Animal Manure and Related Biomass Feedstock Market Assessment and Preliminary Feasibility Study for a Papermill Biomass/CoGen Facility

Task 4 Summary Report

for

Southern States Energy Board
SERBEP Program

with

South Carolina Energy Office

Submitted by:

Task Completion Date: January 3, 2000
Report Issue Date: January 15, 2001

A Division of LINPAC Inc. A Member of the LINPAC Group of Companies

Animal Manure and Related Biomass Feedstock Market Assessment and Preliminary Feasibility Study for a Paper Mill Biomass Cogeneration Facility

Linpac Paper
Task 4 Summary Report
Description of Animal Manure and Waste Management Infrastructure

Table of Contents

Linpac Paper
Task 4 Summary Report
Description of Animal Manure and Waste Management Infrastructure

Task 4 Summary:

The Task 4 workscope involved an overview of the waste management infrastructure and waste management methods, as well as disposal costs, available disposal locations and handling systems. Also, as the State of South Carolina generally follows federal regulations, policy and guidelines, there are some important federal waste management policies and guidelines and new industry pressures that were incorporated into the evaluation. These guidelines contain methods for achieving the objectives of environmentally sound management and disposal of solid and hazardous waste, resource conservation, and maximum utilization of valuable resources.

The Biomass/Cogen facility can be strategically looked at as a "no landfill waste hauling infrastructure facility". The facility concept is unique in that it can act as an alternative to landfilling without being competitive or detrimental to the current waste industry hauling practices, and can work in compliment with the existing infrastructure and industry market forces. The ability to recover organic wastes varies by the type of waste generated. For instance with animal manures it must be assumed that the transportation of manures would be limited, particularly wet manures, due to the moisture content's affect on transportation costs. Animal manure is represented by swine, cattle and poultry production. The manure that these animals generate can take different forms and represent different handling problems. Manures can be generated in solid or liquid form. Typical composition of these materials is as follows:

- swine manure is typically generated as a liquid.
- cattle manure can be generated as a liquid or solid.
- poultry manure is typically generated a solid.

For animal manure land application and lagoon treatment of manure has been the historical disposal methodology. This would make it difficult to recover material unless improved animal manure handling infrastructure and other feedstock handling infrastructure was in place to concentrate the materials or a facility were located very close to target areas. However, industry scrutiny may add to current pressures for improved disposal methods, along with the following regulatory factors :

- new regulations for phasing out of animal manure and waste lagoons.
- new regulations for limiting the land application of animal manures and biomass wastes.

Animal manures are often handled on-site or through a different system than the traditional municipal solid waste stream. Many of these generators are not used to paying any tip fees to dispose of their wastes. There are various technologies for dewatering manure:

- gravity separation
- drying
- solidification
- mechanical separators

For the other four targeted biomass feedstocks (Animal Residuals, Food Manufacturing, Food Service and Pulp and Paper) landfilling has been the historically dominant disposal technology for

their solid waste. Waste providers have hauling and disposal infrastructure in place, although recently alternative disposal methodologies have been used, including the following:

- Incineration
- Composting (on-site and off-site)
- Land Application (on-site and off-site)
- Animal Feeding and Rendering
- Sewering (typical as liquid residuals)

Operations like the Biomass/Cogen facility, even with a proven technology like the CCI/BTA process, still has many challenges in gaining market share in the State of South Carolina and SERBEP region. These challenges center on acquiring the raw material stream. Generating material flow to the proposed facility in an environment that is effectively dominated in the animal manure case by current "zero" cost disposal parameters, or with regard to the other targeted biomass waste streams by large waste hauling/landfilling companies and/or very restrictive franchise requirements, requires careful evelopment of opportunities. Ultimately, successful facility development requires taking advantage of specific "holes" in the marketplace that allow the developers to exploit one or more of the following marketplace opportunities or "holes" in service.

- A large generator or industry that controls its own waste stream, and would see a benefit to the targeted waste stream being diverted.
- A small hauler with no landfill resources that has the capability to direct its waste to the facility with preferential tipfees
- A City or County who is trying to increase recycling by extracting biomass organics from the waste stream either by source separated collection or removal of organics,
- A recycling facility that is trying to increase its throughput and expand to biomass
- A facility operator that has a stream of the target biomass material available that would like to increase recovery of material, so as to be able to attract larger accounts.

All of these market forces build complexity into the process of siting and developing a Biomass / Cogen facility, and require proper engineering, permitting and business planning. A critical factor for siting and successfully operating a Biomass / Cogen facility is the regional waste disposal tipfee structure. The average tip fee for all regional landfills in SERBEP is in the $24 - $29 per ton range. However there are areas that have far greater landfill tipping fee costs, some approaching $80 - $95 per ton. Since Cowpens, South Carolina is at the northern edge of the SERBEP region, and since the Cowpens site is along the I-85 corridor, the potential to reach into higher tipping fee agricultural regions and urban areas exists. Data suggests that tipping fees at an average of $30 - $40 per ton are reasonable to achieve with a targeted program.

