APPENDIX E

MERCED COUNTY 2005, 2020, AND 2030 GREENHOUSE GAS EMISSIONS TECHNICAL METHODS APPENDIX

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This technical methods appendix summarizes the assumptions used to develop the Merced County Greenhouse Gas (GHG) Inventory as part of the Merced County General Plan Update Climate Change Chapter. This inventory uses the GHG inventory standards established by the U.S. EPA, the California Air Resources Board (CARB), and the California Climate Action Registry.

This GHG Inventory includes 2005 baseline conditions for unincorporated Merced County, California, 2020 and 2030 Business as Usual (BAU) Conditions, and 2020 and 2030 Mitigated Conditions. The 2005 baseline year was chosen because it is between the AB 32 baseline year (2004) and the Merced County General Plan Update Background Report baseline year (2006). The year 2020 was selected because it represents the year in which the California Air Resources Board's AB 32 Climate Action Scoping Plan shows a reduction of 29 percent in carbon dioxide equivalents (CO_2e) for mitigated conditions as compared to BAU. The 2030 year was included because it represents the buildout year for the Merced County General Plan.

For the unincorporated areas of Merced County, the inventory estimated activity and consumption data for the following GHG emission sources: transportation; area sources; electricity, water and wastewater; natural gas; solid waste management; and agriculture emissions.

1 METHODOLOGY

This technical methods appendix describes the assumptions applied to create the GHG inventory for unincorporated Merced County.

1.1 STUDY AREA

This GHG inventory is to be used by Merced County as part of its General Plan Update, which governs unincorporated Merced County; therefore, this GHG inventory is focused on the unincorporated area of Merced County. The incorporated jurisdictions within the county and the University of California at Merced campus are each responsible for their own general plan or master plan, and for developing their own GHG inventories as part of compliance with AB 32. Further, this unincorporated county inventory does not itemize any specialty issue subareas (such as government operations or school districts).

1.2 REPORTING FORMAT

This greenhouse gas inventory reports emissions in metric tons per year and as CO_2 equivalents (CO_2e). All of the units reported for various emissions sources and reported in this inventory were converted to metric tons (also known as a "tonne"), a measurement equal to 1,000,000 grams (or 1,000 kilograms). One tonne converts to 2,204 pounds. By comparison, the standard ton used in the United States (a short ton) is equal to 2,000 pounds.

To accurately report non-CO_2 gases, the mass estimates of these gases have been converted to CO_2 equivalents based on each of the non-CO_2 gases' global warming potential (GWP). GWP is defined as the amount of radiative forcing that would result from the emission of one kilogram of a non-CO_2 GHG that is equivalent to that from the emission of one kilogram of carbon dioxide over a fixed period of time.

GWPs were developed by the Intergovernmental Panel on Climate Change (IPCC) to quantify the globally averaged relative radiative forcing effects of a given GHG, using carbon dioxide as the reference gas. In 1996, the IPCC published a set of GWPs for the most commonly measured greenhouse gases in its Second Assessment Report (SAR). In 2001, the IPCC published its Third Assessment Report (TAR), which adjusted the GWPs to reflect new information on atmospheric lifetimes and an improved calculation of the radiative forcing of carbon dioxide (see Table 1). However, SAR GWPs are still used by international convention and the United States to maintain the value of the carbon dioxide "currency." To maintain consistency with international practice, the California Climate Action Registry requires participants to use GWPs from the SAR for calculating their emissions inventory. For this reason, this GHG inventory uses the SAR GWPs.

Table 1 Global Warming Potential for the Common GHG Pollutants

Greenhouse Gas	GWP (IPCC 1996)	GWP (IPCC 2001)
CO_2 – carbon dioxide	1	1
CH_4 - methane	21	23
N_2O – nitrous oxide	310	296

Source: IPCC 1996; IPCC 2001.

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2 INVENTORY APPROACH

The following describes the inventory approach for each of the evaluated GHG emission sources: transportation; area sources; electricity; water and wastewater services; natural gas; solid waste management; and agriculture.

2.1 TRANSPORTATION

METHODOLOGY

Transportation-related GHG emissions for all of Merced County in 2005 and 2030 were based on vehicle miles traveled (VMT) data obtained from the Merced County traffic model, as shown in Table 2 (KD Anderson, 2011). For 2005, daily VMT in Merced County equals 10,731,826 miles, while for the 2030 base case, daily VMT equals 19,676,476. Two adjustments were made to these values. First, daily VMT was converted to annual VMT by multiplying by 365 days per year. Second, VMT was adjusted to reflect only the travel occurring within the unincorporated portion of Merced County by multiplying by the unincorporated population percentage. Population numbers for Merced County were obtained from the Merced County Association of Governments, and are shown in Table 3 below.

In 2005, the population for unincorporated Merced County equaled 36.4 percent of Merced County's population. Consequently, VMT (shown in the fourth column) was adjusted so that the total unincorporated VMT equals 36.4 percent of county-wide VMT. In 2030, the population for unincorporated Merced County would equal 36.6 percent of Merced County's population. Consequently, total VMT of 19,676,476 was multiplied by 36.6 percent to get the amount of travel in unincorporated Merced County in 2030.

For 2020 VMT, an interpolation was made between 2005 and 2030 total VMT estimates. The 2020 Base VMT was estimated by interpolating between 2005 and the 2030 Base VMT. The 2020 Mitigated VMT was estimated by interpolating between 2005 and 2030 Mitigated VMT. Once 2020 Base and 2020 Mitigated VMT's had been estimated, the percentage of VMT travel in unincorporated Merced County was estimated using the percent of Merced County's 2020 population that would be living in the unincorporated area (35.7 percent).

Table 2 Merced County VMT Estimates

Year	VMT/day	VMT/day Incorporated Portion	VMT/day Unincorporated Portion	VHT/day	Speed (miles per hour)
2005	10,731,826	6,830,144	3,901,682	258,832	41.46
2010 Base	12,520,756	8,087,266	4,433,490	324,598	38.57
2020 Base	16,098,616	10,345,061	5,753,555	456,130	35.29
2020 Mitigated	16,063,739	10,322,649	5,741,090	435,038	36.92
2030 Base	19,676,476	12,484,092	7,192,384	587,662	33.48
2030 Mitigated	19,618,347	12,447,211	7,171,136	552,509	35.51

VMT = vehicle miles traveled, VHT = vehicle hours traveled
Source: KD Anderson, 2011.

Table 3 Merced County Population Estimates

Year	Population Incorporated	Population Unincorporated	Total
2005	155,100	88,600	243,700
2010	178,400	97,800	276,200
2020	219,000	121,800	340,800
2030	264,700	152,500	417,200

Source: Merced County Association of Governments, 2004.

EMISSION RATES APPLIED

The next step was to run the EMFAC2007 model using the Merced County portion of BURDEN. BURDEN is a module within the EMFAC2007 software that can be used to generate estimates of gasoline and diesel fuel consumption. BURDEN was adjusted so that the Merced County VMT reflected only unincorporated VMT as shown in Table 2. BURDEN's estimates of daily fuel consumption were multiplied by 365 to determine annual gasoline and diesel fuel consumption associated with daily VMT as shown in Table 4

Table 4 Merced County Unincorporated On-Road Gasoline and Diesel Fuel Consumption

Year	Fuel Type	Gallons/day	Gallons/year
2005	Gasoline	159,130	58,082,450
	Diesel	144,820	52,859,300
2020	Gasoline	242,370	88,465,050
	Diesel	200,840	73,306,600
2030	Gasoline	308,850	112,730,250
	Diesel	243,690	88,946,850

Source: California Air Resources Board, 2009.

