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## Appendix A

### Governor Minner's Letter Establishing the Working Group

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October 18, 2005

The Honorable John A. Hughes  
Department of Natural Resources and Environmental Control  
89 Kings Highway  
Dover DE 19901

Dear John:

Based on your recommendations and discussions with my staff, I am directing you to create a Solid Waste Management Technical Working Group. As you have stated, the options currently in front of us do not include the full range of best-practices technologies and management methods available for handling solid waste.

While I strongly believe that increased recycling rates and a yard-waste ban should be part of our long-term answer to solid waste management concerns in Delaware, even fully mandatory recycling would not be a sufficient long-term solution to landfill capacity and solid-waste disposal concerns. We have an obligation to assess the entire range of options, technical and non-technical. This working group would focus on the technical options.

The working group will perform a feasibility review of available municipal solid waste management alternatives and recommend a municipal solid waste management program or programs capable of being implemented that would best serve Delaware's long-term and short-term municipal solid waste management needs.

In reviewing and evaluating available municipal solid waste management alternatives, the working group will consider and address – at a minimum – such factors as environmental impact, environmental benefits, cost, technical reliability, economic feasibility, flexibility and adaptability, and funding sources. It should also identify any legislative action considered necessary to implement any recommended municipal solid waste management program or programs.

This working group should be comprised of individuals with technical backgrounds, financial backgrounds and/or experience with municipal solid waste management systems and technologies.

Please direct the group to prepare a report that includes:

- Identification of public policy issues and impending problems resulting from a continuation of present solid waste policies;
- A summary of the municipal solid waste management systems and technologies reviewed, compared to Delaware's current municipal solid waste management systems and technologies, and with respect to the implementation of each management system and technology reviewed an assessment of:
  1. Environmental impacts and benefits;
  2. Capital and operational costs;
  3. Reliability and experience with the technologies and management systems;
  4. The economic feasibility of implementing the technologies and management systems; and
- Recommendations, including legislative action necessary to implement the recommendations.

Direct the group to deliver a report to me by May 15, 2006.

As we have discussed, former DNREC Secretary Toby Clark is available to serve as a technical expert and I encourage you to seek his expertise and involvement as you see fit on this very important project. The combination of Toby's intellect, independence, environmental credentials and knowledge of our state will serve the citizens of Delaware thoughtfully and effectively.

I expect that you will submit the final list of committee members by week's end so that work can begin as quickly as possible.

Sincerely,

Ruth Ann Minner  
Governor

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## Appendix B

### Members of the Solid Waste Management Technical Working Group

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#### **Edwin H (Toby) Clark, II -- Project Director**

Dr. Clark was the Secretary of Delaware's Department of Natural Resources and Environmental Control from 1989 to 1993. His previous experience included being a vice-president of the Conservation Foundation, the Associate Assistant Administrator of EPA's program for Pesticides and Toxic Substances, and the senior economist and senior staff member for pollution control of the President's Council on Environmental Quality. Since leaving DNREC he has been the President of Clean Sites, a non-profit organization dedicated to cleaning up hazardous waste sites, and the Executive Director of the Environmental Education and Training Institute of North America. He has taught at Williams College and at the University of California, Santa Cruz, and has served on a dozen Boards and Committees of the National Academy of Sciences, as well as several EPA advisory committees. He received his PhD in public policy from Princeton University as well as masters degrees in public policy and civil engineering.

#### **Karen Garrison - Staff Support**

*DNREC  
89 Kings Hwy.  
Dover, DE 19901  
(302) 739-9000*

#### **Pasquale S. (Pat) Canzano, P.E., DEE**

Mr. Canzano is the Chief Operating Officer of the Delaware Solid Waste Authority where he is responsible for planning, organizing, and implementing DSWA's programs, budget, and operations. Before assuming this position in 1991, he served as DSWA's Chief of Engineering and Operations. He has served as an Adjunct Professor at Wesley College in the Environmental Science Department and as a member of the doctoral candidate review committee for environmental engineering at the University of Delaware. He is a professional engineer, an elected member of the licensing board of the Council of the Delaware Association of Professional Engineers, a Diplomat of and Board member of the American Academy of Environmental Engineers, and holds patents in chemical adsorption/desorption processes, low pressure regulating valves, and organic based Rankine power cycles for solar and waste heat recovery applications. He received his masters degree in chemical engineering from the Polytechnic Institute of Brooklyn.

## **Andrew Goudy**

Dr. Goudy is professor of chemistry and chair of the chemistry department at Delaware State University. Before joining the Delaware State faculty in 2001, he taught at West Chester University where he served as chair of the chemistry department, dean of undergraduate studies, and in other administrative posts. He is the author or joint author of 48 publications and papers, has received numerous federal and private sector grants and contracts, and has served as a manuscript and proposal reviewer for the National Science Foundation, the Research Corporation, and the Petroleum Research Fund. In addition to his academic work, he serves on several advisory boards for the state of Delaware. He has received a PhD in physical chemistry from the University of Pittsburgh and a masters degree in analytical chemistry from Indiana University of Pennsylvania.

## **Gary R. Hater**

Mr. Hater has worked for Waste Management, Inc. for 16 years and is currently the company's Senior Director of Bioreactor/Biosite Technology & New Technology. His group evaluates existing and prospective conversion technologies for the company's world wide operations, manages the company's Technology Forum, and is responsible for development, implementation, and trouble shooting for fixed site Bioremediation facilities. He received his masters degree in biology from the University of Cincinnati, has coauthored numerous papers on Bioremediation and Bioreactors, and holds a number of patents for developments in these fields.

## **H. Lanier (Lanny) Hickman, Jr., P.E., DEE, BCEE**

Mr. Hickman was the Executive Director of the Solid Waste Association of North America from 1978 to 1996. Prior to joining SWANA he was the Director of Operations for EPA's solid waste management program. He currently devotes his time to writing, teaching, lecturing, and consulting on solid waste management issues for the World Bank. He also serves as a board member and on a number of committees of the American Academy of Environmental Engineers. He received a masters degree in sanitary engineering from the University of Michigan and is a registered professional engineer.

