Alternative Resources, Inc.
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Web Links to Conversion Technology Information and Studies
County of Los Angeles, California and New York City
January 2009

In 2008, DEP commissioned a study to assess materials management options for the Massachusetts Solid Waste Master Plan review (the "Tellus Report", December 2008). That study included a literature review of alternative solid waste management technologies such as gasification and anaerobic digestion. Web links to full copies of several of the reports referenced within that review are provided below.

County of Los Angeles, California

The County of Los Angeles Department of Public Works has been working collaboratively since 2004 with the Los Angeles County Integrated Waste Management Task Force and the Alternative Technology Advisory Subcommittee to evaluate and promote the development of conversion technologies in California, particularly for management of post-recycled MSW and MRF residuals. Initially, the County identified and considered over 70 technology suppliers and conducted a preliminary evaluation on approximately 30 of those companies. Subsequently, the County narrowed the list and conducted a detailed evaluation on five technology suppliers. The County's detailed evaluation included verification and evaluation of technology supplier qualifications and technology capabilities, based on information provided by the companies and interviews and facility tours conducted by the County. As a result of this comprehensive work, documented in a report dated October 2007, the County identified four technology suppliers that have demonstrated the technical capabilities of their conversion technologies to process post-recycled MSW and MRF residuals, including both gasification and anaerobic digestion. The County has received and evaluated proposals from these technology suppliers, ranging in size from approximately 100 to 1,000 tpd, and will recommend one or more projects to the County Board of Supervisors for approval in early 2009.

The County's conversion technology website (www.socalconversion.org) provides information on the project, including the October 2007 report cited above, along with other news and information. The links to the October 2007 LA County report are as follows, for the Report, the Appendices, and the Executive Summary, respectively:

http://www.socalconversion.org/pdfs/LACo_Conversion_PII_Report.pdf
http://www.socalconversion.org/pdfs/LACo_Conversion_PII_Appendices.pdf
http://www.socalconversion.org/pdfs/LACo_Conversion_PII_ExecSum.pdf

New York City

New York City initiated an evaluation of conversion technologies in 2004, as a component of the City's Comprehensive Solid Waste Management Plan (SWMP). The Department of Sanitation (DSNY) and the Economic Development Corporation jointly commissioned an initial (Phase 1) evaluation of new and emerging technologies that was completed in September 2004. The Phase I study identified and reviewed over 40 technology suppliers. The City established a multi-step, progressive evaluation process, applying an increasing level of scrutiny to identify the most promising technologies. Fourteen technologies were comparatively reviewed in the third level of screening.

The results of the Phase 1 Study included the determination that thermal processing and anaerobic digestion are currently in commercial operation for mixed MSW outside of the United States, and concluded that these technologies could be considered for commercial application in the United States, including serving New York City, with suitable project definition and risk sharing between the public and private sectors. Subsequently, the City conducted a Phase 2 Study consisting of a focused validation and verification of eight technologies believed to be representative of the most developed technologies within the more advanced technology categories (anaerobic digestion and thermal processing). The Phase 2 Study included a detailed review of technical, environmental, cost and business information provided by the companies, through a comprehensive Request for Information and technology presentations/interviews. The results of the Phase 2 Study were published in March 2007. The City is currently conducting a siting study, which will lead to a procurement for a facility in the 300 to 1,000 tpd size range. As it moves forward in project development, the City is considering both gasification and anaerobic digestion technologies.

New York City's Phase 1 and Phase 2 reports are available on DSNY's website, under "SWMP Implementation - Other Initiatives". The main link, followed respectively by the specific links to the Phase 1 and Phase 2 reports, are as follows:

http://www.nyc.gov/html/dsny/html/swmp_implementation/swmp_otherinit.shtml
http://www.nyc.gov/html/dsny/downloads/pdf/swmp_implement/otherinit/wmtech/phase1.pdf
http://www.nyc.gov/html/dsny/downloads/pdf/swmp_implement/otherinit/wmtech/phase2.pdf

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MEMORANDUM

1651B-9

TO: John Fischer, Branch Chief, Waste and Toxics Planning, MADEP

FROM: Jim Binder, ARI

DATE: October 19, 2009

RE: **Comments on December 2008 Tellus Report**

Initial comments based on ARI's review of the December 2008 Tellus Institute Report, "Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan Review" are provided herein. These comments focus on the potential role of alternative technologies such as gasification and anaerobic digestion in the Commonwealth's future plans for solid waste management. Such technologies are not intended to replace source reduction or recycling efforts, but to enhance them and further recover materials and energy that would have otherwise been discarded or underutilized in a landfill. Further they provide flexibility for enhancing recycling in today's volatile and recently collapsed market for recycled materials. Comments are provided on key related points in the Executive Summary of Key Findings and other elements of the report which refer to Alternative Technologies and work completed by ARI for the City of New York and the County of Los Angeles.

In general, we find the report incomplete and misleading regarding its discussion of alternative technologies. In some instances, the report appears to be "slanted" against such technologies either in its reporting of factual information or omission of such information that presents a different view. Although our comments are based on an initial review of the report, we believe they are significant and warrant DEP's attention. Consequently, we believe that this report should not be "final" but "draft", subject to public and/or peer review. In the interim, in our opinion, DEP should make a clear statement regarding its position regarding its endorsement, or lack thereof, of the report and its findings. Today, the public knows that DEP funded the study, but is unaware of DEP's positions regarding the study's findings.

Some specific comments follow.

1. Item 2 of the Executive Summary recommends that DEP monitor developments regarding alternative waste management technologies that produce energy such as gasification, pyrolysis and anaerobic digestion. I am not sure what monitor means regarding specific DEP actions, e.g., begin reviewing and revising existing regulations to accommodate consideration and permitting of such technologies, or do nothing until such technologies are more widely applied elsewhere. The comment appears to suggest that such technologies are not ready for application in Massachusetts. We refer the DEP to the referenced NYC and LA County Reports which emphasize the need to develop these technologies now to meet zero waste goals based on commercial operating experience overseas. Both jurisdictions as well as many others in the US are doing so now and are active in procurement, contract negotiation or implementation of projects ranging in size from 100 to several thousand tons per day. To be a leader, Massachusetts should allow such technologies to be actively pursued by both municipal and private parties, not stand in the way of application of new technology that enhances materials recovery and recycling, reduction in greenhouse gas emissions and production of renewable energy. The Tellus Report has not described the most recent information on commercial operation of these technologies overseas nor described the initiatives underway by municipalities in the US to use these technologies, yet it had such information available to it through the referenced studies, papers and presentations.

2. Item 3 of the Executive Summary concludes that gasification and pyrolysis facilities are unlikely to play a major role in MSW management in Massachusetts by 2020. The comments cite long lead times, significant capital costs, the loss of solid waste management flexibility associated with long-term contractual arrangements that such facilities require, and the relatively small benefit with respect to greenhouse gas emissions compared to diversion or landfilling. These statements are contrary to those in many of the referenced studies. Further, the Tellus Report does not state the conclusions of the NYC and Los Angeles County Reports or report the next steps being taken in those jurisdictions. Siting studies are underway in NYC to accommodate anaerobic digestion and thermal conversion technologies. Thermal conversion and anaerobic digestion facilities being implemented for Los Angeles County are planned for operation starting in 2011. In Massachusetts, the City of Taunton is working to procure a facility for operations commencing in 2013. An RFQP was released in June 2008. The Taunton facility may range in size from 100 to 1800 tons per day, the later size certainly having a significant impact on waste management in Massachusetts. This is not 2020.

3. Item 4, although more favorable to anaerobic digestion, states that it may be more suitable to source-separated organics rather than post-recycled, mixed municipal solid waste. We would point DEP to the benefits of post-recycled mixed municipal solid waste anaerobic digestion facilities operating commercially in Europe, Israel and Australia. Again, there are many such facilities in commercial operation overseas, several of which were cited in the NYC and Los Angeles County studies or other recent and publicly available reviews, but not in the Tellus Report. The Tellus statement regarding source-separated organics is not reflective of recent, reported information on facility performance.

4. Items 5 through 7 appear to state that modern landfills emit less greenhouse gas emissions than waste-to-energy facilities, incinerators, gasification facilities and anaerobic digestion facilities. This seems contradictory to US EPA studies. Perhaps the US EPA model should have been considered for this study. One must examine in detail the emissions estimates used for each of these technologies as well as the other assumptions made for the analysis to confirm or refute this the report’s findings, but such findings appear to contradict most published studies. It would seem that the potential for reduction in greenhouse gas emissions

should consider the potential of a technology to offset the use of carbon fuels to produce energy. Clearly, as shown in Table ES-2, Item 8, all of the technologies perform more effectively than landfills regarding energy potential. It is also not clear what assumptions were made regarding transport of waste to the landfills which are becoming more distant to Massachusetts, and the associated truck emissions associated with transport.

5. Item 9 implies that only a small fraction of the Commonwealth's electric needs could be supplied by gasification facilities; i.e., 4% of the Commonwealth's 2005 energy consumption. If accurate, that is not an insignificant amount of energy.

6. Items 10, 11, 12 and 13 require an analysis of the Morris Environmental Benefits Calculator Model and its application. This would require substantial time and effort. It is fair to ask, however, why the US EPA model was not used for this study, and if it was, whether the results would vary.

7. The section on alternative technologies starting on page 8, in general, reflects either a lack of information or a misunderstanding of that information that is available, particularly thermal conversion, although also anaerobic digestion. Thermal gasification is not incineration. There is not direct combustion of the waste, gases generated can be pre-cleaned prior to combustion to reduce air emissions, gases generated can be used to make fuels, combined cycle (steam, gas turbine) systems can be used to more efficiently recover energy, and the residue can be vitrified to enhance its marketability. The readiness of alternative technology has gained substantial acceptance in the past five years in the US. It is commercially used overseas. Certain facilities require pre-processing, others do not. Studies in California have demonstrated the relatively high BTU value of waste materials after recycling. Yes, thermal conversion produces CO_2 emissions, but less than that for generation of an equivalent amount of energy from fossil fuel power plants. Also, many studies suggest that landfilling produces higher levels of greenhouse gas emissions.

   In regard to the last point made on page 9 that capital requirements for building alternative technology facilities are high and require long-term contracts for waste and that such may limit future flexibility in the Commonwealth's overall materials management efforts must be put in a comparative setting. Capital requirements for modern recycling and compost facilities are high and require long-term waste commitments to be financeable, yet composting is recommended. Also, it has not been demonstrated that there will be an adequate market for high volumes of compost. Will that material be landfilled or used as alternative daily cover material in landfills? Does the report address only composting of source separated organics? If so, what is to be done with the post-recycled municipal waste that is and will continue to be landfilled or exported? As reported by DEP, although the Commonwealth has made great strides in waste reduction and recycling, it has barely kept pace with increased waste generation, thereby resulting in continued waste export at the same or increased levels seen ten years ago. There is a need for consideration of new technology to be integrated with continued waste reduction and recycling efforts.

   It is our opinion that putting in landfills waste materials that have material value in them or energy value is not in line with the Commonwealth's goals for waste management.

8. Beyond the Executive Summary, there are comments that can be made on many pages. The Summary of Findings on Alternative Technologies, page 22, states that the energy recovery step for pyrolysis and gasification "has yet to perform consistently when processing MSW at a commercial scale". That is not true, as referenced by the studies cited in the Tellus Report.

The next statement on the page raises the old fears that like incineration, pyrolysis and gasification may undermine recycling. One can develop a contract allowing increased recycling without penalty. One can also argue that in a day of reduced value for recyclables as exists today, pyrolysis and gasification offer the flexibility to provide useful, high end value for materials that would otherwise be landfilled. The waste management system that is created in Massachusetts will have a better chance for success if it offers the flexibility to address different markets for materials, depending on market conditions.

9. On page 25, reference is made to a gasification facility in Tokyo as an example of a large facility. The NYC and Los Angeles County reports referenced by Tellus offer many other examples of gasification facilities, including those processing approximately 600 tons per day, and some of which have been operating since 1999. The report goes on to state that the ash must be treated and discusses aging, metals separation, and size reduction. What is not stated is the process of vitrification that renders the residue inert and enhances its use for aggregate and other building purposes. Vitrification is common practice in Japan and part of many of the gasification technology systems. Again, this information was available in the NYC and Los Angeles County reports referenced by Tellus.

