UNIVERSITY OF GEORGIA BIOCONVERSION CENTER

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ABSTRACT

The University of Georgia began development of a comprehensive Composting and Bioconversion Center in 1995. Salient guiding principles in the development of the laboratory were 1) adequate space for processing samples and for doing pilot scale demonstrations which can be easily cleaned and is well ventilated; 2) suitable environment for sophisticated analyses equipment; 3) balance needs for proximity to main office coupled with reality that some processes must be secluded due to odor and further waste handling. The center has evolved to include a 1200 square ft building on the UGA campus equally divided between sample prep and analyses for bench scale studies (Phase 1). Additionally, a Phase 2, 12 acre site 7 miles from campus has developed into a 3-acre windrow pad, 7000 square ft classroom/demonstration building with intermediate scale bins and sample prep area, a 3500 square ft building for new products/value-added research was recently completed. A 4 acre land application system for site runoff is nearing final permitting and completion. The paper will address how the guiding principles were applied to develop the facility. Some specific shortcomings in the design and resulting "work arounds" are discussed.

DESIGN PRINCIPLES

The UGA Bioconversion center was developed in four phases through the Georgia Environmental Technologies Consortium. The UGA bioconversion center was envisioned to facilitate aerobic composting process design for municipalities and industries, facilitate the study of innovative approaches such as anaerobic composting and pyrolysis, enable investigation of pre/post processing operations associated with composting, enable investigation of air quality issues associated with solid and liquid waste and serve as an education and demonstration center. The following design principles were applied:

1. Facilities should have convenient access to the UGA campus.

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2. Sample preparation areas are as important from a size point-of-view as is clean analyses grade space.

3. Composting can be odiforus due to input stream storage and process itself. Only bonafide composters smell "green" around compost.

4. All facets of the bioconversion operation must be done within the local, state and federal regulatory framework.

5. Adequate space for preprocessing and value added postprocessing is important.

6. Educational outreach is a significant portion of the UGA bioconversion mission.

PHASE 1

Phase 1 consisted of renovating an existing 1200 ft^2 butler style building shown in Figure 1. This building is on the UGA main campus. The sample prep area, approximately 600 ft^2, is heated and ventilated but not air conditioned. It provides space for ovens and furnaces. Bench scale compost bins shown in Figure 2 are also located in the sample prep area. The phase 1 facility is very convenient for researchers doing bench scale recipe development and other process development. Prototype bioreactors for air quality control approach evaluation are examples of other prototype equipment which are located in this facility.

The clean analyses area provides space for gas analyses, and other analyses basic to compost research such as density, maturity, stability and related determinations. Figure 3 shows the gas chromatograph and other gas analyses equipment.

The Phase 1 building essentially satisfied design criteria 1 and 2. Criterion 3 was satisfied in that the bench scale produced relatively few odors (mainly associated with the furnaces) which were isolated from other campus activities. The Phase 1 bench-scale testing and evaluation facility operates with environmental constraints similar to those of ordinary campus chemistry/biology laboratories.

PHASE 2

The University of Georgia Phase 2 bioconversion facility was envisioned to provide additional research, demonstration and education capability. Composting recipes developed in the Phase 1 facility are scaled up to prototype levels, requiring substantial amounts of materials. The Phase 2 facility is permitted as a solid waste handling facility under the Georgia Environmental Protection Division (Ga EPD). The solid waste permit is a permit by rule, requiring that 75% of the material on site originated from the University of Georgia. The center piece of the permit application is the design and

development report. The requirements for this report are given in Appendix A. Appendix A provides the format for the design and development report needed in Georgia for composting operations.

Phase 2 complied with the solid waste permit requirement by partnering with the University of Georgia Grounds Department, who have an extensive campus yard waste composting operation. The UGA grounds department had moved their composting operation twice in the last five years due to campus expansion.

Under Ga DNR rules, any facility which handles food waste, biosolids or animal manure (in a commercial nonfarm environment) must dispose of runoff in an acceptable manner. This necessitated collection of the runoff and disposal in an approved land application system (LAS). The Ga EPD water division oversees LAS operations. Thus, Phase 2 was required to be in compliance with solid waste and water permits.

