Memo

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Date: October 5, 2018

To: Constance Robledo and Mindi Nunes, Yolo County Administrator's Office

From: Dan Krekelberg, Erik de Kok, and Honey Walters

Subject: Countywide Greenhouse Gas Emissions Inventory Update for the Yolo County Climate Action Plan – Technical Memorandum

INTRODUCTION

In March 2011, the Yolo County (County) Board of Supervisors adopted a countywide Climate Action Plan (CAP) that established a strategy for smart growth implementation, greenhouse gas (GHG) emissions reductions, and adaptation to climate change. Ascent Environmental, Inc. (Ascent) served as a consultant to the County during the development of this plan, preparing a 2008 base-year GHG emissions inventory for community-wide sources in the unincorporated County and future-year GHG emissions projects. In May 2018, Ascent was tasked by the County to update the GHG emissions inventory using new data sources, emissions factors and current methodologies. This technical memorandum summarizes the updated GHG Inventory for 2016, the most recent year for which data is available, provides a general comparison of the 2008 and 2016 inventories, and a detailed description of the data, methods and assumptions used to achieve these results.

ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of two main parts:

- **Section 1: Summary of Inventory Results** presents an overview of the 2016 GHG emissions inventory for each sector. Key components include:
  - a summary of annual emissions by sector, and
  - a general comparison of 2008 and 2016 emissions for some sectors.
- **Section 2: Data, Methods, and Assumptions by Sector** summarizes data, methods, and assumptions used in the 2016 inventory and adjustments to the 2008 inventory.

1 SUMMARY OF INVENTORY RESULTS

1.1 2016 INVENTORY RESULTS

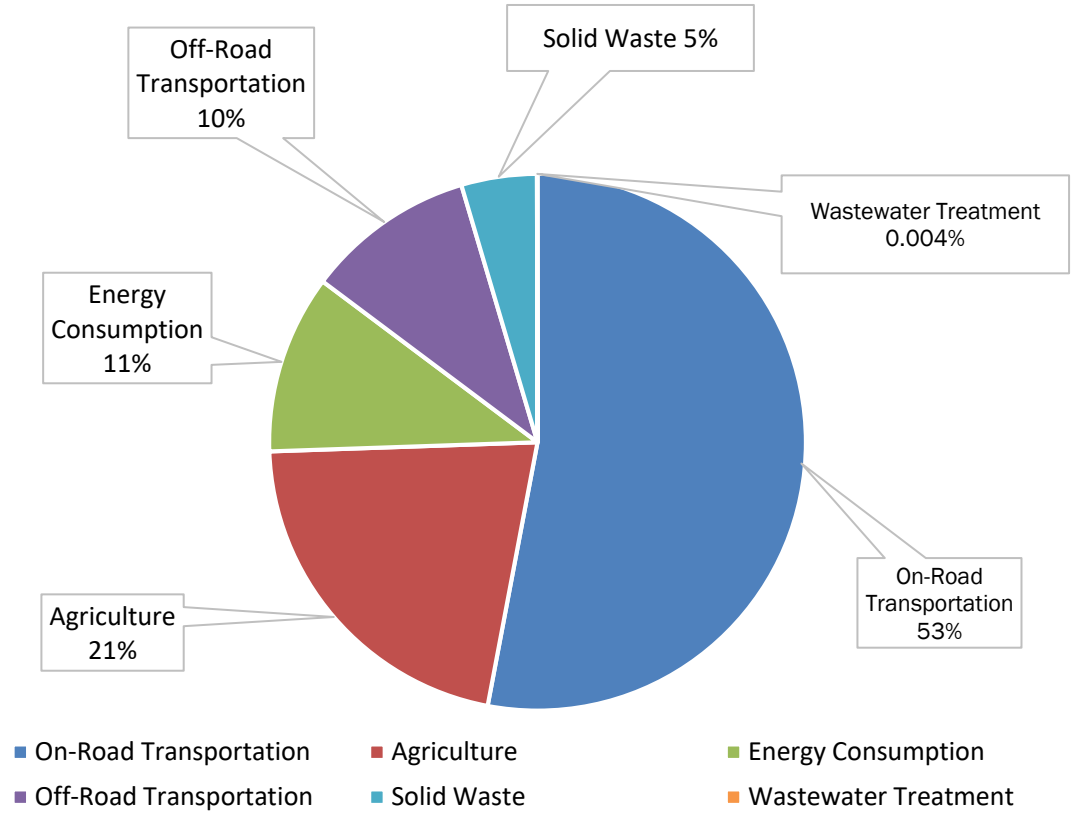
The overall community-wide GHG emissions for the unincorporated County was 1,082,801 metric tons (MT) of carbon dioxide equivalent (CO_2e) in 2016, as shown in Table 1. The largest proportion of GHG emissions in the County in 2016 came from the On-Road Transportation sector, followed by Agriculture, Energy Consumption, Off-Road Transportation, Solid Waste and Wastewater Treatment. The total GHG emissions for 2016 indicates a decrease of 96,012 $MTCO_2e$ or ~8 percent from the adjusted 2008 inventory. GHG reductions, compared to the 2008 inventory, occurred in the Energy Consumption, On-Road Transportation, Agriculture, and Wastewater Treatment sectors. Solid Waste and Off-Road Transportation sectors experienced GHG increases compared to 2008. Increases and decreases in each sector are described in Section 1.2, along with a description of factors that may have contributed to these changes. In some cases, the changes are the result of more granular data and revised calculation methods used for the 2016 inventory, though efforts were made to adjust the 2008 Inventory where possible to offer a more direct comparison of the two inventories.

