

Comments Received during the Public Review Period on the “Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008.”

Reviewer: Bill Allen

General Comment

Comment: It's cooling and temperatures are below the levels of the 1930s! CO₂ is not causing warming! Collecting data on "greenhouse" emissions is a total waste of tax payer money! CO₂ is required for life to exist on this planet and the more we have the better is for all plant life.

Comment: We don't need to be wasting taxpayer money on collecting data on green house gases! This is a surface temperature measurement for Yemassee, SC and as you can see, temperatures have declined since the 1930s; 1934 is officially the hottest year on record in the US. You should be aware of the "urban heating effect" which causes surface temperatures in urban areas to be warmer due to the effects of human activities. The temperatures in downtown large cities are as much as 8 degrees warmer than the surrounding rural areas! There is absolutely no reason to regulate CO₂!

Comment: The attachment shows how the temperature data shows a warming bias due to the urban heat effect. The first graph shows the temperature much closer to what it really has been, with the hottest years in the 30s. [See Appendix A for additional details.]

**Reviewer: Francis Jeffrey & Janine Gonsenhauser, Circular Sea [TM]
Consultants**

Annex 5: Assessment of the Sources and Sinks of Greenhouse Gas Emissions Excluded

Comment: We wish to point out that in the section, Annex 5 (PDF) (6 pp, 180K) - Assessment of the Sources and Sinks of Greenhouse Gas Emissions Excluded, the treatment of the Ocean in the category of "non-anthropogenic" effects, or as indeterminate, may be very misleading. By our own science-based estimates, the Ocean system provides an annual net sink of about 10Gt [CO₂], of which about 5Gt [CO₂] is recycled into oxygen returned to the atmosphere. The former figure is in positive relationship with (chiefly) the CO₂ concentration of the atmosphere (now around 388 ppm [by volume], versus some 280 ppm pre-industrially). The latter figure (ie, 5Gt.) is in positive relationship with the health and productivity of the ocean, on average, which has declined about 20% over the same time-frame (as quantified by the statistic called "NPP" -- cf: the Panetta and Watkins committees, for assessments of recent decline.) The United States is largest national source of influences upon both Ocean sink figures, the former (directly) via net CO₂ emissions, and the latter (indirectly and inversely) via water pollution; consequently the changes in these statistics are properly anthropogenic effects, which are on the same order of magnitude as the figures themselves, when considered on decadal time-scales. (In addition, decreases and degradations of marine biomass may amount to net and cumulative emissions of greenhouse gasses, and the cumulative absorption of un-recycled CO₂ in the Ocean amounts to

acidification which modifies the physical environment adversely for beneficial biota and carbon-sequestering components [such as the carbonate capsids of some phytoplankton, for example].)

Reviewer: Giles Ragsdale

Executive Summary

Comment: Given the recent contentious events related to climate change data manipulation, exactly how far back and how often is “recent” historical data updated (per the Executive Summary)?

Comment: Overall an increase of 14% is noted in the total US emissions. Has any thought been given to at least noting the rate of CO₂ emissions/Net emissions on a per capita basis year over year in order to provide some context related to the US population increase and whether emissions are trending up or down per capita?

Trends

Comment: A comparison is made between 2007 and 2008. Why is no mention made that the 2008 MTCO₂eq total is also lower than 2005, 2006, as well as 2007 and is the lowest since 2000? Ditto for the totals for Fossil Fuel Combustion and overall Net Emissions, etc. There are circumstances but these trends seems significant and noteworthy.

Reviewer: Bernard Kutter

General Comment

Comment: It is time for America to take responsibility for our actions. America has caused the vast majority of the Worlds atmospheric increase in CO₂ and other green house gasses. The results are already affecting the world in the form of increased ocean acidity killing corals, melting of glaciers, changing weather patterns. We will always have the excuse that reducing our emissions is too hard, that it will cost too much, that the developing world should reduce their emissions. The reality is that America can reduce our emissions while simultaneously enhancing our long term economic prospects. Indigenously produced wind turbines, solar, geothermal and nuclear combined can reduce our emissions to levels well below 1990. Please put strong curbs on the allowed emissions of CO₂ and other green house gases.

Reviewer: Eric Johnson

General Comment

Comment: The U.S. Environmental Protection Agency's work on the 2010 Draft U.S Greenhouse Gas Inventory is excellent. This will provide an important reference for evaluating environmental impacts of greenhouse gas emissions and for identifying priority areas for reducing greenhouse gas emissions. The tables and figures on greenhouse gas emissions by economic sector and trends in greenhouse gas emissions are very useful. This document establishes important benchmarks for comparison with other nations and to evaluate the

effectiveness of future greenhouse gas reduction efforts. Thank you for your detailed work on this document.

Reviewer: Robert Vincin

General Comment

Comment: The point is missed about cause effect solution on climate change. I sat in UNTAD UNFCCC etc assemblies from 1996. I am in PRC lowering CO₂ as invited foreign expert since 2005. Volcanoes emitted mass CO₂e nitrates sulfate for living matter to breath sequester. Emissions from power stations steel-mills are micro volcanoes. The principal climate change issue is mass land use land use clearing desertification and now no working no C4 CO₂ sinks. I am a foreign expert guest in PRC since 2005 lowering CO₂ and in so doing reversing deserts and the mass global cloud, restarting rain cycles. USA Senators are looking in the wrong place. The historians of tomorrow cannot wait until it is their turn 2020-50 as the bees birds micro organism are failing to work. Rain and trace element cycles along with CO₂ cycles have stalled. The Senate should come visit work as a global unit. We need new thinking working practicing delegates at COP16 to detail simple low cost solution BAU We borrowed the Planet from the historians let up put it back in working and balanced order.

Reviewer: Michael Wondsidler

General Comment

Comment: The US GHG Inventory should integrate a systems-based view and include this along with the normal sector-based view. When viewed together, the traditional sector-based view and the systems-based view offer a broader and easier to understand view of US GHG emissions. Both citizens and government representatives can benefit from a systems-based view and find this approach enlightening and educational in formulating choices and political actions to find solutions to counteract climate change.

Comment: Emissions resulting from personal and organizational consumption should be included in the US Greenhouse Gas Inventory. The US Greenhouse Gas Inventory should be state that the inventory is limited to emissions that physically originate within the national borders of the US. It should relate that imports for US consumption creates emissions that are counted in the inventories of other nations. Emissions from US exports are less than those from goods the US imports. Since we must also include the impacts of our consumption, the GHG emissions of the US is higher than suggested by the current IPCC accounting methods. This is really important:

Consumption is the reasons for the emissions, and not including this will give critics of the EPA justification that the US Inventory is not a realistic picture of how much the US contributes to GHG emissions. Also, this encourages businesses and economic value to leave the US for other countries not counted in our inventory.

Comment: Since we need to reduce the current and short term impacts of GHGs, we should also include the US inventory results using both the 100-year and 20-year global warming potentials

(GWPs). This analysis would be helpful to citizens and governmental planners and decision makers.

Reviewer: Peter Schultze, Environmental Programs Analyst, City of Emeryville Public Works Department

General Comment

Comment: Products and consumption of products and their domestic and international GHG related emissions need to be formally addressed in the inventory. It is something sorely lacking in most CAPs including the one developed by me for my jurisdiction.

General Comment

Comment: The views of emissions both by sector and systems analysis need to be presented so that more of the whole picture is understood.

General Comment

Comment: Shorter-term GWPs are illustrative of important issues; such as the differences between methane and CO₂ emissions, for example, and the relation to organic materials in the landfill. A 20 year GWP analysis would be helpful in creating our local policies and should be considered for the document.

Reviewer: Chris Cuomo

General Comment

Comment: My comment is that the public needs to know more about greenhouse gas emissions and other pollution caused by the military, at home and abroad. I therefore request that that information be included in the final report. The fact that the IPCC does not require reporting is irrelevant to the American public's need to know.

Comment: My question is whether you are able to direct me to any sources for [information about greenhouse gas emissions and other pollution caused by the military, at home and abroad].

Reviewer: Bailey Payne, Waste Reduction Coordinator, Marion County Public Works

General Comment

Comment: I've been working with a group called the West Coast Climate Forum which is made up of people working for the EPA, state & local governments. We have been discussing the importance of integrating a system-based view with the traditional sector-based view when it comes to inventorying where green houses come from. Much of the greenhouse gases associated with materials are released when natural resources are extracted or products are manufactured

and this isn't well reflected in the traditional sector-based model. Thank you for your consideration.

Reviewer: Sego Jackson, Principal Planner, Snohomish County Solid Waste Division

General Comment

Comment: The US Inventory should integrate a systems-based or consumption-based view and present it alongside the sector-based view. Even if a detailed analysis is not available, providing text and graphics that demonstrate how an alternate view provides valuable information for policy and program development would be tremendously helpful to the public, stakeholders, policy makers and planners. Coupled with the traditional sector-based view, the systems-based view offers a much more comprehensive perspective on how the US contributes to GHG emissions. At the very least this should be included under "planned improvements" in the waste section. [See Appendix B for additional details.]

Comment: Consumption-related emissions should be formally acknowledged in the US Greenhouse Gas Inventory. The US Greenhouse Gas Inventory should be much more explicit in stating that the inventory is limited to emissions that physically originate within the national borders of the US. It should explain that the US also contributes to emissions that are counted in the inventories of other nations, as a consequence of imports. The emissions associated with US exports are less than those associated with US imports. When viewed from the perspective of consumption, the greenhouse gas impact of the US is higher than suggested by the traditional IPCC accounting standard. This is of great importance: consumption is the root cause of emissions. Until this is clearly explained and addressed, stakeholders, policy makers, and planners will not understand the key overarching strategy of reducing consumption of energy and resources. [See Appendix B for additional details.]

Comment: Please include both 100-year and 20-year global warming potentials (GWPs) in the Inventory. While the Inventory points out that other GWPs are also available it would be more useful to actually include that analysis in the Inventory to assist policymakers, planners, and stakeholders. [See Appendix B for additional details.]

Reviewer: Ralph J. Villani, Esq.

Energy

Comment: Why not use methane gases from coal mines as an energy source instead of scrubbing it into the atmosphere; maybe that might prevent another coal mine disaster and loss of life.

Reviewer: Carey Hamilton, Executive Director, Indiana Recycling Coalition

General Comment

Comment: On behalf of the Indiana Recycling Coalition (IRC), I am writing to encourage the U.S. Environmental Protection Agency to integrate the systems-based view in the U.S. Greenhouse Gas Inventory and present it alongside the traditional sector-based view. EPA recently published a “systems-based view” - see chart, p. 11, of GHG emissions. Coupled with the traditional sector-based view, the systems-based view offers a much more comprehensive perspective on how the US contributes to GHG emissions, in particular in the area of materials management. As a statewide education and advocacy organization the IRC works to advance a more sustainable materials management system, including advocating for stronger waste reduction, reuse, recycling and composting policies, in our state. We find the systems-based view to be very informative and instructional in developing policy actions to advance these efforts while simultaneously addressing climate change. Thank you for the opportunity to comment on this policy-making process. I can be reached at the number below should you have any questions about the IRC's position on this important issue.

Reviewer: Jennifer Dawani, Environmental Scientist, Air and Waste Management Division of U.S. EPA (Region 7)

General Comment

Comment: Adding a systems-based viewpoint on our emissions consistent with OSWERS report - http://www.epa.gov/oswer/docs/ghg_land_and_materials_management.pdf> see chart, p. 11, of GHG emissions. to give a more comprehensive perspective on how the US contributes to GHG emissions. Regardless of data limitations, I sincerely urge you to formally acknowledge consumption-related emissions in the inventory. The inventory should be much more explicit in stating that the inventory is limited to emissions that physically originate within the national borders of the US and acknowledge that the US also contributes to emissions attributed to other nations, as a consequence of our imports. This is important because consumption is the root cause of emissions, that we must at least acknowledge.

Reviewer: Edward A. Mainland, Co-chair of Energy-Climate Committee, Sierra Club California

Landfills

Comment: Methane Emissions from Landfills. Methane emissions are one of the most dangerous near-term emissions problem in the entire GHG picture. Most widely used methods unfortunately may seriously underestimate the problem of methane emissions from landfills. They particular underestimate the near-term emissions (three years) which are most significant. They also underestimate the greenhouse power of these emissions. They underestimate the percentage of GHG emissions caused by landfills. And they miscalculate how much methane can be recovered and used in Landfill Gas To Energy operations and they overly credit the GHG reduction benefit of these operations. EPA's Inventory is the logical place to immediately rectify these analytic and factual shortcomings and misapprehensions. As a separate filing, you will be receiving a recent paper on this problem by Jim Stewart, Sierra Club's Los Angeles Chapter. The need to reduce short-term impacts of GHGs such as landfill methane is imperative. EPA's inventory should present GHG results using both 100-year and 20-year global warming impacts

(GWPs). IPCC standards require the use of 100-year Global Warming Potentials (GWPs). EPA's inventory should not only point out that other GWPs are available but should include the other, alternative underlying analyses so that policymakers, state and local government energy staffers, and the public may be aware of them and start taking them more into account in policy and operations.

Comment: Acknowledge consumption-related emissions. Please ensure that EPA's GHG Inventory is crystal clear in noting that the Inventory is focussed only to those GHG emissions that are produced inside U.S. borders. The Inventory also should make clear that the U.S. also emits carbon that other nation's inventories count. That's because of imports. Carbon emissions from U.S. exports are smaller than those reckoned from imports to this country. That means that consumption-wise, U.S. carbon impacts are considerably higher than conventional IPCC reckoning admits. The EPA Inventory should explain why this is do. It's widely recognized that the chief source of emissions is consumption. EPA presumably would wish to avoid criticism that it's failing to assess and measure all these consumption impacts. EPA needs to convince decision makers, the media and the public that the Inventory really does give a complete and reliable picture of U.S. carbon emissions. EPA doesn't need to engender this kind of criticism unnecessarily. By giving a full look at consumption impacts, EPA can and should avoid causing complaints that EPA is indirectly rewarding off-shoring of emissions and the employment that goes along with that.

Comment: Priority to systems-based view over traditional sector-based view. EPA's recently published a "systems-based view" http://www.epa.gov/oswer/docs/ghg_land_and_materials_management.pdf (chart, p. 11, GHG emissions) was welcome and beneficial. A systems-based view clearly presents a more complete and useful approach to assessing how much the United States is responsible for world carbon emissions. EPA should give the systems-based approach more visibility so that local officials and the public at large can work from a sounder basis in formulating actions to address carbon emissions more productively, effectively and scientifically.

Reviewer: Matt Korot, Resource Conservation & Recycling Program Director, Metro

General Comment

Comment: Metro, the elected regional government serving nearly 1.5 million citizens in the Portland, Oregon metropolitan area, recently conducted an inventory of greenhouse gases for our region. In developing this inventory, Metro utilized the systems-based approach detailed in EPA's *Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices* report. As a national leader in developing policies and programs to reduce waste, Metro finds the systems-based approach to be a useful tool for identifying and analyzing additional policies to reduce emissions. It enables us to explicitly show how consumption of goods and food makes a significant contribution to greenhouse gas emissions. I strongly encourage you to include the systems-based inventory methodology alongside the traditional sector-based accounting approach contained in the draft U.S. inventory. Integrating the systems view into the U.S. inventory report would encourage other states and local governments to consider this approach, resulting in a more comprehensive set of policy tools to address emissions.

Comment: In addition, I encourage you to include in your report both the 100-year Global Warming Potential (GWP) and a 20-year GWP. The shorter timeframe provides more consistency with our regional planning efforts and provides a better frame of reference by which to actively engage our citizens.

Reviewer: Julie Muir, PSSI/Stanford Recycling

General Comment

Comment: The US Inventory should integrate the systems-based view and present it alongside the traditional sector-based view. EPA recently published a “systems-based view” < http://www.epa.gov/oswer/docs/ghg_land_and_materials_management.pdf > see chart, p. 11, of GHG emissions. Coupled with the traditional sector-based view, the systems-based view offers a much more comprehensive perspective on how the US contributes to GHG emissions. The sector based view only deals with end of the tailpipe solutions and doesn't put to solutions that will get us to 80% reduction. The general public and local policy makers find the systems-based view to be very informative and instructional in developing personal and policy actions to address climate change.

Comment: Consumption-related emissions should be formally acknowledged in the US Greenhouse Gas Inventory. The US Greenhouse Gas Inventory should be much more explicit in stating that the inventory is limited to emissions that physically originate within the national borders of the US. It should explain that the US also contributes to emissions that are counted in the inventories of other nations, as a consequence of imports. The emissions associated with US exports are less than those associated with US imports. When viewed from the perspective of consumption, the greenhouse gas impact of the US is higher than suggested by the traditional IPCC accounting standard. This is of great importance: consumption is the root cause of emissions, and failure to at least acknowledge the impacts of consumption exposes EPA to unnecessary criticism that the US Inventory is providing an incomplete picture of how the nation contributes to emissions (and indirectly, rewarding off-shoring of emissions and associated jobs).

Comment: Given the need to reduce the short-term impacts of greenhouse gases, it would be very helpful if the US Inventory portrayed results using both 100-year, and 20-year GWPs. While the IPCC standards require the use of 100-year Global Warming Potentials (GWPs), the Inventory correctly points out that other GWPs are also available, and including that analysis would be helpful to planners, policymakers, and the public.

Comment: The information in the EPA report on Products and Packaging should be included.

Waste

Comment: The bizarre treatment of landfills and incinerators as well as biogenic emissions makes it difficult to advocate for the proper solutions to material management, leading to more wasting of materials. It also undermines work in this field at the state-level.

Reviewer: Laurence K. Lau, Deputy Director for Environmental Health, State of Hawaii

Waste

Comment: While the draft seems very comprehensive, I ask that it or future versions include an analysis of materials management. For example, the EPA OSWER presented in Hawaii another look at emissions that provided a useful perspective. Closing the Loop on Climate Change, Edward Chu, October 23, 2008 (Center for Program Analysis, OSWER, chu.ed@epa.gov) It highlights the roles of buildings, land use patterns, and providing goods, items that are indirectly covered by the draft inventory. The materials management approach is easier for some people to grasp, and policy makers benefit from having a variety of tools.

General Comment

Comment: I also ask for some analysis of life cycle issues. Life cycle analyses may be necessary to describe materials management properly, as “things” often represent imbedded energy and emission costs.

Reviewer: Rick Albright, Director, Office of Air, Waste & Toxics, U.S. EPA Region 10

General Comment

Comment: The Executive Summary of the 2010 Draft U.S. Greenhouse Gas (GHG) Inventory provides a discussion of an alternative view of GHG emissions with the inclusion of “emissions by economic sector.” We recommend that this be expanded to also include a presentation of emissions by economic system, based on the systems approach to the U.S. GHG Inventory included in OSWER’s 2009 report, Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices.

Assisting government, business and public understanding of the complex connections between the economy, consumption and GHG emissions is one of EPA’s essential roles. OSWER’s 2009 report provides important new thinking on GHG emissions by re-casting the U.S. GHG Inventory into a system-based view of the data. By presenting a life cycle perspective of GHG emissions associated with providing goods and food to the economy, the systems-based view demonstrates important opportunities to reduce GHG emissions through the management of materials from resource extraction through end-of-life. The systems-based inventory also illustrates the important connections between land management decisions and GHG emissions, especially emissions from transportation. As discussed in the OSWER report, this perspective daylights important prevention-oriented mitigation strategies that can enhance the overall effectiveness of our climate protection program. Several large cities on the West Coast are already beginning to incorporate this thinking into their climate actions plans.

Reviewer: Shannon Binns, Program Manager, Green Press Initiative

General Comment

Comment: As a member of the Land Use Technical Working Group (TWG) for the new GHG Protocol Product Life Cycle Accounting and Reporting Standard, I can also tell you there is a strong interest from organizations who are measuring and trying to reduce their GHG impacts to have guidance in this area as well, and that has been our working group's task. We have recognized that despite the complexity of measuring product carbon footprints for products that rely heavily on the harvesting of natural resources -- such as paper products -- it is necessary to provide some guidance for measuring these impacts and have done so in the new draft standard. The draft standard has already been tested by 60 companies and as you can read in this article, "Increasingly, companies are looking beyond their own boundaries and developing strategies to reduce GHG emissions in their supply chains and in the products they make and sell," [said] Bjorn Stigson, president of WBCSD. "By taking a comprehensive approach to GHG measurement and management, businesses and policymakers can focus attention on the greatest opportunities to reduce emissions within the full value chain, leading to more sustainable decisions about the products companies buy, sell, and produce."

Reviewer: John Davies, Sustainable Transport and Climate Change Team, Office of Natural and Human Environment, Federal Highway Administration

Mobile Combustion

Comment: The impact of rising biofuel utilization on transportation CO₂ trends should be clarified in EPA's inventory. DOT recognizes that biofuel combustion CO₂ is not included in energy sector totals, since it's assumed that CO₂ released during combustion is re-absorbed as biofuel crops regenerate. However, the inventory's combustion-only estimates are often used as the basis for calculating upstream emissions, which can be considerable for biofuels. This suggests the need for an expanded discussion of GHG accounting issues in the context of transportation GHG trends, as well as the inclusion of placeholder data to allow for the fuel cycle calculation.

Comment: Transportation estimates in Tables such as 2-15 and 3-12 could include tailpipe biofuel combustion estimates as an italicized item similar to the "wood biomass and ethanol consumption" estimate currently presented in Tables ES-2 and 3-1. It would also be worthwhile to include a footnote explaining why these emissions are not included in the total.

Comment: It could also be very helpful to include actual transportation biofuel consumption data in the Annex. This information could be included as an italicized subitem (beneath the main table) in Annex 2 Tables A-10 to A-29, or in the front section of Annex section 3.2.

Comment: The impact of increased biofuel consumption (and the related accounting issues) could also be discussed in the transportation narratives of Sections 2.1 and 3.1, which could also point to the RFS literature for details on upstream analysis of transportation fuels.

