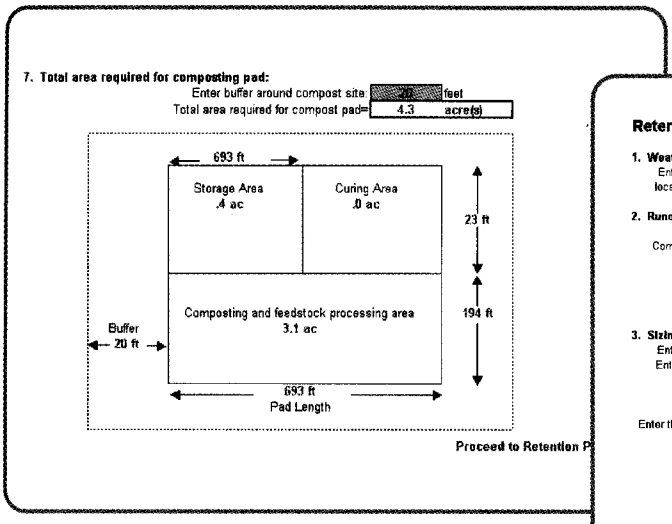

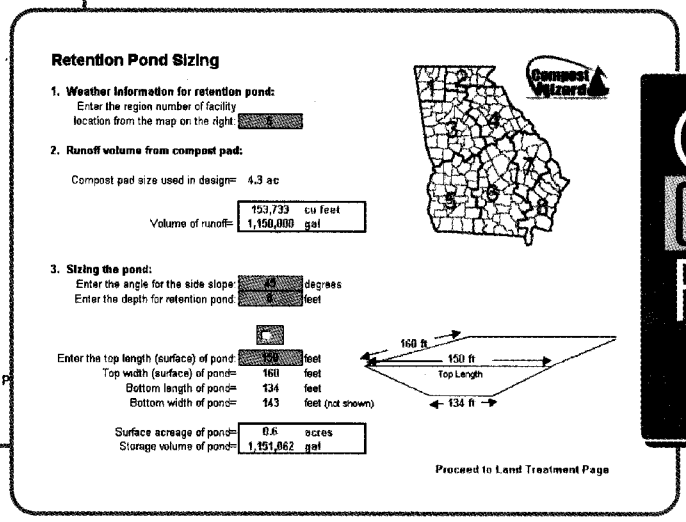

Figure 1. Layout of compost pad (above)
Figure 2. Retention pond sizing (right)

COMPOST OPERATORS FORUM

Modeling A Compost Facility

Engineers at the University of Georgia develop a computer program to address "what if" questions for a windrow composting facility concerning process design, pad size, retention pond and costs.

Jason Governo

PLANNERS, engineers and facility operators are often faced with the challenging questions of how much land, equipment, labor and investments are required for composting. The numerous factors that impact decisions make it tedious to formulate assessments quickly. To address this situation, engineers at the University of Georgia have developed a user-friendly, spreadsheet based computer program that they call Computer Wizard assist in the design of windrow composting operations.

A well-designed commercial operation has seven defined steps: Feedstock recovery, feedstock preparation, composting, stabilization, curing, refining and storing. The Compost Wizard uses a multistep linked process that — based on regulations in Georgia and current scientific recommendations — takes into account these steps to design the composting area, runoff collection pond and land treatment system for a windrow facility. The program includes design algorithms that address the "what ifs" for this type of operation.

Critical user inputs are covered, such as amount of feedstocks, types of equipment, number of workers, and facility location to develop preliminary designs of the composting process. Each design variable has interrelated economic ties to estimate both the required start-up capital and operational costs of the facility. Users can quickly vary inputs and generate many different design scenarios to address site-specific needs and conditions for a particular operation.

Description of Design Process

The design process for a turned windrow composting facility involves five steps: process design, sizing of the composting area, runoff, collection pond, land treatment design for runoff and capital and operating cost estimation. The Compost Wizard was written in design modules, in spreadsheet form within Microsoft Excel. Design modules utilize user inputs and previously calculated outputs for its calculations.

An example is provided of the design comparison of an existing 45-tons/day biosolids composting facility in southeastern Georgia. This facility is located at a publicly owned wastewater treatment facility (POTW).

(A) Composting Process Design

To maintain rapid composting, feedstocks are blended to provide an initial C:N ratio of approximately 30 and a moisture content of 55 percent. The computer program requires the user to input the available feedstock quantities and properties, and target process conditions based on either a continuous or batch operation scenario. The total daily throughput of a facility is calculated, and the user's

manual provides tables that contain properties of many different commonly used feedstocks. These tables assist in the development of the compost process. This version of the Compost Wizard does not include recipe development.

(B) Compost Pad

The compost pad consists of a windrow area in which the active composting process and turning occurs, a curing area in which final stabilization of the product occurs, and the storage area which contains the final marketable product.

The program asks the user for input about windrow height, width and length, process duration time, and estimated volumetric reduction (shrinkage) of the material. With the information, the windrow volume, number of windrows, acres required and a graphical layout of the site are presented. Figure 1 (not to scale) is an example of a graphical layout of the compost pad, as required by the Compost Wizard, for the example facility. All curing is done in the same location by combining windrows so no "extra" curing space is required.

Managers may not choose to physically move the material from one region of the pad to another, however, that material does occupy space that cannot be used for other operations. The size of the curing pad area is based on the curing period and the size of the curing windrows. After the curing process is finished, windrows can either be left in place where they are (curing pad) or moved to another location (storage pad) for storage before end use.