10. On page 29, significant allegations are made regarding operational problems at the Karlsruhe gasification facility in Germany. The reference for these allegations is a newspaper article cited by Greenaction for Environmental Health and Global Alliance for Incinerator Alternatives, Incinerators in Disguise: Case Studies of Gasification, Pyrolysis, and Plasma in Europe, Asia and the United States (2006). Yet, there is no other point of view presented, including that from the facility operator which should be stated. This does not seem to be complete, factual reporting.

11. On page 30, a statement under Environmental is made that "The Massachusetts combustors all began operations prior to 1990 and, from an emissions standpoint, perform far worse than state-of-the-art WTE facilities". This statement is made seemingly to downplay an earlier statement that emissions from gasification plants may be lower than those from conventional combustion technologies. In fact, like all waste-to-energy plants in the US, the facilities in Massachusetts were significantly upgraded in the 1990s and early 2000s to meet stringent federal and Commonwealth requirements for increased control of air emissions.

12. Also, on page 30, a statement is made that gasification and pyrolysis have significant wastewater impacts. In fact, process wastewater is most often reused in the plant to reduce water consumption, and modern gasification facilities can be designed to have zero wastewater discharge to the sewer. Landfills on the other hand will always have leachate requiring treatment and discharge, and may leak, untreated, to the environment if there is a breach in the liner system.

13. In Section IV, Successful Waste Reduction Programs, page 3, there is a list presented of programs reviewed in many municipal locations. That is fine, but the question to be asked is why was not a similar list of the ten or more municipal initiatives currently being undertaken with alternative technologies in the US presented in the Alternative Technologies section. Also, San Francisco is listed. It needs to be kept in mind that San Francisco currently landfills 2000 tons per day of municipal solid waste. The point being that there is a need for additional technology for managing this waste, just as there will continue to be in Massachusetts.

ARROWECOLOGY
THE WAY TO ZERO WASTE

Melvin S. Finstein, Ph.D.
Head, ArrowBio U.S.A.

26 December 2008

Mr. John Fischer
Branch Chief, Waste and Toxics Planning
Massachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02108

Re: Tellus Report
of December 2008

Via E-Mail

Dear Mr. Fischer:

Thank you for the opportunity to comment on the Tellus Report. In my opinion, its conclusions and recommendations regarding the roles of composting and anaerobic digestion of municipal solid waste (MSW) are internally inconsistent and not cognizant of recent advances in the field. The Report's following statements encapsulate what I wish to comment on.

> …source reduction, recycling and composting are the most advantageous management options for all (recyclable/compostable) materials in the waste stream.
>
> After maximizing ….composting, it is appropriate for DEP to continue to monitor developments regarding alternative waste management technologies that produce energy ….[such as] anaerobic digestion.
>
> ….Anaerobic digestion may be most suitable for source-separated organic material as an alternative to conventional composting….
>
> Intensive pre-processing step makes this technology [anaerobic digestion] costly and difficult to use for large amounts of MSW.

Not at issue here are the roles of source reduction, recycling and the composting of separately collected vegetative waste (yard waste, leaves). Vegetative waste poses different problems than MSW and is not to be equated with it. My comments concern MSW.

The nub of the problem concerns "pre-processing" – or to use a term signifying function – separation/preparation. Whereas it is said that anaerobic digestion requires intensive separation/preparation, it is implied that composting has no such requirement. In fact, both composting and anaerobic digestion are hostage to this requirement. Separation/preparation is key because MSW is an unruly mixture of biodegradable and non-biodegradable materials; is heterogeneous, abrasive and wet; and, in all respects, is highly variable.

The Report states that only "After maximizing …composting…." of "...*all* (recyclable/compostable) materials…" should the DEP continue to monitor developments in energy producing technologies such as anaerobic digestion [italics added]. It is not recognized that the composting of *all* biodegradable organics would require intensive separation/preparation.

The underlying philosophy of the Report seems to be that what is needed is universally mandated (at the residential, restaurant, and industry levels) source-separation of all biodegradable organics for the purpose of composting. However, source-separation programs, their financial and environmental costs aside, encounter imperfect compliance, hence still necessitating facility-level separation/preparation for either composting or anaerobic digestion.

The Report does not appreciate that the problematic nature of MSW has been substantially overcome by an anaerobic digestion technology that is unique in integrating a physical *water-based* separation/preparation stage and an advanced version of the microbiological stage. This comment refers to the ArrowBio process, described in the first attachment herein (*BioCycle*, November 2008). Except for recyclable fiber, which is removed prior the water stage, water-based separation/preparation is far more efficient in recovering metal, plastic, and glass than the usual air-based methods. (I note parenthetically that water-based separation/preparation is not applicable to composting.). The water is derived from the waste's moisture content (second attachment). Overall, the system's products are: recyclable materials; biogas containing methane used directly to generate electricity, or upgraded to pipeline quality or to CNG for use as transportation fuel; and clean, well stabilized digestate (a.k.a., compost).

Notwithstanding the Tellus Report, the aforementioned anaerobic digestion technology offers a ready option that circumvents many of the obstacles to effective recovery of material *and* energy from *mixed MSW.* The main obstacle seen in the Report is thus resolved.

The third attachment shows the ArrowBio process as the cornerstone of the comprehensive Macarthur Resource Recovery Park in suburban Sydney, Australia. In the illustration it is labeled "Ecolibrium Mixed Waste Processing Facility." A second plant is on order for a different Sydney suburb. ArrowBio projects are well advanced in California and elsewhere worldwide.

Finally, regarding the cost of anaerobic digestion, please see the fourth extract from the Report reproduced at the top of this letter. Suffice it to say that disposal costs in Massachusetts are the highest in the nation. Were the Report's recommendations followed, they would go higher.

I believe that the Massachusetts Solid Waste Master Plan should be cognizant of these matters and recognize the benefits of anaerobic digestion without need of elaborate source separation.

I was glad to have met with you last summer to discuss these matters at length, and I hope the present comments add to that conversation. Please feel free to contact me for additional conversation or information.

Sincerely,

Mel Finstein

105 Carmel Road, Wheeling, WV 26003

From: Frank Campbell [frankc@iwtonline.com]
Sent: Monday, January 19, 2009 2:52 PM
To: Fischer, John (DEP)
Subject: Comments on the Tellus Institute's Materials Management Options Report

Follow Up Flag: Follow up
Flag Status: Red

Attachments: Salinas Valley - GHG Savings from IWT Project.xls; Environmental Guarantees.pdf; Air Emission Chart.pdf

Mr. Fischer,

Interstate Waste Technologies licenses the Thermoselect high temperature gasification technology for the US, Mexico and the Caribbean.

We reviewed the final report on the Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan Review and have the following comments:

I. Executive Summary of Key Findings

1. <u>Finding #3</u>

Large scale commercial facilities incorporating the Thermoselect technology have operated successfully beginning in 1992 in Europe and 1999 in Japan. There is more than 17 years of successful experience processing mixed MSW generating electricity at these facilities.

The lead time to plan, site, construct and operate gasification facilities is no longer than for any other industrial or waste processing facility.

IWT supports recycling programs in communities where we propose projects. We have found where strong recycling programs are in effect, the heat content of the resultant waste is higher than before recycling and enables more efficient operation of our facilities and increased generation of electricity per ton of waste processed.

Attached is our consultant's analysis of the savings in greenhouse gas emissions compared to landfilling waste, collecting the methane and flaring it. It shows a significant reduction in CO_2e emissions resulting from processing waste in our facilities.

Our facilities achieve 100% diversion rate.

2. <u>Finding #5</u>

We have attached pages from a recent proposal submitted to the Salinas Valley Solid Waste Management Authority for a 1,000 ton per day conversion technology project. We propose incorporating Thermoselect gasification technology in combination with GE Frame 6B combustion turbine combined cycle electricity generating equipment.

Please note our guaranteed emissions are equal or superior to recently accepted BACT for a natural gas fired power plant in southern California. These guaranteed emissions, coupled with the significant carbon dioxide reductions, provides an exceptionally environmentally friendly facility.

3. Finding #6

Guaranteed air emissions from IWT's facilities are based on actual performance of electricity generating equipment firing synthesis gas similar to the synthesis gas generated in Thermoselect facilities.

4. Finding #7

Please refer to our consultant's report attached to our response to I, Finding #3.

5. Finding #10

Please refer to our response to Findings #3 and #5 which provides information with respect our guaranteed emissions.

6. Finding #11

We recommend increasing the amount of waste processed in new facilities incorporating conversion technologies in order to maximize the environmental benefits of superior technologies.

II. Key Findings Organized by Technology - Alternative Technologies (pages 8 and 9)

1. First Bullet - Thermoselect technology can process MSW without preprocessing.

2. Second Bullet - Please refer to our response to Section I, Finding #3 for input about carbon dioxide emissions reductions. Projected emissions from our facilities are much less than from modern landfills.

3. Fifth Bullet - The Thermoselect technology has been operating on a commercial scale since 1992. This 17 year operating history should qualify the technology as "mature".

4. Sixth Bullet - The Thermoselect technology does not require the removal of metals, glass or any other materials. It processes waste as received.

5. Seventh Bullet - Please refer to our response to Section I, Finding #3 with respect to the effects our system has on climate change.

6. Eighth Bullet - IWT has found the Thermoselect technology fits in well in communities that have extensive recycling programs in place. As an example, California recycles more than 50% of its waste prior to providing it to proposed conversion technology projects. The waste received in these facilities has been recycled to the maximum extent possible prior to processing.

Our website (www.iwtonline.com) contains additional specific information about how the Thermoselect technology operates and its environmental benefits. We would be pleased to provide additional information to the Massachusetts Department of Environmental Protection or to meet to discuss our proposed technologies further.

Regards,
Frank Campbell

Francis C. Campbell
President
Interstate Waste Technologies

Phone: 610-644-1665
Fax: 610-644-1733
Email: Frankc@iwtonline.com

MTCO2 Emissions Saved by the Project vs Landfilling Waste and Flaring the Gas
Accepting 343,208 tpy (312,007 MTyr) of Solid Waste for 30 Years

	1	2	3	4	5	6	7	8	
Year	**Waste in Place, MT**	**Waste in Place, Short Tons**	**MTCE Generated from Landfill Flaring**	**MTCO2 Generated from Landfill Flaring**	**MTCO2 Produced from Firing Natural Gas for 58 MW**	**Total MTCO2 from Landfill Flaring and Power Generation**	**MTCO2 Produced from IWT's 58 MW Project**	**MTCO2 Saved by IWT's Project**	
			At 0.06 MTCE/short ton MSW per EPA Solid Waste Report	Convert MTCE to MTCO2	Based on using GE MS 5002 gas turbines on natural gas	Col 4 + Col 5	From GT Pro calculations from IWT	Col 7-Col 6 (Negative value is a savings for IWT's project)	
1	312,007	343,208	44,617	163,566	274,681	438,247	456,382	18,135	**Savings begin in year 2, when emissions from flaring become significant**
2	624,014	686,415	89,234	327,132	274,681	601,813	456,382	-145,431	
3	936,021	1,029,623	133,851	490,698	274,681	765,379	456,382	-308,997	
4	1,248,028	1,372,831	178,468	654,264	274,681	928,945	456,382	-472,563	
5	1,560,035	1,716,039	223,085	817,830	274,681	1,092,511	456,382	-636,129	
6	1,872,042	2,059,246	267,702	981,396	274,681	1,256,077	456,382	-799,695	
7	2,184,049	2,402,454	312,319	1,144,961	274,681	1,419,642	456,382	-963,260	
8	2,496,056	2,745,662	356,936	1,308,527	274,681	1,583,208	456,382	-1,126,826	
9	2,808,063	3,088,869	401,553	1,472,093	274,681	1,746,774	456,382	-1,290,392	
10	3,120,070	3,432,077	446,170	1,635,659	274,681	1,910,340	456,382	-1,453,958	
11	3,432,077	3,775,285	490,787	1,799,225	274,681	2,073,906	456,382	-1,617,524	
12	3,744,084	4,118,492	535,404	1,962,791	274,681	2,237,472	456,382	-1,781,090	
13	4,056,091	4,461,700	580,021	2,126,357	274,681	2,401,038	456,382	-1,944,656	
14	4,368,098	4,804,908	624,638	2,289,923	274,681	2,564,604	456,382	-2,108,222	
15	4,680,105	5,148,116	669,255	2,453,489	274,681	2,728,170	456,382	-2,271,788	
16	4,992,112	5,491,323	713,872	2,617,055	274,681	2,891,736	456,382	-2,435,354	
17	5,304,119	5,834,531	758,489	2,780,621	274,681	3,055,302	456,382	-2,598,920	
18	5,616,126	6,177,739	803,106	2,944,187	274,681	3,218,868	456,382	-2,762,486	
19	5,928,133	6,520,946	847,723	3,107,753	274,681	3,382,434	456,382	-2,926,052	
20	6,240,140	6,864,154	892,340	3,271,319	274,681	3,546,000	456,382	-3,089,618	
21	6,552,147	7,207,362	936,957	3,434,884	274,681	3,709,565	456,382	-3,253,183	
22	6,864,154	7,550,569	981,574	3,598,450	274,681	3,873,131	456,382	-3,416,749	
23	7,176,161	7,893,777	1,026,191	3,762,016	274,681	4,036,697	456,382	-3,580,315	
24	7,488,168	8,236,985	1,070,808	3,925,582	274,681	4,200,263	456,382	-3,743,881	