Table 1 GHG Emissions by Sector for Unincorporated Yolo County, 2008 – 2016

Sector	2008		2016		2008 - 2016 Change	
	MT CO_2e	Percent of Annual Total (%)	MT CO_2e	Percent of Annual Total (%)	MT CO_2e	Percent (%)
Energy Consumption	170,091	14.4	116,651	10.8	-53,439	-31.4
On-Road Transportation	586,956	49.8	573,640	53.0	-13,316	-2.3
Off-Road Transportation	106,686	9.1	110,334	10.2	+3,648	+3.4
Solid Waste	46,793	4.0	49,239	4.5	+2,445	+5.2
Agriculture	267,141	22.7	232,569	21.5	-34,572	-12.9
Wastewater Treatment	1,186	0.1	368	0.004	-818	-69.0
Total	**1,178,853**	**100.0**	**1,082,801**	**100.0**	**-96,052**	**-8.1**

Note: MT= metric tons; GHG = greenhouse gas; CO2e = carbon dioxide equivalent. Columns may not add to totals due to rounding.

Source: Ascent Environmental 2018.



Note: Wastewater Treatment not visible because it is less than one percent of the 2016 inventory.

Source: Ascent Environmental 2018.

Figure 1: GHG Inventory for Unincorporated Yolo County by Sector, 2016

1.2 2016 INVENTORY RESULTS AND COMPARISON BY SECTOR

1.2.1 Energy Consumption

1.2.1.1 Residential Energy Consumption

GHG emissions in the residential energy sector result from the consumption of natural gas and electricity in single-family and multi-family buildings. These energy resources are used for lighting, air-conditioning, space heating, water heating, appliances and electronics. In 2016, natural gas and electrical utility services were provided to private residences in the unincorporated County by the Pacific Gas and Electric Company (PG&E). Aggregated energy use was provided by PG&E to complete the GHG analysis of this subsector and are expressed as Million Metric British Thermal Units (MMBtu) for natural gas and kilowatt hours (kWh) for electricity in Table 3 below. Between 2008 and 2016 natural gas consumption and associated GHG emissions in the residential sector decreased by ~11 percent. Residential electricity consumption between 2008 and 2016 decreased by ~7 percent but experienced a decrease in GHG emissions of ~57 percent, as shown in Tables 2 and 3.

While reductions in residential electrical consumption contributed to GHG reductions, the most influential factor for GHG reduction was a "greener" mix of energy resources used by PG&E in 2016 to generate electricity (PG&E 2018). This is measured by an electricity emissions factor that estimates the GHG intensity of electricity production. From 2008 to 2016 the CO_2 per unit of electricity produced declined by ~54 percent, as illustrated in Figure 2 below. This reduction reflects a downward trend in GHG intensity of the electrical sector over the last decade resulting from State requirements for increased renewable energy procurement by utilities. 2016 had an exceptionally low emission factor due to the addition of more renewables to PG&E's generation, plus increased hydropower from a wet season in northern California with above average rainfall.

Because reduced emissions factors account for a large proportion of the GHG reductions, changes in energy consumption between 2008 and 2016 may serve as a better indicator for assessing the performance of CAP measures targeted toward the residential energy sector.

Table 2 Residential Energy GHG Emissions in Unincorporated Yolo County, 2008 - 2016

Sector	2008	2016	2008 - 2016 Change	
	MT CO_2e	MT CO_2e	MT CO_2e	Percent (%)
Residential - Natural Gas	8,702	7,782	-920	-10.6
Residential - Electricity	20,519	8,762	-11,757	-57.3
Residential Subtotal	**29,221**	**16,544**	**-12,677**	**-43.4**

Note: GHG = greenhouse gas; MT= metric tons; CO2e = carbon dioxide equivalent. Columns may not add to totals due to rounding.

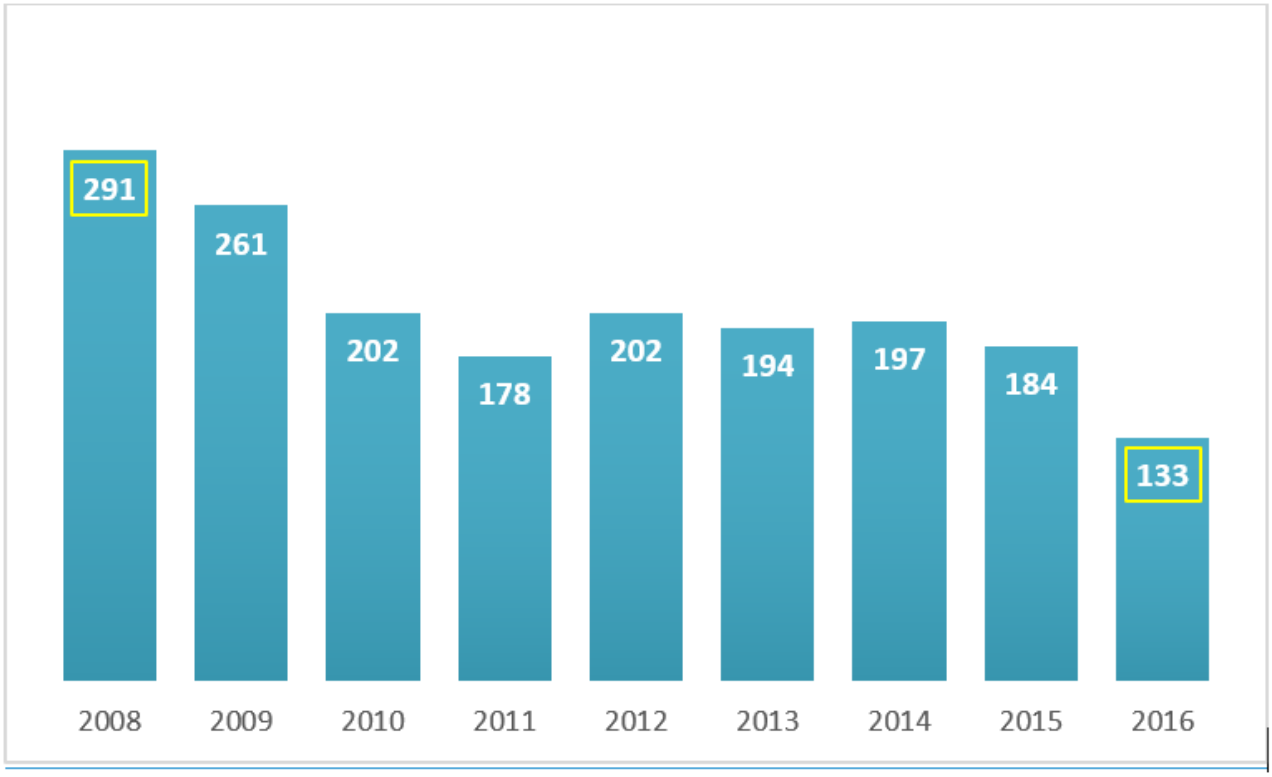
Source: Ascent Environmental 2018.