Then, the resulting annual fuel use was multiplied by the GHG emission factors for CO_2, CH_4, and N_2O shown in Table 5.

Table 5 GHG Emission Factors for On-Road Gasoline and Diesel (kg/gallon)

Fuel Type	CO_2	CH_4	N_2O
Gasoline	8.81	0.0147	0.0079
Diesel	10.15	0.0051	0.0048

Source: California Climate Action Registry 2009.

Table 6 summarizes the resulting annual GHG emissions when the fuel use values shown in Table 4 are multiplied by the GHG emission factors shown in Table 5.

Table 6 GHG Unincorporated (BAU) Transportation Emissions (unmitigated, metric tons/year)

Area	CO_2	CH_4	N_2O	CO_2e
2005	1,048,228	1,123	728	1,297,634
2020	1,523,439	1,674	1,073	1,891,148
2030	1,895,964	2,111	1,344	2,356,991

Source: URS Corporation, 2012.

MITIGATED CALCULATIONS

For the 2020 and 2030 mitigated transportation emissions, four separate adjustments were made:

1) Low Carbon Fuels Standard;
2) Pavley Rule;
3) Sustainable Communities; and
4) VMT Reduction.

Each of these is discussed separately below.

Low Carbon Fuels Standard

First, unmitigated emissions were adjusted to account for ARB's Low Carbon Fuels Standard (LCFS). LCFS requires that the carbon content and resulting CO_2 emissions would be reduced by a maximum of 7.2 percent by 2020 and beyond. Consequently, both the 2020 and 2030 mitigated total transportation emissions have been reduced by 7.2 percent to account for the LCFS (California Air Resources Board, 2010).

Pavley Rule

In addition, the Pavely Rule requires more energy efficient light-duty automobiles and light- and medium-duty trucks. The requirement for more energy efficient cars and trucks results in lower GHG emissions, although these reductions only apply to the light-duty and medium-duty component of the vehicle fleet. Table 7 shows the percentage reductions that have been applied to the light and medium duty portions of the vehicle fleet based on the Pavley Rule.

Table 7. Pavley Rule Percentage Reductions in 2020 and 2030

Fleet Component	Percent CO_2e Reduction 2020	Percent CO_2e Reduction 2030
Light Duty Auto	20.37 %	30.60 %
Light Duty Truck 1	18.69 %	28.71 %
Light Duty Truck 2	12.89 %	20.63 %
Medium Duty Truck	12.59 %	20.47 %
Source: California Air Resources Board, 2010.		

Sustainable Communities

The Sustainable Communities and Climate Protection Act of 2008 requires that CARB develop regional greenhouse gas emission reduction targets for passenger vehicles. ARB has established targets for 2020 and 2035 for each region covered by one of the State's 18 metropolitan planning organizations (MPOs). For the eight San Joaquin Valley MPOs, CARB has established an emission reduction target of 5 percent reduction by 2020 and 10 percent reduction by 2035 (CARB, 2011). By interpolation, these numbers translate into an 8 percent reduction by 2030. Passenger vehicles (light-duty autos and trucks) constitute 40 percent of Merced County's total vehicle emissions in 2020 and 2030. Therefore, to account for ARB's Sustainable Communities emission reduction targets, 2020 emissions have been reduced by 2 percent in 2020 and by 3.2 percent in 2030.

VMT Reduction

The transportation study conducted for the Merced County General Plan included mitigated VMT for 2030 (KD Anderson, 2011). As described above, mitigated VMT for 2020 was calculated by interpolating between 2005 and 2030 mitigated VMT. Mitigated VMT for unincorporated Merced County in 2020 and 2030 was estimated by multiplying total VMT by the percentage of the unincorporated county's population. The 2020 and 2030 mitigated VMT estimates are shown above in Table 2.

Mitigated emissions were estimated by taking the ratio of mitigated VMT to unmitigated VMT, which equaled 99.8 percent in 2020 and 99.7 percent in 2030.

Mitigated Results

Table 8 summarizes the mitigated CO_2e emissions from the four measures listed above that include the LCFS, the Pavley Rule, the Sustainable Communities goals, and the VMT reduction. These three measures reduce 2020 transportation emissions by 22.5 percent in 2020 as compared to 2020 BAU emissions, and by 30.7 percent in 2030 as compared to 2030 BAU conditions.

Table 8 Unincorporated Merced County GHG Transportation Emissions (mitigated, metric tons/year)

Area	CO_2e	% Reduction from BAU
2020	1,465,102	22.5%
2030	1,633,445	30.7%

Source: URS Corporation 2012.

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2.2 AREA SOURCES

Area sources include landscape emissions (primarily gasoline combustion) and emissions from hearths, which include wood- and natural gas-fired fireplaces and stoves.

METHODOLOGY

Landscape Maintenance Equipment

Landscape maintenance equipment generates emissions from fuel combustion, from evaporation of unburned fuel, and from fugitive dust generated by equipment such as leaf blowers. For the GHG analysis, only emissions from fuel combustion emit GHGs. The CO_2 emission factors have been developed from the OFFROAD2007 model (ARB, 2006).

Hearths

A two-step process was used to estimate hearth emissions. First the percentage of hearths in each category was estimated. The emission estimates assume the following residential mix of hearths: 0 percent wood burning fireplaces, 68 percent woodstove and woodstove inserts, 32 percent natural gas fireplaces, and 0 percent without any hearths (Broderick, D. and J. Houck, 2003). Then, the amount of fuel consumed and the associated GHG emissions were estimated for each hearth type.

EMISSION RATES APPLIED

Landscape maintenance equipment

Land scape maintenance equipment CO_2 emission rates are derived from ARB's OFFROAD2007 emissions model are as follows (ARB, 2006):

CO_2 (lbs/day) = 0.0525 pounds CO_2 / Single Family Housing Unit (SFHU)/day * # of SFHU

CO_2 (lbs/day) = 1.6 pounds CO_2 / Business Unit * Number Business Units

Hearths - Natural Gas Fireplaces

AP-42 emission factors were used to estimate emissions from natural gas combustion in fireplaces and stoves (U.S. EPA, 1998). The emission equation assumes that the average stove is 30,000 Btus for single family, 20,000 Btus for multi-family, that there are 1,020 Btus per standard cubic foot of natural gas, that each natural gas fireplace is used for an average of three hours per day and 90 days per year (270 hours per year).

The equations assume the following CO_2 emission factor for all types of natural gas stoves:

CO_2 - 120,000 pounds per 1000 standard cubic foot of natural gas (scf)
CH_4 – 2.3 pounds per 1000 scf
N_2O – 2.2 pounds per 1000 scf (U.S. EPA, 1998).

Hearths - Wood Stoves

Wood stove emission factors include emission rates for CO_2 and methane from noncatalytic, catalytic, conventional, and pellet stoves. Annual emissions assume 2.71 tons wood (1.48 cords) would be burned per stove per residential unit during the heating season (Broderick, D., and J. Houck. 2003).