25	7,800,175	8,580,193	1,115,425	4,089,148	274,681	4,363,829	456,382	-3,907,447	
26	8,112,182	8,923,400	1,160,042	4,252,714	274,681	4,527,395	456,382	-4,071,013	
27	8,424,189	9,266,608	1,204,659	4,416,280	274,681	4,690,961	456,382	-4,234,579	
28	8,736,196	9,609,816	1,249,276	4,579,846	274,681	4,854,527	456,382	-4,398,145	
29	9,048,203	9,953,023	1,293,893	4,743,412	274,681	5,018,093	456,382	-4,561,711	
30	9,360,210	10,296,231	1,338,510	4,906,978	274,681	5,181,659	456,382	-4,725,277	
Total	145,083,255	159,591,581	20,746,905	76,058,155	8,240,430	84,298,585	13,691,460	**-70,607,125**	**Total savings in MTCO2 by doing the IWT project over the 30-year period**

ENVIRONMENTAL GUARANTEES

1. Air Emissions

The proposed criteria air emissions from the facility match recently permitted energy projects in California firing natural gas. A comparison between current Federal New Source Performance Standards (NSPS) for Municipal Waste Combustors (MWC) and the proposed Facility emissions show that Facility emissions will be dramatically lower.

The attached Table shows the US EPA NSPS maximum allowable air emissions for criteria pollutants from MWC's corrected to 7% oxygen (Column 1).

Column 2 includes the projected air emissions from the facility corrected to 7% oxygen to be compatible with EPA Standards.

Please note that the projected air emissions from the facility are extremely low compared to the US EPA allowable limits. For example, NOX emissions are about 30 times lower, CO 48 times lower, SOX 115 times lower and Dioxins 18,570 times lower.

Column 3 includes allowable air emissions for California based on recently established Best Available Control Technology (BACT) for gas turbines corrected to 15% oxygen (the percentage used for gas turbine emissions calculations).

Column 4 includes projected air emissions from the facility based on California BACT for gas turbines, corrected to 15% oxygen with the balance corrected to 7%. The emissions from the facility are equivalent to the best controlled energy projects in California.

2. Cooling Tower Emissions

The Cooling Tower, if used, will have a design drift control of 0.0005 percent, which is equivalent to recent BACT controls in California.

3. Liquid Discharges

There are no liquid discharges from the facility except a sanitary wastewater line from the facility's kitchen, bathrooms and showers.

4. Solid Waste

IWT guarantees to produced marketable recycled products. There will be no solid waste residuals from the facility.

5. Odor Control

The entire facility is housed in an enclosed building. The waste receiving area and storage pit will be maintained under negative pressure in order to prevent odor emissions. Under normal operating conditions, the air in and around the tipping pit will be evacuated, filtered and used as makeup air in the gas turbine. In the event of partial or full facility outages, air from the waste receiving area will be directed through carbon filters to maintain negative pressure in the waste receiving area and vented. In addition, removal of waste from the storage pit will be monitored to prevent excessive aging of waste.

6. Noise Control

The facility will comply with established noise limits. Deliveries of material and maintenance activities will be conducted principally during normal daylight hours to minimize the noise level during evening and night hours. The perimeter of facility will be lined with trees to act as noise buffer.

7. Fugitive Dust Control

A vacuum system will be installed and utilized to minimize fugitive dust during the house keeping process. Also, road sweepers will be utilized to keep the roads free of dust.

8. Vector Control

Adequate housekeeping will be maintained to prevent infestation of rodents. Routine vector control inspection will be subcontracted and inspection frequency will be adjusted as necessary.

9. Litter Control

Housekeeping areas will be assigned to operations and maintenance personnel to maintain a litter free facility. General litter pick-up activity will be conducted twice per day to keep access and interior roads and other site areas free of litter.

In addition, a telephone “hotline” will be made available to residents, with complaints recorded and followed up on immediately.

JOHNSON CANYON RESOURCE MANAGEMENT PARK PROJECT
AIR EMISSIONS

Criteria Pollutants	USEPA NSPS	Projected Facility Emissions @ 7% O2	Recent California BACT @ 15% Oxygen	Projected Facility Emissions
Nitric Oxides (NOx) Ammonia Slip	 150 ppmv @ 7% 02 N/A	 5.2 ppmvd@ 7% O2 13 ppmvd @ 7% O2	 2 ppmvd @ 15% O2 5 ppmvd @ 15% O2	 2 ppmvd @ 15% O2 5 ppmvd @ 15% O2
Carbon Monoxide (CO)	100 ppmv @ 7% O2	2.1 ppmvd @ 7% O2	0.8 ppmvd @ 15% O2	0.8 ppmvd @ 15% O2
Sulfur Dioxide (SO2)	30 ppmv @ 7% O2	0.26 ppmvd @ 7% O2	0.1 ppmvd @ 15% O2	0.1 ppmvd @ 15% O2
Volatile Organic Compounds (VOC)	N/A	1.05 ppmvd @ 7% O2	0.4 ppmvd @ 15% O2	0.4 ppmvd @ 15% O2
Particulate Matter (PM 10)	20 mg/m3 @ 7% O2	0.13 mg/m3 @ 7% O2	1.54 mg/m3 @ 15%O2 0.00401 lb/MMbtu (HHV)	0.05 mg/m3 @ 15% O2 0.00013 lb/MMbtu (HHV)
Dioxins/Furnans	13 ng/m3 @7% O2	0.0007 ng/m3 @7% O2	N/A	0.0007 ng/m3 @ 7% O2
Cadmium	0.01 mg/m3 @ 7% O2	0.0027 mg/m3 @ 7% O2	N/A	0.0027 mg/m3 @ 7% O2
Mercury	0.0081 mg/m3 @ 7% O2	0.001 mg/m3 @ 7% O2	N/A	0.001 mg/m3 @ 7% O2
Lead	0.14 mg/m3 @ 7% O2	0.0054 mg/m3 @ 7% O2	N/A	0.0054 mg/m3 @ 7% O2
Hydrogen Chloride (HCL)	25 ppmv @ 7% 02	0.066 ppmvd @ 7% 02	N/A	0.066 ppmvd @ 7% 02

Note: The MWC NSPS limits are measured at 7% 02. Combustion turbine NSPS limits are measured at 15% 02.

really big flaw in Tellus/DEP report

Posted by: "Roger Guzowski" rguzowski@fivecolleges.edu
Fri Jan 30, 2009 12:35 pm (PST)

I really want to thank DEP for what I think has been good discussions about the solid waste master plan. I also want to thank DEP for putting the new Tellus report on the web.

http://www.mass.gov/dep/recycle/priorities/dswmpu01.htm
<https://exchange.amherst.edu/exchweb/bin/redir.asp?URL=http://www.mass.gov/dep/recycle/priorities/dswmpu01.htm> .

However, given that this report is going to be cited a lot in comments regarding the new solid waste master plan, I would like to suggest a dialog about what I consider to be a horrible flaw in this report: that is that is does not focus on specific materials, but rather aggregates all materials together. I think at this point in the collective waste management discussion, we need something more specific than this.

I don't think that on an aggregated scale for all materials anyone argues with the notion that recycling is preferable to combustion or landfilling. That is why we have had a solid waste hierarchy from EPA (and DEP) for more than 20 years now.

However, at this point in the discussion, I think we need to get into specific discussions about specific materials and how to plan for them. To the best of my knowledge there is no one proposing that we combust materials like aluminum cans or white paper. If they are I have some discussion points that will not make it through decency filters in this discussion group. However, as we get into other materials, this issue gets a lot murkier and I am very distressed to see that this murkiness was not better addressed in the Tellus report.

Take for example the issue of cereal boxes (or similar materials) and the ongoing debate about their true recyclability. Let's assume for example that I have 100 tons of sorted office paper and 15 tons of cereal boxes. If I call those cereal boxes recyclable and mix them into my otherwise SOP-grade paper, I have relegated that entire 115 tons for use only as a low grade residential mixed paper and a new life only as a cereal box or equivalent product (assuming the entire 115 tons is not discarded as waste in this horrible market or any similar market downturn we face in the next decade or so). And in the process (even if it does get to a mill) there is a decent likelihood that a significant portion of the 15 tons of cereal boxes is leaving the recycling mill not as recycled finished product, but rather as short-fiber waste than needs to be somehow disposed of or dealt with as a residual. Conversely, I could send those 15 tons of cereal boxes to a combustion facility, recover some energy value from them, and ship the other 100 tons of SOP to a higher grade mill in which it can preserve more of it's value (value both in economic and environmental terms), are more likely to ensure that it is being recycled even in these markets, and likely be recycled more times before becoming short fiber waste. Given that scenario, is "recycling" those cereal boxes (or insert other favorite marginal recyclable/outthrow here) so clearly advantageous over combustion, or digestion or other strategy, or do those other strategies have a role?

We might even find an answer in that process that helps us better reach into the commercial waste stream and increase recycling within that stream.

If we are looking to unflatten our statewide recycling/recovery rate and return to a point in which the Solid Waste Master Plan is one of the best solid waste planning documents in the country (which I believe the original document was but subsequent revisions are not), I think we need to really deal with these sorts of difficult, murky grey-area questions.

Or, we can continue on the path we are on, continue to avoid these difficult questions, and prepare to explain to the residents of Ohio, Pennsylvania, and upstate NY why they are having to plan for how to deal with our (soon to be exported) wastes because we failed to do so.

Just my two cents worth.

Roger Guzowski
Five College Recycling Manager
cell: 413-658-5558
rguzowski@fivecolleges.edu

New York City Economic Development Corporation
110 William Street • New York, NY 10038 • www.nycedc.com

March 6, 2009

Mr. John Fischer, Branch Chief
Waste and Toxics Planning
Massachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02108

Re: Comment Letter, *Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan Review* (Tellus Institute, 2008)

Dear Mr. Fischer,

I am writing to provide general feedback on the Tellus Institute report, referenced above, and to update you on the status of some of New York City's own initiatives in alternative solid waste conversion technologies.

Based on the research New York City has undertaken as part of our own Comprehensive Solid Waste Management Plan (SWMP) – including the *Focused Verification and Validation of Advanced Solid Waste Management Conversion Technologies* (prepared by Alternative Resources Inc (ARI), 2006) – we are seeking opportunities to integrate alternative technologies into our traditional solid waste management planning efforts. Also, as stated in the City's *PlaNYC*: *A Greener, Greater New York,* we believe that new technologies can complement and augment recycling and composting efforts, provide a significant source of clean, renewable energy, and help reduce greenhouse gas emissions. Therefore, we disagree with the Tellus Institute's implication that alternative technologies threaten to impede recycling, composting, and waste reduction efforts.

We also disagree with the report's general bias towards source separation and the particular assessment that anaerobic digestion is best suited for source-separated organic waste streams. Our own investigation found several successful, commercial-scale AD operations in Europe and Israel that handle a mixed municipal waste stream. We are concerned that these representations could potentially shift public opinion—as well as other municipalities and states—against a set of promising solid waste management strategies that, while in their infancy in the United States, are mature and successful in other areas of the world.

