Appendix I

A. Environmental Benefits of Recycling

The benefits of recycling stem from four sources: the value of the recycled material in its reuse; the reduction in the waste requiring collection, transportation, processing, and disposal; the reduction in raw materials required to manufacture products; and the energy saved in processing the raw materials to the point of manufacturing use. The reuse value of the material is reflected in its market price, although, with an average recyclables net market value (after transportation and processing) close to zero, the chief benefit of recycling for consumers is the avoided cost of disposal. This diverted tonnage is expected to increase during the 10-year planning period (2011-2021), during which it is estimated that nearly 690,000 tons of waste will be recycled. If this recycled material was landfilled instead, it would have a disposal cost in excess of $36 million (based on an average landfill tipping fee of $53/ton). Instead, the recycled material is used again in a variety of useful products, thus saving the raw materials (and the energy required to process the raw materials) that would normally be needed to produce those products.

There are many important benefits gained from recycling, including economic and environmental benefits which have Regional, national, and global significance. According to the US EPA, recycling processors and manufacturers account for over $100 billion in revenue. The EPA states that "the use of recycled materials spurs innovation, a key to long term economic growth." Investments in recycling collection, equipment and the recycled products manufacturing companies themselves, also filter through the economy and contribute to economic growth. The social and environmental benefits of recycling are just as important since they reduce pollution, save energy, and reduce greenhouse gas emissions. Recycling and buying recycled products are important, easily achievable strategies to combat climate change.

According to the EPA, the U.S currently recycles nearly 32 % of its waste, which reduces an amount of greenhouse gases equal to removing 39.6 million cars from the road. Increasing the recycling rate to 35% nationwide would reduce greenhouse gas emissions by an additional 5.2 million metric tons of CO_2 equivalent. Data analyzed by the Northeast Recycling Council (NERC) shows that Pennsylvania saved 9 million metric tons of CO_2 equivalents by recycling 4.9 million metric tons of waste in 2005.

For more statistics, see the following website:
http://www.epa.gov/osw/nonhaz/municipal/pubs/msw_2010_rev_factsheet.pdf

Although there are disagreements about the exact quantification of environmental benefits from recycling, we can say for certain that recycling saves resources including trees, metal, oil, natural gas and various materials used in the manufacturing process. It saves energy, and reduces pollution. It creates sustainable jobs both locally and nationally. It is an important engine for economic growth and prosperity. It is an easily achievable climate-change strategy that most Pennsylvanians can understand and appreciate. The 300,000+ tons of recyclables collected and processed in the five-County Region since 2005 have contributed significantly to Pennsylvania's economy and environmental health. They serve as a strong foundation for future success.

The Northeast Recycling Council, a group comprised of ten states including Pennsylvania, developed a calculator to assess the environmental benefit of various recycling activities on a state by state basis. These estimates are useful for local officials as well as for businesses to use in analyzing the results of their recycling efforts, and to convey to the general public the benefits of their activities in quantifiable terms. Specific environmental benefits to the Region have been estimated using the NERC calculator (see Appendix B for complete report). To summarize this report, the environmental savings associated with recycling that occurred throughout the Region in 2009 can be put in terms of Savings Equivalencies, as follows:

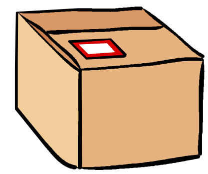
- Net Greenhouse Gas savings from Curbside Recycling = 27,070 metric tons carbon equivalency
- Net Energy Savings from Curbside Recycling = nearly 700,000 million BTUs
- Gasoline saved = nearly 5,680,000 gallons
- Coal saved from recycling steel and glass – nearly 8,300 tons
- Landfill Space saved by recycling = more than 72,500 CY
- Equivalent number of tree seedlings grown = nearly 1,625,000
- Energy savings in terms of average households/year = nearly 6,900

As can be seen, the equivalent environmental savings associated with recycling are quite substantial. In addition, there is a strong economic benefit to businesses associated with "green" markets created by access to recycled materials. The US EPA states that "recycling means business" and a recent NERC study backs this up with strong data. According to a 2008 NERC study of five Northeast states (Pennsylvania, New York, Maine, Massachusetts and Delaware), recycling industries employ over 104,000 workers in businesses that pay wages comparable to other industries, generating gross receipts in excess of $35 billion, with $4.2 billion in payroll. These data substantiate that recycling works both throughout Pennsylvania and in the local five-County Region.

B. Definition of materials addressed by Act 101

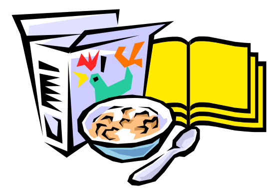
Newsprint – Newsprint or newspaper is primarily generated in the residential sector. Post-consumer waste newspaper is called "old newspaper" or "ONP". ONP can be recycled back into newsprint. It can also be made into cellulose insulation, animal bedding, mulch, low-grade copy and computer paper, and paperboard. Paperboard is a trade term that includes all cardboard types, such as corrugated cardboard and tablet backings, as well as the paper lining on gypsum wallboard. ONP can also be shredded and used as a bulking agent in composting wet organic wastes, such as sludge or manure.

Corrugated Paper – Corrugated paper, referred to in the recycling industry as "old corrugated containers" or "OCC", composed primarily of corrugated cardboard boxes, also comprises a significant portion of the municipal waste stream. The majority of it is generated in the commercial sector. Recovery of OCC is conducted by the commercial waste generators and private haulers to reduce disposal costs and potentially earn modest sales revenue. Recovered OCC is mixed with virgin pulp to make new corrugated. It can also be used in the manufacture of other types of paperboard.