Wood stove emissions are estimated using the following equation:

Wood Stove Emissions (pounds per day) = ((A * C) + (B * D) + (E * F) + (J * K)) * (G)* (H * I)

Where:

A=EPA-certified noncatalytic stove emission rate (pounds pollutant per ton of ton wood burned)
B=EPA-certified catalytic stove emission rate (pounds pollutant per ton of wood burned)
C=Percent of all stoves assumed to be noncatalytic
D=Percent of all stoves assumed to be catalytic
E=Conventional wood stove emission rate (pounds pollutant per ton wood burned)
F=Percent of all stoves assumed to be conventional
G=Cords of wood burned per year per residential unit
H=Number of residential units
I=Percentage of residential units with wood stoves
J=Pellet stove emission rate (pounds pollutant per ton wood burned)
K=Percent of all stoves assumed to be pellet

The following defaults were assumed for wood stove emissions:

A=3,400 pounds CO_2 / ton, 16 pounds CH_4/ton, 0.3 pounds N_2O/ton
B=3,400 pounds CO_2/ ton, 16 pounds CH_4/ton, 0.3 pounds N_2O/ton
C=50% (entered as 0.50)
D=50% (entered as 0.50)
E=3,400 pounds CO_2/ ton
F=0.0%
G=1.48 cords per year per residential unit
I=68% (entered as 0.68)
J=3,400 pound CO_2/ton, 16 pounds CH_4/ton, 0.3 pounds N_2O/ton
K=0.0%

Hearths - Wood Combustion Fireplaces

Fireplace emissions are estimated using the following equation:

Fireplace Emissions (pounds per day) = (J * K * L * M* Q) / N

Where:

J = Fireplace emission rate (pounds of pollutant per residential unit per ton of wood burned)
K = Cords of wood burned per year per residential unit
L = Number of residential units

M= Percentage of residential units with wood stoves
N = Average number of days wood stoves used per year
Q = Conversion factor pounds wood per cord

The following defaults were used to estimate fireplace emissions:

J = 3,400 pounds of CO_2/ton
K = 1.48 cords burned per year per residential unit
L = residential units are based on the residential land uses specified by the user
M = 0% (entered as 0.0)
N = 82 days per year

Emission Results and Mitigated Emissions

Table 9 shows the emission results for 2005, 2020 BAU, and 2030 BAU conditions, which are based on the assumptions described above. Table 7 also shows mitigated 2020 and 2030 emissions. Mitigated emissions are based on a new, more restrictive policy that has been added to the general plan. Implementation of this new policy assumes that 50 percent of existing wood stoves will switch to natural gas by 2020, and 90 percent of new residences would use natural gas stoves in lieu of wood stoves. By 2030, 75 percent of existing wood stoves are assumed to be converted to natural gas, and 100 percent of all new residences would use natural gas fired stoves.

Table 9 Unincorporated Merced County Area Source Emissions (metric tons/yr)

Category	2005	2020 BAU	2020 Mitigated	2030 BAU	2030 Mitigated
Landscaping Emissions (CO_2):	142	216	216	301	301
Hearth Emissions (CO_2):	45,318	70,166	11,661	96,681	16,069
Wood Burning Fireplaces (N_2O):	-	-	-	-	-
Natural Gas Fireplaces (N_2O):	0.08	0.1	0.1	0.2	0.2
Wood Burning Stoves (CH_4):	184	285	285	392	392
Natural Gas Fireplaces (CH_4):	0.080	0.1	0.1	0.2	0.2
Total (CO_2e):	**49,345**	**76,396**	**17,892**	**105,270**	**24,658**

Source: URS Corporation, 2012.

REFERENCES

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U.S. EPA 1996. AP-42 Wood Stove Combustion Factors. Available at: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s10.pdf

2.3 ELECTRICITY

METHODOLOGY

Existing land use information and energy use factors were used to estimate 2005, 2020, and 2030 unincorporated Merced County direct electricity use. Electricity use associated with water use and wastewater treatment was estimated separately and is discussed in the following section. Electricity use was estimated by multiplying the number of residential units by the kWh/residential unit-yr. Table 10 shows electricity use estimates for 2005, 2020, and 2030.

Table 10 Unincorporated Merced County Residential Electricity Use Estimates

Year	Residence Type	Number of units	Estimated Electricity Use/Year (kwh/ residence)	Total Residential Electricity Use (mwh/year)
2005	Single Family Residential	24,192	7,052	170,602
	Multi-Family Residential	1,831	4,238	7,760
2020	Single Family Residential	36,675	7,052	258,632
	Multi-Family Residential	4,275	4,238	18,117
2030	Single Family Residential	51,199	7,052	361,055
	Multi-Family Residential	5,226	4,238	22,148

Source: Kema-Xenergy Itron Roper ASW, 2004.
kwh = kilowatt-hour, mwh = megawatt-hour

Similarly, non-residential electricity use was estimated by multiplying total square footage by an electricity use in kwh/square foot-yr, as shown in Table 11.

Table 11 Unincorporated Merced County Non-Residential Land Use Electricity Use Estimates

Year	Land Use Type	Square Footage (1,000)	Estimated Electricity Use/Year (kwh/sf-yr)	Electricity Use/Year (mwh)
2005	Retail	3,711	10.06	37,333
	Commercial	380	14.18	5,388
	Industrial	10,271	22.67	232,844
2020	Retail	6,246	10.06	62,385
	Commercial	3,041	14.18	43,121
	Industrial	17,668	22.67	400,534
2030	Retail	20,753	10.06	208,775
	Commercial	4,492	14.18	63,697
	Industrial	22,013	22.67	449,035

Source: Itron,, Inc. 2006.

EMISSION RATES APPLIED

Table 12 shows the GHG emission rates for electricity. For 2020 and 2030, two CO_2 emission rates are shown, an unmitigated and a mitigated rate. The unmitigated rate is used per SJVAPCD guidance that recommends no change in GHG emissions per unit of activity as established for the baseline period. Consequently, the 489 pounds CO_2/megawatt-hour is the baseline period GHG emission factor. Changes to PG&E's resource mix that include acquisition of renewable resources will lower the average CO_2/megawatt-hour emission rate for 2020 and 2030.

Table 12 GHG Emission Factors for Electricity Generation

Year	Emission Factor
2005	489.0 pounds CO_2/megawatt-hour
	0.0067 pounds CH_4/megawatt-hour
	0.0037 pounds N_2O/megawatt-hour
2020	489.0 pounds CO_2/megawatt-hour, unmitigated
	290.0 pounds CO_2/megawatt-hour, mitigated
	0.0067 pounds CH_4/megawatt-hour
	0.0037 pounds N_2O/megawatt-hour
2030	489.0 pounds CO_2/megawatt-hour, unmitigated
	290.0 pounds CO_2/megawatt-hour, mitigated
	0.0067 pounds CH_4/megawatt-hour
	0.0037 pounds N_2O/megawatt-hour

Source: CO_2 Emission rates from *PG&E 2011*; CH_4 and N_2O emission rates from *California Climate Action Registry 2009*.

The CO_2 emission rate is specific to PG&E electricity use and is more accurate in this case than California-wide electricity emission rates. PG&E does not publish CH_4 or N_2O-specific emission rates. Consequently, statewide rates were used for these two pollutants.

To estimate GHG emissions, unincorporated Merced County's 2005, 2020, and 2030 electricity use was multiplied by the appropriate emission factors shown above, and the results were converted to metric tons. Metric tons were multiplied by each pollutant's global warming potential and added together to obtain total electric use CO_2e emissions. The results for each year are shown in Table 13.