Two specific, related efforts underway in New York City might be of interest to you:

- A task force comprised of representatives of the City Council, Administration, and the five Borough Presidents will work this year to review potentially suitable alternative waste conversion technology pilot project sites in all five boroughs. This work will capitalize on the research developed in the ARI report cited above, and is a requirement of our SWMP.

- We are currently underway with the second phase of an anaerobic digestion feasibility study, which is expected to culminate with the release of an RFP for the development of an AD facility at the City's Hunts Point Food Distribution Center.

I will keep you apprised of the results of both projects. In the meantime, I would be glad to answer any questions you might have regarding New York City's investigation of new waste management conversion technologies. Thank you for this opportunity to comment.

Best regards,

Venetia Lannon
Senior Vice President

Cc: Harry Szarpanski, Deputy Commissioner
DSNY Bureau of Long Term Export

LOS ANGELES COUNTY
SOLID WASTE MANAGEMENT COMMITTEE/
INTEGRATED WASTE MANAGEMENT TASK FORCE
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P.O. BOX 1460, ALHAMBRA, CALIFORNIA 91802-1460
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GAIL FARBER
CHAIR

March 4, 2009

Mr. John Fischer
Branch Chief, Waste and Toxics Planning
Massachusetts Dept. of Environmental Protection
1 Winter Street
Boston, MA 02108

Dear Mr. Fischer:

COMMENTS REGARDING THE DECEMBER 2008 TELLUS INSTITUTE REPORT, *"ASSESSMENT OF MATERIALS MANAGEMENT OPTIONS FOR THE MASSACHUSETTS SOLID WASTE MASTER PLAN REVIEW"*

The Los Angeles County Integrated Waste Management Task Force (Task Force) would like to comment on the report entitled, "*Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan Review*" (Assessment), developed on behalf of the Massachusetts Department of Environmental Protection by the Tellus Institute. Although the Assessment references Los Angeles County's Phase II Conversion Technology Report (adopted in 2007), the Report's findings are not adequately represented, and the conclusions in the Assessment seem inconsistent with our findings. As an entity that has expended significant resources in evaluating alternative solid waste management technologies, I hope we can be of assistance in your evaluation of these technologies and share the insight we have gained from our research efforts.

Pursuant to Chapter 3.67 of the Los Angeles County Code and the California Integrated Waste Management Act of 1989 (AB 939, as amended), the Task Force is responsible for coordinating the development of all major solid waste planning documents prepared for the County of Los Angeles (County) and the 88 cities in Los Angeles County with a combined population in excess of ten million. Consistent with these responsibilities, and to ensure a coordinated and cost-effective and environmentally-sound solid waste management system in Los Angeles County, the Task Force also addresses issues impacting the system on a countywide basis. The Task Force membership includes representatives of the League of California Cities-Los Angeles County Division, the Los Angeles County Board of Supervisors, the City of Los Angeles, the waste management industry, environmental groups, the public, and a number of other governmental agencies.

One distressing claim in the Assessment stated that “landfills with efficient gas-capture systems reduce two and a half times as much eCO_2 as gasification and pyrolysis facilities” (Executive Summary, page 3). This claim is in direct contradiction to several reports developed here in California, including the County’s Phase II Report, which found the use of conversion technologies to manage solid waste would significantly reduce emissions, including greenhouse gas (GHG) emissions as discussed below. We are concerned that the Assessment does not fully acknowledge the full range of demonstrated benefits of conversion technologies, such as the following:

1. **Conversion technologies can create green collar jobs and spur the economy** - Conversion technologies would create a range of new, high tech jobs and contribute to the local economy by creating new advanced infrastructure.

2. **Conversion technologies can decrease net air emissions and greenhouse gases** - In February 2008, California Air Resources Board’s Economic and Technology Advancement Advisory Committee (ETAAC) released its report entitled “*Technologies and Policies to Consider for Reducing Greenhouse Gas Emissions in California*”. The ETAAC Report noted that by conservative estimates, conversion technologies have the potential to reduce annual GHG emissions by approximately five million metric tons of CO_2 equivalent in California. In fact, the Task Force estimates the potential GHG reduction of conversion technologies may be three times greater, since conversion technologies have a simultaneous triple benefit to the environment: (1) reduction of transportation emissions resulting from long distance shipping of waste; (2) elimination of methane production from waste that would otherwise be landfilled; and (3) displacement of the use of fossil fuels by net energy (fuel and electricity) produced by conversion technologies.

3. **Conversion technologies can produce renewable energy and green fuels, thereby reducing our dependence on foreign oil** - Conversion technologies produce fuel and/or energy. By utilizing conversion technologies, California, Massachusetts and other states can develop clean, locally-produced renewable energy and green fuels, including ethanol, biodiesel, and electricity, which can be used to promote energy independence. Benefits from this independence include insulating residents from energy markets fluctuations, and avoiding environmental impacts associated with the extraction, refining, transportation, and combustion of fuels.
4. **Conversion technologies are an effective and environmentally preferable alternative to landfilling** - Based on reports developed by the State of California Integrated Waste Management Board, the County of Los Angeles, and other independent agencies, conversion technologies

are environmentally preferable to land disposal practices. Copies of these reports are available at www.SoCalConversion.org. While economically the cost of utilizing conversion technologies may exceed current landfill disposal rates in California, disposal costs are expected to increase as landfill capacity declines within the coming decade. Development of conversion technologies is needed now to provide decision makers with environmentally preferable and economically viable options for the management of post-recycled waste materials.

5. **Conversion technologies can manage materials that are not practically recyclable and at the same time create an incentive to increase recycling** - Not all solid waste currently disposed can be recycled or composted. Contaminated organic materials, higher number plastics and other materials, which cannot be recycled or processed in an economically feasible manner, are ideal feedstock for conversion technologies. At the same time, inorganic materials including glass, metals and aggregate have no value for conversion technologies, and therefore create an incentive to separate and recover those materials for recycling prior to the conversion process.

The Task Force believes conversion technologies are a very real and immediate solution to reducing the amount of waste going to landfills and diversifying our solid waste management system. For this reason, the County of Los Angeles has spent the last decade extensively evaluating conversion technology suppliers from around the world. After a careful vetting process, four companies were invited to submit proposals to develop a highly-efficient conversion technology demonstration facility onsite with a materials recovery facility. The goal of this unique project is to demonstrate the technical, environmental and economic benefits of conversion technologies, which have already demonstrated successful operation in Europe, Japan and other countries for many years.

By design, we have made our process as transparent as possible so as to provide a public resource to other communities considering conversion technologies, in order to avoid having to reinvent the wheel. In fact, our technical consultant for the second phase of our conversion technology evaluation – Alternative Resources, Inc. – is based in Massachusetts and would be a valuable resource to discuss the findings of Los Angeles County's Phase II Report in detail.

We look forward to the Assessment being revised to accurately reflect the current global status of conversion technologies and their potential environmental benefits, and would be happy to provide additional, specific information upon request to assist in this endeavor. Should you have any questions, please contact Mr. Mike Mohajer of the Task Force at (909) 592-1147.

Sincerely,

Margaret Clark

Margaret Clark, Vice-Chair
Los Angeles County Solid Waste Management Committee/
Integrated Waste Management Task Force and
Council Member, City of Rosemead

TM/CS:ca
P:sec\taskforce\letter\tf letter-MA DEP

cc: Each Member of the Los Angeles County Integrated Waste Management Task Force
Each Member of the Los Angeles County Alternative Technology Advisory Subcommittee
Alternative Resources, Inc (Jim Binder, Susan Higgins)

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May 8, 2009

John Fischer
Branch Chief, Waste and Toxics Planning
Massachusetts Department of Environmental Protection
One Winter Street
Boston, Massachusetts 02108

Reference: Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan Review – Final Report, dated December 2008

Dear Mr. Fischer,

We have reviewed the referenced Assessment Report and find it inadequate regarding transparency, verifiable methodology, consistency with international standards and supporting data. The Department needs to invest significant work in this report for it to be a useful basis for policy development.

Your cover letter described the report as a literature review that summarizes data and information regarding the lifecycle energy and environmental aspects of various solid waste options. That may have been the goal of the Department, but the Report fails to reach it.

There are two major themes that frame the comments submitted herein. The first is that the majority of the Report's findings are based on a hybrid life cycle assessment (Morris Environmental Benefits Calculator) that is comprised of modules from various life cycle assessment (LCA) programs developed by others. However, the input data and calculation methodology is completely missing, preventing a thorough review. Second, the scope of the literature review shows a distinct bias that has excluded numerous LCA reports and readily available data.

In regards to the hybrid LCA, there is virtually no input data or transparency, in the report or in the general literature, explaining how this LCA works. LCA's are not very difficult; however, the adage "garbage in, garbage out" applies here. We have attached a simple and straightforward, albeit simplified, LCA that is open, transparent and fully referenced. This is the minimum level of information that is needed to review the report.

We are equally interested in whether Tellus conducted any independent check and independent set of calculations, such as a carbon balance, that would verify the results. The analysis presented herein demonstrates that the Report's conclusions are skewed when considering key variables in a LCA. The results

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also demonstrate that the singular results provided in the Report for landfills and waste-to-energy also are not representative of the municipal solid waste (MSW) industry.

We find it curious that a review of the Report's references shows a complete absence of papers authored by the authors of the LCA studies referenced in the Report, or papers by anyone in the waste-to-energy industry. These other LCA's arrived at a completely different conclusion than the Report. Also, why weren't the numerous U.S. Environmental Protection Agency (EPA) reports that used the same cited EPA LCA studies on this subject, which are readily available on the internet, included in the literature review? It is worth pointing out that the waste-to-energy industry was never contacted for information. On the other hand, the list of references in the Report does show a strong dependency on individuals and groups that could safely be described as opposed to waste-to-energy.

These points are the tip of the iceberg. The attached document provides detailed questions and comments that challenge the Report's recommendations, database and life cycle assessment methodology. As stated above, a significant failing of this Report that limits a thorough review is the lack of data and transparency in the report itself. How could anyone verify the completeness or accuracy of this new LCA without having the methodology, input, calculations and output?

We are also interested in learning more about the Department's goals in quantifying energy and environmental aspects of various management options. Was there a specific decision to select optimized operating data for landfills and alternative thermal options while using average data for waste-to-energy facilities? The Department is well aware that there is a large degree of variability in performance of landfill gas collection systems, as well as the energy generation by gasification, yet the Report is based on optimized values as if a singular data point can define those options. The consequence of selecting skewed optimized inputs for those options is a skewed output that is not representative of actual operations.

In summary, we have two key conclusions regarding the Report:

1. The Report lacks sufficient facts and analysis to support the recommendations presented in the Report. Consequently, the Department cannot base its Solid Waste Master Plan on this Report.
2. The Department should secure the services of qualified independent professionals with experience in waste management and life cycle assessment to peer review this report. An independent review would be consistent with the standards set forth by the EPA administrator who has stated that policy must be based on peer-reviewed science to prevent the infiltration of ideology into the policy decision-making process. We are

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confident that an independent review will yield results similar to our comments.

We are available to meet and discuss these issues and our comments at your convenience. We have attempted to make our analysis as clear and transparent as possible with citations for critical parameters. We expect the same for the hybrid LCA used as the basis of the Report.

We look forward to working with the Department on correcting the Report.

Sincerely.

Ted Michaels

Comments of the Energy Recovery Council (ERC) on Assessment of Materials Management Options for the Massachusetts Solid Waste

Master Plan Review

Final Report, dated December 2008

1.0 Overview of Morris Environmental Benefits Calculator

The Department's contractor, Tellus, used the Morris Environmental Benefits Calculator (MEBCalc) as the basis for the evaluation of impacts of waste management options. Therefore, a detailed understanding of this life cycle assessment (LCA) methodology is critical in order to understand the results. A complete set of inputs and a thorough explanation of the calculation methodology are needed before the results can be fully reviewed.

ERC had requested from the Department detailed information on the MEBCalc methodology and data. However, all that was provided was limited factors that do not qualify as the inputs needed for a LCA. There was no information on the methodology nor is there any methodological information available in the general literature. What we are faced with is a "black box."

Information provided on pages 42 thru 48 and Appendix 2 of the Report is presented below. This information forms the basis of certain LCA questions that follow that are organized according to functional groups.