An overview of the Phase 2 facility is shown in Figure 4. The general location was 1 mile from housing developments and was surrounded by forests on two sides. Adequate water and power were available. Excavation requirements were minimal. The site was easily accessible. The main road was somewhat of a disadvantage in that many UGA administrators and USEPA Region IV personnel pass by the facility on a daily basis. Thus, all on-site irrigation and other water management activities must be done "by the book." Since the photograph in Figure 4 was taken, additional vegetation has been planted to serve as a site buffer. Many existing trees which were to have served as buffer vegetation were removed by the contractor in spite of extensive precautions to the contrary.

A research facility with a clean analysis area of approximately 1500 ft^2, a sample prep/bin composting area of approximately 4000 ft^2, a class room of 1000 ft^2 and 200 ft^2 office space serves as the Phase 2 headquarters. The bin scale composting area consists of 4 bins which enable compost systems research. Each bin (see Figure 5) is underlain by a drain. Bins may also be aerated. Studies have been completed wherein fans were temperature controlled. The bins are isolated from other parts of the prep area by a plastic curtain which gives some odor control. A ventilation system which removes air from the bin area to an adjacent biofilter is in place. The sample prep area has enough room for small front end loaders to maneuver when removing material from the bins, mixing it and returning material to respective bins. There are adequate floor drains and ventilation. Doors are equipped with air curtains. The space has heating and air-conditioning capability. Small windrow pads represent the logical scale up for many projects of interest to municipalities. The UGA facility has 6 concrete lined and drained pads such as shown in Figure 6. These pads are located adjacent to the research facility and may be aerated with small blowers.

The clean analyses component of the research facility serves the same purpose for the prototype scale up research as did the corresponding space in Phase 1. It is envisioned that activities in Phase 1 may be moved to Phase 2 due to campus expansion in the future.

The class room is equipped with tables for 25 students. The class room windows are equipped with drapes for light exclusion, needed for slide presentations. Flourescent lighting is provided for the classroom. However, the lights are "all or nothing." In retrospect a variable intensity light source enabling some lighting during presentations for note taking would have been helpful.

The University grounds department uses a 3.5 acre windrow pad (see Figure 7) for campus yard waste composting operations. The pad is a packed clay with crusher run rock liner. Grounds department personnel cooperate with researchers in finding ways to accelerate the composting process. A yard waste windrow requires as much as 9 months to compost when left unattended. Introduction of some animal manure for C/N ratio adjustment, moisture adjustments and introduction of air using static pile approaches have been jointly investigated with promising results.

Because food wastes, animal manures and biosolids were contemplated as amendments to the yard waste on the 3.5 acre pad, site runoff had to be disposed of in an acceptable way. The site was not sewered nor was there a nearby waste treatment plant. Therefore the only option was to land apply the runoff in the adjacent forest.

Land application system design and approval requires a length process involving preliminary inspection by Ga EPD regulators, preparation of a detailed irrigation system and land application design development report requiring extensive site physical and chemical characterization, development of an approved operation and maintenance manual with scheduled water and soil sampling. The process includes a public comment period. The catchment pond is shown in Figure 8 and a photograph of the land application system is shown in Figure 9. The LAS is a 4 acre solid set system with distribution laterals lying on the soil surface. The entire 4 acres may be irrigated or one may divide the system into two 2 acre sites. The system includes a warning horn which sounds for 2 minutes enabling anyone in the area to leave before water application begins. The operator of record of any LAS facility in Georgia must have a Class III biological treatment plant operators license.

The University grounds department purchased a small hose-towed irrigation system for irrigating the windrow pad area shown in Figure 4. Experience has shown that significant portions of the runoff may be reapplied to the compost windrows during dry weather. Reapplication has little effect on the design size of the catchment pond because the pond must hold surplus water falling in wet months (typically winter).

A second 3500 ft^2 building, the value added processing facility, is shown in Figure 4. Foundations and required utilities for a pelletizer, twin screw extruder, thermal press and vacuum drier were included. This mission is currently under development and the equipment is being ordered.

DESIGN SHORTFALLS

The primary goals and design principles are well satisfied with the UGA design. In retrospect, the system should be somewhat more secluded than it is. Excellent natural buffers were removed

during the construction period.