Table 13 Unincorporated Merced County Electricity GHG Emission Estimates (metric tons/year)

Pollutant	2005	2020 BAU	2020 Mitigated	2030 BAU	2030 Mitigated
CO_2	100,712	173,777	92,546	256,195	130,513
CH_4	1.4	2.4	2.1	3	3
N_2O	0.8	1.3	1.2	1.9	1.7
CO_2e	**100,978**	**174,234**	**92,957**	**256,869**	**131,092**

Source: URS Corporation, 2012.

MITIGATED CALCULATIONS

Mitigated electricity consumption (shown in Table 13) includes two assumptions. The first assumes an increase in the energy efficiency of new and existing buildings above the average energy efficiency values assumed for 2005. This mitigation assumes that, by 2020, all new construction will have energy use that is 15 percent below existing energy use rates, and that 50 percent of existing residential and non-residential buildings will be retrofitted to reduce energy use by 15 percent below existing energy use rates. This results in an electricity reduction of 10.2 percent overall in 2020 as compared to BAU.

By 2030, mitigated electricity consumption is assumed to be reduced by 14.1 percent. This percentage assumes that all new construction (after 2020) would achieve an emission reduction of 25 percent below existing energy use rates, and that 75 percent of existing buildings built before 2020 would be retrofitted to achieve an energy efficiency of 25 percent below existing energy use rates.

The second mitigated electricity assumption is associated with the Renewable Portfolio Standards mandated by SB 2(1). This law requires that electric utilities increase their percentage of renewable resource generation to 33 percent by 2020. Accordingly, the mitigated 2020 and 2030 emission estimates assume 290 metric tons CO_2 per megawatt-hour generated, whereas unmitigated assumes 489 metric tons CO_2 per megawatt-hour (PG&E, 2011).

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2.4 WATER AND WASTEWATER

METHODOLOGY

A three step approach was used to estimate GHG emissions associated with water use and wastewater disposal associated with land use development. Agricultural water use and associated GHG emissions are estimated separately and discussed in the agricultural sections. In the first step, the amount of water used and the amount of wastewater disposed of was identified for Merced County in 2005, 2020, and 2030. The amount of water used was based on information in a Merced County water use report (Nolte 2009). The quantities of water were then divided into indoor and outdoor use. All indoor water use was assumed to be disposed of by wastewater treatment.

STEP 1 – ESTIMATING WATER USE

Table 14 shows residential and nonresidential water use estimates for four years. The years 2009 and 2030 were based on a Merced County water use report (Nolte, 2009). Water use in 2005 and 2020 estimated by interpolation.

Table 14 Residential and Nonresidential Water Use Estimates

	2005	2009	2020	2030
Million Gallons /Year	14,875	20,211	34,888	48,231
Acre-Feet/Year	45,640	62,016	107,051	147,992

Source: Nolte, 2009. Estimated water use supplied for 2009 and 2030. Water use for 2005 and 2020 estimated by interpolation. These estimates do not include agricultural water use.

Indoor versus Outdoor Water Use

Once total water use was known, it was divided into indoor versus outdoor use using the information shown in Table 15.

Table 15 Indoor versus Outdoor Water Use Estimates

	2005	2020	2030
% indoor water use	0.636	0.62	0.61
% outdoor water use	0.364	0.38	0.39
Total	**1.00**	**1.00**	**1.00**

Source: URS Corporation and Maddaeus Water Management, 2004.

The equations used to estimate indoor and outdoor water use are shown below.

Indoor use (2005) = 0.636 x 14,874 million gallons/year
= 9,460 million gallons/year

Outdoor use (2005) = 0.364 x 14,874 million gallons/year
= 5,414 million gallons/year

Indoor use (2020) = 0.62 x 34,888 million gallons/year
= 21,631 million gallons/year

Outdoor use (2020) = 0.38 x 34,888 million gallons/year
= 13,257 million gallons/year

Indoor use (2030) = 0.61 x 48,231 million gallons/year
= 29,421 million gallons/year

Outdoor use (2030) = 0.39 x 48,231 million gallons/year
= 18,810 million gallons/year

STEP 2 – ESTIMATING ENERGY USE

The second step involves estimating energy use associated with this water demand. Electricity consumption associated with water use was based on a report prepared for the California Energy Commission (Navigant 2006). Table 16 summarizes the electricity consumption associated with water use.

Table 16 Electricity Consumption for Water Use

	Indoor Uses		Outdoor Uses	
	Northern California (kWh/MG)	**Southern California (kWh/MG)**	**Northern California (kWh/MG)**	**Southern California (kWh/MG)**
Water Supply and Conveyance	2,117	9,727	2,117	9,727
Water Treatment	111	111	111	111
Water Distribution	1,272	1,272	1,272	1,272
Wastewater Treatment	1,911	1,911	0	0
Regional Total	**5,411**	**13,022**	**3,500**	**11,111**

Source: Navigant Consulting 2006.

Using the indoor and outdoor water use estimated in Step 1, electricity use associated with that water was estimated separately using the kilowatt hours per million gallon estimates shown in Table 16 above.

Indoor Energy Use (2005)
Mwh/year = (5411 kwh/million gallons) x (9,460 million gallons/year) x (mwh/1000 kWh)
= 51,188 mwh/year

Outdoor Energy Use (2005)
MWh/year = (3500 kwh/million gallons) x (5,414 million gallons/year) x (mwh/1000 kwh)
= 18,949 mwh/year

Total Indoor + Outdoor Electricity Use Associated with Water Use (2005) = 51,188 mwh/year (indoor) + 18,949 mwh/year (outdoor)
= 70,137 mwh/year

Indoor Energy use (2020)
Mwh/year = (5411 kwh/million gallons) x (21,631 million gallons/year) x (mwh/1000 kwh)
= 117,045 mwh/year

Outdoor Energy Use (2020)
MWh/year = (3500 kwh/million gallons) x (13,257 million gallons/year) x (mwh/1000 kwh)
= 46,400 mwh/year

Total Indoor + Outdoor Electricity Use Associated with Water Use (2020) = 117,045 mwh/year (indoor) + 46,400 mwh/year (outdoor)
= 163,445 mwh/yr

Indoor Energy use (2030)
Mwh/year = (5411 kwh/million gallons) x (29,421 million gallons/year) x (mwh/1000 kwh)
= 159,197 mwh/year

Outdoor Energy Use (2030)
MWh/year = (3500 kwh/million gallons) x (18,810 million gallons/year) x (mwh/1000 kwh)
= 65,835 mwh/year

Total Indoor + Outdoor Electricity Use Associated with Water Use (2030) = 159,197 mwh/year (indoor) + 65,835 mwh/year (outdoor)
= 225,032 mwh/year

STEP 3 - GREENHOUSE GAS EMISSIONS ASSOCIATED WITH WATER-RELATED ELECTRICITY USE

The third step involves estimating GHG emissions associated with the water- and wastewater-related electricity use estimated in Step 2.