In addressing the current waste management infrastructure and practices for disposition of animal manure and the related biomass wastes targeted, the following conclusions, based on the barriers and opportunities for the Biomass/Cogen facility development, can be provided:

Barriers:

- Many animal manure and related biomass waste generators currently do not pay a tip fee to dispose of their wastes, and are use to "zero" cost economics.
- Transportation costs present a large challenge in moving highly wet material such as animal manure or other wet biomass wastes long distances
- Some competing end uses for organics are highly value-added (secondary processing of slaughterhouse animal residuals for example)
- Generators of biomass waste in the food service sectors can be relatively small volumes and very decentralized, requiring a good procurement program.

- Food biomass waste in the food service sector is generally not source separated, but rather commingled with other solid wastes (paper, plastic, metals, etc.)

Opportunities:

- Changing regulations, particularly with regard to lagoons and land application, may serve to assess disposal costs directly to the industry, and encourage disposal alternatives for organic wastes, particularly animal manures, as a cost effective alternative.
- Animal manure, animal residuals, food manufacturing, food service and Pulp and Paper biomass wastes are relatively homogenous and contaminant free.
- Animal manure waste represents a huge generated volume, and even with very low percentage recovery or capture rates the available manure is vary large.
- Food processing wastes are generated by a relatively small number of large producers
- High landfill/incinerator tip fees, or alternative disposal methods in certain regions may encourage the animal processing, food manufacturing, food service and Pulp and Paper industries to separate organic wastes specifically for the biomass/Cogen facility as a disposal alternative.
- The concentration of certain biomass feedstock types and organic materials in certain regional areas provide an excellent opportunity for recovery alternatives.

Development of an appropriate strategic vision is necessary with regard to obtaining the organic raw material stream and accomplishing a successful animal manure and biomass feedstock procurement effort that works in compliment to existing waste management infrastructure.

Regulatory Impacts on Waste Management Practices

An overview of the regulatory and key permitting regulations and guidelines specific to the Cowpens site was previously provided in the Task 2 Summary Report. However, since the State of South Carolina generally follows federal regulations, policy and guidelines, there are some important federal waste management policies and guidelines, as well as new industry pressures, that can also serve as the basis of a biomass waste management strategic planning. This strategy can be used to determine the impact on the facility and the appropriate procurement program.

The regulatory areas of concern can impact the plant operations directly via facility regulation or indirectly as a result of "other industry" regulation that can affect facility support requirements such as animal manure and biomass feedstock sourcing, composted product distribution, etc.. The following section addresses some of these areas of concern as it relates to the general impacts on waste management requirements for future raw material procurement and facility operations. This section also describes the waste management policy environment in which the Biomass/Cogen facility would be implemented. Included is discussion of federal regulations for waste disposal and transportation, and the approach to managing solid waste and waste recovery.

RCRA Subtitle D: Non Hazardous Waste:

The Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 (42 U.S.C. 6942(b)) (RCRA), is the primary federal statute governing solid waste management. The principal objectives of RCRA are far-reaching and complementary:

1. Promote the protection of human health and the environment from potential adverse effects of improper solid waste management;
2. Conserve material and energy resources through source reduction and recycling;
3. Assist in the development of solid waste management plans;
4. Improve solid waste management practices; and

5. Promote the demonstration, construction, and application of solid waste management, resource recovery, and resource conservation systems which preserve and enhance the quality of air, water, and land resources.

Federal Guidelines for Solid Waste Management Plans:

The United States Environmental Protection Agency issued guidelines assist in the development and implementation of State solid waste management plans in accordance with RCRA. These guidelines contain methods for achieving the objectives of environmentally sound management and disposal of solid and hazardous waste, resource conservation, and maximum utilization of valuable resources. These guidelines address the minimum requirements for approval of State plans. The plans must prohibit the establishment of new open dumps within the State, and contain requirements that all solid waste (including solid waste originating in other States, but not including hazardous waste) shall be (i) utilized for resource recovery or (ii) disposed of in sanitary landfills or otherwise disposed of in an environmentally sound manner. The plan must also provide for the closing or upgrading of all existing open dumps.

No local government within the State may be prohibited under State or local law from entering into long-term contracts for the supply of solid waste to resource recovery facilities. The state plan must also provide for resource conservation or recovery and for the disposal of solid waste in sanitary landfills or for any combination of practices so as may be necessary to use or dispose of such waste in a manner that is environmentally sound. In addition, a policy and strategy for encouragement of resource recovery and conservation activities must be developed. In order to encourage resource recovery and conservation, the State should provide for technical assistance, training, information development and dissemination, financial support programs, market studies and market development programs.

Municipal Solid Waste (MSW) Definitions:

The Biomass/Cogen facility targets animal manure and related biomass feedstocks such as Animal Slaughter/Processing residuals Food Manufacturing residuals, Food Service residuals and Pulp and Paper mill residuals. These biomass feedstocks, with the exception of Food Service residuals, are agricultural and industrial sources and are not typically labeled as MSW wastes. However, Food Service residuals and some of the other feedstock sources may apply to MSW standards or indeed come in under the MSW based waste hauling infrastructure and control. The EPA defines MSW to include "wastes such as durable goods, nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources. Examples of waste from these categories also includes appliances, newspapers, clothing, boxes, disposable tableware, office and classroom paper, wood pallets, and cafeteria wastes. The Biomass/Cogen facility could readily take food wastes, cafeteria wastes, and yard trimmings if a homogenous stream or a suitable volume could be developed, thereby falling under the MSW guidelines. MSW does not include wastes from other sources, such as construction and demolition (C&D) waste, municipal sludges, combustion ash, and industrial process wastes that might also be disposed of in municipal waste landfills or incinerators. EPA's estimate of waste generation is an estimate of the generation of MSW only.

