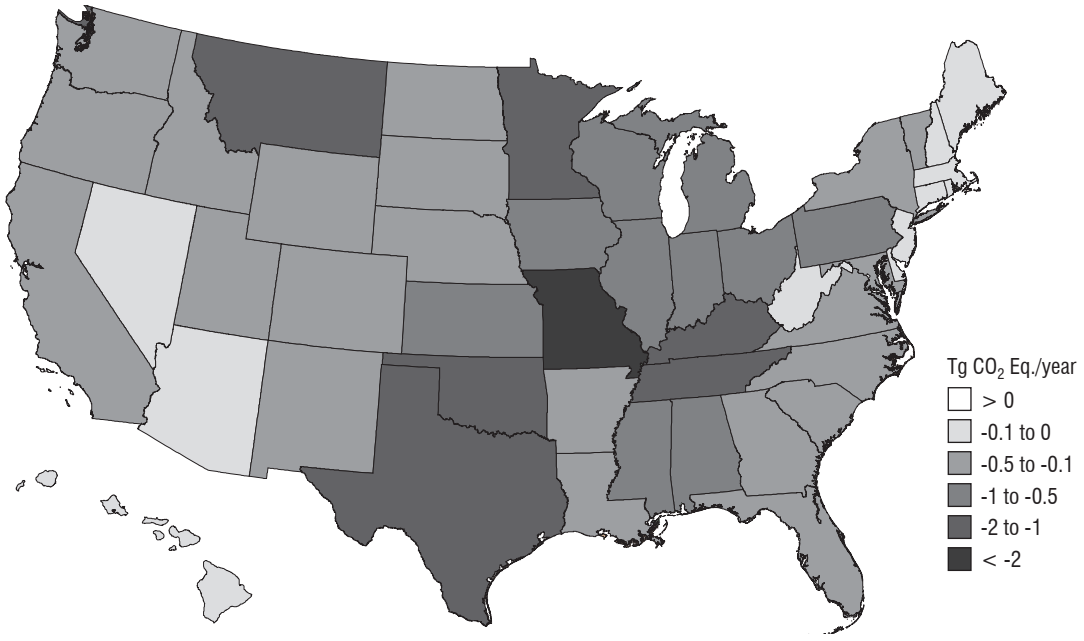
Figure 7-11

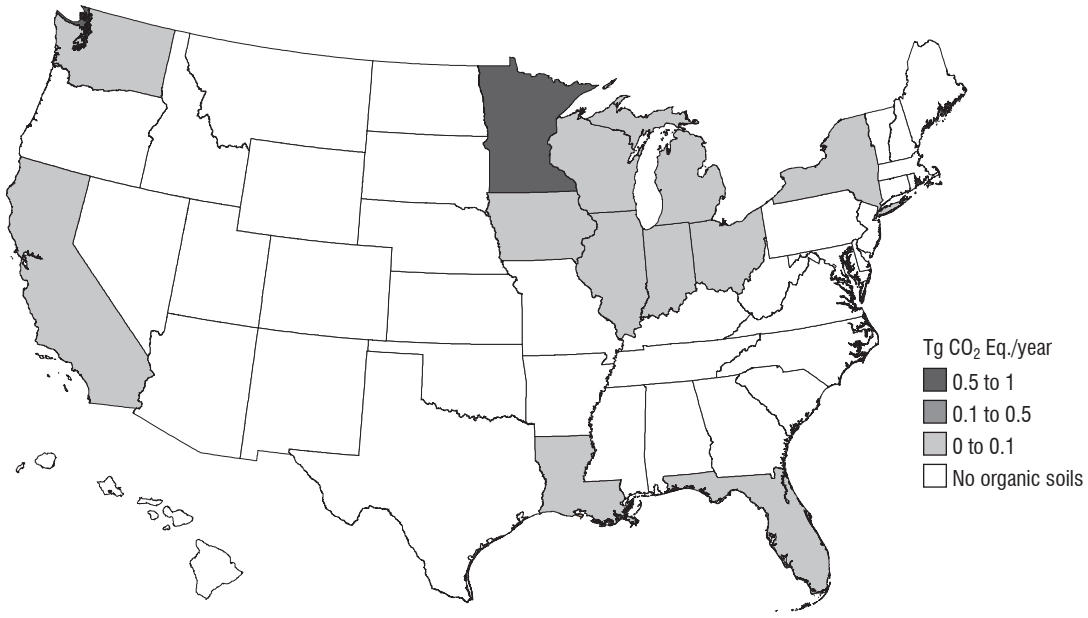
Total Net Annual CO_2 Flux for Mineral Soils Under Agricultural Management within States, 2010, *Land Converted to Grassland*



Note: Values greater than zero represent emissions, and values less than zero represent sequestration. Map accounts for fluxes associated with the Tier 2 and 3 Inventory computations. See Methodology for additional details.

Figure 7-12

Total Net Annual CO_2 Flux for Organic Soils Under Agricultural Management within States, 2010, *Land Converted to Grassland*



Note: Values greater than zero represent emissions.

8. Waste

Waste management and treatment activities are sources of greenhouse gas emissions (see Figure 8-1). Landfills accounted for approximately 16.2 percent of total U.S. anthropogenic methane (CH_4) emissions in 2010, the third largest contribution of any CH_4 source in the United States. Additionally, wastewater treatment and composting of organic waste accounted for approximately 2.5 percent and less than 1 percent of U.S. methane emissions, respectively. Nitrous oxide (N_2O) emissions from the discharge of wastewater treatment effluents into aquatic environments were estimated, as were N_2O emissions from the treatment process itself. N_2O emissions from composting were also estimated. Together, these waste activities account for less than 3 percent of total U.S. N_2O emissions. Nitrogen oxides (NO_x), carbon monoxide (CO), and non-CH_4 volatile organic compounds (NMVOCs) are emitted by waste activities, and are addressed separately at the end of this chapter. A summary of greenhouse gas emissions from the Waste chapter is presented in Table 8-1 and Table 8-2.

CO_2, N_2O, and CH_4 emissions from the incineration of waste are accounted for in the Energy sector rather than in the Waste sector because almost all incineration of municipal solid waste (MSW) in the United States occurs at waste-to-energy facilities where useful energy is recovered. Similarly, the Energy sector also includes an estimate of emissions from burning waste tires, because virtually all of the combustion occurs in industrial and utility boilers that recover energy. The incineration of waste in the United States in 2010 resulted in 12.4 Tg CO_2 Eq. emissions, nearly half of which is attributable to the combustion of plastics. For more details on emissions from the incineration of waste, see Section 3.3.

Figure 8-1: 2010 Waste Chapter Greenhouse Gas Sources

[BEGIN BOX]

Box 8-1: Methodological approach for estimating and reporting U.S. emissions and sinks

In following the UNFCCC requirement under Article 4.1 to develop and submit national greenhouse gas emission inventories, the emissions and sinks presented in this report, and this chapter, are organized by source and sink categories and calculated using internationally-accepted methods provided by the Intergovernmental Panel on Climate Change (IPCC).[229] Additionally, the calculated emissions and sinks in a given year for the United States are presented in a common manner in line with the UNFCCC reporting guidelines for the reporting of inventories under this international agreement.[230] The use of consistent methods to calculate emissions and sinks by all nations providing their inventories to the UNFCCC ensures that these reports are comparable. In this regard, U.S. emissions and sinks reported in this inventory report are comparable to emissions and sinks reported by other countries. Emissions and sinks provided in this inventory do not preclude alternative examinations,[231] but rather this inventory presents emissions and sinks in a common format consistent with how countries are to report inventories under the UNFCCC. The report itself, and this chapter, follows this standardized format, and provides an explanation of the IPCC methods used to calculate emissions and sinks, and the manner in which those calculations are conducted.

[END BOX]

Overall, in 2010, waste activities generated emissions of 132.5 Tg CO_2 Eq., or just under 2 percent of total U.S. greenhouse gas emissions.

[229] See http://www.ipcc-nggip.iges.or.jp/public/index.html.

[230] See http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php.

[231] For example, see http://www.epa.gov/aboutepa/oswer.html.

Table 8-1: Emissions from Waste (Tg CO_2 Eq.)

Gas/Source	1990	2005	2006	2007	2008	2009	2010
CH_4	**163.9**	**130.8**	**130.0**	**130.0**	**131.4**	**129.3**	**125.8**
Landfills	147.7	112.7	111.7	111.7	113.1	111.2	107.8
Wastewater Treatment	15.9	16.5	16.7	16.6	16.6	16.5	16.3
Composting	0.3	1.6	1.6	1.7	1.7	1.6	1.6
N_2O	**3.8**	**6.4**	**6.5**	**6.7**	**6.8**	**6.7**	**6.8**
Domestic Wastewater Treatment	3.5	4.7	4.8	4.8	4.9	5.0	5.0
Composting	0.4	1.7	1.8	1.8	1.9	1.8	1.7
Total	**167.7**	**137.2**	**136.5**	**136.7**	**138.2**	**136.0**	**132.5**

Note: Totals may not sum due to independent rounding.

Table 8-2: Emissions from Waste (Gg)

Gas/Source	1990	2005	2006	2007	2008	2009	2010
CH_4	**7,805**	**6,228**	**6,189**	**6,191**	**6,258**	**6,157**	**5,988**
Landfills	7,032	5,367	5,320	5,320	5,386	5,295	5,135
Wastewater Treatment	758	785	794	791	792	787	779
Composting	15	75	75	79	80	75	75
N_2O	**12**	**21**	**21**	**22**	**22**	**22**	**22**
Domestic Wastewater Treatment	11	15	15	16	16	16	16
Composting	1	6	6	6	6	6	6

Note: Totals may not sum due to independent rounding.

[BEGIN BOX]

Box 8-2: Waste Data from the Greenhouse Gas Reporting Program

On October 30, 2009, the U.S. EPA published a rule for the mandatory reporting of greenhouse gases from large GHG emissions sources in the United States. Implementation of 40 CFR Part 98 is referred to as EPA's Greenhouse Gas Reporting Program (GHGRP). 40 CFR part 98 applies to direct greenhouse gas emitters, fossil fuel suppliers, industrial gas suppliers, and facilities that inject CO_2 underground for sequestration or other reasons and requires reporting by 41 industrial categories. Reporting is at the facility level, except for certain suppliers of fossil fuels and industrial greenhouse gases. In general, the threshold for reporting is 25,000 metric tons or more of CO_2 Eq. per year. For calendar year 2010, the first year in which data were reported, facilities in 29 categories provided in 40 CFR part 98 were required to report their 2010 emissions by the September 30, 2011 reporting deadline.

EPA's GHGRP dataset and the data presented in this inventory report are complementary and, as indicated in the respective planned improvements sections for source categories in this chapter, EPA is analyzing how to use facility-level GHGRP data to improve the national estimates presented in this inventory. Most methodologies used in EPA's GHGRP are consistent with IPCC, though for EPA's GHGRP, facilities collect detailed information specific to their operations according to detailed measurement standards. This may differ with the more aggregated data collected for the inventory to estimate total, national U.S. emissions. In addition, it should be noted that the definitions and provisions for reporting fuel types in EPA's GHGRP may differ from those used in the national inventory in meeting the UNFCCC reporting guidelines. In line with the UNFCCC reporting guidelines[232], the inventory report is a comprehensive accounting of all emissions from fuel types identified in the IPCC guidelines and provides a separate reporting of emissions from biomass. Further information on the reporting categorizations in EPA's GHGRP and specific data caveats associated with monitoring methods in EPA's GHGRP has been provided

[232] See http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf.

on the EPA's GHGRP website.[233]

EPA presents the data collected by EPA's GHGRP through a data publication tool[234] that allows data to be viewed in several formats including maps, tables, charts and graphs for individual facilities or groups of facilities.

[END BOX]

8.1. Landfills (IPCC Source Category 6A1)

In 2010, landfill CH_4 emissions were approximately 107.8 Tg CO_2 Eq. (5,135 Gg of CH_4), representing the third largest source of CH_4 emissions in the United States, behind natural gas systems and enteric fermentation. Emissions from municipal solid waste (MSW) landfills, which received about 69 percent of the total solid waste generated in the United States, accounted for about 94 percent of total landfill emissions, while industrial landfills accounted for the remainder. Approximately 1,900 operational landfills exist in the United States, with the largest landfills receiving most of the waste and generating the majority of the CH_4 (EPA 2010; *BioCycle* 2008, adjusted to include missing data from five states). While the number of landfills has decreased significantly over the past 20 years, from 6,326 in 1990 to 1,908 in 2009), the average landfill size has increased (EPA 2010).

After being placed in a landfill, waste (such as paper, food scraps, and yard trimmings) is initially decomposed by aerobic bacteria. After the oxygen has been depleted, the remaining waste is available for consumption by anaerobic bacteria, which break down organic matter into substances such as cellulose, amino acids, and sugars. These substances are further broken down through fermentation into gases and short-chain organic compounds that form the substrates for the growth of methanogenic bacteria. These CH_4-producing anaerobic bacteria convert the fermentation products into stabilized organic materials and biogas consisting of approximately 50 percent biogenic carbon dioxide (CO_2) and 50 percent CH_4, by volume. Significant CH_4 production typically begins one or two years after waste disposal in a landfill and continues for 10 to 60 years or longer.

Methane emissions from landfills are a function of several factors, including: (1) the total amount of waste in MSW landfills, which is related to total waste landfilled annually; (2) the characteristics of landfills receiving waste (i.e., composition of waste-in-place, size, climate); (3) the amount of CH_4 that is recovered and either flared or used for energy purposes; and (4) the amount of CH_4 oxidized in landfills instead of being released into the atmosphere. From 1990 to 2010, net CH_4 emissions from landfills decreased by approximately 27 percent (see Table 8-3 and Table 8-4). This net CH_4 emissions decrease can be attributed to many factors, including changes in waste composition, an increase in the amount of landfill gas collected and combusted, a higher frequency of composting, and increased rates of recovery for degradable materials (e.g., paper and paperboard).

The estimated annual quantity of waste placed in MSW landfills increased from about 206 Tg in 1990 to 254 Tg in 2010, an increase of 23 percent (see Annex 3.14). Despite increased waste disposal, the amount of decomposable materials (i.e., paper and paperboard, food scraps, and yard trimmings) discarded in MSW landfills have decreased by approximately 21 percent from 1990 to 2009 (EPA 2010). In addition, the amount of landfill gas collected and combusted has increased. In 1990, for example, approximately 960 Gg of CH_4 were recovered and combusted (i.e., used for energy or flared) from landfills, while in 2010, 7,627 Gg CH_4 was combusted, which represents a 5 percent increase in the quantity of CH_4 recovered and combusted from 2009 levels (see Annex 3.14). In 2010, an estimated 54 new landfill gas-to-energy (LFGTE) projects and 46 new flares began operation (EPA 2011).

Over the past 9 years, however, the net CH_4 emissions have fluctuated from year to year, but a slowly increasing trend has been observed. While the amount of landfill gas collected and combusted continues to increase every year, the rate of increase in collection and combustion no longer exceeds the rate of additional CH_4 generation from the amount of organic MSW landfilled as the U.S. population grows.

Over the next several years, the total amount of municipal solid waste generated is expected to increase as the U.S. population continues to grow. The percentage of waste landfilled, however, may decline due to increased recycling

[233] See <http://www.ccdsupport.com/confluence/display/ghgp/Detailed+Description+of+Data+for+Certain+Sources+and+Processes>.
[234] See <http://ghgdata.epa.gov>.

and composting practices. In addition, the quantity of CH_4 that is recovered and either flared or used for energy purposes is expected to continue to increase as a result of 1996 federal regulations that require large municipal solid waste landfills to collect and combust landfill gas (see 40 CFR Part 60, Subpart Cc 2005 and 40 CFR Part 60, Subpart WWW 2005), voluntary programs that encourage CH_4 recovery and use such as EPA's Landfill Methane Outreach Program (LMOP), and federal and state incentives that promote renewable energy (e.g., tax credits, low interest loans, and Renewable Portfolio Standards).

Table 8-3: CH_4 Emissions from Landfills (Tg CO_2 Eq.)

Activity	1990	2005	2006	2007	2008	2009	2010
MSW Landfills	172.6	241.2	247.6	252.9	256.8	260.4	264.0
Industrial Landfills	11.6	15.4	15.4	15.5	15.7	15.8	15.9
Recovered							
Gas-to-Energy	(13.4)	(55.9)	(58.2)	(61.9)	(66.2)	(74.4)	(79.8)
Flared	(6.7)	(75.5)	(80.7)	(82.4)	(80.6)	(78.3)	(80.3)
Oxidized[a]	(16.4)	(12.5)	(12.4)	(12.4)	(12.6)	(12.4)	(12.0)
Total	**147.7**	**112.7**	**111.7**	**111.7**	**113.1**	**111.2**	**107.8**

Note: Totals may not sum due to independent rounding. Parentheses indicate negative values.
[a] Includes oxidation at both municipal and industrial landfills.

Table 8-4: CH_4 Emissions from Landfills (Gg)

Activity	1990	2005	2006	2007	2008	2009	2010
MSW Landfills	8,219	11,486	11,790	12,041	12,227	12,401	12,574
Industrial Landfills	554	733	736	740	746	752	758
Recovered							
Gas-to-Energy	(640)	(2,662)	(2,773)	(2,946)	(3,152)	(3,543)	(3,802)
Flared	(321)	(3,593)	(3,842)	(3,923)	(3,837)	(3,726)	(3,825)
Oxidized[a]	(781)	(596)	(591)	(591)	(598)	(588)	(571)
Total	**7,032**	**5,367**	**5,320**	**5,320**	**5,386**	**5,295**	**5,135**

Note: Totals may not sum due to independent rounding. Parentheses indicate negative values.
[a] Includes CH_4 oxidation at municipal and industrial landfills.

Methodology

CH_4 emissions from landfills were estimated as the CH_4 produced from municipal solid waste landfills, plus the CH_4 produced by industrial landfills, minus the CH_4 recovered and combusted, minus the CH_4 oxidized before being released into the atmosphere:

$$CH_{4,\text{Solid Waste}} = [CH_{4,\text{MSW}} + CH_{4,\text{Ind}} - R] - Ox$$

where,

$CH_{4,\text{Solid Waste}}$ = CH_4 emissions from solid waste
$CH_{4,\text{MSW}}$ = CH_4 generation from municipal solid waste landfills,
$CH_{4,\text{Ind}}$ = CH_4 generation from industrial landfills,
R = CH_4 recovered and combusted, and
Ox = CH_4 oxidized from MSW and industrial landfills before release to the atmosphere.

The methodology for estimating CH_4 emissions from municipal solid waste landfills is based on the first order decay model described by the Intergovernmental Panel on Climate Change (IPCC 2006). Values for the CH_4 generation potential (L_0) and rate constant (k) were obtained from an analysis of CH_4 recovery rates for a database of 52 landfills and from published studies of other landfills (RTI 2004; EPA 1998; SWANA 1998; Peer, Thorneloe, and Epperson 1993). The rate constant was found to increase with average annual rainfall; consequently, values of k were developed for 3 ranges of rainfall. The annual quantity of waste placed in landfills was apportioned to the 3 ranges of rainfall based on the percent of the U.S. population in each of the 3 ranges, and historical census data were used to account for the shift in population to more arid areas over time. A detailed description of the methodology used to estimate CH_4 emissions from landfills can be found in Annex 3.14.

National landfill waste generation and disposal data for 2007, 2009, and 2010 were extrapolated based on *BioCycle* data for 2008 and the U.S. Census population from 2010. Data for 1989 through 2008 were obtained from *BioCycle* (BioCycle 2006, 2008, and 2010). Because *BioCycle* does not account for waste generated in U.S. territories, waste generation for the territories was estimated using population data obtained from the U.S. Census Bureau (2010) and national per capita solid waste generation from *BioCycle* (2010). Estimates of the annual quantity of waste landfilled for 1960 through 1988 were obtained from EPA's *Anthropogenic Methane Emissions in the United States, Estimates for 1990: Report to Congress* (EPA 1993) and an extensive landfill survey by the EPA's Office of Solid Waste in 1986 (EPA 1988). Although waste placed in landfills in the 1940s and 1950s contributes very little to current CH_4 generation, estimates for those years were included in the first order decay model for completeness in accounting for CH_4 generation rates and are based on the population in those years and the per capita rate for land disposal for the 1960s. For calculations in this Inventory, wastes landfilled prior to 1980 were broken into two groups: wastes disposed in landfills (Methane Conversion Factor, MCF, of 1) and those disposed in dumps (MCF of 0.6). Please see Annex 3.14 for more details.

The estimated landfill gas recovered per year was based on updated sales data collected from vendors of flaring equipment (referred to as the flare vendor database), a database of landfill gas-to-energy (LFGTE) projects compiled by LMOP (EPA 2011), and a database developed by the Energy Information Administration (EIA) for the voluntary reporting of greenhouse gases (EIA 2007). The three databases were carefully compared to identify landfills that were in two or all three of the databases to avoid double counting reductions. Based on the information provided by the EIA and flare vendor databases, the CH_4 combusted by flares in operation from 1990 to 2010 was estimated.

The flare vendor database estimates CH_4 combusted by flares using the midpoint of a flare's reported capacity while the EIA database uses landfill-specific measured gas flow. As the EIA database only includes data through 2006; 2007 to 2010 recovery for projects included in the EIA database were assumed to be the same as in 2006. This quantity likely underestimates flaring because these databases do not have information on all flares in operation. Additionally, the EIA and LMOP databases provided data on landfill gas flow and energy generation for landfills with LFGTE projects. If a landfill in the EIA database was also in the LMOP and/or the flare vendor database, the emissions avoided were based on the EIA data because landfill owners or operators reported the amount recovered based on measurements of gas flow and concentration, and the reporting accounted for changes over time. If both flare data and LMOP recovery data were available for any of the remaining landfills (i.e., not in the EIA database), then the emissions recovery was based on the LMOP data, which provides reported landfill-specific data on gas flow for direct use projects and project capacity (i.e., megawatts) for electricity projects. The flare data, on the other hand, only provided a range of landfill gas flow for a given flare size. Given that each LFGTE project is likely to also have a flare, double counting reductions from flares and LFGTE projects in the LMOP database was avoided by subtracting emission reductions associated with LFGTE projects for which a flare had not been identified from the emission reductions associated with flares (referred to as the flare correction factor). A further explanation of the methodology used to estimate the landfill gas recovered for the current Inventory can be found in Annex 3.14.

A destruction efficiency of 99 percent was applied to CH_4 recovered to estimate CH_4 emissions avoided. The value for efficiency was selected based on the range of efficiencies (86 to 99 percent) recommended for flares in EPA's AP-42 Compilation of Air Pollutant Emission Factors, Chapter 2.4 (EPA 2008), efficiencies used to establish new source performance standards (NSPS) for landfills, and in recommendations for closed flares used in LMOP.

Emissions from industrial landfills were estimated from activity data for industrial production (ERG 2011), waste disposal factors, and the first order decay model. As over 99 percent of the organic waste placed in industrial landfills originated from the food processing (meat, vegetables, fruits) and pulp and paper industries, estimates of industrial landfill emissions focused on these two sectors (EPA 1993). The amount of CH_4 oxidized by the landfill cover at both municipal and industrial landfills was assumed to be ten percent of the CH_4 generated that is not recovered (IPCC 2006, Mancinelli and McKay 1985, Czepiel et al. 1996). To calculate net CH_4 emissions, both CH_4 recovered and CH_4 oxidized were subtracted from CH_4 generated at municipal and industrial landfills.

Uncertainty and Time-Series Consistency

Several types of uncertainty are associated with the estimates of CH_4 emissions from landfills. The primary uncertainty concerns the characterization of landfills. Information is not available on two fundamental factors affecting CH_4 production: the amount and composition of waste placed in every landfill for each year of its operation. The approach used here assumes that the CH_4 generation potential and the rate of decay that produces CH_4, as determined from several studies of CH_4 recovery at landfills, are representative of U.S. landfills.

Additionally, the approach used to estimate the contribution of industrial wastes to total CH_4 generation introduces uncertainty. Aside from uncertainty in estimating CH_4 generation potential, uncertainty exists in the estimates of oxidation by cover soils. There is also uncertainty in the estimates of CH_4 that is recovered by flaring and energy projects. The IPCC default value of 10 percent for uncertainty in recovery estimates was used in the uncertainty analysis when metering was in place (for about 64 percent of the CH_4 estimated to be recovered). For flaring without metered recovery data (approximately 34 percent of the CH_4 estimated to be recovered), a much higher uncertainty of approximately 50 percent was used (e.g., when recovery was estimated as 50 percent of the flare's design capacity).

N_2O emissions from the application of sewage sludge on landfills are not explicitly modeled as part of greenhouse gas emissions from landfills. N_2O emissions from sewage sludge applied to landfills would be relatively small because the microbial environment in landfills is not very conducive to the nitrification and denitrification processes that result in N_2O emissions. Furthermore, the 2006 IPCC Guidelines (IPCC 2006) did not include a methodology for estimating N_2O emissions from solid waste disposal sites "because they are not significant." Therefore, any uncertainty or bias caused by not including N_2O emissions from landfills is expected to be minimal.

The results of the IPCC Good Practice Guidance Tier 2 quantitative uncertainty analysis are summarized in Table 8-5. Landfill CH_4 emissions in 2010 were estimated to be between 51.3 and 154.5 Tg CO_2 Eq., which indicates a range of 52 percent below to 43 percent above the 2010 emission estimate of 107.8 Tg CO_2 Eq.

Table 8-5: Tier 2 Quantitative Uncertainty Estimates for CH_4 Emissions from Landfills (Tg CO_2 Eq. and Percent)

Source	Gas	2010 Emission Estimate (Tg CO_2 Eq.)	Uncertainty Range Relative to Emission Estimate[a] (Tg CO_2 Eq.)		(%)	
			Lower Bound	Upper Bound	Lower Bound	Upper Bound
Landfills	**CH_4**	**107.8**	**52.3**	**154.8**	**-52%**	**+44%**
MSW	CH_4	93.5	38.6	138.6	-59%	+48%
Industrial	CH_4	14.3	10.3	17.3	-28%	+21%

[a] Range of emission estimates predicted by Monte Carlo Stochastic Simulation for a 95 percent confidence interval.

Methodological recalculations were applied to the entire time-series to ensure time-series consistency from 1990 through 2010. Details on the emission trends through time are described in more detail in the Methodology section, above.

QA/QC and Verification

A QA/QC analysis was performed for data gathering and input, documentation, and calculation. A primary focus of the QA/QC checks was to ensure that CH_4 recovery estimates were not double-counted and that all LFGTE projects and flares were included in the respective project databases. Both manual and electronic checks were made to ensure that emission avoidance from each landfill was calculated in only one of the three databases. The primary calculation spreadsheet is tailored from the IPCC waste model and has been verified previously using the original, peer-reviewed IPCC waste model. All model input values were verified by secondary QA/QC review.

Recalculations Discussion

No methodological changes were made for this Inventory. The national landfill waste generation data for 2007, 2008, and 2009 were recalculated using the most recent BioCycle data for 2008 (BioCycle 2010). These recalculations resulted in decreased waste generation amounts for those years and, in turn, decreased the total CH_4 emissions estimates from landfills for 2008 and 2009 compared to the previous year's Inventory. The BioCycle survey is the only continually updated nationwide survey of waste generated and disposed in landfills in the United States. For years when BioCycle data are not available, the waste generation data used for the Inventory are extrapolated and later updated as later surveys are published, resulting in changes over the affected portion of the time series.

Planned Improvements

Improvements to the inventory being examined include incorporating data from the EPA's GHGRP and modifying the default oxidation rate applied to MSW and industrial landfills.

Beginning in 2011, all MSW landfills that accepted waste on or after January 1, 1980 and generate CH_4 in amounts equivalent to 25,000 metric tons or more of carbon dioxide equivalent (CO_2 Eq.) were required to calculate and report their greenhouse gas emissions to EPA through its GHGRP. This consists of the landfill, landfill gas collection systems, and landfill gas destruction devices, including flares. The data collected from the GHGRP will be used in future Inventories to revise the parameters used in the CH_4 generation calculations, including degradable organic carbon (DOC), the flare correction factor, the methane correction factor (MCF), fraction of DOC dissimilated (DOC_F), the destruction efficiency of flares, the oxidation factor, and the decay rate constant (k). The addition of this higher tier data will improve the emission calculations to provide a more accurate representation of greenhouse gas emissions from MSW landfills. . In examining data from EPA's GHGRP that would be useful to improve the emissions estimates for MSW landfills, particular attention will be made to ensure time series consistency, as the facility-level reporting data from the GHGRP are not available for all inventory years as reported in this inventory. In implementing improvements and integration of data from the GHGRP, the latest guidance from the IPCC on the use of facility-level data in national inventories will be relied upon[235].

In addition to MSW landfills, industrial landfills at facilities generating CH_4 in amounts equivalent to 25,000 metric tons or more of CO_2 Eq. are required to report their GHG emissions in September 2012 through EPA's GHGRP. Similar data for industrial landfills as is required for the MSW landfills will be reported. Any additions or improvements to the Inventory using reported GHGRP data will be made for the industrial landfill portion of the inventory. Improvements may include breaking out the industrial waste landfills into three regions (dry, moderate, and wet) as is done for the MSW landfills, allowing for region-specific k values rather than a default IPCC value. As with MSW landfills, any improvements made to the emissions estimates for industrial landfills will include efforts to ensure time series consistency using the latest guidance from the IPCC.

As a first step toward investigating the possibility of increasing the oxidation rate used in the Inventory, a literature review was conducted in 2011 to assess the state of oxidation at a range of landfills (RTI 2011). A standard CH_4 oxidation rate of 10 percent has been used in the LFG inventory for both industrial and MSW landfills since the inventory began and is currently recommended as the default for well-managed landfills in the latest IPCC guidelines (2006). Recent comments on the Inventory methodology indicated that a default oxidation rate of 10 percent may be less than oxidation rates achieved at well-managed landfills with gas collection and control.

Changing the oxidation rate and calculating the amount of CH_4 oxidized from landfills with gas collection and control requires the estimation of waste disposed of in these types of landfills. The Inventory methodology uses waste generation data from the BioCycle State of Garbage reports, which reports the total amount of waste generated and disposed nationwide by state. In 2010, the State of Garbage survey requested data on the recovery of landfill gas for the first time. Twenty-eight states reported that 260 out of 1,414 (18 percent) operational landfills recovered gas (BioCycle 2010). However, the survey did not include closed landfills with gas collection and control systems. In the future, the amount of states collecting and reporting this information is expected to increase.

While the research findings indicate some evidence that landfills with gas collection and control achieve a 20 percent or higher oxidation rate, there is not sufficient certainty to adopt a higher oxidation rate at this time. It is expected that with increased reporting by states in the State of Garbage survey, as well as the data collected through the GHGRP, the oxidation rate for at least a subset of landfills may be increased in a future Inventory.

[Begin Text Box]

Box 8-3: Biogenic Wastes in Landfills

Regarding the depositing of wastes of biogenic origin in landfills, empirical evidence shows that some of these wastes degrade very slowly in landfills, and the C they contain is effectively sequestered in landfills over a period of

[235] See: http://www.ipcc-nggip.iges.or.jp/meeting/pdfiles/1008_Model_and_Facility_Level_Data_Report.pdf

time (Barlaz 1998, 2006). Estimates of C removals from landfilling of forest products, yard trimmings, and food scraps are further described in the Land Use, Land-Use Change, and Forestry chapter, based on methods presented in IPCC (2003) and IPCC (2006).

[End Box]

8.2. Wastewater Treatment (IPCC Source Category 6B)

Wastewater treatment processes can produce anthropogenic CH_4 and N_2O emissions. Wastewater from domestic[236] and industrial sources is treated to remove soluble organic matter, suspended solids, pathogenic organisms, and chemical contaminants. Treatment may either occur on site, most commonly through septic systems or package plants, or off site at centralized treatment systems. Centralized wastewater treatment systems may include a variety of processes, ranging from lagooning to advanced tertiary treatment technology for removing nutrients. In the United States, approximately 20 percent of domestic wastewater is treated in septic systems or other on-site systems, while the rest is collected and treated centrally (U.S. Census Bureau 2009).

Soluble organic matter is generally removed using biological processes in which microorganisms consume the organic matter for maintenance and growth. The resulting biomass (sludge) is removed from the effluent prior to discharge to the receiving stream. Microorganisms can biodegrade soluble organic material in wastewater under aerobic or anaerobic conditions, where the latter condition produces CH_4. During collection and treatment, wastewater may be accidentally or deliberately managed under anaerobic conditions. In addition, the sludge may be further biodegraded under aerobic or anaerobic conditions. The generation of N_2O may also result from the treatment of domestic wastewater during both nitrification and denitrification of the N present, usually in the form of urea, ammonia, and proteins. These compounds are converted to nitrate (NO_3) through the aerobic process of nitrification. Denitrification occurs under anoxic conditions (without free oxygen), and involves the biological conversion of nitrate into dinitrogen gas (N_2). N_2O can be an intermediate product of both processes, but has typically been associated with denitrification. Recent research suggests that higher emissions of N_2O may in fact originate from nitrification (Ahn et al. 2010).

The principal factor in determining the CH_4 generation potential of wastewater is the amount of degradable organic material in the wastewater. Common parameters used to measure the organic component of the wastewater are the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Under the same conditions, wastewater with higher COD (or BOD) concentrations will generally yield more CH_4 than wastewater with lower COD (or BOD) concentrations. BOD represents the amount of oxygen that would be required to completely consume the organic matter contained in the wastewater through aerobic decomposition processes, while COD measures the total material available for chemical oxidation (both biodegradable and non-biodegradable). Because BOD is an aerobic parameter, it is preferable to use COD to estimate CH_4 production. The principal factor in determining the N_2O generation potential of wastewater is the amount of N in the wastewater. The variability of N in the influent to the treatment system, as well as the operating conditions of the treatment system itself, also impact the N_2O generation potential.

In 2010, CH_4 emissions from domestic wastewater treatment were 7.8Tg CO_2 Eq. (370 Gg). Emissions gradually increased from 1990 through 1997, but have decreased since that time due to decreasing percentages of wastewater being treated in anaerobic systems, including reduced use of on-site septic systems and central anaerobic treatment systems. In 2010, CH_4 emissions from industrial wastewater treatment were estimated to be 8.6 Tg CO_2 Eq. (409 Gg). Industrial emission sources have increased across the time series through 1999 and then fluctuated up and down with production changes associated with the treatment of wastewater from the pulp and paper manufacturing, meat and poultry processing, fruit and vegetable processing, starch-based ethanol production, and petroleum refining industries. Table 8-6 and Table 8-7 provide CH_4 and N_2O emission estimates from domestic and industrial wastewater treatment.

With respect to N_2O, the United States identifies two distinct sources for N_2O emissions from domestic wastewater: emissions from centralized wastewater treatment processes, and emissions from effluent from centralized treatment

[236] Throughout the inventory, emissions from domestic wastewater also include any commercial and industrial wastewater collected and co-treated with domestic wastewater.

systems that has been discharged into aquatic environments. The 2010 emissions of N_2O from centralized wastewater treatment processes and from effluent were estimated to be 0.3 Tg CO_2 Eq. (1 Gg) and 4.7 Tg CO_2 Eq. (15.3 Gg), respectively. Total N_2O emissions from domestic wastewater were estimated to be 5.0 Tg CO_2 Eq. (16.3 Gg). N_2O emissions from wastewater treatment processes gradually increased across the time series as a result of increasing U.S. population and protein consumption.

Table 8-6: CH_4 and N_2O Emissions from Domestic and Industrial Wastewater Treatment (Tg CO_2 Eq.)

Activity	1990		2005	2006	2007	2008	2009	2010
CH_4	**15.9**		**16.5**	**16.7**	**16.6**	**16.6**	**16.5**	**16.3**
Domestic	8.8		8.3	8.2	8.1	8.0	8.0	7.8
Industrial*	7.1		8.2	8.5	8.5	8.6	8.5	8.6
N_2O	**3.5**		**4.7**	**4.8**	**4.8**	**4.9**	**5.0**	**5.0**
Domestic	3.5		4.7	4.8	4.8	4.9	5.0	5.0
Total	**19.4**		**21.2**	**21.5**	**21.4**	**21.5**	**21.5**	**21.3**

* Industrial activity includes the pulp and paper manufacturing, meat and poultry processing, fruit and vegetable processing, starch-based ethanol production, and petroleum refining industries.
Note: Totals may not sum due to independent rounding.

Table 8-7: CH_4 and N_2O Emissions from Domestic and Industrial Wastewater Treatment (Gg)

Activity	1990		2005	2006	2007	2008	2009	2010
CH_4	**758**		**785**	**794**	**791**	**792**	**787**	**779**
Domestic	421		397	391	386	383	380	370
Industrial*	338		389	403	405	409	406	409
N_2O	**11**		**15**	**15**	**16**	**16**	**16**	**16**
Domestic	11		15	15	16	16	16	16

* Industrial activity includes the pulp and paper manufacturing, meat and poultry processing, fruit and vegetable processing, starch-based ethanol production, and petroleum refining industries.
Note: Totals may not sum due to independent rounding.