Reviewer: Joe Carriero, National Park Service

General Comment

Comment: Under the Executive Order “Federal Leadership in Environmental, Energy, and Economic Performance” issued in October 2009, federal agencies are now required to “measure, report, and reduce their greenhouse gas (GHG) emissions from direct and indirect activities.” The Department of Energy (DOE) Federal Energy Management Program (FEMP) in cooperation with other federal agencies has developed the Federal Greenhouse Gas Accounting and Reporting Guidance to define methods for reporting emissions. EPA should ensure that methods used in this annual inventory of greenhouse gas emissions and sinks are consistent with the FEMP methodologies. If source categories or reporting methods differ, it would be appropriate to define the basis for differences in a new section added to this report. [See Appendix C for additional details.]

Land Use, Land Use Change, and Forestry

Comment: The inventory results are informative and for the most part clearly presented. While we agree that currently available methods make it difficult to specifically quantify the impacts of forest fires on net carbon sequestration in forests, EPA should acknowledge the numerous efforts by federal agencies to improve methods to characterize fire emissions. Future inventories may be able to refine these estimates. [See Appendix C for additional details.]

Reviewer: S. Rao Chitikela, Ph.D, P.E., BCEE

Wastewater

Comment: Are the CO₂ emissions of wastewater treatment using aerobic/anaerobic bioprocesses considered in this report?

-- CO₂ emissions of biological activated sludge processes and other nitrification/denitrification processes are significant.

Comment: Are the CO₂ emissions of fuel combustion operations at the POTWs considered for this report?

-- For example, fuel-oil or natural gas (or recovered biogas or other fuel) is fired in the sludge heaters to maintain the mesophilic temperatures of the anaerobic sludge digesters.

Reviewer: Tom Huetteman, Associate Director, Waste Management Division, U.S. EPA Region 9

General Comment

Comment: The Executive Summary of the 2010 Draft U.S. Greenhouse Gas (GHG) Inventory provides a discussion of an alternative view of GHG emissions with the inclusion of “emissions by economic sector.” We recommend that this be expanded to also include a presentation of emissions by economic system, based on the systems approach to the U.S. GHG Inventory included in OSWER’s 2009 report, Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices. Assisting government, business and public understanding of the complex connections between the economy, consumption and GHG emissions is one of EPA’s essential roles. OSWER’s 2009 report provides important new thinking on GHG emissions by re-casting the U.S. GHG Inventory into a system-based view of

the data. By presenting a life cycle perspective of GHG emissions associated with providing goods and food to the economy, the systems-based view demonstrates important opportunities to reduce GHG emissions through the management of materials from resource extraction through end-of-life. The systems-based inventory also illustrates the important connections between land management decisions and GHG emissions, especially emissions from transportation. As discussed in the OSWER report, this perspective daylights important prevention-oriented mitigation strategies that can enhance the overall effectiveness of our climate protection program. Several large cities on the West Coast are already beginning to incorporate this thinking into their climate actions plans. We recognize the need for careful deliberation when making changes to the Inventory, and we would like to begin a robust internal dialogue on this recommendation. Please feel free to contact me to discuss further our recommendation.

Reviewer: Paula Wise, Deconstruction & ReUse Network

Waste

Comment: This is a incredibly important act. I hope that you will to incorporate Reuse and deconstruction into the mix. I understand Recycling is included. Recycling is good, but reuse is better. Keeping items in there original state reduces greenhouse gases. I ask that you please consider this.

Reviewer: Joyce Dillard

Energy, Oil & Gas

Comment: Since oil wells are on residential property in the City of Los Angeles, how are emissions gauged separately in relationship to automobiles or other industry emissions? Is there a danger that these emissions can be masked under an industrial veil and not production?

Comment: How is fracking being addressed for oil extraction?

Comment: How is subsidence being handled in relationship to gas leakage?

General Comment

Comment: Is there a groundwater quality standard for landfills and/or oil fields.

Comment: Are there requirements to report and measure any de-watering as a Methane Mitigation?

Comment: Methane Mitigation Standards do not seem to exist. Are there Federal standards? If so, do they address NPDES requirements?

Reviewer: Kyle Meisterling

Annex 3

Comment: Annex 3, "Methodology for Estimating CH₄ emissions from Landfills" (p A-280), The heading # reads "3.1." should probably be 3.14.

Reviewer: Karin Ritter, American Petroleum Institute

Energy, Petroleum Systems

Comment: API recently revised the API Compendium. References to emission factors from the API Compendium should be updated to reflect the 2009 version of API's Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry. For example, Section 3.7 Petroleum Systems (p. 3-49, line 22 and p. 3-50, line 27) and Annex 3.5 Petroleum Systems (p. A-149, line 32) reference "API (2004)". Note: the emission factors referenced in these citations did not change between the 2004 and 2009 editions.

Comment: The most significant change noted in the 2008 national inventory was the addition of asphalt blowing CO₂ emissions for refineries in the Petroleum Systems category. This emission source accounts for 36% of the total non-combustion CO₂ emissions from petroleum systems in 2008. The CH₄ factor for asphalt blowing is the same as is used in the 2007 EPA Inventory of Greenhouse Gas Emissions and Sinks. However, neither emission factor is consistent with the 2009 API Compendium.

The 2009 API Compendium cites a simple emission factor for uncontrolled asphalt blowing from AP-42 (EPA, AP-42, Section 5.1.2.10, 1995). The AP-42 emission factor for asphalt blowing is assumed to be on an air-free basis (AP-42 does not specify this, but notes the factor represents "emissions"). Asphalt blowing exhaust composition data (13 mol% CH₄ and 9 mol% CO₂, on an air free basis) presented in an Oil & Gas Journal article is applied to derive the CH₄ and CO₂ emission factors of 5.55E-4 tonnes CH₄/bbl asphalt blown and 1.01E-3 tonnes CO₂/bbl asphalt blown, respectively. (Further details on the derivation of these emission factors is provided in Appendix B of the 2009 API Compendium.)

For comparison, the EPA emission factors converted to a similar basis are 4.9E-5 tonnes CH₄/bbl and 1.09E-3 tonnes CO₂/bbl. However, the primary distinction between the API Compendium emission factors and those used in the EPA inventory is the units of measure applied to the activity factor. The API emission factors are based on the volume (or mass) of asphalt blown, while the EPA emission factors appear to be based on the total volume of asphalt produced (411 Mbbbl/cd production). As a result, the EPA emission factors result in much higher emission estimates.

Energy, Natural Gas & Petroleum Systems

Comment: EPA notes under planned improvements for both the Natural Gas Systems and Petroleum Systems source categories that results from two studies on flashing losses from oil and condensate tanks will be reviewed for the next inventory update cycle. API and its member companies provided comments last August on the study by the Texas Commission on Environmental Quality. API expressed serious concerns over the presentation of results from that study, where differences between model-estimated values and field data were reported as errors in the model calculations, and in the lack of information provided to evaluate measurement data quality. API is concerned that this report inadequately portrays the reliability of emissions estimation methods commonly used in the oil and natural gas industry, and may result in erroneous conclusions about the credibility of widely used flash emission models. In addition, the extrapolation of the report findings to estimating methane emissions from work specifically addressing Volatile Organic Compounds emissions is inappropriate.

Comment: There are a number of sources that do not appear to be included in the national GHG inventory. For the refining sector, these include CO₂ emissions from flares, catalytic cracking units, fluid coking units, catalytic reforming units, sulfur recovery units, and coke calcining units. Emissions from each of these sources are required to be reported under the Mandatory GHG Reporting Regulation (MRR), and for which EPA had to assess the emissions as part of the justification for their inclusion in the MRR. The inventory should incorporate EPA's current understanding of these emissions or document why they are excluded from the inventory.

Annex 3.4, Natural Gas Systems

Comment: Emission factors and activity factors are only provided for 2008 (with the exception of "key activity data drivers" provided in Table A-114), yet emissions are shown for multiple years. Recommend adding emission and activity factors for all years for which emissions are being estimated, for full disclosure. (In addition, it is discussed in Step 1 that activity factors vary by year.)

Comment: If emission factors determined for 1995 are assumed to be representative of emissions from each source type over the period 1990 through 2008, recommend adding that information to Step 1 or Step 3, similar to the text in Annex 3.5 Petroleum Systems, p. A-149, line 19.

Comment: Table A-112 - Recommend showing non-zero values for emission factors for the following activity types: Turbines (Storage), Generators (Engines), and Generators (Turbines). Emissions from these sources are not zero; therefore the emission factor must also not be zero.

Comment: Table A-114 - Activity counts for "Non-associated Gas Wells" correspond to the sum of the count of "Non-associated Gas Wells" and "Unconventional Gas Wells" presented in Table A-110 and A-117. Recommend adding a footnote to Table A-114 to reflect this summation.

Comment: Emissions for the year 2000 are missing from all tables in this annex; however, they are shown in Section 3.6 (Tables 3-37 through 3-40). Emissions (and all data used to derive emissions) for the year 2000 should be added to Annex 3.4.

Comment: Activity factors are only provided for 2008, yet emissions are shown for multiple years. Recommend adding activity factors for all years for which emissions are being estimated, for full disclosure. (In addition, it is discussed in Step 2 that activity factors vary by year.) Text should also be added to Annex 3.5 defining the sources of the activity factor data.

Reviewer: Kevin Bundy, Senior Attorney, Center for Biological Diversity

Biomass Burning

Comment: EPA's inventory document repeats a pernicious assumption that has profound consequences for both the climate and the nation's forests: the assumption that biomass combustion is "carbon neutral." EPA recognizes, as it must, that the combustion of biomass and biofuels produces CO₂ and other greenhouse gases. Yet EPA declines to include these emissions in national totals "because biomass fuels are of biogenic origin." According to EPA, "[i]t is assumed that the carbon (C) released during the consumption of biomass is recycled as U.S. forests and crops regenerate, causing no net addition of CO₂ to the atmosphere." As described in detail below, scientists have concluded that this assumption represents a critical error in

EPA's climate accounting methodology. This error pervades all of EPA's biomass calculations, but it is especially glaring as applied to facilities that burn woody biomass from tree plantations, forest thinning projects, or fire salvage projects. Promotion of new and expanded biomass energy facilities predicated on this assumption is beginning to threaten both the ecology of the nation's forests and the stability of the world's climate. EPA thus should revise the Inventory to eliminate reliance on the "carbon neutrality" assumption and should adopt accounting methods that accurately measure emissions from both biomass combustion and associated land use change on time scales relevant to climate protection efforts. [See Appendix D for additional details.]

Reviewer: Bill Sheehan, Product Policy Institute (plus 62 other organizations' signatures)

General Comment

Comment: The US Inventory should integrate "systems-based" greenhouse accounting -- and present it alongside the traditional sector-based view.

Comment: Consumption-related emissions should be formally acknowledged in the US Greenhouse Gas Inventory. The US Greenhouse Gas Inventory should be much more explicit in stating that the inventory is limited to emissions that physically originate within the national borders of the US. It should explain that the US also contributes to emissions that are counted in the inventories of other nations, as a consequence of imports.

Comment: Given the need to reduce the short-term impacts of greenhouse gases, the US Inventory should portray results using both 100-year, and 20-year Global Warming Potentials. While the IPCC standards require the use of 100-year Global Warming Potentials (GWPs), the Inventory correctly points out that other GWPs are also available, and including that analysis would be helpful to planners, policymakers, and the public.

Reviewer: Cynthia A. Finley, Ph.D, Director, National Association of Clean Water Agencies

Water – Wastewater Treatment

Comment: NACWA believes that using the literature nitrogen loading values or EPA-collected values from U.S. POTWs would better reflect the actual emissions from POTWs in the U.S. than the current methods based on the IPCC Guidelines. The IPCC Guidelines do not necessarily reflect actual conditions at POTWs throughout the U.S. This is illustrated by the emission factor ("EF1") of 3.2 g N₂O/person-year for plants with no intentional denitrification, used in the Draft Inventory and in the IPCC Guidelines to calculate nitrous oxide emissions from centralized wastewater treatment plants. This value was obtained from a single study of a very small wastewater treatment plant (1.06 million gallons per day, or MGD) in a small university town in New Hampshire. The population of this town is 12,500 during the school year, but drops to 6,200 in the summer months, during which most of the measurements for this study were made. If the IPCC can use this single study to define an emission factor that is used for centralized treatment facilities all over the world, certainly EPA can justify changing the nitrogen loading

rate for facilities in the U.S. based on multiple literature values and data that it can collect from POTWs across the nation. [See Appendix E for complete comment.]

Comment: In the $N_2O_{WOUT\,NIT/DENIT}$ equation (line 44, page 8-13), the FIND-COM factor should be moved outside of the square brackets. This is a typographical error rather than an error that affects the calculations.

Comment: In the $N_2O_{EFFLUENT}$ equation (line 45, page 8-13), the USPOP factor should be multiplied by the WWTP factor, as it is in the $N_2O_{WOUT\,NIT/DENIT}$ equation, since septic system users should not be included in the amount of effluent discharged to aquatic environments. NACWA recommends that any nitrous oxide contributions from septic systems be calculated in a separate equation if they are even included in the Inventory.

Comment: The units provided in the definitions of N_2O_{TOTAL} , N_2O_{PLANT} , $N_2O_{NIT/DENIT}$, and $N_2O_{WOUT\,NIT/DENIT}$ (lines 2-7, page 8-14) should be Gg, not kg, since conversions are made to Gg in the equations used to calculate these values.

Comment: The value of 269 Tg N for N_{SLUDGE} (line 37, page 8-14) appears to be an error, resulting in a negative value for $N_2O_{EFFLUENT}$. The value of 141 Gg N found in the Annex in Table A-193 (page A-231) is a more appropriate magnitude. However, even substituting this 141 Gg N value for N_{SLUDGE} does not result in a N_{TOTAL} value that agrees with the value of 15.9 Gg N_2O in Table 8-7. EPA should review the equation for $N_2O_{EFFLUENT}$ and all of the values used in it for accuracy.

Reviewer: John Davis

Landfills

Comment: Landfills emit methane. The Inventory should acknowledge that methane is standardized to CO_2 's 100-year atmospheric life, therefore understating methane's real 20-year impact. Please see the attached article "Lifetime Leveraging: An Approach to Achieving International Agreement and Effective Climate Protection Using Mitigation of Short-Lived Greenhouse Gases". [See Appendix F for article.]

Comment: Landfills are credited with carbon sequestration, thereby perversely reducing their methane impact. Common sense dictates that burying anthropogenic carbon should not be considered a GHG reduction. Sequestration credit is particularly perverse in rewarding activities that reduce recycling and composting, where real GHG reduction occurs. Methane avoidance, through recycling and composting, should be acknowledged in the Inventory and full methane production, independent of sequestration, should be presented.

Waste

Comment: Recycling avoids primary extraction and processing, with its associated GHG emissions. Composting reduces GHG emissions from synthetic fertilizer and pesticide production. Food and landscape materials composting avoids methane generation. The Inventory should demonstrate the potential for full recycling and composting benefits, including landfill methane avoidance.

General Comment

Comment: EPA's seminal work on materials consumption needs to be incorporated in the Inventory. The 2009 report "Opportunities to Reduce Greenhouse Gas Emissions Through Materials and Land Management Practices" demonstrates the impact of global consumption patterns and systems views, rather than narrowly focused sector based impacts. The Inventory should acknowledge the system and consumption work that will lead to significant policy development.

Reviewer: Peter Anderson, Executive Director, Center for a Competitive Waste Industry

Landfills

Comment: Global warming potential. Include in the table showing each sector's responsibility for anthropogenic greenhouse gas emissions the applicable value when current instead of obsolete Global Warming Potential multipliers are used. [See Appendix G for additional details.]

Comment: Short-term strategies. Employ a two-pronged strategy that includes a short-term along with the long-term approach in reported inventory values. [See Appendix G for additional details.]

Comment: First Order Decay Model. Replace the First Order Decay Model, which fails to account for internal moisture levels critical for gas generation, with a revised model that does. [See Appendix G for additional details.]

Reviewer: Garrett Fitzgerald, Sustainability Coordinator, City of Oakland

General Comment

Comment: Include a "systems" or "consumption"-based perspective on GHG emissions within the Draft Inventory. [See Appendix H for additional details.]

Reviewer: MaryEllen Etienne, Executive Director, Reuse Alliance

General Comment

Comment: Mention reuse wherever materials management and/or recycling is mentioned in order to acknowledge its significance within the EPA waste management hierarchy and in the handling of GHGs (it is not currently found in the current documentation).

Comment: Consider the energy savings and emission reductions of reuse.

Comment: Take account of the full life-cycle of materials, from research, extraction, transportation retail, use, and disposal.

Comment: Creates a systems-based analysis of direct and indirect emissions or of energy consumption related to materials management.

Reviewer: Barbara Warren, Executive Director, Citizens' Environmental Coalition

Waste

Comment: Seek global agreement to update the methodology so that it reflects the best current scientific information.

General Comment

Comment: Continue to use the agreed upon 2nd IPCC assessment guidance, but add a supplement to the inventory that reflects current understanding of better scientific information. This also will help identify additional opportunities for greenhouse gas reductions. For example, see our discussion of issues related to WASTE below. [Issues discussed are: failure to include upstream GHGs and embodied energy in solid waste, mis-using the SAR 100 year GWP for Methane (should be 20 year), over-estimating LF gas collection efficiency, incorrect treatment of biogenic emissions.] [See Appendix I for additional details.]

Comment: Identify solutions and best practices which can be implemented immediately by state and local governments. All solutions and best practices should be sustainable, offering benefits in 3 spheres -economic, environmental and social-- with no damaging or detrimental drawbacks. Adopting sustainable solutions becomes easy, when multiple benefits, beyond GHG reductions, are within reach.

Comment: Do more analysis at the micro-level. What is the most efficient way to get food from the farm to household dinner tables? the most efficient way to deliver health care? How energy efficient can supermarkets be made? Hospitals? Sewage treatment plants? Schools? Various industries? Etc.

Comment: Strive to make all of the systems we use and rely on - sustainable. Until we do we will not be able to address climate change.

Comment: Immediately address WASTE and WASTING in a much more substantial way. Post World War II we have dramatically increased the amount of waste we generate. WASTE and WASTING are similar to energy losses, except that waste involves the loss or destruction of material resources as well as embedded energy.

Reviewer: Margaret M. Guerriero, Director, Land and Chemicals Division – EPA Region 5

General Comment

Comment: We encourage you to revise the draft inventory to include, at a minimum, a reference to this important and insightful EPA, peer-reviewed resource. Ideally, future versions of the inventory will include both a sector-based and a systems-based view to present a more comprehensive picture of U.S. GHG emissions. [See Appendix J for additional details.]

Appendix A

UNITED STATES AND GLOBAL DATA INTEGRITY ISSUES

By Joseph D'Aleo

Update October 8, 2009

ABSTRACT

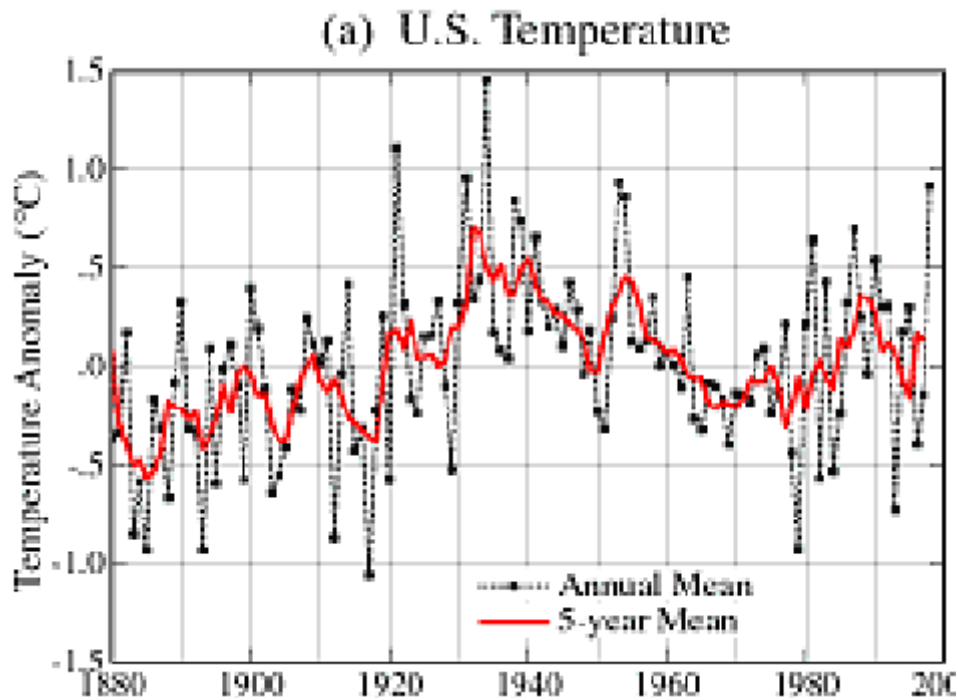
Issues with the United States and especially the global data bases make them inadequate to use for trend analysis and thus any important policy decisions based on climate change. These issues include inadequate adjustments for urban data, bad instrument siting, use of instruments with proven biases that are not adjusted for, major global station dropout, an increase in missing monthly data and questionable adjustment practices.

We hear official press releases announcing 2008 was the 8th, 9th or tenth warmest in 127 to 147 years in the various global data bases. Yet the NASA satellite record shows the year for the globe was the coldest this decade and 14th coldest in the 30 years of satellite monitoring. Here we will show how these global estimates are contaminated and can't be trusted and certainly should not be used for important policy decisions.

US CLIMATE DATA

NOAA NCDC USHCN

When first implemented in 1990 as USHCN version1, it employed 1221 stations across the United States. In 1999, NASA's James Hansen published this graph of USHCN version 1 annual mean temperatures:



About which Hansen correctly noted: *“The U.S. has warmed during the past century, but the warming hardly exceeds year-to-year variability. Indeed, in the U.S. the warmest decade was the 1930s and the warmest year was 1934.”*

USHCN was generally accepted as the world’s best data base of temperatures with the stations most continuous and stable, and adjustments made for time of observation, urbanization, known land use changes around sites, and instrumentation changes, each of which can produce major contamination issues for temperature data.