Table 3 Residential Energy Consumption in unincorporated Yolo County, 2008 - 2016

Sector	2008		2016		2008 - 2016 Change		
	Activity	Units	Activity	Units	Activity	Units	Percent (%)
Residential - Natural Gas	163,488	MMBtu	146,209	MMBtu	-17,280	MMBtu	-10.6
Residential - Electricity	70,243,476	kWh	65,619,313	kWh	-4,624,163	kWh	-6.6

Note: kWh = kilowatt hours; MMBTu = million metric British thermal units

Source: Ascent Environmental 2018.



Note: Data converted from pounds of per megawatt hours to grams per kilowatt hour for consistency with reported data in this inventory.

Source: U.S. Environmental Protection Agency.

Figure 2: Grams of carbon dioxide generated per kilowatt hour of delivered electricity from PG&E

1.2.1.2 Commercial/Industrial Energy Consumption

GHG emissions in the commercial and industrial energy sector result from the consumption of fossil fuels and electricity in privately owned office buildings, shopping centers, manufacturing facilities, farms, industrial facilities and other non-residential uses. Fossils fuels include natural gas, diesel and propane. Electricity covers all retail customers supplied power by PG&E and estimated emissions from electricity used for groundwater pumping in the unincorporated county.

Fossil fuel consumption for commercial and industrial uses in the unincorporated county in 2016 showed a 12 percent decrease from 2008. GHG emissions from fossil fuel consumption in 2016 was 75,908 CO_2e, a ~14 percent decrease from 2008. The difference in percentage decreases between consumption and emissions was primarily due to changes in the efficiency of engines used in the industrial sector and type of fuels used.

Electricity consumption for commercial and industrial uses in the unincorporated county in 2016 showed a less than 1 percent decrease from 2008. GHG emissions from electricity consumption in 2016 was 24,146 CO_2e a ~60 percent decrease from 2008. This gap between reductions in consumption versus emissions reflects the greening of PG&E's mix of resources used for electricity generation as described in the residential subsector in the previous section.

Emissions specifically for the water-electricity subsector were 54 MT CO_2e in 2016. This was a decrease of 15 MT CO_2e or ~22 percent from the 2008 calculations. Three Community Service Areas (CSAs) providing

water to the County were analyzed in this subsector; Wild Wings, North Davis Meadows and El Macero. CSAs are specifically addressed in the community-wide inventory since they provide water to private entities but are categorized as municipal uses under PG&E's energy reporting data. Because electricity is used to pump and convey water to end users, changes in water consumption result in changes to electricity consumption. Between 2008 to 2016 water consumption within the CSAs increased from 531 to 903 million gallons of water per year while electricity increased from 236,127 to 401,833 kWh, or ~70 percent for both measurements. Although water and electricity consumption showed an overall increase in the subsector, increased renewables in PG&E's electricity generation portfolio resulted in lower GHG emissions for the subsector.

Table 4 Commercial/Industrial GHG Emissions in Unincorporated Yolo County, 2008-2016

Sector	2008	2016	2008 - 2016 Change	
	MT CO_2e	MT CO_2e	MT CO_2e	Percent (%)
Commercial/Industrial - Natural Gas & Fossil Fuels	87,821	75,908	-11,913	-13.6
Commercial/Industrial - Electricity	52,980	24,146	-28,834	-54.4
Water- Electricity	69	54	-15	-22.2
Commercial/Industrial Subtotal	**140,870**	**100,108**	**-40,762**	**-28.9**

Note: GHG = greenhouse gas; MT= metric tons; CO_2e = carbon dioxide equivalent
Source: Ascent Environmental 2018.

Table 5 Commercial/Industrial Energy Consumption in Unincorporated Yolo County, 2008-2016

Sector	2008		2016		2008 - 2016 Change		
	Activity	Units	Activity	Units	Activity	Units	Percent (%)
Commercial/Industrial - Natural Gas & Fossil Fuels	1,495,459	MMBtu	1,315,538	MMBtu	-179,921	MMBtu	-12.0
Commercial/Industrial - Electricity	181,369,971	kWh	180,841,331	kWh	-528,640	kWh	-0.3
Water- Electricity	236,127	kWh	401,833	kWh	+165,706	kWh	+70.2

Note: kWh = kilowatt hours; MMBtu = million metric British thermal units

Source: Ascent Environmental 2018.