Methodology

Domestic Wastewater CH_4 Emission Estimates

Domestic wastewater CH_4 emissions originate from both septic systems and from centralized treatment systems, such as publicly owned treatment works (POTWs). Within these centralized systems, CH_4 emissions can arise from aerobic systems that are not well managed or that are designed to have periods of anaerobic activity (e.g., constructed wetlands), anaerobic systems (anaerobic lagoons and facultative lagoons), and from anaerobic digesters when the captured biogas is not completely combusted. CH_4 emissions from septic systems were estimated by multiplying the United States population by the percent of wastewater treated in septic systems (20 percent), an emission factor (10.7 g CH_4/capita/day) and converting that to Gg/year. Methane emissions from POTWs were estimated by multiplying the total BOD_5 produced in the United States by the percent of wastewater treated centrally (80 percent), the relative percentage of wastewater treated by aerobic and anaerobic systems, the relative percentage of wastewater facilities with primary treatment, the percentage of BOD_5 treated after primary treatment (67.5 percent), the maximum CH_4-producing capacity of domestic wastewater (0.6), and the relative MCFs for aerobic (zero or 0.3) and anaerobic (0.8) systems with all aerobic systems assumed to be well-managed. Methane emissions from anaerobic digesters were estimated by multiplying the amount of biogas generated by wastewater sludge treated in anaerobic digesters by the proportion of CH_4 in digester biogas (0.65), the density of CH_4 (662 g CH_4/m^3 CH_4) , and the destruction efficiency associated with burning the biogas in an energy/thermal device (0.99). The methodological equations are:

$$\textit{Emissions from Septic Systems} = A$$
$$= US_{POP} \times (\%\ \text{onsite}) \times (EF_{SEPTIC}) \times 1/10\text{^}9 \times \text{Days}$$

$$\textit{Emissions from Centrally Treated Aerobic Systems} = B$$
$$= [(\%\ \text{collected}) \times (\text{total } BOD_5 \text{ produced}) \times (\%\ \text{aerobic}) \times (\%\ \text{aerobic w/out primary}) + (\%\ \text{collected}) \times (\text{total } BOD_5$$

produced) × (% aerobic) × (% aerobic w/primary) × (1-% BOD removed in prim. treat.)] × (% operations not well managed) × (B_o) × (MCF-aerobic_not_well_man) × 1/10^6

Emissions from Centrally Treated Anaerobic Systems = C
= [(% collected) × (total BOD_5 produced) × (% anaerobic) × (% anaerobic w/out primary) + (% collected) × (total BOD_5 produced) × (% anaerobic) × (% anaerobic w/primary) × (1-%BOD removed in prim. treat.)] × (B_o) × (MCF-anaerobic) × 1/10^6

Emissions from Anaerobic Digesters = D
= [(POTW_flow_AD) × (digester gas)/ (per capita flow)] × conversion to m^3 × (FRAC_CH_4) × (365.25) × (density of CH_4) × (1-DE) × 1/10^9

Total CH_4 Emissions (Gg) = A + B + C + D

where,

US_{POP}	= U.S. population
% onsite	= Flow to septic systems / total flow
% collected	= Flow to POTWs / total flow
% aerobic	= Flow to aerobic systems / total flow to POTWs
% anaerobic	= Flow to anaerobic systems / total flow to POTWs
% aerobic w/out primary	= Percent of aerobic systems that do not employ primary treatment
% aerobic w/primary	= Percent of aerobic systems that employ primary treatment
% BOD removed in prim. treat.	= 32.5%
% operations not well managed	= Percent of aerobic systems that are not well managed and in which some anaerobic degradation occurs
% anaerobic w/out primary	= Percent of anaerobic systems that do not employ primary treatment
% anaerobic w/primary	= Percent of anaerobic systems that employ primary treatment
EF_{SEPTIC}	= Methane emission factor (10.7 g CH_4/capita/day) – septic systems
Days	= days per year (365.25)
Total BOD_5 produced	= kg BOD/capita/day × U.S. population × 365.25 days/yr
B_o	= Maximum CH_4-producing capacity for domestic wastewater (0.60 kg CH_4/kg BOD)
1/10^6	= Conversion factor, kg to Gg
MCF-aerobic_not_well_man.	= CH_4 correction factor for aerobic systems that are not well managed (0.3)
MCF-anaerobic	= CH_4 correction factor for anaerobic systems (0.8)
DE	= CH_4 destruction efficiency from flaring or burning in engine (0.99 for enclosed flares)
POTW_flow_AD	= Wastewater influent flow to POTWs that have anaerobic digesters (gal)
digester gas	= Cubic feet of digester gas produced per person per day (1.0 ft^3/person/day) (Metcalf and Eddy 1991)
per capita flow	= Wastewater flow to POTW per person per day (100 gal/person/day)
conversion to m^3	= Conversion factor, ft^3 to m^3 (0.0283)
FRAC_CH_4	= Proportion CH_4 in biogas (0.65)
density of CH_4	= 662 (g CH_4/m^3 CH_4)
1/10^9	= Conversion factor, g to Gg

U.S. population data were taken from the U.S. Census Bureau International Database (U.S. Census 2011) and include the populations of the United States, American Samoa, Guam, Northern Mariana Islands, Puerto Rico, and the Virgin Islands. Table 8-8 presents U.S. population and total BOD_5 produced for 1990 through 2010, while Table 8-9 presents domestic wastewater CH_4 emissions for both septic and centralized systems in 2010. The proportions of domestic wastewater treated onsite versus at centralized treatment plants were based on data from the 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, and 2009 American Housing Surveys conducted by the U.S. Census Bureau (U.S. Census 2009), with data for intervening years obtained by linear interpolation. The percent of wastewater flow to aerobic and anaerobic systems, the percent of aerobic and anaerobic systems that do and do not employ primary treatment, and the wastewater flow to POTWs that have anaerobic digesters were obtained from the

1992, 1996, 2000, and 2004 Clean Watershed Needs Survey (EPA 1992, 1996, 2000, and 2004). Data for intervening years were obtained by linear interpolation and the years 2004 through 2010 were forecasted from the rest of the time series. The BOD_5 production rate (0.09 kg/capita/day) and the percent BOD_5 removed by primary treatment for domestic wastewater were obtained from Metcalf and Eddy (1991 and 2003). The CH_4 emission factor (0.6 kg CH_4/kg BOD_5) and the MCF used for centralized treatment systems were taken from IPCC (2006), while the CH_4 emission factor (10.7 g CH_4/capita/day) used for septic systems were taken from Leverenz et al. (2010). The CH_4 destruction efficiency for methane recovered from sludge digestion operations, 99 percent, was selected based on the range of efficiencies (98 to 100 percent) recommended for flares in AP-42 Compilation of Air Pollutant Emission Factors, Chapter 2.4 (EPA 1998), efficiencies used to establish new source performance standards (NSPS) for landfills, and in recommendations for closed flares used by the Landfill Methane Outreach Program (LMOP). The cubic feet of digester gas produced per person per day (1.0 ft^3/person/day) and the proportion of CH_4 in biogas (0.65) come from Metcalf and Eddy (1991). The wastewater flow to a POTW (100 gal/person/day) was taken from the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, "Recommended Standards for Wastewater Facilities (Ten-State Standards)" (2004).

Table 8-8: U.S. Population (Millions) and Domestic Wastewater BOD_5 Produced (Gg)

Year	Population	BOD_5
1990	253	8,333
2005	300	9,864
2006	303	9,958
2007	306	10,057
2008	309	10,149
2009	311	10,236
2010	313	10,278

Source: U.S. Census Bureau (2011); Metcalf & Eddy 1991 and 2003.

Table 8-9: Domestic Wastewater CH_4 Emissions from Septic and Centralized Systems (2010)

	CH_4 emissions (Tg CO_2 Eq.)	% of Domestic Wastewater CH_4
Septic Systems	5.1	65.4%
Centralized Systems	2.7	34.6%
Total	**7.8**	**100%**

Note: Totals may not sum due to independent rounding.

Industrial Wastewater CH_4 Emission Estimates

Methane emissions estimates from industrial wastewater were developed according to the methodology described in IPCC (2006). Industry categories that are likely to produce significant CH_4 emissions from wastewater treatment were identified. High volumes of wastewater generated and a high organic wastewater load were the main criteria. The top five industries that meet these criteria are pulp and paper manufacturing; meat and poultry processing; vegetables, fruits, and juices processing; starch-based ethanol production; and petroleum refining. Wastewater treatment emissions for these sectors for 2010 are displayed in Table 8-10 below. Table 8-11 contains production data for these industries.

Table 8-10: Industrial Wastewater CH_4 Emissions by Sector (2010)

	CH_4 emissions (Tg CO_2 Eq.)	% of Industrial Wastewater CH_4
Pulp & Paper	4.1	48%
Meat & Poultry	3.6	42%
Petroleum Refineries	0.6	7%
Fruit & Vegetables	0.1	1%
Ethanol Refineries	0.1	1%
Total	**8.6**	**100%**

Note: Totals may not sum due to independent rounding.

Table 8-11: U.S. Pulp and Paper, Meat, Poultry, Vegetables, Fruits and Juices, Ethanol, and Petroleum Refining Production (Tg)

Year	Pulp and Paper	Meat (Live Weight Killed)	Poultry (Live Weight Killed)	Vegetables, Fruits and Juices	Ethanol	Petroleum Refining
1990	128.9	27.3	14.6	38.7	2.7	702.4
2005	131.4	31.4	25.1	42.9	11.7	818.6
2006	137.4	32.5	25.5	42.9	14.5	826.7
2007	135.9	33.4	26.0	44.7	19.4	827.6
2008	134.5	34.4	26.6	45.1	26.9	836.8
2009	137.0	33.8	25.2	46.5	31.7	822.4
2010	137.0	33.7	25.9	43.7	39.5	848.6

Methane emissions from these categories were estimated by multiplying the annual product output by the average outflow, the organics loading (in COD) in the outflow, the percentage of organic loading assumed to degrade anaerobically, and the maximum CH_4 producing potential of industrial wastewater (B_o). Ratios of BOD:COD in various industrial wastewaters were obtained from EPA (1997a) and used to estimate COD loadings. The B_o value used for all industries is the IPCC default value of 0.25 kg CH_4/kg COD (IPCC 2006).

For each industry, the percent of plants in the industry that treat wastewater on site, the percent of plants that have a primary treatment step prior to biological treatment, and the percent of plants that treat wastewater anaerobically were defined. The percent of wastewater treated anaerobically onsite (TA) was estimated for both primary treatment ($\%TA_p$) and secondary treatment ($\%TA_s$). For plants that have primary treatment in place, an estimate of COD that is removed prior to wastewater treatment in the anaerobic treatment units was incorporated.

The methodological equations are:

$$CH_4 \text{ (industrial wastewater)} = [P \times W \times COD \times \%TA_p \times B_o \times MCF] + [P \times W \times COD \times \%TA_s \times B_o \times MCF]$$

$$\%TA_p = [\%Plants_o \times \%WW_{a,p} \times \%COD_p]$$

$$\%TA_s = [\%Plants_a \times \%WW_{a,s} \times \%COD_s] + [\%Plants_t \times \%WW_{a,t} \times \%COD_s]$$

where,

CH_4 (industrial wastewater) = Total CH_4 emissions from industrial wastewater (kg/year)
P = Industry output (metric tons/year)
W = Wastewater generated (m^3/metric ton of product)
COD = Organics loading in wastewater (kg/m^3)
$\%TA_p$ = Percent of wastewater treated anaerobically on site in primary treatment
$\%TA_s$ = Percent of wastewater treated anaerobically on site in secondary treatment
$\%Plants_o$ = Percent of plants with onsite treatment

$\%WW_{a,p}$ = Percent of wastewater treated anaerobically in primary treatment
$\%COD_p$ = Percent of COD entering primary treatment
$\%Plants_a$ = Percent of plants with anaerobic secondary treatment
$\%Plants_t$ = Percent of plants with other secondary treatment
$\%WW_{a,s}$ = Percent of wastewater treated anaerobically in anaerobic secondary treatment
$\%WW_{a,t}$ = percent of wastewater treated anaerobically in other secondary treatment
$\%COD_s$ = percent of COD entering secondary treatment
B_o = Maximum CH_4 producing potential of industrial wastewater (default value of 0.25 kg CH_4/kg COD)
MCF = CH_4 correction factor, indicating the extent to which the organic content (measured as COD) degrades anaerobically

As described below, the values presented in Table 8-12 were used in the emission calculations and are described in detail in Aguiar and Bartram (2008).

Table 8-12: Variables Used to Calculate Percent Wastewater Treated Anaerobically by Industry (%)

Variable	Industry						
	Pulp and Paper	**Meat Processing**	**Poultry Processing**	**Fruit/ Vegetable Processing**	**Ethanol Production – Wet Mill**	**Ethanol Production – Dry Mill**	**Petroleum Refining**
$\%TA_p$	0	0	0	0	0	0	0
$\%TA_s$	10.5	33	25	4.2	33.3	75	100
$\%Plants_o$	60	100	100	11	100	100	100
$\%Plants_a$	25	33	25	5.5	33.3	75	100
$\%Plants_t$	35	67	75	5.5	66.7	25	0
$\%WW_{a,p}$	0	0	0	0	0	0	0
$\%WW_{a,s}$	100	100	100	100	100	100	100
$\%WW_{a,t}$	0	0	0	0	0	0	0
$\%COD_p$	100	100	100	100	100	100	100
$\%COD_s$	42	100	100	77	100	100	100

Source: Aguiar and Bartram (2008) Planned Revisions of the Industrial Wastewater Inventory Emission Estimates for the 1990-2007 Inventory. August 10, 2008.

Pulp and Paper. Wastewater treatment for the pulp and paper industry typically includes neutralization, screening, sedimentation, and flotation/hydrocycloning to remove solids (World Bank 1999, Nemerow and Dasgupta 1991). Secondary treatment (storage, settling, and biological treatment) mainly consists of lagooning. In determining the percent that degrades anaerobically, both primary and secondary treatment were considered. In the United States, primary treatment is focused on solids removal, equalization, neutralization, and color reduction (EPA 1993). The vast majority of pulp and paper mills with on-site treatment systems use mechanical clarifiers to remove suspended solids from the wastewater. About 10 percent of pulp and paper mills with treatment systems use settling ponds for primary treatment and these are more likely to be located at mills that do not perform secondary treatment (EPA 1993). However, because the vast majority of primary treatment operations at U.S. pulp and paper mills use mechanical clarifiers, and less than 10 percent of pulp and paper wastewater is managed in primary settling ponds that are not expected to have anaerobic conditions, negligible emissions are assumed to occur during primary treatment.

Approximately 42 percent of the BOD passes on to secondary treatment, which consists of activated sludge, aerated stabilization basins, or non-aerated stabilization basins. No anaerobic activity is assumed to occur in activated sludge systems or aerated stabilization basins (note: although IPCC recognizes that some CH_4 can be emitted from anaerobic pockets, they recommend an MCF of zero). However, about 25 percent of the wastewater treatment systems used in the United States are non-aerated stabilization basins. These basins are typically 10 to 25 feet deep. These systems are classified as anaerobic deep lagoons (MCF = 0.8).

A time series of CH_4 emissions for 1990 through 2001 was developed based on production figures reported in the Lockwood-Post Directory (Lockwood-Post 2002). Published data from the American Forest and Paper Association, data published by Paper Loop, and other published statistics were used to estimate production for 2002 through 2010 (Pulp and Paper 2005, 2006, and monthly reports from 2003 through 2008; Paper 360° 2007). The overall

wastewater outflow was estimated to be 85 m^3/metric ton, and the average BOD concentrations in raw wastewater was estimated to be 0.4 gram BOD/liter (EPA 1997b, EPA 1993, World Bank 1999).

Meat and Poultry Processing. The meat and poultry processing industry makes extensive use of anaerobic lagoons in sequence with screening, fat traps and dissolved air flotation when treating wastewater on site. About 33 percent of meat processing operations (EPA 2002) and 25 percent of poultry processing operations (U.S. Poultry 2006) perform on-site treatment in anaerobic lagoons. The IPCC default B_o of 0.25 kg CH_4/kg COD and default MCF of 0.8 for anaerobic lagoons were used to estimate the CH_4 produced from these on-site treatment systems. Production data, in carcass weight and live weight killed for the meat and poultry industry, were obtained from the USDA Agricultural Statistics Database and the Agricultural Statistics Annual Reports (USDA 2011). Data collected by EPA's Office of Water provided estimates for wastewater flows into anaerobic lagoons: 5.3 and 12.5 m^3/metric ton for meat and poultry production (live weight killed), respectively (EPA 2002). The loadings are 2.8 and 1.5 g BOD/liter for meat and poultry, respectively.

Vegetables, Fruits, and Juices Processing. Treatment of wastewater from fruits, vegetables, and juices processing includes screening, coagulation/settling, and biological treatment (lagooning). The flows are frequently seasonal, and robust treatment systems are preferred for on-site treatment. Effluent is suitable for discharge to the sewer. This industry is likely to use lagoons intended for aerobic operation, but the large seasonal loadings may develop limited anaerobic zones. In addition, some anaerobic lagoons may also be used (Nemerow and Dasgupta 1991). Consequently, 4.2 percent of these wastewater organics are assumed to degrade anaerobically. The IPCC default B_o of 0.25 kg CH_4/kg COD and default MCF of 0.8 for anaerobic treatment were used to estimate the CH_4 produced from these on-site treatment systems. The USDA National Agricultural Statistics Service (USDA 2011) provided production data for potatoes, other vegetables, citrus fruit, non-citrus fruit, and grapes processed for wine. Outflow and BOD data, presented in Table 8-13, were obtained from EPA (1974) for potato, citrus fruit, and apple processing, and from EPA (1975) for all other sectors.

Table 8-13: Wastewater Flow (m^3/ton) and BOD Production (g/L) for U.S. Vegetables, Fruits, and Juices Production

Commodity	Wastewater Outflow (m^3/ton)	BOD (g/L)
Vegetables		
Potatoes	10.27	1.765
Other Vegetables	8.71	0.797
Fruit		
Apples	3.66	1.371
Citrus	10.11	0.317
Non-citrus	12.42	1.204
Grapes (for wine)	2.78	1.831

Ethanol Production. Ethanol, or ethyl alcohol, is produced primarily for use as a fuel component, but is also used in industrial applications and in the manufacture of beverage alcohol. Ethanol can be produced from the fermentation of sugar-based feedstocks (e.g., molasses and beets), starch- or grain-based feedstocks (e.g., corn, sorghum, and beverage waste), and cellulosic biomass feedstocks (e.g., agricultural wastes, wood, and bagasse). Ethanol can also be produced synthetically from ethylene or hydrogen and carbon monoxide. However, synthetic ethanol comprises only about 2 percent of ethanol production, and although the Department of Energy predicts cellulosic ethanol to greatly increase in the coming years, currently it is only in an experimental stage in the United States. According to the Renewable Fuels Association, 82 percent of ethanol production facilities use corn as the sole feedstock and 7 percent of facilities use a combination of corn and another starch-based feedstock. The fermentation of corn is the principal ethanol production process in the United States and is expected to increase through 2012, and potentially more; therefore, emissions associated with wastewater treatment at starch-based ethanol production facilities were estimated (ERG 2006).

Ethanol is produced from corn (or other starch-based feedstocks) primarily by two methods: wet milling and dry milling. Historically, the majority of ethanol was produced by the wet milling process, but now the majority is produced by the dry milling process. The wastewater generated at ethanol production facilities is handled in a variety of ways. Dry milling facilities often combine the resulting evaporator condensate with other process wastewaters, such as equipment wash water, scrubber water, and boiler blowdown and anaerobically treat this

wastewater using various types of digesters. Wet milling facilities often treat their steepwater condensate in anaerobic systems followed by aerobic polishing systems. Wet milling facilities may treat the stillage (or processed stillage) from the ethanol fermentation/distillation process separately or together with steepwater and/or wash water. CH_4 generated in anaerobic digesters is commonly collected and either flared or used as fuel in the ethanol production process (ERG 2006).

Available information was compiled from the industry on wastewater generation rates, which ranged from 1.25 gallons per gallon ethanol produced (for dry milling) to 10 gallons per gallon ethanol produced (for wet milling) (Ruocco 2006a,b; Merrick 1998; Donovan 1996; and NRBP 2001). COD concentrations were also found to be about 3 g/L (Ruocco 2006a; Merrick 1998; White and Johnson 2003). The amount of wastewater treated anaerobically was estimated, along with how much of the CH_4 is recovered through the use of biomethanators (ERG 2006). Methane emissions were then estimated as follows:

$$\text{Methane} = [\text{Production} \times \text{Flow} \times \text{COD} \times 3.785 \times ([\%\text{Plants}_o \times \%\text{WW}_{a,p} \times \%\text{COD}_p] + [\%\text{Plants}_a \times \%\text{WW}_{a,s} \times \%\text{COD}_s] + [\%\text{Plants}_t \times \%\text{WW}_{a,t} \times \%\text{COD}_s]) \times B_o \times \text{MCF} \times \%\text{ Not Recovered}] + [\text{Production} \times \text{Flow} \times 3.785 \times \text{COD} \times ([\%\text{Plants}_o \times \%\text{WW}_{a,p} \times \%\text{COD}_p] + [\%\text{Plants}_a \times \%\text{WW}_{a,s} \times \%\text{COD}_s] + [\%\text{Plants}_t \times \%\text{WW}_{a,t} \times \%\text{COD}_s]) \times B_o \times \text{MCF} \times (\%\text{ Recovered}) \times (1\text{-DE})] \text{ x } 1/10\text{^}9$$

where,

Production	= gallons ethanol produced (wet milling or dry milling)
Flow	= gallons wastewater generated per gallon ethanol produced (1.25 dry milling, 10 wet milling)
COD	= COD concentration in influent (3 g/l)
3.785	= conversion, gallons to liters
$\%\text{Plants}_o$	= percent of plants with onsite treatment (100%)
$\%\text{WW}_{a,p}$	= percent of wastewater treated anaerobically in primary treatment (0%)
$\%\text{COD}_p$	= percent of COD entering primary treatment (100%)
$\%\text{Plants}_a$	= percent of plants with anaerobic secondary treatment (33.3% wet, 75% dry)
$\%\text{Plants}_t$	= percent of plants with other secondary treatment (66.7% wet, 25% dry)
$\%\text{WW}_{a,s}$	= percent of wastewater treated anaerobically in anaerobic secondary treatment (100%)
$\%\text{WW}_{a,t}$	= percent of wastewater treated anaerobically in other secondary treatment (0%)
$\%\text{COD}_s$	= percent of COD entering secondary treatment (100%)
B_o	= maximum methane producing capacity (0.25 g CH_4/g COD)
MCF	= methane conversion factor (0.8 for anaerobic systems)
% Recovered	= percent of wastewater treated in system with emission recovery
% Not Recovered	= 1 - percent of wastewater treated in system with emission recovery
DE	= destruction efficiency of recovery system (99%)
1/10^9	= conversion factor, g to Gg

A time series of CH_4 emissions for 1990 through 2010 was developed based on production data from the Renewable Fuels Association (RFA 2011).

Petroleum Refining. Petroleum refining wastewater treatment operations produce CH_4 emissions from anaerobic wastewater treatment. The wastewater inventory section includes CH_4 emissions from petroleum refining wastewater treated on site under intended or unintended anaerobic conditions. Most facilities use aerated biological systems, such as trickling filters or rotating biological contactors; these systems can also exhibit anaerobic conditions that can result in the production of CH_4. Oil/water separators are used as a primary treatment method; however, it is unlikely that any COD is removed in this step.

Available information from the industry was compiled. The wastewater generation rate, from CARB (2007) and Timm (1985), was determined to be 35 gallons per barrel of finished product. An average COD value in the wastewater was estimated at 0.45 kg/m^3 (Benyahia et al. 2006).

The equation used to calculate CH_4 generation at petroleum refining wastewater treatment systems is presented below:

$$\text{Methane} = \text{Flow} \times \text{COD} \times B_o \times \text{MCF}$$

where,

Flow	= Annual flow treated through anaerobic treatment system (m^3/year)
COD	= COD loading in wastewater entering anaerobic treatment system (kg/m^3)
B_o	= maximum methane producing potential of industrial wastewater (default value of 0.25 kg CH_4 /kg COD)
MCF	= methane conversion factor (0.3)

A time series of CH_4 emissions for 1990 through 2010 was developed based on production data from the Energy Information Association (EIA 2011).

Domestic Wastewater N_2O Emission Estimates

N_2O emissions from domestic wastewater (wastewater treatment) were estimated using the IPCC (2006) methodology, including calculations that take into account N removal with sewage sludge, non-consumption and industrial/commercial wastewater N, and emissions from advanced centralized wastewater treatment plants:

- In the United States, a certain amount of N is removed with sewage sludge, which is applied to land, incinerated, or landfilled (N_{SLUDGE}). The N disposal into aquatic environments is reduced to account for the sewage sludge application.
- The IPCC methodology uses annual, per capita protein consumption (kg protein/[person-year]). For this inventory, the amount of protein available to be consumed is estimated based on per capita annual food availability data and its protein content, and then adjusts that data using a factor to account for the fraction of protein actually consumed.
- Small amounts of gaseous nitrogen oxides are formed as byproducts in the conversion of nitrate to N gas in anoxic biological treatment systems. Approximately 7 g N_2O is generated per capita per year if wastewater treatment includes intentional nitrification and denitrification (Scheehle and Doorn 2001). Analysis of the 2004 CWNS shows that plants with denitrification as one of their unit operations serve a population of 2.4 million people. Based on an emission factor of 7 g per capita per year, approximately 21.2 metric tons of additional N_2O may have been emitted via denitrification in 2004. Similar analyses were completed for each year in the Inventory using data from CWNS on the amount of wastewater in centralized systems treated in denitrification units. Plants without intentional nitrification/denitrification are assumed to generate 3.2 g N_2O per capita per year.

N_2O emissions from domestic wastewater were estimated using the following methodology:

$$N_2O_{TOTAL} = N_2O_{PLANT} + N_2O_{EFFLUENT}$$

$$N_2O_{PLANT} = N_2O_{NIT/DENIT} + N_2O_{WOUT\ NIT/DENIT}$$

$$N_2O_{NIT/DENIT} = [(US_{POPND}) \times EF_2 \times F_{IND\text{-}COM}] \times 1/10\text{^}9$$

$$N_2O_{WOUT\ NIT/DENIT} = \{[(US_{POP} \times WWTP) - US_{POPND}] \times F_{IND\text{-}COM} \times EF_1\} \times 1/10\text{^}9$$

$$N_2O_{EFFLUENT} = \{[(((US_{POP} \times WWTP) - (0.9 \times US_{POPND})) \times Protein \times F_{NPR} \times F_{NON\text{-}CON} \times F_{IND\text{-}COM}) - N_{SLUDGE}] \times EF_3 \times 44/28\} \times 1/10\text{^}6$$

where,

N_2O_{TOTAL}	= Annual emissions of N_2O (Gg)
N_2O_{PLANT}	= N_2O emissions from centralized wastewater treatment plants (Gg)
$N_2O_{NIT/DENIT}$	= N_2O emissions from centralized wastewater treatment plants with nitrification/denitrification (Gg)
$N_2O_{WOUT\ NIT/DENIT}$	= N_2O emissions from centralized wastewater treatment plants without nitrification/denitrification (Gg)
$N_2O_{EFFLUENT}$	= N_2O emissions from wastewater effluent discharged to aquatic environments (Gg)
US_{POP}	= U.S. population
US_{POPND}	= U.S. population that is served by biological denitrification (from CWNS)
WWTP	= Fraction of population using WWTP (as opposed to septic systems)

EF_1	= Emission factor (3.2 g N_2O/person-year) – plant with no intentional denitrification
EF_2	= Emission factor (7 g N_2O/person-year) – plant with intentional denitrification
Protein	= Annual per capita protein consumption (kg/person/year)
F_{NPR}	= Fraction of N in protein, default = 0.16 (kg N/kg protein)
$F_{NON-CON}$	= Factor for non-consumed protein added to wastewater (1.4)
$F_{IND-COM}$	= Factor for industrial and commercial co-discharged protein into the sewer system (1.25)
N_{SLUDGE}	= N removed with sludge, kg N/yr
EF_3	= Emission factor (0.005 kg N_2O -N/kg sewage-N produced) – from effluent
0.9	= Amount of nitrogen removed by denitrification systems (EPA 2008)
44/28	= Molecular weight ratio of N_2O to N_2

U.S. population data were taken from the U.S. Census Bureau International Database (U.S. Census 2011) and include the populations of the United States, American Samoa, Guam, Northern Mariana Islands, Puerto Rico, and the Virgin Islands. The fraction of the U.S. population using wastewater treatment plants is based on data from the 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, and 2009 American Housing Survey (U.S. Census 2009). Data for intervening years were obtained by linear interpolation. The emission factor (EF_1) used to estimate emissions from wastewater treatment for plants without intentional denitrification was taken from IPCC (2006), while the emission factor (EF_2) used to estimate emissions from wastewater treatment for plants with intentional denitrification was taken from Scheehle and Doorn (2001). Data on annual per capita protein intake were provided by U.S. Department of Agriculture Economic Research Service (USDA 2009). Protein consumption data for 2005 through 2010 were extrapolated from data for 1990 through 2004. Table 8-14 presents the data for U.S. population and average protein intake. An emission factor to estimate emissions from effluent (EF_3) has not been specifically estimated for the United States, thus the default IPCC value (0.005 kg N_2O-N/kg sewage-N produced) was applied. The fraction of N in protein (0.16 kg N/kg protein) was also obtained from IPCC (2006). The factor for non-consumed protein and the factor for industrial and commercial co-discharged protein were obtained from IPCC (2006). Sludge generation was obtained from EPA (1999) for 1988, 1996, and 1998 and from Beecher et al. (2007) for 2004. Intervening years were interpolated, and estimates for 2005 through 2009 were forecasted from the rest of the time series. An estimate for the N removed as sludge (N_{SLUDGE}) was obtained by determining the amount of sludge disposed by incineration, by land application (agriculture or other), through surface disposal, in landfills, or through ocean dumping. In 2010, 274 Gg N was removed with sludge.

Table 8-14: U.S. Population (Millions), Available Protein (kg/person-year), and Protein Consumed (kg/person-year)

Year	Population	Available Protein	Protein Consumed
1990	253	38.7	29.6
2005	300	41.7	32.0
2006	303	41.9	32.2
2007	306	42.1	32.3
2008	309	42.2	32.4
2009	311	42.4	32.5
2010	313	42.6	32.7

Source: U.S. Census Bureau 2011, USDA 2009.

Uncertainty and Time-Series Consistency

The overall uncertainty associated with both the 2010 CH_4 and N_2O emission estimates from wastewater treatment and discharge was calculated using the IPCC Good Practice Guidance Tier 2 methodology (2000). Uncertainty associated with the parameters used to estimate CH_4 emissions include that of numerous input variables used to model emissions from domestic wastewater, and wastewater from pulp and paper manufacture, meat and poultry processing, fruits and vegetable processing, ethanol production, and petroleum refining. Uncertainty associated with the parameters used to estimate N_2O emissions include that of sewage sludge disposal, total U.S. population, average protein consumed per person, fraction of N in protein, non-consumption nitrogen factor, emission factors per capita and per mass of sewage-N, and for the percentage of total population using centralized wastewater treatment plants.

The results of this Tier 2 quantitative uncertainty analysis are summarized in Table 8-15. Methane emissions from wastewater treatment were estimated to be between 12.3 and 21.5 Tg CO_2 Eq. at the 95 percent confidence level (or in 19 out of 20 Monte Carlo Stochastic Simulations). This indicates a range of approximately 25 percent below to 31 percent above the 2010 emissions estimate of 16.3 Tg CO_2 Eq. N_2O emissions from wastewater treatment were estimated to be between 1.2 and 10.1 Tg CO_2 Eq., which indicates a range of approximately 77 percent below to 99 percent above the 2010 emissions estimate of 5.0 Tg CO_2 Eq.

Table 8-15: Tier 2 Quantitative Uncertainty Estimates for CH_4 Emissions from Wastewater Treatment (Tg CO_2 Eq. and Percent)

Source	Gas	2010 Emission Estimate (Tg CO2 Eq.)	Uncertainty Range Relative to Emission Estimate[a] (Tg CO2 Eq.)		(%)	
			Lower Bound	Upper Bound	Lower Bound	Upper Bound
Wastewater Treatment	**CH_4**	**16.3**	**12.3**	**21.5**	**-25%**	**+31%**
Domestic	CH_4	7.8	5.8	9.9	-26%	+28%
Industrial	CH_4	8.6	5.1	13.3	-41%	+54%
Wastewater Treatment	**N_2O**	**5.0**	**1.2**	**10.1**	**-77%**	**+99%**

[a] Range of emission estimates predicted by Monte Carlo Stochastic Simulation for a 95 percent confidence interval.

Methodological recalculations were applied to the entire time-series to ensure time-series consistency from 1990 through 2010. Details on the emission trends through time are described in more detail in the Methodology section, above.

QA/QC and Verification

A QA/QC analysis was performed on activity data, documentation, and emission calculations. This effort included a Tier 1 analysis, including the following checks:

- Checked for transcription errors in data input;
- Ensured references were specified for all activity data used in the calculations;
- Checked a sample of each emission calculation used for the source category;
- Checked that parameter and emission units were correctly recorded and that appropriate conversion factors were used;
- Checked for temporal consistency in time series input data for each portion of the source category;
- Confirmed that estimates were calculated and reported for all portions of the source category and for all years;
- Investigated data gaps that affected emissions estimates trends; and
- Compared estimates to previous estimates to identify significant changes.

All transcription errors identified were corrected. The QA/QC analysis did not reveal any systemic inaccuracies or incorrect input values.

Recalculations Discussion

For domestic wastewater CH_4 calculations, the emission estimations were updated for septic systems using new research from WERF (Leverenz et al. 2010). Previously, the septic equation used MCF and BOD produced (Gg/yr) along with percent of wastewater treated and B_o to estimate emissions. In the current Inventory, that calculation was updated with a new emission factor of 10.7 g CH_4/capita/day, which uses population along with percent of wastewater treated and B_o for estimating emissions. This recalculation caused changes from the 1990 through 2009 Inventory for all years. Other minor updates in input data such as population and production resulted in slight changes in the later years of the Inventory.

For domestic wastewater N_2O calculations, an update was made to the $N_2O_{EFFLUENT}$ equation to make it more accurately reflect emissions. U.S. population is now multiplied by the fraction of the population not using septic systems for wastewater treatment. In addition, the factor for industrial and commercial co-discharged protein was previously left out of the calculations. This error was fixed in the current Inventory. These updates caused changes from the 1990 through 2010 Inventory for all years. Other minor updates in input data such as population resulted in slight changes in the later years of the Inventory.

Planned Improvements

The methodology to estimate CH_4 emissions from domestic wastewater treatment currently utilizes estimates for the percentage of centrally treated wastewater that is treated by aerobic systems and anaerobic systems. These data come from the 1992, 1996, 2000, and 2004 CWNS. The question of whether activity data for wastewater treatment systems are sufficient across the time series to further differentiate aerobic systems with the potential to generate small amounts of CH_4 (aerobic lagoons) versus other types of aerobic systems, and to differentiate between anaerobic systems to allow for the use of different MCFs for different types of anaerobic treatment systems, continues to be explored. Recently available CWNS data for 2008 were evaluated for incorporation into the inventory, but due to significant changes in format, this dataset is not sufficiently detailed for inventory calculations. However, additional information and other data continue to be evaluated to update future years of the Inventory.

For industrial wastewater emissions, data recently collected by EPA's Office of Air for pulp and paper mills and petroleum refineries will be evaluated to determine if sufficient information is available to update the estimates of wastewater generated per unit of production and the percent of industry wastewater treated anaerobically in these industries (%TA). Initial evaluations of EPA's Office of Air data for pulp and paper manufacturing indicate there is sufficient information to update emission estimates in the next inventory year. Data collected under the EPA's GHGRP will also be investigated for updating this variable. Data collection from industrial wastewater treatment is expected to occur in 2012. In examining data from EPA's GHGRP that would be useful to improve the emission estimates for the industrial wastewater category, particular attention will be made to ensure time series consistency, as the facility-level reporting data from EPA's GHGRP are not available for all inventory years as reported in this inventory. In implementing improvements and integration of data from EPA's GHGRP, the latest guidance from the IPCC on the use of facility-level data in national inventories will be relied upon[237].

Currently, it is assumed that all aerobic wastewater treatment systems are well managed and produce no CH_4 and that all anaerobic systems have an MCF of 0.8. Efforts to obtain better data reflecting emissions from various types of municipal treatment systems are currently being pursued.

With respect to estimating N_2O emissions, the default emission factors for indirect N_2O from wastewater effluent and direct N_2O from centralized wastewater treatment facilities have a high uncertainty. Research is being conducted by WERF to measure N_2O emissions from municipal treatment systems. In addition, a literature review has been conducted focused on N_2O emissions from wastewater treatment to determine the state of such research and identify data to develop a country-specific N_2O emission factor or alternate emission factor or method. Such data will continue to be reviewed as they are available to determine if a country-specific N_2O emission factor can or should be developed, or if alternate emission factors should be used.

For the current Inventory, the use of new measurement data from WERF to develop U.S.-specific emission factors for N_2O and CH_4 emissions from septic systems was investigated. The data available to develop an emission factor for CH_4 was determined to be of sufficient quality and was incorporated into the inventory emissions calculation.

[237] See: http://www.ipcc-nggip.iges.or.jp/meeting/pdfiles/1008_Model_and_Facility_Level_Data_Report.pdf.

Due to the high uncertainty of the measurements for N_2O from septic systems, estimates of N_2O emissions were not included in the current Inventory. Appropriate emission factors for septic system N_2O emissions will continue to be investigated as the data collected by WERF indicate that septic soil systems are a source of N_2O emissions.

In addition, the estimate of N entering municipal treatment systems is under review. The factor that accounts for non-sewage N in wastewater (bath, laundry, kitchen, industrial components) also has a high uncertainty. Obtaining data on the changes in average influent N concentrations to centralized treatment systems over the time series would improve the estimate of total N entering the system, which would reduce or eliminate the need for other factors for non-consumed protein or industrial flow. The dataset previously provided by the National Association of Clean Water Agencies (NACWA) was reviewed to determine if it was representative of the larger population of centralized treatment plants for potential inclusion into the inventory. However, this limited dataset was not representative of the number of systems by state or the service populations served in the United States, and therefore could not be incorporated into the inventory methodology. Additional data sources will continue to be researched with the goal of improving the uncertainty of the estimate of N entering municipal treatment systems.

The value used for N content of sludge continues to be investigated. This value is driving the N_2O emissions for wastewater and is static over the time series. To date, new data has not been identified that would be able to establish a time series for this value.

A review of other industrial wastewater treatment sources for those industries believed to discharge significant loads of BOD and COD has been ongoing. Food processing industries have the highest potential for CH_4 generation due to the waste characteristics generated, and the greater likelihood to treat the wastes anaerobically. However, in all cases there is dated information available on U.S. treatment operations for these industries. Previously, both the organic chemicals and the seafood processing industry were investigated to estimate their potential to generate CH_4. Despite the lack of current data, emissions were estimated for both sectors. The organic chemicals industry was estimated to emit 15 Gg/year of CH_4, and seafood processing was estimated to emit 3.0-3.5 Gg/year. Due to the insignificant amount of CH_4 estimated to be emitted and the lack of reliable, up-to-date data, these industries were not selected for inclusion in the industry. Other industries will be reviewed as necessary for inclusion in future years of the Inventory using EPA's Permit Compliance System and Toxics Release inventory. In addition, information from EPA's GHGRP will be used to determine likely candidates for inclusion. As such, sugar processing (beet and cane sugar), beverage (wineries, distilleries, breweries, soft drinks), and dairy (including cheese making) industries have been identified for possible consideration in the future.

8.3. Composting (IPCC Source Category 6D)

Composting of organic waste, such as food waste, garden (yard) and park waste, and sludge, is common in the United States. Advantages of composting include reduced volume in the waste material, stabilization of the waste, and destruction of pathogens in the waste material. The end products of composting, depending on its quality, can be recycled as fertilizer and soil amendment, or be disposed in a landfill.

Composting is an aerobic process and a large fraction of the degradable organic carbon in the waste material is converted into carbon dioxide (CO_2). Methane (CH_4) is formed in anaerobic sections of the compost, but it is oxidized to a large extent in the aerobic sections of the compost. Anaerobic sections are created in composting piles when there is excessive moisture or inadequate aeration (or mixing) of the compost pile. The estimated CH_4 released into the atmosphere ranges from less than 1 percent to a few percent of the initial C content in the material (IPCC 2006). Depending on the N content of the feedstock and how well the compost pile is managed, nitrous oxide (N_2O) emissions can be produced. The sources of N_2O formation are complicated, but are mainly associated with anaerobic conditions, ranging from less than 0.5 percent to 5 percent of the initial nitrogen content of the material (IPCC 2006). Animal manures are typically expected to generate more N_2O than, for example, yard waste, however data are limited.

From 1990 to 2010, the amount of material composted in the United States has increased from 3,810 Gg to 18,763 Gg, an increase of approximately 392 percent. From 2000 to 2010, the amount of material composted in the United States has increased by approximately 26 percent. Emissions of CH_4 and N_2O from composting have increased by the same percentage (see Table 8-16 and Table 8-17). In 2010, CH_4 emissions from composting were 1.6 Tg CO_2 Eq. (75 Gg), and N_2O emissions from composting were 1.7 Tg CO_2 Eq. (5.6 Gg). The wastes that are composted include primarily yard trimmings (grass, leaves, and tree and brush trimmings) and food scraps from residences and commercial establishments (such as grocery stores, restaurants, and school and factory cafeterias). The composting

waste quantities reported here do not include backyard composting. The growth in composting since the 1990s is attributable to primarily two factors: (1) steady growth in population and residential housing, and (2) the enactment of legislation by state and local governments that discouraged the disposal of yard trimmings in landfills. In 1992, 11 states and the District of Columbia had legislation in effect that banned or discouraged disposal of yard trimmings in landfills. Currently, 23 states and the District of Columbia, representing about 50 percent of the nation's population, have enacted such legislation (EPA 2010). The total amount of waste composted has decreased slightly since 2008, by approximately 6 percent.