Table 1. Basis of MEBCalc

Parameter	WARM	DST	IPCC	CMU	NC State	Other
Material decomposition rates	Yes	---	---	---	---	---
Carbon Storage	Yes	---	---	---	---	---
Biogenic CO2	Yes	Yes	Yes	---	---	---
Landfill gas collection %	Yes (75)	---	---	---	---	---
MSW volume reduction %	---	Yes (90)	---	---	---	---
Ferrous recovery %	---	Yes (70)	---	---	---	---
Criteria emissions	?	Yes	?	?	?	?
Air toxic emissions	?	?	?	?	?	?
Avoided grid CO2	?	?	?	?	?	?
Net Energy production	?	?	?	?	?	?

WARM – Waste Reduction Model

DST – Municipal Solid Waste Decision Support Tool
IPCC – Intergovernmental Panel on Climate Change
CMU – Carnegie Mellon University
NC State – North Carolina State University
Other – Additional references cited but never explained include US NIST, BEES Model, and Consumer Environmental Index

1.1 Content and Basis of the Report's integrated Life Cycle Assessment (LCA)

1. Multiple LCA models (WARM, DST, etc.) were cited in the Report. However, details of how they were used are missing. Other listed LCA models (CMU and NC State) were listed as inputs but how and where were also never explained. A complete explanation of how each different part of each LCA was used is required before we can complete a review of the MEBCalc. Without this, the Department cannot accept the results of this hybrid LCA approach. Tellus or Morris should identify the inputs to each module of each LCA to provide reviewers with the information necessary to verify that the inputs were consistent across all LCA's.
2. An explanation of why certain LCA's were used for different parameters is warranted. For example, the Report does not provide any rationale or explanation of what parts were used and why. The factual basis for this approach is warranted given the uncertainty that the same inputs were used in each of the LCA modules and that the modules are fully compatible.
3. Given that different models were apparently used to evaluate different waste management practices, the waste properties entered into each model must be compared to ensure consistency. For example, if the inputs are based on waste compositional analysis, each MSW management option evaluated by the models must be consistent in terms of biogenic and anthropogenic split, decomposable carbon, etc. Failure to achieve consistency renders the report useless. Given its critical nature, this information should be made readily available.

1.2 Life Cycle Assessment Variables

1. There are well known differences between WARM and DST with the US EPA currently evaluating why each LCA yields different results. WARM, limited to GHG emissions, is known to include a variety of default values that compromises its utility. As an example, WARM limitations include a constant landfill gas collection efficiency, constant carbon storage, constant waste-to-energy (WTE) thermal efficiency, constant methane generation potential, etc. These constant factors are not consistent with the reality of waste management operations where there is variation in performance. The authors of the Report should provide an explanation of why an analysis would use WARM instead of the DST given these limiting factors and why they did not consider a range of factors to fully consider variability of performance.
2. The WARM model is known to have a carbon storage factor that is factually incorrect because the factor includes the anthropogenic component of MSW. The original WARM carbon storage factor has been corrected by the author of the original study to remove anthropogenic components from the carbon storage

factor. The revised value is about one-third of the original factor. However, in any case, the ability to estimate and verify this factor is highly questionable. The authors should provide an explanation of which carbon storage factor was used and presuming that they decided to knowingly include the anthropogenic component due to comments on page 50, they should provide an explanation that addresses US EPA's decision to not include carbon storage from anthropogenic components. The Department should address this issue with the knowledge that the Reports inclusion (page 50) of anthropogenic carbon is completely inconsistent with LCA procedures for MSW management.

We question whether the Department is seriously considering inclusion of any carbon storage in any GHG inventory given that there is so little data on this parameter and there are no means to measure, let alone verify, this parameter. The Department should reconsider the magnitude of carbon storage as presented in the Report and the long-term consequences of including it as a GHG mitigation mechanism.

3. The methane generation potential of MSW is never identified or discussed in the Report despite the common knowledge that this parameter is known to be a primary variable that dictates the results of a LCA. This factor and a carbon balance must be provided by the authors as they are essential to validate any results regarding methane emissions.
4. There is general recognition that the 75 % landfill gas collection factor is an instantaneous value and not a lifecycle efficiency that recognizes variable collection efficiency over the 100 year anaerobic decomposition period. Any LCA must recognize that federal operating requirements for landfills do not require landfill gas to be collected for the first five years and the last 40 to 50 years of the anaerobic decomposition period. The analysis must also recognize the limited data base (3 data points in USA and 8 from Europe) cited by the landfill industry as the data set for the entire industry for the period when a landfill gas collection system is in operation. When these limited landfill gas collection efficiency results are applied to various landfill operating stages, the life cycle efficiency for the best performing landfills is between 56 and 67%. The range for non-optimized landfills is 55 to 45 % range or lower. Because the actual lifecycle landfill gas collection efficiency is below 75 % for the best run landfills - any LCA that assumes 75 % collection efficiency would underestimate methane emissions from a landfill.

   As a consequence, the GHG avoidance of WTE would also be underestimated.

   In order to address this influential variable, any analysis of the Report by the Department should include a range of landfill gas collection unless the Department has specific data for each stage of a landfill(s) accepting MSW from Massachusetts.

5. The statement on page 48 of the report that emission factors from modern landfills, waste-to-energy incinerators (WTE), gasification, and pyrolysis plants

are “based largely on modeling” as “opposed to actual operational data from real world experience” demonstrates a complete lack of knowledge of the WTE industry. The WTE industry has been subject to state and federal (40 CFR Part 60, subpart Cb) stack test requirements that have required annual testing of each unit since December 2000. Massachusetts has a more stringent requirement with a 9-month frequency. There are hundreds of test runs for each regulated pollutant along with continuous emission monitoring data for criteria pollutants. The absence of a similarly robust database for landfills (with or without landfill gas collection and/or energy recovery) and gasification/pyrolysis demonstrates a shortcoming of any comparison such as Table III-2 of the report.

In order for the Department to fully understand any emission factor for all of the different MSW disposal options;

a. The authors of the Report should provide the emission data used to project LCA emissions for each waste management option along with an explanation of the sources of the data and the key statistics (data quantity, variability, confidence, etc.).

b. The Department should consider assigning a range that fully addresses the issue.

The Department will realize that the WTE industry has a robust data base with relatively little variability because all units are equipped with similar combustion and air pollution controls. The emission data from landfills and alternative technologies will be relatively limited in data quantity and there will be larger variability due to variability in the process control.

The department should also be aware that the DST has emission data for many of the regulated criteria pollutants and can be adjusted to recognize specific data.

In summary, the Department should dismiss all of the results in Table ES-1 until the authors of the Report present their data and the public can evaluate the representative nature of each data base.

6. There are several key questions regarding the net energy production for each MSW management option that need to be addressed;
   a. There is a significant range of net power production from landfills with landfill gas to energy due to the 100-year anaerobic digestion process and the fact that landfill gas is not collected during this entire period. What is the basis for the singular value?
   b. There is very little information in the public domain that clearly identifies the long-term “Net” electrical production from alternative thermal processes. The emphasis on “Net” is because many if not all alternative processes have external energy inputs such as the addition of fossil fuels (coke, coal, etc.), oxygen for enhanced combustion conditions or electrical power for operation of plasma

torches. A complete mass & energy balance needs to be documented to demonstrate the origin of any value used in the LCA.

c. The Department needs to establish some uniformity on input values to assure that output values are comparable. As an example - the report acknowledges that gasification technologies have a wide range of net power generation, yet the Authors decided to use the values that presented the best case for these technologies despite any evidence of where this is being achieved on a continuous basis. The 585 kWh/ton net power value cited for WTE is approximately the national average for WTE. However, since the best case values were used for gasification, why wasn't the net power factor from better performing WTE units used? In the US, this would be 700 kWh/ton. For full scale operating units in Europe, it would be 900 kWh/ton.

In summary, the Report's analyses and output has no relevance as it uses skewed data as input values and the results cannot be compared. The results also have little value unless the inputs are actual performance data.

We recommend that the Report needs to be revised to include a range of performance data. If publicly available data such as that from a compliance test program is not available to demonstrate verifiable performance, that option should not be included in the analysis.

2.0 Issues Specific to GHG Calculations

The Report did not include sufficient information to enable an understanding of which LCA modules and LCA methodologies were used in calculating Report's LCA results. There was also inadequate information to determine if GHG results for each MSW management option in Table III-2 were only the results for a specific operation or if these results were a complete LCA comparison of alternatives. The comparison approach is most common for MSW management because it addresses the difference if MSW is managed by one option or the other. The comparison approach is the basis of the USEPA report cited throughout the report and WARM and DST results.

The lack of transparency has created a lot of questions regarding all pollutants and parameters. For the purpose of evaluating Table III-2, the focus is on the landfill and WTE GHG mitigation factors because these alternatives have been the subject of many LCAs and the Reports results are not consistent with these LCAs, including those that use the DST.

As mentioned previously, a LCA comparing MSW management options must use the same MSW characteristics for each technology LCA. In simple terms – the MSW characteristics are inputs to a LCA and if they are different and/or the LCA has different default values – the results are not comparable. Inputs can be waste composition such as the percent of paper, plastic, food, etc. but when it comes down to calculating results - the primary variables are total carbon, the biogenic/anthropogenic split, the methane generation potential, the integrated landfill gas collection efficiency over the 100 year period, and known power generation rates. The absence of this information in the Report makes it non-transparent and it casts doubt on the results.

The following sections identify the key variables in a LCA for landfills and WTE management options and values for each. In addition to raising questions on the value used by the Report, we are also presenting a simulation for two reasons; 1) an attempt to simulate the results in the report, and 2) demonstrate to the Department how the LCA results can vary as a function of certain input values.

2.1 Methane Generation Potential (Lo as m3/ton)
Table 1 above identifies that the WARM defaults were used for material decomposition rates but the Report never explains if it used the methane generation potential factor (Lo) for mixed MSW (default value of ~ 70 m3/ton MSW) or if the approach assumed waste composition and methane generation for each material such as paper, food waste, etc.

If the default value of 70 m3/ton was used, the Department should know that this default is not appropriate and, at a minimum the value should have been 100 m3/ton. There are several reasons for this assertion. First, EPA had to adjust the 70 m3/ton factor to reconcile the carbon balance for the samples used to derive the 70 m3/ton factor. The new factor identified in EPA GHG report is 168 m3/ton. Second, the EPA value for establishing inventories is 100 m3/ton with a 170 m3/ton value required for Prevention of Significant deterioration (PSD) permits and Title V permits. Third, EPA is currently reviewing the Lo factor and has proposed a new inventory value of 130 m3/ton to replace the existing default of 100 m3/ton. If the Report is based on compositional analysis, the resulting methane generation factor must be compared with these references to validate the results.

There are several potential problems with the material decomposition factors in WARM:
1. The waste components were those used in a one-time laboratory experiment that included four 2-liter vessels of each material. While the results are interesting, they are not adequate to predict the behavior of full scale landfills managing millions of tons of MSW per year.
2. The waste components are very specific and often do not match up with waste categories in field sample surveys. As a result, users typically have to adjust the weight percents or force a component into a certain category.
3. The material decomposition approach does not include a carbon balance and unless the user does that – the results essentially have no QA/QC or test for reasonableness.

In summary, a Lo value of 100 or 170 should have been used. We will show the impact of each Lo below.

2.2 Landfill Gas Collection Efficiency and Soil Oxidation
The report is clear in its application of a 75 % landfill gas collection efficiency however it simply accepts this value as a constant without considering evolving and readily available information. A constant landfill gas collection efficiency over the 100-year

anaerobic decomposition period is not recognized by the landfill industry or by others involved in LCA analysis of landfills. The more common approach recognizes landfill gas collection as a variable during different operating periods is illustrated by Table 2 which includes seven different scenarios to illustrate the potential variability of an integrated life cycle collection efficiency.

Scenario 1 and 2 illustrate lower quality landfill gas collection systems whereas Scenario 3, 4, 5 and 6 illustrate a trend where a landfill would be using the most modern and aggressive landfill gas collection techniques. Scenario 6 presents results of an international survey of actual landfill gas collection efficiencies with Scenario 7 identifying a survey by the Solid Waste Industry for Climate Solutions.