## **Michael Keefe**

Dr. Keefe is Associate Professor and Associate Chairman for Undergraduate Education in Mechanical Engineering, at the University of Delaware where he has been a faculty member since 1985. Before joining the University he was a development engineer for Honeywell, Inc. He received his PhD and Masters degrees in mechanical engineering from the University of Minnesota. He is joint author of a number of technical papers, is a registered professional engineer in Delaware, and was named Engineer of the Year by the Delaware Engineering Society in 2005.

**Wallace (Wally) Kremer**

Mr. Kremer is currently a member of the Delaware Environmental Alliance for Senior Involvement (DeEASI). He was a research/technology manager when he retired from E. I. Du Pont de Nemours, where he had been employed for 41 years. His work there involved evaluating alternative and innovative technologies for use at DuPont facilities in the United States and abroad, including research, pilot plant studies, strategic planning, and economic evaluations. He has assisted DNREC in addressing several environmental issues, and is the Environmental Committee Chairman for the Council of Civic Organizations of Brandywine Hundred. He has a degree in chemical engineering from the University of Wisconsin.

**Matthew F. (Matt) Lintner**

Mr. Lintner is a partner in the Wilmington law firm Morris, James, Hitchens & Williams LLP. He has represented and advised private parties, citizen groups and governmental entities with respect to federal and state environmental laws and environmental compliance and project permitting issues. Before coming to Delaware Mr. Lintner served Deputy Attorney General for the State of California in the environmental enforcement division, and also worked in private practice representing a variety of clients including citizen groups on environmental issues. He received his law degree from the Stanford Law School where he was a member of the Stanford Law Review. He is a member of the Delaware Bar and the California Bar, and served as a staff aide to Delaware's Metachem Task Force.

**William (Bill) Montgomery**

Mr. Montgomery is the Chief of Staff to Wilmington Mayor James M. Baker. Prior to his current job, he was Director of Legislative Council, Division of Research, State of Delaware, and served as Legislative Staff Director for the Wilmington City Council for ten years. He serves on several boards, including those of the Grand Opera House, the Delaware Theatre Company, and Sister Cities of Wilmington, Inc. He received his Bachelor's Degree in Sociology and his Master's in Public Administration from the University of Delaware.

**Paul E. Sample**

Dr. Sample is the technical coordinator for the Technical Advisory Office established by the Delaware General Assembly as part of the Division of Research for the Delaware Legislative Council. He worked for E. I. Du Pont de Nemours from 1957 to 1990 in their Films and Polymers Departments in a series of manufacturing, product development, and research management assignments. After leaving DuPont he established a technical consulting business. He has served on several advisory committees for the state of Delaware and has led a number of standards development activities for the American Society for Testing and Materials International. His professional activities include membership in the American Institute of Chemical Engineers, the American Chemical Society and Sigma Xi, a

research honorary. He received his Masters and PhD degrees in Chemical Engineering from West Virginia University.

### **James D. (Jim) Werner**

Mr. Werner is Director of DNREC's Division of Air and Waste Management where he is responsible for managing the state's solid waste regulatory program among other environmental programs, including air pollution control and hazardous waste management and cleanup. Before joining DNREC in 2005 he was Director of the Air and Land Protection Division in Missouri's Department of Natural Resources where he had similar responsibilities, including solid waste management. Prior to moving to Missouri, he served as Director of Strategic Planning and Analysis for the U.S. Department of Energy's Office of Environmental Management, and as founding Director of DOE's Office of Long Term Stewardship. Previously he worked an environmental engineer for a national non-profit organization and a private environmental consulting firm. He has more than 25 years of technical, field, policy and management experience and responsibility at the federal, state and local level. He has a masters degree in environmental engineering from Johns Hopkins University as well as a bachelor's degree in biology and geography from the University of Delaware.

### **Paul R. Wilkinson**

Dr. Wilkinson is Chairman of the Recycle Public Advisory Council and a member of DeLEASI, a volunteer organization of retired environmental professionals. He was previously employed by E. I. Du Pont de Nemours as an environmental manager and worked as a consultant to DuPont Safety and Environmental Resources and to the World Environment Center. He has been involved with environmental laws and issues over the past twenty years. He represented DeLEASI on the Governor's Citizen Work Group on Recycling, serves on the Governor's Commission on Community and Volunteer Service, as a member of the Local Emergency Planning Committee, and works as a volunteer for national EASI in the EASI Ambassador Program. He received his Ph.D. in analytical chemistry from West Virginia University.

### **Tad B. Yancheski, P.G., P.E., CHMM**

Mr. Yancheski is Director of Environmental Services for Tetra Tech, Inc. At Tetra Tech he has worked on a program that globally promotes the responsible management of wastes and recyclables. This has involved his visiting and investigating the design and operations of waste management and recycling facilities throughout the United States and in numerous foreign countries. He also directs projects providing services to private clients, local governments, DNREC, and EPA on the cleanup of contaminated sites, and planning, permitting and compliance issues involved in a broad range of environmental protection programs. He is a professional geologist and professional engineer and holds a Certified

Hazardous Materials Management certification. He received his B.A. in Geography, B.S. in Geology, and M.S. in Geology from the University of Delaware.

### **Marian R. Young**

Ms. Young is President and owner of the consulting firm BrightFields, Inc. and has 25 years experience as an environmental consultant, performing and managing real estate transaction assessments, site investigations and remedial actions for private, commercial and government clients. Prior to founding BrightFields, she worked at WIK Associates and Roy F. Weston, Inc. She has worked in Delaware for over 11 years, most recently leading a public/private partnership team through the brownfield investigation and construction environmental management aspects of the redevelopment of Wilmington's Christina Riverfront. She co-chairs the Committee of 100's Environmental Committee and previously participated on the Governor's Recycling Work Group. She received a degree in agronomy/soil science from Delaware Valley College of Sciences and Agriculture and has undertaken graduate studies in hydrogeology and soil chemistry at the University of Delaware.

