvements include construction of a two-lane bi-directional HOV direct connector on eastbound I-80 to northbound SR65 and southbound SR65 to westbound I-80; replacement of the eastbound I-80 to northbound SR65 loop connector with a three-lane flyover ramp; ramp widening and additional lane at the southbound SR65 on-ramp from Galleria Boulevard; connector widening with associated auxiliary lane at the westbound I-80 to northbound SR65 connector; reconstruction and widening of the southbound SR65 to eastbound I-80 connector flyover; widening of I-80 and SR65 and associated ramp realignments at Eureka Road, Taylor Road and Galleria Boulevard; widening the East Roseville Viaduct; replacement of the Taylor Road overcrossing to accommodate widening I-80; and construction of HOV lanes on SR65 from the I-80/SR 65 interchange past the Galleria Boulevard interchange. Phase 1 of the project is estimated at $30 million, with the ultimate project estimated at $250 million.

State Route 65 / Ferrari Ranch Road Interchange

In Lincoln, the project involves construction of an interchange at SR65 / Lincoln Bypass at estimated at $15 million.

State Route 65 / Whitney Ranch Parkway Interchange

Construction of a full movement interchange at Whitney Ranch Parkway and SR65 is proposed at an estimated cost of $20 million.

State Route 65 / Sunset Boulevard Interchange

West of Rocklin, at the junction of SR65 and Sunset Boulevard, the project involves construction of an interchange for $34 million.

State Route 65 / Galleria Boulevard Interchange Improvements

At the existing interchange on SR 65/Galleria Boulevard and Stanford Ranch Road in Roseville, modification of all on and off ramps on the interchange is proposed to provide improved operations. The estimated cost of the improvements is $5 million.

State Route 49 Widening

This project would consist of widening SR49 between Luther Road and Nevada Street at an estimated cost of $10 million.