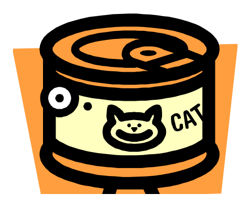
High Grade Office Paper – High grade paper includes computer print-out, office papers, and ledgers. Most of it is found in the commercial sector, particularly in office buildings, where it can comprise the majority of the office's waste stream. Computer printout and white ledger can be made back into high grade paper. However, to make bright white paper requires that the recycled fiber be supplemented with a large percentage of virgin pulp. A common use is in the manufacture of tissue products such as paper towels and toilet paper. High grade paper is also used to make paperboard.

Mixed Paper – Mixed paper refers to a mixture of the above three types of waste paper plus other waste papers such as junk mail, phone books, magazines, and non-corrugated cardboard such as cereal and pizza boxes (sometimes referred to as chipboard). Roofing material and boxboard manufacture are traditional uses of mixed paper, and for the production of low grade tissue and toweling products.



Glass – Although glass is found in a variety of forms and colors (e.g. clear, green and amber) in the municipal solid waste stream, container glass (i.e. bottles and jars) is the most commonly recyclable type of glass. The majority is generated in the residential sector. Waste container glass can be melted and mixed with virgin glass ingredients to make new container glass.

Steel and Bimetal Cans – There are two types of steel cans: tin-coated cans commonly known as "tin cans" and "bimetal" beverage cans. Bimetal cans have a coated steel body and aluminum ends. Bimetal beverage cans are easily mistaken for aluminum cans.



Aluminum Cans - Aluminum cans or used beverage cans (UBC) are among the most easily recoverable aluminum products. Aluminum cans are very readily reprocessed into new aluminum sheet. Other products containing aluminum, such as cookware, use a different type of aluminum and are not accepted at recycling centers since the different varieties are not readily substitutable. The cost savings from using scrap aluminum rather than virgin inputs has provided for a strong scrap aluminum market.

Plastics – Plastic is a generic term that defines a wide variety of materials that are made up of one or more combination of plastic resins. The two most common, recyclable types of plastic are PET (Polyethylene terepthalate - #1) and HDPE (high density polyethylene - #2). PET (#1) is most commonly used to produce soft drink bottles. HDPE (#2) is most commonly used to produce milk and water containers, colored and opaque detergent bottles, and motor oil containers. Plastics labeled #3 - #7 currently have a minimal demand, so are not regularly collected; however, these items can be added to the list of recyclable products as demand increases.

Yard and Leaf Waste – Mandated municipalities are required to separate yard and leaf waste from other municipal wastes. Since September 26, 1990, no waste disposal facility accepts shipments comprised primarily of yard and leaf wastes unless a separate composting facility has been provided. Organic material can be ground to mulch, or processed to create compost, which has been proven to be beneficial in many agricultural applications, while removing a substantial waste stream from landfill disposal.

Other Recyclable Materials not specifically addressed by Act 101 – Large appliances or "white goods" can be shredded and steel separated for recycling. Some scrap dealers in the Region accept white goods. In addition many appliance stores will accept appliance trade-ins when selling a new appliance. In addition there are regional Recycling Events that include major appliances, computers and electronics, clothing and textiles, books and other items.

Electronics – Electronic equipment contains metals that, if not properly managed or contained, can become hazardous wastes. The "Covered Device Recycling Act" (House Bill 708), PA Act 108 of 2010 establishes a recycling program for certain covered devices; imposes duties on manufacturers and retailers of certain covered devices; provides for the powers and duties of the Department of Environmental Protection and for enforcement; establishes the Electronic Materials Recycling Account in the General Fund; and prescribes penalties for noncompliance.

Provided markets can be found, various other types of materials in the waste stream can be recycled. Tires, used motor oil, and automotive batteries are examples of recyclable items that pose disposal problems. Used tires can be retreaded, shredded and processed into crumb rubber for use in rubber plastic products, or they can be used to produce a durable ingredient in the production of asphalt. Alternatively tires can be shredded and burned as a source of fuel. The metal in automotive batteries and the polypropylene plastic case are recyclable. Used motor oil can be refined to produce heating fuel, industrial lubricants and even new motor oil. Used textiles can also be recycled. Textiles can be reused as rags, or reprocessed into filler products such as insulation or furniture padding. Non-treated wood can be recycled into playground mulch and used as a fuel sources. Good sources for identification of locations to drop off these "hard-to-recycle" materials is included in the Appendices (Links to Websites of Interest).

C. Typical Composition of Landfilled Recyclable Materials

According to the Municipal Solid Waste Characterization Study conducted by R. W. Beck for the PADEP, there were over 2 million tons of recyclable materials landfilled in 2001. This material included paper, plastic, glass, metal, organics, and inorganics. The following page contains a table from the R. W. Beck study ("Table 1: Statewide Aggregate Landfilled Municipal Solid Waste Composition Detail"), which lists the type of each material and the tons disposed in 2001. Copies of the complete study can be obtained from the PADEP web site at the following website location:

http://www.dep.state.pa.us/dep/deputate/airwaste/wm/RECYCLE/Waste_Comp/Study.htm.

This information shows that there is still considerable room for improvement in recycling. For counties and municipalities to increase their recycling, they need to investigate expanding the types of materials collected curbside or drop-off, select material commodities that are more cost-effective to collect, expand the number and hours of drop-off programs, intensify public outreach efforts (particularly through schools), and focus on recycling in commercial, institutional, and multi-family facilities. They also need to continue to increase the number of special collections, and composting opportunities.