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## Appendix C

### Multi-Process Evaluations

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The following are the multi-process evaluations used by the Solid Waste Management Technical Working Group in undertaking its evaluations:

1. California Integrated Waste Management Board, Conversion Technologies; Report to Legislature (Draft), February, 2005 available at: <http://www.ciwmb.ca.gov/Organics/Conversion/Events/CTWorkshop/DraftReport.pdf>
2. Hackett, Colin, *et al*, Evaluation of Conversion Processes and Products, report prepared for the California Integrated Waste Management Board, Final Draft, September 2004, available at: [http://biomass.ucdavis.edu/pages/reports/UC\\_CIWMB\\_Final\\_Sept.doc](http://biomass.ucdavis.edu/pages/reports/UC_CIWMB_Final_Sept.doc)
3. Technical Advisory Office of the State of Delaware Legislative Council, Division of Research in cooperation with Delaware Environmental Alliance for Senior Involvement, “Municipal Solid Waste Processes: Assessment of Alternative Technologies”, November 10, 2005
4. Enviro Consulting Ltd and University of Birmingham with Risk and Policy Analysts Ltd, Open University and Maggie Thurgood, “Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes” prepared for the UK Department of Environment, Food, and Rural Affairs, March 2004, available at <http://www.defra.gov.uk/environment/waste/research/health/index.htm>
5. URS Corporation, “Summary Report: Evaluation of Alternative Solid Waste Processing Technologies” Prepared for the City of Los Angeles, Department of Public Works, Bureau of Sanitation, September 2005, available at: <http://www.lacity.org/SAN/alternative-technologies-summary-report.pdf>
6. URS Corporation, “Evaluation of Alternative Solid Waste Processing Technologies” Prepared for the City of Los Angeles, Department of Public Works, Bureau of Sanitation, September 2005, available at: <http://www.lacity.org/san/alternative-technologies-final-City-report.pdf>
7. URS, “Conversion Technology Evaluation Report”, prepared for The County of Los Angeles Department of Public Works and The Los Angeles County Solid Waste Management Committee/Integrated Waste Management Task Force’s Alternative Technology Advisory Subcommittee, August 18, 2005, available at

[http://ladpw.org/epd/tf/Attachments/SubCommittee%20Attachments/CT\\_Eval\\_Report.pdf](http://ladpw.org/epd/tf/Attachments/SubCommittee%20Attachments/CT_Eval_Report.pdf)

8. “Evaluation of New and Emerging Solid Waste Management Technologies”, prepared for the New York City Economic Development Corporation and New York City Department of Sanitation, September 16, 2004, available at:  
<http://www.nyc.gov/html/dsny/downloads/pdf/guides/swmp/swmp-4oct/appendix-f.pdf>
9. Queensland Government Environmental Protection Agency, “Green & Organic waste processing and marketing in Queensland”, October, 2002, available at:  
[http://www.epa.qld.gov.au/publications/p00428aa.pdf/Green\\_organic\\_waste\\_processing\\_and\\_marketing\\_in\\_Queensland.pdf](http://www.epa.qld.gov.au/publications/p00428aa.pdf/Green_organic_waste_processing_and_marketing_in_Queensland.pdf)
10. Gary Hater *et al*, “Conversion Facility Chosen for Palm Desert, California, BioCycle, July 2005, Vol. 46, No. 7, p. 63 available at  
<http://www.jgpress.com/archives/free/000479.html>

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## Appendix D

### Questions for Technology Vendors

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#### Delaware Solid Waste Management Technical Working Group Questions for Technology Vendors<sup>1</sup>

1. Describe Process including individual processing steps
  - What environmental/pollution abatement controls are incorporated?
  - What are resulting environmental releases?
    - Annual air emissions of criteria pollutants?
    - Annual air emissions of hazardous pollutants?
    - Other air emissions?
    - Annual waste water discharges by type of contaminant?
    - Annual amount of solid waste/slag/fly ash left at end of process?
      - Is this considered to be hazardous according to RCRA?
    - Odors?
    - Noise?
  
2. How many commercial facilities are in operation and actually processing wastes at commercial scale – MSW, components of MSW, sewage sludge?
  - For how long in full processing and operation?
  - How many are located in US?
  - How many have a capacity of at least 500 tons per day?
    - How long have these been in operation?
  - How many have a capacity of at least 100 tons per day?
    - How long have these been in operation?
  - Can you provide a list of commercial facilities showing their size, location, and when they began operation?
  
3. Reliability
  - How reliable have the commercial units been?
    - Number of upsets per year
    - Percent of time off-line because of upsets?
    - Typical duration of being off line because of upsets?
    - Maximum duration of being offline because of upsets?
  - Is weather a factor in reliability?
  - What happens when there is an upset in the process?
  - What happens when there is an upset in the environmental controls?

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<sup>1</sup> The Working Group recognizes that some of these questions may not be relevant to all of the alternatives being considered. However, they indicate the type of information that the Working Group is attempting to obtain on each of the alternatives.

#### 4. Feed Stock/Inputs

- What feedstocks can it accept?
  - MSW
  - Waste water treatment sludge
  - Biosolids
  - Yard waste
  - Food wastes
  - Tires
- What prior processing of the waste stream or sludge is required/desirable?
  - How much of the typical MSW feed stock is typically rejected as unsuitable for process, negative sort, residue, etc.?
- How sensitive is process to variations in feedstock?
  - Composition?
  - Quantity?
- Can this type of facility be expanded easily to address increasing waste volumes?
- Is economic operation dependent on a certain minimum quantity of waste, etc.?
- What are the major O&M inputs?
  - What are the three major elements of O&M Costs (as a percent of total O&M cost)?
  - How much and what form of energy is required per ton of processed material?
  - How much water and of what quality (brackish)?
  - Labor
- Are there worker safety issues?
- Other O&M issues?