Table 8-16: CH_4 and N_2O Emissions from Composting (Tg CO_2 Eq.)

Activity	1990		2005	2006	2007	2008	2009	2010
CH_4	0.3		1.6	1.6	1.7	1.7	1.6	1.6
N_2O	0.4		1.7	1.8	1.8	1.9	1.8	1.7
Total	**0.7**		**3.3**	**3.3**	**3.5**	**3.5**	**3.3**	**3.3**

Table 8-17: CH_4 and N_2O Emissions from Composting (Gg)

Activity	1990		2005	2006	2007	2008	2009	2010
CH_4	15		75	75	79	80	75	75
N_2O	1		6	6	6	6	6	6

Methodology

Methane and N_2O emissions from composting depend on factors such as the type of waste composted, the amount and type of supporting material (such as wood chips and peat) used, temperature, moisture content and aeration during the process.

The emissions shown in Table 8-16 and Table 8-17 were estimated using the IPCC default (Tier 1) methodology (IPCC 2006), which is the product of an emission factor and the mass of organic waste composted (note: no CH_4 recovery is expected to occur at composting operations):

$$E_i = M \times EF_i$$

where,

E_i = CH_4 or N_2O emissions from composting, Gg CH_4 or N_2O,
M = mass of organic waste composted in Gg,
EF_i = emission factor for composting, 4 g CH_4/kg of waste treated (wet basis) and 0.3 g N_2O/kg of waste treated (wet basis), and
i = designates either CH_4 or N_2O.

Estimates of the quantity of waste composted (M) are presented in Table 8-18. Estimates of the quantity composted for 1990 and 1995 were taken from the *Characterization of Municipal Solid Waste in the United States: 1996 Update* (Franklin Associates 1997); estimates of the quantity composted for 2000, 2005, 2006, 2007, 2008, and 2009 were taken from EPA's *Municipal Solid Waste In The United States: 2009 Facts and Figures* (EPA 2010); estimates of the quantity composted for 2010 were calculated using the 2009 quantity composted and a ratio of the U.S. population in 2009 and 2010 (U.S. Census Bureau 2011).

Table 8-18: U.S. Waste Composted (Gg)

Activity	1990		2005	2006	2007	2008	2009	2010
Waste Composted	3,810		18,643	18,852	19,695	20,049	18,870	18,763

Source: Franklin Associates 1997 and EPA 2009.

Uncertainty and Time-Series Consistency

The estimated uncertainty from the 2006 IPCC Guidelines is ±50 percent for the Tier 1 methodology. Emissions from composting in 2010 were estimated to be between 1.7 and 5.0 Tg CO_2 Eq., which indicates a range of 50 percent below to 50 percent above the actual 2010 emission estimate of 3.3 Tg CO_2 Eq. (see Table 8-19).

Table 8-19 : Tier 1 Quantitative Uncertainty Estimates for Emissions from Composting (Tg CO_2 Eq. and Percent)

Source	Gas	2010 Emission Estimate (Tg CO2 Eq.)	Uncertainty Range Relative to Emission Estimate (Tg CO2 Eq.)		(%)	
			Lower Bound	Upper Bound	Lower Bound	Upper Bound
Composting	CH_4, N_2O	3.3	1.7	5.0	-50%	+50%

Methodological recalculations were applied to the entire time-series to ensure time-series consistency from 1990 through 2010. Details on the emission trends through time are described in more detail in the Methodology section, above.

Planned Improvements

For future Inventories, additional efforts will be made to improve the estimates of CH_4 and N_2O emissions from composting. For example, a literature search may be conducted to determine if emission factors specific to various composting systems and composted materials are available.

8.4. Waste Sources of Indirect Greenhouse Gases

In addition to the main greenhouse gases addressed above, waste generating and handling processes are also sources of indirect greenhouse gas emissions. Total emissions of NO_x, CO, and NMVOCs from waste sources for the years 1990 through 2010 are provided in Table 8-20.

Table 8-20: Emissions of NO_x, CO, and NMVOC from Waste (Gg)

Gas/Source	1990		2005	2006	2007	2008	2009	2010
NO_x	**+**		**2**	**2**	**2**	**2**	**2**	**2**
Landfills	+		2	2	2	2	2	2
Wastewater Treatment	+		+	+	+	+	+	+
Miscellaneous[a]	+		0	0	0	0	0	0
CO	**1**		**7**	**7**	**7**	**7**	**7**	**7**
Landfills	1		6	6	6	6	6	6
Wastewater Treatment	+		+	+	+	+	+	+
Miscellaneous[a]	+		+	+	+	+	+	+
NMVOCs	**673**		**114**	**113**	**111**	**109**	**76**	**76**
Wastewater Treatment	57		49	49	48	47	33	33
Miscellaneous[a]	557		43	43	42	41	29	29
Landfills	58		22	21	21	21	14	14

[a] Miscellaneous includes TSDFs (Treatment, Storage, and Disposal Facilities under the Resource Conservation and Recovery Act [42 U.S.C. § 6924, SWDA § 3004]) and other waste categories.
Note: Totals may not sum due to independent rounding.
+ Does not exceed 0.5 Gg.

Methodology

Due to the lack of data available at the time of publication, emission estimates for 2010 rely on 2009 data as a proxy. Emission estimates for 2009 were obtained from preliminary data (EPA 2010, EPA 2009), and disaggregated based on EPA (2003), which, in its final iteration, will be published on the National Emission Inventory (NEI) Air Pollutant Emission Trends web site. Emission estimates of these gases were provided by sector, using a "top down"

estimating procedure—emissions were calculated either for individual sources or for many sources combined, using basic activity data (e.g., the amount of raw material processed) as an indicator of emissions. National activity data were collected for individual source categories from various agencies. Depending on the source category, these basic activity data may include data on production, fuel deliveries, raw material processed, etc.

Uncertainty and Time-Series Consistency

No quantitative estimates of uncertainty were calculated for this source category. Methodological recalculations were applied to the entire time-series to ensure time-series consistency from 1990 through 2010.

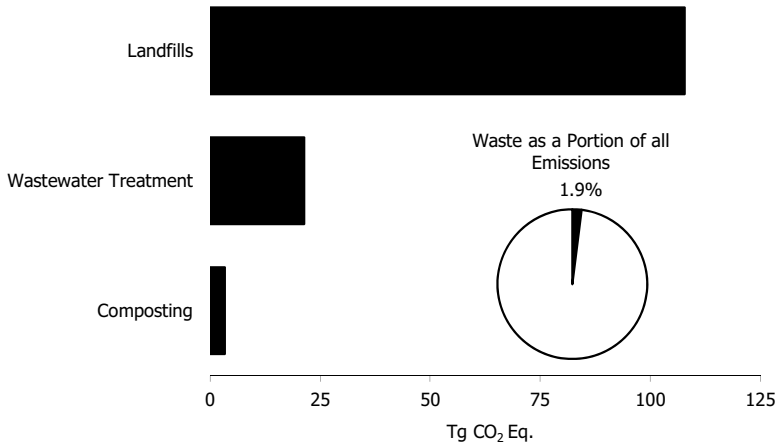


Figure 8-1: 2010 Waste Chapter Greenhouse Gas Sources

9. Other

The United States does not report any greenhouse gas emissions under the Intergovernmental Panel on Climate Change (IPCC) “Other” sector.

10. Recalculations and Improvements

Each year, emission and sink estimates are recalculated and revised for all years in the Inventory of U.S. Greenhouse Gas Emissions and Sinks, as attempts are made to improve both the analyses themselves, through the use of better methods or data, and the overall usefulness of the report. In this effort, the United States follows the 2006 IPCC Guidelines (IPCC 2006), which states, "Both methodological changes and refinements over time are an essential part of improving inventory quality. It is *good practice* to change or refine methods" when: available data have changed; the previously used method is not consistent with the IPCC guidelines for that category; a category has become key; the previously used method is insufficient to reflect mitigation activities in a transparent manner; the capacity for inventory preparation has increased; new inventory methods become available; and for correction of errors."

The results of all methodological changes and historical data updates are presented in this section; detailed descriptions of each recalculation are contained within each source's description found in this report, if applicable. Table 10-1 summarizes the quantitative effect of these changes on U.S. greenhouse gas emissions and sinks and Table 10-2 summarizes the quantitative effect on annual net CO_2 fluxes, both relative to the previously published U.S. Inventory (i.e., the 1990 through 2009 report). These tables present the magnitude of these changes in units of teragrams of carbon dioxide equivalent (Tg CO_2 Eq.).

The Recalculations Discussion section of each source presents the details of each recalculation. In general, when methodological changes have been implemented, the entire time series (i.e., 1990 through 2009) has been recalculated to reflect the change, per IPCC (2006). Changes in historical data are generally the result of changes in statistical data supplied by other agencies.

The following emission sources and sinks, which are listed in descending order of absolute average annual change in emissions or sequestration between 1990 and 2009, underwent some of the most important methodological and historical data changes. A brief summary of the recalculations and/or improvements undertaken is provided for each source.

- *Forest Land Remaining Forest Land (CH_4 & N_2O emissions, CO_2 sink).* There were five changes in the current Inventory affected the national stock and change estimates for forest ecosystems. The basic models used to estimate HWP C stocks and change are unchanged from the previous Inventory. Adopting the method of Woodall et al. (2011a) for both live and standing dead trees affected these two pools in somewhat different ways. First, live tree C stocks are lower because the new method estimates lower biomass for most trees. However, the relative effect on net annual stock change was minimal and varied from state to state. Second, the change from modeled estimates of standing dead to the tree-based estimates (Woodall et al. 2011a, Domke et al. 2011, Woodall et al. In Press) also resulted in lower estimates of stocks, yet the newer stock-change estimates included greater sequestration throughout the 21-year interval. The remaining three changes to the Inventory originate as modifications in the forest inventory data, specifically the FIADB. A number of Sothern states revised some previously-existing inventories from the late 1990s and early 2000s. From this, stock and stock-change estimates varied slightly for seven states over the mid-part of the 1990 through 2010 interval. In some cases, C stocks increased while in others they decreased. The net effect is a slight increase in sequestration as estimated for the late 1990s and early 2000s. The fourth change is the addition of the periodic data for Alaska timberlands so that a stock-change estimate is now included for a large part of coastal Alaska. The net effect on the national totals is a slight increase in sequestration applied throughout the interval. Finally, forest area, and thus C stock, estimates were revised upward for central and western portions of Oklahoma and Texas since the previous Inventory report. These changes only affect stocks and not change because those forest lands are based on single current surveys only.

  The changes in estimation procedures for live and standing dead trees affected estimates of uncertainty. The CRM method, which is largely a function of tree volume, appears to reduce levels of individual-tree error for both live and standing dead trees. In addition, empirical (i.e., field-based measurements of individual trees) estimates of standing dead trees have replaced a stand-level model, which should further reduce error. Additional information regarding error associated with the volume and CRM models remains limited and is an active area of ongoing research (e.g., FIA National Volume/Biomass Study).

  For the current Inventory, non-CO_2 emissions were calculated using the 2006 IPCC default emission factors for CH_4 and N_2O instead of the 2003 IPCC default emission factors. These default emission factors were converted

to CH_4 to CO_2 and N_2O to CO_2 emission ratios and then multiplied by CO_2 emissions to estimate CH_4 and N_2O emissions. The previous 2003 IPCC methodology provides emission ratios that are multiplied by total C emitted.

The National Association of State Foresters (NASF) releases data on land under wildland protection every several years. In 2011, NASF released these data for the year 2008, which affected the ratio of forest land to land under wildland protection for the years 2007 through 2009. For each of these three years, the updated ratio decreased the forest area burned estimates for the lower forty-eight states by around 15 percent. See the explanation in Annex 3.12 for more details on how the forestland to land under wildland protection ratio is used to calculate forest fire emissions.

In previous Inventory reports, the methodology has assumed that the C density of forest areas burned in wild and prescribed fires does not vary between years. This assumption has been in contrast to the forest C stock estimates, which are updated annually for all years based on data from the USDA Forest Service. The methodology adopted for the current Inventory improves the C density factors by incorporating dynamic C density values based on the annual C pool data provided by the USDA Forest Service for the years 1990 to 2010. As a result of this update, estimates of CO_2 and non-CO_2 emissions from wild and prescribed fires decreased by between 20 and 30 percent as compared to the estimates included in the previous Inventory. This decrease occurred because the dynamic C density values calculated were 20 to30 percent lower (depending on the year) than the C density values previously used for the methodology. For more information on how C density contributes to estimates of emissions from forest fires, see Annex 3.12.

In total, these changes resulted in a decrease in CH_4 and N_2O emissions from forest land remaining forest land across the entire time series, with an average annual decrease of 1.8 Tg CO_2 Eq. (20.1 percent) for CH_4 and 1.4 Tg CO_2 Eq. (19.2 percent) for N_2O. These changes also resulted in an increase in C sequestration across the time series, with an average annual increase of 44.9 Tg CO_2 Eq. (8.1 percent).

- *Wastewater Treatment (CH_4 & N_2O).* For domestic wastewater CH_4 calculations, the emission estimations were updated for septic systems using new research from WERF (Leverenz et al. 2010). Previously, the septic equation used MCF and BOD produced (Gg/yr) along with percent of wastewater treated and Bo to estimate emissions. In the current Inventory, that calculation was updated with a new emission factor of 10.7 g CH_4/capita/day, which uses population along with percent of wastewater treated and Bo for estimating emissions. This recalculation caused changes relative to the previous Inventory for all years. Other minor updates in input data such as population and production resulted in slight changes in the later years of the Inventory.

  For domestic wastewater N_2O calculations, an update was made to the $N_2O_{EFFLUENT}$ equation to make it more accurately reflect emissions. U.S. population is now multiplied by the fraction of the population not using septic systems for wastewater treatment. In addition, the factor for industrial and commercial co-discharged protein was previously left out of the calculations. This error was fixed in the current Inventory. These updates caused changes relative to the previous Inventory for all years. Other minor updates in input data such as population resulted in slight changes in the later years of the Inventory.

  In total, these changes resulted in an average annual decrease of 7.9 Tg CO_2 Eq. (32.0 percent) in CH_4 emissions and 0.2 Tg CO_2 Eq. (3.8 percent) in N_2O emissions from wastewater treatment for the period 1990 through 2009.

- *Enteric Fermentation (CH_4).* There were several modifications to the Enteric Fermentation methodology relative to the previous Inventory that had an effect on emission estimates, including the following:

  Emissions from bulls were estimated using Tier 2 methodology. This resulted in an increase of emissions from bulls by an average of approximately 79 percent per year compared to the previous Inventory estimates which used a Tier 1 methodology, such that bulls represent 3.4 percent of total enteric fermentation emissions from cattle. Revisions to the DE values for foraging cattle diets were applied to 1990 through 2010, resulting in an average change of less than 0.1 percent for foraging beef cattle emissions estimates for 1990 through 2006 and an average increase of 0.4 percent for 2007 through 2009. During the QA/QC process, it was realized that the one data point from 1988 (total births) had been revised by USDA since its original download. Therefore, the data point was corrected from 39,318.0 to 39,317.9 thousand births. This is a very minor change, but it is noted in detail specifically because it affects 1990 base year emissions by trickling through the transition matrix in the growing populations for 1989 and 1990. The equations used to distribute end-of-year remaining populations for

feedlot cattle to the individual state populations were updated so that the population proportions reflect the current year rather than the following year populations. This did not affect total populations, but there were minor changes to the populations by state for feedlot cattle for all years.

Previously, American bison and mules, burros, and donkeys were excluded from this source category. Emission estimates are now included for these animal types for all years, and contribute an average of 0.2 percent of total emissions from enteric fermentation across the time series.

The USDA published revised estimates in several categories that affected historical emissions estimated for cattle, including slight revisions in 2009 cattle on feed population estimates for "other states" (aggregated data for states with small populations of cattle on feed), dairy cow milk production for several states, and steer and heifer placement and slaughter statistics. Additionally, calf births were revised for both the 2008 and 2009 estimates. These changes had an insignificant impact on the overall results.

There were additional population changes for goats from 2003 through 2006, sheep for 2004, 2006, and 2009, and swine in 2009, as discussed in the recalculations discussion for manure management. Historical emission estimates for goats increased an average of 12.1 percent per year compared to the previous emission estimates for the years mentioned above. All other population changes resulted in a decrease in emissions of less than 1 percent for the animal type and year noted. As a result of all these changes, overall CH_4 emissions from enteric fermentation increased an average of 2.3 Tg CO_2 Eq. (1.7 percent) per year for 1990 through 2009.

- *Agricultural Soil Management (N_2O).* County-level animal populations were updated relative to the previous Inventory report based on 2007 USDA Census of Agriculture data (USDA 2007), which changed the animal population estimates for 2002 through 2009. The N excretion values for cattle changed for 1990 through 2009. Waste management system (WMS) distributions for dairy and swine were updated based on Census of Agriculture farm size data (USDA 2007). These changes created an average annual increase of 2.0 Tg CO_2 Eq. (1.0 percent) from agricultural soil management from 1990 through 2009.

- *Stationary Combustion (CH_4 and N_2O).* Historical CH_4 and N_2O emissions from stationary sources (excluding CO_2) were revised due to a few of changes, impacting the entire time series, relative to the previous Inventory. Slight changes to emission estimates for sectors are due to revised data from EIA (2011). Wood consumption data in EIA (2011) were revised for the residential, commercial, electric power, and industrial sectors from 1990 to 2009. Additionally, a Tier 2 emission estimation methodology was applied to estimate emissions from the electric power sector across the entire time series. This primarily impacted N_2O emission estimates, as the number of coal fluidized bed boilers increased significantly from 2000 through 2005. The combination of the methodological and historical data changes resulted in an average annual increase of less than 0.1 Tg CO_2 Eq. (0.5 percent) in CH_4 emissions from stationary combustion and an average annual increase of 1.9 Tg CO_2 Eq. (13.7 percent) in N_2O emissions from stationary combustion for the period 1990 through 2009.

- *Substitution of Ozone Depleting Substances (HFCs).* A review of the window units and residential unitary air conditioning end-uses led to minor revisions in the assumed transition scenarios. Overall, these changes to the Vintaging Model had negligible effects on estimates of greenhouse gas emissions across the time series. An update to the retail food refrigeration end-uses resulted in the replacement of the medium retail food end-use with small condensing units and large condensing units. In addition, updates were made to the charge sizes, leak rates, and equipment transitions for each end-use. These changes to the Vintaging Model had a significant impact on the estimates of greenhouse gas emissions for the retail food refrigeration sector. In total, changes resulted in an average annual increase of 1.8 Tg CO_2 Eq. (0.1 percent) in HFC emissions.

- *Electrical Transmission and Distribution (SF_6).* In the current Inventory, SF_6 emission estimates for the period 1990 through 2009 were updated relative to the previous report based on 1) new data from EPA's SF_6 Emission Reduction Partnership; 2) revisions to interpolated and extrapolated non-reported Partner data; and 3) a correction made to 1999 through 2001 reported emissions data for a Partner. Correcting the reported emissions not only directly impacted overall emissions for 1999 through 2001, but also impacted the regression coefficient used to estimate emissions for non-Partners, which is based on the relationship between transmission miles and emissions for Partners that reported emissions in 1999. Specifically, the regression coefficient for utilities with fewer than 10,000 transmission miles decreased from 1.001 kg of emissions per transmission mile to 0.89 kg of emissions per transmission mile. Based on the revisions listed above, SF_6 emissions from electrical transmission and distribution decreased between 6 and 9 percent for each year from 1990 through 2009 relative to the previous report. Based on the revisions listed above, SF_6 emissions from electrical transmission and

distribution decreased between 6 and 9 percent for each year from 1990 through 2009, with an average decrease of 1.3 Tg CO_2 Eq. (6.8 percent).

- *Non-Energy Uses of Fossil Fuels (CO_2).* Relative to the previous Inventory, emissions from non-energy uses (NEU) of fossil fuels decreased by an average of 1.2 Tg CO_2 Eq. (0.7 percent) across the entire time series. Two competing changes contributed to these recalculations. The larger of the two changes was a decrease in emissions caused by a change in petrochemical input data reported by the Energy Information Administration (EIA) in its Monthly Energy Review. In particular, a decline in EIA's estimate of petroleum coke consumed for non-energy purposes across the time series explains the majority of the decrease. The smaller of the two changes was an increase in emissions caused by EIA's revision of its methodology for calculating LPG consumed for non-energy uses in consultation with EPA. These estimates had previously been based on the assumption that the portion of LPG used for NEU remained constant at its 2004 level for the rest of the time series. For the current Inventory, EIA instead retrieved data describing the portion of LPG in NEU from Petroleum Supply Annual for the entire 1990 through 2010 time series and revised the previous assumption accordingly. Because 2004 was an uncharacteristically low year for non-energy consumption of LPG, this revision resulted in an overall increase in estimates of LPG consumed for NEU and thus an increase in estimated emissions. Combined, the net effect of these two changes was to decrease emission estimates across the time series by 1.0 Tg CO_2 Eq. (0.7 percent) since 2004.
- *Biomass – Wood (CO_2)* Wood consumption values were revised relative to the previous Inventory for 2009 based on updated information from EIA's Annual Energy Review (EIA 2011). Additionally, the change in methodology for calculating emissions from woody biomass led a decrease in emissions from the electricity generation sector and an increase in emissions for the other sectors over the time series. This adjustment of historical data for wood biomass consumption resulted in an average annual decrease in emissions from wood biomass consumption of about 1.0 Tg CO_2 Eq. (0.5 percent) from 1990 through 2009.
- *Adipic Acid Production (N_2O).* For the current Inventory, plant specific N_2O emissions data for Plant 3 were obtained directly from the plant engineer for 2005 through 2009. In the previous Inventory, 2005 through 2009 estimates of N_2O emissions from adipic acid production at Plant 3 were developed using plant production data. For the 1990 through 2009 inventory, Plant 3 emissions for, which uses thermal destruction, the N2O abatement system destruction factor was assumed to be 98.5 percent, and the abatement system utility factor was assumed to be 97 percent (IPCC 2006). This recalculation resulted in an 84 percent increase in average annual estimated N2O emissions from adipic acid production between 2005 and 2009, relative to the previous report. In total, changes resulted in an average annual increase of 0.8 Tg CO_2 Eq. (20.9 percent) in N_2O emissions

Table 10-1: Revisions to U.S. Greenhouse Gas Emissions (Tg CO_2 Eq.)

Gas/Source	1990	2005	2006	2007	2008	2009
CO_2	**0.8**	**(6.2)**	**(2.1)**	**(1.4)**	**2.8**	**(4.7)**
Fossil Fuel Combustion	(0.1)	(6.7)	(0.1)	1.0	5.6	(2.8)
Electricity Generation	NC	+	+	+	+	(7.6)
Transportation	+	+	+	(0.1)	(0.1)	8.2
Industrial	(0.1)	(6.7)	(0.1)	2.4	3.7	(3.8)
Residential	NC	+	+	(0.7)	1.1	(0.2)
Commercial	+	+	+	(0.5)	0.9	0.6
U.S. Territories	NC	NC	NC	NC	NC	+
Non-Energy Use of Fuels	1.0	0.7	(1.8)	(2.4)	(2.3)	0.4
Iron and Steel Production & Metallurgical Coke Production	0.1	0.1	0.1	0.1	0.1	0.2
Natural Gas Systems	+	+	+	+	+	+
Cement Production	NC	NC	NC	NC	NC	NC
Lime Production	NC	NC	NC	NC	NC	+
Incineration of Waste	NC	+	+	+	(0.3)	(0.6)
Limestone and Dolomite Use	NC	NC	NC	NC	NC	NC
Ammonia Production	NC	NC	NC	+	+	(0.5)
Cropland Remaining Cropland	NC	NC	NC	+	+	(0.6)
Urea Consumption for Non-Agricultural Purposes	NC	NC	NC	+	+	(0.5)
Soda Ash Production and Consumption	NC	NC	NC	NC	+	(0.7)
Petrochemical Production	NC	NC	NC	NC	NC	NC
Aluminum Production	NC	NC	NC	NC	NC	NC
Carbon Dioxide Consumption	+	+	+	+	+	+
Titanium Dioxide Production	NC	NC	NC	NC	NC	0.1
Ferroalloy Production	NC	NC	NC	NC	NC	NC
Zinc Production	+	(0.1)	(0.1)	(0.1)	(0.1)	+
Phosphoric Acid Production	NC	NC	NC	NC	+	+
Wetlands Remaining Wetlands	NC	NC	NC	NC	NC	+
Lead Production	NC	NC	NC	NC	+	NC
Petroleum Systems	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.1)
Silicon Carbide Production and Consumption	NC	NC	NC	NC	NC	NC
Land Use, Land-Use Change, and Forestry (Sink)[a]	*(20.3)*	*(29.5)*	*(46.1)*	*(47.4)*	*(47.0)*	*(47.5)*
Biomass - Wood[b]	*(0.8)*	*(1.2)*	*(1.2)*	*(1.1)*	*(1.0)*	*(2.0)*
International Bunker Fuels[b]	*NC*	+	+	+	+	*(0.8)*
Biomass - Ethanol[b]	+	+	+	+	+	*1.0*
CH_4	**(6.6)**	**(5.7)**	**(7.4)**	**(8.4)**	**(8.8)**	**(14.1)**
Natural Gas Systems	(0.2)	+	0.1	0.1	0.9	(0.3)
Enteric Fermentation	1.7	2.5	2.5	2.8	2.8	2.8
Landfills	0.3	0.2	+	0.5	(2.8)	(6.3)
Coal Mining	NC	(0.1)	(0.1)	+	(0.2)	(0.9)
Manure Management	+	1.3	1.6	1.9	2.3	1.3
Petroleum Systems	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.3)
Wastewater Treatment	(7.6)	(7.8)	(7.8)	(7.8)	(7.9)	(8.0)
Rice Cultivation	NC	NC	NC	NC	NC	NC
Stationary Combustion	+	0.1	+	0.1	0.1	0.1
Abandoned Underground Coal Mines	NC	NC	NC	(0.3)	(0.6)	(0.4)
Forest Land Remaining Forest Land	(0.7)	(1.7)	(3.6)	(5.5)	(3.1)	(2.0)
Mobile Combustion	NC	+	+	+	+	+
Composting	NC	NC	NC	NC	NC	(0.1)
Petrochemical Production	NC	NC	NC	NC	+	+
Iron and Steel Production & Metallurgical Coke Production	NC	NC	NC	NC	NC	NC
Field Burning of Agricultural Residues	(0.1)	+	+	+	+	+

Ferroalloy Production	NC	NC	NC	NC	NC	NC
Silicon Carbide Production and Consumption	NC	NC	NC	NC	NC	NC
Incineration of Waste	NC	NC	NC	NC	NC	NC
International Bunker Fuels[b]	*NC*	+	+	+	+	+
N_2O	**1.1**	**9.0**	**10.4**	**9.8**	**6.3**	**8.4**
Agricultural Soil Management	2.2	1.7	2.2	1.7	2.2	2.7
Mobile Combustion	NC	0.1	0.1	(1.3)	(0.9)	(1.4)
Stationary Combustion	(0.6)	5.9	6.3	6.6	6.9	7.9
Manure Management	0.3	0.3	0.4	0.4	0.3	0.3
Nitric Acid Production	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Wastewater Treatment	(0.2)	(0.1)	(0.1)	+	+	(0.1)
N_2O from Product Uses	NC	NC	NC	NC	NC	NC
Forest Land Remaining Forest Land	(0.6)	(1.4)	(3.0)	(4.5)	(2.6)	(1.7)
Adipic Acid Production	NC	2.5	4.6	7.0	0.5	0.9
Composting	NC	NC	NC	NC	NC	(0.1)
Settlements Remaining Settlements	NC	NC	NC	+	(0.1)	(0.2)
Incineration of Waste	NC	NC	NC	NC	NC	NC
Field Burning of Agricultural Residues	+	+	+	+	+	+
Wetlands Remaining Wetlands	NC	NC	NC	NC	NC	+
International Bunker Fuels[b]	(1.8)	(6.4)	(8.5)	(10.6)	(13.1)	(14.6)
HFCs	**NC**	**(5.2)**	**(7.5)**	**(9.6)**	**(11.9)**	**(13.6)**
Substitution of Ozone Depleting Substances	NC	(5.2)	(7.5)	(9.6)	(11.9)	(13.6)
HCFC-22 Production	NC	NC	NC	NC	NC	NC
Semiconductor Manufacture	NC	NC	NC	NC	NC	+
PFCs	**(0.1)**	**NC**	**NC**	**NC**	**NC**	**+**
Semiconductor Manufacture	NC	NC	NC	NC	NC	+
Aluminum Production	(0.1)	NC	NC	NC	NC	NC
SF_6	**(1.7)**	**(1.2)**	**(1.1)**	**(1.1)**	**(1.2)**	**(1.0)**
Electrical Transmission and Distribution	(1.7)	(1.2)	(1.1)	(1.1)	(1.2)	(1.0)
Magnesium Production and Processing	NC	NC	NC	NC	+	+
Semiconductor Manufacture	NC	NC	NC	NC	NC	+
Net Change in Total Emissions[b]	**(6.6)**	**(9.3)**	**(7.6)**	**(10.6)**	**(12.8)**	**(25.0)**
Percent Change	**-0.1%**	**-0.1%**	**-0.1%**	**-0.1%**	**-0.2%**	**-0.4%**

+ Absolute value does not exceed 0.05 Tg CO_2 Eq. or 0.05 percent.
Parentheses indicate negative values
NC (No Change)
[a] Not included in emissions total.
[b] Excludes net CO_2 flux from Land Use, Land-Use Change, and Forestry, and emissions from International Bunker Fuels.

Note: Totals may not sum due to independent rounding.

Table 10-2: Revisions to Annual Net CO_2 Fluxes from Land Use, Land-Use Change, and Forestry (Tg CO_2 Eq.)

Component: Net CO_2 Flux From Land Use, Land-Use Change, and Forestry	**1990**	**2005**	**2006**	**2007**	**2008**	**2009**
Forest Land Remaining Forest Land	(20.3)	(29.4)	(46.1)	(47.3)	(47.3)	(47.5)
Cropland Remaining Cropland	NC	NC	NC	NC	NC	NC
Land Converted to Cropland	NC	NC	NC	NC	NC	NC
Grassland Remaining Grassland	NC	NC	NC	NC	NC	NC
Land Converted to Grassland	NC	NC	NC	NC	NC	NC
Settlements Remaining Settlements	NC	NC	NC	NC	NC	NC
Other	NC	(0.1)	+	+	0.3	+
Net Change in Total Flux	**(20.3)**	**(29.5)**	**(46.1)**	**(47.4)**	**(47.0)**	**(47.5)**
Percent Change	**-2.4%**	**-2.8%**	**-4.3%**	**-4.5%**	**-4.5%**	**-4.7%**

NC (No Change)

Note: Numbers in parentheses indicate a decrease in estimated net flux of CO_2 to the atmosphere, or an increase in net sequestration.

Note: Totals may not sum due to independent rounding.

+ Absolute value does not exceed 0.05 Tg CO_2 Eq. or 0.05 percent

11. References

Executive Summary

BEA (2010) *2009 Comprehensive Revision of the National Income and Product Accounts: Current-dollar and "real" GDP, 1929–2009*. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, Washington, DC. July 29, 2010. Available online at < http://www.bea.gov/national/index.htm#gdp >.

EIA (2010) Supplemental Tables on Petroleum Product detail. *Monthly Energy Review, September 2010,* Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2009/09).

EIA (2009) *International Energy Annual 2007*. Energy Information Administration (EIA), U.S. Department of Energy. Washington, DC. Updated October 2008. Available online at <http://www.eia.doe.gov/emeu/iea/carbon.html >.

EPA (2010) "2009 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards.

EPA (2009) "1970 - 2008 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

IPCC (2007) Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon , D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press. Cambridge, United Kingdom 996 pp.

IPCC (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2003) Good Practice Guidance for Land Use, Land-Use Change, and Forestry. National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, J. Penman, et al. (eds.). Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>. August 13, 2004.

IPCC (2001) Climate Change 2001: The Scientific Basis. Intergovernmental Panel on Climate Change, J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, C.A. Johnson, and K. Maskell (eds.). Cambridge University Press. Cambridge, United Kingdom.

IPCC (2000) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. , National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change. Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

IPCC (1996) Climate Change 1995: The Science of Climate Change. Intergovernmental Panel on Climate Change, J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg, and K. Maskell. (eds.). Cambridge University Press. Cambridge, United Kingdom.

IPCC/UNEP/OECD/IEA (1997) Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

NOAA/ESRL (2009) "Trends in Atmospheric Carbon Dioxide." Available online at <http://www.esrl.noaa.gov/gmd/ccgg/trends/>. 11 January 2010.

UNFCCC (2003) National Communications: Greenhouse Gas Inventories from Parties included in Annex I to the Convention, UNFCCC Guidelines on Reporting and Review. Conference of the Parties, Eighth Session, New Delhi. (FCCC/CP/2002/8). March 28, 2003.

U.S. Census Bureau (2010) U.S. Census Bureau International Database (IDB). Available online at <http://www.census.gov/ipc/www/idbnew.html>. August 15, 2010.

Introduction

CDIAC (2009) "Recent Greenhouse Gas Concentrations." T.J. Blasing; DOI: 10.3334/CDIAC/atg.032. Available online at <http://cdiac.ornl.gov/pns/current_ghg.html>. 23 February 2010.

EPA (2009) Technical Support Document for the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act. U.S. Environmental Protection Agency. December 2009.

IPCC (2007) Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon , D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press. Cambridge, United Kingdom 996 pp.

IPCC (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2003) Good Practice Guidance for Land Use, Land-Use Change, and Forestry. National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, J. Penman, et al. (eds.). Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>. August 13, 2004.

IPCC (2001) Climate Change 2001: The Scientific Basis. Intergovernmental Panel on Climate Change, J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, C.A. Johnson, and K. Maskell (eds.). Cambridge University Press. Cambridge, United Kingdom.

IPCC (2000) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change. Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

IPCC (1999) Aviation and the Global Atmosphere. Intergovernmental Panel on Climate Change. J.E. Penner, et al. (eds.). Cambridge University Press. Cambridge, United Kingdom.

IPCC (1996) Climate Change 1995: The Science of Climate Change. Intergovernmental Panel on Climate Change, J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg, and K. Maskell (eds.). Cambridge University Press. Cambridge, United Kingdom.

IPCC/TEAP (2005) *Special Report: Safeguarding the Ozone Layer and the Global Climate System, Chapter 4: Refrigeration*. 2005. Available at http://www.auto-ts.com/hcfc/technology%20option/Refrigeration/transport%20refrigeration.pdf

IPCC/UNEP/OECD/IEA (1997) Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Jacobson, M.Z. (2001) "Strong Radiative Heating Due to the Mixing State of Black Carbon in Atmospheric Aerosols." Nature, 409:695-697.

NOAA/ESRL (2009) "Trends in Atmospheric Carbon Dioxide." Available online at <http://www.esrl.noaa.gov/gmd/ccgg/trends/>. 11 January 2010.

UNEP/WMO (1999) Information Unit on Climate Change. Framework Convention on Climate Change. Available online at <http://unfccc.int>.

UNFCCC (2006) Updated UNFCCC Reporting Guidelines on Annual Inventories Following Incorporation of the Provisions of Decision 14/CP.11. United Nations Framework Convention on Climate Change, Nairobi. (FCCC/SBSTA/2006/9). August 16, 2006.

Trends in Greenhouse Gas Emissions

BEA (2010) *2009 Comprehensive Revision of the National Income and Product Accounts: Current-dollar and "real" GDP, 1929–2009*. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, Washington, DC. July 29, 2010. Available online at < http://www.bea.gov/national/index.htm#gdp >.

Duffield, J. (2006) Personal communication. Jim Duffield, Office of Energy Policy and New Uses, USDA and

Lauren Flinn, ICF International. December 2006.

EIA (2011) Supplemental Tables on Petroleum Product detail. *Monthly Energy Review, January 2011,* Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2011/01).

EPA (2010) "2009 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards.

EPA (2009) "1970 - 2008 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

IPCC (2001) Climate Change 2001: The Scientific Basis. Intergovernmental Panel on Climate Change, J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, C.A. Johnson, and K. Maskell (eds.). Cambridge University Press. Cambridge, United Kingdom.

U.S. Census Bureau (2010) U.S. Census Bureau International Database (IDB). Available online at <http://www.census.gov/ipc/www/idbnew.html>. August 15, 2010.

Energy

EIA (2010) Indicators: CO_2 Emissions. *International Energy Statistics 2010*. Energy Information Administration <http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm>.

Carbon Dioxide Emissions from Fossil Fuel Combustion

AAR (2009 through 2011) *Railroad Facts.* Policy and Economics Department, Association of American Railroads, Washington, DC.

AISI (2004 through 2011) *Annual Statistical Report*, American Iron and Steel Institute, Washington, DC.

APTA (2007 through 2011) *Public Transportation Fact Book.* American Public Transportation Association, Washington, DC. Available online at <http://www.apta.com/resources/statistics/Pages/transitstats.aspx>.

APTA (2006) *Commuter Rail National Totals.* American Public Transportation Association, Washington, DC. Available online at <http://www.apta.com/research/stats/rail/crsum.cfm>.

BEA (2011) *2010 Comprehensive Revision of the National Income and Product Accounts: Current-dollar and "real" GDP, 1929–2010*. Bureau of Economic Analysis (BEA), U.S. Department of Commerce, Washington, DC. July 29, 2011. Available online at < http://www.bea.gov/national/index.htm#gdp >.

BEA (1991 through 2009) Unpublished BE-36 survey data. Bureau of Economic Analysis, U.S. Department of Commerce. Washington, DC.

Benson, D. (2002 through 2004) Unpublished data. Upper Great Plains Transportation Institute, North Dakota State University and American Short Line & Regional Railroad Association.

Coffeyville Resources Nitrogen Fertilizers (2011) Nitrogen Fertilizer Operations. Available online at <http://coffeyvillegroup.com/NitrogenFertilizerOperations/index.html>.

Dakota Gasification Company (2006) *CO_2 Pipeline Route and Designation Information.* Bismarck, ND. Available online at <http://www.dakotagas.com/SafetyHealth/Pipeline_Information.html>.

DESC (2011) Unpublished data from the Defense Fuels Automated Management System (DFAMS). Defense Energy Support Center, Defense Logistics Agency, U.S. Department of Defense. Washington, DC.

DHS (2008) Email Communication. Elissa Kay, Department of Homeland Security and Joe Aamidor, ICF International. January 11, 2008.

DOC (1991 through 2011) Unpublished Report of Bunker Fuel Oil Laden on Vessels Cleared for Foreign Countries. Form-563. Foreign Trade Division, Bureau of the Census, U.S. Department of Commerce. Washington, DC.