Table 1

Statewide Aggregate Landfilled MSW Composition Detail (Weight Percent)

		Material Categories	Tons Disposed	Mean Composition	Standard Deviation	Confidence Interval Lower (%)	Confidence Interval Upper (%)	Sampling Error
Paper			**3,117,182**	**33.3%**	**20.0%**	**31.7%**	**34.9%**	**4.9%**
	1	Newspaper	389,263	4.2%	4.4%	3.9%	4.5%	8.2%
	2	Corrugated Cardboard	785,032	8.4%	10.7%	7.7%	9.3%	9.2%
	3	Office	341,975	3.7%	5.7%	3.3%	4.2%	13.0%
	4	Magazine/ Glossy	251,027	2.7%	4.1%	2.4%	3.1%	14.4%
	5	Polycoated/Aseptic Containers	49,074	0.5%	1.2%	0.5%	0.6%	13.3%
	6	Mixed Paper	433,821	4.6%	5.0%	4.3%	5.1%	7.8%
	7	Non-recyclable Paper	866,990	9.3%	7.5%	8.7%	10.0%	6.7%
Plastic			**1,062,336**	**11.3%**	**9.2%**	**10.7%**	**12.1%**	**6.3%**
	8	#1 PET Bottles	87,601	0.9%	1.4%	0.9%	1.0%	9.7%
	9	#2 HDPE Bottles	68,082	0.7%	0.8%	0.7%	0.8%	8.0%
	10	#3-#7 Bottles	16,871	0.2%	0.4%	0.2%	0.2%	16.2%
	11	Expanded Polystyrene	71,088	0.8%	1.5%	0.7%	0.9%	12.5%
	12	Film Plastic	465,586	5.0%	4.8%	4.7%	5.4%	7.1%
	13	Other Rigid Plastic	353,108	3.8%	5.1%	3.4%	4.2%	10.8%
Glass			**282,316**	**3.0%**	**5.3%**	**2.7%**	**3.4%**	**10.3%**
	14	Clear Glass	129,923	1.4%	2.0%	1.3%	1.5%	10.0%
	15	Green Glass	38,468	0.4%	1.1%	0.4%	0.5%	18.6%
	16	Amber Glass	66,238	0.7%	1.9%	0.6%	0.9%	23.6%
	17	Non-recyclable Glass	47,688	0.5%	2.1%	0.4%	0.6%	15.8%
Metals			**508,702**	**5.4%**	**8.6%**	**5.1%**	**5.9%**	**7.3%**
	18	Steel Cans	102,532	1.1%	1.3%	1.0%	1.2%	8.1%
	19	Aluminum Cans	48,844	0.5%	1.1%	0.5%	0.6%	12.7%
	20	Other Ferrous	282,131	3.0%	8.0%	2.7%	3.4%	12.1%
	21	Other Aluminum	43,057	0.5%	1.2%	0.4%	0.5%	10.4%
	22	Other Non-Ferrous	32,138	0.3%	1.4%	0.3%	0.4%	15.9%
Organics			**3,204,208**	**34.2%**	**21.7%**	**32.8%**	**35.7%**	**4.2%**
	23	Yard Waste- Grass	136,084	1.5%	3.9%	1.2%	1.8%	21.7%
	24	Yard Waste- Other	347,164	3.7%	8.2%	3.1%	4.6%	19.4%
	25	Wood- Unpainted	540,611	5.8%	15.8%	5.2%	6.7%	12.9%
	26	Wood- Painted	234,406	2.5%	8.6%	2.3%	2.9%	12.6%
	27	Food Waste	1,127,170	12.0%	11.8%	11.3%	13.1%	7.7%
	28	Textiles	352,570	3.8%	6.8%	3.5%	4.2%	9.8%
	29	Diapers	217,875	2.3%	4.1%	2.1%	2.6%	10.5%
	30	Fines	92,451	1.0%	1.3%	0.9%	1.1%	8.4%
	31	Other Organics	155,877	1.7%	4.1%	1.5%	1.9%	12.7%
Inorganics			**1,194,338**	**12.7%**	**23.2%**	**11.8%**	**13.9%**	**8.3%**
	32	Electronics	137,299	1.5%	4.3%	1.3%	1.8%	16.4%
	33	Carpet	163,371	1.7%	6.2%	1.5%	2.1%	17.4%
	34	Drywall	99,009	1.1%	6.1%	0.9%	1.3%	15.7%
	35	Other C&D	446,516	4.8%	16.0%	4.2%	5.5%	13.7%
	36	HHW	28,203	0.3%	1.2%	0.3%	0.4%	13.6%
	37	Other Inorganics	207,682	2.2%	5.9%	2.0%	2.6%	14.2%
	38	Furniture	112,258	1.2%	6.8%	1.0%	1.6%	25.5%
		Total	9,369,083	100.0%				

D. Processing/ Disposal Alternatives

The following section briefly highlights waste processing and disposal system alternatives that are currently available in the industry. This section also focuses on alternatives that have specific compatibility or that show particular promise within the current Columbia, Lycoming, Montour, Snyder, and Union Counties' waste management system that was described earlier in this chapter.

Landfill

Development of a New Sanitary Landfill

Sanitary landfilling is an engineered method of disposing of solid waste on land. State and federal environmental regulations and advances in design technologies have combined to minimize the impact of sanitary landfills on the surrounding environment. The PADEP Municipal Waste Regulations require all new and existing (operating) landfills to be designed with a double liner system with leachate collection and detection elements. In addition, after closure of the landfill, the disposal area is required to be capped with a low permeability liner system to restrict the downward flow of precipitation into the waste material.

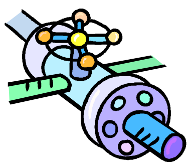
A landfill can accept a broad variety of materials including sewage sludge, construction and demolition waste, and incinerator ash, as well as municipal and residual wastes. These materials, as well as bulky items such as furniture, building materials, and large appliances that do not contain Freon, can be readily disposed of, but may pose operational difficulties. Further, special permit modifications are required for the disposal of sewage sludge and incinerator ash. For these reasons, not all landfills accept all of these materials.