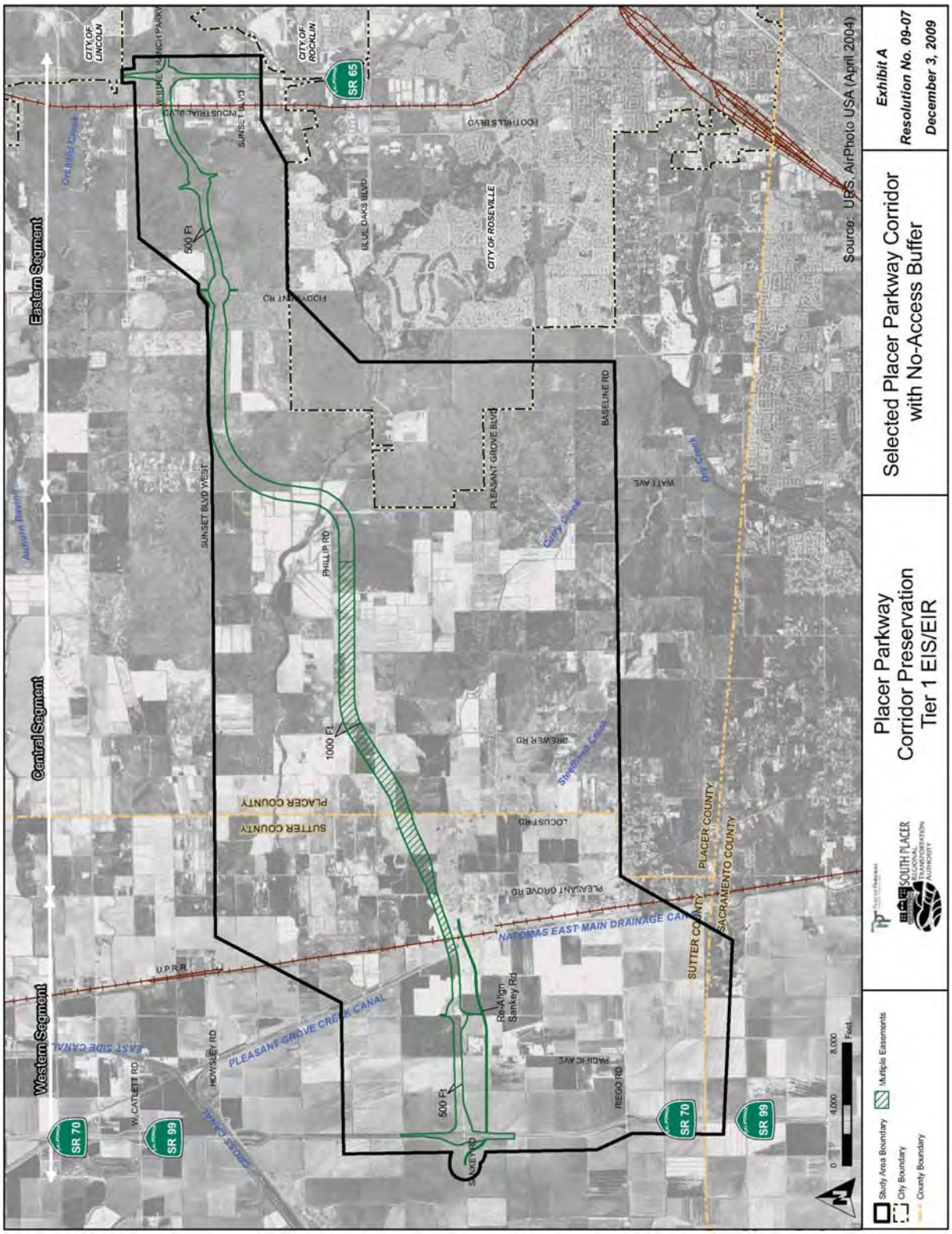
Sierra College Boulevard Improvements

The improvements to Sierra College Boulevard would consist of widening the roadway to four or six lanes, including shoulder improvements, from SR193 to the Sacramento County line, and reconstructing the interchange at I-80. Various studies prepared for the project conclude that the total cost of all proposed improvements would be approximately $43 million.

Auburn-Folsom Road Widening

The project involves shoulder widening capacity improvements, safety improvements and installation of a traffic signal at Fuller Drive for about $28 million

Figure 6.1c
Placer Parkway Preferred Alternative



Placer Parkway

The concept of a transportation facility that would connect SR65 to SR 70/99 has been discussed for decades. Five corridor alignments alternatives were evaluated in a Tier 1 EIS/Program EIR. The Final Tier 1 EIS / Program EIR identified Alternative 5 with a no-access buffer as the Preferred Alternative under NEPA and the Environmentally Superior Alternative under CEQA. In December 2009, SPRTA selected Alternative 5 with a no-access buffer as the Preferred Alternative. Through a parallel federal coordination (modified NEPA/404) process, the USCOE and USEPA concurred on the Preferred Alternative. FHWA issued the Record of Decision on May 7, 2010.The corridor is illustrated in Figure 6.1c; and is about a15-mile long, four-lane facility, connecting from SR 65 at Whitney Boulevard / Sunset Boulevard to SR 70/99 between Riego Road and Sankey Road in Sutter County. The total estimated cost of the Placer Parkway project ranges from $660 million. Phase 1 will include a Tier 2 Project Level environmental review and permit process and will identify a roadway alignment within the corridor at an estimated cost of $70 million. The SPRTA has designated Placer County as the lead agency for the project level environmental and design work.

State Route 89 Improvements

Rehabilitation improvements are proposed along SR89 from Squaw Valley Road to the Nevada County line in Truckee. The rehabilitation improvements are estimated to cost about $9 million.