Impacts of Methane from Landfills:

The Biomass/Cogen facility can be strategically looked at as a "no landfill waste hauling infrastructure facility". The facility concept is unique in that it can act as an alternative to landfilling without being competitive or detrimental to the current waste industry hauling practices, and can work in compliment with the existing infrastructure and industry market forces. Alternatives to landfill disposal in a key area of national concern due to a typical landfill's potential negative impacts on the environment. One area of great concern is the production of landfill gas. Landfill gas, which is comprised mainly of methane and carbon dioxide, results from the anaerobic (in the

absence of oxygen) decomposition of organic degradable wastes buried in the landfill. The gas production process begins when waste is put into the landfill and can continue for 30 years or more. Wastes currently buried in municipal landfills are biologically decaying and releasing large quantities of methane to the atmosphere. These gases become "greenhouse active" and impact global warming and other air quality issues. Efforts to harness the gas at the landfill can be very costly per the amount of landfill biogas captured. Additionally, landfill gas can contain high amounts of sulfur or other contaminants that present air emission problems when used.

The EPA estimates that emissions from manure management account for about 10% of the total methane emissions in 1995. Methane's increasing concentration in the atmosphere has important implications for global climate change and other air standards. Methane is very effective at absorbing infrared radiation (IR) given off by the Earth's surface. By absorbing IR and inhibiting its release into space, the presence of methane contributes to increased atmospheric and surface temperatures. This process is commonly referred to as "the greenhouse effect." In addition to this direct radiative impact (also called radiative forcing), methane's participation in chemical reactions in the atmosphere indirectly contributes to global warming by influencing the amount of ozone in the troposphere, hydroxyl in the troposphere, and water vapor in the stratosphere. Methane's indirect impacts are expected to be about equal in magnitude to its direct impacts. Overall, one gram of methane has the impact of about 21 grams of carbon dioxide over a 100 year period. This value of 21 is the 100-year global warming potential (GWP). Over a 50-year time frame, one gram of methane would have the impact of about 60 grams of carbon dioxide, i.e., a 50 year GWP of 60. Methane's high GWP and relatively short lifetime make it possible to mitigate global warming quickly by reducing methane emissions.

The United States Environmental Protection Agency promulgated emission guidelines for municipal solid waste landfills in 1996. State plans must include controls of MSW landfill emissions at each MSW landfill meeting the following three conditions:

(1) The landfill has accepted waste at any time since November 8, 1987, or has additional design capacity available for future waste deposition;
(2) The landfill has a design capacity greater than or equal to 2.5 million megagrams or 2.5 million cubic meters. The landfill may calculate design capacity in either megagrams or cubic meters for comparison with the exemption values. Any density conversions shall be documented and submitted with the report; and
(3) The landfill has a nonmethane organic compound (NMOC) emission rate of 50 megagrams per year or more.

The State plan shall include the installation of a collection and control system at each MSW landfill meeting the previous conditions. States must develop provisions for the control of collected MSW landfill emissions through the use of control devices. The control devices can include the following:

(1) An open flare designed and operated in accordance with established operating parameters; or
(2) A control system designed and operated to reduce NMOC by 98 weight percent; or
(3) An enclosed combustor designed and operated to reduce the outlet NMOC concentration to 20 parts per million as hexane by volume, dry basis at three percent oxygen, or less.

Future emphasis on landfill alternatives to better harness biomass waste produced biogas is a key priority. Redirecting the biomass waste from landfills to a Biomass/Cogen type facility can provide for superior biogas production and a more beneficial use of the biomass resources. A Biomass/Cogen facility is an option that can potentially provide a more sustainable and cost effective solution for the above guidelines.

Rule 503—Standards for the Use or Disposal of Sewage Sludge

The EPA established a rule, which consists of general requirements, pollutant limits, management practices, and operational standards, for the final use or disposal of sewage sludge generated during the treatment of domestic sewage in a treatment works. Standards apply to sewage sludge applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator. The rules also include pathogen and alternative vector attraction reduction requirements for sewage sludge applied to the land or placed on a surface disposal site. The rules apply to any person who prepares sewage sludge, applies sewage sludge to the land, or fires sewage sludge in a sewage sludge incinerator and to the owner/operator of a surface disposal site. As pointed out in the Task 2 Summary Report, if the facility compost products (or indeed certain feedstock raw materials) is considered as an "industrial sludge," the dewatered residual from an industrial process, the South Carolina water pollution regulations for disposition of industrial sludge indicate that the material would be dealt with under regulations for solid waste:

> 61-9.504.4 Relationship to other regulations:
>
> (b) The disposal of industrial sludge involving the composting or co-composting of the industrial sludge with yard trash, land-clearing debris, or a combination of yard trash and land clearing debris shall comply with the requirements established by the Department in R.61-107.4 [Solid Waste Management: Yard Trash and Land-Clearing Debris; and Composting]. The submission and information requirements shall be determined by the Department.
>
> (c) The disposal of industrial sludge utilizing an innovative and experimental solid waste management technology or process shall be permitted under R.61-107.10. [Solid Waste Management: Research, Development and Demonstration Permitting].