The chief environmental concerns associated with landfilling waste are leachate contamination of groundwater, the danger of explosions caused by migrating methane gas, atmospheric and environmental health hazards from landfill gases, truck traffic, odor, litter, and the aesthetic "eyesore" of the landfill site in general. Applications for new landfill permits in Pennsylvania must demonstrate that the benefits of the project clearly outweigh the "harms" or negative impacts. Development of a new sanitary landfill is also capital-intensive, with high permitting, land, and site development costs.

Expansion of an Existing Landfill

An alternative to developing a new landfill is to expand an existing landfill. There are two main ways to expand an existing landfill. The first method is to enlarge the existing landfill's footprint, or in other words, to expand horizontally. This can be done by developing new cells adjacent to the existing landfill cells, or by developing new cells on a remaining portion of the existing landfill property. Some landfills are limited by their existing footprint, and do not have the capability of expanding horizontally. These landfills may expand using the second method of vertical expansion, employing the use of a mechanically stabilized earth (MSE) berm around the perimeter of the existing footprint. An MSE berm allows the expansion to occur while the operation is still accepting waste, so as not to interrupt waste flow to the landfill. A vertical expansion with an MSE berm allows a landfill to modify its geometry, to allow an increase in capacity, without substantial liner footprint increase or setback conflicts.

Landfill Gas Recovery



Landfill gas (LFG) is the natural by-product of the decomposition of solid waste in landfills and is composed primarily of carbon dioxide and methane. As part of federal regulations, landfill gas is required to be monitored and collected. The most common options for managing landfill gas are flaring, use of landfill gas as energy, direct use of landfill gas for electricity generation and use of cleaned landfill gas in a pipeline to customers and/or natural gas lines. Using LFG helps to reduce odors and other hazards associated with LFG emissions, and helps businesses, states, energy providers, and communities protect the environment and build a sustainable future.

Flaring

A gas flare, alternatively known as a flare stack, is an elevated vertical thermal combustor. They are used to eliminate waste gas when gas extraction rates do not sustain direct use or electricity generation. Flares can be either open or enclosed. Enclosed flares are typically more expensive, but maintain high combustion temperatures and specific residence times as well as limit noise and light pollution. Some US states require the use of enclosed flares over open flares, including PA. Venting of landfill gas is a significant source of greenhouse gas emissions which is why the US EPA regulates the emissions of landfill gas. Recently, under the Kyoto Protocol, garbage collecting companies in some developing nations have received a carbon bonus for installing combustion devices for the methane gas produced at their landfills, preventing methane from reaching the atmosphere. After the burning, this gas is converted to heat, water and CO2. Flares are beneficial in all landfill gas systems as they can help control excess gas extraction spikes and emissions during maintenance down times.

Landfill Gas to Energy

Landfill gas is treated to remove impurities, condensate, and particulates. The treatment system depends on the end use. Minimal treatment is needed for the direct use of gas in boilers, furnaces, or kilns. Using the gas in electricity generation now requires more in depth treatment due to the requirements of the newer combustion equipment. Treatment systems are divided into primary and secondary treatment processing. Primary processing systems remove moisture and particulates. Secondary treatment systems employ multiple cleanup processes, physical and chemical, depending on the specifications of the end use. Two constituents that may need to be removed are siloxanes and sulfur compounds which are damaging to engine and turbine equipment and significantly increase maintenance cost.

Historically, landfill gas has been converted at on-site locations using dedicated internal combustion engines. These projects used to be relatively simple to permit and demonstrated favorable economics by requiring minimal infrastructure to support the end product. However, in recent years, air permits for internal combustion engines have become more difficult to obtain, and in the future appear to require gas treatment prior to the engine. The alternative for larger projects is the employment of gas turbines. Microturbines are used for small gas flow conditions.

Internal Combustion Engine

More than 70 percent of all landfill electricity projects use internal combustion (IC) engines because of relatively low cost, high efficiency, and good size match with most landfills. IC engines have relatively high maintenance costs and air emissions when compared to gas turbines. IC projects have a large amount of thermal energy which is most commonly exhausted to the atmosphere as waste heat.

Gas Turbine

Gas turbines usually meet an efficiency of 20 to 28 percent at full load using landfill gas. Efficiencies drop when the turbine is operating at partial load. Gas turbines have relatively low maintenance costs and nitrogen oxide emissions when compared to IC engines. Gas turbines require high gas compression, which uses more electricity to compress, therefore reducing the overall efficiency. Gas turbines are also more resistant to corrosive damage than IC engines.

Microturbine

Microturbines can produce electricity with lower amounts of landfill gas than gas turbines or IC engines. Microturbines can operate between 20 and 200 cfm and emit fewer nitrogen oxides than IC engines. Also, they can function with less methane content (as little as 35 percent). Microturbines may require extensive gas treatment and come in sizes of 30, 70, and 250 kW.

Landfill Gas To Direct Use

Landfill gas can be treated at the landfill, compressed and conveyed in a pipeline for direct use in equipment located some distance from the landfill. Aside from the economics of constructing a pipeline, these projects offer benefits in air permitting since the off-site facility already maintains permits and the heating value of the landfill gas can be sold as a renewable fuel offsetting fossil fuel at the off-site location. These projects tend to have higher development costs compared to electric only but are offset by more predictable permitting outcomes, better environmental value to the community, and provide long-term attachment of the landfill gas end user to the community.

Pipelines transmit landfill gas to boilers, dryers, or kilns, where it is used much in the same way as natural gas. The use of landfill gas in a project has economics that establish the landfill gas as the cheaper energy compared to the alternative natural gas or oil. Boilers, dryers, and kilns are used often because they maximize utilization of the gas, limited treatment of the gas is required, and the gas can be combined with other fuels. Boilers use the gas to transform water into steam for use in various applications, i.e. heating of existing structures at the landfill site or nearby businesses and homes. Disadvantages of boilers, dryers, and kilns are that they need to be retrofitted in order to accept the gas and the end user has to be nearby for favorable project economics as pipelines are required to convey the landfill to the fuel consumer. Early projects limited pipeline lengths to 3 to 5 miles, but recent projects have constructed pipelines for distances over 10 miles with a once planned PA project to be 22 miles.