#### 5. Facility Siting

- For a facility that could handle 1000 tons per day, what is the minimal and optimal space requirement (i.e., acreage) that would be required to construct and operate such a facility?
- What is the time frame required to design and construct such a facility?
- What type of permits would typically be required (i.e., air emissions, wastewater discharge, hazardous waste storage, etc.?)
- What is the experience with the ease (or difficulty) or regulatory permitting of this type of facility?

#### 6. Products/outputs

- What are material products/outputs?
  - Amounts related to amount of feed stock?
  - What hazards are/may be associated with products/outputs?
- What are energy outputs by type?
  - Btus (or other suitable measure) of energy (by type of energy) per ton of waste processed?
- What is the net energy balance?

#### 7. Life Cycle Analysis

- Are you aware of life cycle analyses that have been completed for the process?
- References

#### 8. Economics

- Capital costs for a 1000 tpd facility, 500 tpd facility, 100 tpd facility
- Annual operating and maintenance costs as related to capacity
- Expected life of investment
- Gross cost per ton (before deducting value of products) as related to capacity
- Net cost per ton (after deducting value of products)
- Costs not included in these figures
  - E.g. costs of disposing of non-commercial outputs such as fly ash and slag
- Required tipping fee to make facility economically viable

#### 9. Contacts

- To answer additional questions about process
- Community contacts for existing facilities

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## Appendix E

### Processes Not Evaluated

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Two processes that were investigated but dropped from consideration before being formally evaluated were acid hydrolysis and pyrolysis.

Acid hydrolysis is a chemical process for converting organic materials into ethanol that has been in widespread use for over a century. However, existing acid hydrolysis plants operate with a homogeneous feedstock, and the process is very susceptible to upsets, which can cause serious environmental risks, from feed stock variations. As a result, there are no commercial acid hydrolysis installations for MSW processing. A recent proposal to construct such a plant in Middletown, New York fell through when the company contracted to build the system apparently went bankrupt.<sup>2</sup>

Pyrolysis, which uses heat in an oxygen starved environment to convert organic materials to low grade oil, has been proposed as a solid waste processing technology for decades. Indeed demonstration pyrolysis MSW processing plants were constructed in San Diego and Baltimore during the 1970's. However, they never operated successfully and were closed down and dismantled.<sup>3</sup> Some pyrolysis plants are apparently in operation in Europe and Japan, although the working group was unable to verify that they are operating on a competitive commercial basis.<sup>4</sup> A small pyrolysis plant in California did apparently successfully run a test lasting 18 days in 2005 using MSW as a feedstock. Attempts to contact this company were unsuccessful. In addition, the monitoring of the emissions during this test run showed higher contaminant levels than other thermal processes such as Waste-To-Energy, although they were well below US and German limits except for NOx.<sup>5</sup> The uncertainty of the process, the higher emission levels, and the inability to contact a US vendor, combined to remove it from further consideration.<sup>6</sup>

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<sup>2</sup> Middletown Times Herald-Record, "Masada project still on?", July 30, 2005 accessed through Middletown Times Herald-Record web site [www.recordonline.com/archive/2005/07/30/masada30.htm](http://www.recordonline.com/archive/2005/07/30/masada30.htm).

<sup>3</sup> See H.Lanier Hickman, Jr., *American Alchemy: The History of Solid Waste Management in the United States*, Forester Press, Santa Barbara, ND, pp. 227-233.

<sup>4</sup> Hackett et al, "Evaluation of Conversion Technologies and Processes", September, 2004, identifies 12 commercial plants in operation as of the summer of 2004, 10 in Japan and 2 in Germany.

<sup>5</sup> See Nazemi and Chen, "Status Update by South Coast Air Quality Management District on IES Romoland's Permit, September 20, 2005 available at [www.ciwmb.ca.gov/agendas/mtgdocs/2005/09/00019545.ppt](http://www.ciwmb.ca.gov/agendas/mtgdocs/2005/09/00019545.ppt) and William Welch, Evaluation of Environmental Impacts of Alternative Thermal Conversion Technologies Using Municipal Solid Waste Feedstocks", November 16, 2005 available at [http://www.performancegraphics.com/Media/AB1090\\_CE-CERT\\_111605.pdf](http://www.performancegraphics.com/Media/AB1090_CE-CERT_111605.pdf).

<sup>6</sup> The Del-EASI group did inspect a pyrolysis type pilot plant being promoted by Changing World Technologies in Philadelphia. Their assessment concluded that they "would not recommend this approach for MSW" processing. (Ref: Technical Advisory Office of the State of Delaware Legislative Council, Division of

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Research in cooperation with Delaware Environmental Alliance for Senior Involvement, Municipal Solid Waste Processes Assessment of Alternative Technologies” November 20, 2005, Appendix III, p. 29)

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## Appendix F

### Source (Solid Waste) Reduction, Recycling and Their Role in Integrated Municipal Solid Waste Management.

By H. Lanier Hickman, Jr., P.E., DEE, BCEE

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#### ***INTRODUCTION***

This discussion examines policy issues associated with solid waste (source) reduction and recycling. Such an examination must be coached in terms of the current conditions of these practices and the role that the state has played, to date, in support of these two parts of the integrated municipal solid waste management.

To guide the discussion in this chapter the following definitions, developed by the USEPA, are used:

***Source (Solid Waste)<sup>7</sup> Reduction*** is defined as any action that reduces the amount of solid waste to be collected and managed. It includes:

- reducing the amount of solid wastes generated at the source;
- redesigning of products or packaging so that less material is used, resulting in fewer discarded materials,
- voluntary or imposed behavioral changes in the use of materials which results in the selection of products and materials which last longer, or reduce the amount of materials discarded; or
- increasing the durability and usability of materials that would result in longer lasting products.

An examination of this definition is essential to understanding the challenges faced by local governments when they try to prevent the generation of solid waste. In order for this to be accomplished, generation must be stopped at the source, not once it has been discarded as a solid waste. The operative word here is “source” and consequently, it is probably more descriptive to use the term source reduction than solid waste reduction. Why?, because in order to reduce the amount of solid waste generated by each generator to the municipal solid waste stream efforts have to focus at the source. Consequently, this discussion will use the term source reduction.