DOE (2012) *2010 Worldwide Gasification Database*. National Energy Technology Laboratory and Gasification Technologies Council. Available online at <http://www.netl.doe.gov/technologies/coalpower/gasification/worlddatabase/index.html>. Accessed on 15 March

2012

DOE (1993 through 2011) *Transportation Energy Data Book*. Office of Transportation Technologies, Center for Transportation Analysis, Energy Division, Oak Ridge National Laboratory. ORNL-5198.

DOT (1991 through 2011) *Fuel Cost and Consumption*. U.S. Department of Transportation, Bureau of Transportation Statistics, Washington, DC. DAI-10. http://www.transtats.bts.gov/fuel.asp.

Eastman Gasification Services Company (2003) Project Data on Eastman Chemical Company's Chemicals-from-Coal Complex in Kingsport, TN. Available online at <http://www.netl.doe.gov/coal/gasification/pubs/pdf/Eastman%20Chemicals%20from%20Coal%20Complex.pdf>.

EIA (2012) Supplemental Tables on Petroleum Product detail. *Monthly Energy Review, February 2012*, Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2012/02).

EIA (2011a) *Annual Energy Review 2010*. Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0384(2011). October 19, 2011.

EIA (2011b) *Quarterly Coal Report: January-March 2011*.Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0121.

EIA (2011c) *U.S. Energy-Related Carbon Dioxide Emissions, 2010*. Energy Information Administration, U.S. Department of Energy. Washington, DC. August 2011. Available online at <http://www.eia.gov/environment/emissions/carbon/>.

EIA (2009a) *Emissions of Greenhouse Gases in the United States 2008, Draft Report.* Office of Integrated Analysis and Forecasting, Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE-EIA-0573(2009).

EIA (2009b) *Natural Gas Annual 2008*. Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0131(06). November 2009.

EIA (2009c) *Manufacturing Consumption of Energy 2006*. Energy Information Administration, U.S. Department of Energy. Washington, DC. Released July, 2009.

EIA (2007a) Personal Communication. Joel Lou, Energy Information Administration. and Aaron Beaudette, ICF International. *Residual and Distillate Fuel Oil Consumption for Vessel Bunkering (Both International and Domestic) for American Samoa, U.S. Pacific Islands, and Wake Island*. October 24, 2007.

EIA (2007b) *Historical Natural Gas Annual, 1930 – 2007*. Energy Information Administration, U.S. Department of Energy. Washington, DC.

EIA (2002) *Alternative Fuels Data Tables*. Energy Information Administration, U.S. Department of Energy. Washington, DC. Available online at <http://www.eia.doe.gov/fuelalternate.html>.

EIA (2001) *U.S. Coal, Domestic and International Issues*. Energy Information Administration, U.S. Department of Energy. Washington, DC. March 2001.

EIA (1991 through 2009) *Fuel Oil and Kerosene Sales.* Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0535-annual.

EPA (2011) Acid Rain Program Dataset 1996-2010. Office of Air and Radiation, Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, D.C.

EPA (2010a) Carbon Content Coefficients Developed for EPA's Mandatory Reporting Rule. Office of Air and Radiation, Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, D.C.

EPA (2010b*) NONROAD 2009a Model*. Office of Transportation and Air Quality, U.S. Environmental Protection Agency. Available online at <http://www.epa.gov/oms/nonrdmdl.htm>.

Erickson, T. (2003) *Plains CO_2 Reduction (PCOR) Partnership*. Presented at the Regional Carbon Sequestration Partnership Meeting Pittsburgh, Pennsylvania, Energy and Environmental Research Center, University of North Dakota. November 3, 2003. Available online at <http://www.netl.doe.gov/publications/proceedings/03/carbon-seq/Erickson.pdf>.

FAA (2012) Personal Communication between FAA and Leif Hockstad for aviation emissions estimates from the Aviation Environmental Design Tool (AEDT). February 2012.

FAA (2011) *FAA Aerospace Forecasts Fiscal Years 2011-2031*. Table 30 "General Aviation Aircraft Fuel Consumption," Federal Aviation Administration. Available online at <http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/aerospace_forecasts/2011-2031/media/2011%20Forecast%20Doc.pdf>.

FAA (2006) *System for assessing Aviation's Global Emission (SAGE) Model*. Federal Aviation Administration's Office of Environment and Energy, 2006. Additional information available at: http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/sage/>.

Fitzpatrick, E. (2002) *The Weyburn Project: A Model for International Collaboration*. Available online at <http://www.netl.doe.gov/coalpower/sequestration/pubs/mediarelease/mr-101102.pdf>.

FHWA (1996 through 2012) *Highway Statistics.* Federal Highway Administration, U.S. Department of Transportation, Washington, DC. Report FHWA-PL-96-023-annual. Available online at <http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm>.

FRB (2011) *Industrial Production and Capacity Utilization*. Federal Reserve Statistical Release, G.17, Federal Reserve Board. Available online at <http://www.federalreserve.gov/releases/G17/table1_2.htm>. November 16, 2010.

Gaffney, J. (2007) Email Communication. John Gaffney, American Public Transportation Association and Joe Aamidor, ICF International. December 17, 2007.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Jacobs, G. (2010) Personal communication. Gwendolyn Jacobs, Energy Information Administration and Rubaab Bhangu, ICF International. *U.S. Territories Fossil Fuel Consumption, 1990–2009.* Unpublished. U.S. Energy Information Administration. Washington, DC.

Marland, G. and A. Pippin (1990) "United States Emissions of Carbon Dioxide to the Earth's Atmosphere by Economic Activity." *Energy Systems and Policy*, 14(4):323.

SAIC/EIA (2001) *Monte Carlo Simulations of Uncertainty in U.S. Greenhouse Gas Emission Estimates*. *Final Report*. Prepared by Science Applications International Corporation (SAIC) for Office of Integrated Analysis and Forecasting, Energy Information Administration , U.S. Department of Energy. Washington, DC. June 22, 2001.

USAF (1998) *Fuel Logistics Planning.* U.S. Air Force: AFPAM23-221. May 1, 1998.

U.S. Bureau of the Census (2011) *Current Industrial Reports Fertilizer Materials and Related Products: 2010 Summary*. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

USGS (2011) *2010 Mineral Yearbook; Aluminum [Advanced Release]*. U.S. Geological Survey, Reston, VA.

USGS (2010a) *2009 Mineral Commodity Summaries: Aluminum*. U.S. Geological Survey, Reston, VA.

USGS (2007) *2006 Mineral Yearbook: Aluminum*. U.S. Geological Survey, Reston, VA.

USGS (2009a) *2008 Mineral Yearbook: Aluminum*. U.S. Geological Survey, Reston, VA.

USGS (1991 through 2011) *Minerals Yearbook: Manufactured Abrasives Annual Report.* U.S. Geological Survey, Reston, VA.

USGS (1994 through 2011) *Minerals Yearbook: Lead Annual Report.* U.S. Geological Survey, Reston, VA.

USGS (1995, 1998, 2000 through 2002) *Mineral Yearbook: Aluminum Annual Report.* U.S. Geological Survey, Reston, VA.

USGS (1991 through 2010a) *Minerals Yearbook: Silicon Annual Report*. U.S. Geological Survey, Reston, VA.

USGS (1991 through 2010b) *Mineral Yearbook: Titanium Annual Report.* U.S. Geological Survey, Reston, VA.

Stationary Combustion (excluding CO_2)

EIA (2012) Supplemental Tables on Petroleum Product detail. *Monthly Energy Review, February 2012,* Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2012/02).

EIA (2010) *Annual Energy Review 2010*. Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0384(2011). October 19, 2011.

EPA (2010a*) NONROAD 2009a Model*. Office of Transportation and Air Quality, U.S. Environmental Protection Agency. Available online at <http://www.epa.gov/oms/nonrdmdl.htm>.

EPA (2010b) "2009 Average annual emissions, all criteria pollutants in MS Excel." National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data. Office of Air Quality Planning and Standards.

EPA (2003) E-mail correspondance. Air pollutant data. Office of Air Pollution to the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency (EPA). December 22, 2003.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. , National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change. Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Jacobs, G. (2010) Personal communication. Gwendolyn Jacobs, Energy Information Administration and Rubaab Bhangu, ICF International. *U.S. Territories Fossil Fuel Consumption, 1990–2009.* Unpublished. U.S. Energy Information Administration. Washington, DC.

SAIC/EIA (2001) *Monte Carlo Simulations of Uncertainty in U.S. Greenhouse Gas Emission Estimates*. *Final Report*. Prepared by Science Applications International Corporation (SAIC) for Office of Integrated Analysis and Forecasting, Energy Information Administration , U.S. Department of Energy. Washington, DC. June 22, 2001.

Mobile Combustion (excluding CO_2)

AAR (2009 through 2011) *Railroad Facts.* Policy and Economics Department, Association of American Railroads, Washington, DC.

ANL (2006) Argonne National Laboratory (2006) GREET model Version 1.7. June 2006.

APTA (2007 through 2011) *Public Transportation Fact Book.* American Public Transportation Association, Washington, DC. Available online at < http://www.apta.com/resources/statistics/Pages/transitstats.aspx >.

APTA (2006) *Commuter Rail National Totals.* American Public Transportation Association, Washington, DC. Available online at <http://www.apta.com/research/stats/rail/crsum.cfm>.

Benson, D. (2002 through 2004) Personal communication. Unpublished data developed by the Upper Great Plains Transportation Institute, North Dakota State University and American Short Line & Regional Railroad Association.

BEA (1991 through 2005) Unpublished BE-36 survey data. Bureau of Economic Analysis (BEA), U.S. Department of Commerce.

Browning, L. (2009) Personal communication with Lou Browning , "Suggested New Emission Factors for Marine Vessels.", ICF International.

Browning, L. (2005) Personal communication with Lou Browning, Emission control technologies for diesel highway vehicles specialist, ICF International.

Browning, L. (2003) “VMT Projections for Alternative Fueled and Advanced Technology Vehicles through 2025.” 13th CRC On-Road Vehicle Emissions Workshop. April 2003.

DHS (2008) Email Communication. Elissa Kay, Department of Homeland Security and Joe Aamidor, ICF International. January 11, 2008.

DESC (2011) Unpublished data from the Defense Fuels Automated Management System (DFAMS). Defense Energy Support Center, Defense Logistics Agency, U.S. Department of Defense. Washington, DC.

DOC (1991 through 2011) Unpublished Report of Bunker Fuel Oil Laden on Vessels Cleared for Foreign Countries. Form-563. Foreign Trade Division, Bureau of the Census, U.S. Department of Commerce. Washington, DC.

DOE (1993 through 2011) *Transportation Energy Data Book*. Office of Transportation Technologies, Center for Transportation Analysis, Energy Division, Oak Ridge National Laboratory. ORNL-5198.

DOT (1991 through 2011) *Fuel Cost and Consumption*. U.S. Department of Transportation, Bureau of Transportation Statistics, Washington, DC. DAI-10. http://www.transtats.bts.gov/fuel.asp.

EIA (2012) Supplemental Tables on Petroleum Product detail. *Monthly Energy Review, February 2012*, Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2012/02).

EIA (2011) *Annual Energy Review 2010*. Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0384(2011). October 19, 2011.

EIA (2008a) "Table 3.1: World Petroleum Supply and Disposition." *International Energy Annual.* Energy Information Administration, U.S. Department of Energy. Washington, DC. Available online at <http://www.eia.doe.gov/iea/pet.html>.

EIA (2007a) Personal Communication. Joel Lou, Energy Information Administration and Aaron Beaudette, ICF International. *Residual and Distillate Fuel Oil Consumption for Vessel Bunkering (Both International and Domestic) for American Samoa, U.S. Pacific Islands, and Wake Island*. October 24, 2007.

EIA (2007 through 2011) *Natural Gas Annual*. Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0131(11).

EIA (2002) *Alternative Fuels Data Tables*. Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov/fuelrenewable.html>.

EIA (1991 through 2012) *Fuel Oil and Kerosene Sales.* Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0535-annual.

EPA (2008) “1970 - 2007 Average annual emissions, all criteria pollutants in MS Excel.” *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

EPA (2007a) Annual Certification Test Results Report. Office of Transportation and Air Quality, U.S. Environmental Protection Agency. Available online at <http://www.epa.gov/otaq/crttst.htm>.

EPA (2007b) Confidential engine family sales data submitted to EPA by manufacturers. Office of Transportation and Air Quality, U.S. Environmental Protection Agency.

EPA (2011a) Motor Vehicle Emission Simulator (MOVES). Office of Transportation and Air Quality, U.S. Environmental Protection Agency. Available online at <http://www.epa.gov/otaq/ngm.htm>.

EPA (2011b*) NONROAD 2008a Model*. Office of Transportation and Air Quality, U.S. Environmental Protection Agency. Available online at <http://www.epa.gov/oms/nonrdmdl.htm>.

EPA (2000) *Mobile6 Vehicle Emission Modeling Software*. Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, Michigan.

EPA (1999a) *Emission Facts: The History of Reducing Tailpipe Emissions.* Office of Mobile Sources. May 1999. EPA 420-F-99-017. Available online at <http://www.epa.gov/oms/consumer/f99017.pdf>.

EPA (1999b) Regulatory Announcement: EPA's Program for Cleaner Vehicles and Cleaner Gasoline. Office of Mobile Sources. December 1999. EPA420-F-99-051. Available online at <http://www.epa.gov/otaq/regs/ld-

hwy/tier-2/frm/f99051.pdf>.

EPA (1998) *Emissions of Nitrous Oxide from Highway Mobile Sources: Comments on the Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990–1996*. Office of Mobile Sources, Assessment and Modeling Division, U.S. Environmental Protection Agency. August 1998. EPA420-R-98-009.

EPA (1997) *Mobile Source Emission Factor Model (MOBILE5a)*. Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, Michigan.

EPA (1994a) *Automobile Emissions: An Overview.* Office of Mobile Sources. August 1994. EPA 400-F-92-007. Available online at <http://www.epa.gov/otaq/consumer/05-autos.pdf>.

EPA (1994b) *Milestones in Auto Emissions Control.* Office of Mobile Sources. August 1994. EPA 400-F-92-014. Available online at <http://www.epa.gov/otaq/consumer/12-miles.pdf>.

EPA (1993) *Automobiles and Carbon Monoxide*. Office of Mobile Sources. January 1993. EPA 400-F-92-005. Available online at <http://www.epa.gov/otaq/consumer/03-co.pdf>.

Esser, C. (2003 through 2004) Personal Communication with Charles Esser, Residual and Distillate Fuel Oil Consumption for Vessel Bunkering (Both International and Domestic) for American Samoa, U.S. Pacific Islands, and Wake Island.

FAA (2012) Personal Communication between FAA and Leif Hockstad for aviation emissions estimates from the Aviation Environmental Design Tool (AEDT). February 2012.

FAA (2011) *FAA Aerospace Forecasts Fiscal Years 2011-2031*. Table 30 "General Aviation Aircraft Fuel Consumption," Federal Aviation Administration. Available online at <http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/aerospace_forecasts/2011-2031/media/2011%20Forecast%20Doc.pdf>.

FAA (2006) *System for assessing Aviation's Global Emission (SAGE) Model*. Federal Aviation Administration's Office of Environment and Energy, 2006. Additional information available at: <http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/sage/>.

FHWA (1996 through 2012) *Highway Statistics*. Federal Highway Administration, U.S. Department of Transportation, Washington, DC. Report FHWA-PL-96-023-annual. Available online at <http://www.fhwa.dot.gov/policyinformation/statistics.cfm>.

Gaffney, J. (2007) Email Communication. John Gaffney, American Public Transportation Association and Joe Aamidor, ICF International. December 17, 2007.

ICF (2006a) *Revisions to Alternative Fuel Vehicle (AFV) Emission Factors for the U.S. Greenhouse Gas Inventory.* Memorandum from ICF International to John Davies, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. November 2006.

ICF (2006b) *Revised Gasoline Vehicle EFs for LEV and Tier 2 Emission Levels.* Memorandum from ICF International to John Davies, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. November 2006.

ICF (2004) *Update of Methane and Nitrous Oxide Emission Factors for On-Highway Vehicles*. Final Report to U.S. Environmental Protection Agency. February 2004.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency, Paris, France.

Lipman, T. and M. Delucchi (2002) "Emissions of Nitrous Oxide and Methane from Conventional and Alternative Fuel Motor Vehicles." *Climate Change*, 53:477-516.

Unnasch, S., L. Browning, and E. Kassoy (2001) *Refinement of Selected Fuel-Cycle Emissions Analyses, Final Report to ARB.*

U.S. Census Bureau (2000) *Vehicle Inventory and Use Survey*. U.S. Census Bureau, Washington, DC. Database CD-EC97-VIUS.

Whorton, D. (2006 through 2012) Personal communication, Class II and III Rail energy consumption, American Short Line and Regional Railroad Association.

Carbon Emitted from Non-Energy Uses of Fossil Fuels

ACC (2011) "*Guide to the Business of Chemistry, 2011*," American Chemistry Council.

ACC (2003-2010) "PIPS Year-End Resin Statistics for 2010: Production, Sales and Captive Use." Available online at <http://www.americanchemistry.com/Jobs/EconomicStatistics/Plastics-Statistics/Production-and-Sales-Data-by-Resin.pdf>.

Bank of Canada (2011) Financial Markets Department Year Average of Exchange Rates. Available online at <http://www.bankofcanada.ca/rates/exchange/exchange-rates-in-pdf/?page_moved=1>.

EIA (2011) Supplemental Tables on Petroleum Product detail. *Monthly Energy Review, September 2011,* Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2011/09).

EIA (2010) *EIA Manufacturing Consumption of Energy (MECS) 2006,* U.S. Department of Energy, Energy Information Administration, Washington, DC.

EIA (2005) *EIA Manufacturing Consumption of Energy (MECS) 2002,* U.S. Department of Energy, Energy Information Administration, Washington, DC.

EIA (2001) *EIA Manufacturing Consumption of Energy (MECS) 1998,* U.S. Department of Energy, Energy Information Administration, Washington, DC.

EIA (1997) *EIA Manufacturing Consumption of Energy (MECS) 1994,* U.S. Department of Energy, Energy Information Administration, Washington, DC.

EIA (1994) *EIA Manufacturing Consumption of Energy (MECS) 1991,* U.S. Department of Energy, Energy Information Administration, Washington, DC.

EPA (2011) EPA's Pesticides Industry Sales and Usage, 2006 and 2007 Market Estimates. Available online at <http://www.epa.gov/oppbead1/pestsales/. Accessed January 2012>.

EPA (2010) "1970 - 2009 Average annual emissions, all criteria pollutants in MS Excel." National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

EPA (2009) Biennial Reporting System (BRS) Database. U.S. Environmental Protection Agency, Envirofacts Warehouse. Washington, DC. Available online at <http://www.epa.gov/enviro/html/brs/>. Data for 2001-2007 are current as of Sept. 9, 2009.

EPA (2007b) *Municipal Solid Waste in the United States: Facts and Figures for 2006*. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. Available online at <http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm>.

EPA (2006a) *Air Emissions Trends - Continued Progress Through 2005*. U.S. Environmental Protection Agency, Washington DC. December 19, 2006. Available online at <http://www.epa.gov/air/airtrends/index.html>.

EPA (2004) EPA's Pesticides Industry Sales and Usage, 2000 and 2001 Market Estimates. Available online at <http://www.epa.gov/oppbead1/pestsales/. Accessed September 2006>.

EPA (2002) EPA's Pesticides Industry Sales and Usage, 1998 and 1999 Market Estimates, table 3.6. Available online at <http://www.epa.gov/oppbead1/pestsales/99pestsales/market_estimates1999.pdf>. Accessed July 2003.

EPA (2001) AP 42, Volume I, Fifth Edition. Chapter 11: Mineral Products Industry. Available online at <http://www.epa.gov/ttn/chief/ap42/ch11/index.html>.

EPA (2000a) *Biennial Reporting System (BRS)*. U.S. Environmental Protection Agency, Envirofacts Warehouse. Washington, DC. Available online at <http://www.epa.gov/enviro/html/brs/>.

EPA (2000b) *Toxics Release Inventory, 1998*. U.S. Environmental Protection Agency, Office of Environmental Information, Office of Information Analysis and Access, Washington, DC. Available online at <http://www.epa.gov/triexplorer/chemical.htm>.

EPA (1999) EPA's Pesticides Industry Sales and Usage, 1996-1997 Market Estimates. Available online at <http://www.epa.gov/oppbead1/pestsales/97pestsales/market_estimates1997.pdf>.

EPA (1998) EPA's Pesticides Industry Sales and Usage, 1994-1995 Market Estimates. Available online at <http://www.epa.gov/oppbead1/pestsales/95pestsales/market_estimates1995.pdf>.

FEB (2011) *Fiber Economics Bureau, as cited in C&EN (2011) Output Ramps up in all Regions*. Chemical Engineering News, American Chemical Society, 4 July. Available online at <http://www.cen-online.org>.

FEB (2010) *Fiber Economics Bureau, as cited in C&EN (2010) Output Declines in U.S., Europe*. Chemical & Engineering News, American Chemical Society, 6 July. Available online at <http://www.cen-online.org>.

FEB (2009) *Fiber Economics Bureau, as cited in C&EN (2009) Chemical Output Slipped In Most Regions* Chemical & Engineering News, American Chemical Society, 6 July. Available online at <http://www.cen-online.org>.

FEB (2007) *Fiber Economics Bureau, as cited in C&EN (2007) Gains in Chemical Output Continue*. Chemical & Engineering News, American Chemical Society. July 2, 2007. Available online at <http://www.cen-online.org>.

FEB (2005) *Fiber Economics Bureau, as cited in C&EN (2005) Production: Growth in Most Regions* Chemical & Engineering News, American Chemical Society, 11 July. Available online at <http://www.cen-online.org>.

FEB (2003) *Fiber Economics Bureau, as cited in C&EN (2003) Production Inches Up in Most Countries*, Chemical & Engineering News, American Chemical Society, 7 July. Available online at <http://www.cen-online.org>.

FEB (2001) *Fiber Economics Bureau, as cited in ACS (2001) Production: slow gains in output of chemicals and products lagged behind U.S. economy as a whole* Chemical & Engineering News, American Chemical Society, 25 June. Available online at <http://pubs.acs.org/cen>.

Financial Planning Association (2006) Canada/US Cross-Border Tools: US/Canada Exchange Rates. Available online at <http://www.fpanet.org/global/planners/US_Canada_ex_rates.cfm>. Accessed August 16, 2006.

Gosselin, Smith, and Hodge (1984) "Clinical Toxicology of Commercial Products." Fifth Edition, Williams & Wilkins, Baltimore.

Huurman, J.W.F. (2006) R*ecalculation of Dutch Stationary Greenhouse Gas Emissions Based on Sectoral Energy Statistics 1990-2002*. Statistics Netherlands, Voorburg, The Netherlands.

IISRP (2003) "*IISRP Forecasts Moderate Growth in North America to 2007*" International Institute of Synthetic Rubber Producers, Inc. New Release. Available online at <http://www.iisrp.com/press-releases/2003-Press-Releases/IISRP-NA-Forecast-03-07.html>.

IISRP (2000) "Synthetic Rubber Use Growth to Continue Through 2004, Says IISRP and RMA" International Institute of Synthetic Rubber Producers press release.

INEGI (2006) Producción bruta total de las unidades económicas manufactureras por Subsector, Rama, Subrama y Clase de actividad. Available online at <http://www.inegi.gob.mx/est/contenidos/espanol/proyectos/censos/ce2004/tb_manufacturas.asp>. Accessed August 15.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe, eds.; Institute for Global Environmental Strategies (IGES). Hayama, Kanagawa, Japan.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Marland, G., and R.M. Rotty (1984) “Carbon dioxide emissions from fossil fuels: A procedure for estimation and results for 1950-1982”, Tellus 36b:232-261.

NPRA (2002) North American Wax - A Report Card. Available online at <http://www.npra.org/members/publications/papers/lubes/LW-02-126.pdf>.

RMA (2009a) *Scrap Tire Markets in the United States: 9th Biennial Report*. Rubber Manufacturers Association, Washington, DC. May 2009.

RMA (2009b) “Scrap Tire Markets: Facts and Figures – Scrap Tire Characteristics.” Available online at: http://www.rma.org/scrap_tires/scrap_tire_markets/scrap_tire_characteristics/ Accessed 17 September 2009.Schneider, S. (2007) E-mail between Shelly Schneider of Franklin Associates (a division of ERG) and Sarah Shapiro of ICF International, January 10, 2007.

U.S. Bureau of the Census (2009) *Soap and Other Detergent Manufacturing: 2007*. Available online at <http://smpbff1.dsd.census.gov/TheDataWeb_HotReport/servlet/HotReportEngineServlet?emailname=vh@boc&filename=mfg1.hrml&20071204152004.Var.NAICS2002=325611&forward=20071204152004.Var.NAICS2002 >.

U.S. Bureau of the Census (2004) *Soap and Other Detergent Manufacturing: 2002*, Issued December 2004, EC02-31I-325611 (RV). Available online at <http://www.census.gov/prod/ec02/ec0231i325611.pdf>.

U.S. Bureau of the Census (1999) *Soap and Other Detergent Manufacturing: 1997*, Available online at <http://www.census.gov/epcd/www/ec97stat.htm>.

U.S. International Trade Commission (1990-2011) “Interactive Tariff and Trade DataWeb: Quick Query.” Available online at <http://dataweb.usitc.gov/>. Accessed October 2011.

Incineration of Waste

ArSova, Ljupka, Rob van Haaren, Nora Goldstein, Scott M. Kaufman, and Nickolas J. Themelis (2008) “16th Annual BioCycle Nationwide Survey: The State of Garbage in America” Biocycle, JG Press, Emmaus, PA. December.

Bahor, B (2009) Covanta Energy’s public review comments re: *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007.* Submitted via email on April 9, 2009 to Leif Hockstad, U.S. EPA.

De Soete, G.G. (1993) “Nitrous Oxide from Combustion and Industry: Chemistry, Emissions and Control.” In A. R. Van Amstel, (ed) Proc. of the International Workshop Methane and Nitrous Oxide: Methods in National Emission Inventories and Options for Control, Amersfoort, NL. February 3-5, 1993.

Energy Recovery Council (2009) “2007 Directory of Waste-to-Energy Plants in the United States.” Accessed September 29, 2009.

EPA (2011a) Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Tables and Figures for 2010. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. Washington, DC. Available online at <http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm>.

EPA (2007, 2008, 2011b) Municipal Solid Waste in the United States: Facts and Figures. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. Washington, DC. Available online at <http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm>.

EPA (2006) Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. Washington, DC.

EPA (2000) Characterization of Municipal Solid Waste in the United States: Source Data on the 1999 Update. Office of Solid Waste, U.S. Environmental Protection Agency. Washington, DC. EPA530-F-00-024.

Goldstein, N. and C. Madtes (2001) “13th Annual BioCycle Nationwide Survey: The State of Garbage in America.” BioCycles, JG Press, Emmaus, PA. December 2001.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Kaufman, et al. (2004) “14th Annual BioCycle Nationwide Survey: The State of Garbage in America 2004” Biocycle, JG Press, Emmaus, PA. January, 2004.

RMA (2012a) “Scrap Tire Markets: Facts and Figures – Scrap Tire Characteristics.” Available online at <http://www.rma.org/scrap_tires/scrap_tire_markets/scrap_tire_characteristics/>. Accessed 18 January 2012.

RMA (2012b) "Rubber FAQs." Rubber Manufacturers Association. Available online at <http://www.rma.org/about_rma/rubber_faqs/ Accessed 18 January 2012>.

RMA (2011) “U.S. Scrap Tire Management Summary 2005-2009.” Rubber Manufacturers Association. October

2011. Available online at: <http://www.rma.org/scrap_tires/scrap_tire_markets/2009_summary.pdf>.

Schneider, S. (2007) E-mail between Shelly Schneider of Franklin Associates (a division of ERG) and Sarah Shapiro of ICF International, January 10, 2007.

Simmons, et al. (2006) "15th Nationwide Survey of Municipal Solid Waste Management in the United States: The State of Garbage in America" BioCycle, JG Press, Emmaus, PA. April 2006.

van Haaren, Rob, Thermelis, N., and Goldstein, N. (2010) "The State of Garbage in America." BioCycle, October 2010. Volume 51, Number 10, pg. 16-23.

Coal Mining

AAPG (1984) *Coalbed Methane Resources of the United States.* AAPG Studies in Geology Series #17.

DOE (1983) *Methane Recovery from Coalbeds: A Potential Energy Source*. U.S. Department of Energy. DOE/METC/83-76.

EIA (2010) *Annual Coal Report 1991-2009 (*Formerly called *Coal Industry Annual)*. Table 1. Energy Information Administration, U.S. Department of Energy,Washington, DC.

EPA (1996) *Evaluation and Analysis of Gas Content and Coal Properties of Major Coal Bearing Regions of the United States*. U.S. Environmental Protection Agency. EPA/600/R-96-065.

GRI (1988) *A Geologic Assessment of Natural Gas from Coal Seams.* Topical Reports, Gas Research Institute 1986-88.

Mutmansky, Jan M. and Yanbei Wang (2000) "Analysis of Potential Errors in Determination of Coal Mine Annual Methane Emissions." *Mineral Resources Engineering*, 9(4). December 2000.

USBM (1986) *Results of the Direct Method Determination of the Gas Contents of U.S. Coal Basins*. Circular 9067, U.S. Bureau of Mines.

Abandoned Underground Coal Mines

EPA (2003) *Methane Emissions Estimates & Methodology for Abandoned Coal Mines in the U.S.* Draft Final Report. Washington, DC. June 2003.

Mutmansky, Jan M., and Yanbei Wang (2000) *Analysis of Potential Errors in Determination of Coal Mine Annual Methane Emissions.* Department of Energy and Geo-Environmental Engineering, Pennsylvania State University. University Park, PA.

U.S. Department of Labor, Mine Health & Safety Administration (2011) *Data Retrieval System*. Available online at <http://www.msha.gov/drs/drshome.htm>.

Natural Gas Systems

AAPG (2004) Shale Gas Exciting Again. American Association of Petroleum Geologists. Available online at <http://www.aapg.org/explorer/2001/03mar/gas_shales.html>.

AGA (1991 through 1998) Gas Facts. American Gas Association. Washington, DC.

API (2005) "Table 12—Section III—Producing Oil Wells in the United States by State." In *Basic Petroleum Data Book.* American Petroleum Institute, Volume XXV, Number 1. February 2005.

Alabama (2011) Alabama State Oil and Gas Board. Available online at <http://www.ogb.state.al.us>.

BOEMRE (2011a) Gulf of Mexico Region Offshore Information. Bureau of Ocean Energy Management, Regulation and Enforcement, U.S. Department of Interior. Available online at <http://www.gomr.mms.gov/homepg/offshore/fldresv/resvmenu.html>.

BOEMRE (2011b) Gulf of Mexico Region. Bureau of Ocean Energy Management, Regulation and Enforcement, U.S. Department of Interior. Available online at <http://www.gomr.boemre.gov/homepg/pubinfo/freeasci/platform/freeplat.html >.

BOEMRE (2011c) OCS Platform Activity. Bureau of Ocean Energy Management, Regulation and Enforcement, U.S. Department of Interior. Available online at < http://www.boemre.gov/stats/PDFs/OCSPlatformActivity.pdf >.

BOEMRE (2011d) Pacific OCS Region. Bureau of Ocean Energy Management, Regulation and Enforcement, U.S. Department of Interior. Available online at <http://www.gomr.mms.gov/homepg/pubinfo/pacificfreeasci/platform/pacificfreeplat.html html >.

BOEMRE (2004) *Gulfwide Emission Inventory Study for the Regional Haze and Ozone Modeling Effort.* OCS Study MMS 2004-072.

Brookhaven (2004) Natural Gas Field Subject of Interest at Brookhaven College. Brookhaven College. Available online at <http://www.brookhavencollege.edu/news/2004/news1752.html>.

EIA (2011a) Lease Condensate Production, 1989-2009, Natural Gas Navigator. Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.gov/dnav/ng/ng_prod_lc_s1_a.htm >.

EIA (2011b) "Table 1—Summary of Natural Gas Supply and Disposition in the United States 2006-2011." Natural Gas Monthly, Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov>.

EIA (2011c) "Table 2—Natural Gas Consumption in the United States 2006-2011." Natural Gas Monthly, Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov>.

EIA (2011d) "Table 5— Marketed Production of Natural Gas in Selected States and the Federal Gulf of Mexico, 2006-2011." Natural Gas Monthly, Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov>.

EIA (2011e) Table 5.2. Monthly Energy Review. Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov>.

EIA (2011f) Table 6.2. Annual Energy Review. Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov>.

EIA (2011g) Table A4. Annual Energy Review. Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov>.

EIA (2011h) U.S. Imports by Country. Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://www.eia.doe.gov>.

EIA (2005) "Table 5—U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1977-2003." Energy Information Administration, Department of Energy, Washington, DC.

EIA (2004) *US LNG Markets and Uses*. Energy Information Administration, U.S. Department of Energy, Washington, DC. June 2004. Available online at <http://www.eia.doe.gov/pub/oil_gas/natural_gas/feature_articles/2004/lng/lng2004.pdf>.

EIA (2001) "Documentation of the Oil and Gas Supply Module (OGSM)." Energy Information Administration, U.S. Department of Energy, Washington, DC. Available online at <http://tonto.eia.doe.gov/FTPROOT/modeldoc/m063(2001).pdf>.

EIA (1996) "Emissions of Greenhouse Gases in the United States" Carbon Dioxide Emissions. Energy Information Administration, U.S. Department of Energy, Washington, DC.

EPA (2011) Natural Gas STAR Reductions 1990-2010. Natural Gas STAR Program.

EPA (2007) *Reducing Methane Emissions During Completions Operations*. Natural Gas STAR Producer's Technology Transfer Workshop. September 11, 2007. Available online at <http://epa.gov/gasstar/documents/workshops/glenwood-2007/04_recs.pdf>.

EPA (2006a) *Installing Plunger Lift Systems in Gas Wells*. Lessons Learned from Natural Gas STAR Partners. October 2006. Available online on <http://epa.gov/gasstar/documents/ll_plungerlift.pdf>.

EPA (2006b) *Replacing Wet Seals with Dry Seals in Centrifugal Compressors*. Lessons Learned from Natural Gas STAR Partners. October 2006. Available online at <http://epa.gov/gasstar/documents/ll_wetseals.pdf>.

EPA (2004) *Green Completions* Natural Gas STAR Producer's Technology Transfer Workshop. September 21,

2004. Available online at <http://epa.gov/gasstar/workshops/techtransfer/2004/houston-02.html>.

EPA (1999) *Estimates of Methane Emissions from the U.S. Oil Industry (Draft Report).* Prepared by ICF-Kaiser, Office of Air and Radiation, U.S. Environmental Protection Agency. October 1999.

EPA/GRI (1996) *Methane Emissions from the Natural Gas Industry*. Prepared by Harrison, M., T. Shires, J. Wessels, and R. Cowgill, eds., Radian International LLC for National Risk Management Research Laboratory, Air Pollution Prevention and Control Division, Research Triangle Park, NC. EPA-600/R-96-080a.

FERC (2010) *North American LNG Terminals* . Federal Energy Regulatory Commission, Washington, DC. Available online at <http://www.ferc.gov/industries/lng/indus-act/terminals/lng-existing.pdf>.

GTI (2001) Gas Resource Database: Unconventional Natural Gas and Gas Composition Databases. Second Edition. GRI-01/0136.

HPDI (2010) Production and Permit Data, October 2010.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, H.S. Eggleston, L. Buenida, K. Miwa, T Ngara, and K. Tanabe, eds.; Institute for Global Environmental Strategies (IGES). Hayama, Kanagawa, Japan.

Kansas (2010) Kansas Geological Survey. Oil and Gas Production Data, All Wells, University of Kansas. Available online at <http://www.kgs.ku.edu/PRS/petroDB.html>.

Lippman (2003) Rocky Mountain Region Second Quarter 2003 Production Report. Lippman Consulting, Inc.

Montana (2010) Montana Online Oil and Gas Information System. Montana Board of Oil and Gas Conservation, Billing Office. Available online at <http://bogc.dnrc.state.mt.us/jdpIntro.htm>.

New Mexico (2011) Annual Gas Well Counts by State District. Available online at <http://www.emnrd.state.nm.us/ocd/>.

New Mexico (2005) Districts. Available online at <http://www.emnrd.state.nm.us/ocd/districts.htm>.

OGJ (1997-2011) "Worldwide Gas Processing." *Oil & Gas Journal,* PennWell Corporation, Tulsa, OK. Available online at <http:// http://www.ogj.com/>.

Oklahoma (2010) Oklahoma Petroleum Information Center—Coalbed-Methane Completions database. Oklahoma Geological Survey. Available online at <http://www.ogs.ou.edu/homepage.php>.

PHMSA (2010) Transmission Annuals Data. Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, Washington, DC. Available online at < http://phmsa.dot.gov/pipeline/library/data-stats >.

PHMSA (2011) Gas Distribution Annual Data. Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, Washington, DC. Available online at < http://phmsa.dot.gov/pipeline/library/data-stats >.

TERC (2009) *VOC Emissions from Oil and Condensate Storage Tanks.* Hendler, Albert, URS Corporation; Nunn, Jim, COMM Engineering; Lundeen, Joe, Trimeric Corporation. Revised April 2, 2009. Available online at: <http://files.harc.edu/Projects/AirQuality/Projects/H051C/H051CFinalReport.pdf>.

Texas (2011a) Gas Well Counts by County. Texas Railroad Commission. Available online at <http://webapps.rrc.state.tx.us/PDQ/generalReportAction.do >.

Texas (2011b) Oil Well Counts by County. Texas Railroad Commission. Available online at <http://webapps.rrc.state.tx.us/PDQ/generalReportAction.do >.

Texas (2010a) *The Barnett Shale Regional Report*. Foster, Brad, Devon Energy, Texas Railroad Commission. Available online at <http://www.rrc.state.tx.us/data/index.php>.

Texas (2010b) Oil and Gas District Boundaries. Texas Railroad Commission. Available online at <http://www.rrc.state.tx.us/divisions/og/ogmap.html>.

Utah (2010) Oil and Gas Data Download. Utah Division of Oil, Gas and Mining—Department of Natural Resources. Available online at <http://ogm.utah.gov/oilgas/DOWNLOAD/downpage.htm>.

WGC (2009) “Methane’s Role in Promoting Sustainable Development in the Oil and Natural Gas Industry.” October 2009.

World Oil Magazine (2011a) “Outlook 2011: Producing Gas Wells.” 232(2). February 2011. Available online at <http://www.worldoil.com>.

World Oil Magazine (2011b) “Outlook 2011: Producing Oil Wells.” 232(2). February 2011. Available online at <http://www.worldoil.com>.

Wyoming (2010) Wyoming Oil and Gas Conservation Commission. Available online at <http://wogcc.state.wy.us/coalbedchart.cfm>.

Petroleum Systems

API (2009) Compendium of Greenhouse gas Emissions Methodologies for the Oil and Gas Industry. American Petroleum Institute. Austin, TX, August 2009.

BOEMRE (2011a) *OCS Platform Activity*. Bureau of Ocean Energy Management, Regulation, and Enforcement, U.S. Department of Interior. Available online at <http://www.boemre.gov/stats/>.

BOEMRE (2011b) *Platform Information and Data.* Bureau of Ocean Energy Management, Regulation, and Enforcement, U.S. Department of Interior. Available online at <http://www.gomr.boemre.gov/homepg/pubinfo/freeasci/platform/freeplat.html>.