Landfill Gas to Pipeline Quality

Landfill gas contains about half the heating value of natural gas. Landfill gas can be converted to high-Btu gas by reducing its carbon dioxide, nitrogen, and oxygen content. The high-Btu gas can then be piped into existing natural gas pipelines or used in the form of CNG (compressed natural gas) or LNG (liquid natural gas). CNG and LNG can be used on site to power hauling trucks, equipment using natural gas, or sold commercially offsetting natural gas.

The conversion of landfill gas into a high BTU gas was considered experimental a few years ago. However, the difficulty in attaining air permits for on site facilities to generate electricity have quickly advanced the prototype equipment into working production facilities. Some of the best working examples of these conversion technologies are currently found on the west coast of the US.

Combustion (Waste-to-Energy)

In a typical waste-to-energy combustion facility, waste is unloaded into a receiving pit. An overhead crane feeds waste into the furnace hopper. The crane operator may pick out oversize items, such as large appliances, and will mix the waste to obtain homogeneous fuel supply. Within the combustion chamber, the burning waste is transported along the moving grates of the stoker assembly or similar grate system. Heavy ash, called bottom ash, falls off the end grate and is cooled with water. The hot combustion gases pass through the combustion chamber and pass across boiler tubes to produce steam. Also, the walls of the furnace itself are typically fitted with a network of water-filled tubes that use the heat to produce steam. The steam is often passed through a turbine to produce electricity. The produced steam may also be distributed to nearby establishments for heating and/or for use as a process steam.

A combustion incinerator can process approximately 98 percent, by weight, of the municipal solid waste stream. The quantity of ash residue requiring disposal will equal approximately 20-30 percent, by weight (by volume, approximately 10 percent) of the processed waste stream. The non-processibles (materials removed prior to combustion) and the unburned ash residues are usually handled through combination of recycling and landfilling. The non-processibles and especially the ash residue involve special disposal considerations that impact their disposal costs. Lower disposal costs, when compared to MSW, can be achieved if the ash is classified as an alternative daily cover (ADC).

Federal and State regulations require that landfills cover their solid waste daily with a minimum of six (6) inches of dirt. The daily cover is intended to minimize disease vectors and animal attraction, control leachate and erosion, reduce fire hazard potential, minimize wind-blown litter, reduce noxious odors, provide an aesthetic appearance and allow accessibility regardless of weather. Alternative daily cover was created to reduce the costs of placing six (6) inches or more of dirt each day on the landfill and/or decrease the amount of air space consumed by the six inches of daily cover. Alternative daily cover includes a wide variety of materials including, but not limited to foam, tarps, recycled tire chips, finely crushed glass, ash, etc. The type of alternative daily cover used at each landfill is dependent upon many considerations. Some of these considerations are regulatory, environmental, economic, longevity, and public perception.

The chief environmental concerns of waste combustion are air emissions of acid gases, heavy metals (e.g., lead, mercury), and certain organic compounds, and contamination of air and water through improper handling and disposal of the ash residue.

State and federal emissions control requirements, which currently mandate that new facilities install scrubbers for acid gas control and electrostatic precipitators (ESPs) or fabric filters (baghouses) for particulate removal, are aimed at minimizing the risk of harmful health effects from solid waste incineration. Current technology and air regulations allow MSW combustion to have less air emissions than an equivalent coal-fired power plant.

In general, waste-to-energy projects are very capital-intensive due to extensive equipment and building needs. Larger waste-to-energy facilities are generally constructed in similar fashion to power utility plants with field-erected combustion and boiler systems. These can be economically feasible at sizes as low as 300 tons per day (tpd). Below 300 tpd, most waste-to-energy facilities are constructed with pre-fabricated, modular furnaces. Such modular systems have a lower capital cost. Recent high oil prices have generated a renewed interest in MSW combustion.

Refuse-Derived Fuel (RDF)

At an RDF facility, mixed waste is processed mechanically (and perhaps manually) into a form rendering it more suitable for use as a fuel. Typical processing steps involve size reduction, removal of noncombustible materials, mixing/blending and either shredding or densification into pellets or briquettes.

The RDF product can be marketed to institutional or industrial facilities for use as a supplemental fuel in their existing boilers. Additional air pollution control measures may be required depending upon the specific application. If insufficient markets exist, the RDF can be burned at the RDF facility in a dedicated boiler. In Pennsylvania, PADEP requires a facility that burns RDF fuel to obtain a waste management permit much the same way as a waste-to-energy facility does. This negatively impacts the prospects for developing an RDF project.

The fuel preparation process produces residuals requiring disposal; the quantity depends on the composition of the input waste on the processing system. The process typically removes ferrous metal for recycling, and may separate other materials for recycling. If a dedicated boiler is used, there will be ash requiring disposal.

The potential environmental impacts of an RDF facility are similar to those of a waste-to-energy facility. There are additional concerns of worker health and safety due to the potential for explosions in the shredder and exposure to airborne material such as bacteria and molds. RDF projects are very equipment and capital-intensive. Finding a long-term user for the refuse-derived fuel material is critical to the financial feasibility of an RDF project.

Biogasification

Biogasification involves the conversion of the organic fraction of municipal solid waste into methane gas by the activities of anaerobic bacteria in an enclosed digester. The methane gas can be used as a fuel for steam production, for subsequent sale to nearby utilities or industries, or it can be cleaned and sold as a stand-alone fuel.

The biogasification technology has been traditionally used to process highly liquid, easily biodegradable wastes such as animal manure and organic sludge. To use this technology to process municipal solid waste, extensive preprocessing of the waste must be done to separate out the organic fraction and process it into small, uniform particle sizes which are essential for proper anaerobic digestion. The temperature, carbon-nitrogen ratio, and pH of the waste mixture must be carefully monitored and controlled to achieve proper digestion of the waste. A by-product of the decomposition process is a solid residue (i.e., waste which has not been converted to methane gas) which must either be disposed of elsewhere, or further processed for use as fuel or compost.