State Route 193 Improvements

A variety of improvements are proposed by Caltrans over the next several years for SR193. These include widening SR193 from Ferrari Ranch Road to Sierra College Boulevard at an estimated cost of $6 million. Other significant projects include reconstruction of the bridge at Auburn Ravine at a cost of $5 million; improvements to the roads curves at an estimated cost of $13 million; and pavement rehabilitation along segments at an estimated cost of $5 million.

Midas Avenue Grade Separation

In Rocklin, the project would involve construction of a two-lane grade separation of UP railroad tracks on Midas Avenue, from Pacific Street to Third Street, construct 2 lane grade at an estimated cost of $9 million. Project is identified on the California Public Utilities Commission (CPUC) grade separation priority list.

Figure 6.1d
Regionally Significant Roadway Projects – Western County

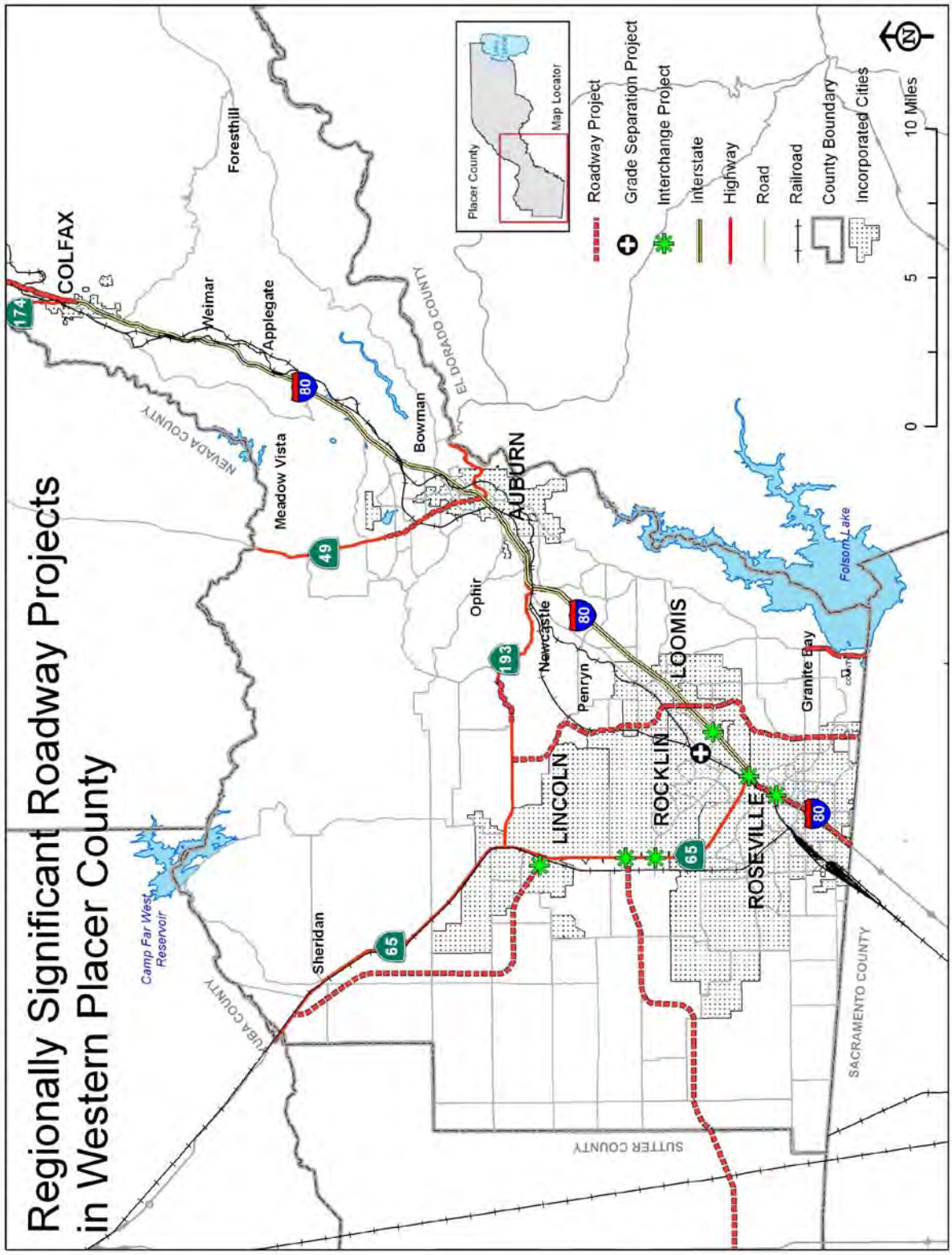
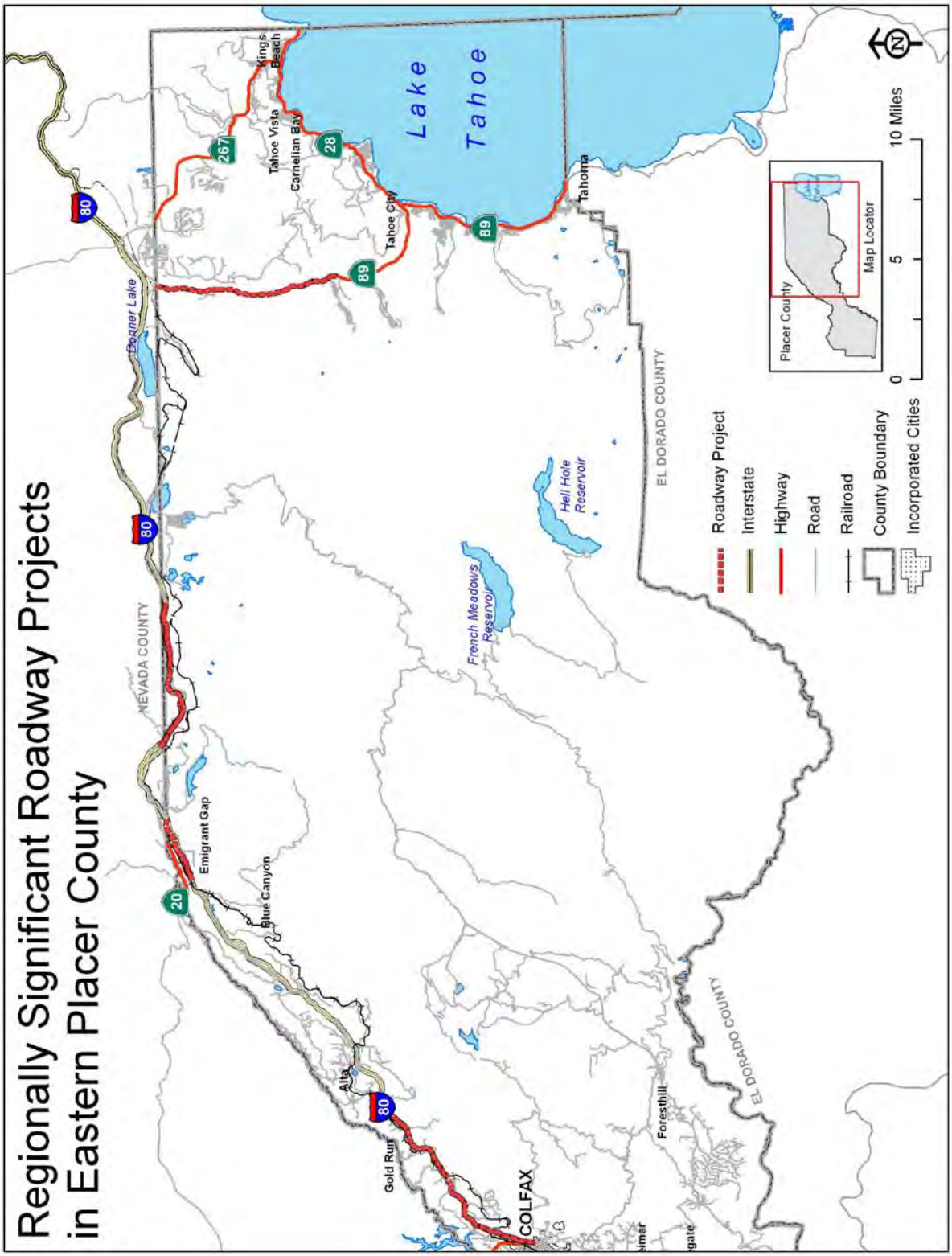