URBAN HEAT ISLAND

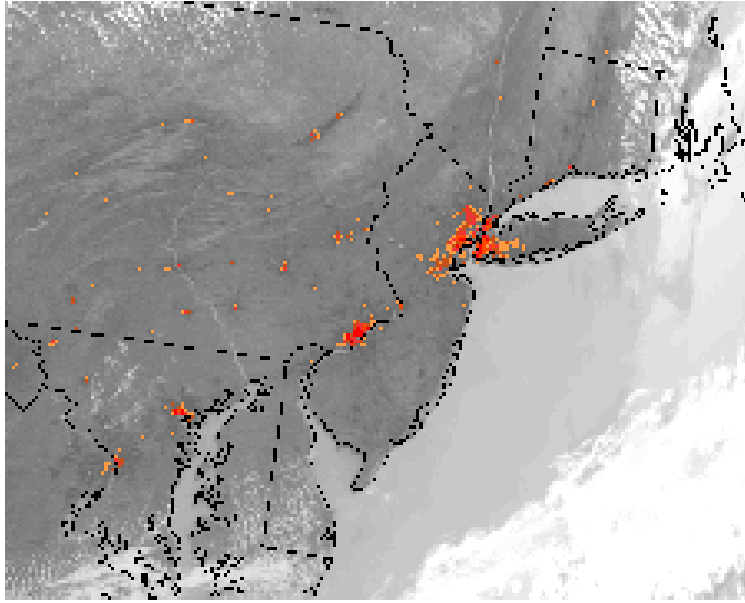
There is no real dispute that weather data from cities, as collected by meteorological stations, is contaminated by urban heat island (UHI) bias, and that this has to be removed to identify climatic changes or trends. In cities, vertical walls, steel and concrete absorb the sun’s heat and are slow to cool at night. More and more of the world is urbanized (population increased from 1.5 B to 6 B in 1900s).

The UHI effect occurs not only for big cities but also for towns. Oke (who won the 2008 American Meteorological Society’s Helmut Landsberg award for his pioneer work on urbanization) had a formula for the warming that is tied to population. Oke (1973) found that the UHI (in °C) increases according to the formula

$$UHI = 0.73 \log_{10} POP$$

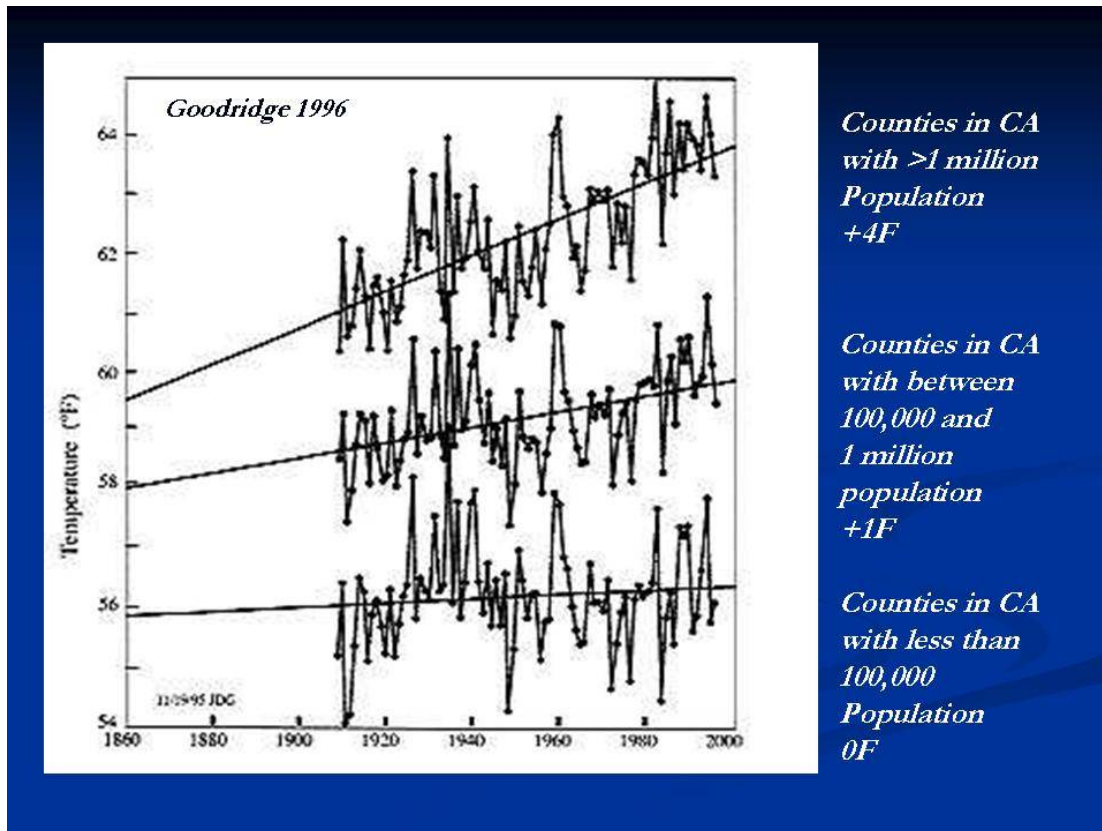
where *pop* denotes population. This means that a village with a population of 10 has a warm bias of 0.73°C, a village with 100 has a warm bias of 1.46°C, a town with a

population of 1000 people has a warm bias of 2.2°C , and a large city with a million people has a warm bias of 4.4°C .



Urban heat islands as seen from infrared sensors onboard satellites.

Goodrich (1996) showed the importance of urbanization to temperatures in his study of California counties in 1996. He found for counties with a million or more population the warming from 1910 to 1995 was 4F, for counties with 100,000 to 1 million, 1F and for counties with less than 100,000, no change (0.1F).



NCDC's Tom Karl (1988) employed a similar scheme for the first USHCN data base (released in 1990) that was the best data set available at that time. He noted that the national climate network formerly consisted of predominantly rural or small towns with populations below 25,000 (as of 1980 census) and yet that a UHI effect was clearly evident.

Tom Karl et al's adjustments were smaller than Oke had found (0.22°C annually on a town of 10,000 and 1.81°C on a city of 1 million and 3.73°C for a city of 5 million).

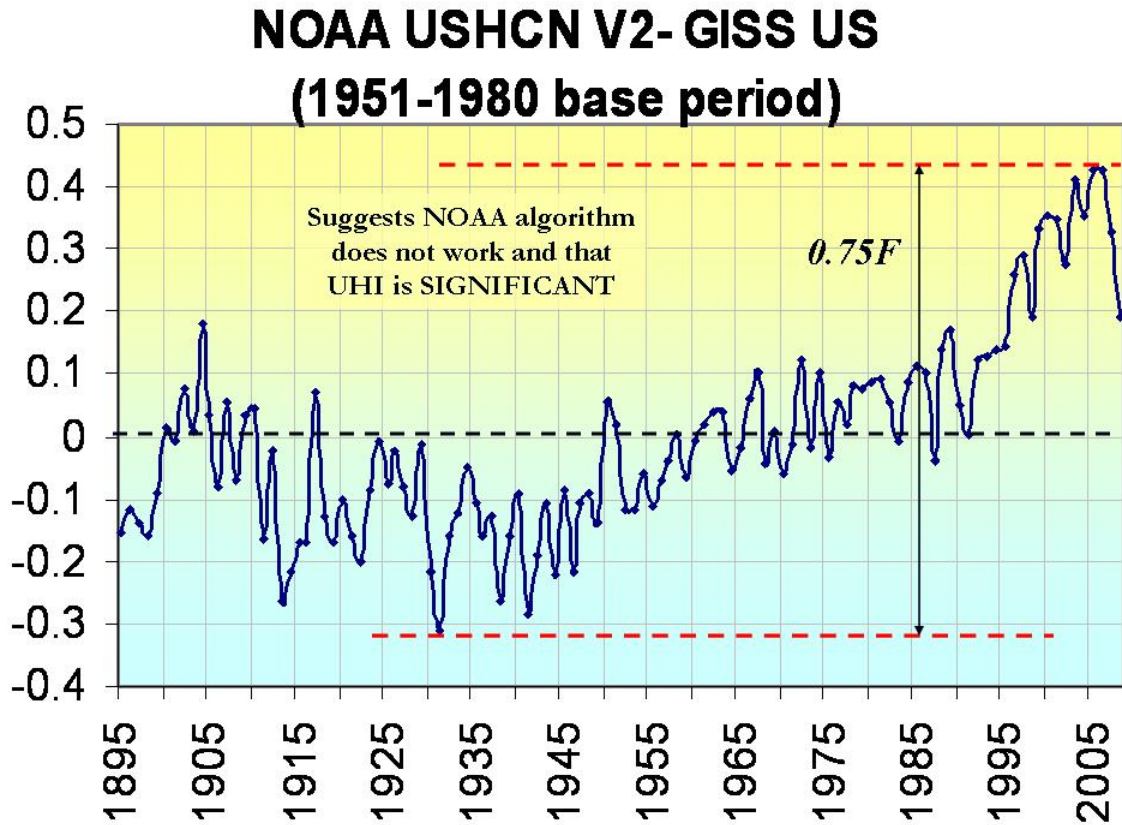
Karl observed that in smaller towns and rural areas the net UHI contamination was relatively small but that significant anomalies showed up in rapidly growing population centers.

USHCN also maintained a METADATA base (not perfect) that identified changes in observing site locations and instrumentation and supposedly made adjustments accordingly, along with adjustment for change in the time of observation over the years.

NASA GISS US

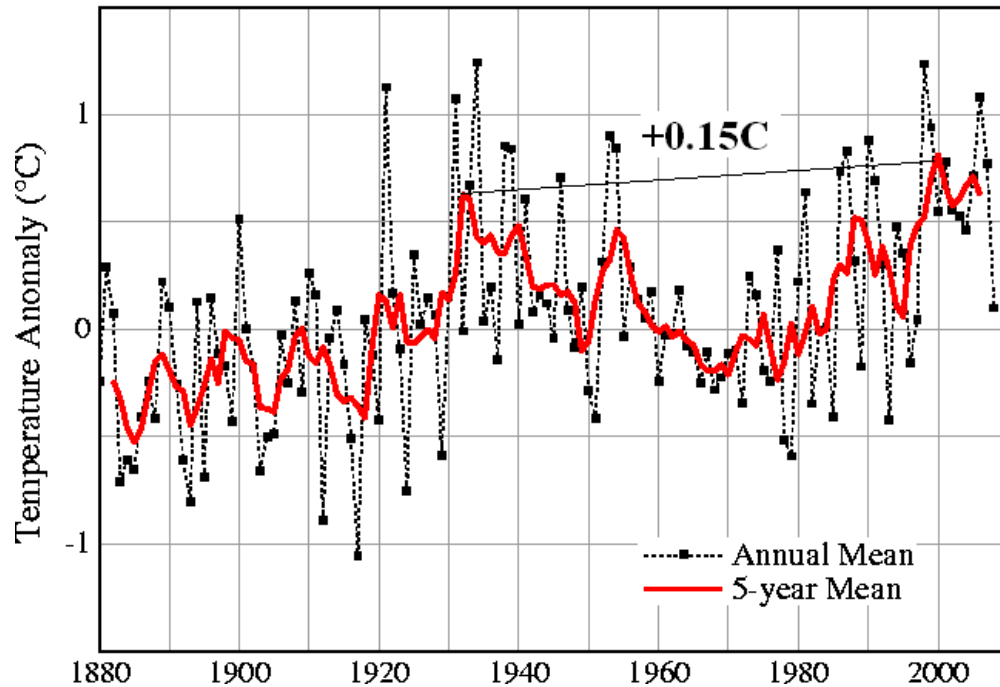
GISS uses in the USA, southern Canada and northern Mexico an urbanization adjustment based on the amount of night time light measured by satellites from the station locations. Unlit stations are classified as rural stations. This does produce some adjustment and a reasonable plot of temperatures but as GISS notes, this is just less than 2% of the globe."

The difference from their adjusted values and the NOAA no longer adjusted shows NOAA was misguided in their removal of the urban adjustment, with a net cooling of 0.2F in 1930s and warming of 0.4F near 2005. NOAA data adjusted to the GISS base period of 1951-1980.



The net warming in the UHI adjusted GISS US data set from the peak around 1930 to the peak near 2000 was a meager 0.15C. It may be assumed the same would be true for the world if we could make a similar needed UHI adjustment.

U.S. Temperature

*GISS Adjusted US Temperatures****INSTRUMENT CHANGES***

Dr. Ben Herman at the University of Arizona confirmed in working with the climate station in Tucson, AZ that the new HO83 had a significant warm bias. This observation was based on the work by Gall et al. (1992) and Jones (1995). Stephen McIntyre has summarized in [The HO-83 Hygro-thermometer \(http://www.climateaudit.org/?p=1954\)](http://www.climateaudit.org/?p=1954) the findings by Tom Karl et al in 1995 of a discontinuity of about 0.5°C before and after switchover. This change to the HO-83 seemingly went unadjusted for in the USHCN data base for the period from the 1980s to the late 1990s when the instruments were replaced.

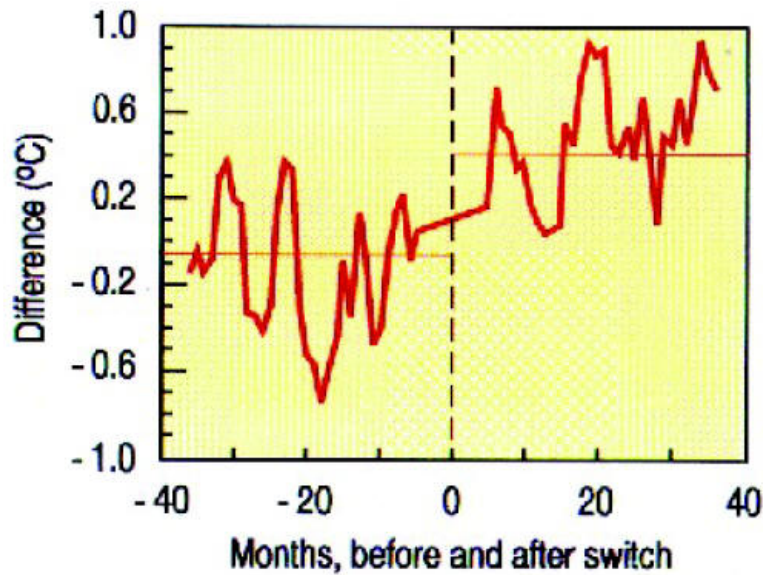


FIG. 2. Effects of changing instruments from the HO63 to the HO83 series on the maximum temperature in the United States (Karl et al. 1995).

BAD SITING

Pielke and Davey (2005) found a majority of stations including climate stations in eastern Colorado did not meet WMO requirements for proper siting. He has extensively documented poor siting and land use change issues in numerous peer review papers, many summarized in the landmark paper [Unresolved issues with the assessment of multi-decadal global land surface temperature trends](#) (2007).

Anthony Watts started a volunteer effort to document siting issues with all 1221 stations in US. He and his team is now through over 919 stations. See the results on <http://surfacestations.org> and numerous examples highlighted on <http://wattsupwiththat.wordpress.com>. All of these siting issues identified introduce a warm bias.

Here are some examples:



USHCN Station Hopkinsville, KY (Pielke et al 2006)



Max/Min sensor near John Martin Reservoir, CO (Davey 2005)



Tucson , Arizona in a parking lot on pavement.



Wickenburg, Arizona next to a building on a paved surface

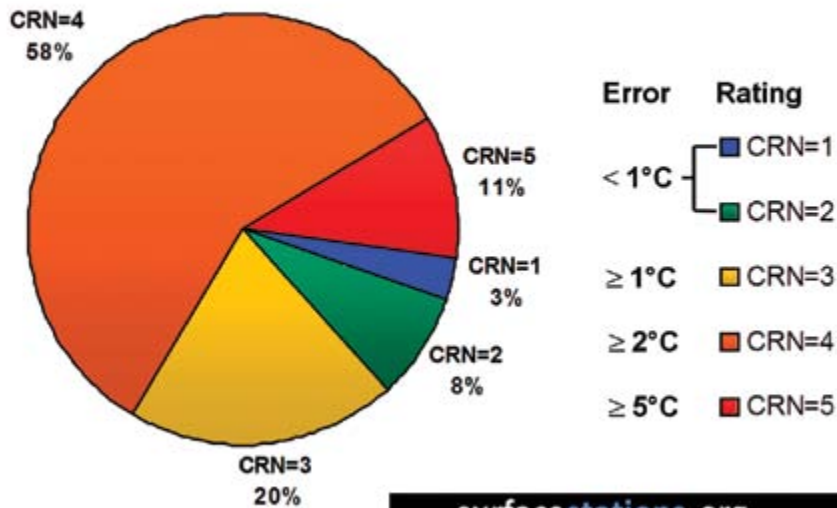


Waterville, WA over volcanic cinders

The vast majority of stations did not meet the governments own criteria for siting as established in the documentation for the Climate Reference Network.

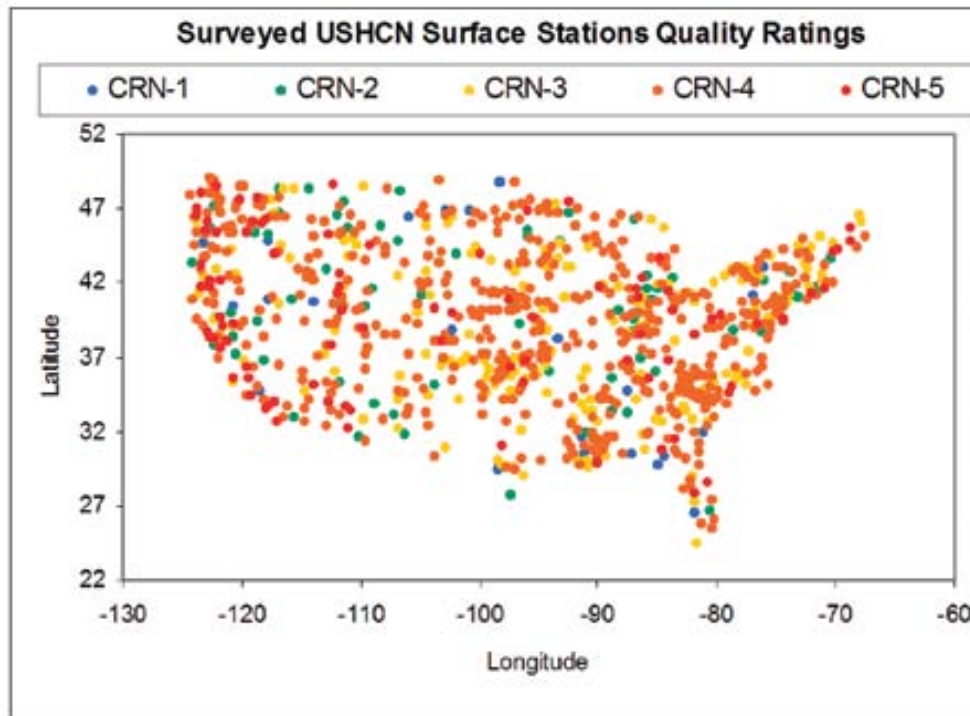
Using the government's own rating system, Anthony has shown a majority of the stations are inadequately sited (89% are CRN 3-5, 69% CRN 4-5 poor to very poor)

USHCN - Station Site Quality by Rating



USHCN - 70% surveyed as of 2/11/09

The distribution of poor and very poor (CRN 4, CRN 5) was widespread across all the states.



MAJOR CHANGES TO USHCN IN 2007

In 2007 the NCDC (the National Climatic Data Center), in its version 2 of USHCN, inexplicably removed the Karl UHI adjustment and substituted a CHANGE POINT ALGORITHM that looks for sudden shifts (discontinuities). This is best suited for finding site moves or local land use changes (like paving a road or building next to sensors or shelters) but not the slow ramp up characteristic of a growing town or city.

I had a conversation with NCDC's Tom Karl two years ago when the USHCN version 2 was announced. I told Tom I had endorsed his 1988 *Journal of Climate* paper (Urbanization: Its Detection and Effect in the United States Climate Record) having been a fan of the work that Landsberg and Oke on whose work that paper depended on.

I asked him if USHCNv2 would no longer have an urbanization adjustment. After a few moments of silence, he told me he had asked those who had worked on version 2 that question and was reassured that the new algorithms would catch urban warming and other changes – including “previously undocumented inhomogeneities” (discontinuities that suggest some local site changes or moves that were never documented).

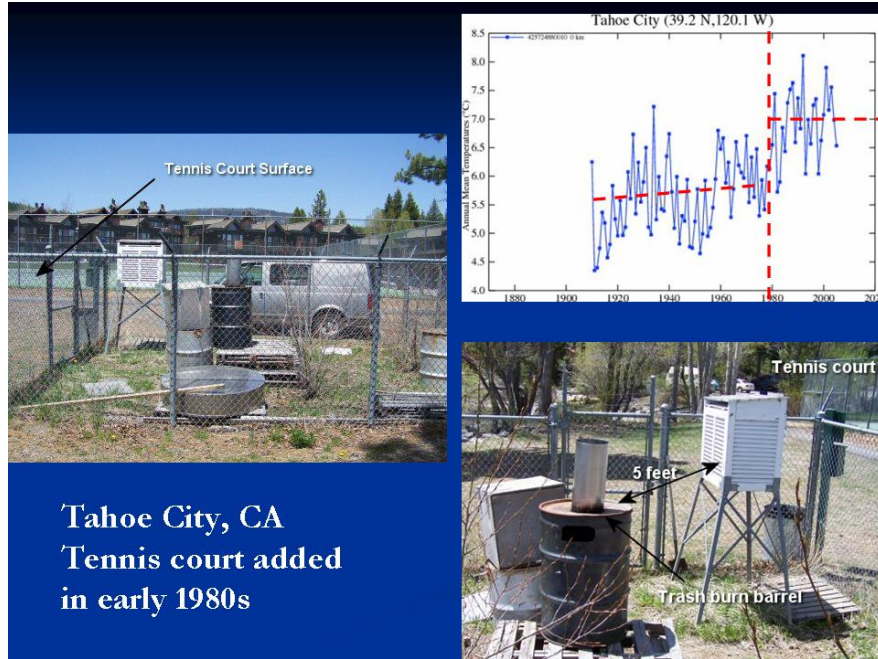
The difference between the old and new is shown here. Note the significant post 1995 warming and mid 20th century cooling due to deurbanization of the data base.