The sample prep/bin composting area in the primary facility is too small. There is not room to turn the bins and maintain stockpiled materials. Conduits for data loggers have been added. Drainage from the external concrete windrow pads and from the interior bins was originally pumped directly to the irrigation pump well, turning it into a septic tank. This line was subsequently diverted directly to the runoff catchment pond. In systems where there was no surface water catchment, one should anticipate an additional septic tank with debris traps.

In retrospect, partnering with a municipal treatment plant would have been highly desirable. In our case the research mission precluded such partnering. The water permit is expensive to manage due to the sampling and record keeping required. The irrigation system requires frequent maintenance due to broken and clogged sprinklers. Falling limbs and debris are problems. Proper winterization is essential. The catchment pond was not originally designed with a liner and had to be retrofitted after failing a seepage test. The LAS system cost about 20% of the entire project cost. The LAS system accounts for most of the ongoing sampling and monitoring expenses.

Figure 1. Phase One Bioconversion Facility located on the UGA Campus

Figure 2. Bench scale compost barrels located Facility located on the UGA Campus in Phase One sample preparation area

Figure 3. Analysis area photograph showing a gas chromatograph for analyzing off gases from the bench scale composting apparatus

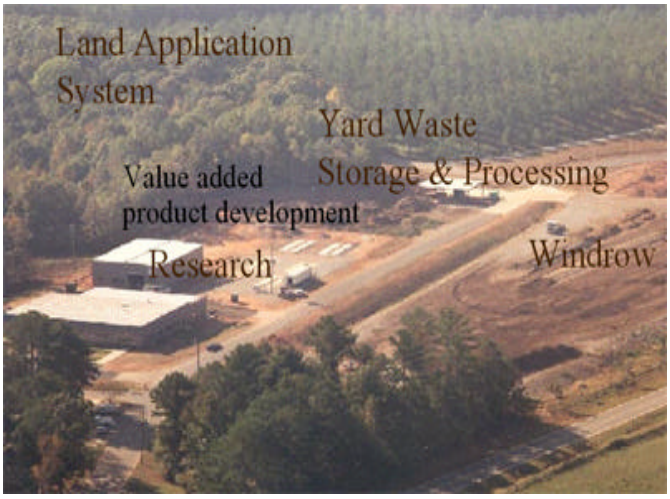

Figure 4. Aerial view of the University of Georgia Phase 2 Bioconversion Laboratory

Figure 5. Photograph of two of four compost bins showing the drainage/aeration system. A mixture of wool waste and cotton gin trash is shown in the bin on the right.

Figure 6. Concrete lined prototype windrow Pads adjacent to the research facility. The drain empties into the leachate pond (see Figure 4).

Figure 7. Windrow of yard waste compost with a windrow turner in the background.

Figure 8. Photograph showing the runoff catchment. The structure in the front is the water intake.

Figure 9. Photograph of land application System showing control valves and warning horn.

Appendix A

Georgia EPD SOLID WASTE PROCESSING DESIGN AND OPERATION PLAN

Supplemental Data for Solid Waste Handling Permit

The Design and Operation Plan should be developed only after EPD has received written zoning approval from the applicable governing authority. The approval letter should specifically reference the process. EPD staff will make an on-site investigation as part of the design review procedure. The following format is to be followed. The information and data listed below are minimum requirements for inclusion in the plans. Additional information and data may be required depending upon the specific facility and waste received.

General

Sheet dimensions of the location map, site design sheet, and detail plan of the facility should be 24" X 36". Sheet size is not to exceed 30" X 36" nor be less than 24" X 30". Each of these sheets in the plan are to be the same size using a title block.

Plans are to be prepared by a professional engineer registered in Georgia. The engineer's stamp must be placed on each sheet of the plan.

Submit two (2) copies of the Design and Operation Plan for initial review. Six 6) copies of the Design and Operation Plan are required when the plan is approved.