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<sup>7</sup> The term “solid waste” is parenthetically inserted here to assure that readers recognize that source reduction in the context of this discussion is an attempt to interrupt and stop the generation of a solid waste stream.

**Recycling** is defined as the diversion, or removal, of materials from a solid waste stream and the use of those materials in one of the following ways:

- for the same purpose as it was originally designed, or
- for use in its original form, but for other purposes, or
- the return of production line process wastes into main stream production line feed stock, or
- the treatment and reconstitution of the materials for one product to produce secondary raw materials for other products, and/or other productive uses.

**Integrated Municipal Solid Waste Management** – a combination of four methods of management – source reduction, recycling (materials recovery and composting), combustion (waste-to-energy and landfill gas recovery) and landfilling (sanitary).

**Municipal Solid Waste** – a solid waste stream composed of residential, commercial and industrial non-process, non-hazardous wastes.

The following discussions will address source reduction and recycling from these three streams, before they are combined to become municipal solid waste.

## **SOURCE REDUCTION**

### **Source Reduction at the Residential Point of Generation**

There are several challenges that face any integrated municipal solid waste management system when source reduction is attempted. Challenges include:

- that the consumer, and the system, have no control of the products that enter a residential dwelling;
- that unique approaches have to be instituted for different residential settings, i.e. single-family versus multi-family; high-income versus low-income customers;
- the economic and institutional barriers to instituting source reduction programs; and
- the amount of reduction versus the effort and costs to reach that amount.

Approaches that have been the most attempted with varying levels of success are discussed below.

**Encouragement And Support Of Yard Waste Composting Programs** – such programs tend to be voluntary rather than mandatory and would normally be applied to single-family dwellings. The sponsors of this approach either provide a composting vessel at little or no cost, or provide plans for building a composting bin. Public education is an essential tool in this program. While participation will vary and at times not be high, any measure of reduction has its value.

**Shopping Practices** – approaches that are popular include encouraging bulk buying, using one's own shopping bag, and buying products in containers that are more easily recycled.

Reducing the amount of containers and shopping bags brought into a residence results in a reduction of the amount of solid waste generated by the residential sector regardless of whether it is single-family or multi-family. The sponsors of this approach usually are public education and motivation driven. Again, while participation will vary and at times not be high, any measure of reduction has its value.

***Bag No Grass Cuttings Programs*** – this approach bans the collection of grass and trimmings resulting in no-bags or containers of this material for collection. First steps in this program are to encourage the purchase of mulching mowers or the installation of mulching blades on existing mowers. The sponsors of this approach frequently work with vendors of mowers and mowing equipment to promote conversion and to ensure that both mowers and blades are in stock before the ban begins. Trimmings are another story and it is better to avoid the cessation of the collection of these materials.

***Junk Mail Programs*** – reducing the amount of junk mail received will result in a reduction of the amount of solid waste generated by the residential sector regardless of whether it is single-family or multi-family. There are organizations that can be enlisted to help the public lessen the amount of junk mail they receive<sup>8</sup>. Public education is an essential tool in this program. While participation will vary and at times not be high, any measure of reduction has its value.

***Drop-off Programs*** – DSWA has an extensive network of drop-off centers that receive recyclables. This network might be expanded to receive other materials not normally accepted at this time, as well as increase the number of centers, or special drop-off centers for non-recyclables. While this is not an actual source reduction initiative, use of the drop-off centers would lessen the amount of solid wastes that has to be collected.

***In summary***, actual source reduction in the residential sector will only be modest as it relates to the weight of materials placed out for collection. However, involvement of the public has a broader impact on their attitudes and a sustainable environment and materials usage. Implementation will probably require:

- state policy leadership, legislation and assistance (technical and financial) on a statewide basis and
- local governments to enact ordinances and find funds to implement source reduction programs at the residential solid waste point of generation.

## **Source Reduction at Commercial and Industrial Points of Generation**

The potential for measurable source reduction at the commercial and industrial points of solid waste generation is possible. To date, in the U.S., the major focus on both source

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<sup>8</sup> There are a number of organizations that assist states and local governments to promote junk mail reduction programs. Some of note includes [www.obviously.com](http://www.obviously.com), [www.junkbusters.com](http://www.junkbusters.com), and [www.ecofuture.com](http://www.ecofuture.com). A visit to the internet with a search for junk mail will reveal numerous sources for assistance.

reduction and recycling has been in the residential sector. Most business enterprises have been only modestly involved in source reduction. Where source reduction programs are in place, they have normally been fostered by forward-looking states. Approaches that have been most common are discussed below

**Material Exchanges** – exchanges provide a means whereby a commercial or industrial solid waste generator is matched with another commercial or industrial enterprise that can use some material in their solid waste stream as a material for their own production lines. For exchanges to work a central clearinghouse is necessary. In addition, resources to work with commercial and industrial enterprises to enroll them in such a program and to guide them through the analysis necessary to understand the solid waste stream are essential. In many instances forward-looking states have been the catalyst to establish a material exchange system within their borders and in cooperation with neighboring states that have the same forward-looking culture.

**Waste Audits** – audits of a the solid waste stream generated by a commercial or industrial solid waste generator requires developing several interesting sets of data including:

- the sources of all of the solid waste going out the back door,
- the nature and character of the solid waste from each source within the enterprise, and
- an assessment of where materials are wasted needlessly.

Waste audits are not a new concept just created to deal with a solid waste stream. Historically, when plants need to control their industrial wastewaters, the first step is to see how much water use can be reduced, thereby reducing the amount of wastewater generated. For commercial and industrial solid waste generators, several lessons can be learned and put to practical application:

- where changes can be made in processes that would reduce the amount of solid waste generated,
- how much of what is generated is due to employee behavior, and can training and incentives bring about employee involvement in the reduction of the amount of solid waste generated,
- what solid wastes is being generated that can be reused within the footprint of the facility,
- what solid wastes would be marketable in a materials exchange program, and
- what solid wastes that is being thrown away has the potential for diversion and recycling.