USHCN V2-V1

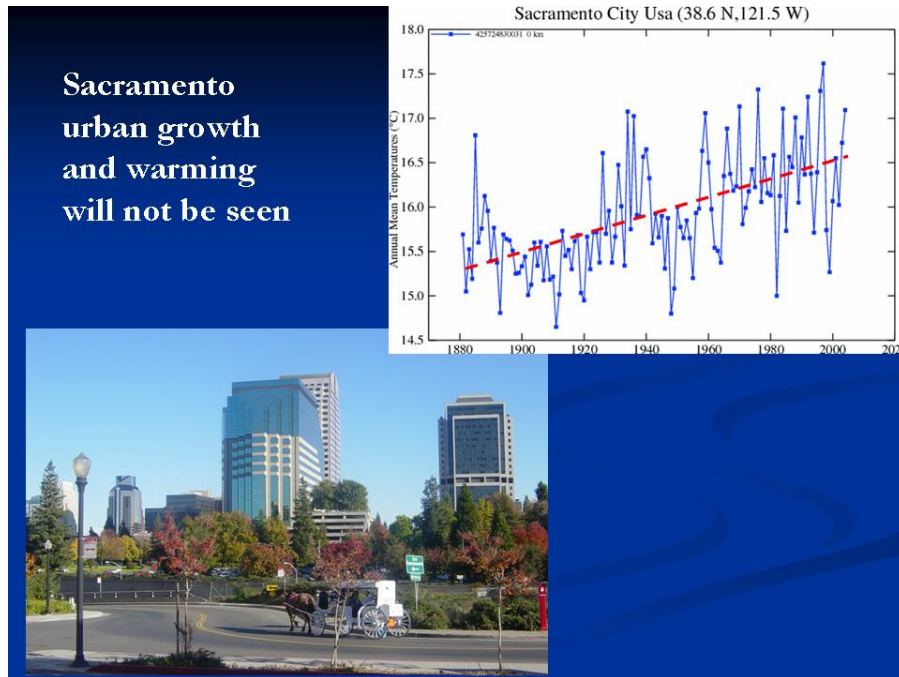


The change can be seen clearly in [this animation](#).

The new algorithms are supposed to correct for urbanization, changes in siting and instrumentation by recognizing sudden shifts in the temperatures.



It should catch this kind of change above in Tahoe City, CA.

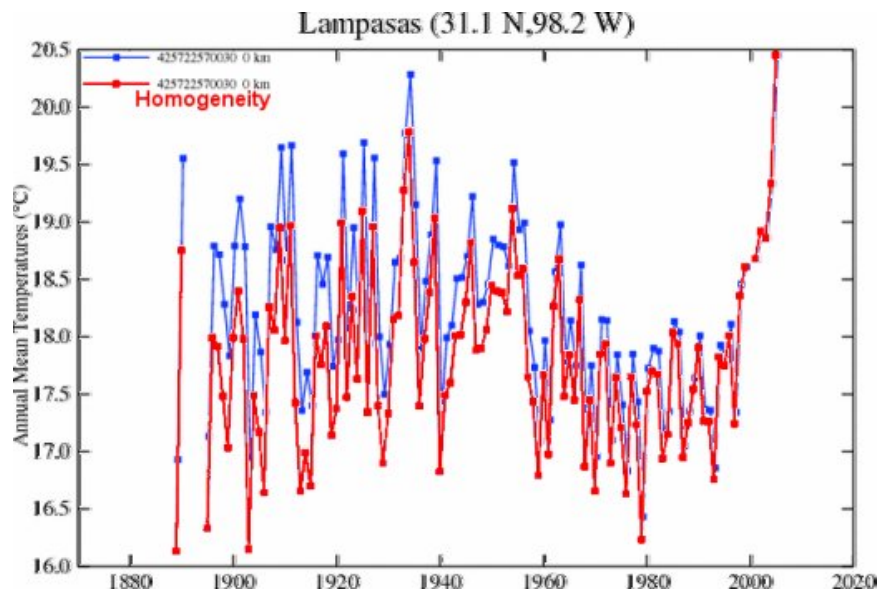


It is unlikely to catch the slow warming associated with the growth over many years of cities and towns as in Sacramento, CA above.

There is even some evidence that the algorithm does not catch some site changes it should catch. Take for example Lampasas, Texas as identified by Anthony Watts.



Lampasas, Texas site moved to near a building and street from a more appropriate grassy site after 2001. Note even with the new “homogeneity” adjustment (red) this artificial warming is left although the old data (blue) is cooled to accentuate warming even further.



The net result is to make the recent warm cycle max more important relative to the early century max in the 1930s.



Lifetime-leveraging

An approach to achieving international agreement and effective climate protection using mitigation of short-lived greenhouse gases

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Connecticut, USA, and*

Michael C. MacCracken

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Abstract

Purpose – The purpose of this paper is to suggest an approach to post-Kyoto climate negotiations that could provide a way out of the apparent deadlock between developed and developing countries. This is an urgent issue as the world already appears to be close to a level of climate change that could be considered “dangerous”.

Design/methodology/approach – The paper explores the potential that control of short-lived greenhouse gases such as methane, tropospheric ozone, and soot could have, in addition to steep cutbacks in industrialized nations, to both mitigate global warming and overcome political stalemate in the international climate negotiations.

Findings – Although rarely mentioned in climate discourse, reducing emissions of short-lived greenhouse gases offers a cost-effective way of actually reducing the radiative forcing in the atmosphere, while at the same time producing substantial subsidiary benefits such as improved urban air quality. The paper suggests leveraging this potential in the post-Kyoto treaty in order to “buy time” to address the arguably more difficult problem of essentially eliminating fossil-fuel related CO₂ emissions, which will ultimately be required to truly bring climate change under control. While high-income countries work on steep cutbacks of all greenhouse gas emissions, middle-income nations could make significant additional contributions by undertaking commitments to control only short-lived greenhouse gases until they reached a threshold level of per-capita GDP, at which point they would cap and begin reducing all greenhouse gas emissions.

Originality/value – This paper recognizes that political tradeoffs will have to be made in negotiating the next climate treaty, and offers a way of approaching these tradeoffs that could minimize resulting environmental damage.

Keywords Climatology, Global warming, International cooperation, Environmental politics

Paper type Research paper



The views expressed in this paper represent the views of the authors and not necessarily of any institutions with which they have been or are affiliated.

Thanks to Steve Smith and Navin Ramankutty for providing emissions data used for modeling. Thanks also to Nina Rinnerberger, Ivan Valencia, Bhuwan Thapa, Takanobu Terada, Claudia Vinay, and Lars Christiansen for valuable suggestions on the policy aspects of this proposal and for their comments on the draft.

often-overlooked, short-lived greenhouse gases to both substantially decrease radiative-forcing (“buying time” to fully get to grips with more intractable CO₂ emissions), and to overcome the negotiations deadlock between high- and middle-income countries.

Reductions in the atmospheric burdens of tropospheric ozone, methane and soot represent an opportunity to significantly reduce the human-induced radiative forcing that is causing global warming. Moreover, much of the reduction in these emissions can be done at little cost, and in a way that is consistent with the broad development strategy of middle-income nations. In fact, the benefits of reducing soot and ozone concentration in term of improved public health will likely be larger than the benefits of mitigated climate change. This targeting of short-lived pollutants, combined with aggressive cuts in emissions from high-income countries, aspirational goals and CDM-participation from low-income countries, and improvements in energy intensity to slow the growth of energy-related CO₂ emissions in middle-income countries, should be enough limit peak temperature increase to less than 2-2.5°C above pre-industrial temperatures. If this can be done, and the radiative forcing then be gradually reduced from the peak levels in following decades, the objective of the UNFCCC, namely to avoid “dangerous anthropogenic interference with the climate”, may be achieved.

Notes

1. All temperature increases in this proposal are given as the warming above the preindustrial baseline, even if this is not mentioned each time.
2. Calculated using radiative forcing given by the IPCC (2007a, p. 204) and assuming a climate sensitivity of 0.8°C/Wm⁻² (approximately 3°C for a doubling of CO₂).
3. Radiative forcing is a useful measure for directly comparing diverse factors that affect the Earth’s climate. Measured in Watts per meter squared (Wm⁻²), the value describes the equivalent change in net solar irradiance at the tropopause (top of the troposphere) caused by a given climate driver (for example, an increase in greenhouse gas concentration or a change in albedo).
4. Note that, because it takes several decades for the global temperature to equilibrate with a change in radiative forcing, breaching the forcing threshold will not immediately lead to breaching of the temperature threshold. Rather the threshold is a stabilization target, indicating that the value should not be exceeded for a substantial length of time (more than a decade or so).
5. In the longer-term, the world should aim for stabilization at a maximum (and ideally well below) 3.1 Wm⁻² of positive forcing (rather than net forcing), which would likely require the removal of some long-lived greenhouse gases from the atmosphere. Exceeding the forcing threshold with long-lived greenhouse gases and then relying on the cooling effect of short-lived sulfates places an indefinite burden on future generations, requiring them to either continue emissions of sulfates that might otherwise be controlled to improve public health, or to launch a geoengineering project to otherwise sustain their cooling effect.
6. Because emissions of halocarbons are covered under the Montreal Protocol and subsequent conventions, their limitation is not considered here. It is instead assumed that limitations in halocarbon emissions will be aggressively pursued under that agreement (Velders *et al.*, 2007).
7. For example, ozone is not emitted directly, but is formed from the reaction of NO_x and volatile organic compounds. Soot is distributed extremely heterogeneously in the atmosphere and the effect of emissions reductions on atmospheric warming depends

partly on the ambient black carbon concentration and on the underlying surface albedo, hence differs from region to region, making international trading of emissions reductions problematic.

8. The model used is a simple four region Excel model that accounts for emissions of CO₂ from fossil fuel burning and deforestation, CH₄, N₂O, and the direct and indirect effects of sulfate. Past emissions are assembled with datasets from WRI (2007), Houghton (2003), Ramankutty and Foley (1999), Stern and Kaufman (1998), Olivier and Berdowski (2001) and Smith *et al.* (2004), with projected emissions from IPCC (2000) and lifetime and forcing equations from Hansen *et al.* (2007) and IPCC (2001, 1997). The complicated chemistry and spatial heterogeneity of tropospheric ozone and soot make them too difficult to include in such a simple model so reductions in radiative forcing will in fact be larger than suggested above under the proposed scenario; for an indication of the likely magnitude of these effects, see CCSP (2008).
9. Although the B2 scenario is intermediate in the suite of SRES storylines, the growth in emissions since 2000 has exceeded the high-end A1FI scenario (Canadell *et al.*, 2007). However, the B2 storyline might be roughly consistent with developing countries undertaking commitments to improve energy efficiency, as proposed above.

References

- Aldy, J.E., Barrett, S. and Stavins, R.N. (2003), "Thirteen plus one: a comparison of global climate policy architectures", FEEM working paper, Vol. 64, July.
- Baer, P. and Athanasiou, T. (2007), "Frameworks and proposals: a brief, adequacy and equity-based evaluation of some prominent climate policy frameworks and proposals", *Global Issues Papers*, Vol. 30.
- BP (2007), *Statistical Review of World Energy 2007*, British Petroleum – BP, London.
- Bureau of Energy Efficiency (2008), *About Us*, Bureau of Energy Efficiency, New Delhi, available at: www.bee-india.nic.in (accessed 21 June 2008).
- Canadell, J.G., Pataki, D. and Pitelka, L. (2007), "Contributions to accelerating atmospheric CO₂ growth from economic activity, carbon intensity, and efficiency of natural sinks", *Proceedings of the National Academy of Sciences*, Vol. 104 No. 47, pp. 18866-70.
- CCSP (2008), "Climate projections based on emissions scenarios for long-lived and short-lived radiatively active gases and aerosols", in Levy, H. II, Shindell, D.T., Gilliland, A., Schwarzkopf, M.D. and Horowitz, L.W. (Eds), *A Report by the US Climate Change Science Program and the Subcommittee on Global Change Research*, Department of Commerce, NOAA's National Climatic Data Center, Washington, DC.
- Hansen, J., Sato, M., Ruedy, R., Kharecha, P., Lacis, A. and Miller, R. (2007), "Dangerous human-made interference with climate – a GISS modelE study", *Atmospheric Chemistry and Physics*, Vol. 7, pp. 2287-312.
- Houghton, R.A. (2003), "Revised estimates of the annual net flux of carbon to the atmosphere from changes in land use and land management 1850-2000", *Tellus B*, Vol. 2, pp. 378-90.
- IPCC (1997), in Houghton, J.T., Kram, A., Makarov, B., Sorensen, B., Yokobori, K. and Zhou, F. (Eds), *Technical Paper II: An Introduction to Simple Climate Models Used in the IPCC Second Assessment Report*, Intergovernmental Panel on Climate Change – IPCC, pp. 41-2.
- IPCC (2000), in Nakićenović, N. and Swart, R. (Eds), *Special Report on Emissions Scenarios (SRES)*, Intergovernmental Panel on Climate Change – IPCC, Cambridge University Press, Cambridge.

- IPCC (2001), in Houghton, J.T., Ding, Y., Griggs, D., Noguer, M., van der Linden, P. and Xiaosu, D. (Eds), *Climate Change 2001: The Scientific Basis*, Intergovernmental Panel on Climate Change – IPCC, Cambridge University Press, Cambridge, pp. 800-23.
- IPCC (2007a), in Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (Eds), *Climate Change 2007: The Physical Science Basis*, Intergovernmental Panel on Climate Change – IPCC, Cambridge University Press, Cambridge.
- IPCC (2007b), in Parry, M., Canziani, O.F. and Palutikof, J.P. (Eds), *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Intergovernmental Panel on Climate Change – IPCC, Cambridge University Press, Cambridge.
- Lange, A., Vogt, C. and Ziegler, A. (2007), “On the importance of equity in international climate policy: an empirical analysis”, *Energy Economics*, Vol. 29 No. 3, pp. 545-62.
- MacCracken, M.C. (2008a), “Prospects for future climate change and the reasons for early action”, *Journal of the Air and Waste Management Association*, Vol. 58, pp. 735-86.
- MacCracken, M.C. (2008b), “Prospects for future climate change and the reasons for early action: a summary of the 2008 critical review”, *The Magazine for Environmental Management*, June.
- Manne, A.S. and Richels, R.G. (2000), “A multi-gas approach to climate policy – with and without GWPs”, FEEM Working Paper, No. 44.
- Marland, G., Boden, T.A. and Andres, R.J. (2007), “Global, regional, and national fossil fuel CO₂ emissions”, *Trends: A Compendium of Data on Global Change*, Oak Ridge National Laboratory, Information Analysis Center, Oak Ridge, TN.
- Matthews, H.D. and Caldeira, K. (2008), “Stabilizing climate requires near-zero emissions”, *Geophysical Research Letters*, Vol. 35, L04705.
- Meinshausen, M. (2006), “What does a 2°C target mean for greenhouse gas concentrations? A brief analysis based on multi-gas emission pathways and several climate sensitivity uncertainty estimates”, in Schellnhuber, J.S., Cramer, W., Nakicenovic, N., Wigley, T.M.L. and Yohe, G. (Eds), *Avoiding Dangerous Climate*, Cambridge University Press, New York, NY, pp. 265-79.
- Olivier, J.G.J. and Berndowski, J.J.M. (2001), “Global emissions sources and sinks”, in Berndowski, J., Guichert, R. and Heij, B.J. (Eds), *The Climate System*, A.A. Balkema and Swets & Zeitlinger Publishers, Lisse, pp. 33-78.
- Pew Center on Global Climate Change (2007), “Climate change mitigation measures in the People’s Republic of China”, available at: www.pewclimate.org
- Point Carbon (2008), “Carbon market transactions in 2020: dominated by financials?”, *Carbon Market Analyst*, 21 May.
- Posner, E.A. and Sunstein, C.R. (2008), “Justice and climate change”, Harvard Project on International Climate Agreements, Discussion Paper 08-04.
- Ramanathan, V. and Carmichael, G. (2008), “Global and regional changes due to black carbon”, *Nature Geoscience*, Vol. 1, pp. 221-7.
- Ramankutty, N. and Foley, J. (1999), “Estimating historical changes in global land cover: croplands 1700-1992”, *Global Biogeochemical Cycles*, Vol. 13, pp. 997-1027.
- Reilly, J., Prinn, R., Harnisch, J., Fitzmaurice, H., Jacoby, H., Kicklighter, D. and Melillo, J. (1999), “Multi-gas assessment of the Kyoto Protocol”, *Nature*, Vol. 407, pp. 549-55.
- Rosenzweig, C. (2008), “Attributing physical and biological impacts to anthropogenic climate change”, *Nature*, Vol. 453, pp. 353-7.

-
- SEG (2007), “Confronting climate change: avoiding the unmanageable and managing the unavoidable”, in Bierbaum, R.M., Holdren, J.P., MacCracken, M.C., Moss, R.H. and Raven, P.H. (Eds), *Scientific Expert Group on Climate Change – SEG*, prepared for the United Nations Commission on Sustainable Development by Sigma Xi, Research Triangle Park, NC, and the United Nations Foundation, Washington, DC.
- Smith, S.J., Andres, R., Conception, E. and Lurz, J. (2004), “Sulfur dioxide emissions: 1850-2000”, JGCRI Report, Pacific Northwest National Laboratories-14537.
- Stern, D. and Kaufman, R. (1998), “Annual emissions of global anthropogenic methane: 1860-1994”, *Trends Online: A Compendium of Data on Global Change*, CDIAC Oak Ridge National Laboratory, Oak Ridge, TN.
- Stern, N. (2007), *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge.
- Sugiyama, T. and Deshuh, L. (2004), “Must developing countries commit quantified targets? Time flexibility and equity in climate change mitigations”, *Energy Policy*, Vol. 32, pp. 697-704.
- Tarasofsky, R.G. (2008), “Heating up international trade law: challenges and opportunities posed by efforts to combat climate change”, *Climate Change Law Review*, Vol. 1, pp. 7-17.
- Tol, R.S.J., Heintz, R.J. and Lammers, P.E.M. (2003), “Methane emission reduction: an application of FUND”, *Climatic Change*, Vol. 57, pp. 71-98.
- UNDP (2007), *Human Development Report 2007/2008: Fighting Climate Change*, United Nations Development Programme – UNDP, New York, NY.
- UNEP (2008), *CDM Pipeline*, United Nations Environment Programme, New York, NY, available at: cdmpipeline.org/cdm-projects-region.htm#1 (accessed 1 May 2008).
- Velders, G.J.M., Andersen, S.O., Daniel, J.S., Fahey, D.W. and McFarland, M. (2007), “The importance of the Montreal Protocol in protecting climate”, *Proceedings of the National Academy of Sciences*, Vol. 104, pp. 4814-19.
- World Bank (2007), *International Trade and Climate Change: Economic, Legal and Institutional Perspectives*, World Bank, Washington, DC.
- World Bank (2008), *World Bank List of Economies*, World Bank, Washington, DC, available at: <http://go.worldbank.org/K2CKM78CC0> (accessed 17 October 2008).
- WRI (2007), *Carbon Analysis Indicator Tool, Version 3.0*, World Resources Institute – WRI, Washington, DC, available at: cait.wri.org

Further reading

- Stephens, B.B., Gurney, K.R. and Tans, P.P. (2007), “Weak northern and strong tropical land carbon uptake from vertical profiles of atmospheric CO₂”, *Science*, Vol. 316, pp. 1732-5.
- Wigley, T.M.L. (2005), “The climate change commitment”, *Science*, Vol. 307, pp. 1766-9.

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Appendix G

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April 14, 2010

Mr. Leif Hockstad
U.S. Environmental Protection Agency
Climate Change Division (6207J)
1200 Pennsylvania Ave., NW
Washington, DC 20460

Re: 2010 Draft U.S. Greenhouse Gas Inventory Report
Comments by the Center for a Competitive Waste Industry

Dear Mr. Hoskstad:

Thank you for the opportunity to provide comments by the Center for a Competitive Waste Industry on the U.S. Environmental Protection Agency's (EPA) 2010 Draft U.S. Greenhouse Gas Inventory Report (Draft). As someone formerly retained by EPA to review its landfill gas protocols, and someone independent of the landfill industry, we hope that you find the recommendations useful.

In summary, we recommend that the Draft be changed as follows:

(1) *Global warming potential.* Include in the table showing each sector's responsibility for anthropogenic greenhouse gas emissions the applicable value when current instead of obsolete Global Warming Potential multipliers are used.

(2) *Short-term strategies.* Employ a two-pronged strategy that includes a short-term along with the long-term approach in reported inventory values.

(3) *First Order Decay Model.* Replace the First Order Decay Model, which fails to account for internal moisture levels critical for gas generation, with a revised model that does.

Some of the recommendations can be accommodated within the Intergovernmental Panel on Climate Changes' (IPCC) Guidelines,¹ and others may not. For those that may not, nothing in the Guidelines precludes an Annex I signatory to the United Nations Framework Convention on Climate Change (UNFCCC) treaty from providing supplemental information as part of the formal inventory. For the future, inasmuch as EPA's views have guided the development of the IPCC's 1996 and 2006 support documents for landfills, and to the extent that the facts presented are correct and its policies, constructive, the agency can pursue their inclusion in future updates of the Guidelines.

¹ IPCC, 2006 *Guidelines for National Greenhouse Gas Inventories* (2006).



I. GENERIC COMMENTS

A. Global Warming Potential

The reported anthropogenic warming impacts from the different greenhouse gases (GHGs) are converted into a common carbon dioxide (CO₂) equivalent basis by the use of Global Warming Potential (GWP) multipliers, which is a set of factors for each GHG. Of import, these factors are not immutable, but rather are periodically updated to comport with the current state of knowledge about such complex factors as indirect effects.

However, even though the Draft tracks Guidelines, it uses GWP factors that were actually published in 1996 (but, in fact, actually estimated several years prior to that publication date), and ignores the last 15 or more years of updated values that reflect what is now known.

According to the Draft, obsolete data was relied upon because:

“The UNFCCC reporting guidelines for national inventories were updated in 2006, but continue to require the use of GWPs from the IPCC Second Assessment Report (SAR) (IPCC 1996). This requirement ensures that current estimates of aggregate greenhouse gas emissions for 1990 to 2008 are consistent with estimates developed prior to the publication of the IPCC Third Assessment Report (TAR) and the IPCC Fourth Assessment Report (AR4).”²

There may be value in having a consistent time series, but there is an even greater value in providing an inventory for 2010 that reflects the current state of knowledge. Otherwise, if a consistent time series were the only consideration reflected in the inventory, decision-makers, who use the inventory to triage priorities for government action, will be presented with obsolete information about the different GHG gases that does not reflect what we now know about how those gases’ impact climate.