1.2.2 On-Road Transportation

GHG emissions in the On-Road Transportation sector result from fuel combustion in on-road vehicles, which include passenger vehicles (i.e., cars and light-duty trucks), medium- and heavy-duty trucks, motorcycles, and other types of vehicles permitted to operate "on-road". GHG emissions for this sector were 573,640 MT CO_2e in 2016. Vehicle miles traveled (VMT) data and emissions data from the California Air Resources Board (CARB) are typically used to estimate GHG emissions in this sector. VMT data compiled show that VMT increased ~10 percent from 2008 to 2016 yet emissions declined ~2 percent. This is likely due to increased

fuel efficiency standards for new motor vehicles which caused the average CO_2e per mile for vehicles of all types to drop from 892g in 2008 to 853g in 2016.

A proprietary model was used for calculating VMT in the County's 2030 General Plan Update and was used in the 2008 base year but was not available to be reused for 2016. However, alternative VMT data were made available for the 2016 inventory and for updating the 2008 Inventory from SACOG's Sacramento Activity-Based Travel Simulation (SACSIM) Model. This method may be preferable, since an analysis of the original technical memo revealed that unincorporated county VMT figures were extremely low relative to 2025 projections from the same study. This suggests the VMT model used in 2008 predated the Regional Targets Advisory Committee (RTAC) recommendations for VMT calculation, which is now used in most Travel Demand Models including SACOG's SACSIM.

Table 6 On-Road Transportation GHG Emissions in Unincorporated Yolo County, 2008 – 2016

Sector	2008	2016	2008 - 2016 Change	
	MT CO_2e	MT CO_2e	MT CO_2e	Percent (%)
On-Road Transportation	586,956	573,640	-13,316	-2.3

Source: Ascent Environmental 2018.

Table 7 On-Road Transportation Vehicle Miles Travelled in Unincorporated Yolo County, 2008 – 2016

Sector	2008		2016		2008 - 2016 Change		
	Activity	Units	Activity	Units	Activity	Units	Percent (%)
On-Road Transportation	2,741,968	VMT/day	3,019,646	VMT/day	+277,678	VMT/day	+10.1

Note: VMT=Vehicle Miles Travelled

Source: Ascent Environmental 2018.

1.2.3 Off-Road Transportation

GHG emissions in the Off-Road transportation sector result from fuel combustion associated with vehicles, heavy equipment and machinery operating off paved roads. This Off-Road Transportation sector is new to the 2016 GHG Inventory but is comprised of three subsectors that were analyzed in the 2008 Inventory; Industrial Equipment, Farm Equipment and Construction & Mining. These categories have been nested under this sector since they use the same modeling tools for GHG quantification and are among the activities recognized as Off-Road emissions sources in the CARB statewide GHG Inventory. Activities occurring under these subsectors are indicated below (CARB 2007).

- **Industrial Equipment** - Asphalt Pavers, Bore/Drill Rigs, Cement and Mortar Mixers, Concrete/Industrial Saws, Cranes, Crawler Tractors, Crushing/Processing Equipment, Dumpers/Tenders, Excavators, Graders, Off-Highway Tractors, Off-Highway Trucks, Pavers, Paving Equipment, Plate Compactors, Rollers, Rough Terrain Forklifts, Rubber Tired Dozers, Rubber Tired Loaders, Scrapers, Signal Boards, Skid Steer Loaders, Surfacing Equipment, Tampers/Rammers, Tractors/Loaders/Backhoes, Trenchers
- **Farm Equipment** - Combines, Hydro Power Units, Sprayers, Swathers, Tillers.
- **Construction & Mining** - Aerial Lifts, Forklifts, Sweepers/Scrubbers

GHG emissions for all subsectors are estimated by projecting from a 2007 base year using a CARB-approved modeling tool called OFFROAD 2007. Overall, the Off-Road Transportation sector increased ~3 percent from 2008 – 2016 with Construction & Mining activity offsetting relatively unchanged emissions from Farm Equipment and a ~4 percent decrease in Industrial Equipment use.

Table 8 Off-Road Transportation GHG Emissions in Unincorporated Yolo County, 2008 – 2016

Emissions Sector	2008	2016	2008 - 2016 Change	
	MT CO_2e	MT CO_2e	MT CO_2e	Percent (%)
Off-Road Transportation	**106,686**	**110,334**	**+3,648**	**+3.4**
Industrial Equipment	5,893	5,674	-219	-3.7
Farm Equipment	71,667	71,638	-29	0.0
Construction & Mining	29,126	33,022	+3,896	+13.4

Note: GHG = greenhouse gas; MT= metric tons; CO_2e = carbon dioxide equivalent.

Source: Ascent Environmental 2018.

1.2.4 Solid Waste

GHG emissions in the Solid Waste sector result from fuels combusted in the equipment used to transport and process waste, and from gasses released as waste in landfills decays over time. These processes are categorized into two subsectors; Waste Generation and Waste-in-Place. Waste Generation covers annual CO_2e from all waste generated by a community, including wastes disposed within the community's boundaries or transferred to landfills outside of the community. Waste-in-Place includes the annual CO_2e released from landfills located within a community, using historical information about the number of tons disposed within the landfill since it's opening, the composition of and management practices such as landfill gas (LFG) that seek to mitigate the release of GHGs.

Waste-in-Place emissions occurring from the Yolo County Central Landfill (YCCL) were 42,961 MT CO_2e for 2016, an increase of ~7 percent from 2008. The annual total tonnage of waste received by the landfill was 198,746 tons in 2016, an increase of ~13 percent over 2008. Over the 8-year period from the end of 2008 through 2016, 1,315,143 tons of mixed solid waste was added to the landfill. Improvements to the efficiency of the LFG capture system at YCCL from 75 percent to 80 percent resulted in improved GHG reductions through the recovery of fugitive methane (CH_4) emissions. Calculations for this subsector used EPA's Landfill Emissions Tool for more detailed assessment of waste-in-place emissions.