The application of the biogasification technology has received a recent resurgence in interest as a renewable energy source due to the high cost of oil. Projects being developed usually involve the use of a clean organic feedstock, and this technology is still in the developmental stages.

The potential environmental impacts of a biogasification facility are those of operating a shear shredder and odors. There are additional concerns of worker health and safety due to the potential exposure to airborne material such as bacteria and molds. Biogasification projects are very equipment and capital-intensive. Finding a long-term user for the fuel is critical to the financial feasibility of a biogasification project.

One example of biogasification technology that has been employed recently in other parts of the world is ArroBio.

ArrowBio

The ArrowBio process is an integrated solution that receives MSW pre-sorted or unsorted, which eliminates the need for prior separation or classification of mixed waste. The waste is delivered and dumped into a pit, where bulky items will be removed and the waste bags will be opened. The preliminary dry waste preparation and separation stage is based on the concept that most of the biodegradable organic materials are smaller and can subsequently be separated with the waste's liquids by a trommel. The larger particles, such as cardboard, paper and plastics will go through and can be separated manually. The preliminary liquid-based waste preparation and separation stage is based on the concept that inorganic materials, such as metals and glass, weigh more than water, while plastics and biodegradable organic matter have a weight that is equal to or less than water. The larger materials will enter the primary vat, while the smaller materials will go to the secondary vat.

The heavy components that dropped to the bottom and were subsequently separated from the organic stream include ferrous metals, non-ferrous metals, glass and other static materials. These materials travel down a processing line, where they are separated by a number of methods, including a magnetic force, an eddy current and manual means. The remaining materials are returned to the dissolving tank and proceed to the light materials process.

The light organic waste, already separated from the heavy components, is transported through a conveyor into a trommel, where strong water streams wash the materials and they enter a rough screen where the smaller elements go through the holes to a hydro-crushing unit. The large items proceed to a sorting conveyor, where the PET and HDPE materials are screened out manually. The metals are removed by a magnet, and the film plastic is blown out by using an air sifter. The rest of the materials enter into a rough shredder and then to the hydro-crusher.

The biodegradable material enters the filtering system. The residual contaminations are filtered out, and the grit, sand, broken glass, and small metal elements are screened out using a settling vat. Larger elements go through a secondary air sifter and then return for a second cycle in the system, or are dropped out of the process and sent to a landfill. The remaining energy rich organic watery solution is sent to the biological reactors to yield fertilizer, water and biogas.

In the biological reactors section the fluid undergoes two more processes, both of which are coordinated by naturally occurring microorganisms. In the first bioreactor tank, acidogenic fermentation transforms complex organic material into simpler organic acids and fatty acids. This acid rich organic matter is then heated and transported to the Methanogenic Fermentation reactor for anaerobic degradation of the organic materials and the generation of clean fertilizer, water and biogas. The biogas can be used for energy needs and for heating the Methanogenic tank. The anaerobic digestion process generates fertilizer, water and biogas containing up to 75% methane. The biogas can be sold as clean green energy for transportation and power plants.

There are plants in Hiria, Israel and Sydney, Australia that are currently utilizing the ArrowBio process.

Composting/Co-Composting

Composting is a biological oxidation process that breaks down the biodegradable organic material in waste into simpler, more stable compounds, carbon dioxide, moisture and heat. The compost end-product is humus containing nutrients and minerals that can be used as a soil supplement. Although of lesser nutrient value than fertilizer, the compost improves soil structure for root development, increases water retention in sandy soils, improves drainage in clayey soils and adds to the cation exchange capacity of soils. A quality compost product appears much like peat and has similar uses. A typical municipal refuse composting operation consists of the following four basic steps:

- Pre-processing – Initial processing consists of sorting, shredding, and preparation of a feedstock mixture suitable for composting. Some of the recyclable materials in the waste, such as ferrous and non-ferrous metals and glass, may be removed at this stage. The mixture of biodegradable materials, or feedstock, is adjusted to optimum moisture and nutrient levels, and particle size of the materials may be reduced. A "dirty MRF" type of pre-processing line is sometimes used to prepare a wastestream for composting.
- Municipal waste is sometimes co-composted with wastewater biosolids (sewage sludge). This mixture of two waste streams provides nutrients and moisture from the biosolids that are needed for the proper composting of the high-carbon municipal solid waste. Water can be added to the mix to attain optimal moisture levels. The solid waste acts as a bulking agent for the composting of the biosolids.
- Biological and chemical decomposition - This composting stage makes use of naturally occurring bacteria and other microorganisms to break down the organic portion of the waste, in the presence of oxygen, into stable by-products.
- Curing - Curing is required to stabilize the compost mix and to assure that the biochemical breakdown process is complete. Curing helps assure that the compost product will not contain toxic compounds when used as a growing medium. After a 1-2 month curing phase, the material is usually considered stabilized.
- Product Screening - The compost product is prepared for use through screening, removal of contaminants (such as glass), packaging (if needed), and marketing.

Solid waste composting stabilizes only the organic fraction of the waste stream. Contaminants such as glass, plastic, metal, rubber, and textiles should be screened out, depending upon the final uses and market specifications, and either recycled or landfilled as appropriate. Compost-laden recyclables typically carry a lower sales value than curbside-collected, clean recyclables.

A composting facility can divert and reclaim approximately 60-70 percent of the municipal solid waste stream from disposal through landfilling. The quality of the final product benefits from the presorting/ removal of glass, household hazardous waste, household batteries and used motor oil. Building corrosion, odor control, and fire suppression needs at mixed waste composting sites, as well as the quality of the final product, are critical issues that need to be addressed for proper development of a composting project. The residue sent to the landfill after separation from the compost feedstock is largely inorganic in nature, and most of the soluble components of the waste stream have been removed.