Initiation of a waste audit program can best be fostered at the state level; history tells us that the states have been the focus of establishing such programs. Education and training of commercial and industrial enterprises; statewide policy initiatives to stimulate waste audits and implementation of the findings; and incentives are logical program efforts to establish an effective statewide program.

**Pollution Prevention** - another term frequently used with source reduction is pollution prevention (P2). The USEPA has invested considerable effort in establishing a nationwide

pollution prevention program<sup>9</sup>. The State of Delaware has a P2 program housed in the Department of Natural Resources and Environmental Control. An examination of the programs currently active in the Delaware P2 program, suggests that the focus appears to be on the reduction of toxic and hazardous materials, with very little attention of commercial and industrial solid wastes. An effective commercial and industrial solid waste source reduction effort in Delaware will need comparable state investment.

***Other Concepts*** – There are a number of other initiatives that can be advanced in Delaware to reduce the amount of solid waste generated by commercial and industrial enterprises. Some of these include:

- *green buildings* – designing buildings to be more amenable to the installation of source reduction efforts,
- *demolition and renovation practices* – demolition and renovation of buildings can be accomplished in a way that recyclable materials are sorted at the site and sent through the recycling cycle rather than the solid waste cycle,
- *printing and copying practices* – commercial and industrial enterprises that generate major office paper documents can incorporate printing on two sides of the paper which can result in a dramatic reduction in the amount of office and printing paper consumed and eventually discarded,
- *green meetings* – incorporation of such practices as limiting the use of paper to be used at meetings (in this age of the laptop and palm pilots many attendees no longer need meeting materials); providing proceedings only on disks; requiring venues to use china and flatware rather than styrofoam and plastic cups, dishes, etc.
- *other* – there are endless initiatives not discussed here that can be put into place, provided the leadership and economic base of state government is invested to implement source reduction initiatives.

In summary, an effective commercial and industrial solid waste source reduction effort can bring about measurable reduction in the amount of solid waste generated by commercial and industrial enterprises. However, adoption the practices discussed will not be measurably successful without leadership by some statewide organization. Further examination by the state should address state policy leadership, legislation and assistance (technical and financial) on a statewide basis. Commercial and industrial solid waste generators will need to be educated, trained and supported in their efforts, if there is to be success in these two sectors of solid waste generators.

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<sup>9</sup> [www.epa.gov/p2](http://www.epa.gov/p2) is the website address for EPA's P2 program. Their program goes beyond just solid waste to also address the reduction of toxic chemicals and materials in products.

## **RECYCLING**

### **Recycling (Diversion) at the Residential Point of Generation**

For recycling the citizens of Delaware have depended on the effective drop-off center program offered by Delaware Solid Waste Authority (DSWA). But matter how much effort is invested by DSWA participation will never reach the levels of diversion that curbside diversion programs can provide. In addition, the costs for the current drop-off center program are funded by the tipping fee charges at the DSWA sanitary landfills. The DSWA has begun to offer curbside diversion and collection services on a fee basis. Participation of residential generators has been modest, probably because of several factors:

- For the most part, residents in the incorporated areas of the state normally receive solid waste collection services. Where local governments provide such services, it is normally paid for out of the general fund. This approach creates a number of impediments to implementing diversion programs including a mis-interpretation that solid waste management services are free and that recycling programs pay for themselves, so “why pay for something that is making money”? The current approach of burying the costs of solid waste management and recycling services in local government budgets and the tipping fees at the DSWA sanitary landfills impedes such initiatives as pay as you throw (PAYT) programs that have proven to be successful.
- Currently, state government has not implemented chosen to provide support to initiatives that other states have used to educate the public on the positive results of recycling. This has made it more difficult to develop a statewide culture for recycling. Even with the major public education efforts of DSWA, residential solid waste generator participation in recycling lags.

For the state to increase the diversion of recyclables from residential points of generation will require not only the current DSWA drop-off program, but incorporation of curbside diversion of recyclables in all incorporated local governments. Current practices indicate that a voluntary curbside program will probably show only a modest level of participation. To be effective, the following policies need to be examined:

**Public Education** - educate the public more to develop increase the recycling culture at the point of generation, and educate the public that recycling/diversion programs cost money and therefore they are going to have to pay for it.

**Examine How To Expand Curbside Diversion** – currently modest curbside diversion efforts are ongoing in the state. To initiate a comprehensive curbside diversion program a number of considerations need to be addressed including:

- *the value of mandatory diversion programs* -the potential success of mandatory diversion needs to be fully examined to determine the level of success that can be achieved and how on a statewide basis this could be done. Experience suggests that mandatory programs (recognizing they can not be enforced and will not have 100% participation) are successful, but un-and-to-themselves they will not alone increase diversion and recycling to the level needed,

- *the polluter pays principle* - couple these efforts with a thorough examination of user fee charges for both the collection of solid waste and the diverted materials. Determine how well will pay as you throw (PAYT) policies work in Delaware. Many local governments have recognized that It is poor public policy to continue to carry solid waste management services on the general tax rolls when it is a utility service that has and can pay its own way, and
- *expansion of the current DSWA curbside collection service* – with DSWA already in the business of providing curbside collection service their participation in the future may offer a way to expand curbside diversion programs provided the state takes a leadership role in addressing the other two considerations discussed above.

***Multi-Family Residential Points Of Generation*** – a thorough examination of how best to implement diversion programs for multi-family complexes offers the opportunity for measurable diversion of recyclable materials from the residential solid waste stream. Incorporating multi-family dwellings into a residential diversion and recycling program has challenged every local government that has tried it, but there are successes that need to be studied for application in the State of Delaware.