Table 2. Integrated LFG Collection Efficiency for Various Scenarios

Landfill Information			LFG Collection Efficiency (%)						
LFG Collection Stage	Time (Years)	CH_4 Generated (% of total)	1	2	3	4	5	6 Spokas	7 SWICS
1	3	14	0	0	0	0	0	0	0
2	7	25	25	35	50	50	90	35	60
3	10	24	50	50	75	75	90	85	75
4	30	29	50	75	90	90	90	90	90
5	50	8	0	0	0	90	90	0	0
Total	100	100	32	46	58	69	77	56	62

Several observations from this rather straight forward methodology:

- The only way to achieve a nominal 75 % collection efficiency is to actually achieve 90 % collection during a 97 year period. This has never been done (note that Subpart WWW was only promulgated in the mid 1990's) and landfill gas collection IS NOT a required performance standard in state or federal landfill regulations.
- The best case performance at actual landfills only yields a nominal value in the 55 to 62 % range. The Department should note that the landfill gas collection data provided to support Scenario 7 is limited to eleven landfills – eight in Europe and 3 in the USA and this s limited to short term events. These measurements are not correlated to any landfill design standards so application to the 1600 to 1800 landfills in the USA is speculative.

While this information should cast doubt on the merit of a constant default value, we have adopted the constant factor in an attempt to simulate the Reports results for landfills.

The Report never identifies soil oxidation as a factor however both EPA and IPCC recommend a default value of 10 %. Therefore, this value was used in our simulation.

2.3 Global Warming Potential (GWP) of Methane
The Report is clear in identifying that methane has a much greater GWP than CO2 and the Appendix references a GWP of 23. . The UNFCC adopted a 100-year GWP for methane of 23 in their Third Assessment report however the IPCC's Fourth Assessment Report issued in 2007 provided an update on GWP including a 100-year GWP of 25 and a 20-year GWP of 72.

While we understand that a 100-year GWP of 100 is necessary for comparison with other LCA's, the Department should consider the IPCC's position as documented in their report entitled "Climate Change 1994 – Radiative Forcing of Climate Change and An Evaluation of the IPCC IS92 Emission Scenarios". When considering the choice of a time horizon for GWP, the report states:

> "If the policy emphasis is to guard against the possible occurrence of potentially abrupt, non-linear climate responses in the relatively near future, then a choice of a 20-year time horizon would yield an index that is relevant to making such decisions regarding appropriate greenhouse gas abatement strategies."

For the purpose of the simulation, we used the IPCC 100-year GWP of 23 used in the Report; however, the Department should consider use of newer GWPs in developing policy and state inventories. As an example, New Jersey is using the new 100-year GWP of 25 for state inventories including methane from New Jersey MSW buried in out-of-state landfills.

2.4 Carbon Storage
The Report clearly uses carbon storage default values from the WARM model and is equally clear that it intentionally included anthropogenic components in carbon storage. This position is clearly inconsistent with all international methodologies, including the US EPA, and it is a major factor that drives the results presented in the report.

Inclusion of anthropogenic carbon storage is wrong for the following reasons:

- US EPA, IPCC and others are very clear that anthropogenic components are not to be included in carbon storage. The general concept is that transferring a anthropogenic component from one form of storage to another is not a GHG mitigation process. In fact, the author of the EPA factor used in WARM has issued a correction to remove the anthropogenic components.
- Inclusion of anthropogenic carbon storage is double counting when comparing landfills with WTE because 1) the landfill gets "credit" for this carbon and 2) CO2 from combustion of the same material is considered an emission.
- To our knowledge, this is the first LCA for MSW management that ever considered inclusion of anthropogenic components such as plastics, rubber, etc.

Inclusion of biogenic carbon storage is also debatable for several reasons:

- Carbon storage in landfills is a debated issue regarding behavior of biogenic components over hundreds of years and the difficulty to establish a meaningful value for this factor, let alone one that could be verified with field measurements.

International accounting procedures for inventories recognize carbon storage from biogenic materials “for information purposes only”.

- The information used to estimate the biogenic carbon storage is from a one-tome laboratory experiment limited to four 2-liter sample. This is certainly not sufficient to characterize the MSW from a state let alone the national inventory.
- In addition to a limited data set, there is not a standardized sample and testing method to address this parameter.

When all of the above is considered – there is little to no technical justification to include carbon storage on principle alone. Inclusion of carbon storage is especially controversial when considering that it is the largest potential factor leading to the Report’s conclusions.

For the purpose of a simulation, we applied a range of carbon storage factors. This was done in the absence of a value in the Report and to illustrate the magnitude of the impact of this debatable parameter.

2.5 Avoided Grid CO2

The report clearly states that any renewable energy from landfill gas to energy or WTE only displaces natural gas generation, the marginal fuel type. This is an incorrect assumption.

First, waste-to-energy plants are baseload facilities. They are not marginal power producers. They operate 24 hours a day, 7 days a week, 365 days a year. Therefore, they offset baseload power.

Second, in a carbon-constrained operating environment, utilities should be using low carbon or carbon neutral sources such as waste-to-energy, to offset their higher carbon emitting sources, i.e., coal and oil. Utilities would not offset lower carbon emitting sources such as natural gas with waste-to-energy facilities.

Third, even if you believe that the correct offset is marginal power, ISO New England is very clear in stating that the marginal power is **FUEL OIL** and natural gas.

Rather than debate whether the correct offset is marginal power or baseload power, a justifiable alternative approach for selecting the avoided grid CO_2 factor is to use EPA’s eGRID non-baseload factor, which is updated on an annual basis. These power plants are considered to be the most likely to be displaced. The eGRID non-baseload 2007 factor (2005 data) factor for NPCC New England is 1,314 lb CO_2 / MWh.

There is no justification in using only the natural gas marginal power emission factor since nowhere is this referenced by ISO New England or any other source except Morris. That is unless the intent is to present the worst case for waste-to-energy.

In order to address the Reports assumptions, the simulation provided in Section 2.6 considered a range of natural gas emission factors (900 to 1200 lbs/MWh) and the eGRID factor of 1314 lbs/MWh for comparison purpose.

2.6 Simulated LCA Results for a Landfill with Energy Recovery

A LCA should include direct and indirect emissions including both upstream and downstream impacts. Landfills are relatively simple to model because the results are driven by methane because its Global Warming Potential is so much greater than CO2 emitted from local mobile sources. Consequently, the generation rate of methane in a landfill (Lo) is a critical factor.

Table 1 presents two scenarios for estimating landfill emissions. Scenario 1 is based on a Lo of 100, the existing EPA default Lo for estimating inventory values and Scenario 2 is the EPA default Lo of 170 for PSD calculations. Line B is a conversion of m3/ton to lbs CO2e/ton to be consistent with the report's selection of engineering units. Application of a landfill gas collection efficiency of 75 % and a soil oxidation factor of 10 % yields the landfill methane emission factor. The methane emission factor in Line F identifies the GHG emission factor of methane. It also demonstrates the impact of an assumed landfill gas collection efficiency. As an example, this assumption is responsible for reducing 2295 lbs CO2e/ton (0.75*3060) and 3900 lbs CO2e/tonin Scenario 2.

Line H identifies the range of landfill gas emissions avoided by a MWh or electricity distributed to the grid on the basis assumed in the Report – all natural gas. The amount of avoided CO2e from a landfill generating electricity is only 95 to 126 lbs CO2e/ton for scenario 1 and 2. This is a small number relative to the methane factors.

Line L presents the carbon storage factor in units used by US EPA. The 0.06 factor is typically associated with the biogenic fraction whereas 0.18 is associated with carbon storage of both biogenic and anthropogenic. Line M presents these factors as lbs CO2e/ton MSW for direct comparison with the report. As you can see – estimates of carbon storage can result in a very large number.

Line K is the landfill emission factor without carbon storage whereas Line N is the emission factor IF carbon storage is included.

Table 1. Summary of Direct Landfill Emission Factors

	Reference Information	Scenario 1		Scenario 2	
A	Methane potential Lo as M3/Mg	100		170	
B	Baseline lbs CO2E/ton MSW	3060		5201	
C	LFG Collection Efficiency	75		75	
D	Residual methane as lbs CO2E	765		1300	
E	Soil Oxidation as %	10		10	
F	Methane Emission Factor (lb CO2e / ton)	688		1170	
G	Avoided Grid CO2	Low	Typical	Low	Typical

H	Power generation MWh/ton	0.105		0.105		0.105		0.105	
I	Natural Gas CO2 Factor (lbs/MWh)	900		1200		900		1200	
J	LFGTE Avoided grid CO2/ton	94.5		126		94.5		126	
K	Landfill Emission Factor (lb CO2e / ton)	594		562		1076		1044	
L	Carbon Storage Factor as MTCE/ton MSW	0.06	0.18	0.06	0.18	0.06	0.18	0.06	0.18
M	as lbs CO2/ ton MSW	484	1452	484	1452	484	1452	484	1452
N	Net Calculation	110	-858	78	-890	592	-376	560	-408

Several key observations can be derived from Table1:

- The methane generation rate before (Row B) and after (Row F) landfill gas collection demonstrates the importance of the assumed landfill gas collection factor.
- The carbon storage factor can dominate the results when using either biogenic or anthropogenic components. Note that when EPA corrected the 0.18 factor to remove anthropogenic components – this translated to a net difference of 968 lbs CO2e/ton MSW (1452 – 484 = 968). This factor by itself is far more that avoided grid CO2 – a parameter that can be measured and can be more than the methane emission itself.
- The landfill emission factor based on conventional LCA procedures is presented in Row K. In every case – landfills are a source of CO2e emissions. This is consistent with international findings.
- If carbon sequestration is considered, Row N provides an estimate of the final result. If only biogenic carbon is considered, the landfill continues to be a source of CO2e emissions. The only way for a landfill to be a reducer of GHG emissions is to include storage of anthropogenic carbon – a practice without scientific basis and discounted by the US EPA and international community.

There are also two major conclusions that must be considered by the Department:

1. The only way that the Report's finding of 504 lbs CO2e/ton for landfills could be substantiated is by using the carbon storage for anthropogenic carbon.
2. Landfills are a net source of GHG emissions. This is consistent with other LCA's using the DST.

The Department must address the scientific basis of the Report including the inclusion of carbon storage from anthropogenic materials in the face of other climate authorities' position against such treatment. The following citation from the US EPA GHG Lifecycle report cited by the Report will help to provide context for this question:

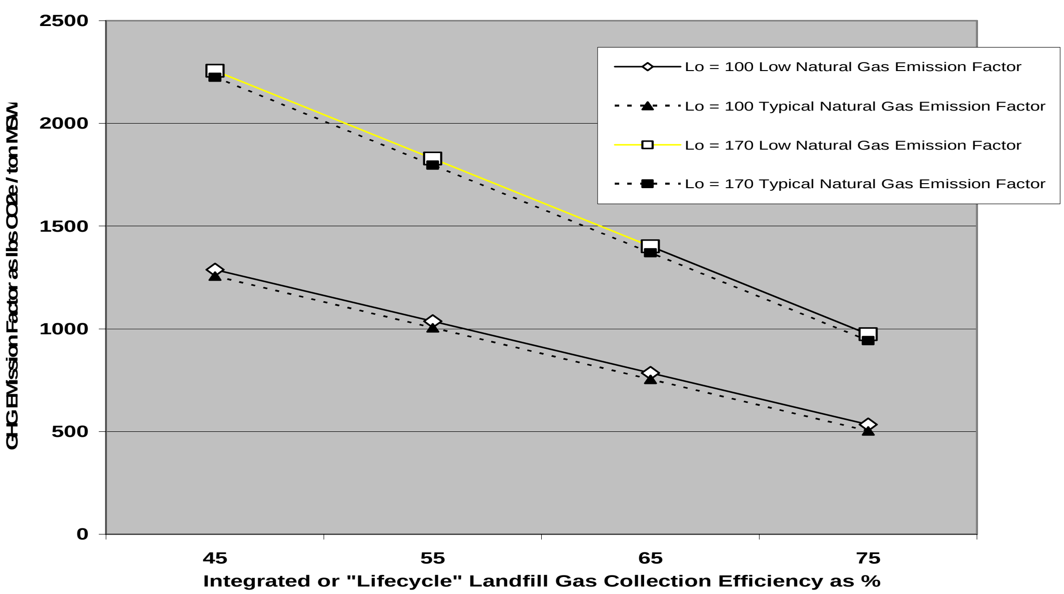
> "Finally, landfills are another means by which carbon is removed from the atmosphere. Carbon stocks increase over time because much of the organic matter placed in landfills does not decompose, especially if the landfill is located in an arid area. However, not all carbon in landfills is counted in determining the extent to which landfills are carbon stocks. For example, the analysis does not count plastic in landfills toward carbon storage. Plastic in a landfill represents simply a transfer from one carbon stock (the oil field containing the petroleum or natural gas from which the plastic was made) to another carbon stock (the landfill); thus, no change has occurred in the overall amount of carbon

stored. On the other hand, the portion of organic matter (such as yard trimmings) that does not decompose in a landfill represents an addition to a carbon stock, because it would have largely decomposed into CO2 if left to deteriorate on the ground."[1]

The issue of carbon storage is also relevant when determining CO2 emissions from combustion of MSW at a waste-to-energy facility where CO2 is included as a positive emission factor in accordance with international convention. Giving credit to landfills is incorrect in principal but, according to the calculations as described, a LCA that compares a landfill with an WTE facility would give a landfill twice the credit, i.e., carbon storage credit plus WTE anthropogenic CO2 emissions.