There is a strong industry push to develop segregated organics composting facilities throughout the US, and low-technology yard waste composting facilities are commonly used by municipalities and counties throughout the northeast US to divert a significant fraction of the municipal wastestream to a beneficial use, at a relatively low cost (Pennsylvania currently has nearly 500 of them). Exhibit 4 contains the locations of the compost facilities that are known to exist within the five-County Region.

One example of a low technology composting facility that is currently operating in the Region, and that has recently included food waste as part of its feedstock, is the Briar Patch Organic Farm in Union County.

Briar Patch Organic Farm/Weis Markets Composting Initiative

This small, private windrow-technology composting facility has been in operation for nearly 20 years. In 1994, Union County received a PADEP 902 grant to purchase the following yard waste processing equipment:

- Tractor-drawn windrow turner;
- Tractor; and
- Bobcat.

An agreement was made between Union County and Mr. Preston Boop, owner of Briar Patch Organic Farm (located in Union County), for Mr. Boop to process the County's yard wastes at his site with the equipment purchased through the grant. The yard waste from the Borough of Lewisburg is delivered for processing approximately twice per year. Additionally, the general public is allowed to drop off their yard waste at the site. The organic farm currently uses yard trimmings from the Borough of Lewisburg, vegetative materials, manure, and animal mortalities generated on-farm to make compost. Workers process this material in windrows and sell the finished compost or soil amendments or apply it on-site to grow certified organic feed for dairy farmers.

In 2010, Briar Patch Organic Farm began a 3-month pilot program to accept and process food waste from a Weis Markets (headquartered in Sunbury) grocery store in the region. The grocery store source-separated food residuals and delivered them to the compost site. Twelve tons per week of organic food waste was delivered to Briar Patch Farm, mixed into windrows, and composted. The pilot program ended in March 2010.

In September 2010, Weis Markets began a second pilot project with composter Two Particular Acres (Royersford PA) and aggregate producer H&K Group. The H&K group has more than 40 operating quarries, a fleet of more than 700 trucks and other necessary equipment and real estate to partner with Two Particular Acres and offer instant infrastructure, and the regional capacity to handle the incoming organic feedstocks. The H&K Group, Two Particular Acres and Weis Markets have partnered to form American Biosoils and Compost. The newly formed company submitted to PADEP a new modified General Permit 30 that will allow anyone who already has a composting permit, to take in as much food waste as they can handle on their site as long as they take in twice the amount of yard debris. Additionally, the company made an application under a new general permit with permit provisions and conditions, to possibly move forward until the modified General Permit 30 is issued. Two Particular Acres is currently acting as the test site with the four-store initial pilot project. American Biosoils and Compost will open up four more sites in Pennsylvania, once a permit is in place, with an additional 20 sites not far behind. Currently, Ned Foley of Two Particular Acres collects the food waste from the Weis Markets stores participating in the program. Black 96-gallon toters labeled "COMPOSTABLES ONLY" are stored in walk-in coolers at the Weis Markets sites to keep their organic contents stable. The Weis stores have been averaging 1 ton of organic material a week. Weis Markets hopes to use the compost for customers (supplying the material for sale in their stores), as well as use in wetland mitigation, landscaping mulch or as soil amendment on new construction projects.

Wal-Mart in NorthCentral PA

The Wal-Mart Corporation has established goals, companywide, to become more environmentally sustainable and reduce the amount of waste generated in their facilities through source reduction and reuse, composting and recycling. With this in mind, several Wal-Marts in NorthCentral PA have contracted with Organix for the collection of compostable materials. Wal-Mart collects compostable material, i.e. old produce that is not sellable and old coffee grounds, in compost bins on site. Organix picks these bins up once or twice per week and takes the compostable materials to the Reinford Dairy Farm in Mifflintown, PA. At the Reinford Dairy Farm, the material is placed in a digester and eventually converted into electricity that is used on the farm.

Emerging Waste Conversion Technologies

Pyrolysis

Pyrolysis involves the heating of waste without sufficient oxygen for combustion, causing its decomposition into combustible gases, liquids, and a solid residue (char) which resembles coal. This technology was traditionally used to produce methanol, acetic acids, and turpentine from wood. The most promising aspects of its application to municipal solid waste are low air emissions and the flexibility to produce a broad range of energy forms, which would enable the facility to respond to changes in local energy demands.

The pyrolysis technology has not been commercially developed in the United States for application to the municipal solid waste stream. An attempt to develop a large-scale pyrolysis project to process municipal waste was attempted unsuccessfully by Monsanto for the City of Baltimore in the 1970's. Thus, it is still considered to be an experimental waste processing technology. Obstacles which have hindered the commercialization of pyrolysis as a municipal solid waste processing technology include: the interference of inorganic materials with the pyrolysis process; inconsistencies in the quality of the liquid and char end products of pyrolysis; the low combustion value of the char end product; and the lack of energy markets for end-products.

Pyrolysis/Gasification

This technology is a variation of the pyrolysis process. Another reactor is added to this system whereby any carbon char or pyrolysis liquids produced from the initial pyrolysis step are further gasified, which may use air, oxygen, and/or steam for these gasification reactions. Pyrolysis/ gasification reactors operate predominantly in an oxygen-starved environment, since the combustion reactions quickly consume the oxygen, producing heat sufficient for the pyrolysis reactions, resulting in a raw synthesis gas (syngas) exiting the reactor. The raw syngas is cleaned up of particulate matter from the reactor, which can include sulfur, chlorides/acid gases, and trace metals such as mercury. Syngas is used in a power generation plant to produce energy, such as steam and electricity, for use in the process, and the excess generation is exported as energy. The exported energy is typically converted into electricity and supplied/ sold to the grid.