As a salient example, the GWP for methane is assumed to be 21 times CO₂, which is what was known in the years prior to 1996, almost 20 years ago.

Since then, in AR4 (published in 2007), methane’s GWP (on a 100 year basis) was 25 times CO₂,³ and the most recent information from the National Aeronautics and Space Administration (NASA) is that methane has 34 times the long-term warming impact of CO₂.⁴ The reason why this value changes is due to the growing knowledge about the *indirect* impacts of methane on radiative forcing, first in terms of stratospheric water vapor, then tropospheric ozone, and, most recently, mixing with aerosols.

² Draft, at p. ES-3.

³ IPCC, [Fourth Assessment Report: Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing](#) (2007), at p. 212. That value, in turn, was several years out of date when FAR was finally published in 2007, and, as indicated next, has now been supplanted.

⁴ Drew Shindell, [“Improved Attribution of Climate Forcing Emissions,”](#) 326 SCIENCE 716 (2009).

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To use a GWP for methane in 2010 of 21, when the most reliable value today is 62% *greater*, has the effect of grossly undercounting the impacts of sources of anthropogenic methane emissions compared to sources of other greenhouse gases. That cannot but gravely distort society's response to a much more serious threat and result in a misapplication of resources to avert climate change, especially in the context of near-term impacts described next.

Therefore, we recommend that the final inventory include the existing table that shows a consistent time series from 1990 to 20008 (as modified by the other comments that follow below) to comport with the Guidelines. But, then the table should include an additional right-hand column showing the 2008 data converted to the current data on GWPs. Nothing in the Guidelines precludes or discourages more accurate supplementation.

There is an enormous value in incorporating the most reliable data into decision-making, and the Draft fails to accord this need its due. If the definition of "authoritative" were somehow to be twisted to mean "hopelessly out-of-date," the practical utility of the entire exercise would be called into question and resemble nothing so much as "fiddling while the world burns." The difference between 1996's very preliminary state of knowledge then, which was largely ignorant of methane's indirect effects, and today, more than 15 years later, is simply too great to ignore on the grounds of nothing more substantive than bureaucratic inertia.

B. Short Term Climate Impacts

Each GHG has a different residence time in the atmosphere before they decay or are absorbed, from 0.38 years for methylene chloride to 50,000 years for PFC-14, with 12 years for methane.⁵ In order to equate each GHG to CO₂, the same residency must be assumed to perform the calculation, even though, in fact, the gases remain airborne for vastly different periods. The current convention for that common denominator is 100 years, which initially was the proxy for CO₂'s duration in the atmosphere.⁶

However, global warming does not proceed linearly over time, but rather, accelerated by positive feedback loops, changes in climate can ramp up rapidly and irreversibly in the near term as tipping points are crossed.⁷ In response to this implacable reality, a growing body of scientific opinion has more recently urged a two-pronged strategy to address those points of no return. This is not to suggest either ignoring or demoting the long-term consequences. Rather, the recommendation is only to recognize that, in order to sustain the viability of human institutions until that far-off day arrives, we must first insure that quick action is taken to avert crossing key tipping points, after which further remedial action is no longer possible:

"Policy must evolve and incorporate the emerging science in order to be effective. There is a growing need to create a two-pronged framework capable of

⁵ See NOTE 3, *supra*.

⁶ *Id.*

⁷ Timothy M. Lenton, et al., "Tipping elements in the Earth's climate system," 105 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 6, at pp. 1786-1793.

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not only mitigating long-term climate change but also managing the magnitude and rate of change of near-term R[adiative] F[orcing]. Short-lived pollutants (black carbon and tropospheric ozone) and medium-lived pollutants (methane) account for more than half of the positive RF generated in years 1 to 20.”⁸

Once the need for such a two-pronged strategy is understood, then attention quickly turns to methane as the most important GHG for that approach, as Dr. Jackson alludes to in his above statement. According to climate scientists at the National Aeronautics and Space Administration (NASA), the combination of methane’s warming potency, and its short lifetime in the atmosphere, plays an especially critical role in the near term when we confront those critical tipping points. Methane’s residency is 12 years, and, when measured in the next 20 instead of 100 years, is 105 times as powerful as CO₂.⁹

“[F]easible reversal of the growth of atmospheric [methane] and other trace gases would provide a vital contribution toward averting dangerous anthropogenic interference with global climate...[Methane] deserves special attention in efforts to stem global warming...Given the difficulty of halting near-term CO₂ growth, the only practical way to avoid [dangerous interference] with climate may be simultaneous efforts to reverse the growth of [methane].”¹⁰

Similarly, Robert Watkins, the co-chair of the IPCC’s Third Assessment, recently wrote in the disappointing aftermath of Copenhagen:

“This month’s Copenhagen talks focused on the leading climate change culprit: CO₂. But reversing global temperature increases by reducing carbon emissions will take many decades, if not centuries. Even if the largest cuts in CO₂ contemplated in Copenhagen are implemented, it simply will not reverse the melting of ice already occurring ...The most obvious strategy is to make an all-out effort to reduce emissions of methane. Methane’s short life makes it especially interesting in the short run, given the pace of climate change. If we need to suppress temperature quickly in order to preserve glaciers, reducing methane can make an immediate impact. Compared to the massive requirements necessary to reduce CO₂, cutting methane requires only modest investment. Where we stop methane emissions, cooling follows within a decade, not centuries. That could make the difference for many fragile systems on the brink.”¹¹

⁸ Stacy C. Jackson, “Parallel Pursuit of Near-Term and Long-Term Climate Mitigation,” 326 *SCIENCE* 526 (2009), excerpted from 526-527. See, also, Alissa Kendall, et al., “Accounting for Time-Dependent Effects of Biofuel Life Cycle Greenhouse Gas Emissions Calculations,” *Environ. Sci. Techn.* (August 14, 2009), p. 6907.

⁹ See note 3, *supra*.

¹⁰ James Hansen, “[Greenhouse gas growth rates](#)”, 101 *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES* 46 (November 16, 2004), p. 161094.

¹¹ Robert Watson and Mahamed El-Ashry, “[A Fast, Cheap Way to Cool the Planet.](#)” *The Wall Street Journal* (December 29, 2009).

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Indeed, EPA, itself, has long observed methane's critical importance for addressing short term climate impacts:

“This relatively short lifetime makes methane an excellent candidate for mitigating the impacts of global warming because emission reductions could lead to stabilization or reduction in methane concentrations within 10-20 years.”¹²

For these reasons, we strongly urge the Draft to include an additional chapter on short-term impacts (i.e. the next twenty years), along with the 100-year inventory values, and the GWP factors that are applicable to that time frame, along with reference to the greenhouse gases most important to short term climate action plans. In the case of methane, as noted, that would be a multiplier of 105 times CO₂'s warming potential when using the latest data, and 72 times CO₂'s, when using the data from AR4. This would enable decision-makers to assess where their short-term climate action plans should be most effectively directed.

This additional supplementation also comports fully with the IPCC protocols. The Second Assessment stated that while the UN Framework held there should be one set of consistent 100 year based GWP values across reporting nation's inventories, it also specifically provided that “[p]arties may also use other time horizons.”¹³

II. LANDFILLS

As discussed in Chapter 8 of the Draft, along with Annex 3.1, landfills are among the significant sources of GHGs associated with climate change, because organic discards, which are half or more of total discards, if not separated at the source, are most often buried. In the oxygen-starved environment of a sealed landfill, food scraps, soiled paper, grass clippings, leaves, brush and other organic matter decompose anaerobically under the influence of methanogenic microbes. These thrive in the absence of oxygen, and create methane as a byproduct of decomposition.

Because modern lined landfills can extend for hundreds of acres in extent and rise hundreds of feet above grade, gas generated inside the waste body flows out into the atmosphere through myriad routes that defy measurement. This includes not only through cracks, tears and broken seams at the surface and along the sides and top, but also conveyed along the bottom of a facility following leachate collection gravel trenches and piping, wherever there is a path of least resistance.¹⁴

¹² EPA, *U.S. Methane Emissions 1990 – 2020: Inventories, Projections, and Opportunities for Reductions* (EPA430-R-99-013, 1999), at p. 1-2.

¹³ EPA, *Greenhouse Gases and Global Warming Potential Warming Values* (April 2002), at p. 9.

¹⁴ George Tchobanoglous, *Integrated Solid Waste Management* (McGraw Hill, 1993), at p. 394. Memorandum to Brian Guzzone, EPA, from Chad Leatherwood, Eastern Research Group, Inc., dated November 18, 2002, re: Review of Available Data and Industry Contacts Regarding Landfill Gas Collection Efficiency (Leatherwood Memo), at p. 2.

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In an attempt to overcome this lack of data, the process underlying the Annex's description purports to use the following mass balance equation that is calculated for each year:

$$\left| \text{Gas released} = \text{Gas generated} - \text{Gas captured} - \text{Gas oxidized} \right| (1)$$

As discussed below, the problems with this attempt to represent reality are:

(1) **Incorrect Modeling.** Only one of the three terms to the right, Gas Captured, is known. Two are only modeled, not observed, values, namely Gas Generation and Gas Oxidized.¹⁵ To estimate the unknown Gas Generation in order to then estimate Gas Released, a model is used which is inapplicable to the particular and unique conditions of a lined landfill and fails to include a coefficient for the most critical independent variable involved in decomposition of buried wastes, the level and distribution of essential moisture. Moreover, many of the landfill input data appears to be incorrect.

(2) **Incomplete Landfill Phases.** Gas generation from wastes interred today continue for decades into the future at a rate that varies with five different phases in a landfill's life that affects the level and distribution of essential moisture, all of which is ignored by the Draft's methodology.

(3) **Oxidation Misapplied.** The studies used to estimate oxidation are inapplicable to lined landfills.

Most of the controverted modeling turns on the equation used in the Draft to estimate Gas Generated, which is explained first.

A. Modeling

EPA first estimates the amount of annual Gas Generated based upon modeling by using a First Order Decay (FOD) equation, which in its simplified form is expressed:¹⁶

$$\left| \text{Methane} = \sum_{i=1}^n M \times L_o \times k \times e^{-k \times t_i} \right| (2)$$

¹⁵ Gas Oxidized refers to the extent to which escaping methane is oxidized in a soil layer on top of the landfill.

¹⁶ Debra Reinhart, *First Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072, June 2005), at Part 2-6, which describes 12 different variations on the same form. The variants primarily modify the manner in which time is accounted for (e.g. delaying the onset of gas generation for a lag phase, using decimal time instead of annual time intervals, etc.), rather than making the model more robust by accounting for more factors. Current default values recommended by EPA, which were reached by trial and error, are $L_o = 100 \text{ m}^3/\text{Mg}$ and $k = 0.04/\text{yr}$. EPA, *AP-42: Municipal Solid Waste Landfills*, Vol. 1, , at p. 2.4-4.

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Where: M is remaining mass, L_0 is lifetime gas potential, k is annual decay rate

Unfortunately, this simplified model, and all of its variants, was derived from, and is only applicable to, a continuous decay phenomena acting upon a declining mass, where the decay rate is independent of the availability of limiting pre-conditions that otherwise would impede particle disintegration. An example would be the radioactive decay of a uranium isotope that is represented by a constant decay rate multiplied by the mass, which declines each year as the original mass is reduced by the prior year's decay.

Moisture pre-condition. Anaerobic decomposition in a landfill suffers far too many complications for such a simplified model to be valid. In particular, first, as discussed in this section, the model does not account for whether the distribution and quantity of essential moisture is adequate to sustain the near optimal levels of decomposition assumed by the model. Yet, inexplicably, the Draft's list of relevant factors for methane formation ignores the necessity for their being very high moisture levels.¹⁷

Along with heat, microbes and pH, which generally are not limiting conditions, decomposition in a landfill cannot comprehensively proceed as the model predicts unless there is a continuing adequate supply of moisture greater than 50%. However, the entrained moisture in the incoming wastes is less than 25%,¹⁸ and the very act of collecting gas from a landfill quickly dehydrates a covered site in a few years because half of the gas removed (by weight) is water vapor.¹⁹

In addition, the liquids need to be evenly distributed. Unfortunately, moisture is not dispersed throughout landfills. Municipal solid waste is exceedingly heterogeneous, heavily compacted in a landfill to about eight times its original volume, interspersed over each day's lift with daily cover, and often confined in splayed open plastic bags, all of which creates highly preferential paths of flow. Earlier estimates from the 1990s are that liquids only reach 23% to 34% of the mass,²⁰ and, with in-place densities more than 50% greater today, the dispersion of moisture is presumably significantly less now.

Typically, then, and at best, only limited volumes of gas is actually generated at an operating landfill, before it is closed tight. Even for that short period, decomposition is essentially restricted to isolated pockets where there are aggregations of food scraps and grass clippings that transport their own moisture with them, as well as at the bottom where hydraulic heads accumulate above clogged leachate lines and gravel beds. Differences in cover and operational

¹⁷ Draft, at p. 2, lines 21-25.

¹⁸ George Tchobanoglous, *Integrated Solid Waste Management: Engineering Principles and Management Issues* (McGraw-Hill, 1993), at pp. 72-73 and 393.

¹⁹ Rapid dehydration can be seen by the fact that, at 100% saturation and 40° C (104°F) temperature, the condensate is 51% by weight of the weight of the gas, according to standard Humidity Tables, and landfill gas weighs 0.0834 lbs./cf., according to standard conversions.

²⁰ Debra Reinhart, *Prediction and Measurement of Leachate Head on Landfill Liners*, Florida Center for Solid and Hazardous Waste Management (Report #98-3) (1998), at p. viii.

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practices implicate whether there is any replenishment or supplementation of moisture levels in situ that, in some cases, increases gas generation. After closure, and for as long as the cover seal maintains its integrity, gas generation rapidly tapers off as the site, for a time, takes on the intended characteristics of a “dry tomb.” After the cover eventually fails, gas generation resumes until the residual carbon is exhausted and the site is biologically stabilized.

None of this wide moisture related variation in the rate of decomposition, and gas generation, is accounted for by FOD modeling, which represents a continuous function and that divergence underlies the irrational outputs the model generates.

Anomalous outputs. The extreme inexplicable and anomalous variability of the results the FOD model produces, which is widely reported in the literature, undermines its credibility at the outset. Even the EPA AP-42 background paper acknowledged that in its analysis:

“The recommended defaults k and L_0 for conventional landfills, based upon the best fit to 40 different landfills, yielded predicted CH₄ emissions that ranged from ~30 to 400% of measured values and had a relative standard deviation of 0.73.”²¹

The most recent survey by Thompson of the results of FOD modeling in landfills concluded that:

“Landfill gas models continue to receive criticism due to their poor accuracy and insufficient validation: most model results have not been evaluated against methane recovery data. A few studies have compared methane recovery data to estimates of methane generation from models, but only for a few landfills. This limited approach is inadequate to validate the model for a wide, rather than site-specific application.”²²

Similar:

²¹ EPA, *Background Information Document for Updating AP42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills* (EPA/600/R-08-116) (September 2008), at p. 9.

²² Shirley Thompson, et al., “Building a better methane generation model: Validating models with methane recovery rates from 35 Canadian landfills,” *Waste Management* 29 (2009), 2085, at 2086. Thus, to illustrate Dr. Thompson’s point, the oft-cited French study, K. Spokas, et al., “Methane mass balance at three landfill sites: What is the efficiency of capture by gas collection systems,” *Waste Management* 26 (2006) 516, which was based on a study of only three landfills, was rejected by EPA’s own consultant, who found:

“The results of this study on two landfills reported LFG collection efficiencies of 94 percent and 98 percent. However, at the French facility that reported 94 percent LFG collection efficiency, this efficiency was based on the lowest of three predicted LFG generation levels for that facility. When the highest estimate of LFG generation is used, then the LFG collection efficiency drops to 84 percent. This raises the issue again that a major difficulty in determining LFG collection efficiencies is accurately estimating LFG generation levels.” Memorandum to Brian Guzzone, US EPA, from Chad Leatherwood, Eastern Research Group, Inc., dated November 18, 2002, re: Review of Available Data and Industry Contacts Re: Landfill Gas Collection Efficiency, at p. 2.

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“Results of this study suggest that the first order model cannot always be applied to full-scale landfill gas collection data with statistical significance.”²³

Another published paper that performed a random verification of related modeling of California landfills found a dispersion of 25 major landfills of predicted compared to actual values for gas collection efficiency, which ranged from 7% to 100%.²⁴

A more recent unpublished survey of 46 California landfills by the California Air Resources Board reproduced in Table 1 found implied gas collection efficiency from gas generation estimated with LandGEM first order equations ranging from 6% to 225% gas captured, which is an exceedingly impressive engineering feat. California Air Resources Board, Staff Spreadsheet Titled Landfill Survey Data Public (2010), released in response to a Public Records request by Californians Against Waste. Similarly, the Wisconsin Department of Natural Resources did a comparison of actual gas collected to estimate gas generation in the State’s landfills and found a wide and physically impossible outputs like those found in California’s study. See on-line at <http://dnr.wi.gov/org/aw/wm/solid/gas/gas.htm#art6>.

²³ Debra Reinhart, “Landfill Gas to Energy: Incentives and Benefits,” University of Central Florida (Report #08-32026)(February 2010), at p. vi.

²⁴ Nickolas Themelis and Prisilla Ulloa, “Methane generation in landfills,” *Renewable Energy* 32 (2007), 1243, at 1250.

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Landfill Survey Response Data			Survey CH ₄ Captured/Model CH ₄ Generation (%)						
Landfill	2006 WIP (%)	Avg. CH ₄ (%)	2000	2001	2002	2003	2004	2005	2006
1	9.4%	35%	109%	120%	107%	108%	112%	140%	140%
2	3.7%	46%	87%	108%	114%	109%	107%	135%	130%
3	3.2%	52%	61%	63%	73%	68%	52%	51%	83%
4	3.0%	39%	63%	73%	66%	79%	76%	90%	87%
5	2.7%	36%	91%	91%	91%	91%	84%	98%	92%
6	2.3%	34%	121%	121%	121%	121%	121%	121%	121%
7	2.2%	42%	99%	105%	109%	111%	105%	107%	104%
8	2.2%	14%	6%	5%	4%	6%	5%	6%	6%
9	1.9%	16%	66%	65%	65%	57%	59%	76%	76%
10	1.8%	25%	125%	113%	100%	97%	112%	124%	124%
11	1.8%	50%	64%	69%	71%	69%	66%	63%	63%
12	1.8%	42%	127%	127%	127%	127%	127%	146%	117%
13	1.4%	32%	121%	137%	128%	123%	119%	126%	126%
14	1.3%	49%	124%	119%	105%	102%	102%	76%	72%
15	1.3%	50%	59%	51%	41%	54%	54%	54%	54%
16	1.3%	43%	351%	261%	231%	226%	172%	166%	165%
17	1.2%	40%	45%	45%	45%	45%	53%	46%	44%
18	1.1%	39%	118%	118%	118%	118%	133%	118%	109%
19	1.1%	47%	78%	54%	96%	103%	90%	90%	116%
20	1.1%	44%	64%	63%	65%	40%	51%	39%	37%
21	0.8%	51%	89%	90%	103%	82%	81%	83%	108%
22	0.7%	50%	74%	73%	76%	88%	75%	94%	121%
23	0.6%	48%	152%	180%	140%	109%	104%	96%	91%
24	0.5%	48%	28%	35%	42%	50%	62%	70%	64%
25	0.4%	59%	57%	57%	57%	57%	57%	57%	57%
26	0.4%	29%	22%	22%	20%	21%	21%	25%	21%
27	0.4%	48%	23%	23%	23%	23%	15%	21%	34%
28	0.3%	38%	20%	26%	23%	21%	19%	14%	16%
29	0.3%	40%	111%	111%	116%	102%	114%	99%	98%
30	0.3%	43%	104%	104%	104%	104%	104%	93%	114%
31	0.3%	37%	29%	29%	29%	30%	33%	28%	25%
32	0.2%	42%	31%	31%	31%	31%	31%	28%	34%
33	0.2%	41%	22%	22%	19%	20%	21%	24%	30%
34	0.2%	48%	103%	85%	80%	91%	124%	123%	135%
35	0.2%	17%	6%	6%	5%	6%	6%	6%	6%
36	0.1%	48%	78%	78%	78%	102%	74%	66%	79%
37	0.1%	32%	35%	40%	38%	54%	62%	62%	50%
38	0.1%	33%	38%	17%	20%	16%	17%	27%	23%
39	0.1%	38%	257%	257%	341%	234%	234%	216%	257%
40	0.1%	37%	44%	38%	33%	18%	33%	33%	33%
41	0.0%	45%	76%	76%	76%	85%	78%	65%	76%
42	0.0%	37%	69%	66%	63%	59%	56%	52%	49%
43	0.0%	30%	46%	41%	37%	32%	27%	23%	19%
44	0.0%	27%	165%	161%	157%	138%	137%	138%	126%
45	0.0%	31%	38%	38%	38%	38%	38%	22%	47%
46	0.0%	30%	18%	17%	14%	14%	14%	14%	10%

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Statistical validation failed. Initially, attempts to support the validity of FOD models was based upon a putative statistical test using regression equations of a sample that purported to show its predictions were a good fit.

The regression analysis prepared for EPA by Peer was intended to validate the FOD model's applicability to the approximately 2,000 MSW landfills in the United States,²⁵ but it failed to do so. The Peer study used too small a sample of only 21 landfills, or only 1% of the population, which is too few degrees of freedom for statistical significance. Also, none of those selected for the sample were chosen randomly, which removes the normal distribution essential for regression equations to estimate a population.

Furthermore, not only was the selection process not random, it was also chosen with a specific bias that has the effect of significantly skewing results to appear to show high capture rates. This was done by limiting the sample to landfills with energy recovery. These facilities typically recirculate leachate, which accelerates decomposition and gas generation,²⁶ in order to boost the profitability of electricity sales. That has been shown to increase near term gas generation very significantly, while only moderately increasing the volume of gas captured.²⁷ Since the model is blind to the fact that gas generation was augmented, the uptick in gas collected makes it seem appear that capture rates have significantly improved, even though they most probably have significantly declined.