BOEMRE (2011c) *Pacific OCS Region*. Bureau of Ocean Energy Management, Regulation, and Enforcement, U.S. Department of Interior. Available online at <http://www.gomr.boemre.gov/homepg/pubinfo/pacificfreeasci/platform/pacificfreeplat.html>.

BOEMRE (2005) *Field and Reserve Information.* Bureau of Ocean Energy Management, Regulation, and Enforcement, U.S. Department of Interior. Available online at < http://www.gomr.boemre.gov/homepg/offshore/fldresv/resvmenu.html >.

BOEMRE (2004) *Gulfwide Emission Inventory Study for the Regional Haze and Ozone Modeling Effort.* Bureau of Ocean Energy Management, Regulation, and Enforcement (formerly Minerals Management Service), U.S. Department of Interior. OCS Study MMS 2004-072.

EIA (1990 through 2010) *Refinery Capacity Report.* Energy Information Administration, U.S. Department of Energy. Washington, DC. Available online at <http://www.eia.doe.gov/oil_gas/petroleum/data_publications/refinery_capacity_data/refcapacity.html>.

EIA (1995 through 2010a) *Annual Energy Review*. Energy Information Administration, U.S. Department of Energy. Washington, DC. Available online at <http://www.eia.doe.gov/emeu/aer/contents.html>.

EIA (1995 through 2010b) *Monthly Energy Review*. Energy Information Administration, U.S. Department of Energy. Washington, DC. Available online at <http://www.eia.doe.gov/emeu/mer>.

EIA (1995 through 2010) *Petroleum Supply Annual. Volume 1*. U.S Department of Energy Washington, DC. Available online at: <http://www.eia.doe.gov/oil_gas/petroleum/data_publications/petroleum_supply_annual/psa_volume1/psa_volume1.html>.

EPA (2005) *Incorporating the Mineral Management Service Gulfwide Offshore Activities Data System (GOADS) 2000 data into the methane emissions inventories.* Prepared by ICF International. U.S. Environmental Protection Agency. 2005.

EPA (1999) *Estimates of Methane Emissions from the U.S. Oil Industry (Draft Report).* Prepared by ICF International. Office of Air and Radiation, U.S. Environmental Protection Agency. October 1999.

EPA (1996) *Methane Emissions from the U.S. Petroleum Industry (Draft)*. Prepared by Radian. U.S. Environmental Protection Agency. June 1996.

EPA (1995) *Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources.* U.S. Environmental Protection Agency. Available online at <http://www.epa.gov/ttn/chief/ap42/index.html>.

EPA/GRI (1996a) *Methane Emissions from the Natural Gas Industry, V7: Blow and Purge Activities*. Prepared by Radian. U.S. Environmental Protection Agency. April 1996.

EPA/GRI (1996b) *Methane Emissions from the Natural Gas Industry, V11: Compressor Driver Exhaust*. Prepared by Radian. U.S. Environmental Protection Agency. April 1996.

EPA/GRI (1996c) *Methane Emissions from the Natural Gas Industry, V12: Pneumatic Devices*. Prepared by Radian. U.S. Environmental Protection Agency. April 1996.

EPA/GRI (1996d) *Methane Emissions from the Natural Gas Industry, V13: Chemical Injection Pumps*. Prepared by Radian. U.S. Environmental Protection Agency. April 1996.

HPDI (2011) Production and Permit Data, October 2009.

IOGCC (2009) *Marginal Wells: fuel for economic growth 2008 Report*. Interstate Oil & Gas Compact Commission. Available online at <http://iogcc.myshopify.com/>.

OGJ (2010a) *Oil and Gas Journal 1990-2009*. Pipeline Economics Issue, November 2010.

OGJ (2010b) *Oil and Gas Journal 1990-2009*. Worldwide Refining Issue, January 2010.

TERC (2009) *VOC Emissions from Oil and Condensate Storage Tanks*. Hendler, Albert, URS Corporation; Nunn, Jim, COMM Engineering; Lundeen, Joe, Trimeric Corporation. Revised April 2, 2009. Available online at: <http://files.harc.edu/Projects/AirQuality/Projects/H051C/H051CFinalReport.pdf>.

United States Army Corps of Engineers (1995-2009) *Waterborne Commerce of the United States, Part 5: National Summaries*. U.S. Army Corps of Engineers. Washington, DC.

Energy Sources of Indirect Greenhouse Gases

EPA (2010) "2009 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards.

EPA (2009) "1970 - 2008 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

EPA (2003) E-mail correspondence containing preliminary ambient air pollutant data. Office of Air Pollution and the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. December 22, 2003.

EPA (1997) *Compilation of Air Pollutant Emission Factors, AP-42*. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, NC. October 1997.

International Bunker Fuels

Anderson, B.E., et al., *Alternative Aviation Fuel Experiment (AAFEX)*, NASA Technical Memorandum, in press, 2011.

ASTM (1989) *Military Specification for Turbine Fuels, Aviation, Kerosene Types*, NATO F-34 (JP-8) and NATO F-35. February 10, 1989. Available online at <http://test.wbdg.org/ccb/FEDMIL/t_83133d.pdf>.

Chevron (2000) *Aviation Fuels Technical Review (FTR-3)*. Chevron Products Company, Chapter 2. Available online at <http://www.chevron.com/products/prodserv/fuels/bulletin/aviationfuel/2_at_fuel_perf.shtm>.

DESC (2011) Unpublished data from the Defense Fuels Automated Management System (DFAMS). Defense Energy Support Center, Defense Logistics Agency, U.S. Department of Defense. Washington, DC.

DHS (2008) Personal Communication with Elissa Kay, Residual and Distillate Fuel Oil Consumption (International Bunker Fuels). Department of Homeland Security, Bunker Report. January 11, 2008.

DOC (2011) Unpublished Report of Bunker Fuel Oil Laden on Vessels Cleared for Foreign Countries. Form-563. Foreign Trade Division, Bureau of the Census, U.S. Department of Commerce. Washington, DC.

EIA (2011a) *Annual Energy Review 2010*. Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0384(2011). October 19, 2011.

EIA (2011b) Supplemental Tables on Petroleum Product detail. *Monthly Energy Review, September 2011,* Energy

Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2011/09).

FAA (2012) Personal Communication between FAA and Leif Hockstad for aviation emissions estimates from the Aviation Environmental Design Tool (AEDT). February 2012.

FAA (2006) *System for assessing Aviation's Global Emission (SAGE) Model*. Federal Aviation Administration's Office of Aviation Policy, Planning, and Transportation Topics, 2006.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

USAF (1998) *Fuel Logistics Planning.* U.S. Air Force pamphlet AFPAM23-221, May 1, 1998.

Wood Biomass and Ethanol Consumption

EIA (2011) *Annual Energy Review 2010*. Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0384 (2010). October 19, 2011.

EPA (2011) Acid Rain Program Dataset 1996-2010. Office of Air and Radiation, Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, D.C.

EPA (2010) Carbon Content Coefficients Developed for EPA's Mandatory Reporting Rule. Office of Air and Radiation, Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, D.C.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Industrial Processes

Cement Production

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

U.S. Bureau of Mines (1990 through 1993) *Minerals Yearbook: Cement Annual Report.* U.S. Department of the Interior, Washington, DC.

USGS (1995 through 2011) *Mineral Commodity Summaries - Cement.* U.S. Geological Survey, Reston, VA.

Van Oss (2008) Personal communication. Hendrik van Oss, Commodity Specialist of the U.S. Geological Survey and Erin Gray, ICF International. December 16, 2008.

Lime Production

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. , National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change. Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

Lutter (2009 through 2010) Personal communication. Karen Lutter, California Air Resources Board and Mausami Desai, EPA. October 20, 2009; September 28, 2010.

Males, E. (2003) Memorandum from Eric Males, National Lime Association to Mr. William N. Irving & Mr. Leif Hockstad, Environmental Protection Agency. March 6, 2003.

Miner, R. and B. Upton (2002) Methods for estimating greenhouse gas emissions from lime kilns at kraft pulp mills.

Energy. Vol. 27 (2002), p. 729-738.

Prillaman (2008 through 2010) Personal communication. Hunter Prillaman, National Lime Association and Mausami Desai, EPA. November 5, 2008; October 19, 2009; October 21, 2010.

USGS (1992 through 2011) *Minerals Yearbook: Lime*. U.S. Geological Survey, Reston, VA.

Limestone and Dolomite Use

U.S. Bureau of Mines (1991 & 1993a) *Minerals Yearbook: Crushed Stone Annual Report*. U.S. Department of the Interior. Washington, DC.

U.S. Bureau of Mines (1990 through 1993b) *Minerals Yearbook: Magnesium and Magnesium Compounds Annual Report*. U.S. Department of the Interior. Washington, DC.

USGS (1995 through 2011a) *Minerals Yearbook: Crushed Stone Annual Report*. U.S. Geological Survey, Reston, VA.

USGS (1995 through 2011b) *Minerals Yearbook: Magnesium Annual Report*. U.S. Geological Survey, Reston, VA.

Soda Ash Production and Consumption

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

USGS (1994 through 2011) Minerals Yearbook: Soda Ash Annual Report. U.S. Geological Survey, Reston, VA.

Ammonia Production and Urea Consumption

Bark (2004) *CoffeyvilleNitrogen Plant* Available online at <http://www.gasification.org/Docs/2003_Papers/07BARK.pdf>. December 15, 2004.

Coffeyville Resources Nitrogen Fertilizers (2011) Nitrogen Fertilizer Operations. Available online at <http://coffeyvillegroup.com/NitrogenFertilizerOperations/index.html>.

Coffeyville Resources Nitrogen Fertilizers (2010) Nitrogen Fertilizer Operations. Available online at <http://coffeyvillegroup.com/NitrogenFertilizerOperations/index.html>.

Coffeyville Resources Nitrogen Fertilizers (2009) Nitrogen Fertilizer Operations. Available online at <http://coffeyvillegroup.com/NitrogenFertilizerOperations/index.html>.

Coffeyville Resources Nitrogen Fertilizers, LLC (2005 through 2007a) Business Data. Available online at <http://www.coffeyvillegroup.com/businessSnapshot.asp>.

Coffeyville Resources Nitrogen Fertilizers (2007b) Nitrogen Fertilizer Operations. Available online at <http://coffeyvillegroup.com/nitrogenMain.aspx>.

EEA (2004) *Natural Gas Issues for the U.S. Industrial and Power Generation Sectors*. Submitted to National Commission on Energy Policy.

EFMA (2000) *Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry*. Booklet No. 5 of 8: Production of Urea and Urea Ammonium Nitrate.

EFMA (1995) *Production of Ammonia*. European Fertilizer Manufacturers Association. March 1, 1995.

EIA (2011) *Natural Gas Prices for the U.S. 2005-2010* Available online at <http://205.254.135.24/dnav/ng/ng_pri_sum_dcu_nus_a.htm>.

TFI (2002) *U.S. Nitrogen Imports/Exports Table*. The Fertilizer Institute. Available online at <http://www.tfi.org/statistics/usnexim.asp>. August 2002.

TIG (2002) *Chemical Profiles – Urea*. The Innovation Group. Available online at <http://www.the-innovation-group.com/ChemProfiles/Urea.htm>. September 2007.

U.S. Bureau of the Census (2011) *Current Industrial Reports Fertilizer Materials and Related Products: 2010 Summary*. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

U.S. Bureau of the Census (2010) *Current Industrial Reports Fertilizer Materials and Related Products: 2009 Summary*. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

U.S. Bureau of the Census (2009) *Current Industrial Reports Fertilizer Materials and Related Products: 2008 Summary*. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

U.S. Bureau of the Census (2008) *Current Industrial Reports Fertilizer Materials and Related Products: 2007 Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b/mq325b075.xls.>.

U.S. Census Bureau (2007) *Current Industrial Reports Fertilizer Materials and Related Products: 2006 Summary*. Available online at < http://www.census.gov/industry/1/mq325b065.pdf>.

U.S. Census Bureau (2006) *Current Industrial Reports Fertilizer Materials and Related Products: 2005 Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2002, 2004, 2005) *Current Industrial Reports Fertilizer Materials and Related Products: Fourth Quarter Report Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (1998 through 2002b, 2003) *Current Industrial Reports Fertilizer Materials and Related Products: Annual Reports Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2002a) *Current Industrial Reports Fertilizer Materials and Related Products: First Quarter 2002*. June 2002. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2002c) *Current Industrial Reports Fertilizer Materials and Related Products: Third Quarter 2001*. January 2002. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2001a) *Current Industrial Reports Fertilizer Materials and Related Products: Second Quarter 2001*. September 2001. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (1991 through 1994) *Current Industrial Reports Fertilizer Materials Annual Report.* Report No. MQ28B. U.S. Census Bureau, Washington, DC.

U.S. Department of Agriculture (2011) Economic Research Service Data Sets, Data Sets, U.S. Fertilizer Imports/Exports: Standard Tables. Available online at <http://www.ers.usda.gov/Data/FertilizerTrade/standard.htm>.

USGS (1994 through 2009) Minerals Yearbook: Nitrogen. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/nitrogen/>.

U.S. ITC (2002) *United States International Trade Commission Interactive Tariff and Trade DataWeb, Version 2.5.0*. Available online at <http://dataweb.usitc.gov/scripts/user_set.asp>. August 2002.

Urea Consumption for Non-Agricultural Purposes

EFMA (2000) *Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry*. Booklet No. 5 of 8: Production of Urea and Urea Ammonium Nitrate.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

TFI (2002) *U.S. Nitrogen Imports/Exports Table.* The Fertilizer Institute. Available online at <http://www.tfi.org/statistics/usnexim.asp>. August 2002.

U.S. Bureau of the Census (2011) *Current Industrial Reports Fertilizer Materials and Related Products: 2010 Summary*. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

U.S. Bureau of the Census (2010) *Current Industrial Reports Fertilizer Materials and Related Products: 2009 Summary*. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

U.S. Bureau of the Census (2009) *Current Industrial Reports Fertilizer Materials and Related Products: 2008 Summary*. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

U.S. Bureau of the Census (2008) *Current Industrial Reports Fertilizer Materials and Related Products: 2007 Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b/mq325b075.xls.>.

U.S. Census Bureau (2007) *Current Industrial Reports Fertilizer Materials and Related Products: 2006 Summary*. Available online at < http://www.census.gov/industry/1/mq325b065.pdf>.

U.S. Census Bureau (2006) *Current Industrial Reports Fertilizer Materials and Related Products: 2005 Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2002, 2004, 2005) *Current Industrial Reports Fertilizer Materials and Related Products: Fourth Quarter Report Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (1998 through 2002b, 2003) *Current Industrial Reports Fertilizer Materials and Related Products: Annual Reports Summary*. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2002a) *Current Industrial Reports Fertilizer Materials and Related Products: First Quarter 2002*. June 2002. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2002c) *Current Industrial Reports Fertilizer Materials and Related Products: Third Quarter 2001*. January 2002. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Census Bureau (2001a) *Current Industrial Reports Fertilizer Materials and Related Products: Second Quarter 2001*. September 2001. Available online at <http://www.census.gov/cir/www/325/mq325b.html>.

U.S. Department of Agriculture (2011) Economic Research Service Data Sets, Data Sets, U.S. Fertilizer Imports/Exports: Standard Tables. Available online at <http://www.ers.usda.gov/Data/FertilizerTrade/standard.htm>.

USGS (1994 through 2009) Minerals Yearbook: Nitrogen. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/nitrogen/>.

U.S. ITC (2002) *United States International Trade Commission Interactive Tariff and Trade DataWeb, Version 2.5.0*. Available online at <http://dataweb.usitc.gov/scripts/user_set.asp>. August 2002.

Nitric Acid Production

Desai (2012) Personal communication. Mausami Desai, U.S. Environmental Protection Agency, January 25, 2012.

EPA (2010) *Draft Nitric Acid Database.* U.S. Environmental Protection Agency, Office of Air and Radiation. September, 2010.

EPA (1997) *Compilation of Air Pollutant Emission Factors, AP-42.* Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, NC. October 1997.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

US Census Bureau (2011) *Current Industrial Reports. Fertilizers and Related Chemicals: 2010.* "Table 1: Summary of Production of Principle Fertilizers and Related Chemicals: 2009 and 2010." June, 2011. MQ325B(10)-5. Available online at < http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

US Census Bureau (2010a) *Current Industrial Reports. Fertilizers and Related Chemicals: 2009.* "Table 1: Summary of Production of Principle Fertilizers and Related Chemicals: 2009 and 2008." June, 2010. MQ325B(08)-5. Available online at < http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

US Census Bureau (2010b) Personal communication between Hilda Ward (of U.S. Census Bureau) and Caroline Cochran (of ICF International). October 26, 2010 and November 5, 2010.

US Census Bureau (2009) *Current Industrial Reports. Fertilizers and Related Chemicals: 2008.* "Table 1: Shipments and Production of Principal Fertilizers and Related Chemicals: 2004 to 2008." June, 2009. MQ325B(08)-5. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html>.

US Census Bureau (2008) *Current Industrial Reports. Fertilizers and Related Chemicals: 2007.* "Table 1: Shipments and Production of Principal Fertilizers and Related Chemicals: 2003 to 2007." June, 2008. MQ325B(07)-5. Available online at <http://www.census.gov/manufacturing/cir/historical_data/mq325b/index.html >.

US Census Bureau (2006) *Current Industrial Reports.*, "Table 995: Inorganic Chemicals and Fertilizers." August,

2006. Series MAQ325A Available online at <www.census.gov/compendia/statab/2007/tables/07s0995.xls>.

Adipic Acid Production

ACC (2011) "Business of Chemistry (Annual Data).xls." American Chemistry Council Guide to the Business of Chemistry. August 2011.

C&EN (1995) "Production of Top 50 Chemicals Increased Substantially in 1994." *Chemical & Engineering News*, 73(15):17. April 10, 1995.

C&EN (1994) "Top 50 Chemicals Production Rose Modestly Last Year." *Chemical & Engineering News*, 72(15):13. April 11, 1994.

C&EN (1993) "Top 50 Chemicals Production Recovered Last Year." *Chemical & Engineering News*, 71(15):11. April 12, 1993.

C&EN (1992) "Production of Top 50 Chemicals Stagnates in 1991." *Chemical & Engineering News*, 70(15): 17. April 13, 1992.

CMR (2001) "Chemical Profile: Adipic Acid." *Chemical Market Reporter*. July 16, 2001.

CMR (1998) "Chemical Profile: Adipic Acid." *Chemical Market Reporter*. June 15, 1998.

CW (2007) "Product Focus: Adipic Acid." *Chemical Week*. August 1-8, 2007.

CW (2005) "Product Focus: Adipic Acid." *Chemical Week*. May 4, 2005.

CW (1999) "Product Focus: Adipic Acid/Adiponitrile." *Chemical Week*, p. 31. March 10, 1999.

Desai (2012) Personal communication. Mausami Desai, U.S. Environmental Protection Agency and Toby Mandel, ICF International, January 25, 2012.

Desai (2010) Personal communication. Mausami Desai, U.S. Environmental Protection Agency, and Caroline Cochran, ICF International. November 8, 2010.

Desai (2009) Personal communication. Mausami Desai, U.S. Environmental Protection Agency and Joseph Herr, ICF International. November 19, 2009.

ICIS (2007) "Adipic Acid." *ICIS Chemical Business Americas*. July 9, 2007.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Reimer, R.A., Slaten, C.S., Seapan, M., Koch, T.A. and Triner, V.G. (1999) "Implementation of Technologies for Abatement of N_2O Emissions Associated with Adipic Acid Manufacture." Proceedings of the 2nd Symposium on Non-CO_2 Greenhouse Gases (NCGG-2), Noordwijkerhout, The Netherlands, 8-10 Sept. 1999, Ed. J. van Ham *et al*., Kluwer Academic Publishers, Dordrecht, pp. 347-358.

SEI (2010) *Industrial N_2O Projects Under the CDM: Adipic Acid – A Case for Carbon Leakage?* Stockholm Environment Institute Working Paper WP-US-1006. October 9, 2010.

Thiemens, M.H., and W.C. Trogler (1991) "Nylon production; an unknown source of atmospheric nitrous oxide." *Science* 251:932-934.

VA DEQ (2010) Personal communication. Stanley Faggert, Virgina Department of Environmental Quality and Joseph Herr, ICF International. March 12, 2010.

VA DEQ (2009) Personal communication. Stanley Faggert, Virgina Department of Environmental Quality and Joseph Herr, ICF International. October 26, 2009.

VA DEQ (2006) Virginia Title V Operating Permit. Honeywell International Inc. Hopewell Plant. Virginia Department of Environmental Quality. Permit No. PRO50232. Effective January 1, 2007.

Silicon Carbide Production

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas

Inventories Programme, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe, eds.; Institute for Global Environmental Strategies (IGES). Hayama, Kanagawa, Japan.

U.S. Census Bureau (2005 through 2011) *U.S International Trade Commission (USITC) Trade DataWeb.* Available online at <http://dataweb.usitc.gov/>.

USGS (2011a) *Minerals Commodity Summary: Abrasives (Manufactured) 2009*. U.S. Geological Survey, Reston, VA.

USGS (1991a through 2010a and 2011b) *Minerals Yearbook: Manufactured Abrasives Annual Report.* U.S. Geological Survey, Reston, VA.

USGS (1991b through 2010b and 2011c) *Minerals Yearbook: Silicon Annual Report.* U.S. Geological Survey, Reston, VA.

Petrochemical Production

ACC (2002, 2003, 2005 through 2011) *Guide to the Business of Chemistry*. American Chemistry Council, Arlington, VA.

EIA (2004) *Annual Energy Review 2003*. Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0384(2003). September 2004.

EIA (2003) *Emissions of Greenhouse Gases in the United States 2002*. Office of Integrated Analysis and Forecasting, Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE-EIA-0573(2002). February 2003.

European IPPC Bureau (2004) *Draft Reference Document on Best Available Techniques in the Large Volume Inorganic Chemicals—Solid and Others Industry*, Table 4.21. European Commission, 224. August 2004.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Jordan, J. (2011a) Personal communication, Jim Jordan of Jordan Associates on behalf of the Methanol Institute and Pier LaFarge, ICF International. October 19th, 2011

Jordan, J. (2011b) Personal communication, Jim Jordan of Jordan Associates on behalf of the Methanol Institute and Pier LaFarge, ICF International. October 18th, 2011

Johnson, G. L. (2011) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Pier LaFarge, ICF International. October 2011.

Johnson, G. L. (2010) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Caroline Cochran, ICF International. September 2010.

Johnson, G. L. (2009) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Jean Y. Kim, ICF International. October 2009.

Johnson, G. L. (2008) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Jean Y. Kim, ICF International. November 2008.

Johnson, G. L. (2007) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Tristan Kessler, ICF International. November 2007.

Johnson, G. L. (2006) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Erin Fraser, ICF International. October 2006.

Johnson, G. L. (2005) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Erin Fraser, ICF International. October 2005.

Johnson, G. L. (2003) Personal communication. Greg Johnson of Liskow & Lewis, on behalf of the International Carbon Black Association (ICBA) and Caren Mintz, ICF International November 2003.

Othmer, K. (1992) Carbon (*Carbon Black*), Vol. 4, 1045.

Srivastava, Manoj, I.D. Singh, and Himmat Singh (1999) "Structural Characterization of Petroleum Based Feedstocks for Carbon Black Production," Table-1. *Petroleum Science and Technology* 17(1&2):67-80.

The Innovation Group (2004) *Carbon Black Plant Capacity*. Available online at <http://www.the-innovation-group.com/ChemProfiles/Carbon%20Black.htm>.

U.S. Census Bureau (2007) 2006 *Economic Census: Manufacturing—Industry Series: Carbon Black Manufacturing*. Department of Commerce. Washington, DC. EC0731I3. June 2009.

U.S. Census Bureau (2004) 2002 *Economic Census: Manufacturing—Industry Series: Carbon Black Manufacturing*. Department of Commerce. Washington, DC. EC02-311-325182. September 2004.

U.S. Census Bureau (1999) *1997 Economic Census: Manufacturing—Industry Series: Carbon Black Manufacturing*. Department of Commerce. Washington, DC. EC97M-3251F. August 1999.

Titanium Dioxide Production

Gambogi, J. (2002) Telephone communication. Joseph Gambogi, Commodity Specialist, U.S. Geological Survey and Philip Groth, ICF International. November 2002.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Nelson, H.W. (1969) *Petroleum Coke Handling Problems*. Great Lakes Carbon Corporation.

USGS (2011a) *Mineral Commodity Summary: Titanium 2010*. U.S. Geological Survey, Reston, VA.

USGS (USGS 1991 through 2011b) *Mineral Yearbook: Titanium Annual Report.* U.S. Geological Survey, Reston, VA.

Carbon Dioxide Consumption

Allis, R. et al. (2000) *Natural CO_2 Reservoirs on the Colorado Plateau and Southern Rocky Mountains: Candidates for CO_2 Sequestration*. Utah Geological Survey and Utah Energy and Geoscience Institute. Salt Lake City, Utah.

ARI (1990 through 2011) *CO_2 Use in Enhanced Oil Recovery*. Deliverable to ICF International under Task Order 102, July 15, 2011.

ARI (2007) *CO_2-EOR: An Enabling Bridge for the Oil Transition*. Presented at "Modeling the Oil Transition—a DOE/EPA Workshop on the Economic and Environmental Implications of Global Energy Transitions." Washington, DC. April 20-21, 2007.

ARI (2006) *CO_2-EOR: An Enabling Bridge for the Oil Transition*. Presented at "Modeling the Oil Transition—a DOE/EPA Workshop on the Economic and Environmental Implications of Global Energy Transitions." Washington, DC. April 20-21, 2006.

Broadhead (2003) Personal communication. Ron Broadhead, Principal Senior Petroleum Geologist and Adjunct faculty, Earth and Environmental Sciences Department, New Mexico Bureau of Geology and Mineral Resources, and Robin Pestrusak, ICF International. September 5, 2003.

COGCC (2011) Monthly Production Reports. Available online at < http://cogcc.state.co.us/COGCCReports/production.aspx?id=MonthlyCO2ProdByCounty>. Accessed September 2011.

Denbury Resources Inc. (2002 through 2011) *Annual Report: Form 10-K.* Available online at <http://ir.denbury.com/phoenix.zhtml?c=72374&p=irol-reportsAnnual>. Accessed September 2011.

New Mexico Bureau of Geology and Mineral Resources (2006) Natural Accumulations of Carbon Dioxide in New Mexico and Adjacent Parts of Colorado and Arizona: Commercial Accumulation of CO_2. Available online at <http://geoinfo.nmt.edu/staff/broadhead/CO_2.html#commercial>.

Phosphoric Acid Production

EFMA (2000) "Production of Phosphoric Acid." *Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry*. Booklet 4 of 8. European Fertilizer Manufacturers Association. Available online at

<http://www.efma.org/Publications/BAT%202000/Bat04/section04.asp>.

FIPR (2003) "Analyses of Some Phosphate Rocks." Facsimile Gary Albarelli, the Florida Institute of Phosphate Research, Bartow, Florida, to Robert Lanza, ICF International. July 29, 2003.

FIPR (2003a) Florida Institute of Phosphate Research. Personal communication. Mr. Michael Lloyd, Laboratory Manager, FIPR, Bartow, Florida, to Mr. Robert Lanza, ICF International. August 2003.

USGS (1994 through 2011) *Minerals Yearbook. Phosphate Rock Annual Report*. U.S. Geological Survey, Reston, VA.

Iron and Steel Production and Metallurgical Coke Production

AISI (2004 through 2011a) *Annual Statistical Report*, American Iron and Steel Institute, Washington, DC.

AISI (2011b) Personal communication, Paul Stewart, ICF International, and the American Iron and Steel Institute, August, 2011.

AISI (2008b) Personal communication, Mausami Desai, US EPA, and the American Iron and Steel Institute, October 2008.

DOE (2000) *Energy and Environmental Profile of the U.S. Iron and Steel Industry*. Office of Industrial Technologies, U.S. Department of Energy. August 2000. DOE/EE-0229.EIA

EIA (2011a) *Annual Energy Review 2010*, Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0384(2010).

EIA (2011b) *Natural Gas Annual 2010*, Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0131(10).

EIA (2011c) Supplemental Tables on Petroleum Product detail. Monthly Energy Review, September 2011, Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0035(2011/09).

EIA (1998 through 2011d) *Quarterly Coal Report: October-December*, Energy Information Administration, U.S. Department of Energy. Washington, DC. DOE/EIA-0121.

EIA (1992) Coal and lignite production. *EIA State Energy Data Report 1992*, Energy Information Administration, U.S. Department of Energy, Washington, DC.

EPA (2010) Carbon Content Coefficients Developed for EPA's Mandatory Reporting Rule. Office of Air and Radiation, Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, D.C.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC/UNEP/OECD/IEA (1995) "Volume 3: Greenhouse Gas Inventory Reference Manual. Table 2-2".*IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. IPCC WG1 Technical Support Unit, United Kingdom.

USGS (2011) *Mineral Industry Surveys: Iron and Steel Scrap in December 2010.* U.S. Geological Survey, Reston, VA.

Ferroalloy Production

Corathers, L. (2012) Personal communication. Lisa Corathers, Commodity Specialist, U.S. Geological Survey and Paul Stewart, ICF International. March 09, 2012.

Corathers, L. (2011) Personal communication. Lisa Corathers, Commodity Specialist, U.S. Geological Survey and Paul Stewart, ICF International. March 11, 2011.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Onder, H., and E.A. Bagdoyan (1993) Everything You've Always Wanted to Know about Petroleum Coke. Allis Mineral Systems.

USGS (1991 through 2010) Minerals Yearbook: Silicon Annual Report. U.S. Geological Survey, Reston, VA.

Aluminum Production

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change. Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

USAA (2012) *U.S. Primary Aluminum Production 2011*. U.S. Aluminum Association, Washington, DC. January, 2012.

USAA (2011a) *U.S. Primary Aluminum Production 2010.* U.S. Aluminum Association, Washington, DC.

USAA (2011b) *U.S. Primary Aluminum Production 2011*. U.S. Aluminum Association, Washington, DC. November, 2011.

USAA (2010) *U.S. Primary Aluminum Production 2009.* U.S. Aluminum Association, Washington, DC.

USAA (2008, 2009) *U.S. Primary Aluminum Production.* U.S. Aluminum Association, Washington, DC.

USAA (2004, 2005, 2006) *Primary Aluminum Statistics.* U.S. Aluminum Association, Washington, DC.

USGS (2011) *2010 Mineral Yearbook; Aluminum [Advanced Release]*. U.S. Geological Survey, Reston, VA.

USGS (2010a) *2009 Mineral Commodity Summaries: Aluminum*. U.S. Geological Survey, Reston, VA.

USGS (2010b) *Mineral Industry Surveys: Aluminum in December 2009*. U.S. Geological Survey, Reston, VA.

USGS (2010c) *Mineral Industry Surveys: Aluminum in September 2010*. U.S. Geological Survey, Reston, VA.

USGS (2009a) *2008 Mineral Yearbook: Aluminum.* U.S. Geological Survey, Reston, VA.

USGS (2009b) *Mineral Industry Surveys: Aluminum in December 2008*. U.S. Geological Survey, Reston, VA.

USGS (2007) *2006 Mineral Yearbook: Aluminum.* U.S. Geological Survey, Reston, VA.

USGS (1995, 1998, 2000, 2001, 2002) *Minerals Yearbook: Aluminum Annual Report*. U.S. Geological Survey, Reston, VA.

Magnesium Production and Processing

Bartos S., C. Laush, J. Scharfenberg, and R. Kantamaneni (2007) "Reducing greenhouse gas emissions from magnesium die casting," *Journal of Cleaner Production*, 15: 979-987, March.

Gjestland, H. and D. Magers (1996) "Practical Usage of Sulphur [Sulfur] Hexafluoride for Melt Protection in the Magnesium Die Casting Industry," #13, *1996 Annual Conference Proceedings*, International Magnesium Association. Ube City, Japan.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

RAND (2002) RAND Environmental Science and Policy Center, "Production and Distribution of SF_6 by End-Use Applications" Katie D. Smythe. *International Conference on SF_6 and the Environment: Emission Reduction Strategies*. San Diego, CA. November 21-22, 2002.

USGS (2002, 2003, 2005 through 2008, and 2011b) Minerals Yearbook: Magnesium Annual Report. U.S. Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/magnesium/index.html#mis>.

USGS (2010a) *Mineral Commodity Summaries: Magnesium Metal*. U.S. Geological Survey, Reston, VA. Available

online at < http://minerals.usgs.gov/minerals/pubs/commodity/magnesium/mcs-2010-mgmet.pdf>.

Zinc Production

Horsehead Corp. (2011) 10-k Annual Report for the Fiscal Year Ended December, 31 2010. Available at: <http://google.brand.edgar-online.com/default.aspx?sym=zinc>. Submitted March 16, 2011.

Horsehead Corp. (2010a) 10-k Annual Report for the Fiscal Year Ended December, 31 2009. Available at: <http://google.brand.edgar-online.com/default.aspx?sym=zinc>. Submitted March 16, 2010.

Horsehead Corp. (2010b) *Horsehead Holding Corp. Provides Update on Operations at its Monaca, PA Plant.* July 28, 2010. Available at: <http://www.horsehead.net/pressreleases.php?showall=no&news=&ID=65>.

Horsehead Corp (2008) 10-k Annual Report for the Fiscal Year Ended December, 31 2007. Available at: <http://google.brand.edgar-online.com/default.aspx?sym=zinc>. Submitted March 31, 2008.

Horsehead Corp (2007) Registration Statement (General Form) S-1. Available at <http://google.brand.edgar-online.com/default.aspx?sym=zinc>. Submitted April 13, 2007.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

PIZO (2011) Available at <http://pizotech.com/index.html>. Accessed November 17, 2010.

Sjardin (2003) CO_2 *Emission Factors for Non-Energy Use in the Non-Ferrous Metal, Ferroalloys and Inorganics Industry*. Copernicus Institute. Utrecht, the Netherlands.

Steel Dust Recycling LLC (2010) Available at < http://steeldust.com/home.htm>. Accessed November 17, 2011.

USGS (2012) *2012 Mineral Commodity Summary: Zinc*. U.S. Geological Survey, Reston, VA.

USGS (1994 through 2011) *Minerals Yearbook: Zinc Annual Report.* U.S. Geological Survey, Reston, VA.

Viklund-White C. (2000) "The Use of LCA for the Environmental Evaluation of the Recycling of Galvanized Steel." ISIJ International. Volume 40 No. 3: 292-299.

Lead Production

Dutrizac, J.E., V. Ramachandran, and J.A. Gonzalez (2000) *Lead-Zinc 2000*. The Minerals, Metals, and Materials Society.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Morris, D., F.R. Steward, and P. Evans (1983) *Energy Efficiency of a Lead Smelter.* Energy 8(5):337-349.

Sjardin, M. (2003) *CO_2 Emission Factors for Non-Energy Use in the Non-Ferrous Metal, Ferroalloys and Inorganics Industry*. Copernicus Institute. Utrecht, the Netherlands.

Ullman (1997) *Ullman's Encyclopedia of Industrial Chemistry: Fifth Edition.* Volume A5. John Wiley and Sons.

USGS (2012a) *2012 Mineral Commodity Summary, Lead.* U.S. Geological Survey, Reston, VA.

USGS (1995 through 2012b) *Minerals Yearbook: Lead Annual Report.* U.S. Geological Survey, Reston, VA.

HCFC-22 Production

ARAP (2010) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. September 10, 2010.

ARAP (2009) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. September 21, 2009.

ARAP (2008) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. October 17, 2008.

ARAP (2007) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. October 2, 2007.

ARAP (2006) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Sally Rand of the U.S. Environmental Protection Agency. July 11, 2006.

ARAP (2005) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. August 9, 2005.

ARAP (2004) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. June 3, 2004.

ARAP (2003) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Sally Rand of the U.S. Environmental Protection Agency. August 18, 2003.

ARAP (2002) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. August 7, 2002.

ARAP (2001) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger of the U.S. Environmental Protection Agency. August 6, 2001.

ARAP (2000) Electronic mail communication from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Sally Rand of the U.S. Environmental Protection Agency. August 13, 2000.

ARAP (1999) Facsimile from Dave Stirpe, Executive Director, Alliance for Responsible Atmospheric Policy to Deborah Ottinger Schaefer of the U.S. Environmental Protection Agency. September 23, 1999.

ARAP (1997) Letter from Dave Stirpe, Director, Alliance for Responsible Atmospheric Policy to Elizabeth Dutrow of the U.S. Environmental Protection Agency. December 23, 1997.

ICF (2012) Subpart O submission analysis from EPA Greenhouse Gas Reporting Rule. March 30, 2012.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

RTI (1997) "Verification of Emission Estimates of HFC-23 from the Production of HCFC-22: Emissions from 1990 through 1996." Report prepared by Research Triangle Institute for the Cadmus Group. November 25, 1997; revised February 16, 1998.

RTI (2008) "Verification of Emission Estimates of HFC-23 from the Production of HCFC-22:Emissions from 1990 through 2006." Report prepared by RTI International for the Climate Change Division. March, 2008.

Substitution of Ozone Depleting Substances

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Semiconductor Manufacture

Burton, C.S., and R. Beizaie (2001) "EPA's PFC Emissions Model (PEVM) v. 2.14: Description and Documentation" prepared for Office of Global Programs, U. S. Environmental Protection Agency, Washington, DC. November 2001.

Citigroup Smith Barney (2005) *Global Supply/Demand Model for Semiconductor*s. March 2005.

ITRS (2007, 2008) *International Technology Roadmap for Semiconductors: 2006 Update.* January 2007; *International Technology Roadmap for Semiconductors: 2007 Edition, January 2008;* Available online at <http://www.itrs.net/Links/2007ITRS/Home2007.htm>. Theses and earlier editions and updates are available at <http://public.itrs.net>. Information about the number of interconnect layers for years 1990–2010 is contained in Burton and Beizaie, 2001. PEVM is updated using new editions and updates of the ITRS, which are published annually.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas

Inventories Programme, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe, eds. Institute for Global Environmental Strategies (IGES). Hayama, Kanagawa, Japan.

Semiconductor Equipment and Materials Industry (2010) *World Fab Forecast, May 2011 Edition*.

Semiconductor Industry Association (SIA) (2009) STATS: SICAS Capacity and Utilization Rates Q1-Q4 2008, Q1-Q4 2009, Q1-Q4 2010. Available online at <http://www.sia-online.org/cs/papers_publications/statistics>.

U.S. EPA (2006) *Uses and Emissions of Liquid PFC Heat Transfer Fluids from the Electronics Sector*. U.S. Environmental Protection Agency, Washington, DC. EPA-430-R-06-901.

VLSI Research, Inc. (2010) Worldwide Silicon Demand by Wafer Size, by Linewidth and by Device Type, v. 9.09. August 2010.

Electrical Transmission and Distribution

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Levin et al. (2010) "The Global SF_6 Source Inferred from Long-term High Precision Atmospheric Measurements and its Comparison with Emission Inventories."*Atmospheric Chemistry and Physics*, 10: 2655–2662.

O'Connell, P., F. Heil, J. Henriot, G. Mauthe, H. Morrison, L. Neimeyer, M. Pittroff, R. Probst, J.P. Tailebois (2002) *SF_6 in the Electric Industry, Status 2000*, CIGRE. February 2002.

RAND (2004) "Trends in SF_6 Sales and End-Use Applications: 1961-2003," Katie D. Smythe. *International Conference on SF_6 and the Environment: Emission Reduction Strategies*. RAND Environmental Science and Policy Center, Scottsdale, AZ. December 1-3, 2004.