Metric tons CO_2 (2005) = (489.00 lbs CO_2 /mwh) x (70,137 mwh/year) x (metric ton/2204 lbs)
= 15,561 metric tons CO_2/year

Metric tons CH_4 (2005) = (0.0067 lbs CH_4/mwh) x (70,137 mwh/year) x (metric ton/2204 lbs)
= 0.213 metric tons CH_4/year

Metric tons N_2O (2005) = (0.0037 lbs N_2O /mwh) x (70,137 mwh/year) x (metric ton/2204 lbs)
= 0.118 metric tons N_2O /year

Metric tons CO_2e (2005) = 15,561 metric tons CO_2 + (0.213 metric tons CH_4 *21) + (0.118 metric tons N_2O x 310)
= 15,602 metric tons CO_2e

Metric tons CO_2 (2020) = (489.00 lbs CO_2 /mwh) x (163,445 mwh/year) x (metric ton/2204 lbs) =
= 36,263 metric tons CO_2/year

Metric tons CH_4 (2020) = (0.0067 lbs CH_4/mwh) x (163,445 mwh/year) x (metric ton/2204 lbs)
= 0.50 metric tons CH_4/year

Metric tons N_2O (2020) = (0.0037 lbs N_2O /mwh) x (163,445 mwh/year) x (metric ton/2204 lbs)
= 0.274 metric tons N_2O /year

Metric tons CO_2e (2020) = 36,263 metric tons CO_2 + (0.50 metric tons CH_4 *21) + (0.27 metric tons N_2O x 310)
= 36,359 metric tons CO_2e

Metric tons CO_2 (2030) = (489.00 lbs CO_2 /mwh) x (225,032 mwh/year) x (metric ton/2204 lbs)
= 49,928 metric tons CO_2/year

Metric tons CH_4 (2030) = (0.0067 lbs CH_4/mwh) x (225,032 mwh/year) x (metric ton/2204 lbs)
= 0.684 metric tons CH_4/year

Metric tons N_2O (2030) = (0.0037 lbs N_2O /mwh) x (225,032 mwh/year) x (metric ton/2204 lbs)
= 0.378 metric tons N_2O /year

Metric tons CO_2e (2030) = 7,669 metric tons CO_2 + (0.105 metric tons CH_4 *21) + (0.058 metric tons N_2O x 310)
= 50,059 metric tons CO_2e

Table 17 below summarizes for the years 2005, 2020, and 2030.

Table 17 Unincorporated Merced County Water and Wastewater GHG Emissions (metric tons/year)

	2005	2020 BAU	2020 Mitigated	2030 BAU	2030 Mitigated
CO_2	15,561	36,263	21,506	49,928	29,609
CH_4	0.213	0.50	0.50	0.684	0.684
N_2O	0.118	0.27	0.274	0.378	0.378
CO_2e	**15,602**	**36,357**	**21,601**	**50,059**	**29,741**

Source: URS Corporation, 2012.

Mitigated Emissions

The only difference between unmitigated and mitigated emissions in Table 17 is that the BAU estimates assume 290 metric tons CO_2 per megawatt-hour, whereas unmitigated assumes 489 metric tons CO_2 per megawatt-hour (PG&E, 2011). This difference in CO_2 emission factors between 2009 and the 2020 and 2030 scenarios is due to the Renewable Portfolio Standards (RPS) mandated by Senate Bill 2(1x). The RPS requires that California's electric utilities generate 33 percent of their electricity from renewable resources by 2020.

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2.5 NATURAL GAS

METHODOLOGY

Existing land use information and energy use factors were used to estimate 2005, 2020, and 2030 unincorporated Merced County natural gas use (Table 18). Natural gas use was estimated by multiplying the number of residential units by millions of Btus (MMBtu)/residential unit-yr.

Table 18 Unincorporated Merced County Residential Natural Gas Use

Year	Land Use Type	Number of units	Estimated Natural Gas Use/Year (MMBtu/ residence)	Total Residential Natural Gas Use (MMBtu/year)
2005	Single Family Residential	24,192	50.8	1,228,954
	Multi Family Residential	1,831	23.7	43,395
2020	Single Family Residential	36,675	50.8	1,863,090
	Multi Family Residential	4,275	23.7	101,318
2030	Single Family Residential	51,199	50.8	2,600,909
	Multi Family Residential	5,226	23.7	123,856

Source: Kema-Xenergy Itron Roper ASW, 2004.

Similarly, non-residential natural gas use was estimated by multiplying total square footage by a natural gas use in MMBtu/square foot-yr (Table 19).

Table 19 Unincorporated Merced County Non-Residential Natural Gas Use

Year	Land Use Type	Square Feet (1,000)	Estimated Electricity Use/Year (MMBtu/ square foot)	Estimated Natural Gas Use (MMBtu/year)
2005	Retail	3,711	0.0128	47,500
	Commercial	380	0.027	10,260
	Industrial	10,271	0.042	431,340
2020	Retail	6,246	0.0128	79,949
	Commercial	3,041	0.027	82,107
	Industrial	17,668	0.042	742,056
2030	Retail	20,753	0.0128	265,638
	Commercial	4,492	0.027	121,284
	Industrial	22,013	0.042	924,546

Source: Itron, Inc. 2006.

EMISSION RATES APPLIED

Three GHG emission rates for natural gas use were used for the baseline inventory as shown in Table 20.

Table 20 GHG Emission Factors for Natural Gas Generation

Natural Gas Emission Factors
53.05 kg CO_2/MMBtu
0.005 kg CH_4/MMBtu
0.0001 kg N_2O/MMBtu
Source: California Climate Action Registry 2009.

To estimate GHG emissions, unincorporated Merced County's natural gas use in 2005, 2020, and 2030 was multiplied by the emission factors shown above, and the results were converted to metric tons. Then, the metric ton values were multiplied by each pollutant's global warming potential and added together to obtain total natural gas use CO_2e emissions (Table 21).

Table 21 Unincorporated Merced County Natural Gas GHG Emissions (metric tons/year)

	2005	2020 BAU	2020 Mitigated	2030 BAU	2030 Mitigated
CO_2	93,295	151,927	136,431	213,774	183,632
CH_4	8.8	14	13	20	17
N_2O	0.2	0.3	0.3	0.4	0.3
CO_2e	**93,534**	**152,317**	**136,780**	**214,322**	**184,102**

Source: URS Corporation, 2012.

MITIGATED CALCULATIONS

Mitigated natural gas consumption (also shown in Table 21) assumes an increase in energy efficiency over existing building energy consumption in 2020 and 2030. This assumption is driven by requirements to comply with California's Title 24 regulation. By 2020, all new construction will reduce energy use by 15 percent below existing energy use rates, and 50 percent of existing residential and non-residential buildings will reduce energy use by 15 percent below existing energy use rates . This will reduce natural gas consumption by 10.2 percent overall in 2020 as compared to BAU.

By 2030, mitigated natural gas consumption would be reduced by 14.1 percent overall as a result of energy efficiency improvements. This assumes that all new construction (after 2020) would reduce natural gas consumption (and associated natural gas emissions) by 25 percent below existing energy use rates, and that 75 percent of existing buildings built before 2020 would improve their energy efficiency by 25 percent as compared to 2005 natural gas use rates.

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2.6 SOLID WASTE

METHODOLOGY

A two-step process was used to estimate GHG emissions with solid waste disposal. In step one, the amount of solid waste generated by unincorporated land uses in Merced County was estimated. Estimates of solid waste generation were estimated separately for residential and non-residential land uses.