Moreover, in addition to all those limitations, circular reasoning was used in performing the model's attempt at a statistical validation. In an attempt to assess the reasonableness of the model's estimates of Gas Generation, Eq. (3) is used to provide a putative independent estimate:²⁸

$$\left| \textit{Gas captured} = \textit{Gas generated} \times \textit{Gas capture rate} \right| (3)$$

Solving Eq. (3) for Gas Generated is shown in Eq. (4):

²⁵ R. L. Peer, et al., "A comparison of methods for estimating global methane emissions from landfills," 26 CHEMOSPHERE 387 (1993).

²⁶ Debra Reinhart, *First Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072)(June 2005), at p. 2-2.

²⁷ Contrast: Pat Sullivan and Alexander Stege, "An Evaluation of Air and Greenhouse Gas Emissions and Methane-Recovery Potential from Bioreactor Landfills," *MSW Management* (Sept./Oct. 2000), at p. 78, states that bioreactor landfills increase near term gas capture per ton of waste-in-place by 76%; with 67 FEDERAL REGISTER 36463 and 36465 (May 22, 2002), which states that bioreactors increase gas generation in the near term by 2 to 10 times.

²⁸ Debra Reinhart, "Landfill Gas to Energy: Incentives and Benefits," University of Central Florida (Report #08-32026)(February 2010), at p. 4.

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$$\left| \text{Gas generated} = \frac{\text{Gas captured}}{\text{Gas capture rate}} \right| \quad (4)$$

But, since only one of the two independent variables is known, this exercise rests on a house of cards. For the Gas Capture Rate is also unknown and an unsupported guesstimate is used, defeating the attempt to provide a solid foundation for the calculation. Thus, to solve the equation for Gas Generation, the study just *assumed* that Gas Capture Rate was 75% at all times during a landfill's life. Recalling that one of the purposes of the entire exercise was to establish a factual basis for assuming 75% capture rates in the first place, this led to a circular exercise with no statistical value. As a tautological statement, it establishes nothing about Gas Capture Rates anymore than it does about Gas Generation.

Moreover, the problem is not just that the provenance of the 75% assumption is neither an observed value nor, in view of its definition as the best systems during the limited period of their peak performance, even a reasonable assumption. In addition, in order to perform the Pearson calculations, the analysis assumed that every single landfill in the study (i) exhibited identical performance, even though operating practices significantly affecting collection efficiency vary widely among landfills, as well as (ii) achieved that same high capture rate during all phases of each sites' biologically active or latent life, including the challenging times when there is no installed or functioning gas collection system. However, US EPA has never asserted that its 75% assumption was intended to apply for each landfill at all times. Rather, to the contrary, it only purported that 75% was intended to be an average value when considered across peak times and among all landfills.²⁹

Finally, in view of the fact that moisture, which is a limiting condition for decomposition landfill decay behavior obviously reflects complex interactions, which are especially difficult to model in a heterogeneous waste mass that goes through multiple phases some of which when prerequisite moisture levels are absent. The reason given to justify the paucity of other explanatory variables in the model to explain that complex environment, such as critical internal moisture levels, is that the excluded variables had statistically insignificant estimated coefficients in earlier versions of the regressions.

But, the problem of statistically insignificant coefficient estimates arises for many reasons other than the authors' claimed lack of importance. One of the reasons for insignificant coefficients is a small sample size that leads to limited degrees of freedom, which is evident in the study. Other problems include poorly formulated equations, data measurement errors, and inappropriate error term distribution specifications and related estimation procedures. Each of these problems exist.

²⁹

Debra Reinhart, *First Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072, June 2005), at p. 3-2 and 5-2. US EPA, *Background Information Document for Updating AP42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills* (EPA/600/R-08-116) (September 2008), at p. 7-8.

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This points towards an unreliable and questionable estimation process known as data mining or fishing, and not to the lack of importance of things, such as moisture, needed for a valid model. With these fishing procedures, various fuller models are formulated and discarded, not because they are not well formed or include inappropriate variables, but because the analysts did not want to confront the substantial complexities or consequences that more complete modeling would entail.

The exclusion of variables merely on the basis of low levels of estimated coefficient significance is not statistically justified, as dramatically shown by the irrational scattergun outputs it produces. For, if the excluded data are truly relevant, their exclusion leads to estimation bias and unreliable results. Coefficient significance is not an appropriate means for deleting variables from a regression model. Various appropriate tests exist for testing overall significance of a set of variables – in particular maximum likelihood ratio tests. The Peer paper does not show that these forms of significance testing were performed.

Due to all of the deficiencies discussed above, the results of the regression analyses cannot be relied upon to provide credible annual methane production quantities, anymore than the putative validation of the FOD model can corroborate that the model conforms to statistical norms. In addition to all of the problems discussed above, the low levels of R^2 's in the Peer study (one measure of the explanatory power of estimated regression equations) do not support a conclusion that the regression analyses provide reliable results.

The reason why the FOD model's outputs are anomalous is that its coefficients, variables and structure are incomplete and its input variables are wrong.

The most recent attempt by Thompson to validate FOD models through modifying its architecture is similarly flawed.³⁰ Thompson searches for the best FOD model to validate for estimating gas generation in order to solve the mass balance equation. It uses the Pearson correlation to compare the modeled estimates of gas generation to what it construes to be observed values among six variants of the FOD model at 35 non-randomly selected Canadian landfills with alternative assumptions about one of the factors, namely the assimilated organic fraction in the landfill, and adjustments to the values for L_0 and k that are irrelevant to gas generation.

The problems with this attempt are, first, that this so-called calibration approach is more akin to correlation fishing with a torn net. The study does not present a rational conceptual solution to errors that it identified in past modeling practices. Instead, by trial and error, it iteratively examines for each landfill the modeled gas generation estimates from each of the six variations on the same core equation, along with alternative input values, until it finds a best fitting Pearson correlations among historic landfill data.

However, the Pearson correlation does not show causality, but only a correlation that might be due to chance – a possible explanation whose probability increases markedly as the number of different values for variables and model permutations multiply, which more accurately

³⁰ Shirley Thompson, et al., "Building a better methane generation model: Validating models with methane recovery rates from 35 Canadian landfills," *Waste Management* 29 (2009), at p. 2085.

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resembles shooting fish in a barrel for correlates. In addition, the Pearson correlation is a process that says nothing about whether all critical explanatory variables, such as critical moisture levels, have been included in the model. As such, the Study's procedures are not a valid statistically appropriate procedure to derive reasonable estimates useful for future predictions of gas behavior among the population of municipal solid waste landfills.

Second, like Peer, the Thompson study is also circular. Pearson's correlation looks for linear associations between observed values and the parallel modeled estimates, here of gas generation. However, there are no observed values of gas generation to search for correlations with modeled generation outputs. In the three-term simplified mass balance equation above, only gas captured was known. In order to perform the Pearson analysis, the study resorts, at p. 2088, to the use of Eq. 4 to model further what is intended to be observed gas generation.

But, again, this equation with three terms, which is used in an effort to provide an observed value for gas generation, also has two unknowns. To produce a value for the desired observation for gas generation, the study is forced to make another assumption, which is not based upon any observations, about the gas capture rate. In this study, collection efficiency is *assumed* to be the average of 75%, which is the oft-cited US EPA assumption based upon the questionable decision to focus on the best systems at the limited time of their peak performance, and 85%, which is the claimed, but disputed, *Spokas* assumption,³¹ or 80%. However, the EPA view is based upon a literature review that simply ignored low reported values in the published literature. As regards *Spokas*' claimed 85% value, as noted previously, it was even rejected by EPA and also by *Thompson*.

Again, too, like Peer there is the further problem that, in order to perform the Pearson calculations, the analysis assumed that every single landfill in the study (i) exhibited identical performance during all phases of each sites' life, which is something that EPA never claimed for the assumption.

By way of comparison, incidently, the Intergovernmental Panel on Climate Change (IPCC) states that the average lifetime capture rate equivalent to EPA's best instantaneous rate is actually as low as 20%.³²

Thus, when the *Thompson* study rejected several scenarios because they seemed to "consistently produce[] much higher estimates than the [observed] methane generation rates," the calculated large standard errors it thought the analysis found were actually due to its arbitrary assumption about high capture rates rather than a real statistical deviation. Had the study used the lower IPCC assumption, the findings about which model showed the best fit would probably have been reversed.

As to the intention to improve upon the L_0 and k values by localizing them to the conditions in the Province in which the landfill is located, those only create the illusion, but not

³¹ , Kurt Spokas, et al., "Methane mass balance at three landfill sites: What is the efficiency of capture by gas collection systems," *Waste Management* 26 (2006), at p. 516.

³² IPCC, *Fourth Assessment Report*: Chapter 10:Waste Management (2007), at p. 600.

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the substance, of refinement. Using Provincial waste audits to derive L_0 is a meaningless gesture because audits are just visual inspections with very wide and unknown bands of uncertainty no better than the three-fold dispersion, from 100 to 310 $m^3/Mg.$, currently in the literature.³³

Similarly, the attempts to refine the k value by more closely correlating it to the Province's annual precipitation is also meaningless because the relevant criteria is moisture *inside* the landfills at different points in a landfill's life, not rainfall *outside* the facility. Directly intervening between surface and interior conditions at any given time are the permeability of any cover, any re-injection of leachate or outside liquids, in-situ compaction ratios, waste composition, the functionality of the leachate collection system, site geometry and surface grading practices. At times, in fact, after the final cover is installed and for as long as it is maintained, the waste mass will go bone dry and therefore generate very little gas (hence the moniker, "dry tomb landfills"), even if there is a monsoon raging at the surface.

But, most important for the model's structure, those factors affecting interior moisture levels vary over time. To illustrate, there is no low permeable cover until 5 to 15 years after first waste emplacement (when significant gas is generated), and then a barrier to infiltration installed and remains for as long as the cover is maintained (when very little gas is generated), after which its performance will decline and rain will re-infiltrate the site (when gas generation resumes). Therefore, the operative decay rate is not the same in those three different phases.

If the model is to reflect the critical limiting conditions for decomposition to occur, such as internal moisture levels, then the value for k also must be appropriate, and different, for those distinct time periods. That would be higher in the first and the last phase and much lower in the middle phase of a landfill's biologically active or latent life. Slightly modifying the value for k by site location, rather than by the landfill's phase, and as a constant value under all of these conditions, fails to rectify the fundamental flaw in the first order decay model as it is presently constructed. The use of a constant k value, more closely tied to a largely irrelevant factor, fails to correct the flaws in FOD models current contemplation of k .

Data Problems. The underlying data for the analysis is not transparent, but, we continue to believe that the data inputs used for Gas Captured and Methane Destroyed, systematically understate not only Gas Generation for the reasons described above, but also Gas Captured and destroyed.

From past experience, we believe that the aggregated data for Gas Captured continues to be grossly inflated. In the past when we last consulted for EPA, the landfill owners and vendors refused to provide actual data on gas collected at each landfill for the purpose of compiling a national data base, even though this data is typically available buried in the files of state regulators. In lieu of actual data, the nameplate capacity of the permitted flares were multiplied by the number of hours. This fails to account for subpar performance, maintenance and unexpected downtime. States should be queried to compile actual data, or if that is not possible, a statistical sample of landfills should be selected and state records reviewed to estimate the deviation from manufacturers' claimed values for the different equipment.

³³

Debra ` , *First Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072, June 2005), at p. 3-2.

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On a related note, while the high methane destruction values used are appropriate for flares, state enforcement officials report seeing performance for internal combustion engines below 95%. Field data should be compiled from actual state reports to improve the reliability of long-held assumptions. It is unfortunate that AP-42 continues to fail to provide any of the data that it collected in a form from which more reliable estimates might be developed.

B. First Three Phases. As noted, decomposition, and gas generation, are not a continuous function but rather are moisture dependent. In turn, the level, and distribution, of moisture depends primarily upon when the final cover is installed, and whether leachate is recirculated (and/or outside liquids added), as well as waste composition, in-situ compaction ratios, precipitation and transpiration, the presence of active gas collection wells, and surface grading

Typically, after first waste emplacement, the gas collection system is not installed for five years in large landfills (though not in smaller ones), but it does not function to its design standards until the final cover is installed soon thereafter that creates a necessary seal for the system's vacuum forces to work properly and to prevent oxygen infiltration from the surface when it fully draws. Before the cover is installed, moisture is brought to the landfill entrained in food discards, grass clippings and left over liquids at the bottom of containers, which is supplemented by infiltrating rainfall while the top remains open while the cell fills up. Following capping, the residual moisture is quickly dehydrated by the gas systems, because half of the extracted gas by weight is water vapor.

In wet cell landfills, discussed later, leachate is recirculated soon after first waste emplacement in order to accelerate decomposition, and often the final cover is delayed for several more years to extend the time when infiltrating rainfall can replenish moisture levels.

Thus, through the period of time that the cover is maintained, which may be approximately 30 years following closure, the landfill proceeds through three phases:

- 1 Pre-installation of the gas collection system
- 2 Post-gas collection installation but pre-installation of the final cover
- 3 Post-installation of the gas system and final cover but prior to the end of post-closure maintenance

This is not controversial. These different phases are accepted by EPA, and, indeed, the structure is reflected in the GHG Reporting Rule, and by the landfill industry.³⁴ These phases directly implicate how a landfill GHG inventory needs to be calculated. For, each of these phases evinces very different characteristics for the gas generation and gas collection, that varies significantly what is assumed in the First Order Decay model used in the draft inventory:

³⁴

40 C.F.R. §98.340 Subpart HH. US EPA, *Background Information Document for Updating AP42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills* (EPA/600/R-08-116) (September 2008), at p. 7-9; SCS Engineers (SCS), *Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills* (July 2007), at p. 10.

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Three Phases of Landfill Life Actual Landfill Characteristics Compared to First Order Decay Model		
	Gas Generation	Gas Collection
Pre Gas Collection Dry Tomb Wet Cell	Same Higher	Lower Lower
Post Gas/Pre Cover Dry Tomb Wet Cell	Same Higher	Lower Lower
Post Cover-Pre Maintenance Ends	Lower	Higher

Comparing the second to the third column shows the point that Prof. Hans Oonk made to the draft version of AR4. It convinced the IPCC that the average lifetime capture rate that was equivalent to EPA's 75% assumption of what the best systems might achieve at the point of their peak performance is as low as 20%.

While the EPA and landfill industry have recognized the fact of these three phases of a landfill's life, they do not seem to appreciate the paradox that Oonk first raised, namely gas capture is only good when there is scant gas production, and when most gas is generated, there is little or no gas collection.

The draft inventory, however, recognizes neither, not the existence nor the phases or the paradox that they create. Indeed, by performing the first order decay model on total estimated landfill tonnages in each prior year, instead of on each individual landfill as a function of which phase it is in that year, the calculation ignores all of these very significant distinctions. In aggregate, the effect, again, is to grossly understate landfill GHG emissions.

C. Second Wave

To further complicate matters, there is a critical *fourth* time period in a landfill's life-cycle that is critical to include in the GHG inventory, yet is currently ignored in both the draft inventory and the GHG Reporting Rule. That is the second wave of gas generation, after postclosure maintenance ends, when the majority of a landfill's lifetime gases are generated, and, with the site abandoned, are released unabated.

Moisture restrictions. The second wave occurs because of three factors. First, as noted, the organic material in solid waste require 60% or more moisture to decompose, while incoming wastes contains less than 25% moisture. Absent additional liquids, decomposition will be minimized.

Distribution limited. Second, moisture is not evenly distributed in landfills. Solid waste is highly heterogeneous, heavily compacted to eight times its original density, inter-leafed with daily cover, and often confined in partially splayed open plastic bags, all of which combine to create highly constricted preferred paths of flow. Field studies, undertaken in the late 1990s when waste

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densities were only two-thirds of their current ultra-high compaction levels, show that entrained and infiltrating liquids only reach 23% to 34% of the mass.³⁵ With in-place densities today 50% to 66% greater than when the study was done, dispersion of liquids will tend to be significantly less.

Essentially, prior to the site closing and being covered with a low permeable liner, decomposition is confined to a few areas. It only occurs where there is moisture entrained with the incoming food scraps and grass clippings and leaking out the bottom of bottles containing fluids, as well as where rain travels through cracks and fissures and then pools in pockets where food is decomposing and in voids between large particles.³⁶

After installation of the final cover, however, infiltration largely ceases and any residual moisture is quickly extracted with the gas, half of which is condensate (by weight) in the collection system, rapidly dehydrating the waste mass.³⁷ From the data, probably more than half of the original carbon content in the organic discards remains upon closure.³⁸

Cover ultimately fails. Third, the final cover has a finite life. After closure, at best financial assurance regulations only provide funds for routine maintenance and for only 30 years.³⁹ As EPA repeatedly stated during the 1980's leading up to the promulgation of Subtitle D in 1991, even composite liners "will ultimately fail" within decades after the agency's post-closure care requirements have expired,⁴⁰ "and when they do, "leachate will migrate out of the facility."⁴¹ Yet,

³⁵ Debra Reinhart, *Prediction and Measurement of Leachate Head on Landfill Liners*, Florida Center for Solid and Hazardous Waste Management (Report #98-3) (1998), at p. viii.

³⁶ STI Engineering, *LFG Recovery* (Typescript, 2001).

³⁷ Rapid dehydration can be understood by the fact that, at 100% saturation and 40° C (104°F) temperature, the condensate is 51% by weight of the weight of the gas, according to standard Humidity Tables, and landfill gas weighs 0.0834 lbs./cf., according to standard conversions. Simplified gas generation rates are 10 cf per pound of MSW, declining 2%-3% per year. EPA, *Turning a Liability Into an Asset* (EPA 430-B-96-0004)(September 1996), at p. 2-5. At that rate, the landfill will become bone dry in approximately 3 years after new infiltration is blocked by the installation of a final cover and continuing through the time the cover is maintained.

³⁸ The best data, as we have repeatedly requested EPA to undertake, would be statistical bore samples after closure to measure unsequestered carbon content. However, this has never been done, notwithstanding the enormous importance the answer holds for the long term safety of landfills. For current financial assurances are only required for 30 years after closure.

³⁹ 40 C.F.R. §258.72.

⁴⁰ 53 FEDERAL REGISTER. 168, at pp. 33344-33345 (August 30, 1988).

⁴¹ 46 FEDERAL REGISTER 11128-11129 (February 5, 1981). Similar: "A liner is a barrier technology that prevents or greatly restricts migration of liquids into the ground. No liner, however, can keep all liquids out of the ground for all time. Eventually liners will either degrade, tear, or crack and will allow liquids to migrate out of the unit. Some have argued that liners are devices that provide a perpetual seal against any migration from a waste management unit. EPA has concluded that the more reasonable assumption, based on what is known about the pressures placed on liners over time, is that any liner will begin to leak eventually." FEDERAL REGISTER (July 26, 1982), at pp. 32284-32285.

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the EPA recognized, the duration of a landfill’s hazardous loadings that needs to be isolated may be “many thousands of years,”⁴² long after the time when discharges will occur.

The early warnings from EPA were more recently reinforced from an investigation and field study conducted by the agency’s Inspector General –

“EPA officials have stated that based on current data and scientific prediction, the release of contaminants may eventually occur, even with the application of best available land disposal technology. There is concern that *these barriers will merely postpone the inevitable release of contaminants until after the 30-year liability has expired*. As previously stated, some sites contain materials which are highly resistant to decomposition or which remain toxic forever. There have been several studies to determine the expected life span of landfill liners, and opinions on this issue vary widely. The bottom line is that not even the manufacturers claim that their liners will last forever.”⁴³

Why, then, did the EPA proceed to adopt liner-based regulations in 1991, when they were fully informed that engineered barriers will eventually fail? That question was answered by the EPA Inspector General a decade later in 2001. Extensive interviews with the agency’s staff established that *the reason was political*, not technical—

“Landfill design requirements and post-closure maintenance for both Subtitle C and Subtitle D facilities are expected to prevent leakage in the short term; however, their long-term effectiveness in controlling releases of contaminants is unknown. EPA and others have stated that it is likely that some disposal facilities will leak at some period after they close. ... “However, some who commented were concerned that an extended time frame would place an economic burden on smaller businesses. Therefore, EPA officials *acknowledge the lack of criteria or scientific basis* for establishing the 30-year post-closure time frame. ... EPA made the decision to establish the time frame at 30 years, seemingly *based on a compromise of these competing interests*. EPA officials we spoke to agreed that the 30-year time frame was *not based on specific scientific criteria or research studies*.”⁴⁴

State environmental agencies reached the same conclusion about the fact that the covers would eventually fail and lead to a second wave of gas generation after maintenance ends at closed landfills. The California Integrated Waste Management Board stated:

⁴² 46 FEDERAL REGISTER 28314-28328 (May 26, 1981). *See, also*, Commission of the European Community, *Management and Composition of Leachate from Landfills: Final Report* (1994), at p. 7, TABLE 1.2. H. Belevi and P. Baccini, “Long Term Behavior of Municipal Solid Waste Landfills,” *Waste Management and Research* (1989), at p. 43. Peter Flyhammar, *The Release of Heavy Metals in Stabilized MSW by Oxidation* (Swedish Department of Water Resources, Nov ‘99), at p. 20 TABLE 10.

⁴³ Office of the Inspector General, *RCRA Financial Assurance for Closure and Post-Closure* (2001-P-007) (Mar. 30, 2001), at pp. 33. On-line at: <http://www.epa.gov/oigearth/audit/list301/finalreport330.pdf>. (Emphasis added.)

⁴⁴ U.S. Environmental Protection Agency Inspector General, *RCRA: RCRA Financial Assurance for Closure and Post-Closure* (No. 2001-P-007) (March 28, 2001), at p. 31 (emphasis added).