UDI (2010) *2010 UDI Directory of Electric Power Producers and Distributors, 118th Edition*, Platts.

UDI (2007) *2007 UDI Directory of Electric Power Producers and Distributors, 115th Edition*, Platts.

UDI (2004) *2004 UDI Directory of Electric Power Producers and Distributors, 112th Edition*, Platts.

UDI (2001) *2001 UDI Directory of Electric Power Producers and Distributors, 109th Edition*, Platts.

Industrial Sources of Indirect Greenhouse Gases

EPA (2010) "2009 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards.

EPA (2009) "1970 - 2008 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

EPA (2003) E-mail correspondence containing preliminary ambient air pollutant data. Office of Air Pollution and the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. December 22, 2003.

EPA (1997) *Compilation of Air Pollutant Emission Factors, AP-42*. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, NC. October 1997.

Solvent and Other Product Use

Nitrous Oxide from Product Uses

Airgas (2007) Airgas, INC. Form 10-K. Annual Report Pursuant to Section 13 or 15 (d) of the SEC Act of 1934. Fiscal year ended March, 31, 2007. Available online at <http://www.sec.gov/Archives/edgar/data/804212/000089322007002057/w35445e10vk.htm#102>.

CGA (2003) "CGA Nitrous Oxide Abuse Hotline: CGA/NWSA Nitrous Oxide Fact Sheet." Compressed Gas Association. November 3, 2003.

CGA (2002) "CGA/NWSA Nitrous Oxide Fact Sheet." Compressed Gas Association. March 25, 2002.

FTC (2001) Federal Trade Commission: *Analysis of Agreement Containing Consent Order*

To Aid Public Comment. FTC File No. 001-0040. October, 2001. Available online at <http://www.ftc.gov/os/2001/10/airgasanalysis.htm >.

Heydorn, B. (1997) "Nitrous Oxide—North America." *Chemical Economics Handbook*, SRI Consulting. May 1997.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Tupman, M. (2003) Personal communication .Martin Tupman, Airgas Nitrous Oxide and Daniel Lieberman, ICF International. August 8, 2003.

Tupman, M. (2002) Personal communication. Martin Tupman of Airgas Nitrous Oxide and Laxmi Palreddy, ICF International. July 3, 2002.

Solvent Use

EPA (2010) "2009 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards.

EPA (2009) "1970 - 2008 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

EPA (2003) E-mail correspondence containing preliminary ambient air pollutant data. Office of Air Pollution and the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. December 22, 2003.

EPA (1997) *Compilation of Air Pollutant Emission Factors, AP-42*. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, NC. October 1997.

Agriculture

Enteric Fermentation

Archibeque, S. (2011) Personal Communication. Shawn Archibeque, Colorado State University, Fort Collins, Colorado and staff at ICF International.

Crutzen, P.J., I. Aselmann, and W. Seiler (1986) Methane Production by Domestic Animals, Wild Ruminants, Other Herbivores, Fauna, and Humans. *Tellus*, 38B:271-284.

Donovan, K. (1999) Personal Communication. Kacey Donovan, University of California at Davis and staff at ICF International.

Doren, P.E., J. F. Baker, C. R. Long and T. C. Cartwright (1989) Estimating Parameters of Growth Curves of Bulls, *J Animal Science* 67:1432-1445.

Enns, M. (2008) Personal Communication. Dr. Mark Enns, Colorado State University and staff at ICF International.

FAO (2011) *FAOSTAT Statistical Database*. Food and Agriculture Organization of the United Nations. Available online at <http://apps.fao.org>.

Galyean and Gleghorn (2001) Summary of the 2000 Texas Tech University Consulting Nutritionist Survey. Texas Tech University. Available online at <http://www.depts.ttu.edu/afs/burnett_center/progress_reports/bc12.pdf>. June 2009.

Holstein Association (2010) *History of the Holstein Breed* (website). Available online at <http://www.holsteinusa.com/holstein_breed/breedhistory.html>. Accessed September 2010.

ICF (2006) *Cattle Enteric Fermentation Model: Model Documentation*. Prepared by ICF International for the Environmental Protection Agency. June 2006.

ICF (2003) *Uncertainty Analysis of 2001 Inventory Estimates of Methane Emissions from Livestock Enteric Fermentation in the U.S.* Memorandum from ICF International to the Environmental Protection Agency. May 2003.

IPCC (2006) 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T.

Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2000*) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change. Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Johnson, D. (2002) Personal Communication. Don Johnson, Colorado State University, Fort Collins, and ICF International.

Johnson, D. (1999) Personal Communication. Don Johnson, Colorado State University, Fort Collins, and David Conneely, ICF International.

Johnson, K. (2010) Personal Communication. Kris Johnson, Washington State University, Pullman, and ICF International.

Kebreab E., K. A. Johnson, S. L. Archibeque, D. Pape, and T. Wirth (2008) Model for estimating enteric methane emissions from United States dairy and feedlot cattle. *J. Anim. Sci.* 86: 2738-2748.

Lippke, H., T. D. Forbes, and W. C. Ellis. (2000) Effect of supplements on growth and forage intake by stocker steers grazing wheat pasture. *J. Anim. Sci.* 78:1625-1635

National Bison Association (2011) Handling & Carcass Info (on website). Available online at: <http://www.bisoncentral.com/about-bison/handling-and-carcass-info>. Accessed August 16, 2011.

National Bison Association (1999) Total Bison Population—1999. Report provided during personal email communication with Dave Carter, Executive Director, National Bison Association July 19, 2011.

NRC (1999) *1996 Beef NRC: Appendix Table 22*. National Research Council.

NRC (1984) *Nutrient requirements for beef cattle (6th Ed.)*. National Academy Press, Washington, DC.

Pinchak, W.E., D. R. Tolleson, M. McCloy, L. J. Hunt, R. J. Gill, R. J. Ansley, and S. J. Bevers (2004) Morbidity effects on productivity and profitability of stocker cattle grazing in the southern plains. J. Anim. Sci. 82:2773-2779.

Platter, W. J., J. D. Tatum, K. E. Belk, J. A. Scanga, and G. C. Smith (2003) Effects of repetitive use of hormonal implants on beef carcass quality, tenderness, and consumer ratings of beef palatability. J. Anim. Sci. 81:984-996.

Skogerboe, T. L., L. Thompson, J. M. Cunningham, A. C. Brake, V. K. Karle (2000) The effectiveness of a single dose of doramectin pour-on in the control of gastrointestinal nematodes in yearling stocker cattle. Vet. Parasitology 87:173-181.

USDA (2011) *Quick Stats: Agricultural Statistics Database*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://quickstats.nass.usda.gov/>. Accessed June 28, 2011.

USDA (2010) Beef 2007–08, Part *V: Reference of Beef Cow-calf Management Practices in the United States, 2007–08*. USDA–APHIS–VS, CEAH. Fort Collins, CO #532.0410.

USDA (1997) *Census of Agriculture: 1997 Census Report*. United States Department of Agriculture. Available online at: <http://www.agcensus.usda.gov/Publications/1997/index.asp>. Accessed July 18, 2011.

USDA (1996) *Beef Cow/Calf Health and Productivity Audit (CHAPA): Forage Analyses from Cow/Calf Herds in 18 States*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://www.aphis.usda.gov/vs/ceah/cahm>. March 1996.

USDA (1992) Census *of Agriculture: 1992 Census Report*. United States Department of Agriculture. Available online at: <http://www.agcensus.usda.gov/Publications/1992/index.asp>. Accessed July 18, 2011.

USDA:APHIS:VS (2002) *Reference of 2002 Dairy Management Practices*. National Animal Health Monitoring System. Fort Collins, CO. Available online at <http://www.aphis.usda.gov/vs/ceah/cahm>.

USDA:APHIS:VS (1998) *Beef '97*. National Animal Health Monitoring System. Fort Collins, CO. Available online

at <http://www.aphis.usda.gov/vs/ceah/cahm>.

USDA:APHIS:VS (1996) *Reference of 1996 Dairy Management Practices*. National Animal Health Monitoring System. Fort Collins, CO. Available online at <http://www.aphis.usda.gov/vs/ceah/cahm>.

USDA:APHIS:VS (1994) *Beef Cow/Calf Health and Productivity Audit*. National Animal Health Monitoring System. Fort Collins, CO. Available online at <http://www.aphis.usda.gov/vs/ceah/cahm>.

USDA:APHIS:VS (1993) *Beef Cow/Calf Health and Productivity Audit*. National Animal Health Monitoring System. Fort Collins, CO. August 1993. Available online at <http://www.aphis.usda.gov/vs/ceah/cahm>.

Vasconcelos and Galyean (2007) Nutritional recommendations of feedlot consulting nutritionists: The 2007 Texas Tech University Study. J. Anim. Sci. 85:2772-2781.

Manure Management

Anderson, S. (2000) Personal Communication. Steve Anderson, Agricultural Statistician, National Agriculture Statistics Service, U.S. Department of Agriculture and Lee-Ann Tracy, ERG. Washington, DC. May 31, 2000.

ASAE (1998) *ASAE Standards 1998, 45th Edition*. American Society of Agricultural Engineers. St. Joseph, MI.

Bryant, M.P., V.H. Varel, R.A. Frobish, and H.R. Isaacson (1976) In H.G. Schlegel (ed.); *Seminar on Microbial Energy Conversion*. E. Goltz KG. Göttingen, Germany.

Deal, P. (2000) Personal Communication. Peter B. Deal, Rangeland Management Specialist, Florida Natural Resource Conservation Service and Lee-Ann Tracy, ERG. June 21, 2000.

EPA (2011) AgSTAR Anaerobic Digester Database. Available online at: <http://www.epa.gov/agstar/projects/index.html#database>.

EPA (2008) *Climate Leaders Greenhouse Gas Inventory Protocol Offset Project Methodology for Project Type Managing Manure with Biogas Recovery Systems*. Available online at <http://www.epa.gov/climateleaders/documents/resources/ClimateLeaders_DraftManureOffsetProtocol.pdf>.

EPA (2006) *AgSTAR Digest*. Office of Air and Radiation, U.S. Environmental Protection Agency. Washington, DC. Winter 2006. Available online at <http://www.epa.gov/agstar/pdf/2006digest.pdf>. Retrieved July 2006.

EPA (2005) *National Emission Inventory—Ammonia Emissions from Animal Agricultural Operations, Revised Draft Report*. U.S. Environmental Protection Agency. Washington, DC. April 22, 2005. Available online at <ftp://ftp.epa.gov/EmisInventory/2002finalnei/documentation/nonpoint/nh3inventory_draft_042205.pdf>. Retrieved August 2007.

EPA (2003) *AgSTAR Digest*. Office of Air and Radiation, U.S. Environmental Protection Agency. Washington, DC. Winter 2003. Available online at <http://www.epa.gov/agstar/pdf/2003digest.pdf>. Retrieved July 2006.

EPA (2002a) *Development Document for the Final Revisions to the National Pollutant Discharge Elimination System (NPDES) Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations (CAFOS).* U.S. Environmental Protection Agency. EPA-821-R-03-001. December 2002.

EPA (2002b) *Cost Methodology for the Final Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations*. U.S. Environmental Protection Agency. EPA-821-R-03-004. December 2002.

EPA (2000) *AgSTAR Digest*. Office of Air and Radiation, U.S. Environmental Protection Agency. Washington, DC. Spring 2000. Available online at: http://www.epa.gov/agstar/news-events/digest/2000digest.pdf .

EPA (1992) *Global Methane Emissions from Livestock and Poultry Manure*, Office of Air and Radiation, U.S. Environmental Protection Agency. February 1992.

ERG (2010a) "Typical Animal Mass Values for Inventory Swine Categories." Memorandum to EPA from ERG. July 19, 2010.

ERG (2010b) Telecon with William Boyd of USDA NRCS and Cortney Itle of ERG Concerning Updated VS and Nex Rates. August 8, 2010.

ERG (2010c) "Updating Current Inventory Manure Characteristics new USDA Agricultural Waste Management

Field Handbook Values." Memorandum to EPA from ERG. August 13, 2010.

ERG (2008) "Methodology for Improving Methane Emissions Estimates and Emission Reductions from Anaerobic Digestion System for the 1990-2007 Greenhouse Gas Inventory for Manure Management." Memorandum to EPA from ERG. August 18, 2008.

ERG (2003) "Methodology for Estimating Uncertainty for Manure Management Greenhouse Gas Inventory." Contract No. GS-10F-0036, Task Order 005. Memorandum to EPA from ERG, Lexington, MA. September 26, 2003.

ERG (2001) *Summary of development of MDP Factor for methane conversion factor calculations.* ERG, Lexington, MA. September 2001.

ERG (2000a) *Calculations: Percent Distribution of Manure for Waste Management Systems.* ERG, Lexington, MA. August 2000.

ERG (2000b) *Discussion of Methodology for Estimating Animal Waste Characteristics* (Summary of B_o Literature Review). ERG, Lexington, MA. June 2000.

FAO (2011) *Yearly U.S. total horse population data from the Food and Agriculture Organization of the United Nations database*. Available online at <http://faostat.fao.org>. August 2011.

Garrett, W.N. and D.E. Johnson (1983) "Nutritional energetics of ruminants." *Journal of Animal Science*, 57(suppl.2):478-497.

Groffman, P.M., R. Brumme, K. Butterbach-Bahl, K.E. Dobbie, A.R. Mosier, D. Ojima, H. Papen, W.J. Parton, K.A. Smith, and C. Wagner-Riddle (2000) "Evaluating annual nitrous oxide fluxes at the ecosystem scale." *Global Biogeochemcial Cycles*, 14(4):1061-1070.

Hashimoto, A.G. (1984) "Methane from Swine Manure: Effect of Temperature and Influent Substrate Composition on Kinetic Parameter (k)." *Agricultural Wastes*, 9:299-308.

Hashimoto, A.G., V.H. Varel, and Y.R. Chen (1981) "Ultimate Methane Yield from Beef Cattle Manure; Effect of Temperature, Ration Constituents, Antibiotics and Manure Age." *Agricultural Wastes*, 3:241-256.

Hill, D.T. (1984) "Methane Productivity of the Major Animal Types." *Transactions of the ASAE*, 27(2):530-540.

Hill, D.T. (1982) "Design of Digestion Systems for Maximum Methane Production." *Transactions of the ASAE*, 25(1):226-230.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Johnson, D. (2000) Personal Communication. Dan Johnson, State Water Management Engineer, California Natural Resource Conservation Service and Lee-Ann Tracy, ERG. June 23, 2000.

Lange, J. (2000) Personal Communication. John Lange, Agricultural Statistician, U.S. Department of Agriculture, National Agriculture Statistics Service and Lee-Ann Tracy, ERG. Washington, DC. May 8, 2000.

Miller, P. (2000) Personal Communication. Paul Miller, Iowa Natural Resource Conservation Service and Lee-Ann Tracy, ERG. June 12, 2000.

Milton, B. (2000) Personal Communication. Bob Milton, Chief of Livestock Branch, U.S. Department of Agriculture, National Agriculture Statistics Service and Lee-Ann Tracy, ERG. May 1, 2000.

Moffroid , K and D. Pape. (2011) *1990-2009 Volatile Solids and Nitrogen Excretion Rates.* Dataset to EPA from ICF International. June 2011.

Morris, G.R. (1976) *Anaerobic Fermentation of Animal Wastes: A Kinetic and Empirical Design Fermentation.* M.S. Thesis. Cornell University.

NOAA (2011) *National Climate Data Center (NCDC).* Available online at <ftp://ftp.ncdc.noaa.gov/pub/data/cirs/> (for all states except Alaska and Hawaii) and <ftp://ftp.ncdc.noaa.gov/pub/data/gsod/2008/>. (for Alaska and Hawaii). June 2011.

Pederson, L., D. Pape and K. Moffroid (2007) *1990-2006 Volatile Solids and Nitrogen Excretion Rates*, EPA Contract GS-10F-0124J, Task Order 056-01. Memorandum to EPA from ICF International. August 2007.

Safley, L.M., Jr. and P.W. Westerman (1990) "Psychrophilic anaerobic digestion of animal manure: proposed design methodology." *Biological Wastes*, 34:133-148.

Safley, L.M., Jr. (2000) Personal Communication. Deb Bartram, ERG and L.M. Safley, President, Agri-Waste Technology. June and October 2000.

Stettler, D. (2000) Personal Communication. Don Stettler, Environmental Engineer, National Climate Center, Oregon Natural Resource Conservation Service and Lee-Ann Tracy, ERG. June 27, 2000.

Sweeten, J. (2000) Personal Communication. John Sweeten, Texas A&M University and Indra Mitra, ERG. June 2000.

UEP (1999) *Voluntary Survey Results—Estimated Percentage Participation/Activity*, Caged Layer Environmental Management Practices, Industry data submissions for EPA profile development, United Egg Producers and National Chicken Council. Received from John Thorne, Capitolink. June 2000.

USDA (2011a) *Quick Stats 1.0*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/index.asp>.

USDA (2011b) *Chicken and Eggs 2010 Summary*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. February 2011. Available online at <http://www.nass.usda.gov/Publications/index.asp> .

USDA (2011c) *Poultry - Production and Value 2010 Summary*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. April 2011. Available online at <http://usda.mannlib.cornell.edu/usda/nass/PoulProdVa//2010s/2011/PoulProdVa-04-28-2011_new_format.pdf> .

USDA (2009a) *1992, 1997, 2002, and 2007 Census of Agriculture*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://www.nass.usda.gov/census/>. December 2009.

USDA (2009b) *Chicken and Eggs 2008 Summary*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. February 2009. Available online at <http://www.nass.usda.gov/Publications/index.asp> .

USDA (2009c) *Poultry - Production and Value 2008 Summary*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. April 2009. Available online at <http://www.nass.usda.gov/Publications/index.asp> .

USDA (2009d) *Chicken and Eggs – Final Estimates 2003-2007*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. March 2009. Available online at <http://usda.mannlib.cornell.edu/usda/nass/SB980/sb1024.pdf> .

USDA (2009e) *Poultry Production and Value—Final Estimates 2003-2007*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. May 2009. Available online at <http://usda.mannlib.cornell.edu/usda/nass/SB994/sb1028.pdf>.

USDA (2008) *Agricultural Waste Management Field Handbook, National Engineering Handbook (NEH)*, Part 651. Natural Resources Conservation Service, U.S. Department of Agriculture.

USDA (2004a) *Chicken and Eggs—Final Estimates 1998-2003*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. April 2004. Available online at <http://usda.mannlib.cornell.edu/reports/general/sb/>.

USDA (2004b) *Poultry Production and Value—Final Estimates 1998-2002*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. April 2004. Available online at <http://usda.mannlib.cornell.edu/reports/general/sb/>.

USDA (2003) *APHIS Sheep 2001,Parts I and IV*. Available online at <http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/sheep/>.

USDA (2000a) *National Animal Health Monitoring Systems (NAHMS) Dairy '96 Study.* Stephen L. Ott, Animal and Plant Health Inspection Service, U.S. Department of Agriculture. June 19, 2000.

USDA (2000b) *Layers '99—Part II: References of 1999 Table Egg Layer Management in the U.S.* Animal and Plant Health Inspection Service (APHIS), National Animal Health Monitoring System (NAHMS), U.S. Department of Agriculture. January 2000.

USDA (1999) *Poultry Production and Value—Final Estimates 1994-97*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. March 1999. Available online at <http://usda.mannlib.cornell.edu/reports/general/sb/>.

USDA (1998a) *Chicken and Eggs—Final Estimates 1994-97*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. December 1998. Available online at <http://usda.mannlib.cornell.edu/reports/general/sb/>.

USDA (1998b) *National Animal Health Monitoring System's (NAHMS) Swine '95 Study*. Eric Bush, Centers for Epidemiology and Animal Health , U.S. Department of Agriculture.

USDA (1996a) *Agricultural Waste Management Field Handbook*, *National Engineering Handbook (NEH)*, Part 651. Natural Resources Conservation Service, U.S. Department of Agriculture. July 1996.

USDA (1996b) *Swine '95: Grower/Finisher Part II: Reference of 1995 U.S. Grower/Finisher Health & Management Practices.* Animal Plant Health and Inspection Service, U.S. Department of Agriculture. Washington, DC. June 1996.

USDA (1995a) *Poultry Production and Value—Final Estimates 1988-1993*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. March 1995. Available online at <http://usda.mannlib.cornell.edu/reports/general/sb/>.

USDA (1995b) *Chicken and Eggs—Final Estimates 1988-1993*. National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. December 1995. Available online at <http://usda.mannlib.cornell.edu/reports/general/sb/>.

Rice Cultivation

Anderson, M. (2008 through 2011) Email correspondence. Monte Anderson, Oklahoma Farm Service Agency and ICF International.

Beighley, D. (2011) Email correspondence. Donn Beighley, Southeast Missouri State University, Department of Agriculture and ICF International.

Bollich, P. (2000) Personal Communication. Pat Bollich, Professor with Louisiana State University Agriculture Center and Payton Deeks, ICF International.

Bossio, D.A., W. Horwath, R.G. Mutters, and C. van Kessel (1999) "Methane pool and flux dynamics in a rice field following straw incorporation." *Soil Biology and Biochemistry*, 31:1313-1322.

Buehring, N. (2009 through 2011) Email correspondence. Nathan Buehring, Assistant Professor and Extension Rice Specialist, Mississippi State University Delta Branch Exp. Station and ICF International.

Cantens, G. (2004 through 2005) Personal Communication. Janet Lewis, Assistant to Gaston Cantens, Vice President of Corporate Relations, Florida Crystals Company and ICF International.

Cicerone R.J., C.C. Delwiche, S.C. Tyler, and P.R. Zimmerman (1992) "Methane Emissions from California Rice Paddies with Varied Treatments." *Global Biogeochemical Cycles*, 6:233-248.

Deren, C. (2002) Personal Communication and Dr. Chris Deren, Everglades Research and Education Centre at the University of Florida and Caren Mintz, ICF International. August 15, 2002.

Fife, L. (2011) Email correspondence. Les Fife, Sacramento Valley AgBurn Coordinator and ICF International.

Gonzalez, R. (2007 through 2011) Email correspondence. Rene Gonzalez, Plant Manager, Sem-Chi Rice Company and ICF International.

Guethle, D. (1999 through 2010) Personal Communication. David Guethle, Agronomy Specialist, Missouri Cooperative Extension Service and ICF International.

Holzapfel-Pschorn, A., R. Conrad, and W. Seiler (1985) "Production, Oxidation, and Emissions of Methane in Rice Paddies." *FEMS Microbiology Ecology,* 31:343-351.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.* National Greenhouse Gas Inventories Programme, Intergovernmental Panel on Climate Change, Montreal. May 2000. IPCC-XVI/Doc. 10 (1.IV.2000).

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency, Paris, France.

Kirstein, A. (2003 through 2004, 2006) Personal Communication. Arthur Kirstein, Coordinator, Agricultural Economic Development Program, Palm Beach County Cooperative Extension Service, FL and ICF International.

Klosterboer, A. (1997, 1999 through 2003) Personal Communication. Arlen Klosterboer, retired Extension Agronomist, Texas A&M University and ICF International. July 7, 2003.

Lancero, J. (2006 through 2010) Email correspondence. Jeff Lancero, California Air Resources Board and ICF International.

Lee, D. (2003 through 2007) Email correspondence. Danny Lee, OK Farm Service Agency and ICF International.

Lindau, C.W. and P.K. Bollich (1993) "Methane Emissions from Louisiana First and Ratoon Crop Rice." *Soil Science,* 156:42-48.

Lindau, C.W., P.K Bollich, and R.D. DeLaune (1995) "Effect of Rice Variety on Methane Emission from Louisiana Rice." *Agriculture, Ecosystems and Environment,* 54:109-114.

Linscombe, S. (1999, 2001 through 2011) Email correspondence. Steve Linscombe, Professor with the Rice Research Station at Louisiana State University Agriculture Center and ICF International.

Mayhew, W. (1997) Personal Communication. Walter Mayhew, University of Arkansas, Little Rock and Holly Simpkins, ICF Incorporated. November 24, 1997.

Mutters, C. (2001 through 2005) Personal Communication. Mr. Cass Mutters, Rice Farm Advisor for Butte, Glen, and Tehama Counties University of California, Cooperative Extension Service and ICF International.

Sacramento Valley Basinwide Air Pollution Control Council (2005, 2007) *Report on the Conditional Rice Straw Burning Permit Progra*m. Available online at <http://www.bcaqmd.org/default.asp?docpage=html/bcc.htm>.

Saichuk, J. (1997) Personal Communication. John Saichuk, Louisiana State University and Holly Simpkins, ICF Incorporated. November 24, 1997.

Sass, R.L., F.M Fisher, P.A. Harcombe, and F.T. Turner (1991a) "Mitigation of Methane Emissions from Rice Fields: Possible Adverse Effects of Incorporated Rice Straw." *Global Biogeochemical Cycles,* 5:275-287.

Sass, R.L., F.M. Fisher, F.T. Turner, and M.F. Jund (1991b) "Methane Emissions from Rice Fields as Influenced by Solar Radiation, Temperature, and Straw Incorporation." *Global Biogeochemical Cycles,* 5:335-350.

Sass, R.L., F.M. Fisher, P.A. Harcombe, and F.T. Turner (1990) "Methane Production and Emissions in a Texas Rice Field." *Global Biogeochemical Cycles,* 4:47-68.

Schueneman, T. (1997, 1999 through 2001) Personal Communication. Tom Schueneman, Agricultural Extension Agent, Palm Beach County, FL and ICF International.

Slaton, N. (1999 through 2001) Personal Communication. Nathan Slaton, Extension Agronomist—Rice, University of Arkansas Division of Agriculture Cooperative Extension Service and ICF International.

Stansel, J. (2004 through 2005) Email correspondence. Dr. Jim Stansel, Resident Director and Professor Emeritus,

Texas A&M University Agricultural Research and Extension Center and ICF International.

Stevens, G. (1997) Personal Communication. Gene Stevens, Extension Specialist, Missouri Commercial Agriculture Program, Delta Research Center and Holly Simpkins, ICF Incorporated. December 17, 1997.

Street, J. (1997, 1999 through 2003) Personal Communication. Joe Street, Rice Specialist, Mississippi State University, Delta Research Center and ICF International.

Texas Agricultural Experiment Station (2007 through 2011) *Texas Rice Acreage by Variety*. Agricultural Research and Extension Center, Texas Agricultural Experiment Station, Texas A&M University System. Available online at <http://beaumont.tamu.edu/CropSurvey/CropSurveyReport.aspx>.

Texas Agricultural Experiment Station (2006) *2005 - Texas Rice Crop Statistics Report*. Agricultural Research and Extension Center, Texas Agricultural Experiment Station, Texas A&M University System, p. 8. Available online at <http://beaumont.tamu.edu/eLibrary/TRRFReport_default.htm>.

USDA (2005 through 2011) *Crop Production Summary*. National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, Washington, DC. Available online at <http://usda.mannlib.cornell.edu>.

USDA (2003) *Field Crops, Final Estimates 1997-2002*. Statistical Bulletin No. 982. National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, Washington, DC. Available online at <http://usda.mannlib.cornell.edu/usda/reports/general/sb/>. September 2005.

USDA (1998) *Field Crops Final Estimates 1992-1997*. Statistical Bulletin Number 947 a. National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, Washington, DC. Available online at <http://usda.mannlib.cornell.edu/>. July 2001.

USDA (1994) *Field Crops Final Estimates 1987-1992*. Statistical Bulletin Number 896. National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, Washington, DC. Available online at <http://usda.mannlib.cornell.edu/>. July 2001.

Walker, T. (2005, 2007 through 2008) Email correspondence. Tim Walker, Assistant Research Professor, Mississippi State University Delta Branch Exp. Station and ICF International.

Wilson, C. (2002 through 2007, 2009 through 2011) Personal Communication. Dr. Chuck Wilson, Rice Specialist at the University of Arkansas Cooperative Extension Service and ICF International.

Agricultural Soil Management

AAPFCO (1995 through 2000b, 2002 through 2009) *Commercial Fertilizers*. Association of American Plant Food Control Officials. University of Kentucky, Lexington, KY.

AAPFCO (2000a) 1999-2000 Commercial Fertilizers Data, ASCII files. Available from David Terry, Secretary, Association of American Plant Food Control Officials.

Alexander, R.B. and R.A. Smith (1990) *County-Level Estimates of Nitrogen and Phosphorous Fertilizer Use in the United States, 1945-1985*. U.S. Geological Survey Open File Report 90-130.

Anonymous (1924) Fertilizer Used on Cotton, 1923-1924. "Miscellaneous Agricultural Statistics," Table 753. *1924 Yearbook of the Department of Agriculture*, 1171.

Bastian, R. (2007) Personal Communication. Robert Bastian, Office of Water, U.S. Environmental Protection Agency, Washington, DC and Victoria Thompson, ICF International. July 20, 2007.

Battaglin, W.A., and D.A. Goolsby (1994) *Spatial Data in Geographic Information System Format on Agricultural Chemical Use, Land Use, and Cropping Practices in the United States*. U.S. Geological Survey Water-Resources Investigations Report 94-4176.

Bogue A.G. (1963) *From Prairie to Corn Belt: Farming on the Illinois and Iowa prairies in the Nineteenth Century*. The University of Chicago Press. Chicago, IL.

Bonnen C.A., and F.F. Elliott (1931) *Type of Farming Areas in Texas*. Bulletin Number 427, Texas Agricultural Experiment Station, Agricultural and Mechanical College of Texas.

Brenner, J., K. Paustian, G. Bluhm, J. Cipra, M. Easter, R. Foulk, K. Killian, R. Moore, J. Schuler, P. Smith, and S. Williams (2002) *Quantifying the Change in Greenhouse Gas Emissions Due to Natural Resource Conservation Practice Application in Nebraska*. Colorado State University Natural Resource Ecology Laboratory and Natural Resources Conservation Service, U.S. Department of Agriculture. Fort Collins, CO.

Brenner, J., K. Paustian., G. Bluhm, J. Cipra, M. Easter, E.T. Elliott, T. Koutza, K. Killian, J. Schuler, S. Williams (2001) *Quantifying the Change in Greenhouse Gas Emissions Due to Natural Resource Conservation Practice Application in Iowa*. Final report to the Iowa Conservation Partnership. Colorado State University Natural Resource Ecology Laboratory and U.S. Department of Agriculture Natural Resources Conservation Service. Fort Collins, CO.

Chilcott E.C. (1910) *A Study of Cultivation Methods and Crop Rotations for the Great Plains Area*. Bureau of Plant Industry Bulletin Number 187, U.S. Department of Agriculture. Government Printing Office. Washington, DC.

Cibrowski, P. (1996) Personal Communication. Peter Cibrowski, Minnesota Pollution Control Agency and Heike Mainhardt, ICF Incorporated. July 29, 1996.

Cochran, W.G. (1977) *Sampling Techniques, Third Edition*. Wiley Publishing, New York.

CTIC (1998) *1998 Crop Residue Management Executive Summary*. Conservation Technology Information Center. Available online at <http://www.ctic.purdue.edu/Core4/CT/CT.html>.

Daly, C., G.H. Taylor, W.P. Gibson, T. Parzybok, G.L. Johnson, and P.A. Pasteris (1998) "Development of high-quality spatial datasets for the United States." *Proc., 1st International Conference on Geospatial Information in Agriculture and Forestry*, Lake Buena Vista, FL, I-512-I-519. June 1-3, 1998.

Daly, C., R.P. Neilson, and D.L. Phillips (1994) "A statistical-topographic model for mapping climatological precipitation over mountainous terrain." *Journal of Applied Meteorology*, 33:140-158.

David, M.B., S.J. Del Grosso, X. Hu, G.F. McIsaac, W.J. Parton, E.P. Marshall, C. Tonitto, and M.A. Youssef (2009) "Modeling denitrification in a tile-drained, corn and soybean agroecosystem of Illinois, USA." *Biogeochemistry* 93:7-30.

DAYMET (No date) *Daily Surface Weather and Climatological Summaries*. Numerical Terradynamic Simulation Group (NTSG), University of Montana. Available online at <http://www.daymet.org>.

Delgado, J.A., S.J. Del Grosso, and S.M. Ogle (2009) "15N isotopic crop residue cycling studies and modeling suggest that IPCC methodologies to assess residue contributions to N_2O-N emissions should be reevaluated." *Nutrient Cycling in Agroecosystems*, DOI 10.1007/s10705-009-9300-9.

Del Grosso, S.J., S.M. Ogle, W.J. Parton, and F.J. Breidt (2010) "Estimating Uncertainty in N_2O Emissions from US Cropland Soils." *Global Biogeochemical Cycles*, 24, GB1009, doi:10.1029/2009GB003544.

Del Grosso, S.J., T. Wirth, S.M. Ogle, W.J. Parton (2008) Estimating agricultural nitrous oxide emissions. *EOS 89*, 529-530.

Del Grosso, S.J., A.R. Mosier, W.J. Parton, and D.S. Ojima (2005) "DAYCENT Model Analysis of Past and Contemporary Soil N_2O and Net Greenhouse Gas Flux for Major Crops in the USA." *Soil Tillage and Research*, 83: 9-24. doi: 10.1016/j.still.2005.02.007.

Del Grosso, S.J., W.J. Parton, A.R. Mosier, M.D. Hartman, J. Brenner, D.S. Ojima, and D.S. Schimel (2001) "Simulated Interaction of Carbon Dynamics and Nitrogen Trace Gas Fluxes Using the DAYCENT Model." In Schaffer, M., L. Ma, S. Hansen, (eds.)*; Modeling Carbon and Nitrogen Dynamics for Soil Management*. CRC Press. Boca Raton, Florida. 303-332.

Del Grosso, S.J., W.J. Parton, A.R. Mosier, D.S. Ojima, A.E. Kulmala and S. Phongpan (2000) General model for N_2O and N_2 gas emissions from soils due to denitrification. *Global Biogeochem. Cycles*, 14:1045-1060.

Edmonds, L., N. Gollehon, R.L. Kellogg, B. Kintzer, L. Knight, C. Lander, J. Lemunyon, D. Meyer, D.C. Moffitt, and J. Schaeffer (2003) "Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plans." Part 1. *Nutrient Management, Land Treatment, Manure and Wastewater Handling and Storage, and Recordkeeping*. Natural Resource Conservation Service, U.S. Department of Agriculture.

Elliott, F.F. (1933) *Types of Farming in the United States*. U.S. Department of Commerce. Government Printing

Office. Washington, DC.

Elliott, F.F. and J.W. Tapp (1928) *Types of Farming in North Dakota*. U.S. Department of Agriculture Technical Bulletin Number 102.

Ellsworth, J.O. (1929) *Types of Farming in Oklahoma*. Agricultural Experiment Station Bulletin Number 181. Oklahoma Agricultural and Mechanical College.

Engle, R.H. and B.R. Makela (1947) "Where is All the Fertilizer Going?" The National Fertilizer Association. *The Fertilizer Review*, Vol. XXII, 6:7-10.

EPA (2003) *Clean Watersheds Needs Survey 2000—Report to Congress*, U.S. Environmental Protection Agency. Washington, DC. Available online at <http://www.epa.gov/owm/mtb/cwns/2000rtc/toc.htm>.

EPA (1999) *Biosolids Generation, Use and Disposal in the United States*. Office of Solid Waste, U.S. Environmental Protection Agency. Available online at <http://biosolids.policy.net/relatives/18941.PDF>.

EPA (1993) Federal Register. Part II. Standards for the Use and Disposal of Sewage Sludge; Final Rules. U.S. Environmental Protection Agency, 40 CFR Parts 257, 403, and 503.

ERS (2003) *Ag Chemical and Production Technology*. Economic Research Service, U.S. Department of Agriculture.

ERS (2002) Economic Research Service, U.S. Department of Agriculture. Available online at <http://www.ers.usda.gov/>.

ERS (1997) *Cropping Practices Survey Data—1995*. Economic Research Service, U.S. Department of Agriculture. Available online at <http://www.ers.usda.gov/data/archive/93018/>.

ERS (1994) *Fertilizer Use and Price Statistics*. Stock #86012. Economic Research Service, U.S. Department of Agriculture.

ERS (1988) *Agricultural Resources—Inputs Situation and Outlook Report*. AR-9. Economic Research Service, U.S. Department of Agriculture.

Eve, M. (2001) E-mail correspondence. Marlen Eve, Natural Resources Ecology Laboratory, Colorado State University and Barbara Braatz and Caren Mintz, ICF International. Statistics on U.S. organic soil areas cultivated in 1982, 1992, and 1997, which were extracted from the *1997 National Resources Inventory*. September 21, 2001.

Fraps, G.S. and S.E. Asbury (1931) *Commercial Fertilizers in 1930-1931 and Their Uses*. Agricultural Experiment Station Bulletin Number 434. Agricultural and Mechanical College of Texas.

Hardies, E.W. and A.N. Hume (1927) *Wheat in South Dakota*. Agronomy Department Bulletin Number 222. Agricultural Experiment Station, South Dakota State College of Agriculture and Mechanical Arts. Brookings, SD.

Garey, L.F. (1929) *Types of Farming in Minnesota*. Agricultural Experiment Station Bulletin Number 257. University of Minnesota. St. Paul, MN.

Grant, W.R. and R.D. Krenz (1985) *U. S. grain sorghum production practices and costs*. Staff Report No. AGES 851024. National Economics Division, Economics Research Service, U.S. Department of Agriculture.

Hargreaves, M.W.M. (1993) *Dry Farming in the Northern Great Plains: Years of Readjustment, 1920-1990*. University Press of Kansas. Lawrence, KS.

Hodges, J.A., F.F. Elliott, and W.E. Grimes (1930) *Types of Farming in Kansas*. Agricultural Experiment Station Bulletin Number 251. Kansas State Agricultural College. Manhattan, KS.

Holmes C.L. (1929) *Types of Farming in Iowa*. Agricultural Experiment Station Bulletin Number 259. Iowa State College of Agriculture and Mechanic Arts. Ames, IA.

Holmes G.K. (1902) "Practices in Crop Rotation." *Yearbook of the Department of Agriculture*, 519-532.

Hurd E.B. (1929) *The Corn Enterprise in Iowa*. Agricultural Experiment Station Bulletin Number 268. Iowa State College of Agriculture and Mechanic Arts. Ames, IA.

Hurd E.B. (1930) *Cropping Systems in Iowa Past and Present*. Agricultural Experiment Station Bulletin Number

268. Iowa State College of Agriculture and Mechanic Arts. Ames, IA.

Hurt, R.D. (1994) *American Agriculture: A Brief History*. Iowa State University Press. Ames, IA.

Ibach, D.B. and J.R. Adams (1967) *Fertilizer Use in the United States by Crops and Areas, 1964 Estimates*. Statistical Bulletin Number 408, U.S. Department of Agriculture.

Ibach, D.B., J.R. Adams, and E.I. Fox (1964) *Commercial Fertilizer used on Crops and Pasture in the United States, 1959 Estimates*. U.S. Department of Agriculture Statistical Bulletin Number 348.

ILENR (1993) *Illinois Inventory of Greenhouse Gas Emissions and Sinks: 1990*. Office of Research and Planning, Illinois Department of Energy and Natural Resources. Springfield, IL.