For waste generation, the County exported waste to 10 other facilities outside of the county's boundaries and this activity was included in the 2016 inventory, showing 6,278 MT CO_2e for 2016, a decrease of ~7 percent from 2008.

Table 9 Solid Waste GHG Emissions in Unincorporated Yolo County, 2008 – 2016

Sector	2008	2016	2008 - 2016 Change	
	MT CO_2e	MT CO_2e	MT CO_2e	Percent (%)
Solid Waste	**46,793**	**49,239**	**+2,445**	**+5.2**
Waste-in-Place	40,028	42,961	+2,933	+7.3
Waste Generation	6,765	6,278	-488	-7.2

Note: GHG = greenhouse gas; MT= metric tons; CO_2e = carbon dioxide equivalent.

Source: Ascent Environmental 2018.

Table 10 Solid Waste Tonnage in Unincorporated Yolo County, 2008 – 2016

Sector	2008		2016		2008 - 2016 Change		
	Activity	Units	Activity	Units	Activity	Units	Percent (%)
Solid Waste	**196,685**	**Tons**	**222,752**	**Tons**	**+26,068**	**Tons**	**+13.3**
Waste-in-Place	175,314	Tons	198,746	Tons	+23,433	Tons	+13.4
Waste Generation	21,371	Tons	24,006	Tons	+2,635	Tons	+12.3

Source: Ascent Environmental 2018.

1.2.5 Agriculture

GHG emissions for the Agriculture sector result from crop burning, livestock emissions, rice cultivation, pesticide application, fertilizer application and groundwater pumping for crop irrigation.

GHG emissions were 232,569 MT CO_2e for 2016, a ~13 percent reduction from 2008. A major factor contributing to this reduction was a decrease in the number of diesel-powered irrigation pumps. Permit data for these pumps were provided by the Yolo Solano Air Quality Management (YSAQMD) district for 2016, which provided more detail on pump location and fuel consumption leading to more precise results than 2008. It is possible that some of the pumps counted in the 2008 inventory may have been converted to solar power, but data were not available to confirm the degree to which this has occurred. Pumps that converted to grid sourced electricity will be counted in the Commercial/Industrial Electrical Energy Consumption subsection. If irrigation pumping were to be excluded from the agriculture sector and moved to a separate water sector the emissions from the 2016 agricultural sector would be on-par with 2008. Irrigation pumping remained in the agricultural sector for consistency with the Sectors established in the CAP.

Crop production showed an increased number of acres harvested for rice, almond and walnuts, with the latter two crops contributing the most to residue burning emissions. An increase in acreage used for rice cultivation translated into higher biogenic emissions than in the previous inventory. Flooded farmland used for rice cultivation generates CH_4 through the anaerobic decomposition of organic materials, so increased acreage results in increased CH_4 emissions. Head of cattle also increased, but assumptions had to be made about the share of beef versus dairy cattle for 2016, because these data were not publicly disclosed in reports.

Table 11 Agricultural GHG Emissions for Unincorporated Yolo County, 2008 – 2016

Sector	2008	2016	2008 - 2016 Change	
	MT CO_2e	MT CO_2e	MT CO_2e	Percent (%)
Agriculture	**267,141**	**232,569**	**-34,572**	**-12.9**
Residue Burning	13,648	17,191	3,543	26.0
Livestock	49,958	52,242	2,285	4.6
Rice Cultivation	57,722	68,751	11,029	19.1
Irrigation Pumps	39,231	5,683	-33,548	-85.5
Pesticide Application	31,303	40,008	8,705	27.8
Fertilizer Application	71,591	46,819	-24,772	-34.6
Lime Application	2,326	761	-1,565	-67.3
Urea Application	1,362	1,113	-249	-18.3

Note: GHG = greenhouse gas; MT= metric tons; CO_2e = carbon dioxide equivalent.
Source: Ascent Environmental 2018.

Table 12 Agricultural activities by subsector in Unincorporated Yolo County, 2008 – 2016

Sector	2008		2016		2008 - 2016 Change		
	Activity	Units	Activity	Units	Activity	Units	Percent (%)
Residue Burning	8,978	Tons	13,648	Tons	4,670	Tons	52.0
Livestock	30,816	heads	31,400	heads	584	heads	1.9
Rice Cultivation	30,057	acres	35,800	acres	5,743	acres	19.1
Irrigation Pumps	643	pumps	256	pumps	-387	pumps	-60.2
Pesticide Application	21,471	Tons	26,163	Tons	4,692	Tons	21.9
Fertilizer Application	23,823	Tons	15,580	Tons	-8,243	Tons	-31.6
Lime Application	5,289	MT	1,731	MT	-3,558	MT	-67.3
Urea Application	1,858	MT	1,519	MT	-339	MT	-18.3

Note: MT= metric tons
Source: Ascent Environmental 2018.

1.2.6 Wastewater Treatment

Wastewater treatment emissions associated with the treatment of sewage are related to generation of fugitive CH_4 under anaerobic treatment conditions as well as electricity consumption associated with the treatment process. GHG in this sector were 368 MT CO_2e for 2016, a decrease of ~69 percent from 2008. This decrease from 2008 is due to more accurate influent data, which showed the Esparto Community Services District (CSD) treatment plant not operating at full capacity, as was assumed previously. Wastewater treatment occurring at the Wild Wings CSA was not included in the 2008 inventory but was added to the 2016 inventory.