“However, the initial term of 30 years for P[ost] C[losure] M[aintenance] is unlikely to resolve all the environmental issues related to a closed landfill in California. Since Subtitle D was promulgated, research shows that certain wastes in some landfills stabilize in a short period of time and that, at those landfills, the potential to impact the environment may only last for a short portion of the conventional 30-year PCM period. On the other hand, some landfills may remain a threat to the environment for longer than 30 years. For example, stakeholders have reported to Board staff that landfill gas control systems have had to be installed at landfills that had not operated for up to 60 years. Dry tomb landfills (favored by Subtitle D and 27 CCR) indefinitely suspend and/or retard the decomposition process such that a breach in containment (e.g. extreme climate or earthquake event or inappropriate land use, or simply failure of equipment or containment barriers) could trigger uncontrolled production and release of landfill gas and leachate, and public contact with waste. *The state of the science thus indicates that municipal solid waste landfills will in many cases pose a significant threat to the environment well beyond the conventional 30-year PCM period.*”⁴⁵ (See accompanying FIGURE showing a second wave of gas generation denoted as “containment failure.”)

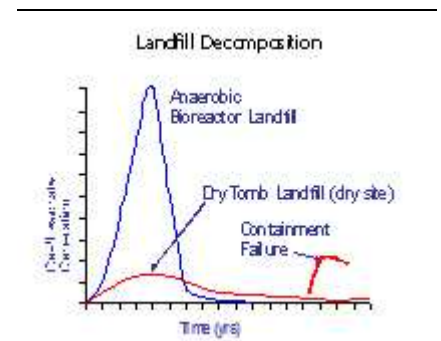


FIGURE 1

Similarly, Washington state’s Department of Ecology has stated:

“The extent to which today’s landfills adequately protect human health and the environment is a subject of debate, however. Requirements that govern siting, operation, closure, and post-closure are stringent and extensive. While the newest landfills are state-of-the-art facilities, they are far from benign in their impacts. Landfills may still affect the air, land, and water but to a significantly lesser degree than before today’s standards went into effect. As waste decomposes in landfills, methane and other hazardous gases are generated. Methane is a greenhouse gas concern because its impact is twenty-three times that of carbon dioxide (EIA). Leachate from decomposing matter in landfills can contain hazardous constituents. If landfill liners and/or leachate collections systems fail, then groundwater and surface-water pollution can occur. No liners are engineered to be 100 percent impenetrable or to last forever without some sort of failure. In fact, US EPA officials have stated that problems can occur more than thirty years after closure of

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CIWMB, Discussion Paper Regarding Postclosure Maintenance Beyond the Initial 30 Years and Financial Assurance Demonstrations (December 6, 2004) (emphasis added).

C E N T E R F O R A C O M P E T I T I V E W A S T E I N D U S T R Y



a landfill, pointing out that ‘even the best liner and leachate collection system will ultimately fail due to natural deterioration.’⁴⁶

In addition, the Wisconsin Department of Natural Resources has also pointed to the same inherent flaw in dry tomb designs for landfills:

“The problem with dry tomb landfills is that the organic wastes in them remain largely undecomposed. They represent a continuing and large potential source of methane gas, as well as a potential source of groundwater pollutants. The essentially perpetual management of these problems represents a long-term financial liability to the waste management industry, and potentially to the state, if public monies have to be used to clean up future problems.”⁴⁷

Furthermore, in the last three years, many in the landfill industry have conceded these basic facts, as well. The Executive Director of the Solid Waste Association of North America (SWANA), John Skinner previously headed EPA’s Office of Solid Waste where he had a major role in drafting Subtitle D. Dr. Skinner has recently written:

“The problem with the dry-tomb approach to landfill design is that it leaves the waste in an active state for a very long period of time. If in the future there is a breach in the cap or a break in the liner and liquids enter the landfill, degradation would start and leachate and gas would be generated. Therefore, dry-tomb landfills need to be monitored and maintained for very long periods of time (some say perpetually), and someone needs to be responsible for stepping in and taking corrective action when a problem is detected. The federal Subtitle D rules require only 30 years of post-closure monitoring by the landfill operator, however, and do not require the operator to set aside funds for future corrective action. Given the many difficulties of ensuring and funding perpetual care by the landfill operator, the responsibility of responding to long-term problems at dry-tomb landfills will fall on future generations, and the funding requirements could quite likely fall on state and local governments.”⁴⁸

Dr. Skinner’s predecessor at SWANA, Lanier Hickman expressed the same view more forcefully:

“Currently many policymakers view F[inancial] A[ssurance] for landfills from the perspective, ‘If it ain’t broke, don’t fix it.’ However, *the question is not ‘if’ there will be future landfill problems, but ‘when.’* Since FA requirements are the last

⁴⁶ Washington Department of Environmental Protection, *Background Information for Beyond Waste Document* (2004), at p. 3.

⁴⁷ Testimony of Suzanne Bangert, Director Wisconsin Department of Natural Resources Bureau of Waste Management Before the Assembly Committee on Natural Resources on Clearing House Rule 04-077 (April 27, 2005).

⁴⁸ John Skinner, “Composting and Bioreactors,” *MSW Management* (July/August 2001), at p. 16 (emphasis added).

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line of defense before the public winds up with the costs for corrective action, it is critical that an FA mechanism be able to guarantee coverage of expected landfill costs.”⁴⁹

Or from Peter While, an environmental scientist with Procter & Gamble –

“...The dry containment method of operating a landfill has been described as long-term storage of waste rather than waste treatment or waste disposal, and does have some significant drawbacks. There will always be pockets of moisture within waste, and *it is generally accepted that all lining and capping systems will eventually leak so rain and/or groundwater will eventually enter the site*. Thus, the decomposition of the organic fraction of the waste will eventually occur, with resulting emissions of landfill gas and leachate. Since pipes and pumps buried within the waste eventually clog up and fail, there will be less chance of collecting and treating these emissions if they occur in the distant future.”⁵⁰

Or from John Pacey, one of the premier landfill engineers –

“The containment provided by these landfills offers environmental protection initially; however, at some point *beyond the 30-year [postclosure] period, there may be partial failure(s)* of the containment lining system (underlying and overlying the waste). The primary environmental issue associated with partial containment system failure and moisture infiltration is the potential associated increase in gas and leachate production and the resulting impact of uncontrolled leachate and/or landfill gas releases to the environment. The nature and magnitude of the releases exiting the landfill and their resulting impacts are directly related to the amounts of organic waste not yet decomposed.”⁵¹

Thus, a very substantial fraction and quite possibly a significant majority of the carbon in the incoming wastes remains when the landfill is closed due to insufficient and unevenly distributed moisture while open. Also, eventually the cover will fail after maintenance ends, reigniting a second wave of gas generation that will probably be larger than the first wave. At that time, there will be no gas collection and all of the future gases from the residual decomposables will escape into the atmosphere.

Not only is it vital that the fifth phase of a landfill’s life be acknowledged, but also it is necessary to include the future emissions that will flow from today’s discards in the annual GHG inventories. Yet, for the organic discards buried in the year for which the inventory is prepared, EPA’s current practice purports to track each landfill’s actual performance only in that annum.

⁴⁹ Rob Arner, H. Lanier Hickman and Cristine Leavitt, “Dump Now, Pay Later?” *MSW Management* (Sept. 2000).

⁵⁰ Peter White, *Integrated Solid Waste Management: A Lifecycle Inventory* (Aspen Pub. 1999), at p. 275.

⁵¹ John Pacey, *et. al.*, *The Bioreactor Landfill - An Innovation in Solid Waste Management*, Monograph (2001), at p. 2 (emphasis added).

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However, in fact, we understand that the agency does not even recognize the fact that a not insignificant fraction of the gases generated that year are from open or not fully closed cells where there is either no gas collection or no low permeable cover. In those cells, the Gas Capture Rate is zero or a fraction of collection system's peak performance, while EPA's calculations presumes capture rates are a constant and optimal at all times, belying any claim that it is tracking each landfill's behavior in that year.

Even if the new four-phase protocols included in Table HH-3 of the GHG Mandatory Reporting Rule were followed in the inventory – which we do not believe it was – that would still ignore the fifth phase when, most likely, a majority of the gases are generated and, since none of those are captured, most of the fugitive emissions occur.

Accounting for future emissions. EPA has previously defended the inventory's omission of the vast majority of postponed GHGs that arising from the residual carbon in the wastes buried today. It has argued that the inventory only encompasses emissions estimated to occur in that year.

However, this view produces a result that ignores the majority of the delayed emissions associated with wastes deposited in that year, which, under EPA's protocols will *never* be counted for in the relevant future. This result is akin to assessing a person's dose absorption of a 24-hour time release pill in the first hour after its being swallowed, and ignoring the further uptake in the following 23 hours.

Moreover, EPA's opinion is fundamentally inconsistent with the IPCC principles that the agency has itself restated in its reports:

“CH₄ emissions from landfills *are* counted [under the IPCC guidance in inventories of anthropogenic GHG emissions.] Even though the source of carbon is primarily biogenic, CH₄ would not be emitted were it not for the human activity of landfilling the waste, which creates anaerobic conditions conducive to CH₄ formation. Note that this approach *does not distinguish between the timing of CO₂ emissions*, provided that they occur in a reasonably short time scale relative to the speed of the processes that affect global climate change. In other words, as long as the biogenic carbon would eventually be released as CO₂, *it does not matter whether it is released virtually instantaneously (e.g., from combustion) or over a period of a few decades (e.g., decomposition on the forest floor).*”⁵²

Finally, the refusal to acknowledge the future stream of methane emissions that inevitably will follow from the burial of organic discards today is also in fundamental conflict with other practices used elsewhere in the inventory. In order to compute the equivalent warming effects of other greenhouse gases to CO₂, each of which has different residence times, the accepted convention uses an assumed common 100-year period for the time each gas, released today, will remain in the atmosphere before it decays or is absorbed. Since methane actually only remains in

⁵² EPA, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (3rd Ed., 2006), at p. 12 (emphasis added).

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the atmosphere for 12 of those 100 years, its actual impacts are diluted by being spread over 88 years when it is no longer present.⁵³

In the event EPA's decision is to bar recognition for those delayed impacts, then, to be consistent, the protocols also must use a single-year basis for calculating the different gases' warming potential, something that would increase methane's carbon-equivalence by more than 100 times. But, the protocols cannot responsibly use a century long frame of reference in one chapter and an instantaneous snapshot in another and produce a coherent analysis in the conclusion.

As to the complaint that there is no nomenclature to properly account for the future stream of emissions in the inventory for the current year, there is a well-trod analogous mechanism to do this. Accounting routinely incorporates into the present a future stream of income flows that derive from an investment made today to best pick from various options. This directly resembles continuing gas emissions from decaying wastes discarded in that year. That technique is the net present value analysis, long used in economic planning and decision-making.

As to the complaint that present value type of calculations require making projections about future events that are not precisely known, that, too, is a red herring. For one thing, the current present-only analysis is already replete with made up assumptions without any factual basis, such as the gas capture rate. For another, ignoring future consequences that will follow from today's actions does not eliminate uncertainty. To the contrary, ignoring the future is a palpable decision that there will be no future decomposition activity from today's discards, which is a totally absurd result. Tomorrow's uncertainty cannot be eliminated by pretending it does not exist.

Of note, a present-value type of calculation attributing future emissions from wastes buried today to the current year is a practice that the IPCC has used elsewhere. The estimation technique of compressing into the present the future emissions from today's sources has more recently been specified as the appropriate methodology in the IPCC's Clean Development Mechanism program.⁵⁴

E. Oxidation

The draft inventory continues the practice of continuing to assume that 10% of escaping methane is oxidized in the cover soil. Previously, EPA has effectively rested its case on the

⁵³ IPCC, *Fourth Assessment Report: Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing* (2007), at p. 212, Table 2.14.

⁵⁴ IPCC, *Proposed New Methodology: Baseline (CDM-NMB) Version 02* (July 15, 2005). As other examples, *see, also*, German Ministry for the Environment, *Waste Sector's Contribution to Climate Protection* (Research Report 205-33-314)(2006), at p. 15.

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Czepiel study, which found in field and laboratory studies during 1994 that 10% of the methane generated in a landfill was oxidized in the cover soil over the course of a year.⁵⁵

When the gases that are emitted are diffused throughout the overlying soil blanket, as would have been the case with most landfills constructed before 1991, this study would be applicable. However, modern landfills gases are not diffused at the surface throughout that earthen layer, because, since 1991 a composite cap has been required under that soil blanket, including in practice a 60-mil (or $\frac{1}{16}$ ") high density polyethylene plastic membrane that effectively impedes the passage of gases from the waste into that cover soil.⁵⁶

This is key. It means that instead of the methane diffusing throughout the topsoil for maximum oxidizing effect, the gases that are released above the landfill are concentrated in high fluxes at a handful of cracks and tears in the plastic sheet. Concentrated high flux emissions quickly overwhelm the capacity of the topsoil to oxidize the escaping methane through these hot spots.⁵⁷

Czepiel expressly stated that not only was his study not done at a landfill with a synthetic geomembrane, but also, “[p]eriodic maintenance of the cover materials has minimized significant surface cracks” in the clay layer, as well.⁵⁸ That is to say, nothing in his study can be used to describe what happens to the methane that flashes through a small number of hot spots on the top face of the landfill.

He further reemphasized again in his conclusion that his findings did not apply when gases are released in high fluxes through narrow cracks:

“Waste settlement, surface erosion and soil dessication often promote significant surface cracking, providing paths of minimal resistance to gas flow, effectively bypassing microbial influence. Our study generally lacked surface cracks, although his characteristic may not be representative of the entire spectrum of landfill surfaces.”⁵⁹

⁵⁵ Czepiel, *supra*, at p. 16,721. There are two other studies listed in the draft paper. However, the one by J. Jensen et al., “CH₄ Emissions from Solid Waste Disposal,” *Background Papers-IPCC Expert Meetings on Good Practice Guidance* (IPCC, 2002), is not a study but a proposed protocol for estimating methane emissions from landfills. In any event, Jensen acknowledges that “[t]he oxidation effect is also highly dependent on the type and thickness of cover at the SWDS.” *Id.*, at p. 429 The other by Mancinelli was withdrawn upon our inquiry. The Mancinelli study has been withdrawn because a copy of the paper cannot be located.

⁵⁶ 40 C.F.R. §258.60(a)(1). As noted previously (see NOTE 111 on page 74), technically, the rule only requires that the permeability of the cover not be less than the bottom liner, although in practice this is met with a composite system in the cover as well.

⁵⁷ Czepiel, *supra*, at p. 16,727. Oxidation was observed to follow the Arrhenius relationship, or parabolic behavior, in which oxidation increases with greater inputs, but only to a distinct maximum, after which it rapidly declines.

⁵⁸ Czepiel, *supra*, at p. 16,721.

⁵⁹ Czepiel, *supra*, at p. 16,728.

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Furthermore, a consultant for the U.K. Department on the Environment conducted a comprehensive study involving 250 measurements at a landfill with a composite cover and found that there was no oxidation effect:

“Methane oxidation is only observed where the diffusion gradient through the cap is very small, and therefore the methane oxidizing bacteria can cope with the rate of supply of gas. When higher fluxes predominate there is little evidence either for or against methane oxidation being a significant component of emission control.”⁶⁰

A similar field examination by researchers at a Swedish landfill corroborated the U.K. findings.

Other Technical Constraints on Oxidation

Even if, for the sake of argument, methane oxidation were able to occur landfills with plastic liners, there are many other limitations of Czepiel’s findings when attempting to apply them without limitation to the typical landfill and across time.

For one thing, in northern climates, oxidation is improbable during cold winters. Also, in addition to the small cracks in the geomembrane, similar problems can afflict the clay liner as well. In the northern climatic zones, the freeze/thaw cycle is a constant source of cracking, and in hot, arid climates, clay is susceptible to cracking from desiccation.⁶¹ For another, remembering that landfill gas is heavier than air and seeks the path of least resistance, no one has yet been able to satisfactorily determine what proportion of landfill gases escape through the top of the landfill—where any oxidation that occurs would take place—and, through the bottom and even the sides of the site or through the leachate collection system—where it would not, as EPA has previously pointed out.⁶² Then, too, there is the practical complications of maintaining optimized laboratory conditions for methanotrophs to oxidize methane over the long term at a real site.⁶³

In any case, even if for the sake of argument it were considered appropriate to give the benefit of oxidation for the period of time prior to the installation of the final cover when there emissions might diffuse through any soil layer, EPA itself has stated that a concomitant reduction in collection efficiency would have to be registered to account for the lack of a seal necessary for efficient gas collection.⁶⁴

⁶⁰ AEA Technology, *Methane emissions from UK landfills* (UK Department of the Environment, Transport and the Regions, 1999), at p. 2-9.

⁶¹ P. Lechner, C. Heiss-Ziegler and M.H. Humer, “Reducing Greenhouse Gas Emissions: How Composting and Compost Can Optimize Landfilling,” *BioCycle* (September 2002).

⁶² 56 FEDERAL REGISTER 24492 (May 30, 1991).

⁶³ Kightley, *supra*, at pp. 596 - 600.

⁶⁴ Debra Reinhart, *First Order Kinetic Gas Generation Model Parameters for Wet Landfills* (EPA-600/R-05/072, June 2005), at p. 5-2.

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For the foregoing reasons, it is no longer rational or responsible to continue conducting the waste section of the GHG inventory exactly as it has done so in the past only because it has always done it this way, regardless of the fact that its foundations have been vitiated by the EPA's reports.

With kinetics experts as part of a team, we stand ready to accept a commission to revise the present first order decay model to properly reflect the things that we know make its present formulation useless.

Sincerely,

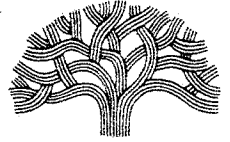
CENTER for a COMPETITIVE WASTE INDUSTRY

Peter Anderson

By: _____

PETER ANDERSON
Executive Director

Appendix H



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Public Works Agency
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April 14, 2010

Mr. Leif Hockstad
Environmental Protection Agency
Climate Change Division (6207J)
1200 Pennsylvania Ave., NW
Washington, DC 20460

RE: City of Oakland Comments on the Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008 (March 2010)

Dear Mr. Hockstad:

The City of Oakland commends the U.S. EPA on continuing to track and report on U.S. greenhouse gas (GHG) emissions. We appreciate this opportunity to comment on the Draft Inventory of U.S. GHG Emissions and Sinks (Draft Inventory).

Recommendation: Include a “systems” or “consumption”-based perspective on GHG emissions within the Draft Inventory.

It is critical that we work together at all levels of government to track and report on GHG emissions in a manner that compels us to take action where we have opportunities for reduction. Framing GHG emissions in a “systems-based” or “consumption-based” view, in addition to the conventional “sector-based” view used in the current Draft Inventory, is important.

The EPA promoted this approach in its recent 2009 whitepaper “Opportunities to Reduce Greenhouse gas Emissions through Materials and Land Management Practices.” The whitepaper, issued by the Office of Solid Waste and Emergency Response, presents an alternative “systems-based” perspective of GHG emissions that includes the upstream impacts of waste reduction and recycling. We find this framing equally compelling as the “sector-based” view. Each perspective has pros and cons, and each includes some data the other ignores when evaluating a nation (or community) in isolation. Most importantly, each also informs consideration of GHG reduction opportunities that the other is not set up to recognize or encourage.

We need to achieve dramatic reductions in GHG emissions, which requires that we unlock new ways of reducing our collective carbon footprint. How we tell the story of our nation’s carbon footprint can help to educate and motivate the individuals, communities, and organizations that our nation comprises to act on their own opportunities to reduce GHG emissions.

Mr. Hockstad

April 14, 2010

Waste reduction and recycling create clear GHG reduction benefits up and down the product lifecycle chain. Our national GHG story, told through the Draft Inventory report, should be framed to cause reflection and motivate action on these GHG reduction opportunities.

Our own staff analysis has shown that GHG reductions associated with waste reduction and recycling opportunities are on the same order of magnitude as those associated with the transportation and building energy use sectors. It is important that we take action in all three of these areas. The fact that they can't all be added and depicted in one pie chart should not prevent us from telling the story of their respective importance.

The simplest solution is to include both the "sector-based" and "systems-based" perspectives in the national GHG inventory. We plan to show both perspectives in our own local GHG accounting and reporting, and are encouraging all communities to make this standard practice. This relatively small adjustment to our reporting can have a big impact in creating GHG reductions associated with lifecycle impacts of all the things we purchase, use and discard.

Please feel free to contact Garrett Fitzgerald, the City of Oakland's Sustainability Coordinator, at gfitzgerald@oaklandnet.com or (510) 238-6179 if you would like to further discuss any of these comments.

We look forward to working with you, the U.S. EPA, and other government agencies as we collaborate to reduce GHG emissions in a meaningful way.

Sincerely,

A handwritten signature in black ink, appearing to read "Susan Kattchee", with a long horizontal flourish extending to the right.

Susan Kattchee
Environmental Services Manager
City of Oakland

Appendix I



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April 13, 2010

Mr. Leif Hockstad
Environmental Protection Agency
Climate Change Division (6207J)
1200 Pennsylvania Ave., NW
Washington, DC 20460
Also sent by email to hockstad.leif@epa.gov

Re: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008

Dear Mr. Hockstad,

We are writing to address some of the inadequacies of the national Greenhouse Gas Inventory and to make specific recommendations for more timely amendments to reflect better science and for improvements to better identify more sustainable options that achieve greenhouse gas reductions. We particularly focus on the inadequate accounting for waste and wasting in the inventory. We have actively engaged in New York's state level greenhouse gas inventory and are concerned that EPA's inventory will hurt our efforts to obtain better scientific treatment of waste issues.

- As currently structured the national inventory gathers rough estimates of end of the pipe emissions of greenhouse gas emissions.
- To a great extent the inventory looks at historical information.
- The national inventory uses conventions adopted for the 2nd IPCC assessment. As a result newer, better information since that time are not being incorporated into the national greenhouse gas inventory.
- The categories of emissions primarily relate to extremely large sectors of combustion sources-- power plants, mobile sources, heating of buildings, etc. The accuracy of these emissions estimates is limited by the methodology and the broad economy- wide focus.
- Despite such problems numerous entities, public and private are engaged in this data collection devoting significant time, energy and personnel resources to the effort.
- There is a massive task before us: achieving 80% reduction in greenhouse gas emissions by 2050 nationally and also globally. Unfortunately, the national inventory is so broad that it is really not useful in identifying the solutions we desperately need immediately.