***Banning Green Wastes From DSWA Sanitary Landfills*** – there is no question that banning green wastes from DSWA sanitary landfills will extend the life of these facilities measurably. However, any ban must be coupled with a comprehensive program for managing the banned green wastes. Currently, there is no program in place to do so. If green wastes account for 15% of the Delaware municipal solid waste stream and 800,000 tons of municipal solid waste is generated annually, there is a potential to have as much as 120,000 tons of green wastes to manage in some other manner. The state cannot proceed arbitrarily with a ban until alternatives are examined. Analysis of how successful conversion of green wastes into marketable compost products at reasonable costs and market availability needs to be examined very carefully before Delaware takes this step.

***In summary***, there are many opportunities for the recycling of many materials in the residential solid waste stream. However, until there is a statewide policy and strategy to make this happen, increases in diversion rates will be modest. Before moving forward to attempt to expand recycling in Delaware the unanswered issues discussed above should be addressed. From that effort a comprehensive strategy and plan should emerge that will provide a forward looking, long-term effort to reach some established goal for diverting and recycling materials from the residential solid waste stream. The examination should address the following:

- a long-term statewide recycling goal,
- mandatory diversions,
- the polluter pays principle,
- implementation of diversion programs in the incorporated local governments,
- how to tap the last major residential solid waste - multi-family points of generation,
- core educational programs support by state money,

- recycling education campaigns by state government to raise the level of awareness for public support and participation,
- assistance in the costs for local governments to develop comprehensive integrated municipal solid waste management plans that include both a diversion and recycling component,
- education at the school level,
- statewide and interstate market development, and
- start-up funds for equipment for diversion and recycling initiatives.

## **Recycling (Diversion) at Commercial and Industrial Points of Generation**

Commercial and industrial solid waste generators probably offer the greatest opportunity for the state for extending the life of the existing DSWA sanitary landfills through increased recycling. Universally in the U.S., increasing diversion and recycling from commercial and industrial points of generation has been difficult. The reasons for this difficulty include:

- in many local governments, collection services are provided by the private sector and intervention in this practice is difficult,
- considerable diversion and recycling of marketable materials such as corrugated containers that have a long history of markets is already in place, and
- separating and sorting materials for diversion at the point of collection takes time and money by the commercial or industrial generator and as such does not help the bottom line.

Some measures taken by state governments around the U.S. to encourage commercial and industrial enterprises to expand their diversion efforts include:

- establishing materials exchanges (see discussion in the commercial and industrial source reduction section),
- recycling cooperative grants to bring like-enterprises together to build better markets and information interchange,
- recycling services directories to help commercial and industrial enterprises find markets for materials in their solid waste streams,
- mapping of sources of specific materials such as food wastes, mixed paper, etc. to better define the market needs,
- waste audits, technical assistance, outreach to enable commercial and industrial enterprises to assess their solid waste streams and develop plans for recycling,
- assistance in contracting for collection services to build into contracts recycling initiatives that benefit both the enterprise and the private service provider ,
- establishing municipal recycling incentive programs that encourage local governments and generators to implement recycling efforts within the context of a local government integrated solid waste management plan, and
- product steward ship to encourage manufacturers to build into their products extended longevity and recyclability.

None of these potential areas currently appear to be used in Delaware to any great degree and they should be considered.

Some of the issues addressed in the residential recycling section this chapter equally applies to commercial and industrial solid waste generators specifically multi-family dwelling complexes and green wastes. There two are discussed here to illustrate the interrelationships between the three solid waste streams.

***Multi-Family Dwelling Complexes*** – it is a common practice in the U.S. to artificially separate small and large multi-family dwelling complexes into two or more size categories – small (usually 4-8 unit complexes and large (greater than 8 units) are quite common. When this is done it is not uncommon for the smaller complexes to be provided collection service by the same service provider (public or private) that serves single-family residence and contract service providers serve the larger complexes.

It can also be said that implementing diversion and recycling initiatives with the smaller complexes can be accomplished almost within the same context as residential solid waste and recycling services. On the other hand, the U.S. has lagged in enlisting the larger complexes into the fabric of integrated solid waste management, specifically diversion and recycling. To implement diversion and recycling programs will require working with owners and management firms and the ability to do this will rest with state law and local government ordinances. Consequently, the initial step is to ensure that there is the necessary permissive legislation at the state level to allow the implantation of diversion and recycling requirements on these complexes.

## Appendix G

### ***Resource Conservation & Replenishment***

By James Werner and Marian Young

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The scope of this evaluation is relatively narrow. A broader analysis could include more life-cycle considerations outside the scope established by the Working Group. By focusing solely on the directly associated environmental costs and energy value of using recycled materials, the scope of this analysis partially disregards them. If these environmental impacts and energy costs were included in the balance of costs and benefits of recycling, composting and incineration, it could result in a different conclusion than one that looks only at the energy value and the environmental costs directly associated with a particular technology. We discuss this broader environmental evaluation briefly as a prelude to our evaluation of the seven specific technologies. Our intent is encourage, and to stimulate discussion regarding approaches to waste management that may not initially look economically feasible in today's dollars, but could prove invaluable for future generations of Delawareans. Although it would be impossible to provide the complete analysis we suggest below, we believe a fundamental central organizing principle for the evaluation process should be to evaluate technologies based on broader environmental and economic sustainability beyond simply avoiding directly measurable public health and environmental harm measurable by toxicologists and epidemiologists.