STEP 1 – ESTIMATE SOLID WASTE GENERATION

2005 Residential Solid Waste Generation:
Solid waste generation/year = 24,192 single-family residential units x 2.232 tons solid waste/residence-yr + 1,831 multi-family residential units x 1.17 tons solid waste/residence-yr = 56,138 tons solid waste/year

2005 Non-residential Solid Waste Generation:
Solid waste generation/year = (10,271,000 sf warehouse sf x 0.0025915 tons solid waste/sf-yr) + (380,000 sf office x 0.0108 tons solid waste/sf-yr + 3,711,000 sf retail x 0.0024 tons solid waste/sf-yr) = 39,627 tons solid waste/year

2005 Total Solid Waste Generation:
95,765 tons solid waste generation/year = 56,139 residential + 39,612 non-residential

2020 Residential Solid Waste Generation:
Solid waste generation/year = 36,675 single-family residential units x 2.232 tons solid waste/residence-yr + 4,275 multi-family residential units x 1.17 tons solid waste/residence-yr = 86,860 tons solid waste/year

2020 Non-residential Solid Waste Generation:
Solid waste generation/year = (17,668,000 sf warehouse sf x 0.0025915 tons solid waste/sf-yr) + (3,041,000 sf office x 0.0108 tons solid waste/sf-yr + 6,246,000 sf retail x 0.0024 tons solid waste/sf-yr) = 93,620 tons solid waste/year

2020 Total Solid Waste Generation:
180,479 tons solid waste generation/year = 86,860 residential + 93,620 non-residential

2030 Residential Solid Waste Generation:
Solid waste generation/year = 51,199 single-family residential units x 2.232 tons solid waste/residence-yr + 5,226 multi-family residential units x 1.17 tons solid waste/residence-yr = 120,389 tons solid waste/year

2030 Non-residential Solid Waste Generation:

Solid waste generation/year = (22,013,000 sf warehouse sf x 0.0025915 tons solid waste/sf-yr) + (4,492,000 sf office x 0.0108 tons solid waste/sf-yr + 20,753,000 sf retail x 0.0024 tons solid waste/sf-yr)
= 155,367 tons solid waste/year
2030 Total Solid Waste Generation:
275,756 tons solid waste generation/year = 120,389 residential + 155,367 non-residential

STEP 2 – ESTIMATE EMISSIONS ASSOCIATED WITH SOLID WASTE

In the second step, emissions were estimated for hauling solid waste to the landfill and for the decomposition of that waste.

Solid Waste Hauling

Table 22 summarizes the haul truck assumptions associated with solid waste hauling. The number of round trips/year is based on the total annual amount of solid waste generated and on the total solid waste truck hauling capacity. The total number of vehicle miles traveled per year is based on the round trips/year times the average round trip truck haul distance. Once VMT is known, it is multiplied by the average grams per mile for CO_2 and CH_4, which are then converted to metric tons per year. The emission rates applied for solid waste handling were based on those included in the ARB EMFAC2007 model (see Table 23).

Table 22 Haul Truck Assumptions

Assumptions	2005	2020	2030
Average Round Trip Truck Haul Distance (miles):	40.00	40.00	40.00
Solid Waste Truck Capacity (tons):	15.00	15.00	15.00
Round Trips/Year:	6,384.39	12,031.95	18,383.79
Miles per Year:	255,375.75	481,278.01	735,351.46
Source: URS Corporation, 2012.			

Table 23 Merced County EMFAC Emission Factors

Year	CO_2 (grams/mile)	Methane (grams/mile)
2005	1723.5	0.06
2020	1803.6	0.03
2030	1812.1	0.01
Source: California Air Resources Board, 2009.		

Hauling Emissions

2005 Metric tons CO_2/year = 255,375.75 miles per year x 1,815.93 grams CO_2/mile x lb/454 grams x metric ton/2204 lbs
= 463.5 metric tons CO_2

2005 Metric tons CH_4/year = 255,375.75 miles per year x 0.06 grams CH_4/mile x lb/454 grams x metric ton/2204 lbs
= 0.015 metric tons CH_4

2005 CO_2e = 463.5 metric tons CO_2 + (0.015 metric tons CH_4 x 21)
= 463.8 metric tons CO_2e in 2005

2020 Metric tons CO_2/year = 481,278.01 miles per year x 1,803.6 grams CO_2/mile x (1-0.072) x lb/454 grams x metric ton/2204 lbs
= 805.0 metric tons CO_2

2020 Metric tons CH_4/year = 481,278.01 miles per year x 0.02 grams CH_4/mile x lb/454 grams x metric ton/2204 lbs
= 0.0096 metric tons CH_4

2020 CO_2e = 805.0 metric tons CO_2 + (0.0096 metric tons CH_4 x 21)
= 805.2 metric tons CO_2e in 2005

2030 Metric tons CO_2/year = 735,351.46 miles per year x 1,812.1 grams CO_2/mile x (1-0.072) x lb/454 grams x metric ton/2204 lbs
= 1,235.8 metric tons CO_2

2030 Metric tons CH_4/year = 735,351.46 miles per year x 0.01 grams CH_4/mile x lb/454 grams x metric ton/2204 lbs
= 0.007 metric tons CH_4

2030 CO_2e = 1,235.8 metric tons CO_2 + (0.007 metric tons CH_4 x 21)
= 1,235.9 metric tons CO_2e in 2005

Landfill Methane Emissions

EPA created the Waste Reduction Model (WARM) to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions from several different waste management practices (EPA 2010). This spreadsheet model was most recently updated in August 2010.

WARM calculates and totals GHG emissions of waste management practices: source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in metric tons of carbon dioxide equivalent across a wide range of material types commonly found in municipal solid waste (MSW). For this analysis, WARM was used to estimate MT CO_2E for Merced's 2005, 2020, and 2030 solid waste volumes conditions. An emission factor of 0.31 metric tons CO_2e per short ton of mixed solid waste was used to generate the emission estimates, which assumes a landfill operating with a flare (EPA, 2010).

2005 Metric tons CO_2e/year = 95,765 tons solid waste/year x 0.31 metric tons CO_2e/ton solid waste (landfilling with flaring)
= 29,687 metric tons CO_2e/year

2005 Total Solid Waste Emissions = 463.5 metric tons CO_2e per year (hauling) + 29,687 metric tons CO_2e per year (landfilling with flaring)
= 30,151 metric tons CO_2e/year

2020 Metric tons CO_2e/year = 180,479 tons solid waste/year x 0.31 metric tons CO_2e/ton solid waste (landfilling with flaring)
= 55,948 metric tons CO_2e/year

2020 Total Solid Waste Emissions = 805.2 metric tons CO_2e per year (hauling) + 55,948 metric tons CO_2e per year (landfilling with flaring)
= 56,754 metric tons CO_2e/year

2030 Metric tons CO_2e/year = 275,756 tons solid waste/year x 0.31 metric tons CO_2e/ton solid waste (landfilling with flaring)
= 85,484 metric tons CO_2e/year

2030 Total Solid Waste Emissions = 1,236 metric tons CO_2e per year (hauling) + 85,484 metric tons CO_2e per year (landfilling with flaring)
= 86,720 metric tons CO_2e/year

Table 24 summarizes total solid waste emissions for each year.

Table 24 Landfill GHG Emissions (metric tons)

Category	2005	2020 BAU	2030 BAU
Truck Hauling (CO_2e)	464	805	1,236
Solid Waste Decomposition (CO_2e)	29,687	55,949	85,485
Total	**30,151**	**56,754**	**86,721**
Source: URS Corporation, 2012.			

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2.7 AGRICULTURE

METHODOLOGY

Agriculture emissions can be attributed to four major sources: 1) livestock emissions resulting from enteric fermentation and manure emissions, 2) agricultural field equipment combustion emissions, 3) fertilizer emissions and 4) water pumping. Each of these is discussed below.