A general sensitivity analysis was run to evaluate the parameters with the greatest impact on landfill emissions. Figure 1 illustrates a range of integrated landfill gas collection efficiencies and both the low (900 lb/MWh) and high (1200 lb/MWh) CO2 emission factor for natural gas-fired engines. The dominant impact of methane emissions and the landfill gas collection efficiency is readily evident.

Figure 1. Landfill Emission Factors as lbs CO_2e when considering only methane emissions and avoided grid CO2



Additional analyses were run to consider the impact of various carbon storage factors and various landfill gas collection efficiencies. Figure 2 presents the results for a Lo of 100 and Figure 3 presents the results for a Lo of 170. Note that in each case the integrated landfill gas efficiency on the X-axis is the LCA value over the full 100-year anaerobic decomposition period and as such – there is a different collection efficiency during different landfill periods of operation.

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[1] US EPA. Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks. 3rd Edition. September 2006. Page 6.

Figure 2. Landfill GHG Emission Factors. Lo of 100, landfill gas to energy, variable landfill gas collection efficiency and both biogenic and total carbon storage.

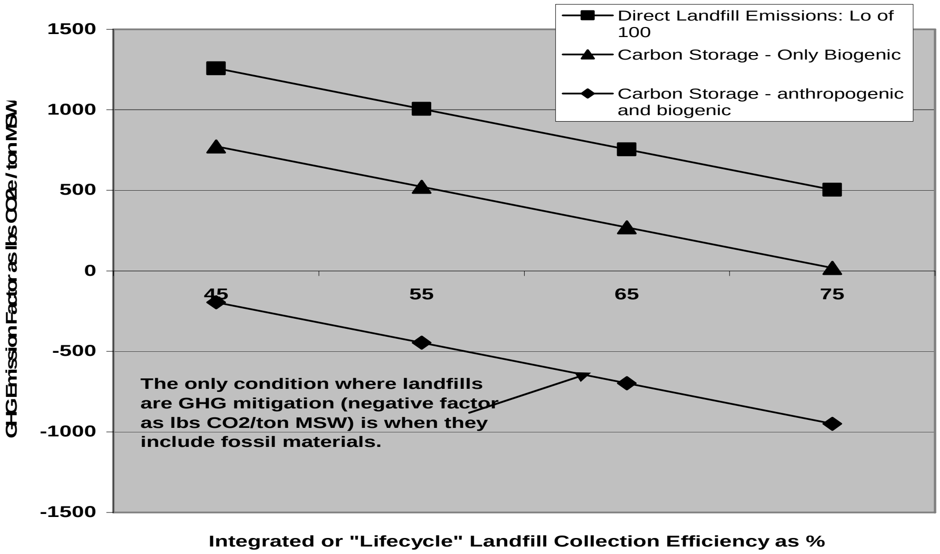
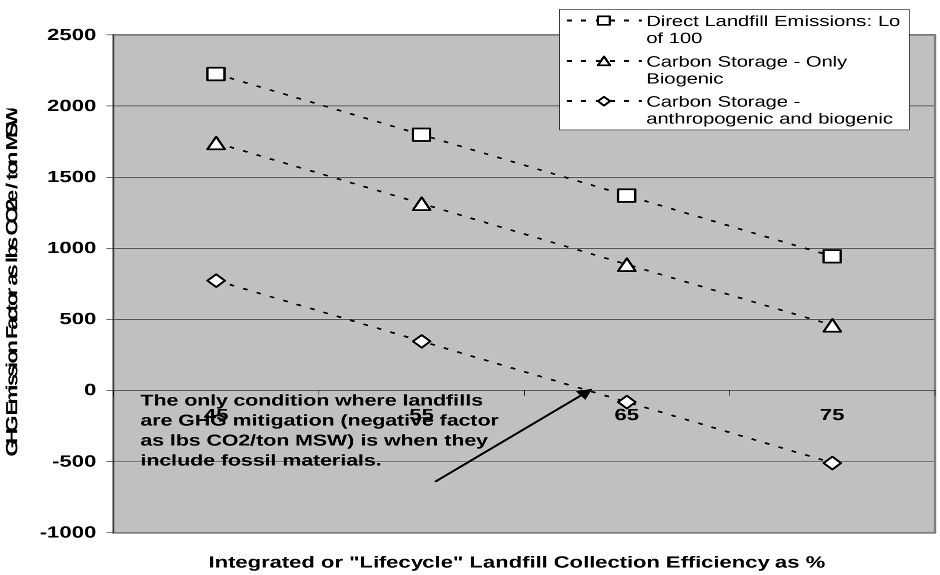


Figure 3. Landfill GHG Emission Factors for a Lo of 170, landfill gas to energy, variable landfill gas collection efficiency and both biogenic and total carbon storage.



From Figures 1 and 2, it can be seen that:

- The only way for a landfill to be a GHG reduction process as concluded in the Report is for the landfill to be given credit for carbon storage of biogenic and anthropogenic materials, which as stated previously, is contrary to conventional accepted practice; and.
- The landfill gas collection efficiency is a very significant factor. Scenario 3, 6 and 7 of Table 2 demonstrates that a modern well-equipped and operated landfill during a test regime would yield a landfill gas collection of 55 to 65 % versus the

75 assumption. Why would the Department advocate the use of an aggressive assumption that skews results in favor of a landfill?

2.7 Waste-to-Energy GHG Operations

Table 2 presents the relatively simple and straightforward calculation procedures for a WTE facility. Based on his table - we cannot imagine how the Report derived a factor of 143 lbs CO2e / ton MSW.

Table 2. Calculation procedures for Estimating GHG Emissions from WTE

	Reference Information	Emission Factors	
	WTE Anthropogenic **CO2 Factor (1)**		
O	Total CO2 as lbs/ton	2127	
P	Anthropogenic CO2 as %	35	
Q	Anthropogenic CO2 as lbs/ton	744	
	WTE Avoided Grid CO2		
R	MWh/Ton (2)	0.585	
S	Avoided Grid CO2		
T	Fossil Generation Factor (lbs/MWh) (3)	1200	
U	WTE Avoided Grid CO2 (lbs CO2/ton)	702	
	WTE Avoided Landfill Methane	Lo of 100	Lo of 170
K	Landfill Emission Factor (lbs CO2/ton) (4)	562	1044
V	**LCA Emission For WTE (lbs CO2/ton) (5)**	-520	-1002

(1) The national average biogenic/anthropogenic CO2 emission ratio for waste-to-energy (Row Q) has been demonstrated by scores of tests using an ASTM test method. It ranges from 65:35 to 67:33. To be conservative, the lower biogenic value is used here.
(2) The amount of electrical generation "per ton" can be directly measured by comparing weigh scales and power sold. There is no need for an estimate.
(3) The 1200 lbs CO2e/MWH emission factor for natural gas was used in this example. Application of the eGRID factor of 1314 lbs CO2e/MWh would increase the avoided CO2 factor proportionally
(4) The landfill emission factor is consistent with traditional LCA's and does not include carbon storage. It certainly cannot include anthropogenic CO2 because it is already addressed in Row Q. Aside from previously stated problems with anthropogenic storage, counting it on both sides of the LCA ledger would amount to "double-counting" of the same parameter.
(5) These results are consistent with those of other LCA's that assumed high Landfill gas collection efficiency.

Observations regarding these results:

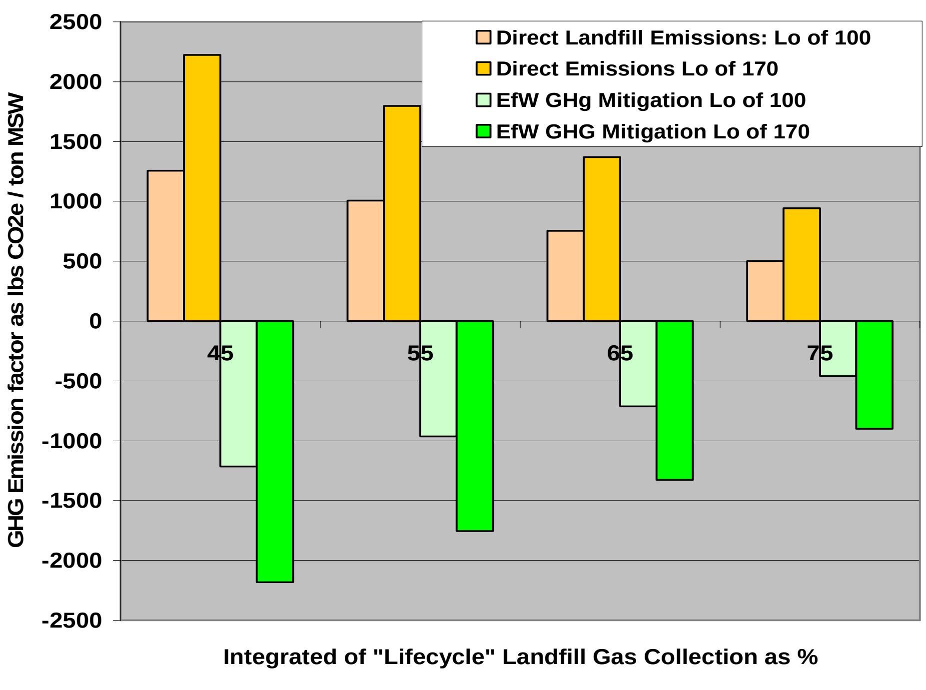
- WTE is a GHG mitigation process as acknowledged by IPCC and other international organizations.

- WTE is essentially carbon neutral when simply comparing anthropogenic CO2 emissions with avoided grid CO2. This statement is based on highly reliable measurements.
- The amount of avoided methane depends on the specific landfill but in all cases – WTE does avoid methane emissions.
- These results are considered to be conservative (i.e., GHG mitigation is actually larger than presented) because several features of an LCA are not included such as ferrous and/or nonferrous recovery, methane avoidance from extraction of natural gas, and other LCA parameters

.
While the comparison of WTE and LFGTE is appropriate when considering alternative forms of renewable energy – the Department should realize that not all landfills have landfill gas collection and energy recovery. Some have no landfill gas collection and there are others that collect and flare gas without any power generation.

Figure 4 presents the amount of GHG emissions attributable to landfills with different landfill gas collection efficiencies and the amount of GHG reduction (mitigation) attributable to WTE due to the combination of avoided landfill emissions and grid CO2.

Figure 4. Amount of GHG Mitigation Attributable to WTE for various methane generation rates and landfill gas collection efficiency.



The emission factors for WTE and avoided grid CO2 in Table 2 are both based upon high quality data that can be verified according to internationally accepted protocols. As such, there is a high degree of confidence in these factors.

The landfill gas factors are not of the same caliber as the WTE data. The landfill gas data is very limited with the majority being from Europe and none of it verified by independent tests on a routine basis. This is a significant failing in the data used by Tellus, especially considering confounding factors such as the 100 year anaerobic digestion period of a landfill and the known variability of performance during different landfill operating periods.

Carbon sequestration is not included in these estimates for several reasons:

1. The laboratory research used to derive the original estimates are inadequate to characterize this parameter;
2. The available data is not of sufficient caliber to compare with WTE;
3. There is no known method or even attempt to verify this parameter on a long term basis;
4. International and national protocols do not include it; and
5. Certainly anthropogenic CO2 should not be included.

2.8 Conclusions

Table 5 presents the GHG conclusions presented in the Report and results derived in the preceding simulation.