The rule does not establish requirements for processes used to treat domestic sewage or for processes used to treat sewage sludge prior to final use or disposal. The determination of the manner in which sewage sludge is used or disposed is a local determination. The rule also does not establish requirements for sewage sludge co-fired in an incinerator with other wastes or for the incinerator in which sewage sludge and other wastes are co-fired. Other wastes do not include auxiliary fuel fired in a sewage sludge incinerator.

Flow Control and Interstate Commerce:

Flow control and interstate transportation of waste are the two major issues currently being contested across the country. Interstate transportation of waste means for example, shipping waste from states like New York and New Jersey that have limited landfill capacity and high tipping fees to states, like Pennsylvania, Ohio, and Indiana that have large capacity and lower fees. Several states have enacted laws restricting the importation of waste from other states, but theses laws have been struck down by the United States Supreme Court on the grounds that these laws, without explicit authorization from Congress, interfere with commerce under the Interstate Commerce Clause of the United States Constitution.

Flow controls can be legally used by State and local governments to designate where MSW and industrial solid waste must be taken for processing, treatment or disposal. This waste management approach requires waste to be delivered to specific facilities such as waste-to-energy (WTE) facilities, materials recovery facilities (MRFs), composting facilities, transfer stations and/or landfills. The facilities can be either publicly or privately owned. One of the direct effects of flow control is that designated facilities are assured of receiving a guaranteed amount of MSW, industrial solid waste and/or recyclable materials. If the designated facilities charge a "tipping fee" for receipt of the MSW/recyclables, flow control assures a source of revenue to meet their capital and operating costs.

Flow controls have become a heavily debated issue among State and local governments, the waste management industry, recyclers, and environmental groups. Financial institutions have also been a part of the discussion because of the relationship between flow controls and financing of waste management facilities. These interested parties hold differing views on the environmental, planning, and economic benefits of flow controls. During the 1990s, several court decisions ruled against the use of flow controls. Notably, in May 1994, the United States Supreme Court in *C & A Carbone, Inc. v. Town of Clarkstown* decided that the use of flow control can discriminate against interstate commerce and, therefore, can violate the commerce clause of the United States Constitution. Legislation was introduced during the 103rd Congress to clarify the legal status of flow controls. A consensus bill was passed by the House of Representatives late in the session; the Senate did not act and the legislation died with this Congress. Similar legislation was introduced in the 104th Congress.

Interstate flow control of waste is unlikely to be an issue. Flow control to designated facilities within a county or region is of more interest to this project, but still will only be an issue where other facilities may be competing for the same feedstocks, or other facility designations already exist (such as waste-to-energy incinerators).

CAFO Standards and Changing Disposal Methods:

Concentrated Area Feedlot Operations (CAFO's) have come under greater scrutiny nationally as well as specifically in South Carolina, adjoining SERBEP States such as North Carolina, and the entire SERBEP region during the last few years. Animal manure produced in the United States was about 1.37 billion solid tons of waste. Recent studies indicate there is too much manure and too little land for continuation of the current CAFO manure disposition methodology. CAFO's by their nature produce a considerable amount of animal waste disposed of in a very concentrated area. Historically this animal waste has been managed through land application (direct injection) based on fertilizer substitution or intermediate lagoon treatment. Two new areas of regulation are being developed and will be implemented in the near future, and are key for the CAFO industry, who will receive these two key regulations as applicable for their animal manure disposal practices:

- new regulations for phasing out of animal manure waste lagoons and lagoon treatment methods, which will require new disposal and treatment methodologies that will convert animal wastes from "zero" charge disposal to a tipping fee or processing cost..

- new regulations for limiting the application of animal manures as agricultural spreads, fertilizers, etc., based on phosphate standards instead of current nitrogen standards, resulting in up to a 75% reduction in the land loading capability and increase the pressure on solid and liquid manure disposal and "markets".

Geographic areas of particular concern to South Carolina include the North Carolina swine industry and the Piedmont regions as it relates to poultry, where in many instances it is likely that lagoon treatment will be discontinued and alternatives to lagoon treatment will be required. For instance, in North Carolina Smithfield Foods, the leading swine producer, and the State of North Carolina's Attorney General signed an agreement aimed at eliminating swine waste lagoons. This has been a overwhelming problem for North Carolina, effecting land and water resources that have impacted drinking water, recreational use and fisheries. Smithfield has committed $15 million to research alternative methods for swine manure disposal. In the Piedmont area the land application regulations of poultry manure may be reduced by as much as 75 percent due to new federal regulations requiring a switch from nitrogen to phosphate as the limiting guideline.

Recent legislation has also required that National Pollution Discharge Elimination System (NPDES) permits be completed for each of these CAFO's. Additionally, no more land application will be allowed of any additional manure products, and in some instances reductions in allowed applications are planned. In the affected regional area, State CAFO permits in addition to the

NPDES paperwork are required. These permits and ongoing operational data collection is designed to ensure that soil loadings of both phosphorous and nitrates to not exceed safe limits. The efforts to permit livestock programs are not limited to CAFO's. Additionally, the same type of regulation is being implemented for range cattle operations as well as "non CAFO" poultry and swine farms.