Livestock Emissions

Livestock populations for milk cows and beef cattle are the major source of emissions for enteric fermentation and manure. Poultry, swine, sheep and turkeys are minor emission sources and are included in this inventory. Estimating animal populations for 2005 followed a consistent methodology that has been applied in Merced County for its Animal Confinement Ordinance and environmental impact report (Merced County, 2002a, 2002b, and 2007), which was recently updated for a San Joaquin Valley Cumulative herd forecast as part of the Foster Farms Dairy EIR (Stanislaus County 2009) and then verified with the SJVAPCD Permits Division (Villalvazo pers. comm. 2009). Actual total herd, cattle and milk cow numbers were obtained from the California Department of Food and Agriculture (CDFA) California Annual Dairy statistics for 2005, statistics on Cows, Dairies, Dairies per Cow by County (CDFA 2005a) and the California Agriculture Resource Directory (CDFA 2005b; Dapper pers. comm. 2009). Dairy and cattle herds typically consist of support stock in addition to the milk cows or the beef cattle, which includes steers, bulls, dry cows, heifers, and calves. Thus, it is necessary to factor in the number of cow and cattle support stock to make the list accurately reflect the total cow and cattle populations. The 2005, 2020, and 2030 total livestock populations presented in Table 24 were developed from factors developed from actual San Joaquin Valley Air Pollution Control District (SJVAPCD) permit data for milk cow support stock as well as national agricultural statistics service data for beef cattle support stock (Villalvazo pers. comm. 2009).

Livestock populations for poultry, swine, sheep and turkeys was obtained from the Merced County agricultural data, also presented in Table 24 (Merced County 2005; Merced County 2010).

Table 25 shows 2005, 2010, 2020, and 2030 animal population levels and enteric and manure emission rates. Annual populations for 2020 and 2030 were based on 2010 animal populations and assume a 1 percent annual growth rate. The emission rates are based on ARB emission factors (ARB, 2009a).

Table 25 Livestock in Unincorporated Merced County for 2005, 2010, 2020, and 2030

Animal Type	Population 2005	Population 2010	Population 2020	Population 2030	Enteric Fermentation Emission Rates (metric tons/head/year)	Manure Emission Rates (metric tons/head/year)	
					Methane (CH_4)	Methane (CH_4)	N_2O
Beef Cattle	27,000	29,074	32,115	35,475	0.085556	0.002158	n/a
Beef replacement heifers	19,200	20,675	22,838	25,227	0.066208	0.001914	n/a
Steers	67,200	72,361	79,932	88,294	0.033349	0.001470	n/a
Bulls	9,600	10,337	11,419	12,613	0.053000	0.002793	n/a
Milk Cows	238,000	256,278	283,091	312,708	0.116520	0.164125	0.000738
Dry Cows	42,911	46,207	51,041	56,381	0.116520	0.164125	0.000738
Heifers 15-24 months	95,486	102,819	113,577	125,459	0.067047	0.002210	0.001620
Heifers 4-14 months	29,631	31,907	35,245	38,932	0.042376	0.002210	0.001620
Calves	95,486	51,256	56,618	62,542	0.042376	0.002210	0.001620
Chickens (fryers)	93,612,430	77,744,725	85,878,543	94,863,339	n/a	0.000018	0.000002
Goats, Hogs, Pigs	30,097	38,735	42,788	47,264	0.001500	0.028228	0.000141
Sheep and Lambs	36,525	29,650	32,752	36,179	0.008000	0.000781	0.000002
Turkeys	2,168,576	2,306,709	2,548,042	2,814,623	n/a	0.000086	0.000010
Total Livestock Population	**96,424,256**	**80,740,732**	**89,187,999**	**98,519,037**			

Source: Planning Partners 2009; Merced County 2005; Merced County, 2010, CARB 2009a.

For purposes of this inventory, all agricultural activity – livestock and farming – was assumed to occur only in Merced County's unincorporated areas.

Table 26 summarizes GHG emissions associated with livestock for 2005, 2020 BAU, 2020 mitigated, 2020 agricultural mitigation alternative, 2030 BAU, 2030 mitigated conditions, and 2030 agricultural mitigation alternative.

The 2020 mitigated emissions assume that revised Merced General Plan policies will result in a 5 percent reduction in GHG emissions associated with manure from dairy cows only. The 2030 mitigated emissions assume that the same General Plan policies will result in a 10 percent GHG reduction. For the 2020 and 2030 agriculture mitigation alternatives, the estimates assume that 90 percent of dairy manure GHG emissions will be controlled by 2020 and 2030.

Table 26 Unincorporated Merced County Livestock GHG Emissions (metric tons/year)

Pollutant	2005	2020 BAU	2020 Mitigated	2020 Ag Mitigation Alternative	2030 BAU	2030 Mitigated	2030 Ag Mitigation Alternative
CO_2	-	-	-	-	-	-	-
CH_4	98,574	116,903	114,135	67,093	129,133	123,020	74,112
N_2O	700	783	754	261	885	801	289
CO_2e	**2,287,167**	**2,697,604**	**2,630,511**	**1,489,941**	**2,979,833**	**2,831,609**	**1,645,822**

Source: URS Corporation, 2012.

Agricultural Field Equipment Combustion Emissions

GHG emission estimates for agricultural operations equipment were obtained by running the CARB OFFROAD2007 model (CARB 2009b). OFFROAD2007 was used to estimate offroad equipment emissions for all Merced County agricultural equipment. Table 27 shows that agricultural equipment emissions are expected to decrease from 2005 to 2020 and from 2020 to 2030. These decreases are based on improvements in the energy efficiency of agricultural equipment, along with improvements in emission control technology.

Table 27 Merced County Agricultural Equipment GHG Emissions

Year	Metric tons CO_2/year	Metric tons CH_4/year	Metric tons N_2O/year	Metric tons CO_2e/year
2005	150,020.6	30.9	1.8	151,214.4
2020	145,014.9	9.8	1.4	145,650.8
2030	141,630.7	5.6	1.3	142,148.5

Source: California Air Resources Board, 2009b.

Fertilizer Emissions

Table 28 summarizes the amount of fertilizer applied in 2005, and the amount estimated to be applied in 2020 and 2030. The total nitrogen applied in 2005 equaled 92,971 tons and is based on California Department of Food and Agriculture data for Merced County (CDFA, 2007). The total

nitrogen applied per acre was calculated for 2005, and that per acre estimate was multiplied by the total number of agricultural acres estimated for 2020 and 2030 to obtain the tons nitrogen applied.

The estimated number of agricultural acres was estimated by using the actual agricultural acreage of 1,160,304 acres in 2010. Under buildout of Merced County's General Plan, the total number of agricultural acres is estimated to decrease by a maximum of 3,681.0 acres. Assuming buildout happens by 2030, the total 2030 agricultural acreage equals the 2010 acreage minus the total agricultural acreage lost (1,160,304 – 3,681.0 = 1,156,623 acres). The 2020 agricultural acreage is simply an interpolation between the 2010 and 2030 acreages.

GHG emission rates from fertilizers are from the statewide GHG inventory technical documentation, and provide an emissions rate of 0.01425 metric tons of nitrous oxides per ton of organic and synthetic fertilizers (CARB 2009a).

Mitigated emissions for 2020 and 2030 assume a 5 percent reduction in the fertilizer use per acre based on a new Merced County General Plan policy designed to reduce the use of nitrogen fertilizer.