The environmental impacts of the various technologies must be evaluated based not only on the direct potential public health, welfare, environmental or worker health and safety impacts, but also on long-term sustainability of the technology and its contributions to conserving resources. For example, waste to energy is often described as contributing to our energy supply, allowing us to conserve fossil fuels. Energy savings, however, can be achieved by other means such as efficiency ("negawatts") by conserving material resources in which a significant amount of energy has been invested. The most obvious example is the need to use electricity (largely generated by coal or hydroelectric dams) to produce aluminum from bauxite ore, and the potential to save 95 percent of the energy by recycling an aluminum can rather than producing from virgin bauxite. Recycling aluminum also obviates the need for bauxite mining, which often occurs in third world countries with little or no environmental regulation or mine waste reclamation requirements. Similarly, the sand used for glass production is not a scarce resource, but the natural gas often used in glass production is increasingly costly from an economic, environmental and national security perspective. Finally, there is a limited supply of complex organic matter for which there is no substitute in building soil. Although the potential benefit for composting waste would be relatively small compared to the acreage washed away in simply bad farming practices or wasteful crop use. In a more comprehensive analysis than possible here, one could calculate and compare the thermodynamic value of the resources (based on the investment necessary

to produce the material (i.e., aluminum, steel, paper, glass) and then compare the thermodynamic benefit derived from various utilization options (i.e., solid waste management techniques). Similarly, substantial energy investments are embodied (like potential energy in a rock that has been pushed uphill) in various lignocellulosics (paper, wood, etc.) such as the fertilizers (if a tree farm was used) or lost biodiversity (if a native forest was cut), machinery, energy (usually petroleum for the field machinery and coal for the electricity) and human capital for harvesting and processing the trees. We urge, to the extent possible, that global intergenerational environmental and life cycle impacts be considered, not merely local community, county, state or even national environmental impacts.

One of the considerations in evaluating various technologies can include the potential of each technology to reuse “waste” resources for replenishment of topsoil with decayed organic material, which is difficult to quantify in terms of public health and environmental benefit, much less economic benefit. Topsoil is the thin (less than 2 feet thick), life-producing veneer over the surface of the earth’s rock or, in the case of most of Delaware, over the surface of the earth’s sand. In addition to its mineral composition (primarily silica, aluminum and iron), topsoil contains organic material that has been broken down into humus and humic acids through the aerobic (primarily microbial and fungal) decomposition of organic materials. In a natural environment, the organic materials consist of leaves, wood, animal bodies, and microorganisms. Since the beginning of time, this decomposition process has built and enriched the thin topsoil layer that we use to grow all of our food.

Agriculturally-based civilizations who have destroyed their topsoil by overgrazing, or lost it to erosion, or depleted it of nutrients have died, or were forced to move to other locations to continue to sustain themselves. Even with modern-day best management practices, we continue to lose significant amounts of topsoil each year to erosion, and agricultural production is dependant on petrochemical-based industrial fertilizers.

Municipal solid waste typically contains a rich variety of organic materials including paper, cardboard, food waste, cloth, and yard waste (grass clippings, leaves, branches). All of these materials can be effectively converted, through either aerobic (composting) or anaerobic (digestion) processes, and the resulting, uniform material can be returned to the soil to enrich it. There are several impediments to this approach. The first involves the work to separate the desirable organic waste components, described above, from the undesirable waste components like plastic, metal, glass, and potentially hazardous materials (e.g., batteries, cleaning supplies, paints, pesticides). The second is the need to develop viable market outlets to take the finished soil amendment from the processing facility. The third impediment, associated with the second one, may be the stigma associated with using a converted waste product in gardens and agriculture. For the most part, people believe that chemical fertilizers in plastic bottles on the store shelf are cleaner and easier to use than bulk soil amendments, and that they are good for the plant. There is little understanding about soil as a living biosystem, and that the health and care of the soil directly affects the health of the plants grown in it and the people and animals that consume the plants. Finally, although these organic materials may produce energy in an incinerator, a life-cycle analysis

of the options may find that the highest and best use of the material may be composting by reducing the environmental impacts and energy needed to produce virgin materials and by helping replenish the fertility of priceless topsoil.

The risks and benefits of waste-to-energy depend greatly on what assumptions are made regarding a variety of factors such as waste feed quality, control of toxic inputs, and effective design, installation and operation. In the case of this Working group report, the fundamental assumption for design of all technologies is that an effective recycling and diversion program resulting in a 50 percent diversion/recycling rate will be implemented and sustained prior to the consideration of any additional waste management technology.

The effective recovery rate of recycled materials versus disposal rate can vary as much as 10 percent as a result of contamination (e.g., from dirt and glass).<sup>10</sup> This assumption of recycling/diversion rates is unprecedented in Delaware, but achieved elsewhere, has a profound effect on the projected risks and benefits of a waste to energy facility.

If all toxic components of wastes (batteries containing mercury, lead, cadmium of other heavy metals) are diverted and recycled or separately disposed prior to combustion<sup>11</sup>, then a waste-to-energy facility may have substantially less air emissions and toxic ash problems than if effective recycling and diversion is accomplished. If plastics are removed from the waste stream prior to combustion, then less chlorinated organics (e.g., dioxins) will be generated in the air emissions requiring expensive and potentially inconsistent controls. Removing plastic from the waste stream, however, substantially reduces the BTU value of the waste per unit weight because plastic has the highest BTU value per pound (13,000-14,000 BTU/lb) of any waste constituent and more than twice the unit BTU content as paper (6,000 BTU/pound).<sup>12</sup> Hence, there could be a conflict between maximizing the energy value extracted by leaving the plastic in the waste feed versus reducing the risk of toxic emissions by removing plastics. Assuming a recycling rate of 50 percent, the BTU content of the resulting waste sent to an incinerator/waste-to-energy facility would have approximately 3,500 BTU/pound instead of 5,000 BTU per pound of raw MSW. This could cause the economics of waste-to-energy to create opposition to recycling/diversion, which could have negative overall environmental and public health effects.

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<sup>10</sup> Sfeir, Hala, Reinhart, D.A., "An Evaluation of MSW Composition Bias Sources", *Journal of Air and Waste Management*, September 1999.

<sup>11</sup> Traditional U.S. recycling and diversions methods are unlikely to result in elimination of toxic inputs. Consequently, a product stewardship system or a very expensive and effective air pollution and ash control system will be required.

<sup>12</sup> Source: Reinhart, Debra R., University of Central Florida, Report for Florida Solid Waste Management Research Center under contract with EPA, revised July 2004; based on data from Franklin and Associates, *Characterization of Municipal Solid Waste in the United States*, EPA-530/ S-94/0-42, 1994.