Table 5. Comparison of GHG Results from the Report and Conventional LCA Calculation Procedures

MSW Option	Conditions	Report Results	Preceding Analysis
Recycling	None	- 3620	---
Landfill	Includes 75 % landfill gas collection and both biomass and anthropogenic carbon storage	- 504	No comparison possible with inclusion of anthropogenic carbon.
	Report did not consider sensitivity analysis and impact of assumptions	- 504	+ 503 to + 2225 Analysis considers direct emissions from landfill including range of landfill gas generation and collection.
	Report did not consider sensitivity analysis and impact of assumptions	- 504	+ 19 to + 1741 Range represents same as above but allows for some carbon storage based on limited 4 vessel research.
Waste-to-Energy	Inadequate information (inputs, calculations, etc.) to	- 143	- 461 to - 2183 Range considers variability of landfill gas generation and collection

	understand what was included		
Gasification	Inadequate information (inputs, calculations, etc.) to understand what was included	- 204	None ventured due to inadequate transparency of input values.

Our conclusion is that there is inadequate information and calculation methodology to analyze the results provided in the Report. Upon applying conventional LCA calculation procedures and the limited inputs from the Report, the results in the Report are inconsistent with LCA's using the same methodology and basic calculations as provided herein.

LCA's are not necessarily complicated routines, however, if the user of such does not understand how to use let alone check the results, the result will be illogical and incorrect results, as in the Tellus Report. This situation is particularly baffling due to the decision to use modules from various LCA methodologies prepared by a variety of other researchers.

Given the lack of transparency of data input, absence of any calculation methodology, the absence of any internal QA/QC and that these results are inconsistent with other analysis using the same LCA methodologies, we can only conclude that the results have no meaning or relevance in the world of waste management.

The Departments goal was practical but this Report falls far short of being sufficient upon which to base any decision

3.0 Issues Specific to Energy Generation

Table ES-2 from the Report, which presents the net energy potential per ton of MSW, is shown below along with several footnotes that are provided by the authors in the Report. The logic and technical basis for the selection of the values in this table are not presented in the Report. We believe that the selection of only the best data for the other technologies is yet another example that demonstrates the bias in the Report.

Table ES-2: Net Energy Generation Potential Per Ton Of MSW

Management Method	**Energy Potential (kWh per ton MSW)**
Recycling	2250
Landfilling	105
Waste-to-Energy	585
Gasification	660
Pyrolysis	660

Anaerobic Digestion	250

- Page 22. The 660 kWh/ton figure represents the high end of the range.
- Page 23. For Pyrolysis. One example cited in Germany. Net power output of 400 to 700 kwh/ton based on feedstock composition.
- Page 25. Gasification. < 400 to 500 kWh/ton for one-stage fluid bed technologies and 700 to < 900 for two-stage gasification/pyrolysis fixed bed facilities.

The average net power from existing WTE facilities is approximately 555 kWh/ton. This is not energy potential or theoretical energy but the actual net power delivered to the grid after subtracting internal power requirements. Some units in the US operate at approximately 700 kWh/ton and newer units in Europe at 900 kWh/ton. However, these data are not included in the Report. These WTE units, unlike gasification and pyrolysis do not require a continuous stream of supplemental fuels. These results are openly available and we would have supplied this and other data if asked.

The uneven treatment of waste-to-energy relative to other technologies raises several questions:

- Was there a specific reason to use a typical WTE facility for comparison with the "high-end" results of the alternative technologies despite the fact these units are not operating in the USA and that the operating and environmental data is far from conclusive?
- Please provide evidence that these gasification and pyrolysis units represented by the data in Table ES-2 are processing MSW similar to that in managed by waste-to-energy plants in Massachusetts. Is front-end "fuel" preparation required for the pyrolysis and gasification facilities? Was the energy and environmental impacts associated with front-end processing included in the LCA for those facilities?
- The energy potential for gasification and pyrolysis on Page 25 is quite broad. What was the rationale for selecting the high end (660 kWh/ton versus 700 kWh/ton) when one group is between 400 and 500 kWh/ton? Please explain the operating history of each so that a direct comparison can be made with waste-to-energy operating performance.
- Gasification units in Japan (those in Europe were closed down years ago) are conventionally described as being low temperature, high temperature and plasma. Each has its own operating characteristics. Low temperature is similar to WTE in that syngas is combusted and conventional air pollution controls are used. High temperature and plasma use auxiliary fuels such as coke, coal or even oxygen to increase temperatures for slagging of bottom ash. Please explain which one was modeled and how these operating features were factored into the LCA. For example, the Plasco demonstration plasma facility in Ottawa supplements the MSW with "non-recycled plastics" increasing the heat rate of its "fuel" by almost 50%. This facility has had extremely limited operation and has yet to maintain consistent integrated operation. It is misleading to cite the power factors for these facilities as if they are using only MSW. To do so would mean

that a coal-fired boiler that burned 1% MSW could be included at an extremely high power factor.
- There is only one plasma unit operating in Japan and it does not process conventional MSW. Please explain if this one unit was somehow included in the Report's analysis.

4.0 Issues Specific to Air Toxics
The information presented in Table ES-1 and elsewhere in the Report is difficult to understand given the absence of input data and lack of transparency in calculation methodology (Sound familiar?). We cannot even begin to analyze the other parameters in Table ES-1 without additional information.

For example:
- What is the emission factor database and is it comparable between MSW management systems?
- What LCA modules were used for each pollutant or class of pollutants?
- Why are the results different from those using the DST and TRACI module that have undergone peer review?

The Department is well aware that there are hundreds if not thousands of compliance test data to define the performance of a WTE facility. There is also have decades of data from continuous emission monitors.

According to EPA's AP 42 methodology, our database warrants an A on a scale of A to F with A being the best. AP 42 for landfills lists 42 air pollutants with 25 known Title III air toxics and several known carcinogens. Yet the data includes some A's, with the remainder being B to D. To put this into context, to get an A only required 20 data points, with a B requiring between 10 and 20 data points. Given the limited landfill emissions database and that there are over 1600 landfills with cells in various modes of operation, it is clear that the Report's input and output for waste-to-energy, landfills and gasification are not comparable.

Information on gasification is even more limited given that there is not one facility operating on MSW in the USA and the data available is only from short-term tests.

5.0 Conclusions and Recommendations
The Department's goals and objectives are laudable. However, the mechanism to derive information has yielded erroneous and useless results. We understand that the Department, the US EPA and other branches of the federal government are advocating an approach where policies should be based on sound science. In this regard, the Report is a failure.

We are ready and willing to share information with the Department in an open and frank manner. We are also willing to do this with the authors of the Report. The Department should note that the authors did not contact the ERC (previously known as the

Integrated Waste Services Association) or any of its members to solicit information that would be useful in such a report.

From our evaluation of the Report, it is clear that the Department must direct Tellus to reveal the methodology and data that lurks within the “black box” called the Morris Environmental Benefits Calculator. The Department must also re-task Tellus to embark on an un-biased science-based approach and work with the solid waste industry, specifically, the waste-to-energy industry to ensure realistic assumptions and data are used in this evaluation

June 11, 2009

Mr. John Fischer
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Boston, Massachusetts 02108

Dear Mr. Fischer:

I understand that you had a conversation with Susan Thorneloe of EPA's Office of Research and Development, and that you told her that you are still accepting comments on the draft Tellus report entitled "Assessment of Materials Management Options for the Massachusetts Solid Waste Master Plan Review (December, 2008)." This report analyzes the environmental impacts of waste management and quantifies the life cycle impacts of various approaches. I have worked with Susan to review the report and we offer the following comments on how the report might be improved in clarifying and documenting assumptions. We also identify concerns with the study which we would be happy to discuss with you in more detail.

We applaud the effort by the State of Massachusetts to use a more holistic approach to value different options for materials management. However, we do think the specific comments below need to be considered prior to the state drawing conclusions from the report.

1. The Morris Environmental Benefits Calculator (MEBCalc) that was used found that the emission factors for CO2 equivalence from Waste-to-Energy (WTE) were higher than the emission factors from landfills. It was not clear from the report documentation how carbon storage was modeled and how the difference in potency of methane versus carbon dioxide emissions was accounted for. There should be available calculator documentation to allow the reader to understand how these differences were taken into account because they could affect the conclusions reached. Also, were both the biogenic and fossil fraction given credit? Was a credit given for ash landfills for WTE? We would suggest each of these be considered prior to final conclusions being drawn.

2. Even for the most state-of-the-art gas collection systems for landfills, there is still methane leakage to the atmosphere. It was not clear from the report documentation how gas collection efficiency was modeled over time. Was 75% collection used for the entire period, not taking into account the period of time after initial waste burial that no gas collection is in place? Again, we suggest this be assessed and considered.

3. Susan was involved in a recently published paper that compared electricity production for discards management.[2] A range of scenarios were evaluated comparing landfill gas to energy (LFGTE) to WTE. The results founds that even for the most optimistic assumptions for LFGTE, WTE is seven times more efficient at recovering energy from waste than landfills (84 vs 590 kWh/ton). The paper's authors concluded that WTE was better than LFGTE in terms of GHG emissions based on their analysis. We would be happy to work with you to try to understand why this paper seems to provide different results than the Tellus study.

4. In the Tellus study, natural gas was used as the fuel offset for electricity production. The report said that in Massachusetts natural gas is the "marginal" fuel, but typically WTE and LFTE offset the "baseload" fuel. We aren't familiar with the term marginal in fuel applications. However, if it is referring to peaking power then that is not the fuel offset that we use in our analyses and could be one source of discrepancy between our study and the Tellus study. We would suggest using the mix of energy sources for baseload power, which is usually the power that is offset by WTE plants. Baseload power mixes typically are sources that provide continuous power to the grid and thus have more coal-derived power in the mix.

5. The report uses data from a Morris and Bagby study to estimate the benefits of composting. Did the Tellus study assume that households apply compost to their yard (grass and soil) which reduces fertilizer and pesticide use by 50%? Is this the current practice in Massachusetts, or is this a desired goal?

6. Along the same lines, we noticed that the recyclables and compost data were mixed together as opposed to being separated. This seems to be giving composting a significant carbon credit based on the total tonnage being inflated with the inclusion of the recycling tonnage number. Is this what was intended? We would suggest that any carbon credit attributed to compost be specific to the quantity actually being composted.

7. A final comment is in regards to tables III-1, III-4, and III-5. From Table III-1 on page 45, it appears that the top three waste items disposed are mixed paper, food waste, and "other" materials. We could not find any assumptions for what materials were included in the enhanced maximum diversion scenario (2). Table III-4 shows a large drop in the eCO2 offset for WTE which signifies less BTU input to WTE facilities, and thus less energy recovered. It was unclear to us why in Table III-5 the same energy balance is shown for WTE in all three scenarios.

As you know, there are two models, the Waste Reduction Model (WARM) and the Municipal Solid Waste Decision Support Tool (MSW-DST), that were developed by EPA to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices.

[2] Kaplan, P.O., DeCarolis, et al (2009). "Is It Better to Burn or Bury Waste for Clean Electricity Generation?" Environmental Science & Technology (published online on February 10, 2009)

For your study, only the (WARM) was used to quantify the greenhouse gas reductions for potential waste management options. This model has the advantage of being available on line and was designed for more broad-based usage relying on national averages for model inputs.

For site-specific analyses, the MSW-DST is available (but not on-line) to evaluate cost and environmental aspects associated with specific waste management strategies or existing systems. The MSW-DST includes multiple design options for waste collection, transfer, materials recovery, composting, waste-to-energy, and landfill disposal. You might consider using this tool in your study as well because it might provide results that should be considered in evaluating policy options for Massachusetts. If interested, please contact Susan at Thorneloe.Susan@epa.gov to discuss the potential use of this tool for application in your state. More information can also be found from the project web site at https://webdstmsw.rti.org/ .

Please do not hesitate to contact us in order to discuss these comments in more detail. My office phone is 703-308-8871 and my email address is brandes.william@epa.gov. Susan's phone is 919-541-2709. It is important for our offices to share information to ensure that the best information is provided to policy making officials. Our goal is not to push a specific waste management option, but instead to provide all the needed information so that policy decisions can be supported by the best available data.

Sincerely,

William F. Brandes, Chief
Energy Recovery and Waste
Disposal Branch
US EPA

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