Iowa State College Staff Members (1946) *A Century of Farming in Iowa 1846-1946*. The Iowa State College Press. Ames, IA.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Jaynes, D.B., T.S. Colvin, D.L. Karlen, C.A. Cambardella, and D.W. Meek (2001) "Nitrate loss in subsurface draining as affected by nitrogen fertilizer rate." *J. Environ. Qual.* 30, 1305-1314.

Kellogg R.L., C.H. Lander, D.C. Moffitt, and N. Gollehon (2000) *Manure Nutrients Relative to Capacity of Cropland and Pastureland to Assimilate Nutrients: Spatial and Temporal Trends for the United States*. U.S. Department of Agriculture Publication Number nps00-0579.

Kezer A. (ca. 1917) *Dry Farming in Colorado*. Colorado State Board of Immigration, Denver, CO.

Kuchler, AW. (1964) "The Potential Natural Vegetation of the Conterminous United States." *Amer. Geographical Soc. NY*, Special Publication No. 36.

Langston C.W., L.M. Davis, C.A. Juve, O.C. Stine, A.E. Wight, A.J. Pistor, and C.F. Langworthy (1922) "The Dairy Industry." *Yearbook of the Department of Agriculture*.

Latta, W.C. (1938) *Outline History of Indiana Agriculture*. Alpha Lambda Chapter of Epsilon Sigma Phi, Purdue University, West Lafayette, IN.

McCarl, B.A., C.C. Chang, J.D. Atwood, and W.I. Nayda (1993) *Documentation of ASM: The U.S. Agricultural Sector Model*, Technical Report TR-93. Agricultural Experimental Station, College Station, TX.

McFarland, M.J. (2001) *Biosolids Engineering*, New York: McGraw-Hill, p. 2.12.

Mosier, A.R. (2004) E-mail correspondence. Arvin Mosier, U.S. Department of Agriculture, Agricultural Research Service and Stephen Del Grosso, Natural Resource Ecology Laboratory, Colorado State University, regarding the uncertainty in estimates of N application rates for specific crops (±20). September 20, 2004.

NASS (2004) *Agricultural Chemical Usage: 2003 Field Crops Summary*. Report AgCh1(04)a, National Agricultural Statistics Service, U.S. Department of Agriculture. Available online at <http://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agcs0504.pdf>.

NASS (1999) *Agricultural Chemical Usage: 1998 Field Crops Summary*. Report AgCh1(99). National Agricultural Statistics Service, U.S. Department of Agriculture. Available online at <http://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agch0599.pdf>.

NASS (1992) *Agricultural Chemical Usage: 1991 Field Crops Summary*. Report AgCh1(92). National Agricultural Statistics Service, U.S. Department of Agriculture. Available online at <http://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agch0392.txt>.

NEBRA (2007) *A National Biosolids Regulation, Quality, End Use & Disposal Survey*. North East Biosolids and Residuals Association, July 21, 2007.

NFA (1946) "Charting the Fertilizer Course: Results of NFA's Third Practice Survey." National Fertilizer Association. *The Fertilizer Review*. Vol. XXI, 2:7-13.

Noller, J. (1996) Personal Communication. John Noller, Missouri Department of Natural Resources and Heike

Mainhardt, ICF Incorporated. July 30, 1996.

NRAES (1992) *On-Farm Composting Handbook* (NRAES-54). Natural Resource, Agriculture, and Engineering Service. Available online at <http://compost.css.cornell.edu/OnFarmHandbook/onfarm_TOC.html>.

NRIAI (2003) Regional Budget and Cost Information. U.S. Department of Agriculture, Natural Resources Conservation Service, Natural Resources Inventory and Analysis Institute. Available online at <http://www.economics.nrcs.usda.gov/care/budgets/index.html>.

Ogle, S. (2002) E-mail correspondence. Stephen Ogle, Natural Resources Ecology Laboratory, Colorado State University and Barbara Braatz, ICF International, concerning revised statistics on U.S. histosol areas cultivated in 1982, 1992, and 1997, which were extracted from the *1997 National Resources Inventory* by Marlen Eve. January 9, 2002.

Ogle, S.M., F.J. Breidt, M. Easter, S. Williams, and K. Paustian. (2007) "Empirically-Based Uncertainty Associated with Modeling Carbon Sequestration in Soils." *Ecological Modeling* 205:453-463.

Oregon Department of Energy (1995) *Report on Reducing Oregon's Greenhouse Gas Emissions: Appendix D Inventory and Technical Discussion.* Oregon Department of Energy. Salem, OR.

Parton, W.J., M.D. Hartman, D.S. Ojima, and D.S. Schimel (1998) "DAYCENT: Its Land Surface Submodel: Description and Testing". *Glob. Planet. Chang*. 19: 35-48.

Parton, W.J., E.A. Holland, S.J. Del Grosso, M.D. Hartman, R.E. Martin, A.R. Mosier, D.S. Ojima, and D.S. Schimel (2001) Generalized model for NO_x and N_2O emissions from soils. *Journal of Geophysical Research*. 106 (D15):17403-17420.

Piper C.V., R.A. Oakley, H.N. Vinall, A.J. Pieters, W.J. Morse, W.J. Spillman, O.C. Stine, J.S. Cotton., G.A. Collier, M.R Cooper, E.C. Parker, E.W. Sheets, and A.T. Semple (1924) "Hay." *Yearbook of the Department of Agriculture*, 285-376.

Ruddy B.C., D.L. Lorenz, and D.K. Mueller (2006) *County-level estimates of nutrient inputs to the land surface of the conterminous United States, 1982-2001*. Scientific Investigations Report 2006-5012. US Department of the Interior.

Ross W.H. and A.L. Mehring (1938) "Mixed Fertilizers." In *Soils and Men*. Agricultural Yearbook 1938. U.S. Department of Agriculture.

Russell E.Z., S.S. Buckley, C.E. Baker, C.E. Gibbons, R.H. Wilcox, H.W. Hawthorne, S.W. Mendum, O.C. Stine, G.K. Holmes, A.V. Swarthout, W.B. Bell, G.S. Jamieson, C.W. Warburton, and C.F. Langworthy (1922) *Hog Production and Marketing*. Yearbook of the U.S. Department of Agriculture.

Saxton, K.E., W.J. Rawls, J.S. Romberger, and R.I. Papendick (1986) "Estimating Generalized Soil-Water Characteristics From Texture." *Soil Sci. Soc. Am. J.* 50:1031-1036.

Skinner, J.J. (1931) *Fertilizers for Cotton Soils*. Miscellaneous Publication Number 126. U.S. Department of Agriculture.

Smalley, H.R., R.H. Engle, and H. Willett (1939) *American Fertilizer Practices: Second Survey*. The National Fertilizer Association.

Smith C.B. (1911) *Rotations in the Corn Belt*. Yearbook of the Department of Agriculture, pp.325-336.

Smith, P., J. Brenner, K. Paustian, G. Bluhm, J. Cipra, M. Easter, E.T. Elliott, K. Killian, D. Lamm, J. Schuler, and S. Williams (2002) *Quantifying the Change in Greenhouse Gas Emissions Due to Natural Resource Conservation Practice Application in Indiana*. Final Report to the Indiana Conservation Partnership, Colorado State University Natural Resource Ecology Laboratory and U.S. Department of Agriculture Natural Resources Conservation Service, Fort Collins, CO.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. (2005) *State Soil Geographic (STATSGO) Database for State*. Available online at <http://www.ncgc.nrcs.usda.gov/products/datasets/statsgo/index.html>.

Spillman W.J. (1908) *Types of Farming in the United States*. Yearbook of the Department of Agriculture, 351-366.

Spillman W.J. (1907) *Cropping Systems for Stock Farms*. Yearbook of the Department of Agriculture, 385-398.

Spillman W.J. (1905) *Diversified Farming in the Cotton Belt*. Yearbook of the Department of Agriculture, 193-218.

Spillman W.J. (1902) *Systems of Farm Management in the United States*. Yearbook of the Department of Agriculture, 343-364.

Taylor, H.H. (1994) *Fertilizer Use and Price Statistics: 1960-93*. Resources and Technology Division, Economic Research Service, U.S. Department of Agriculture, Statistical Bulletin Number 893.

Thornton, P.E., H. Hasenauer, and M.A. White (2000) "Simultaneous Estimation of Daily Solar Radiation and Humidity from Observed Temperature and Precipitation: An Application Over Complex Terrain in Austria." *Agricultural and Forest Meteorology* 104:255-271.

Thornton, P.E. and S.W. Running (1999) "An Improved Algorithm for Estimating Incident Daily Solar Radiation from Measurements of Temperature, Humidity, and Precipitation." *Agriculture and Forest Meteorology*. 93: 211-228.

Thornton, P.E., S.W. Running, and M.A. White (1997) "Generating Surfaces of Daily Meteorology Variables Over Large Regions of Complex Terrain." *Journal of Hydrology*. 190:214-251.

TVA (1991 through 1992a, 1993 through 1994) *Commercial Fertilizers*. Tennessee Valley Authority, Muscle Shoals, AL.

TVA (1992b) *Fertilizer Summary Data 1992*. Tennessee Valley Authority, Muscle Shoals, AL.

USDA (2010a) *Crop Production 2009 Summary*, National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, Washington, DC. Available online at <http://usda.mannlib.cornell.edu>.

USDA (2010b) Quick Stats: U.S. & All States Data - Crops. National Agricultural Statistics Service, U.S. Department of Agriculture. Washington, DC. U.S. Department of Agriculture, National Agricultural Statistics Service. Washington, D.C., Available online at <http://quickstats.nass.usda.gov/>.

USDA (2007) *Census of Agriculture*, National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, Washington, DC.

USDA (2003, 2005 through 2006, 2008 through 2009) *Crop Production Summary*, National Agricultural Statistics Service, Agricultural Statistics Board, U.S. Department of Agriculture, Washington, DC. Available online at <http://usda.mannlib.cornell.edu>.

USDA (2000a) *1997 National Resources Inventory*. National Agricultural Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://www.nrcs.usda.gov/technical/NRI/>.

USDA (2000b) *Agricultural Statistics 2000*. National Agricultural Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://www.usda.gov/nass/pubs/agstats.htm>.

USDA (1998) *Field Crops Final Estimates 1992-1997*. Statistical Bulletin Number 947a. National Agricultural Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://usda.mannlib.cornell.edu>. Accessed July 2001.

USDA (1996) *Agricultural Waste Management Field Handbook, National Engineering Handbook (NEH)*, Part 651. Natural Resources Conservation Service, U.S. Department of Agriculture. July 1996.

USDA (1994) *Field Crops: Final Estimates, 1987-1992*. Statistical Bulletin Number 896, National Agriculture Statistics Service, U.S. Department of Agriculture. Washington, DC. Available online at <http://usda.mannlib.cornell.edu/data-sets/crops/94896/sb896.txt>.

USDA (1966) *Consumption of Commercial Fertilizers and Primary Plant Nutrients in the United States, 1850-1964 and By States, 1945-1964*. Statistical Bulletin Number 375, Statistical Reporting Service, U.S. Department of Agriculture.

USDA (1957) *Fertilizer Used on Crops and Pastures in the United States—1954 Estimates*. Statistical Bulletin Number 216, Agricultural Research Service, U.S. Department of Agriculture.

USDA (1954) *Fertilizer Use and Crop Yields in the United States*. Agricultural Handbook Number 68, the Fertilizer

Work Group, U.S. Department of Agriculture.

USDA (1946) *Fertilizers and Lime in the United States*. Miscellaneous Publication Number 586, U.S. Department of Agriculture.

VEMAP (1995) Members (J.M. Melillo, J. Borchers, J. Chaney, H. Fisher, S. Fox, A. Haxeltine, A. Janetos, D.W. Kicklighter, T.G.F. Kittel, A.D. McGuire, R. McKeown, R. Neilson, R. Nemani, D.S. Ojima, T. Painter, Y. Pan, W.J. Parton, L. Pierce, L. Pitelka, C. Prentice, B. Rizzo, N.A. Rosenbloom, S. Running, D.S. Schimel, S. Sitch, T. Smith, I. Woodward). "Vegetation/Ecosystem Modeling and Analysis Project (VEMAP): Comparing Biogeography and Biogeochemistry Models in a Continental-Scale Study of Terrestrial Ecosystem Responses to Climate Change and CO_2 Doubling." *Global Biogeochemical Cycles*, 9:407-437.

Vogelman, J.E., S.M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel (2001) "Completion of the 1990's National Land Cover Data Set for the conterminous United States." *Photogrammetric Engineering and Remote Sensing*, 67:650-662.

Warren J.A. (1911) *Agriculture in the Central Part of the Semiarid Portion of the Great Plains*. Bulletin Number 215, Bureau of Plant Industry, U.S. Department of Agriculture.

Williams, S.A. (2006) Data compiled for the Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGS) from an unpublished manuscript. Natural Resource Ecology Laboratory, Colorado State University.

Wisconsin Department of Natural Resources (1993) *Wisconsin Greenhouse Gas Emissions: Estimates for 1990*. Bureau of Air Management, Wisconsin Department of Natural Resources, Madison, WI.

Field Burning of Agricultural Residues

Anderson, M. (2008 through 2011) Email correspondence. Monte Anderson, Oklahoma Farm Service Agency and ICF International. July 12, 2010.

Ashman (2008) Email communication. Janet Ashman, Hawaii Agriculture Research Center and Victoria Thompson, ICF International. Ms. Ashman cited an August 2004 report prepared for the U.S. Dept. of Energy by the Hawaiian Commercial & Sugar Co., "Closed-Loop Biomass Co-Firing--Pilot-Scale and Full-Scale Test Results."

Barnard, G., and L. Kristoferson (1985) *Agricultural Residues as Fuel in the Third World*. Earthscan Energy Information Programme and the Beijer Institute of the Royal Swedish Academy of Sciences. London, England.

Cantens, G. (2004 through 2005) Personal Communication. Janet Lewis, Assistant to Gaston Cantens, Vice President of Corporate Relations, Florida Crystals Company and ICF International.

Cibrowski, P. (1996) Personal Communication. Peter Cibrowski, Minnesota Pollution Control Agency and Heike Mainhardt, ICF Incorporated. July 29, 1996.

Deren, C. (2002) Personal communication. Dr. Chris Deren, Everglades Research and Education Centre at the University of Florida and Caren Mintz, ICF International. August 15, 2002.

EPA (1994) *International Anthropogenic Methane Emissions: Estimates for 1990, Report to Congress.* EPA 230-R-93-010. Office of Policy Planning and Evaluation, U.S. Environmental Protection Agency, Washington, DC.

EPA (1992) *Prescribed Burning Background Document and Technical Information Document for Prescribed Burning Best Available Control Measures.* Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, NC. EPA-450/2-92-003.

Gonzalez, R. (2007 through 2011) Email correspondence. Rene Gonzalez, Plant Manager, Sem-Chi Rice Company and ICF International.

Guethle, D. (2007-2010) Email correspondence. David Guethle, Agronomy Specialist, Missouri Cooperative Extension Service and Sarah Menassian, ICF International. July 20, 2009.

Huang, Y., W. Zhang, W. Sun, and X. Zheng (2007) "Net Primary Production of Chinese Croplands from 1950 to 1999." *Ecological Applications*, 17(3):692-701.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories.* The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme, Montreal, IPCC-XVI/Doc. 10 (1.IV.2000). May 2000.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.* Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency, Paris, France.

Jenkins, B.M., S.Q. Turn, and R.B. Williams (1992) "Atmospheric emissions from agricultural burning in California: determination of burn fractions, distribution factors, and crop specific contributions." *Agriculture, Ecosystems and Environment* 38:313-330.

Kinoshita, C.M. (1988) "Composition and processing of burned and unburned cane in Hawaii." *Intl. Sugar Jnl.* 90:1070, 34-37.

Kirstein, A. (2003 through 2004) Personal Communication. Arthur Kirstein, Coordinator, Agricultural Economic Development Program, Palm Beach County Cooperative Extension Service, Florida and ICF International.

Lachnicht, S.L., P.F. Hendrix, R.L. Potter, D.C. Coleman, and D.A. Crossley Jr. (2004) "Winter decomposition of transgenic cotton residue in conventional-till and no-till systems." *Applied Soil Ecology*, 27:135-142.

Lee, D. (2003 through 2007) Email correspondence. Danny Lee, OK Farm Service Agency and ICF International.

McCarty, J.L. (2010) Agricultural Residue Burning in the Contiguous United States by Crop Type and State. Geographic Information Systems (GIS) Data provided to the EPA Climate Change Division by George Pouliot, Atmospheric Modeling and Analysis Division, EPA. Dr. McCarty's research was supported by the NRI Air Quality Program of the Cooperative State Research, Education, and Extension Service, USDA, under Agreement No. 20063511216669 and the NASA Earth System Science Fellowship.

McCarty, J.L. (2009) *Seasonal and Interannual Variability of Emissions from Crop Residue Burning in the Contiguous United States.* Dissertation. University of Maryland, College Park.

Schueneman, T. (1999-2001) Personal Communication. Tom Schueneman, Agricultural Extension Agent, Palm Beach County, FL and ICF International. July 30, 2001.

Schueneman, T.J. and C.W. Deren (2002) "An Overview of the Florida Rice Industry." SS-AGR-77, Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Revised November 2002.

Strehler, A., and W. Stützle (1987) "Biomass Residues." In Hall, D.O. and Overend, R.P. (eds.) *Biomass*. John Wiley and Sons, Ltd. Chichester, UK.

Turn, S.Q., B.M. Jenkins, J.C. Chow, L.C. Pritchett, D. Campbell, T. Cahill, and S.A. Whalen (1997) "Elemental characterization of particulate matter emitted from biomass burning: Wind tunnel derived source profiles for herbaceous and wood fuels." *Journal of Geophysical Research* 102(D3):3683-3699.

USDA (2011) Quick Stats: U.S. & All States Data; Crops; Production and Area Harvested; 1990 - 2010. National Agricultural Statistics Service, U.S. Department of Agriculture. Washington, DC. U.S. Department of Agriculture, National Agricultural Statistics Service. Washington, D.C., Available online at <http://quickstats.nass.usda.gov/>.

Walker, T. (2008) Email correspondence. Tim Walker, Assistant Research Professor, Mississippi State University Delta Branch Exp. Station and Sarah Menassian, ICF International. July 25, 2008.

Land Use, Land-Use Change, and Forestry

IPCC (2003) *Good Practice Guidance for Land Use, Land-Use Change, and Forestry*. The Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme, J. Penman, et al., eds. August 13, 2004. Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

Representation of the U.S. Land Base

Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and J. Wickham. (2011) Completion of the 2006 National Land Cover Database for the Conterminous United States, *PE&RS*, Vol. 77(9):858-864.

Homer, C., J. Dewitz, J. Fry, M. Coan, N. Hossain, C. Larson, N. Herold, A. McKerrow, J.N. VanDriel and J. Wickham. 2007. Completion of the 2001 National Land Cover Database for the Conterminous United States, Photogrammetric Engineering and Remote Sensing, Vol. 73, No. 4, pp 337-341.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

National Atlas (2005) *Federal Lands of the United States*. National Atlas of the United States, U.S. Department of the Interior, Washington DC. Available online at <http://nationalatlas.gov/atlasftp.html?openChapters=chpbound#chpbound>.

Nusser, S.M. and J.J. Goebel (1997) "The national resources inventory: a long-term multi-resource monitoring programme." *Environmental and Ecological Statistics* 4:181-204.

Smith, W.B., P.D. Miles, C.H. Perry, and S.A. Pugh (2009) *Forest Resources of the United States, 2007*. Gen. Tech. Rep. WO-78. U.S. Department of Agriculture Forest Service, Washington, DC.

U.S. Census Bureau (2010) Topologically Integrated Geographic Encoding and Referencing (TIGER) system shapefiles. U.S. Census Bureau, Washington, DC. Available online at <http://www.census.gov/geo/www/tiger>.

Forest Land Remaining Forest Land: Changes in Forest Carbon Stocks

AF&PA. (2006a and earlier) Statistical roundup. (Monthly). Washington, DC: American Forest & Paper Association.

AF&PA. (2006b and earlier) Statistics of paper, paperboard and wood pulp. Washington, DC: American Forest & Paper Association.

Amichev, B. Y. and J. M. Galbraith (2004) "A Revised Methodology for Estimation of Forest Soil Carbon from Spatial Soils and Forest Inventory Data Sets." *Environmental Management* 33(Suppl. 1):S74-S86.

Barlaz, M.A. (1998) "Carbon storage during biodegradation of municipal solid waste components in laboratory-scale landfills." *Global Biogeochemical Cycles* 12 (2):373-380.

Bechtold, W.A.; Patterson, P.L. (2005) The enhanced forest inventory and analysis program—national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: US Department of Agriculture Forest Service, Southern Research Station. 85 p.

Birdsey, R.A., and L.S. Heath (1995) "Carbon Changes in U.S. Forests." In *Productivity of America's Forests and Climate Change*. Gen. Tech. Rep. RM-271. Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture. Fort Collins, CO, 56-70.

Birdsey, R. (1996) "Carbon Storage for Major Forest Types and Regions in the Conterminous United States." In R.N. Sampson and D. Hair, (eds); *Forest and Global Change, Volume 2: Forest Management Opportunities for Mitigating Carbon Emissions*. American Forests. Washington, DC, 1-26 and 261-379 (appendices 262 and 263).

Birdsey, R., and L. S. Heath (2001) "Forest Inventory Data, Models, and Assumptions for Monitoring Carbon Flux." In *Soil Carbon Sequestration and the Greenhouse Effect*. Soil Science Society of America. Madison, WI, 125-135.

Birdsey, R. A., and G. M. Lewis (2003) "Current and Historical Trends in Use, Management, and Disturbance of U.S. Forestlands." In J. M. Kimble, L. S. Heath, R. A. Birdsey, and R. Lal, editors. *The Potential of U.S. Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect*. CRC Press, New York, 15-34.

Domke, G.M., J.E. Smith, and C.W. Woodall. (2011) Accounting for density reduction and structural loss in standing dead trees: Implications for forest biomass and carbon stock estimates in the United States. *Carbon Balance and Management*. 6:14.

Eleazer, W.E., W.S. Odle, III, Y.S. Wang, and M.A. Barlaz (1997) "Biodegradability of municipal solid waste components in laboratory-scale landfills." *Env. Sci. Tech*. 31(3):911-917.

EPA (2010) *Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990–2008*. EPA, Office of Atmospheric Programs. Washington, DC.

EPA (2006) *Municipal solid waste in the United States: 2005 Facts and figures*. Office of Solid Waste, U.S.

Environmental Protection Agency. Washington, DC. (5306P) EPA530-R-06-011. Available online at <http://www.epa.gov/msw/msw99.htm>.

Frayer, W.E., and G.M. Furnival (1999) "Forest Survey Sampling Designs: A History." *Journal of Forestry* 97(12): 4-10.

Freed, R. (2004) Open-dump and Landfill timeline spreadsheet (unpublished). ICF International. Washington, DC.

Hair. D. and A.H. Ulrich (1963) The Demand and price situation for forest products – 1963. U.S. Department of Agriculture Forest Service, Misc Publication No. 953. Washington, DC.

Hair, D. (1958) "Historical forestry statistics of the United States." Statistical Bull. 228. U.S. Department of Agriculture Forest Service, Washington, DC.

Harmon, M.E., C.W. Woodall, B. Fasth, J. Sexton, M. Yatkov. (2011) Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Paper. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

Heath, L. (2007) Email communication between Kim Klunich, EPA, and Linda Heath, U.S. Forest Service. November 9, 2007.

Heath, L.S. (2006a) Email correspondence. Linda Heath, U.S. Department of Agriculture Forest Service and Kimberly Klunich, U.S. Environmental Protection Agency regarding the 95 percent CI for forest area estimates (± 0.24%) and average carbon density for Lower 48 States (± 0.4%). October 26, 2006.

Heath, L.S. (2006b) Email correspondence. Linda Heath, U.S. Department of Agriculture Forest Service and Kimberly Klunich, U.S. Environmental Protection Agency regarding the 95 percent CI for average carbon density for Alaska (±1.2%). October 27, 2006.

Heath, L.S., J.E., Smith, and R.A. Birdsey (2003) Carbon Trends in U. S. Forestlands: A Context for the Role of Soils in Forest Carbon Sequestration. In J. M. Kimble, L. S. Heath, R. A. Birdsey, and R. Lal, editors. *The Potential of U. S. Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect*. Lewis Publishers (CRC Press). Boca Raton, FL, 35-45.

Heath, L. S., and J.E. Smith (2000) "Soil Carbon Accounting and Assumptions for Forestry and Forest-related Land Use Change." In *The Impact of Climate Change on America's Forests.* Joyce, L.A., and Birdsey, R.A. Gen. Tech. Rep. RMRS-59. Rocky Mountain Research Station, Forest Service, U.S. Department of Agriculture. Fort Collins, CO, 89-101.

Heath, L. S., J. E. Smith, C. W. Woodall, D. L. Azuma, and K. L. Waddell (2011) Carbon stocks on forestlands of the United States, with emphasis on USDA Forest Service ownership. *Ecosphere* 2(1), article 6, 21 p.

Howard, James L. (2003) *U.S. timber production, trade, consumption, and price statistics 1965 to 2002*. Res. Pap. FPL-RP-615. Madison, WI: USDA, Forest Service, Forest Products Laboratory. Available online at <http://www.fpl.fs.fed.us/documnts/fplrp/fplrp615/fplrp615.pdf>.

Howard, James L. (2007) *U.S. timber production, trade, consumption, and price statistics 1965 to 2005*. Res. Pap. FPL-RP-637. Madison, WI: USDA, Forest Service, Forest Products Laboratory.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2003) *Good Practice Guidance for Land Use, Land-Use Change, and Forestry*. The Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme, J. Penman, et al., eds. August 13, 2004. Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Jenkins, J.C., D.C. Chojnacky, L.S. Heath, and R.A. Birdsey (2003) "National-scale biomass estimators for United States tree species." *Forest Science* 49(1):12-35.

Johnson, D. W., and P. S. Curtis (2001) "Effects of Forest Management on Soil C and N Storage: Meta Analysis." *Forest Ecology and Management* 140:227-238.

Melosi, M. (2000) *The Sanitary City*. Johns Hopkins University Press. Baltimore, MD.

Melosi, M. (1981) *Garbage in The Cities: Refuse Reform and the Environment: 1880-1980*. Texas A&M Press.

Micales, J.A. and K.E. Skog (1997) "The decomposition of forest products in landfills." *International Biodeterioration & Biodegradation*. 39(2-3):145-158.

National Association of State Foresters (2007a) State Forestry Statistics 1998 Report. Available online at <http://www.stateforesters.org/statistics/FY98_Statistics/Resource%20Base.htm>. March 2008.

National Association of State Foresters (2007b) State Forestry Statistics 2002 Report. Available online at <http://www.stateforesters.org/statistics/FY02_Statistics/2002%20Stat%20Resource%20Base.pdf>. March 2008.

National Association of State Foresters (2007c) State Forestry Statistics 2004 Report. Available online at <http://www.stateforesters.org/statistics/FY04_Statistics/FY2004Statistics.pdf>. March 2008.

Perry, C.H., C.W. Woodall, and M. Schoeneberger (2005) Inventorying trees in agricultural landscapes: towards an accounting of "working trees". In: "Moving Agroforestry into the Mainstream." *Proc. 9th N. Am. Agroforestry Conf*., Brooks, K.N. and Ffolliott, P.F. (eds). 12-15 June 2005, Rochester, MN [CD-ROM]. Dept. of Forest Resources, Univ. Minnesota, St. Paul, MN, 12 p. Available online at <http://cinram.umn.edu/afta2005/>. (verified 23 Sept 2006).

Phillips, D.L., S.L. Brown, P.E. Schroeder, and R.A. Birdsey (2000) "Toward Error Analysis of Large-Scale Forest Carbon Budgets." *Global Ecology and Biogeography* 9:305-313.

Skog, K.E., and G.A. Nicholson (1998) "Carbon Cycling Through Wood Products: The Role of Wood and Paper Products in Carbon Sequestration." *Forest Products Journal* 48:75-83.

Skog, K.E., K. Pingoud, and J.E. Smith (2004) "A method countries can use to estimate changes in carbon stored in harvested wood products and the uncertainty of such estimates." *Environmental Management* 33(Suppl. 1):S65-S73.

Skog, K.E. (2008) "Sequestration of carbon in harvested wood products for the United States." *Forest Products Journal* 58:56-72.

Smith, J.E., and L.S. Heath (2002) "A model of forest floor carbon mass for United States forest types." Res. Paper NE-722. USDA Forest Service, Northeastern Research Station, Newtown Square, PA.

Smith, J.E., and L.S.Heath (2010) "Exploring the assumed invariance of implied emission factors for forest biomass in greenhouse gas inventories." *Environmental Science & Policy* 13:55-62.

Smith, J. E., L. S. Heath, and J. C. Jenkins (2003) *Forest Volume-to-Biomass Models and Estimates of Mass for Live and Standing Dead Trees of U.S. Forests.* General Technical Report NE-298, USDA Forest Service, Northeastern Research Station, Newtown Square, PA.

Smith, J. E., L. S. Heath, and P. B. Woodbury (2004) "How to estimate forest carbon for large areas from inventory data." *Journal of Forestry* 102:25-31.

Smith, W. B., P. D. Miles, C. H. Perry, and S. A. Pugh (2009) *Forest Resources of the United States, 2007*. General Technical Report WO-78, U.S. Department of Agriculture Forest Service, Washington Office.

Smith, J.E., L.S. Heath, and M.C. Nichols (2010) U.S. Forest Carbon Calculation Tool User's Guide: Forestland Carbon Stocks and Net Annual Stock Change. General Technical Report NRS-13 revised, U.S. Department of Agriculture Forest Service, Northern Research Station, 34p.

Steer, Henry B. (1948) *Lumber production in the United States*. Misc. Pub. 669, U.S. Department of Agriculture Forest Service. Washington, DC.

Ulrich, Alice (1985) *U.S. Timber Production, Trade, Consumption, and Price Statistics 1950-1985*. Misc. Pub. 1453, U.S. Department of Agriculture Forest Service. Washington, DC.

Ulrich, A.H. (1989) *U.S. Timber Production, Trade, Consumption, and Price Statistics, 1950-1987*. USDA Miscellaneous Publication No. 1471, U.S. Department of Agriculture Forest Service. Washington, DC, 77.

USDC Bureau of Census (1976) *Historical Statistics of the United States, Colonial Times to 1970, Vol. 1*. Washington, DC.

USDA Forest Service (2011a) Forest Inventory and Analysis National Program: User Information. U.S. Department of Agriculture Forest Service. Washington, DC. Available online at <http://fia.fs.fed.us/tools-data/docs/default.asp>. Accessed 16 November 2011.

USDA Forest Service. (2011b) Forest Inventory and Analysis National Program: FIA Data Mart. U.S. Department of Agriculture Forest Service. Washington, DC. Available online at <http://apps.fs.fed.us/fiadb-downloads/datamart.html>. Accessed 16 November 2011.

USDA Forest Service. (2011c) Forest Inventory and Analysis National Program, FIA library: Field Guides, Methods and Procedures. U.S. Department of Agriculture Forest Service. Washington, DC. Available online at <http://www.fia.fs.fed.us/library/field-guides-methods-proc/>. Accessed 16 November 2011.

USDA Forest Service (2011d) Forest Inventory and Analysis National Program, FIA library: Database Documentation. U.S. Department of Agriculture, Forest Service, Washington Office. Available online at < http://fia.fs.fed.us/library/database-documentation/ >. Accessed 16 November 2011.

USDA Forest Service (2008) Forest Inventory and Analysis National Program, FIA library: Database Documentation. U.S. Department of Agriculture, Forest Service, Washington Office. Available online at < http://www.fia.fs.fed.us/library/database-documentation/ >. Accessed 15 December 2009.

USDA Forest Service (1992) "1984-1990 Wildfire Statistics." Prepared by State and Private Forestry Fire and Aviation Management Staff. Facsimile from Helene Cleveland, USDA Forest Service, to ICF International. January 30, 2008.

USDA (1991) *State Soil Geographic (STATSG0) Data Base Data use information*. Miscellaneous Publication Number 1492, National Soil Survey Center, Natural Resources Conservation Service, U.S. Department of Agriculture, Fort Worth, TX.

Waddell, K., and B. Hiserote. 2005. The PNW-FIA Integrated Database User Guide: A database of forest inventory information for California, Oregon, and Washington. Forest Inventory and Analysis Program, Pacific Northwest Research Station, Portland, Oregon, USA.Woodall, C.W., Amacher, M.C., Bechtold, W.A., Coulston, J.W., Jovan, S., Perry, C.H., Randolph, K.C., Schulz, B.K., Smith, G.C., Tkacz, B, and Will-Wolf, S. (2011) "Status and future of the forest health indicators program of the USA" *Environmental Monitoring and Assessment*, 177:419-436.

Woodall, C.W., L.S. Heath, G.M. Domke, and M.C. Nichols. (2011a) Methods and equations for estimating aboveground volume, biomass, and carbon for trees in the U.S. forest inventory, 2010. Gen. Tech. Rep. NRS-88. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 30 p.

Woodall, C.W., Domke, G.M., MacFarlane, D.W., Oswalt, C.M. (In Press) Comparing Field- and Model-Based Standing Dead Tree Carbon Stock Estimates Across Forests of the United States. *Forestry*.

Woodall, C.W., Amacher, M.C., Bechtold, W.A., Coulston, J.W., Jovan, S., Perry, C.H., Randolph, K.C., Schulz, B.K., Smith, G.C., Tkacz, B., Will-Wolf, S. (2011b) Status and future of the forest health indicators program of the United States. *Environmental Monitoring and Assessment*. 177: 419-436.

Woodbury, P.B., Heath, L.S., and Smith, J.E. (2006) "Land Use Change Effects on Forest Carbon Cycling Throughout the Southern United States." *Journal of Environmental Quality*, 35:1348-1363.

Woodbury, P.B., L.S. Heath, and J.E. Smith (2007) Effects of land use change on soil carbon cycling in the conterminous United States from 1900 to 2050, *Global Biogeochem. Cycles*, 21, GB3006, doi:10.1029/2007GB002950.

Woudenberg, S.W.; Conkling, B.L.; O'Connell, B.M.; LaPoint, E.B.; Turner, J.A.; Waddell, K.L. (2010) The Forest Inventory and Analysis Database: Database description and users manual version 4.0 for Phase 2. Gen. Tech. Rep. RMRS-GTR- 245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 339.

Forest Land Remaining Forest Land: Non-CO_2 Emissions from Forest Fires

Alaska Department of Natural Resources (2008) Division of Forestry. "Fire Statistics." Available online at <http://forestry.alaska.gov/firestats/>. October 2008.

Alaska Interagency Coordination Center (AICC) (2011) "2010 Fire Season Statistics." Available online at <http://fire.ak.blm.gov/content/aicc/stats/2010.pdf>.

Heath, L. (2008) Phone communication between Kim Klunich, EPA, and Linda Heath, U.S. Forest Service. November 24, 2008.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2003) *Good Practice Guidance for Land Use, Land-Use Change, and Forestry*. The Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme, J. Penman, et al., eds. August 13, 2004. Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

National Association of State Foresters (1998) State Forestry Statistics 1998 Report. Available online at <http://www.stateforesters.org/files/1998ResourceBase.pdf >. October 2008.

National Association of State Foresters (2002) State Forestry Statistics 2002 Report. Available online at <http://www.stateforesters.org/files/2002_20Stat_20Resource_20Base.pdf >. October 2008.

National Association of State Foresters (2004) State Forestry Statistics 2004 Report. Available online at <http://www.stateforesters.org/files/FY2004Statistics.pdf >. October 2008.

National Association of State Foresters (2008) State Forestry Statistics 2006 Report. Available online at <http://www.stateforesters.org/files/2006%20State%20Forestry%20Statistics-Web-Final.pdf>. February 2009.

National Association of State Foresters (2011) State Forestry Statistics Spreadsheet. Available online at <http://www.stateforesters.org/publication-type/stats>. November 2011.

National Interagency Fire Center (2011) "Fire Information—Wildland Fire Statistics. Total Wildland Fires and Acres (1960-2009)." Available online at <http://www.nifc.gov/fireInfo/fireInfo_statistics.html >. November 2011.

Smith, J. (2009) E-mail correspondence between Jean Kim, ICF, and Jim Smith, U.S. Forest Service, January 30, 2009.

Smith, J. (2008a) E-mail correspondence between Jean Kim, ICF, and Jim Smith, U.S. Forest Service, December 3, 2008.

Smith, J. (2008b) E-mail correspondence between Jean Kim, ICF, and Jim Smith, U.S. Forest Service, December 8, 2008.

Smith, J. (2008c) E-mail correspondence between Jean Kim, ICF, and Jim Smith, U.S. Forest Service, December 16, 2008.

USDA Forest Service (2010a) Forest Inventory and Analysis National Program: User Information. U.S. Department of Agriculture Forest Service. Washington, DC. Available online at <http://fia.fs.fed.us/tools-data/docs/default.asp>. Accessed 07 October 2010.

USDA Forest Service. (2010b) Forest Inventory and Analysis National Program: FIA Data Mart. U.S. Department of Agriculture Forest Service. Washington, DC. Available online at <http://199.128.173.17/fiadb4-downloads/datamart.html>. Accessed 07 October 2010.

USDA Forest Service. (2010c) Forest Inventory and Analysis National Program, FIA library: Field Guides, Methods and Procedures. U.S. Department of Agriculture Forest Service. Washington, DC. Available online at <http://www.fia.fs.fed.us/library/field-guides-methods-proc/>. Accessed 07 October 2010.

USDA Forest Service (2010d) Forest Inventory and Analysis National Program, FIA library: Database Documentation. U.S. Department of Agriculture, Forest Service, Washington Office. Available online at < http://fia.fs.fed.us/library/database-documentation/>. Accessed 07 October 2010.

USDA Forest Service (1992) "1984-1990 Wildfire Statistics." Prepared by State and Private Forestry Fire and Aviation Management Staff. Facsimile from Helene Cleveland, USDA Forest Service, to ICF International. January 30, 2008.

Forest Land Remaining Forest Land: N_2O Fluxes from Soils

Albaugh, T.J., Allen, H.L., Fox, T.R. (2007) Historical Patterns of Forest Fertilization in the Southeastern United States from 1969 to 2004. Southern Journal of Applied Forestry, 31, 129-137(9).

Binkley, D. (2004) Email correspondence regarding the 95% CI for area estimates of southern pine plantations receiving N fertilizer (±20%) and the rate applied for areas receiving N fertilizer (100 to 200 pounds/acre). Dan Binkley, Department of Forest, Rangeland, and Watershed Stewardship, Colorado State University and Stephen Del Grosso, Natural Resource Ecology Laboratory, Colorado State University. September 19, 2004.

Binkley, D., R. Carter, and H.L. Allen (1995) Nitrogen Fertilization Practices in Forestry. In: *Nitrogen Fertilization in the Environment*, P.E. Bacon (ed.), Marcel Decker, Inc., New York.

Briggs, D. (2007) *Management Practices on Pacific Northwest West-Side Industrial Forest Lands, 1991-2005: With Projections to 2010*. Stand Management Cooperative, SMC Working Paper Number 6, College of Forest Resources, University of Washington, Seattle.

Fox, T.R., H. L.Allen, T.J. Albaugh, R. Rubilar, and C.A. Carlson (2007) Tree Nutrition and Forest Fertilization of Pine Plantations in the Southern United States. Southern Journal of Applied Forestry. 31, 5-11.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

USDA Forest Service (2001) *U.S. Forest Facts and Historical Trends*. FS-696. U.S. Department of Agriculture Forest Service, Washington, DC. Available online at <http://www.fia.fs.fed.us/library/ForestFactsMetric.pdf>.