Table 28 Merced County Fertilizer Emissions

Year	Tons Nitrogen Applied	Merced County Agricultural Acreage	N_2O Emissions (metric tons/year)	CO_2e (metric tons/year)	Mitigated CO_2e (metric tons/year)
2005	92,971	1,147,754	1,325.837	410,699	-
2020	93,845	1,158,464	1,337.199	414,532	393,805
2030	93,702	1,156,623	1,335.074	413,873	393,179

Source: California Department of Food and Agriculture, 2007.
CO_2e estimated by multiplying N_2O emissions by the 310, the global warming potential of N_2O.

Water Pumping Emissions

Agricultural water pumping typically is powered by diesel or electrically powered pumps. The acre-feet of water per acre was estimated for 2005 using estimates of the total agricultural acres in Merced County and the acre-feet of water applied (CDWR, 2011). The acre-feet per acre value in 2005 was used to estimate the amount of acre feet required in 2020 and 2030. The percentages of electricity and diesel fuel use in 2005 were used to estimate 2020 and 2030 electricity and diesel fuel use. Table 29 shows the agricultural acres in 2005, 2020, and 2030, the acre-feet applied per acre, the total acre-feet applied, and the amount of electricity (kwh/year) and gallons of diesel fuel used to pump water. These estimates for electricity and diesel use assume 70 percent of water is pumped using electricity and 30 percent using diesel powered pumps.

Table 29 Unincorporated Merced County Agricultural Water Pumping Estimates

Year	Acres	Acre-feet/Acre	Acre-feet	Electricity Kwh/year	Diesel Gallons/year
2005	1,147,754	1.4	1,612,178	196,363,200	2,067,707
2020	1,158,542	1.4	1,627,331	198,208,911	2,087,142
2030	1,156,780	1.4	1,624,856	197,907,489	2,083,968
Source: California Department of Water Resources, 2011.					

The electricity use was multiplied by the electricity GHG emission factors shown in Table 12 and the diesel GHG emission factors are shown in Table 5. Table 30 shows the resulting emissions associated with agricultural pumping.

The 2020 mitigated and 2030 mitigated emissions include two mitigation components. For the electricity component of water pumping, a reduction is taken to account for reduced CO_2e per megawatt generated. This reduction is a requirement of California's Renewable Portfolio Standards (SB 2 (1)) that requires all of California's electrical utilities to increase their renewable resource percentage to 33 percent by 2020 (PG&E, 2011).

The 2020 and 2030 mitigated emissions also assume a 10 percent reduction in water use and associated electricity and diesel fuel consumption. The 10 percent reduction in water use is the result of expected improvements in watering efficiency that would result from an additional Merced County General Plan policy designed to improve agricultural pump efficiencies.

Table 30 Unincorporated Merced County Agricultural Water Pumping Emissions (metric tons/year)

Year	CO_2	CH_4	N_2O	CO_2e
2005	64,554	1.80	0.87	64,861
2020 BAU	65,157	1.8	0.9	65,466
2020 Mitigated	42,535	1.6	0.8	42,814
2030 BAU	65,053	1.8	0.9	65,362
2030 Mitigated	42,468	1.6	0.8	42,745
Source: URS Corporation, 2012.				

AGRICULTURAL EMISSIONS SUMMARY

Table 31 summarizes agricultural GHG emissions in unincorporated Merced County. BAU and mitigated emissions are shown for 2020 and 2030. Mitigated livestock emissions assume a 5 percent reduction in manure emissions from dairy cattle only and a 0 percent reduction in enteric fermentation emissions by 2020, and a 10 percent reduction in dairy cattle manure emissions from dairy cattle by 2030. These reductions are based on existing and proposed General Plan policies designed to reduce GHG emissions from dairy cattle.

The 2020 and 2030 emissions shown for the agriculture alternative assume a 90 percent reduction in dairy cattle manure emissions and a 0 percent reduction in enteric fermentation emissions. Mitigated fertilizer emissions assume a 5 percent reduction in fertilizer use based on General Plan policies. Mitigated water pumping emissions assume a 10 percent decrease in water use associated with more efficient water application technology and additional reductions to account for the electrical portion of water pumping that will be affected by California's Renewable Portfolio Standard (RPS). The RPS will result in 2020 and 2030 electricity generation that uses 290 metric tons CO_2 per megawatt-hour, whereas the unmitigated (2005) electricity emission estimates assumes 489 metric tons CO_2 per megawatt-hour (PG&E, 2011).

Table 31. Agricultural Emissions Summary (metric tons CO_2e/year)

Category	2005	2020 BAU	2020 Mitigated	2020 Ag Alternative	2030 BAU	2030 Mitigated	2030 Ag Alternative
Livestock	2,287,166	2,697,604	2,630,511	1,489,941	2,979,833	2,831,609	1,645,822
Equipment	151,214	145,651	145,651	145,651	142,148	142,148	142,148
Fertilizers	410,699	414,532	393,805	393,805	413,873	393,179	393,179
Water Pumping	64,861	65,466	42,814	42,814	65,362	42,745	42,745
Total	**2,913,941**	**3,323,252**	**3,212,781**	**2,072,211**	**3,601,216**	**3,409,683**	**2,223,896**

Source: URS Corporation, 2012.

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3 RESULTS

Table 32 presents GHG sources by category. Based on the methods and emission sources described above, the 2005 GHG baseline inventory shows there were 4.489 million metric tons of CO_2e emitted in unincorporated Merced County. The emissions would grow to 5.710 million by 2020 and to 6.671 million in 2030, assuming BAU conditions. With mitigation, 2020 emissions would equal 5.003 million metric tons of CO_2e, and 2030 emissions would equal 5.499 million metric tons. These mitigated emission levels exceed the 2005 baseline inventory. The 2020 and 2030 Ag Alternative emissions equal 3.863 and 4.313 million metric tons, respectively. These emissions are less than the 2005 baseline condition.

Table 32 Total GHG Emissions for Unincorporated Merced County (metric tons CO_2e/year)

Emission Source Category	2005	2020 BAU	2020 Mitigated	2020 Ag Alternative	2030 BAU	2030 Mitigated	2030 Ag Alternative
Transportation	1,297,634	1,891,148	1,465,102	1,465,102	2,356,991	1,633,445	1,633,445
Area Source	49,345	76,396	17,892	17,892	105,270	24,658	24,658
Electricity	100,978	174,234	92,957	92,957	256,869	131,092	131,092
Natural Gas	93,534	152,317	136,780	136,780	214,322	184,102	184,102
Water & Wastewater	15,601	36,359	21,601	21,601	50,059	29,741	29,741
Solid Waste	30,151	56,754	56,754	56,754	86,721	86,721	86,721
Ag – Livestock	2,287,166	2,697,604	2,630,511	1,489,941	2,979,833	2,831,609	1,645,822
Ag- Equipment	151,214	145,651	145,651	145,651	142,148	142,148	142,148
Ag – Fertilizers	410,699	414,532	393,805	393,805	413,873	393,179	393,179
Ag - Water Pumping	64,861	65,466	42,814	42,814	65,362	42,745	42,745
Total	**4,501,184**	**5,710,459**	**5,003,867**	**3,863,298**	**6,671,448**	**5,499,442**	**4,313,655**
Percent Reduction from BAU			**12.4%**	**32.3%**		**17.6%**	**35.3%**

Source: URS Corporation, 2012.

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