A buffer zone is added around the compost pad as an odor control measure. The more rural an area, the less buffer is usually required. Compost operations located in highly populated areas may need a significant buffer around the pad to disperse any odors and keep down odor related complaints.

(C) Retention Pond

In many states, depending on the type of feedstocks processed, regulations require the collection and treatment of all surface runoff from a compost site. In Georgia, biosolids composting operations not located on site at a POTW requires a retention pond with a capacity greater than the expected runoff from a 24-hour/25 year rainfall event.

Design criterion used in the Compost Wizard for sizing of the retention pond is based on the highest monthly rainfall from a 30-year historical weather data set, which provides a volume greater than that needed for a 24 hr/25-year event. Users select the geographical region of the particular state where the facility will be located. The program then automatically references the 30-year historical weather data for that region and bases the design on the month with the maximum projected runoff in that region. To ensure a conservative design, the volume of runoff is calculated as if all the water that falls on the compost pad area is captured in the pond. The retention pond is then sized to collect this runoff with the user specifying the desired side slope angle, depth and pond surface length.

Although the example facility does not require a retention pond because it can route all runoff back to the POTW, Figure 2 shows the size of the pond needed if the windrow composting operation was located away from the POTW and was required to have one.

(D) Land Treatment

Land treatment systems basically apply the captured runoff water to a designated area using agronomic application rates. Although captured water can be circulated back onto the windrows for moisture, our land treatment design standards are based on regulatory standards and not on management strategies.

Land treatment design is dependent once again on the site-specific 30-year historical weather data for that location. It is assumed that the collected runoff is directly sprayed onto the land; therefore, the acreage required for treatment is controlled by either the hydraulic budget of the soil or the nitrogen balance of the cover crop that consumes the applied nutrients. The larger of the hydraulic budget and nitrogen balance areas is used as the required land area needed for treatment.

(E) Capital and Operating Costs

It is difficult to accurately determine the amount of start-up capital and operating costs required to run the operation. Compost Wizard allows the user to input wages and benefits for skilled and unskilled labor, size and number of equipment, number of windrow turns per cycle, fuel costs, contract work, feedstock, disposal, land and construction costs, equipment replacement and facility insurance. It also produces a cash flow statement using adjustable inputs on tipping fee, bulk product sales, interest rate and loan life. Cost avoidance values are also calculated to illustrate how much could be saved by not disposing organic materials in a landfill.

Calculating all input data, the program balances capital expenditures, operational costs and revenue generation to produce a bottom line cost per ton. This can be compared to other waste management options to determine if composting is cost effective or economically feasible.

Table 1. Comparison of predicted design with actual design at a commercial composting facility

	Design Program Calculation	Validation Case Study	% Error
Total land required, ac	4.3	4.2	+ 2.3
Pond size, ac	0.6	n.a.	–
Land treatment, ac	10.2	n.a.	–
Capital costs, $	225,500[1]	232,887	- 3.2
Operating cost, $/yr			
Maintenance	22,550	14,927	+ 51.0
Total O&M	145,427	118,527	+ 22.6
Processing cost, $/ton	12.87	10.49	+ 22.7

[1]Does not include pond or land treatment costs.

Case Study

The Compost Wizard was validated by comparing the program outputs to the design and operations of the biosolids composting facility cited earlier. This facility composts 35 tons of yard trimmings and 10 tons of municipal wastewater biosolids per day. The total processing time for composting and curing to achieve the level of stability desired is 45 days. The facility is located at the wastewater treatment plant and all the runoff from the site is diverted to the headworks of the plant, therefore no collection pond or land treatment is required. The equipment includes two tractors, a windrow turner, a front-end loader, one small dump truck and two side discharge trail-

ers. Two operators run the facility, which was established in 1996 and was funded from a state grant and a low interest loan.

The results of the program calculations closely match the actual size of the facility, with an over prediction of 2.3 percent (Table 1). Because land was available on the site, and minimal construction costs were involved, total capital costs were predicted to be $225,000, a value 3.2 percent lower than actual costs incurred. The program prediction for operating and maintenance of equipment was $22,500/year, which was 51 percent higher than what the facility reported. Total processing cost was calculated to be $12.87/ton, which was 22.7 percent higher than what the facility reported. It should be noted that the facility is a county run operation, and in the author's experience, costs figures may be underestimated because of sharing resources between county departments. Further validations for various sized windrow composting facilities are also being performed.

Software Availability

In an effort to make the program more available to a larger audience, 18 states with known composting interests were selected for distribution. Since Compost Wizard uses site-specific weather data to calculate both pond and land treatment system size, historic weather data was obtained for each state (Arizona, California, Delaware, Florida, Georgia, Indiana, Iowa, Louisiana, Michigan, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Texas, Virginia and Washington). The states were chosen based on current composting infrastructure.

Ideally, Compost Wizard would custom design each operation using each state's specific regulations. However, this version's calculations and requirements are based on Georgia's present design requirements. Compost Wizard will be available for purchase in August, 2001 at www.compostwizard.com. Questions regarding the program can be sent to: jgoverno@engr.uga.edu. ■

Jason Governo is with the University of Georgia's Engineering Outreach Program based in the Driftmier Engineering Center in Athens. *Estimated cost of the Computer Wizard program is $250. A presentation on the computer program will be given by Governo at the BioCycle Southeast Conference in Atlanta August 27 – 29, 2001.*