Cropland Remaining Cropland, Land Converted to Cropland, Grassland Remaining Grassland, and Land Converted to Grassland: Changes in Agricultural Soil Carbon Stocks

Allmaras, R.R., H.H. Schomberg, C.L. Douglas, Jr., and T.H. Dao (2000) "Soil organic carbon sequestration potential of adopting conservation tillage in U.S. croplands." *J Soil Water Conserv* 55:365–373.

Armentano, T.V. and J.T.A. Verhoeven (1990) "Biogeochemical Cycles: Global," in B.C. Patten, et al. (eds.); *Wetlands and Shallow Continental Water Bodies*. SPB Academic Publishing. The Hague, the Netherlands, Vol. I, 281-311.

Bastian, R. (2007) Personal Communication. Robert Bastian, Office of Water, U.S. Environmental Protection Agency, Washington, DC and Victoria Thompson, ICF International. July 20, 2007.

Brady, N.C. and R.R. Weil (1999) *The Nature and Properties of Soils*. Prentice Hall. Upper Saddle River, NJ, 881.

CTIC (1998) "1998 Crop Residue Management Executive Summary." Conservation Technology Information Center. West Lafayette, IN.

Daly, C., R.P. Neilson, and D.L. Phillips (1994) "A Statistical-Topographic Model for Mapping Climatological Precipitation Over Mountainous Terrain." *Journal of Applied Meteorology* 33:140-158.

Dean, W. E., and E. Gorham (1998) Magnitude and significance of carbon burial in lakes, reservoirs, and peatlands. Geology 26:535-538.

Easter, M. , S. Williams, and S. Ogle. (2008) Gap-filling NRI data for the Soil C Inventory. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO. Report provided to the U.S. Environmental Protection Agency, Tom Wirth.

Edmonds, L., R. L. Kellogg, B. Kintzer, L. Knight, C. Lander, J. Lemunyon, D. Meyer, D.C. Moffitt, and J. Schaefer (2003) "Costs associated with development and implementation of Comprehensive Nutrient Management Plans." Part I—Nutrient management, land treatment, manure and wastewater handling and storage, and recordkeeping. Natural Resources Conservation Service, U.S. Department of Agriculture. Available online at <http://www.nrcs.usda.gov/technical/land/pubs/cnmp1.html>.

EPA (1999) *Biosolids Generation, Use and Disposal in the United States*. Office of Solid Waste, U.S. Environmental Protection Agency. Available online at <http://biosolids.policy.net/relatives/18941.PDF>.

EPA (1993) Federal Register. Part II. Standards for the Use and Disposal of Sewage Sludge; Final Rules. U.S.

Environmental Protection Agency, 40 CFR Parts 257, 403, and 503.

ERS (1997) Cropping Practices Survey Data—1995. Economic Research Service, United States Department of Agriculture. Available online at <http://www.ers.usda.gov/data/archive/93018/>.

ERS (1988) *Agricultural Resources—Inputs Situation and Outlook Report*. AR-9. Economic Research Service, U.S. Department of Agriculture.

Euliss, N., and R. Gleason (2002) Personal communication regarding wetland restoration factor estimates and restoration activity data. Ned Euliss and Robert Gleason of the U.S. Geological Survey, Jamestown, ND, to Stephen Ogle of the National Resource Ecology Laboratory, Fort Collins, CO. August 2002.

Eve, M. (2001) E-mail correspondence. Marlen Eve, Natural Resources Ecology Laboratory, Colorado State University and Barbara Braatz and Caren Mintz, ICF International. Statistics on U.S. organic soil areas cultivated in 1982, 1992, and 1997, which were extracted from the *1997 National Resources Inventory.* September 21, 2001.

Grant, W.R. and R.D. Krenz (1985) *U. S. grain sorghum production practices and costs*. Staff Report No. AGES 851024. National Economics Division, Economics Research Service, U.S. Department of Agriculture.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2003) *Good Practice Guidance for Land Use, Land-Use Change, and Forestry*. The Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme, J. Penman, et al., eds. August 13, 2004. Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

IPCC/UNEP/OECD/IEA (1997) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency, Paris, France.

Kellogg, R.L., C.H. Lander, D.C. Moffitt, and N. Gollehon (2000) *Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients: Spatial and Temporal Trends for the United States*. U.S. Department of Agriculture, Washington, DC. Publication number nps00-0579.

McFarland, M.J. (2001) *Biosolids Engineering*, New York: McGraw-Hill, p. 2.12.

Metherell, A.K., L.A. Harding, C.V. Cole, and W.J. Parton (1993) "CENTURY Soil Organic Matter Model Environment." Agroecosystem version 4.0. Technical documentation, GPSR Tech. Report No. 4, USDA/ARS, Ft. Collins, CO.

NASS (2004) *Agricultural Chemical Usage: 2003 Field Crops Summary*. Report AgCh1(04)a. National Agricultural Statistics Service, U.S. Department of Agriculture, Washington, DC. Available online at <Hhttp://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agcs0504.pdfH>.

NASS (1999) *Agricultural Chemical Usage: 1998 Field Crops Summary*. Report AgCH1(99). National Agricultural Statistics Service, U.S. Department of Agriculture, Washington, DC. Available online at <http://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agch0599.pdf>.

NASS (1992) *Agricultural Chemical Usage: 1991 Field Crops Summary*. Report AgCh1(92). National Agricultural Statistics Service, U.S. Department of Agriculture, Washington, DC. Available online at <Hhttp://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agch0392.txtH>.

NEBRA (2007) *A National Biosolids Regulation, Quality, End Use & Disposal Survey*. North East Biosolids and Residuals Association, July 21, 2007

NRAES (1992) *On-Farm Composting Handbook* (NRAES-54). Natural Resource, Agriculture, and Engineering Service. Available online at <http://compost.css.cornell.edu/OnFarmHandbook/onfarm_TOC.html>.

NRCS (1999) *Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys, 2nd Edition.* Agricultural Handbook Number 436, Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC.

NRCS (1997) "National Soil Survey Laboratory Characterization Data," Digital Data, Natural Resources

Conservation Service, U.S. Department of Agriculture. Lincoln, NE.

NRCS (1981) *Land Resource Regions and Major Land Resource Areas of the United States*, USDA Agriculture Handbook 296, United States Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Cente., Lincoln, NE, pp. 156.

Nusser, S.M., J.J. Goebel (1997) The national resources inventory: a long term monitoring programme. *Environmental and Ecological Statistics*, **4**, 181-204.

Ogle, S.M., F.J. Breidt, M. Easter, S. Williams, K. Killian, and K. Paustian (2009) "Scale and uncertainty in modeled soil organic carbon stock changes for US croplands using a process-based model." *Global Change Biology*, in press.

Ogle, S.M., F.J. Breidt, M. Easter, S. Williams and K. Paustian. (2007) "Empirically-Based Uncertainty Associated with Modeling Carbon Sequestration Rates in Soils." *Ecological Modeling* 205:453-463.

Ogle, S.M., F.J. Breidt, and K. Paustian. (2006) "Bias and variance in model results due to spatial scaling of measurements for parameterization in regional assessments." *Global Change Biology* 12:516-523.

Ogle, S.M., M.D. Eve, F.J. Breidt, and K. Paustian (2003) "Uncertainty in estimating land use and management impacts on soil organic carbon storage for U.S. agroecosystems between 1982 and 1997." *Global Change Biology* 9:1521-1542.

Ogle, S., M. Eve, M. Sperrow, F.J. Breidt, and K. Paustian (2002) Agricultural Soil C Emissions, 1990-2001: Documentation to Accompany EPA Inventory Tables. Natural Resources Ecology Laboratory, Fort Collins, CO. Provided in an e-mail from Stephen Ogle, NREL to Barbara Braatz, ICF International. September 23, 2002

Parton, W.J., D.S. Schimel, C.V. Cole, D.S. Ojima (1987) "Analysis of factors controlling soil organic matter levels in Great Plains grasslands." *Soil Science Society of America Journal* 51:1173-1179.

Parton, W.J., J.W.B. Stewart, C.V. Cole. (1988) "Dynamics of C, N, P, and S in grassland soils: a model." *Biogeochemistry* 5:109-131.

Parton, W.J., D.S. Ojima, C.V. Cole, and D.S. Schimel (1994) "A General Model for Soil Organic Matter Dynamics: Sensitivity to litter chemistry, texture and management," in *Quantitative Modeling of Soil Forming Processes*. Special Publication 39, Soil Science Society of America, Madison, WI, 147-167.

Potter, C. S., J.T. Randerson, C.B. Fields, P.A. Matson, P.M. Vitousek, H.A. Mooney, and S.A. Klooster. (1993) "Terrestrial ecosystem production: a process model based on global satellite and surface data." *Global Biogeochemical Cycles* 7:811-841.

Reilly, J.M. and K.O. Fuglie. (1998) "Future yield growth in field crops: What evidence exists?" *Soil Till Res* 47:275–290.

USDA-FSA (2010) Conservation Reserve Program Monthly Summary – September 2010. U.S. Department of Agriculture, Farm Service Agency, Washington, DC, Available online at <http://www.fsa.usda.gov/Internet/FSA_File/sep2010crpstat.pdf>.

USDA (1996) *Agricultural Waste Management Field Handbook, National Engineering Handbook (NEH)*, Part 651. Natural Resources Conservation Service, U.S. Department of Agriculture. July 1996.

USDA (1966) *Consumption of Commercial Fertilizers and Primary Plant Nutrients in the United States, 1850-1964 and By States, 1945-1964*. Statistical Bulletin Number 375, Statistical Reporting Service, U.S. Department of Agriculture.

USDA (1957) *Fertilizer Used on Crops and Pastures in the United States—1954 Estimates*. Statistical Bulletin Number 216, Agricultural Research Service, U.S. Department of Agriculture.

USDA (1954) *Fertilizer Use and Crop Yields in the United States*. Agricultural Handbook Number 68, the Fertilizer Work Group, U.S. Department of Agriculture.

USDA-NRCS (2000) *Digital Data And Summary Report: 1997 National Resources Inventory*. Revised December 2000. Resources Inventory Division, Natural Resources Conservation Service, United States Department of Agriculture, Beltsville, MD.

Peatlands Remaining Peatlands: CO_2 and N_2O Emissions from Peatlands Remaining Peatlands

Apodaca, L. (2008) E-mail correspondence. Lori Apodaca, Peat Commodity Specialist, USGS and Emily Rowan, ICF International. October and November.

Apodaca, L. (2011) Email correspondence. Lori Apodaca, Peat Commodity Specialist, USGS and Emily Rowan, ICF International. November.

Cleary, J., N. Roulet and T.R. Moore (2005) "Greenhouse gas emissions from Canadian peat extraction, 1990-2000: A life-cycle analysis." *Ambio* 34:456–461.

Division of Geological & Geophysical Surveys (DGGS), Alaska Department of Natural Resources (1997–2011) *Alaska's Mineral Industry Report (1997–2010).* Alaska Department of Natural Resources, Fairbanks, AK. Available online at <http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=minerals>.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Szumigala, D.J. (2011) Phone conversation. Dr. David Szumigala, Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources and Emily Rowan, ICF International. January 18th, 2011.

Szumigala, D.J. (2008) Phone conversation. Dr. David Szumigala, Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources and Emily Rowan, ICF International. October 17th, 2008.

Szumigala, D.J., R.A. Hughes and L.A. Harbo (2010) *Alaska's Mineral Industry 2009: A Summary.* Division of Geological & Geophysical Surveys, Alaska Department of Natural Resources, Fairbanks, AK. Available online at <http://www.dggs.alaska.gov/webpubs/dggs/ic/text/ic060.PDF>.

United States Geological Survey (USGS) (1996–2011) *Mineral Commodity Summaries: Peat (1996–2010).* United States Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/peat/index.html#myb>.

United States Geological Survey (USGS) (1991–2011) *Minerals Yearbook: Peat (1994–2009).* United States Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/peat/index.html#myb>.

United States Geological Survey (USGS) (2011a) *Mineral Commodity Summaries 2011: Peat.* United States Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/peat/>.

United States Geological Survey (USGS) (2011b) *2009 Minerals Yearbook: Peat [Advance Release]*. United States Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/peat/index.html#myb>.

Liming and Urea

AAPFCO (1995 through 2000a, 2002 through 2011b) *Commercial Fertilizers*. Association of American Plant Food Control Officials. University of Kentucky. Lexington, KY.

AAPFCO (2000b) *1999-2000 Commercial Fertilizers Data, ASCII files.* Available from David Terry, Secretary, AAPFCO.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Itle, Cortney (2009) Email correspondence. Cortney Itle, ERG and Tom Wirth, U.S. Environmental Protection Agency on the amount of urea used in aircraft deicing. January 7, 2009.

Tepordei, Valentin V. (2003b) Personal communication. Valentin Tepordei, U.S. Geological Survey and ICF

Consulting, August 18, 2003.

Tepordei, V.V. (1997 through 2006) "Crushed Stone," In *Minerals Yearbook*. U.S. Department of the Interior/U.S. Geological Survey. Washington, DC. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>.

Tepordei, V.V. (1996) "Crushed Stone," In *Minerals Yearbook 1994*. U.S. Department of the Interior/Bureau of Mines, Washington, DC. Available online at http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>. Accessed August 2000.

Tepordei, V.V. (1995) "Crushed Stone," In *Minerals Yearbook 1993*. U.S. Department of the Interior/Bureau of Mines, Washington, DC. pp. 1107–1147.

Tepordei, V. V. (1994) "Crushed Stone," In *Minerals Yearbook 1992*. U.S. Department of the Interior/Bureau of Mines, Washington, DC. pp. 1279-1303.

Tepordei, V.V. (1993) "Crushed Stone," In *Minerals Yearbook 1991*. U.S. Department of the Interior/Bureau of Mines, Washington, DC. pp. 1469-1511.

Terry, D. (2007) Email correspondence. David Terry, Fertilizer Regulatory program, University of Kentucky and David Berv, ICF International. September 7, 2007.

TVA (1991 through 1994) *Commercial Fertilizers*. Tennessee Valley Authority, Muscle Shoals, AL.

U.S. EPA. (2000) Preliminary Data Summary: Airport Deicing Operations (Revised). EPA-821-R-00-016. August 2000.

USGS (2011) *Mineral Industry Surveys: Crushed Stone and Sand and Gravel in the First Quarter of 2011*, U.S. Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>.

USGS (2010) *Mineral Industry Surveys: Crushed Stone and Sand and Gravel in the First Quarter of 2010*, U.S. Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>.

USGS (2009) *Mineral Industry Surveys: Crushed Stone and Sand and Gravel in the First Quarter of 2009*, U.S. Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>.

USGS (2008) *Mineral Industry Surveys: Crushed Stone and Sand and Gravel in the First Quarter of 2008*, U.S. Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>.

USGS (2007) *Mineral Industry Surveys: Crushed Stone and Sand and Gravel in the First Quarter of 2007*. U.S. Geological Survey, Reston, VA. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>.

West, T.O., and A.C. McBride (2005) "The contribution of agricultural lime to carbon dioxide emissions in the United States: dissolution, transport, and net emissions," *Agricultural Ecosystems & Environment* 108:145-154.

West, Tristram O. (2008) Email correspondence. Tristram West, Environmental Sciences Division, Oak Ridge National Laboratory, U.S. Department of Energy and Nikhil Nadkarni, ICF International on suitability of liming emission factor for the entire United States. June 9, 2008.

Willett, Jason C. (2010) "Crushed Stone," 2008 Minerals Yearbook. U.S. Department of the Interior/U.S. Geological Survey, Washington, D.C. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>. Accessed August 2010.

Willett, J.C. (2010) "Crushed Stone," In *Minerals Yearbook 2009*. U.S. Department of the Interior/U.S. Geological Survey, Washington, DC. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>. Accessed August 2011.

Willett, J.C. (2009) "Crushed Stone," In *Minerals Yearbook 2007*. U.S. Department of the Interior/U.S. Geological Survey, Washington, DC. Available online at

<http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>. Accessed August 2009.

Willett, J.C. (2007a) "Crushed Stone," In *Minerals Yearbook 2005*. U.S. Department of the Interior/U.S. Geological Survey, Washington, DC. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>. Accessed August 2007.

Willett, J.C. (2007b) "Crushed Stone," In *Minerals Yearbook 2006*. U.S. Department of the Interior/U.S. Geological Survey, Washington, DC. Available online at <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/index.html#mis>. Accessed August 2008.

Settlements Remaining Settlements: N_2O Fluxes from Soils

Albaugh, T.J., Allen, H.L., Fox, T.R. (2007) *Historical Patterns of Forest Fertilization in the Southeastern United States from 1969 to 2004*. Southern Journal of Applied Forestry, 31, 129-137(9)

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Ruddy B.C., D.L. Lorenz, and D.K. Mueller (2006) *County-level estimates of nutrient inputs to the land surface of the conterminous United States, 1982-2001*. Scientific Investigations Report 2006-5012. U.S. Department of the Interior.

Settlements Remaining Settlements: Changes in Carbon Stocks in Urban Trees

Arthur, M. (2011) Phone conversation regarding U.S. Census Bureau information on urban areas and geography. Mike Arthur, U.S. Census Bureau, and Nick Devonshire, ICF International. October 6, 2011.

Cairns, M.A., S. Brown, E.H. Helmer, and G.A. Baumgardner (1997) "Root Biomass Allocation in the World's Upland Forests." *Oceologia* 111:1–11.

deVries, R.E. (1987) *A Preliminary Investigation of the Growth and Longevity of Trees in Central Park*. M.S. thesis, Rutgers University, New Brunswick, NJ.

Dwyer, J.F., D.J. Nowak, M.H. Noble, and S.M Sisinni (2000) *Connecting People with Ecosystems in the 21st Century: An Assessment of Our Nation's Urban Forests*. General Technical Report PNW-GTR-490, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Fleming, L.E. (1988) *Growth Estimation of Street Trees in Central New Jersey*. M.S. thesis, Rutgers University, New Brunswick, NJ.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Nowak, D.J., E.J. Greenfield, R.E. Hoehn, E. Lapoint (2012, in preparation) *Carbon Storage and Sequestration by Trees in Urban and Community Areas of the United States.* USDA, Forest Service, Northeastern Research Station, Syracuse, NY.

Nowak, D.J. (2011a) Phone conference regarding Changes in Carbon Stocks in Urban Trees estimation methodology. David Nowak, USDA, Jennifer Jenkins, EPA, and Mark Flugge and Nikhil Nadkarni, ICF International. January 4, 2011.

Nowak, D.J. (2011b) Phone conference regarding Changes in Carbon Stocks in Urban Trees estimation methodology. David Nowak, USDA, Jennifer Jenkins, EPA, and Mark Flugge and Nick Devonshire, ICF International. November 28, 2011.

Nowak, D.J. (2009) E-mail correspondence regarding new data for Chicago's urban forest. David Nowak, USDA Forest Service to Nikhil Nadkarni, ICF International. October 7, 2009.

Nowak, D.J. (2007a) "New York City's Urban Forest." USDA Forest Service. Newtown Square, PA, February 2007.

Nowak, D.J. (2007b) Personal Communication. David Nowak, USDA Forest Service and Susan Asam, ICF International. September 25, 2007.

Nowak, D.J. (2007c) E-mail correspondence regarding revised sequestration values and standard errors for sequestration values. David Nowak, USDA Forest Service to Susan Asam, ICF International. October 31, 2007.

Nowak, D.J. (2002a) E-mail correspondence containing information on possible urban tree carbon and forest carbon overlap. David Nowak, USDA Forest Service to Barbara Braatz, ICF International. January 10, 2002.

Nowak, D.J. (2002b) E-mail correspondence regarding significant digits. David Nowak, USDA Forest Service to Barbara Braatz, ICF International. October 29, 2002.

Nowak, D.J. (1994) "Atmospheric Carbon Dioxide Reduction by Chicago's Urban Forest." In: *Chicago's Urban Forest Ecosystem: Results of the Chicago Urban Forest Climate Project*. E.G. McPherson, D.J. Nowak, and R.A. Rowntree (eds.). General Technical Report NE-186. U.S. Department of Agriculture Forest Service, Radnor, PA. pp. 83–94.

Nowak, D.J. (1986) "Silvics of an Urban Tree Species: Norway Maple (Acer platanoides L.)." M.S. thesis, College of Environmental Science and Forestry, State University of New York, Syracuse, NY.

Nowak, D.J. and D.E. Crane (2002) "Carbon Storage and Sequestration by Urban Trees in the United States." *Environmental Pollution* 116(3):381–389.

Nowak, D.J., D.E. Crane, J.C. Stevens, and M. Ibarra (2002) *Brooklyn's Urban Forest*. General Technical Report NE-290. U.S. Department of Agriculture Forest Service, Newtown Square, PA.

Nowak, D.J., M.H. Noble, S.M. Sisinni, and J.F. Dwyer (2001) "Assessing the U.S. Urban Forest Resource." *Journal of Forestry* 99(3):37–42.

Nowak, D.J., J.T. Walton, L.G. Kaya, and J.F. Dwyer (2005) "The Increasing Influence of Urban Environments on U.S. Forest Management." *Journal of Forestry* 103(8):377–382.

Smith, W.B. and S.R. Shifley (1984) *Diameter Growth, Survival, and Volume Estimates for Trees in Indiana and Illinois*. Research Paper NC-257. North Central Forest Experiment Station, U.S. Department of Agriculture Forest Service, St. Paul, MN.

Other: Changes in Yard Trimming and Food Scrap Carbon Stocks in Landfills

Barlaz, M.A. (2008) "Re: Corrections to Previously Published Carbon Storage Factors." Memorandum to Randall Freed, ICF International. February 28, 2008.

Barlaz, M.A. (2005) "Decomposition of Leaves in Simulated Landfill." Letter report to Randall Freed, ICF Consulting. June 29, 2005.

Barlaz, M.A. (1998) "Carbon Storage during Biodegradation of Municipal Solid Waste Components in Laboratory-Scale Landfills." *Global Biogeochemical Cycles* 12:373–380.

Eleazer, W.E., W.S. Odle, Y. Wang, and M.A. Barlaz (1997) "Biodegradability of Municipal Solid Waste Components in Laboratory-Scale Landfills." *Environmental Science Technology* 31:911–917.

EPA (2011) *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Tables and Figures for 2010*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. Available online at <http://www.epa.gov/osw/nonhaz/municipal/msw99.htm>.

EPA (2006 through 2011) *Municipal Solid Waste in the United States: Facts and Figures*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. Available online at <http://www.epa.gov/osw/nonhaz/municipal/msw99.htm>.

EPA (2005) *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2003*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. Available online at < http://www.epa.gov/osw/nonhaz/municipal/pubs/msw03rpt.pdf>.

EPA (2005a) *Municipal Solid Waste in the United States: 2003 Data Tables*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. Available online at <http://www.epa.gov/osw/nonhaz/municipal/pubs/03data.pdf>.

EPA (2003) *Characterization of Municipal Solid Waste in the United States: 2001 Update.* (Draft.) U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

EPA (1999) *Characterization of Municipal Solid Waste in the United States: 1998 Update*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2003) *Good Practice Guidance for Land Use, Land-Use Change, and Forestry*. The Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme, J. Penman et al. (eds.). Available online at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

Oshins, C. and D. Block (2000) "Feedstock Composition at Composting Sites." *Biocycle* 41(9):31–34.

Schneider, S. (2007, 2008) E-mail correspondence. Shelly Schneider, Franklin Associates, A Division of ERG and Sarah Shapiro, ICF International.

Tchobanoglous, G., H. Theisen, and S.A. Vigil (1993) *Integrated Solid Waste Management, 1st edition*. McGraw-Hill, NY. Cited by Barlaz (1998).Barlaz, M.A. (2008) "Re: Corrections to Previously Published Carbon Storage Factors." Memorandum to Randall Freed, ICF International. February 28, 2008.

Waste

Landfills

40 CFR Part 60, Subpart Cc (2005) Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills, 60.30c--60.36c, Code of Federal Regulations, Title 40. Available online at <http://www.access.gpo.gov/nara/cfr/waisidx_05/40cfr60_05.html>.

40 CFR Part 60, Subpart WWW (2005) Standards of Performance for Municipal Solid Waste Landfills, 60.750--60.759, Code of Federal Regulations, Title 40. Available online at <http://www.access.gpo.gov/nara/cfr/waisidx_05/40cfr60_05.html>.

Barlaz, M.A. (2006) "Forest Products Decomposition in Municipal Solid Waste Landfills." *Waste Management*, 26(4): 321-333.

Barlaz, M.A. (1998) "Carbon Storage During Biodegradation of Municipal Solid Waste Components in Laboratory-scale Landfills." *Global Biogeochemical Cycles*, 12(2): 373-380, June 1998.

BioCycle (2010) "The State of Garbage in America" By L. Arsova, R. Van Haaren, N. Goldstein, S. Kaufman, and N. Themelis. *BioCycle.* December 2010. Available online at <http://www.jgpress.com/archives/_free/002191.html>.

BioCycle (2008) "The State of Garbage in America" By L. Arsova, R. Van Haaren, N. Goldstein, S. Kaufman, and N. Themelis. *BioCycle.* December 2008. Available online at <http://www.jgpress.com/archives/_free/001782.html>.

BioCycle (2006) "15th Annual BioCycle Nationwide Survey: The State of Garbage in America" By P. Simmons, N. Goldstein, S. Kaufman, N. Goldstein, N. Themelis, and J. Thompson. *BioCycle.* April 2006.

Czepiel, P., B. Mosher, P. Crill, and R. Harriss (1996) "Quantifying the Effect of Oxidation on Landfill Methane Emissions." *Journal of Geophysical Research*, 101(D11):16721-16730.

EIA (2007) Voluntary Greenhouse Gas Reports for EIA Form 1605B (Reporting Year 2006). Available online at <ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/>.

EPA (2011) *Landfill Gas-to-Energy Project Database.* Landfill Methane and Outreach Program. July 2011.

EPA (2010) Municipal Solid Waste Generation, Recycling, and Disposal in the United States Detailed Tables and Figures for 2009. December 2010. Available online at <http://www.epa.gov/osw/nonhaz/municipal/pubs/msw2009rpt.pdf >.

EPA (1998) *Compilation of Air Pollution Emission Factors, Publication AP-42*, Section 2.4 Municipal Solid Waste Landfills. November 1998.

EPA (1993) *Anthropogenic Methane Emissions in the United States, Estimates for 1990: Report to Congress*, U.S.

Environmental Protection Agency, Office of Air and Radiation. Washington, DC. EPA/430-R-93-003. April 1993.

EPA (1988) *National Survey of Solid Waste (Municipal) Landfill Facilities*, U.S. Environmental Protection Agency. Washington, DC. EPA/530-SW-88-011. September 1988.

ERG (2011) Production Data Supplied by ERG for 1990-2009 for Pulp and Paper, Fruits and Vegetables, and Meat. August.

ICF International (2009) Updating Component-specific, First-order Decay Rates Used in Estimating *Changes in Yard Trimmings and Food Scrap Carbon Stocks in Landfills* (Deliverable under EPA Contract Number EP-W-07-068, Task Order 054, Task 03). Memorandum to M. Weitz (EPA), November 12, 2009.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2003) *Good Practice Guidance for Land Use*, Land-Use Change and Forestry, The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, J. Penman, M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, K. Miwa, T. Ngara, K. Tanabe, and F. Wagner (eds.). Hayama, Kanagawa, Japan.

Mancinelli, R. and C. McKay (1985) "Methane-Oxidizing Bacteria in Sanitary Landfills." *Proc. First Symposium on Biotechnical Advances in Processing Municipal Wastes for Fuels and Chemicals*, Minneapolis, MN, 437-450. August.

Peer, R., S. Thorneloe, and D. Epperson (1993) "A Comparison of Methods for Estimating Global Methane Emissions from Landfills." *Chemosphere*, 26(1-4):387-400.

RTI (2011) Updated Research on Methane Oxidation in Landfills. Memorandum to R. Schmeltz (EPA), January 14, 2011.

RTI (2004) Documentation for Changes to the Methodology for the Inventory of Methane Emissions from Landfills. Memorandum to E. Scheehle (EPA), August 26, 2004.

Solid Waste Association of North America (SWANA) (1998) *Comparison of Models for Predicting Landfill Methane Recovery*. Publication No. GR-LG 0075. March 1998.

U.S. Bureau of Census (2010) International Database. August 2010. Available online at <http://www.census.gov/ipc/www/idb/>.

Wastewater Treatment

Ahn et al. (2010) N_2O Emissions from Activated Sludge Processes, 2008-2009: Results of a National Monitoring Survey in the United States. Environ. Sci. Technol. 44: 4505-4511.

Aguiar and Bartram (2008) Planned Revisions of the Industrial Wastewater Inventory Emission Estimates for the 1990-2007 Inventory. August 10, 2008.

Beecher et al. (2007) "A National Biosolids Regulation, Quality, End Use & Disposal Survey, Preliminary Report." Northeast Biosolids and Residuals Association, April 14, 2007.

Benyahia, F., M. Abdulkarim, A. Embaby, and M. Rao. (2006) Refinery Wastewater Treatment: A true Technological Challenge. Presented at the Seventh Annual U.A.E. University Research Conference.

CARB (2007) Attachments C TO F - Supplemental Materials Document for Staff Report: Initial Statement of Reasons for Rulemaking, Mandatory Reporting of Greenhouse Gas Emissions Pursuant to the California Global Warming Solutions Act of 2006 (Assembly Bill 32), Attachment E: Technical Attachment on Development of Emissions Reporting Requirements for Oil Refineries and Hydrogen Plants. California Environmental Protection Agency Air Resources Board, dated October 19, 2007, http://www.arb.ca.gov/regact/2007/ghg2007/suppisor.pdf.

Donovan (1996) *Siting an Ethanol Plant in the Northeast*. C.T. Donovan Associates, Inc. Report presented to Northeast Regional Biomass Program (NRBP). (April). Available online at <http://www.nrbp.org/pdfs/pub09.pdf>. Accessed October 2006.

EIA. (2011) Energy Information Administration. U.S. Refinery and Blender Net Production of Crude Oil and

Petroleum Products (Thousand Barrels). Available online at: http://tonto.eia.doe.gov/dnav/pet/hist/mttrpus1a.htm. Accessed: August 2011.

EPA (1974) *Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Apple, Citrus, and Potato Processing Segment of the Canned and Preserved Fruits and Vegetables Point Source Category*. Office of Water, U.S. Environmental Protection Agency, Washington, DC, EPA-440/1-74-027-a. March 1974.

EPA (1975) *Development Document for Interim Final and Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Fruits, Vegetables, and Specialties Segment of the Canned and Preserved Fruits and Vegetables Point Source Category*. United States Environmental Protection Agency, Office of Water. EPA-440/1-75-046. Washington DC, October 1975.

EPA (1992) *Clean Watersheds Needs Survey 1992 – Report to Congress.* Office of Wastewater Management, U.S. Environmental Protection Agency. Washington, DC.

EPA (1993) *Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard Point Source Category*. EPA-821-R-93-019. Office of Water, U.S. Environmental Protection Agency. Washington, DC. October 1993.

EPA (1996) *1996 Clean Water Needs Survey Report to Congress. Assessment of Needs for Publicly Owned Wastewater Treatment Facilities, Correction of Combined Sewer Overflows, and Management of Storm Water and Nonpoint Source Pollution in the United States.* Office of Wastewater Management, U.S. Environmental Protection Agency. Washington, DC. Available online at <http://www.epa.gov/owm/mtb/cwns/1996rtc/toc.htm>. Accessed July 2007.

EPA (1997a) *Estimates of Global Greenhouse Gas Emissions from Industrial and Domestic Wastewater Treatment*. EPA-600/R-97-091. Office of Policy, Planning, and Evaluation, U.S. Environmental Protection Agency. Washington, DC,. September 1997.

EPA (1997b) *Supplemental Technical Development Document for Effluent Guidelines and Standards (Subparts B & E).* EPA-821-R-97-011. Office of Water, U.S. Environmental Protection Agency. Washington, DC. October 1997.

EPA (1998) "AP-42 Compilation of Air Pollutant Emission Factors." Chapter 2.4, Table 2.4-3, page 2.4-13. Available online at <http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf>.

EPA (1999) *Biosolids Generation, Use and Disposal in the United States*. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. Washington, DC, EPA530-R-99-009. September 1999.

EPA (2000) *Clean Watersheds Needs Survey 2000 - Report to Congress*. Office of Wastewater Management, U.S. Environmental Protection Agency. Washington, DC. Available online at <http://www.epa.gov/owm/mtb/cwns/2000rtc/toc.htm>. Accessed July 2007.

EPA (2002) *Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Industry Point Source Category (40 CFR 432)*. EPA-821-B-01-007. Office of Water, U.S. Environmental Protection Agency. Washington, DC,. January 2002.

EPA (2004a) *Clean Watersheds Needs Survey 2004 – Report to Congress.* U.S. Environmental Protection Agency, Office of Wastewater Management. Washington, DC.

EPA (2008) *Municipal Nutrient Removal Technologies Reference Document: Volume 2 – Appendices.* U.S. Environmental Protection Agency, Office of Wastewater Management. Washington, DC.

ERG (2006) Memorandum: Assessment of Greenhouse Gas Emissions from Wastewater Treatment of U.S. Ethanol Production Wastewaters. Prepared for Melissa Weitz, EPA. 10 October 2006.

Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. (2004) *Recommended Standards for Wastewater Facilities (Ten-State Standards)*.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

IPCC (2000) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*,

Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme, Montreal, IPCC-XVI/Doc. 10 (1.IV.2000). May.

Leverenz, H.L., G. Tchobanoglous, and J.L. Darby (2010) "Evaluation of Greenhouse Gas Emissions from Septic Systems". Water Environment Research Foundation, Alexandria, VA.

Lockwood-Post (2002) Lockwood-Post's Directory of Pulp, Paper and Allied Trades, Miller-Freeman Publications. San Francisco, CA.

Merrick (1998) Wastewater Treatment Options for the Biomass-to-Ethanol Process. Report presented to National Renewable Energy Laboratory (NREL). Merrick & Company. Subcontract No. AXE-8-18020-01. October 22, 1998.

Metcalf & Eddy, Inc. (2003) *Wastewater Engineering: Treatment, Disposal and Reuse*, 4th ed. McGraw Hill Publishing.

Metcalf & Eddy, Inc. (1991) *Wastewater Engineering: Treatment, Disposal and Reuse*, 3rd ed. McGraw Hill Publishing.

Nemerow, N.L. and A. Dasgupta (1991) Industrial and Hazardous Waste Treatment. Van Nostrand Reinhold. NY. ISBN 0-442-31934-7.

NRBP (2001) Northeast Regional Biomass Program. *An Ethanol Production Guidebook for Northeast States*. Washington, D.C. (May 3). Available online at <http://www.nrbp.org/pdfs/pub26.pdf>. Accessed October 2006.

Paper 360◦ (2007) "U.S. production rises slightly in December." March 2007. Available online at < http://www.thefreelibrary.com/U.S.+production+rises+slightly+in+December.(The+Pulse)-a0161909243>. Accessed June 2007.

Pulp and Paper (2006) "AF&PA projects more capacity losses this year, small gains in 2007-08." April 2006.

Pulp and Paper (2005) "U.S. paper/board production rises in 2004 to 91.47 million tons." April 2005.

Pulp and Paper (2003-2008) "Month in Statistics." January 2003-September 2008.

Renewable Fuels Association (2011) Historic U.S. Fuel Ethanol Production. Available online at <http://www.ethanolrfa.org/pages/statistics>. Accessed August 2011.

Ruocco (2006a) Email correspondence. Dr. Joe Ruocco, Phoenix Bio-Systems to Sarah Holman, ERG. "Capacity of Bio-Methanators (Dry Milling)." October 6, 2006.

Ruocco (2006b) Email correspondence. Dr. Joe Ruocco, Phoenix Bio-Systems to Sarah Holman ,ERG. "Capacity of Bio-Methanators (Wet Milling)." October 16, 2006.

Scheehle, E.A., and Doorn, M.R. (2001) "Improvements to the U.S. Wastewater Methane and Nitrous Oxide Emissions Estimate." July 2001.

Timm, C.M. (1985) Water use, conservation and wastewater treatment alternatives for oil refineries in New Mexico. NMERDI-2-72-4628.

U.S. Census Bureau (2009) "American Housing Survey." Table 1A-4: Selected Equipment and Plumbing--All Housing Units. From 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, and 2009 reports. Available online at <http://www.census.gov/hhes/www/housing/ahs/nationaldata.html>. Accessed August 2010.

U.S. Census Bureau (2011) International Database. Available online at <http://www.census.gov/ipc/www/idb/> and <http://www.census.gov/ipc/www/idbprint.html>. Accessed August 2011.

USDA (2009) Economic Research Service. U.S. Food Supply: Nutrients and Other Food Components, Per Capita Per Day. Washington DC. Available online at <http://www.ers.usda.gov/Data/FoodConsumption/spreadsheets/ nutrients07.xls#Totals!a1>. Accessed August 2011.

USDA (2011) National Agricultural Statistics Service. Washington, DC. Available online at <http://www.nass.usda.gov/Publications/Ag_Statistics/index.asp> and <http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/>. Accessed August 2011.

USPoultry (2006) Email correspondence. John Starkey, USPOULTRY to D. Bartram, ERG. 30 August 2006.

White and Johnson (2003) White, P.J. and Johnson, L.A. Editors. Corn: Chemistry and Technology. 2nd ed. AACC Monograph Series. American Association of Cereal Chemists. St. Paul, MN.

World Bank (1999) *Pollution Prevention and Abatement Handbook 1998*, Toward Cleaner Production. The International Bank for Reconstruction and Development, The World Bank, Washington, DC. ISBN 0-8213-3638-X.

Composting

EPA (2010) *Municipal Solid Waste in the United States: 2009 Facts and Figures*. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. Available online at <http://www.epa.gov/osw/nonhaz/municipal/pubs/msw2009rpt.pdf>.

EPA (2009) *Municipal Solid Waste in the United States: 2008 Facts and Figures*. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. Available online at <http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm>.

EPA (2008) *Municipal Solid Waste in the United States: 2007 Facts and Figures*. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC. Available online at <http://www.epa.gov/osw/nonhaz/municipal/pubs/msw07-rpt.pdf >.

Franklin Associates (1997) *Characterization of Municipal Solid Waste in the United States: 1996 Update*. Report prepared for the U.S. Environmental Protection Agency, Municipal and Industrial Solid Waste Division by Franklin Associates, Ltd., Prairie Village, KS. EPA530-R-97-015. June 1997.

IPCC (2006) *2006 IPCC Guidelines for National Greenhouse Gas Inventories.* The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

U.S. Census Bureau (2011) Resident Population Data: Population Change. Available online at <http://2010.census.gov/2010census/data/apportionment-pop-text.php>.

Waste Sources of Indirect Greenhouse Gas Emissions

EPA (2010) "2009 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards.

EPA (2009) "1970 - 2008 Average annual emissions, all criteria pollutants in MS Excel." *National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data*. Office of Air Quality Planning and Standards. Available online at <http://www.epa.gov/ttn/chief/trends/index.html>.

EPA (2003) E-mail correspondence containing preliminary ambient air pollutant data. Office of Air Pollution and the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. December 22, 2003.

EPA (1997) *Compilation of Air Pollutant Emission Factors, AP-42*. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, NC. October 1997.