The end products from the energy generation in the reactor are typically ash, slag, and metals. The metals can be recycled; however, the ash and/or slag require disposal in a landfill.

As of 2009, there were seven facilities utilizing this technology in Japan, with a new facility in development in Puerto Rico. Six of these facilities were using MSW as their source of waste. Of these six facilities in Japan, four were generating power from their operation. The six operations in Japan are using the syngas in gas engines or boiler systems.

Plasma Arc Gasification

This type of facility uses a reactor with a plasma torch, and involves processing organics of waste solids. This method involves a high temperature pyrolysis process where the organics of waste solids are converted into syngas, while the inorganic materials and minerals of the waste solids produce a rock-like, glassy by-product called vitrified slag, mainly comprised of metals and silica glass. The syngas is predominantly CO and H2. The high temperature needed to complete the process is created by an electric arc in a torch where gas is converted into plasma. In commercial practice, the plasma arc gasification process is operated with an injection of a carbonaceous material like coal or coke into the plasma arc gasification reactor. This material reacts quickly with oxygen to produce heat for the pyrolysis reactions. The metals of the vitrified slag can be recovered and recycled, while the slag can be used to make other products such as rock wool, floor tiles, roof tiles, insulation, and landscaping blocks. Vitrified slag is environmentally acceptable as a recyclable by-product, which is a benefit of this method of waste conversion technology. An additional benefit of this method is that developments in design of plasma arc gasification reactors have improved and lessened the need for pretreatment/ preprocessing.

As of 2009, there were three plasma-arc plants in operation in Japan. The total tons accepted at each plant ranged from 25 tons per day to 165 tons per day. Plasma arc gasification has also been used for MSW ash in Chiba City, Imizu (12 tons per day), Kakagawa (30 tons per day), Kinura and Shimonoseki (41 tons per day).

Of the above mentioned energy recovery technologies, including waste-to-energy, plasma arc gasification is the most thermal and economically efficient method. In addition to generating the highest net annual revenue of the above mentioned technologies, including waste-to-energy, it should be noted that the vitrified slag byproduct can be used as road material, which then adds an additional revenue source for this process method.

E. Recyclables collection by Subscription in mandated communities

There have been many conversations with PADEP to discuss the exact requirements of Act 101 as it pertains to recyclables collection in mandated communities. The five-County Region has expressed interest in qualifying a subscription collection method for refuse and recycling in both mandated and non-mandated municipalities. The counties want to find ways to provide and increase recycling services to their residents, but funding for recycling programs is lacking. The following information was provided to the counties from PADEP in response to the inquiry about developing a private subscription-based recyclables collection program in place of a municipality-wide curbside collection program in mandated communities. PADEP's response to this inquiry is as follows:

"*As set forth in Section 1501(e) of Act 101 and Section 272.424 of the regulations, a private subscription, multiple recycling hauler system is allowed under Act 101. The Department does have concerns regarding private waste haulers doing the recycling for their customers in mandated municipalities. Please note that there would be less concern regarding having a private hauler system in a non-mandated municipality because the municipality does not need to meet Chapter 15 of Act 101.*

1. *Recycling service is to be provided to all residents. Section 1501(c) (1)(i) of Act 101 says that mandated municipalities are to adopt an ordinance that requires recycling of at least 3 materials by residents. The recycling program is required, not optional, meaning that all residents must be provided with recycling service, and there cannot be a way for residents to "opt out" of the recycling program. The Department views this as meaning that all residents need to have the service available to them. (Whether or not they actually utilize the recycling service is an issue of ordinance enforcement).*

2. *All haulers collect the recycling in a municipality on the same day. Section 1501(c)(2) says that recycling collection is to occur on a scheduled day at least once per month.*

3. *All haulers should be collecting the same materials per Section 1501(c)(1)(i) of Act 101 and the local ordinance. The statute says that consistency in the program and residential recycling education is necessary, and the municipality is to explain how the recycling system will operate and the dates of collection per Section 1501(c) (3) of Act 101. The municipality chooses the (minimum) 3 materials for recycling.*

4. *Residential participation in the curbside recycling program should be monitored*

5. *Municipalities should revise their recycling ordinances if the new private hauler recycling program were to be implemented.*

6. *Enforcement of recycling program: to ensure the materials collected are getting recycled by the haulers, weights are being reported, residents are participating, etc., Section 1501 (c)(4) of Act 101 requires that the municipality establish provisions to ensure compliance with the recycling ordinance. As set forth in Section 304(f) of Act 101, the municipality is to report its recycling weights to its county by February 15th of each year.*

7. *Grant-funded equipment use: Lycoming County currently has two curbside recycling trucks for residential recycling. These trucks were purchased with grants as set forth in Section 902 of Act 101, for recycling use. If the County no longer does curbside pick-up and no longer needs to use these trucks for recycling, then the Department would anticipate that the County would be in touch with the Department with regard to what steps would be taken with the equipment (i.e., selling the equipment and returning money to the State, or transferring the equipment to another municipality or county, etc).*

8. *If any of the waste haulers do not have the ability to collect recycling: what would happen to their customers?*

9. *Existing curbside contracts: How would existing curbside collection contracts with any municipalities be impacted with such a change by the County?*

10. *Loss of materials to the LCRMS MRF: If private haulers take the recycling they collect anywhere they choose—could this ultimately negatively impact the tonnage received by LCRMS?*

11. *Failure to implement a private hauler-based recycling program in a mandated municipality that complies with the requirements of 1501 (as listed above) could result in the municipality being ordered by DEP to utilize another system (i.e. contracted or municipal collection).”*

Much of PADEP’s cautionary approach to this concept is because it has seen such a system not work properly in this region already. It is expected that PADEP would scrutinize the setup and implementation of such a system closely, to insure that Act 101 requirements are being fully complied with.