Figure 6.1e
Regionally Significant Roadway Projects – Eastern County



Currently Programmed Roadway Projects

Through previous State Transportation Improvement Program (STIP) cycles, Placer County has received funding approval for a number of projects scheduled for the short-range (less than 10-year). Existing programmed projects include roadway improvements and rehabilitation proposed by Placer County jurisdictions funded using RSTP and ARRA, as well as safety projects included in the Caltrans State Highway Operations and Protection Program (SHOPP).

In 2002, Lincoln, Roseville, Rocklin, and Placer County formed the South Placer Regional Transportation Authority (SPRTA), which is a regional fee program administered by PCTPA. This fee program is generating additional funds to pay for improvements on Sierra College Boulevard, Interstate 80 interchanges, the Lincoln Bypass, Placer Parkway, and selected rail and transit projects.

A partial list of key regional roadway improvement projects programmed in the STIP and the MTIP is included in Table 6.1-3.

Table 6.1-3
Programmed Regional Roadway Improvement Projects

Project Title	Completion Year	Status	Cost Estimate
I-80 Eureka Road On-Ramp Improvements	2011	Programmed	$9,600,000
I-80 HOV Lanes & Aux Lanes - Phase 3	2012	Programmed	$33,848,000
I-80 Operational Improvements/HOV - Phase 2	2012	Programmed	$47,576,532
I-80 Maintenance in Placer County	2012	Programmed	$6,165,500
I-80 Rehabilitation - SHOPP	2012	Programmed	$7,515,000
Auburn-Folsom Road Widening	2012	Programmed	$27,300,000
Ferrari Ranch Road at SR65 Bypass	2012	Programmed	$14,495,628
I-80 Rehabilitate Bridge Decks Near Roseville	2013	Programmed	$16,184,000
SR193 Curve Improvement	2014	Programmed	$12,586,000
Whitney Ranch Parkway Interchange	2014	Programmed	$20,000,000
SR65 Lincoln Bypass	2014	Programmed	$291,783,000
I-80 Vertical Clearance Improvements	2015	Programmed	$36,045,000
Galleria Blvd/SR65 Interchange Improvements	2015	Programmed	$5,000,000

(Phase 2)			
SR89 Rehabilitation	2016	Programmed	$8,870,000
I-80 3-Mile Truck Climbing Lane	2018	Programmed	$31,600,000
I-80 / Rocklin Road Interchange	2020	Programmed	$29,850,000
Midas Avenue Grade Separation	2020	Programmed	$8,750,000
Sierra College Boulevard (All Segments)	2020	Programmed	$42,500,000
SR65/I-80 Interchange Improvements (Phase 1)	2020	Programmed	$30,000,000
		Total Programmed Funds	**$640,668,660**

Note: Cost are estimates are in current year dollars, and are based on the latest information available, however unanticipated factors such as environmental issues, land prices, etc. often conspire to escalate costs.

Sources: 2010 State Transportation Improvement Program; SACOG 2009/2012 MTIP, as amended; SACOG 2011/2014 MTIP; and South Placer Regional Transportation Authority (SPRTA) project list.

A comprehensive list of programmed and planned road, bridge, and grade separation projects, funded with STIP, SHOPP, SPRTA, local fees, developer fee/agreements, Hazard Elimination and Safety Program (HES), Highway Bridge Rehabilitation and Replacement Program (HBRRP) and other programs currently included in the approved MTP and programmed in the MTIP, are identified in the Roadway Projects section, below in Table 6.1-4.