New industry pressures also come from well organized groups and law firms that include Tobacco industry type lawsuits and tactics meant to force a quick change. These groups opposed CAFO's and CAFO disposal practices and are determined to change current practices faster than new government regulation can. Many of these groups strongly believe the current practices have been correctly deemed as detrimental, and effects on land and water resources are well documented, and are concerned about significant negative effects for land and water. Their is even potential air quality concerns via unharvested methane effects as described in the above section. One group lead by Robert Kennedy Jr. "announced that they have recruited an all-star team of private bar attorneys and law firms to launch a broad legal assault against the corporate hog industry. Citing the government's failure to prosecute industry practices that shatter rural communities and contaminate public waterways, this public interest group said they will work with prominent plaintiffs lawyers to reform the industry, restore damaged ecosystems and reinvigorate America's family farms. The new coalition has already initiated the first series of lawsuits in North Carolina and is hosting a national meeting of hog activists to support the effort".

On a state-by-state basis regulators and industry groups have been looking more closely at the loading rates that land application has been creating and finding these loading rates are threatening both surface and ground water resources. Past disposition practices and methodology as fertilizers and agricultural spread, have resulted in serious solid waste/landfill overloading, and the concentrated materials becoming pollutants overloading rivers, streams, lakes, groundwater. Overall it appears that the future trend in manure management is moving from one hundred percent land application to the need for significant offsite processing and treatment, particularly in regions where concentrated CAFO industry has developed and overburdened the region's. This trend should allow a future Biomass/Cogen facility to begin to accept material on a tip fee basis where it was once land applied for "zero" cost.

Waste Hauling Infrastructure Considerations:

The ability to recover organic wastes varies by the type of waste generated. For instance with animal manures it must be assumed that the transportation of manures would be limited, particularly wet manures, due to the moisture content's affect on transportation costs. This would make it difficult to recover material unless improved animal manure handling infrastructure and other feedstock handling infrastructure was in place to concentrate the materials or a facility were located very close to target areas. Food wastes and animal manures are often handled on-site or through a different system than the traditional municipal solid waste stream. Many of these generators are not used to paying any tip fees to dispose of their wastes. However, future industry pressures (i.e. - in Animal Residuals for instance, concerns about "mad cow disease" could end up with new regulations that change current practices and provide for a huge increase in this raw material as feedstock) and regulatory pressures may provide new incentives to change current practices and provide for better recovery. For reasons like this, a range of potential capture rates for feedstock type, sectors, and region, based on a number of criteria used to evaluate the ability to recover a given animal manure or related biomass waste stream, including:

- Concentration of generators in a given geographic collection area
- Quantity of waste produced by individual generators (low, medium, high tonnage)
- Material handling equipment cost, load density and other material handling factors (moisture content, density-pounds per cubic yard, level of source separation)

- Current disposal practices and tip fees (competing end uses)
- Competing end uses (other composting, secondary production)
- Transportation type (truck, rail, pipeline, etc.) and costs
- New regulatory pressures and guidelines

As was done conceptually by general region in the Task 3 Summary Report, these evaluation criteria need to be applied specifically to the target source of animal manure, biomass or other organic waste streams to determine a range of potential material availability rates and procurement costs (low=conservative estimate; medium=strong potential; high=aggressive, a mature program). These potential "capture" rates and cost scenarios make assumptions about potential *availability* of target material. Sustainable target tonnage can be derived by assessing the factors and developing a multiplier to total available tonnage, based on the potential for recovering each waste stream. In general, animal waste is considered the most difficult to recover and transport, and therefore the lowest multipliers are applied to this sector.

Animal Manure and Waste Management Infrastructure

South Carolina and the SERBEP region has a fairly well developed infrastructure that relies on a variety of systems and technologies for managing its waste. In order to successfully site, permit, and develop a BTA facility, Linpac will need to fit its plans into the current infrastructure.

Waste Management Infrastructure and Practices:

Competition for the solid waste stream, including the animal manure and biomass stream, occurs on a number of levels including different private sector service providers, "in-house" disposition methods, public sector versus private sector control, and lastly via new technology developments and methods of handling and disposing of waste, . An evaluation of waste type or format, and the waste generation infrastructure that exists to service the waste, can provide a more clear picture of where and how target organic material might be most available due to existing practices.

Animal manure is represented by swine, cattle and poultry production. The manure that these animals generate can take different forms and represent different handling problems. Manures can be generated in solid or liquid form. Typical composition of these materials is as follows:

- swine manure is typically generated as a liquid.
- cattle manure can be generated as a liquid or solid.
- poultry manure is typically generated a solid.

For animal manure land application and lagoon treatment of manure has been the historical disposal methodology. Land application occurs with animal production facilities that use outside 1ots or pastures, or with animal production facilities that have confined production facilities and produce either solid or liquid manure but use managed pasture or crop land application systems for disposal of the animal manure that is generated. Anaerobic lagoon treatment is used for liquid manures, particularly with confined swine production. These methodologies are currently "zero" cost disposal methods with regard to tip fee considerations, but are coming under increased scrutiny due to the environmental costs associated with them. This scrutiny may result in the industry facing new regulations or guidelines that require better disposal methods, which can add new process and treatment cost to the disposal, or require a service provider to assist in the disposal for a tip fee or equivalent charge.