Table 13 Wastewater Treatment GHG Emissions in Unincorporated Yolo County, 2008 – 2016

Sector	2008	2016	2008 - 2016 Change	
	MT CO_2e	MT CO_2e	MT CO_2e	Percent (%)
Wastewater Treatment	1,186	368	-818	-69.0

Note: GHG = greenhouse gas; MT= metric tons; CO_2e = carbon dioxide equivalent.

Source: Ascent Environmental 2018.

Table 14 Wastewater Treatment in Unincorporated Yolo County, 2008 – 2016

Sector	2008		2016		2008 - 2016 Change		
	Activity	Units	Activity	Units	Activity	Units	Percent (%)
Wastewater Treatment	3,220,000	GPD	433,030	GPD	-2,786,970	GPD	-86.5

Note: GPD = Gallons per day

Source: Ascent Environmental 2018.

2 DATA, METHODS, AND ASSUMPTIONS BY SECTOR

Since the adoption of the County's CAP in 2011, new protocols have been developed for calculating communitywide GHG emissions in various sectors. These changes reflect refinements in the planning process that have resulted from research in the field and shared knowledge from local governments engaged in climate action planning. The publication of the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions by the International Council for Local Environmental Initiatives (ICLEI) in 2013 is a notable example of guidance that many local governments are now using to develop their GHG Inventories (ICLEI 2013). The increased sophistication of this accounting can also require additional data sources to produce the most accurate results, which is often not available for past inventory years when producing updates to GHG inventories for local governments that were early adopters of CAPs. The County's 2011 CAP, for instance, used the California Climate Action Registry (Climate Registry) General Reporting Protocol v 3.1. Although the Climate Registry was renamed and rebranded several years ago, the tools developed by the organization remain relevant for calculating GHG emissions for current and past year inventories, particularly when comparisons between these two figures are desired.

Another change that has occurred in the last several years is updated research and publication on the global warming potential (GWP) values of various emissions. In 2014, the Intergovernmental Panel on Climate Change (IPCC) released its Fifth Assessment Report (AR5) which adjusted GWP values for CH_4 and nitrous oxide (N_2O) as well as other substances regulated by the Montreal Protocol (Myhre, et al. 2013). In most equations associated with GHG accounting protocols, CH_4 and N_2O emissions are adjusted for GWP and combined with CO_2 to determine CO_2e, the common metric used to measure GHG emissions. Because GWP values are multipliers, small changes to these values can influence the calculation outcomes. The County's previous GHG Inventory used GWP values from IPCC's Second Assessment Report (SAR) which were 23 for CH_4 and 296 for N_2O over a 100-year horizon (Folland, et. al 2001). Comparatively, AR5 found a GWP value of 28 for CH_4 and 265 for N_2O over a 100-year time horizon. To account for this, the AR5 GWP values were applied to both the 2016 baseline year and an adjusted version of the 2008 baseline to maintain consistency between years.

2.1 ENERGY CONSUMPTION

2.1.1 Residential Energy Consumption

Consistent with the data collection performed in the 2008 inventory, community energy use data for commercial, residential and industrial building types in the unincorporated county was requested from the local utility, PG&E for years 2016 and 2017. Energy use metrics included both natural gas expressed as therms and electricity expressed as kilowatt hours (kWh). These figures were then calculated to CO_2e, by converting the fuel used to CO_2, CH_4 and N_2O using emissions factors for natural gas and electric generation from PG&E, eGrid and The Climate Registry. These figures were then multiplied by AR5 emissions factors and summed to show CO_2e for natural gas and electricity consumption in residential and commercial uses.

2.1.2 Commercial and Industrial Energy Consumption

Commercial energy consumption was obtained through a data request to PG&E that included delivered natural gas and electricity to non-governmental customers from 2005 to 2017. Data from years 2008 and 2016 were used for this inventory update. All data necessary to complete the 2016 inventory was provided by PG&E except for non-government commercial natural gas use, which PG&E stopped reporting annually in 2014 due to the CPUC's 1515 Rule, which prohibits the release of energy data if the sample size is not large enough for anonymity. The ICLEI community GHG Inventory protocol provides guidance on estimating commercial fuel use for years where consumption data is not available, but this guidance is limited to fuel oils, which are not common in California. Non-protocol methods for estimating natural gas consumption for 2016, such as estimating based on past trends from 2005 to 2013 did not prove helpful due to high year-to-year variability (+7 to -8 percent) in commercial natural gas consumption during this period. With annual data and alternative estimation methods unavailable, unadjusted 2013 data for non-governmental natural gas consumption were used to complete the 2016 GHG inventory for the commercial/industrial energy subsector.

GHG emissions for Industrial Emissions were estimated by obtaining permit data for stationary emissions from YSAQMD. This data set was then filtered to exclude uses located in incorporated cities. The fuel consumption and hourly use rates from this countywide permit data were then converted to CO_2, CH_4 and N_2O using conversion factors from Appendix C of the CCAR Reporting Protocol v.3.1, and then to CO_2e by multiplying the emissions factors by AR5 GWP.

Water pumping for non-agricultural uses is included in this sector. The inventory used data from three sources; the Wild Wings, El Macero and North Davis Meadows CSAs. The Wild Wings CSA treats wastewater (without the use of treatment ponds, as covered in the previous section) and combines this treated water with pumped groundwater for watering a golf course and providing water to 355 homes. The El Macero CSA obtains groundwater from the City of Davis for 463 homes in the El Macero community in unincorporated Yolo County. The North Davis Meadows CSA consists of two groundwater pumps in the unincorporated county servicing 95 connections. Water consumption measurements for these facilities were obtained through monthly use reports and contact with facility managers. Water consumption was then converted into electrical consumption using energy intensity factors for groundwater pumping from the California Energy Commission (CEC 2006). Electricity use was then converted into CO_2e using utility emissions factors for PG&E electrical generation in 2008 and 2016.