State Highway Needs Assessment

Caltrans is required to prepare the SHOPP for rehabilitation and reconstruction of all State highways and bridges, and to set goals for each program type. The SHOPP is updated every two years. The SHOPP's statewide pavement performance goal is to reduce distressed lane miles by a reduction from 25 percent of the network needing rehabilitation to no more than 10 percent throughout the State by 2015/2016. Each District develops a ten-year goal to identify project needs and priorities to achieve its portion of the statewide goal. Caltrans is also required to prepare a five-year Maintenance Plan to address the maintenance needs of the State highway system.

Caltrans District 3 has a district wide total of 4309 highway lane miles, with 1349 or 31 percent falling in the distressed category. The distressed category can be broken down as follows: 76.1 percent of State highway lane miles in major structural distress, 23.1 percent in minor structural distress, and 0.9 percent having a poor ride quality. Caltrans expects the number of highway lane miles with distressed pavement to increase significantly over the next decade. Because of limited financial resources, it will likely be necessary for Caltrans to focus its pavement maintenance resources on the highways with the most critical needs, allowing some highways to have poorer pavement and ride quality than travelers have been accustomed to in years past.

Local Streets and Roads Needs Assessment

The recent California Statewide Local Streets and Roads Needs Assessment Final Report (October 2009) uses the Pavement Condition Index (PCI) as an indicator of the type of repair work that will be required for roads. The reported PCI is a weighted average, meaning there may well be pavement conditions that have a rating above or below. Pavement conditions can be skewed due to the larger percentage of new roads with higher PCIs, built over the last several years as part of new development.

Newly constructed road pavement has a PCI of 100. In the first five years of a road there is a slow and gradual deterioration of its pavement. As more time passes, pavement deterioration begins to accelerate. As the pavement deteriorates, treatments are needed to address structural adequacy. Asphalt concrete (AC) overlays are applied at varying thicknesses. When the pavement has failed, reconstruction is required. If pavement repairs are delayed by just a few years, the costs of proper treatment may increase significantly, as much as ten times.

The recent California Statewide Local Streets and Roads Needs Assessment Final Report forecast average pavement expenditures statewide for the next ten years. Pavement expenditures are expected to average about $7,400 per centerline mile for counties and about $15,200 per centerline mile for cities. These expenditure estimates do not include replacement for safety, traffic and regulatory items such as, storm drain, curb and gutter, sidewalk, curb ramps, traffic signals, street lights, sound and retaining walls, traffic signs, NPDES requirements, and ADA compliance. The average cost for replacement of these items in cities is about $21,700 per centerline mile, and $1,400 per centerline mile for counties. City streets tend to have different characteristics than county roads, and the larger difference in costs for cities is due to their mostly urban nature and greater inventories of safety, traffic and regulatory items in these categories. County roads typically require just shoulder widening.

The average Pavement Condition Index (PCI) rating statewide for streets and roads is 68. This rating is considered to be in the “at risk” category. The PCI for major and local roads in Placer County, including cities, is rated at 79 out of a possible rating of 100. This rating is shown in Table 6.1-4This rating falls within the “Good – Excellent” range of the index, and is the highest PCI in the State. Pavement falling in this range of the index is best suited for preservation techniques, such as chip seals or slurry seals, which are usually applied at intervals of five to seven years depending upon the road’s traffic volume. Placer County’s PCI rating of 79 can be attributed in part to recent population growth that resulted in the development of new roads.

Table 6.1-4
Summary Inventory & Pavement Conditions for Placer County

	All	Major	Local	Unpaved
Centerline Miles	1989	559	1370	60
Lane Miles	4099	1262	2717	120
Placer County Average PCI	79	79	79	NA
Statewide Average PCI	68	NA	NA	NA