To effectively handle and transport animal manure to a Biomass/Cogen facility for use as feedstock, the material typically has to be properly handled and prepared at the generation site to reduce

shipping costs. The removal of water in liquid or semi-solid manure is key, as transporting the water can make the cost of transportation prohibitive. There are various technologies for dewatering manure:

- gravity separation - a settling basin, concrete vessel or tank can be use to allow the solids to settle out of solution, whereby they can be periodically removed for disposal. This method can require a large area, a long settling time, and require permits for basins or vessels.
- drying - drying can be used to hasten the removal of the liquid. Drying can occur by "natural" methods under the right climatic conditions, or where the climate does not allow for natural drying, heat and air flow assisted systems can be used. Natural drying is not feasible in some areas of the country, while the energy required to assist in the drying can be cost prohibitive.
- solidification - absorbent materials such as wood or cellulose fiber, yard waste or leaves, agricultural byproducts or compost can be used to thicken the liquid waste, which then can be transported in solid form. The solidification requires dry materials to be added to the mix, an will increase the amount of material that eventually needs to be disposed of. The solidification's increased volume can be both prohibitive or an opportunity depending on the cost of the dry materials used and their benefit to the re-use or disposal method.
- mechanical separators - liquid manure can be dewatered using pumps, screens, filters, thickeners, and centrifugal separators and other devices to increase the solids content of the manure. These system can process large volumes quickly but can involve significant capital, operational and maintenance costs.

For the other four targeted biomass feestocks (Animal Residuals, Food Manufacturing, Food Service and Pulp and Paper) landfilling has been the historically dominant disposal technology for their solid waste. Waste providers have hauling and disposal infrastructure in place, although recently alternative disposal methodologies have been used, including the following:

- Incineration - materials can be incinerated to reduce the volume and control pathogens.
- Composting (on-site and off-site) - composting is now well-established, and an increasing variety of large and small scale composting technologies are available in the marketplace. Around the country, food waste generators such as food manufacturing facilities, food processors, grocery stores, and restaurants are evaluating composting service providers, on-site composting, or small scale in-vessel compost systems.
- Land Application (on-site and off-site) - a large number of animal and food processors land apply at least part of their residuals. Permitting is done at a district level on a company-by-company basis dependent on the material composition and guidelines.
- Animal Feeding and Rendering - animal and food residuals are fed to animals in a variety of forms. Food that has not been in contact with or does not contain meat or meat by-products is exempt from federal regulation and can be fed to cattle and swine with no processing. Other animal and food waste must meet requirements of the 1980 Federal Swine Health Protection Act, which requires meat and meat by-products to be cooked at 212 degrees Fahrenheit for at least 30 minutes.
- Sewering (typical as liquid residuals) - where wastewater treatment facilities exist or sewer charges are not prohibitive, liquid residuals can be directly sewered or solid materials can be diluted and then added to sewer discharge for processing and disposal. In some cases this may even be desirable, for instance where a cellulose laden industrial stream can be combined with a nitrogen laden residential or commercial stream, thereby increasing the effectiveness of the biological activity and steps at the treatment facility.

Landfilling has evolved in recent decades to become somewhat more of an environmentally responsive method, as double composite liner systems, leak detection and similar modern landfill design techniques have been required through more stringent regulations. This has resulted in fewer but larger landfills that function more as regional disposal centers, often serving more than one state. Incineration technology grew significantly a couple of decades ago when landfill

practices were first acknowledged to be inadequate to protect the environment. Market penetration by incineration systems was significant, especially in more urbanized areas. Regulatory pressures were then exerted both on landfills as well as on incinerators in order to protect the environment. Incineration systems were expanded to include energy recovery in order to improve the financial and environmental performance of these systems while still incorporating best available technology for emissions controls. However as incineration has proven to be more expensive than anticipated its share of the waste stream has fallen and landfilling has picked up most of the slack.

Waste Management Service Providers

Even a technology like the Biomass/Cogen's CCI/BTA process, that is assumed to be technically and economically feasible, still has many challenges in gaining market share within the State of South Carolina. These challenges primarily center on acquiring the required raw material stream. Generating material flow to the proposed facility in an environment that is effectively dominated in the animal manure case by current "zero" cost disposal parameters, or with regard to the other targeted biomass waste streams by large waste hauling/landfilling companies and/or very restrictive franchise requirements, requires careful selection and development of opportunities. Several factors in South Carolina have reinforced this situation. They include:

- **Population** - As seen previously the population growth in South Carolina and the adjoining SERBEP region has been consistently increasing in density in and around the urban and rural regions. This trend will effectively increase overall waste generation and also create opposition to landfill siting and CAFO disposal effects on water, land and air quality. Additionally, statewide geological characteristics may make it very difficult to site new landfills or CAFO sites without alternative disposal methods. Together, these factors make new landfill and CAFO development very expensive to pursue, difficult to site and costly to build and operate.