2.2 TRANSPORTATION

2.2.1 On-Road Transportation

The 2008 baseline inventory used VMT by speed bin data from a proprietary, Senate Bill (SB)-375/RTAC-compliant model developed by a third-party consultant as part of the County's 2030 General Plan adopted in 2009. Although requested by the County during data collection, the model used to develop these figures was no longer available to produce a revised set of VMT estimates for year 2016. As an alternative, Ascent requested a customized VMT data set from the region's Metropolitan Planning Organization, the Sacramento Area Council of Governments (SACOG). SACOG publishes the region's Metropolitan Transportation Plan (MTP) and has developed SB-375/RTAC-compliant models to estimate VMT in the Sacramento area, including the County. A proposed update to the regional MTP is anticipated to occur within the next few years and will use 2016 as a baseline year for VMT using a model similar to those used in previous plans. Ascent requested VMT data by speed bin from 2016 and from 2008 specific to the unincorporated portions of the County. Updated emission factors by speed bin were obtained from EMFAC 2017 and used to calculate the CO_2e for 2016.

2.2.2 Off-Road Transportation

GHG emissions for this sector were estimated using CARB's OFFROAD 2007 modeling tool which provides CO_2, CH4 and N2O emissions for Construction and Mining, Industrial Equipment and Agricultural Equipment for the County.

These estimates are then multiplied by AR5 GWP values and summed to calculate CO_2e for the year. GHG emissions for this sector were estimated using California Air Resources Board's OFFROAD 2007 modeling tool which provides CO_2, CH_4 and N_2O emissions for the County. These estimates are then multiplied by AR5 GWP values and summed to calculate CO_2e for the year.

2.3 SOLID WASTE

To calculate emissions for 2016, Ascent evaluated the same subsectors used in the previous inventory, Waste Generation and Waste-in-Place, but referenced new guidance on Solid Waste from Appendix E of ICLEI's U.S. Community Accounting Protocol v.1.1. Calculation methods in this appendix are described in subsection SW.1 for CH_4 associated with waste in place and SW.4 for community generation sent to landfills locally or exported to others outside of the county.

2.3.1 Waste-In-Place

The YCCL is the only operational landfill within the unincorporated County and has been operating since 1975 according to EPA records. This facility reports disposal rates annually to both the California Department of Resources Recycling and Recovery (CalRecycle) and the U.S. Environmental Protection Agency (EPA), which provides current and historic data on annual waste inflows and CH_4 capture efficiency. A 2018 Joint Technical Document from YCCL was also obtained from the County for further detail on the operations occurring at the site.

The U.S. Community Accounting Protocol recommends two options for calculating CH_4 emissions from landfills, SW.1 which is used if the facility reports to the EPA using the Mandatory Reporting Rule (MRR) method or alternative method SW.1.1 if the MRR method was not used. YCCL reports annual emissions to the EPA using the MRR method codified in 40 CFR 98, Subpart HH; therefore, Ascent followed the recommendations in SW 1.1 for the 2016 inventory which pulls emissions data directly from the EPA report. The reported CO_2e emissions in the EPA report uses the AR4 GWP for CH_4. To make the CO_2e consistent with the rest of the 2016 inventory the reported fugitive CH_4 from equation HH6 of the report was multiplied by the AR5 emissions factor CH_4 of 28 to arrive at the final waste-in-place estimate. It should be noted that CH_4 capture is occurring at the site at a rate of 2 million metric standard cubic feet per day of landfill gas (LFG) according to records from the EPA's Landfill Methane Outreach Program, but the use of this gas for flaring and combustion for electricity generation are not reported due to specific exclusions in the MMR reporting protocols. Since the MMR rulemaking occurred in 2009, EPA reports for facility CH_4 emissions are only available as far back as 2010 so the SW.1 cannot be used to update the 2008 inventory. For this reason, the SW.1 method was applied to both 2008 and 2016 for the final inventory results.

2.3.2 Waste Generation

To estimate Waste Generation for the 2016 Inventory, the US Community Protocol's SW.4 method was used. This method calculates CO_2e from the annual waste generated by a community, including waste that is exported to landfills outside of a community's boundaries. According to records from CalRecycle's Disposal Reporting System, 10 facilities other than YCCL received waste from the unincorporated County in 2016. The tonnage of waste attributed to unincorporated county was converted to CH_4 using the U.S. EPA AP-42 conversion factor for tonnage to CH_4 which assumes the material is Mixed Solid Waste (MSW) comprised of materials typically disposed at landfills nationwide. The CH_4 output is then adjusted for facilities utilizing landfill gas (LFG) capture systems, and then converted to CO_2e using GWP values from AR5. CO_2e for YCCL was included for reference but omitted from final calculations in this subsection to avoid double counting since 2016 emissions were included in the reported CH_4 figures used in the Waste-In-Place subsection.

2.4 AGRICULTURE

2.4.1 Residue Burning

Total acres harvested per year for corn, rice, almonds, walnuts and wheat were updated using crop report data for the County 2016. Data for barley was obtained from the U.S. Department of Agriculture (USDA). For calculating the 2016 Inventory, emissions factors were updated to reflected IPCC AR5 values for CH_4 and N20 GWP.