We recommend amendments to the national inventory and that EPA:

1. Seek global agreement to update the methodology so that it reflects the best current scientific information.
2. Continue to use the agreed upon 2nd IPCC assessment guidance, but add a supplement to the inventory that reflects current understanding of better scientific information. This also will help identify additional opportunities for greenhouse gas reductions. For example, see our discussion of issues related to WASTE below.
3. Identify solutions and best practices which can be implemented immediately by state and local governments. All solutions and best practices should be sustainable, offering benefits in 3 spheres -economic, environmental and social-- with no damaging or detrimental drawbacks. Adopting sustainable solutions becomes easy, when multiple benefits, beyond GHG reductions, are within reach .
4. Do more analysis at the micro-level. What is the most efficient way to get food from the farm to household dinner tables? the most efficient way to deliver health care? How energy efficient can supermarkets be made? Hospitals? Sewage treatment plants? Schools? Various industries? Etc.
5. Strive to make all of the systems we use and rely on - sustainable. Until we do we will not be able to address climate change.
6. Immediately address WASTE and WASTING in a much more substantial way. Post World War II we have dramatically increased the amount of waste we generate. WASTE and WASTING are similar to energy losses, except that waste involves the loss or destruction of material resources as well as embedded energy.

Waste

Waste involves a huge sector of our economy that is not adequately captured in the greenhouse gas inventory. This was illustrated for us recently as we worked on NY Climate Action Plan. New Jersey calculated much greater lifecycle emissions vs. direct emissions for waste management. The failure to include upstream GHG emissions and embodied energy in materials serves to disadvantage the most sustainable solid waste options (recycling and composting) vs. the most unsustainable solid waste options (incineration). Doing so flies in the face of EPA's WARM model which finds recycling to save 4-5 times the energy an incinerator recovers from waste. Waste and Energy Loss have many things in common and as a result no inventory can be considered adequate that gives little attention to waste.

We were also shocked to not see reference to EPA's recent report that put greenhouse gas emissions associated with non-food products and packaging at 37%, *EPA, Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices*, Sept. 2009. Joshua Stolaroff, PhD worked on the EPA report and subsequently extended the analysis to include products produced abroad and consumed in the US. This Product Policy Institute white paper states total GHG emissions of non-food products and packaging is 44%. Both reports can be accessed at www.productpolicy.org Such information tells us that we are not appropriately accounting for the greenhouse gas impacts of waste. EPA's own WasteWise

program has numerous examples of large corporations saving millions of dollars by reducing, reusing and recycling waste at their facilities. The dollars saved relate to less waste sent for disposal, less water use, less energy use, more efficient use of materials, etc. We have also included a factsheet we have prepared: *Waste Impacts Climate Change*.

Methane

Global Warming Potential for Methane is listed as 21. We don't know the reason for using the 2nd IPCC assessment guidance for assembling the inventory rather than the 4th. However, methane is pretty unique and needs to have special consideration. It has now been recognized that methane has a relatively short life span in the atmosphere compared to CO₂. It also has much greater global warming potential. Because of its shorter life, its global warming potential should be considered over 10 or 20 years, rather than 100 years. The 4th IPCC assessment puts the global warming potential at 72 over a 20 yr. period. A subsequent report from NASA puts the GWP at 34x CO₂ for the long term and 105x in the near term because of its contribution to ozone formation.

[IPCC, *Fourth Assessment Report: Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing* \(2007\)](#), at p. 212. Most recently, methane's warming potential has been more extensively investigated and NASA's scientists now consider methane to be 34x CO₂ in the long-term, and 105x in the near term, after factoring in indirect impacts on the formation of aerosols, which is another greenhouse gas. Drew Shindell, "[Improved Attribution of Climate Forcing Emissions](#)," 326 *SCIENCE* 716 (2009).

There are important reasons to consider a shorter time frame for climate change. If we can adequately tackle significant greenhouse gases in the short term we might be able to avoid or delay the tipping point for a runaway situation. Doing so would give us more time to institute other more complicated measures to control CO₂. Methane can be key to these short term measures.

Appendix I

According to climate scientists at the National Aeronautics and Space Administration (NASA), the combination of methane's potency, and its short lifetime in the atmosphere, plays an especially critical role in the near term when we confront those critical tipping points:

“[F]easible reversal of the growth of atmospheric [methane] and other trace gases would provide a vital contribution toward averting dangerous anthropogenic interference with global climate...[Methane] deserves special attention in efforts to stem global warming...Given the difficulty of halting near-term CO₂ growth, the only practical way to avoid [dangerous interference] with climate may be simultaneous efforts to reverse the growth of [methane].¹¹

Similarly, Robert Watkins, the co-chair of the IPCC's Third Assessment, recently wrote in the disappointing aftermath of Copenhagen:

“This month's Copenhagen talks focused on the leading climate change culprit: CO₂. But reversing global temperature increases by reducing carbon emissions will take many decades, if not centuries. Even if the largest cuts in CO₂ contemplated in Copenhagen are implemented, it simply will not reverse the melting of ice already occurring ... The most obvious strategy is to make an all-out effort to reduce emissions of methane. Methane's short life makes it especially interesting in the short run, given the pace of climate change. If we need to suppress temperature quickly in order to preserve glaciers, reducing methane can make an immediate impact. Compared to the massive requirements necessary to reduce CO₂, cutting methane requires only modest investment. Where we stop methane emissions, cooling follows within a decade, not centuries. That could make the difference for many fragile systems on the brink.”¹²

¹¹ James Hansen, [“Greenhouse gas growth rates”](#), 101 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 46 (November 16, 2004), p. 161094.

¹² Robert Watson and Mahamed El-Ashry, [“A Fast, Cheap Way to Cool the Planet,”](#) *The Wall Street Journal* (December 29, 2009).

The Above References are from *Beyond Recycling: Composting*, by the Center for a Competitive Waste Industry, prepared for EPA, Region 9 by Peter Anderson, Gary Liss and Steve Sherman, p.9-10.

Landfills do not reach 75% gas collection efficiency.

We are attaching Peter Anderson's memo to these comments. He is a landfill expert and thoroughly reviews the issues around LF gas collection efficiency. Please read his memo in conjunction with this section.

In brief the issues are:

- Landfills are not properly enclosed with an impermeable cap until they are closed.
- The majority of a landfill's operating life (62%) occurs before this impermeable cap and LFG collection system are installed.
- EPA has no factual basis upon which it settled on 75%; it represents wishful thinking.
- There are no field measurements of efficiency of landfill gas collection systems.
- The best evidence of lifetime capture rates are closer to 20%.

Given the highly questionable assumptions related to LFG collection efficiency, we believe it is not possible to accept EPA's estimate of 52% of carbon being sequestered in landfills for purposes of the GHG inventory. We recommend a lower percentage.

For these and other reasons, Peter Anderson reaches the conclusion that diverting organics from landfills has 260 times the benefits of LFG to energy collection systems.

The most sustainable climate change strategy is to divert biodegradable organics including food scraps away from landfills to composting or anaerobic digestion. Food waste should first be prevented, then unused food should feed people, then animals. Remaining food scraps should be composted or anaerobically digested and returned to soils.

Returning these nutrients to soils increases soil nutrients, displaces artificial fertilizers, builds soil holding capacity, decreases run-off, increases water holding, fights plant diseases, increases plant growth and food nutrients, while building soil carbon. Building healthy soil from diversion of biodegradable organic materials is a key example of a sustainable system with lots of ancillary benefits for farmers, nursery businesses and the consuming public. Anaerobic digestion also produces methane, which is a renewable energy source that more reliably captures and uses methane than a leaky landfill ever could.

Unfortunately to date, EPA has not captured the multiple environmental benefits of composting in its WARM model. While EPA is attempting to update this model, even the update will not be capable of capturing all of the above benefits. We believe it is possible to capture the sustainable benefits of a system qualitatively first, before you have all of the numeric measurements to complete a quantitative analysis.

Biogenic Emissions

It is critical that biogenic emissions be addressed with a more critical eye. The current treatment of biogenic emissions provides a distinct advantage to incineration. MSW incinerators rely on an unsustainable waste system—a system that emphasizes disposal over waste reduction, reuse and recycling. Because incinerators destroy resources, those resources cannot be reused or recycled. Thus incinerators by destroying resources prevent their handling by more environmentally sound means that preserve resources and energy. The favorable treatment accorded biogenic emissions coupled with the failure to adequately count the benefits of composting serves to disadvantage the most sustainable option for handling organic waste materials.

In addition, there is a substantive difference between sustainably harvested biomass and the cutting down of irreplaceable rainforests. As currently handled the treatment of biogenic emissions is a one size fits all. As a result it is ripe for abuse.

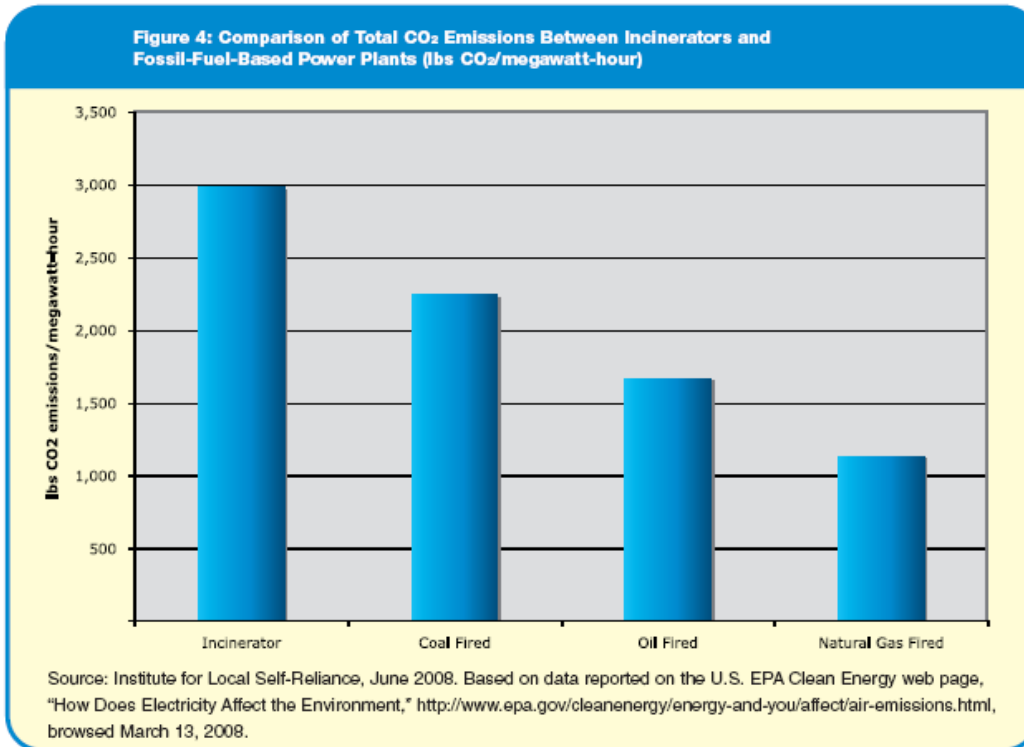
Incinerators and other thermal treatments are the most problematic in this regard.

- All such equipment uses fossil fuel to operate, but this is often not quantified.
- What is burned is not just unprocessed biogenic material, but material that has had large energy inputs in the processing to a finished product. The modeling here does not include this embodied energy.

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- Raw material resources are destroyed in thermal treatment. To get more paper, cardboard, etc. you have to cut down more trees.
- Green organic materials have a high water content and thermal treatments are using energy largely to remove water.
- There are higher and better uses for all materials to be burned in an incinerator and the processing costs are always less than thermal treatment.

This graph shows the total CO₂ emissions of incinerators compared to fossil fuel plants. *Stop Trashing the Climate* report



Below are some sections of the report *Stop Trashing the Climate* p. 39-40, which discuss the issue of biogenic emissions. www.stoptrashingthecclimate.org

The rationale for ignoring CO₂ emissions from biomass materials when comparing waste management and energy generation options often derives from the Intergovernmental Panel on Climate Change (IPCC) methodology recommended for accounting for national CO₂ emissions. In 2006, the IPCC wrote:

“Consistent with the 1996 Guidelines (IPCC, 1997), only CO₂ emissions resulting from oxidation, during incineration and open burning of carbon in waste of fossil origin (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered net emissions and should be included in the national CO₂ emissions estimate. The CO₂ emissions from combustion of biomass materials (e.g., paper, food, and wood waste) contained in the waste are biogenic emissions and should not be included in national total emission estimates. *However, if incineration of waste is used for energy purposes, both fossil and biogenic CO₂ emissions should be estimated. Only fossil CO₂ should be included in national emissions under Energy Sector while biogenic CO₂ should be reported as an information item also in the Energy Sector.* Moreover, if combustion, or any other factor, is causing long term decline in the total carbon embodied in living biomass (e.g., forests), this net release of carbon should be evident in the calculation of CO₂ emissions described in the Agriculture, Forestry and Other Land Use (AFOLU) Volume of the 2006 Guidelines.”¹²⁷ *[emphasis added]*

There is no indication that the IPCC ever intended for its national inventory accounting protocols to be used as a rationale to ignore emissions from biomass materials when comparing energy or waste management options outside of a comprehensive greenhouse gas inventory. Rather, the guidelines state “...if incineration of waste is used for energy purposes both fossil and biogenic CO₂ emissions should be estimated.”

The bottom line is that tremendous opportunities for greenhouse gas reductions are lost when a material is incinerated. When calculating the true climate impact of incineration as compared to other waste management and energy generation options, it is essential that models account for the emissions avoided when a given material is used for its highest and best use. This means, for instance, taking into account emissions that are avoided and carbon sequestered when materials are reused, recycled or composted as compared to incinerated. More climate-friendly alternatives to incinerating materials often include options such as source reduction, waste avoidance, reuse, recycling, and composting.

When wood and paper are recycled or source reduced, rather than incinerated, forests sequester more carbon. In other words, when we reduce the amount of materials made from trees, or when we reuse or recycle those materials, fewer trees are cut down to create new products. This leads to increased amounts of carbon stored in trees and soil rather than released to the atmosphere. As the EPA writes in its 2006 report *Solid*

Waste Management and Greenhouse Gases, "... forest carbon sequestration increases as a result of source reduction or recycling of paper products because both source reduction and recycling cause annual tree harvests to drop below otherwise anticipated levels (resulting in additional accumulation of carbon in forests)."¹²⁸

Thank you for your attention. We would appreciate being informed of future developments to improve the greenhouse gas inventory.

Sincerely,



Barbara J. Warren
Executive Director

encl: Factsheet- Waste Impacts Climate Change
Memo prepared by Peter Anderson

Waste Impacts Climate Change

- Wasting directly impacts climate change because it is directly linked to resource extraction, transportation, processing and manufacturing, all of which use energy and generate emissions. Two recent reports examined the greenhouse gas impacts of products and packaging, the first from EPA found 37% of GHGs associated with non-food products and packaging. The second report was a follow-up and included global trade, although food was still not included; it found 44% of GHGs associated with products and packaging. (Both reports available at www.productpolicy.org)
 - For every bag of trash a household puts at the curb, 70 bags of trash were created upstream in the production process.
 - Zero waste strategies-waste reduction, reuse, recycling, and composting-- are the fastest, cheapest and most effective strategies to protect the climate and the environment. All are associated with greenhouse gas reductions, in addition to many other benefits.
 - Using zero waste strategies and significantly decreasing disposal in landfills and incinerators can reduce GHGs the equivalent of closing 1/5 of all US coal-fired power plants. (See www.stoptrashingthecolimate for this excellent report.)
 - Waste reduction and material recovery strategies are ESSENTIAL to putting us on a path to stabilize the climate by 2050. Greenhouse gas reductions of 80% are needed and we cannot accomplish this goal without adequately addressing waste.
 - Waste incineration and other thermal technologies* do not produce clean, renewable energy. It relies on destroying precious resources, is environmentally polluting and puts out 36% more CO₂ than coal-fired power plants. Recycling is renewable energy saving 4-5 times more energy than an incinerator recovers.
 - Biodegradable materials like food and yard waste degrade in landfills and produce methane, a powerful greenhouse gas with 72 times the global warming potential of CO₂ over a twenty year period. Adequate control of greenhouse gases is even more essential over the next twenty years, because of the possibility of a runaway situation for warming.
 - Landfills even ones with good gas capture systems are able to collect only about 20% of the methane that is generated. (IPCC 4th Assessment, Working Group III, Mitigation of Climate Change, 10.4.2.)
 - Composting of biodegradable material results in a valuable product that improves soil-- increasing nutrients, water retention, and healthy plant growth while reducing plant diseases and the need for synthetic fertilizers. Increasing soil carbon is an added climate change benefit.
-

*Newer thermal technologies include gasification, pyrolysis, plasma arc and other creative descriptions. All are commercially unproven for mixed waste, but their claims sound wonderful.

Greenhouse gas emissions inventories often inappropriately deal with the issue of Biogenic Emissions.

Biogenic emissions are considered natural emissions from the carbon cycle. However burning waste should not be considered renewable because it relies on the destruction of resources rather than preservation. Often inventories do not count the biogenic emissions (CO₂ emissions generated by burning paper, wood, food and yard waste) from incinerators. This could arise from a misunderstanding of IPCC guidance. The IPCC states, " if incineration of waste is used for energy purposes, both fossil and biogenic CO₂ emissions should be estimated."

- All incinerators and thermal technologies use fossil fuel to operate, but this is often not quantified.
- What is burned is not just unprocessed biogenic material, but material that has had large energy inputs in the processing to a finished product. Incineration does not recover this embodied energy, but recycling does.
- Green organic materials have a high water content and thermal treatments are using energy largely to remove water.
- There are higher and better uses for all materials to be burned in an incinerator and any alternative processing costs for composting and recycling are always less than thermal treatment.
- Raw material resources are destroyed in thermal treatment. To get more paper, cardboard, etc. you have to cut down more trees. As EPA states, "forest carbon sequestration increases as a result of source reduction or recycling of paper products because both source reduction and recycling cause annual tree harvests to drop below otherwise anticipated levels (resulting in additional accumulation of carbon in forests). " *Solid Waste Management and Greenhouse Gases*, 2006 EPA Report.

EPA assumes landfills reach 75% gas collection efficiency. In reality:

- Landfills are not properly enclosed with an impermeable cap until they are closed.
- The majority of a landfill's operating life (62%) occurs before this impermeable cap and LFG collection system are installed.
- EPA has no factual basis upon which it settled on 75% collection efficiency; it represents wishful thinking.
- There are no field measurements of efficiency of landfill gas collection systems.
- The best evidence of lifetime capture rates are closer to 20%. (IPCC 4th Assessment, Working Group III, Mitigation of Climate Change, 10.4.2.)
- Significant carbon sequestration in landfills is thus highly questionable.

ZERO WASTE STRATEGIES can significantly reduce disposal and greenhouse gas emissions. ZW strategies provide cost savings, while also creating jobs and economic development. ZW strategies are good for New York and good for our climate.

For 2004, New York recycling reduced greenhouse gas emissions by 5,212,571 metric tons of carbon equivalents (MTCE) in a one year period. New York's recycling saved a total of 230,964,227 Million BTUs of energy. Recycling 811,057 tons of newspapers, phone books, office paper, textbooks, magazines and cardboard in 2004, New York resulting in forest carbon

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sequestration benefits equal to 54,885,090 tree seedlings grown for 10 years.(Northeast Recycling Council, NY 2004 factsheet.)

Prepared for NY Zero Waste Alliance, managed by Citizens' Environmental Coalition, 33 Central Ave. Albany, NY 12210, 518-462-5527. Contact Barbara Warren also at 845-754-7951 or warrenba@msn.com

Appendix J



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

APR 16 2010

REPLY TO THE ATTENTION OF:

L-8J

MEMORANDUM

SUBJECT: Comments on Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008 (March 2010)

FROM: Margaret M. Guerriero, Director
Land and Chemicals Division

A handwritten signature in black ink, appearing to read "Margaret M. Guerriero".

TO: Leif Hockstad, OAR Climate Change Division
Brian B. Cook, OAR Climate Change Division

We appreciate the importance of updating the Inventory of U.S. Greenhouse Gas (GHG) Emissions and Sinks (Inventory) and the need to follow IPCC Guidelines and sector categories for consistency with UNFCCC reporting guidelines. We also appreciate your decision to re-allocate the emissions into more commonly used sector categories to improve the usefulness of the Inventory. We recommend that you consider including additional re-allocations, including those presented in Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices, USEPA OSWER, September 2009 (See chart on page 11, www.epa.gov/oswer/docs/ghg_land_and_materials_management.pdf).

Last year, EPA's Office of Solid Waste and Emergency Response completed a peer-reviewed analysis of the U.S. inventory that shows a systems-based view of emissions, "where each system represents and comprises all parts of the economy working to fulfill a particular need." While the current Inventory's sector-based view is helpful for identifying end-of-pipe strategies for reducing emissions within sectors, OSWER's systems-based view is helpful for identifying opportunities to reduce our GHG emissions through prevention-oriented mitigation strategies.

From our perspective, as a regional pollution prevention and sustainable materials management program, the systems view provides more insight to state and local governments, industry, and individuals looking for opportunities to reduce greenhouse gas emissions through policy options and behavior changes. While the draft Inventory acknowledges that the use of scrap material contributed to the decline in emissions from iron and steel production, the sector-based view of the data makes it difficult to identify other areas where material choices may impact emissions. OSWER's systems-based view estimates that 42 percent of the total U.S. GHG emissions are associated with materials management decisions. For a state or local government developing a climate action plan, knowing the relative emissions profiles of various systems (e.g., the provision of goods is responsible for 29 percent of emissions, relative to local

passenger transport at 15 percent of emissions) is more helpful than the end-of-life emissions from materials as a result of landfilling, composting, and wastewater treatment provided in the current Inventory. In other words, the current Inventory does not reveal the total GHG emissions associated with goods and services across their life cycle. When viewed by systems, the impacts of consumption on our national GHG emissions are far more impressive, and highlight the importance of reducing both overall consumption and the emissions across the lifecycle of goods and materials.

We encourage you to revise the draft Inventory to include, at a minimum, a reference to this important and insightful EPA, peer-reviewed resource. Ideally, future versions of the Inventory will include both a sector-based and a systems-based view to present a more comprehensive picture of U.S. GHG emissions.

If you have any questions, please contact me, or your staff may contact Julie Gevrenov, of my staff, at (312) 886-6832.

cc: Brigid Lowery, Acting Director, OSWER Center for Program Analysis