- Privatization - For the past decade, government agencies throughout the United States have struggled with tax base issues that frequently have resulted in privatizing what had previously been publicly operated waste management systems. Collection routes were sold, landfills and incinerators shut down, and the services turned over to private sector companies. Tougher environmental regulations, especially on landfills and incinerators, contributed to this push towards privatization. In some parts of the country this trend is already in advanced stages of maturity, whereas other areas are still exploring privatization options. Some believe this to be a cyclical trend that will eventually shift back to more public sector operations if private sector industry consolidation continues and if price increases result. As a private sector service provider, the Biomass/Cogen facility should be able to tap into this privatization trend towards higher pricing.

- Private Sector Rationalization - Reductions in the number of publicly operated disposal facilities contributed to a larger trend of consolidation of the collection and disposal system into a few private firms with large market shares across the country. Twenty years ago, Waste Management, Inc. was the first to start the trend, quickly followed by BFI, Laidlaw as well as a host of smaller players powerful in some regions of the country. These firms acquired smaller haulers and owners of single landfills and also grew by taking public programs. This trend entered its advanced stages when entities began to struggle with how to be profitable once the acquisition push began to slow.

- Bigger is Better - One natural consequence of the rationalization and privatization trends in the solid waste management environment is that the bigger companies acquire the smaller companies and larger private facilities generally replace the services provided by smaller public facilities. Frequently in the name of efficiency, efforts are consolidated, staffs reduced, and energies concentrated in focal areas. The larger waste management

companies have pursued this approach quite aggressively in the landfilling business all over the country.

- Increasing Tip Fees - Ten years ago, many predicted landfill capacity shortages and steeply increasing landfill tipping fees that were already showing up in the marketplace. The expected shortage was avoided as landfills secured additional capacity at a faster rate than projected and as recycling and composting diverted waste from landfills. The result has been that the remaining landfills have been competing for waste resulting in lower tipping fees. However, the consolidation and rationalization of the industry (as described above) is expected to reduce competition and result in a return to a gradual escalation in tipping fees. With the current pricing structure, it is unlikely that rates will drop for any significant amount of time.

- Private Waste Management Corporations Shifting Away from Recycling - One of the major impacts of the mergers is a re-evaluation by private sector waste haulers of their commitment to diversion programs (both recycling and composting). The leadership of both mega-companies maintains a operating philosophy that these recovery activities are not core businesses, that they impair company operational and financial performance, and that they should be divested. This leaves significant business opportunities for firms that are recycling, composting or reusing wastestreams, particularly hard to handle waste streams like the targeted biomass residuals.

Ultimately, a successful facility development requires that the developers take advantage of specific "holes" in the marketplace that allow the necessary organic waste stream to be brought to the proposed facility. This will occur if the Biomass/Cogen developers are able to exploit one or more of the following marketplace opportunities or "holes" in service.

- A large generator or industry that controls its own waste stream, and would see a benefit to the targeted waste stream being diverted from their landfill resource.
- A small hauler with no landfill resources that has the capability to direct its waste to a facility with preferential tipfees
- A City or County who is trying to increase recycling by extracting organics from the waste stream either by source separated collection or removal of organics,
- A recycling facility that is trying to increase its throughput
- A facility operator that has a stream of material available that would like to increase recovery of material, so as to be able to attract larger accounts.

All of these market forces build complexity into the process of siting and developing a Biomass / Cogen facility, and require proper engineering, permitting and business planning.

Waste Management Costs:

Waste management costs are typically the total costs associated with a municipality or to a company to handle, manage and dispose of their wastes. If the management of wastes involves only disposal of the wastes, then tipping fees at the landfill site are the major concern. Recognizing the long term environmental effects and costs of just disposing of wastes has led to government legislation to control how much and what type of wastes are to be permitted to be disposed of at disposal sites. This legislation, over the past decade, has been successful in reducing the quantities of waste being disposed of at landfill sites but has also increased waste management costs in some well regulated regional areas. The public sector as part of its regulatory responsibility typically has some responsibility to approve waste disposal sites for the private sector.

A critical factor for siting and successfully operating a Biomass/Cogen facility is the regional waste disposal tipfee structure. In some circumstances, tipfees in SERBEP urban areas can range as high as $80 - $95 per ton. Therefore there are a number of regional opportunities that are available for

exploitation. Landfill disposal costs provides one of the best summaries of the economic opportunity for siting a Biomass/Cogen facility in the state of South Carolina. Appendix A provides a list of the South Carolina's landfills and Material Recovery Facilities, as well as the top 25 landfills for the whole SERBEP region. For the whole SERBEP region, a diskette has been provided that provides the entire SERBEP region's database with all available applicable information. Table 1 provides the average tipping fee for all landfills in a given area and the expected lowest competitive cost for waste hauling for distances from the Linpac Cowpens, South Carolina site. This average includes all the very small rural landfills or landfills permitted for very limited waste types. It is likely that the costs provided using this average is the lowest competitive cost, since these landfills likely cannot take the targeted Biomass/Cogen feedstocks.