Format

I. Title Sheet
   A. Location Map
      1. Minimum 5 mile radius from site
      2. DOT County Map or equivalent: Map should be updated through local reconnaissance. Show north arrow.
      3. Direction of stream flow
   B. Official name of processing operation
   C. Table of contents
   D. Responsible official: Title, address and telephone number
   E. Property owner: Name, address and telephone number.
   F. Consultant: Name, address and telephone number

II. Site Design Sheets
   A. General/plan criteria
      1. Scale: 1 inch = 100 feet
      2. Include a scale line
   B. Indicate north arrow
   C. Property lines: Show bearings, lengths and include a written property description.
   D. Existing site topography: Must extend at least 50 feet beyond property lines
      1. Identify all existing physical/land features
      2. Contour interval: Two (2) feet unless another interval is approved by EPD
   E. Facility layout
   F. Limited access to facility

III. Detail plan of the facility (Detail drawings for shop fabrication and field construction are not necessary)
   A. Facility Layout
      1. Receiving area;
      2. Pre-processing storage area;
      3. Location of processing equipment;
      4. Residue storage area and containers;
      5. Drainage system discharge for wastewater, surface run-on and run-off - include profiles, if necessary;
      6. Location of fire control equipment; and
      7. Vehicle and equipment cleaning area.

   B. Schematic drawing of equipment showing the flow of waste through the processing equipment. Label each part of the process.

IV. Narrative
   A. Description of incoming wastestream(s)
      1. Sources, types, and the weight or volume of each wastestream to be processed.
      2. Compositional estimates - % of liquid/waste constituents, inerts, etc.
      3. Special environmental pollution or handling problems associated with

wastestream.

4. Verification that incoming waste is not hazardous, if necessary.
5. For special solid waste (waste accepted for processing from facilities located outside of Georgia), waste analysis plan as required by Section 391-3-4-.10(c) of the Solid Waste Management Rules.

B. Storage and containment

1. Storage capacity of facility (cubic yards)
   a. Receiving area;
   b. Pre-processing storage; and
   c. Residue storage area and containers.
2. Containment of waste

C. Transportation of waste to facility- Chain of custody procedures for special solid waste.

D. Processing of waste Operating parameters, end use of processed material, design and construction of processing equipment.

E. Disposal of waste residue

1. Containment, handling and removal of residue from facility.
2. Treatment and disposal of wastewater.
3. Method for ensuring solid wastes pass the Paint Filter Test.
4. Transport of waste residue to disposal facility
5. Name, location and permit number of facility disposing of waste residue.
6. Disposal of rinsate from vehicles and storage tanks.

F. Contingency plan and emergency procedures

1. Procedures in response to fires, spills, explosion or equipment failure at facility.
2. Listing of all emergency equipment and spill containment equipment.
3. Include a statement to the effect that type and quantity of fire suppression equipment will be installed per directions of the local fire marshal, and letter of coordination with appropriate emergency response personnel.
4. Arrangements f or handling waste if storage capacity is exceeded due to equipment failure, fire, explosion, etc.

a. General; and
b. Special solid waste.

G. Supervision and manpower requirements

1.Supervision of facility; and
2.Education and training of supervisor(s) and employees.

H. Closure plan

1.Removal of all containerized waste residue, etc.
2.Removal of contaminated wastewater from sumps and floor drains.
3.Estimated cost of closure utilizing third party and facility not operating with seven (7) days of waste on-site.

I. Other permits

1. Air Quality (EPD);
2. Water Quality (EPD); and
3. Local.

J. Financial responsibility

1. Provide proof of adequate financial responsibility for closure by one or a combination of the following mechanisms: surety bond, trust fund, letter of credit, insurance, financial test (See EPD "Wording of Financial Responsibility" packet).
2. Closure cost

a. Provide a detailed written estimate, in current dollars, for cost of closing facility. Estimate must be equal maximum cost for final closure at any time during the active life of the facility.

b.Name, address and telephone number of the person or office to contact about the facility during closure.

c.Discuss closure cost adjustment for inflation each year facility is in operation or increases in cost associated with permit modifications.

K. Other provisions for special solid waste.

1.Procedure for manifesting special solid waste; and
2.Procedure f or recordkeeping and payment of trust fund fee.

L. Post Closure

1.Include a statement to the effect that upon the decommission of the facility no further monitoring or maintenance will be required.