2.4.2 Livestock

Cattle and lambs were evaluated for the 2016 Inventory consistent with the livestock included in the 2008 Inventory. The 2016 Crop Report combined both beef and dairy cattle into a single category. Data from USDA did not disclose the number of dairy cattle, due to a limited number of dairy farms in the county. The UC Davis Department of Animal Science was contacted and was not able to provide this information. Because beef and dairy cattle have different emissions, assumptions had to be made about the ratio of dairy to beef cattle. A split of 88 percent beef to 12 percent dairy was carried over from the 2008 baseline and applied to the head count for 2016. GWP factors for N_2O and CH_4 were applied from IPCC AR5 for 2008 and 2016.

2.4.3 Rice Cultivation

Acres of rice for 2016 were used to update the inventory and converted to CO_2e using the updated emissions factors for grams of CH_4 per hectare used in the California Air Resources Board's 2018 Statewide GHG Inventory. Flooded farmland used for rice cultivation generates CH_4 through the anaerobic decomposition of organic materials, so increased acreage results in increased CH_4 emissions (Sass 2003).

2.4.4 Agricultural Irrigation Pumping

The previous inventory estimated GHG emissions from agricultural pumping using a 2006 report from CARB. This report was prepared for the specific purpose of evaluating a control measure for diesel engines, and therefore did not contain data on other fuel types for agricultural pumping and an update to the report were not found. To obtain updated pumping data for this inventory, Ascent Environmental contacted YSAQMD and obtained permit data for agricultural pumps operating in the district's boundaries for years 2015 through 2017 containing information on fuel use in gallons per year for diesel, gas, and propane fueled pumps. A 2016 baseline year was selected for consistency with other analyzed sectors. Data from incorporated cities and other counties were removed from the data set, as were permits with undefined locations and those that expired prior to January 1, 2016. Using this filtering criteria 256 combustion pumps were found to be operating in the unincorporated County in 2016. This number includes 244 diesel pumps, 11 propane pumps and one gasoline pump.

The 2008 inventory baseline looked only at diesel engines and created an emissions factor based on the total greenhouse gases reported for pumping in the county, divided by the number of diesel pumps. For the 2016 baseline, a more precise calculation was performed by include propane and gasoline in addition to diesel and converting the gallons per year for these fuel to CO_2e, using unit conversions and emissions factors.

2.4.5 Pesticide Application

Pesticide use for 2016 in the unincorporated County was calculated by obtaining pounds applied per year of Methyl Bromide (CH_3Br) and Sulfuryl Fluoride (SO_2F_2) from the California Department of Pesticide Regulation's 2016 Pesticide Use Reporting Database. SO_2F_2 was moved from the stationary sources sector in last GHG inventory to the agricultural sector in this inventory update. According to data, the primary use of SO_2F_2 in the unincorporated County is the application of Profume, which fumigates almond, barley, rice, walnuts and other crop commodities. GWP conversions for CH_3Br were also reduced from 5 GWP per MT to 2 GWP per MT to reflect new GWP values in IPCC AR5.

2.4.6 Fertilizer

Applied tons of nitrogen, lime and urea were obtained for 2016 from California's Statewide Fertilizer Tonnage report from the California Department of Food and Agriculture. Nitrogen GWP values were updated to reflect IPCC AR5.

Data on lime applied for agricultural use county was obtained from the CDFA 2015 Fertilizer Tonnage Report. 2015 was used because the 2016 data for the County showed a sharp drop versus previous years (389 tons of lime applied in 2016, versus 1,902 in 2015 and 2,944 in 2014) and the statewide amounts for 2016 were inconsistent with the figures in used in CARB's 2016 statewide reporting (415,040 tons of lime statewide in CARB report versus 235,088 from the CDFA Tonnage report).

Furthermore, the 2008 tonnage used for calculations was updated to use CDFA Fertilizer Tonnage Report Data on lime applied for that year. The previous inventory used a figure of 26,776 tons per year citing UC Davis as a source, while the CDFA Report data shows that 5,812 tons were used in 2008. The comparison of these years shows a decline in annual lime applied as well as a drop in CO_2e emissions for this commodity.

2.5 WASTEWATER TREATMENT

The 2016 influent data for wastewater treatment at Esparto, Madison, Knights Landing and Wild Wings facilities were obtained from a report on regional wastewater treatment (City of Woodland 2013). Direct correspondence with operators for this data yielded mixed results, with some operators indicating that data were not available and others providing rough estimates that were used as a secondary data source to validate figures from the report referenced above. Updated data on Biochemical Oxygen Demand (BOD) were not available through these sources, but as shown in Figures 3, 4 and 5, satellite imagery of the three sites from 2016 indicates that the ponds analyzed in the 2008 inventory are still being operated, so it was assumed that the BOD measurements from the previous inventory are still valid. The Wild Wings CSA was not included in the 2008 inventory but has been added to the sector for 2016. This facility serves a golf course and homes in the unincorporated county through wastewater recycling combined with groundwater pumping. Annual influent data was included and figures on maximum capacity were included in the reference wastewater treatment report. Figures on BOD for this facility were obtained from an engineering report describing the design specifications of the facility (Nolte & Associates 2001) and from averaging BOD from monthly reporting from water quality report for the first half of 2018.

Note: Photograph Date February 5, 2018

Source: Image © Digital Globe 2018 via Google Earth Pro

Figure 3: Aerial Photograph of Wastewater Treatment Ponds at Esparto Wastewater Treatment Facility

Note: Photograph Date February 5, 2018

Source: Image © Digital Globe 2018 via Google Earth Pro

Figure 4: Aerial photograph of wastewater treatment ponds at Knights Landing Wastewater Treatment Facility

Note: Photograph Date February 5, 2018

Source: Image © Digital Globe 2018 via Google Earth Pro

Figure 5: Aerial photograph of wastewater treatment ponds at Madison Wastewater Treatment Facility

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