Table 1: Average Landfill Tip Fees

Average Tip fee	SERBEP Only	Entire US
Within 300 miles	$25.72	$24.93
Within 600 miles	$27.47	$26.78
Within 900 miles	$27.06	$28.57

Note that the average tip fee calculation for SERBEP and the entire United States is heavily influenced by the large number of rural landfills. However, Appendix B provides a regional landfill tip fee mapping based on tip fee cost, showing the average tipping fee charged in regional areas. This mapping shows that although the averages for all landfills is in the $24 - $29 per ton range, there are areas that have far greater landfill tipping fee costs. Table 2 provides the SERBEP region's State landfill tipping fee's averages. The average developed on a State by State basis, where each State's tipping fee average counts as one figure no matter how many landfills are present in the State and so represents the cost of a region, provides for an average tip fee of about $30 per ton as reasonable to achieve when the procurement is from the southern SERBEP States. The Biomass/Cogen facility will actually be competitive with the higher cost landfills as they are the ones that can handle wet wastes and the targeted biomass residuals.

Table 2: SERBEP Region Tip Fees*

Number of SERBEP landfills Used	Average Tipfee
Alabama	$28.64
Arkansas	$22.66
Florida	$42.83
Georgia	$42.83
Kentucky	$27.31
Louisiana	$20.06
Mississippi	$20.26
Missouri	$27.36
North Carolina	$32.50
South Carolina	$27.27
Tennessee	$28.97
West Virginia	$42.98
State Regional Average	$30.31

**Note: Weighted average by State, with each State average counted equally*

Since Cowpens, South Carolina is at the northern edge of the SERBEP region, and since the Cowpens site is along the I-85 corridor, the potential to reach into higher tipping fee regions in northern Non SERBEP states exists. Table 3 provides the Non SERBEP region's State landfill tipping fee averages. This data suggests that tipping fees at an average of $40 per ton are reasonable to achieve, with higher tip fees when competition against landfills that can dispose of the targeted wet biomass residuals is realized.

Table 3: Non SERBEP Region Tip Fees*

Number of Non SERBEP landfills Used	Average Tipfee
ILLINOIS	$28.50
INDIANA	$30.73
MICHIGAN	$31.98
NEW JERSEY	$61.76
NEW YORK	$56.34
OHIO	$30.39
PENNSYLVANIA	$49.12
VIRGINIA	$38.27
State Regional Average	$40.88

**Note: Weighted average by State, with each State average counted equally*

Recycling of some of the waste stream has always taken place especially as higher value items like metal and some types of paper have been "cherry picked" on the trash routes. This core recycling activity led to diversions in the 10 to 15 percent range nationwide. Only in the last two decades has recycling re-use moved beyond these economic constraints and reached towards the 30 percent level as more innovative ways have been found to 1) divert material from the waste stream, 2) pay for the additional costs of that diversion; and 3) use the material as a feedstock in new product manufacture. Parallel trends developed in organics management as more and more sophisticated systems have been developed to divert the compostable waste stream and process it into marketable organic products.

Current trends show recycling/re-use's market share to be holding its own or dropping slightly. Recycling/re-use will be taking market share primarily from landfilling with a much smaller amount from incineration or other disposal methods. Linpac CCI/BTA technology, with projected tipping fees that are at or below current and future regional landfill tipping fee costs, will fare well on an economic basis in this market share competition. The Biomass/Cogen facility's capability to take problematic biomass wastes, such as wet or liquid wastes, should increase the recovery of regional animal manure and biomass waste. In order to successfully capture necessary waste streams this economic advantage must be matched with clever raw material collection strategies and an aggressive raw material procurement program that will allow the lower tipfee to become a deciding factor over the strong infrastructural bias in favor of the status quo.

Conclusions

As noted throughout the report there are several barriers that will need to be overcome in order to successfully develop a BTA facility. But there are also a number of advantages that make this task easier as well. In addressing the current waste management infrastructure and practices for disposition of animal manure and the related biomass wastes targeted, the following conclusions based on the barriers and opportunities for the Biom ass/Cogen facility development are noted:

Barriers:

- Many animal manure and related biomass waste generators currently do not pay a tip fee to dispose of their wastes, and are use to "zero" cost economics.
- Transportation costs present a large challenge in moving highly wet material such as animal manure or other wet biomass wastes long distances
- Some competing end uses for organics are highly value-added (secondary processing of slaughterhouse animal residuals for example)
- Generators of biomass food waste in the food service sectors can be relatively small volumes and very decentralized, requiring a good procurement program.
- Food biomass waste in the food service sector is generally not source separated, but rather commingled with other solid wastes (paper, plastic, metals, etc.)

Opportunities:

- Changing regulations may serve to assess disposal costs directly to the industry, and encourage disposal alternatives for organic wastes, particularly animal manures, as a cost effective alternative.
- Animal manure, animal residuals, food manufacturing, food service and Pulp and Paper biomass wastes are relatively homogenous and contaminant free.
- Animal manure waste represents a huge generated volume, and even with very low percentage recovery or capture rates the available manure is vary large.
- Food processing wastes are generated by a relatively small number of large producers

- High landfill/incinerator tip fees in certain regions may encourage the food manufacturing, food service and Pulp and Paper industries to separate organic wastes specifically for the biomass/Cogen facility as a disposal alternative.
- The concentration of certain biomass feedstock types and organic materials in certain regional areas provide an excellent opportunity for recovery alternatives.

Development of an appropriate strategic vision is necessary with regard to obtaining the organic raw material stream and accomplishing a successful animal manure and biomass feedstock procurement effort that works in compliment to existing waste management infrastructure.

Appendix A
South Carolina Landfills and MRFs

Appendix B
Regional Landfill Tip Fee Cost Map