Evaluating Biosolids Stabilization Technologies

In southern Florida, lime pasteurization and thermal drying rank high

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In a survey of biosolids stabilization technologies, lime pasteurization and thermal drying emerged as the top ranked methods. Composting ranked last overall, primarily because of siting considerations.

Composting, thermal drying, and alkaline stabilization were considered in the study.

Alternative systems to the marketability of biosolids from several Broward County, Fla., wastewater treatment plants were evaluated. Nine systems encompassing three Class A pathogen-reduction technologies—alkaline stabilization, thermal drying, and composting—were evaluated at system capacities of 39, 72, and 105 dry Mg/d (35, 65, and 95 dry ton/d).

The relatively high cost of all Class A alternatives suggested that continued use of the current Class B land application systems, with added safeguards to improve disposal reliability, should not be ruled out.

System implementation options also were evaluated. Public ownership was preferred over private ownership. However, design, construction, and operation by a single private contractor appeared more favorable than the conventional project delivery approach.

This study was performed to evaluate alternatives for a regional system which would further process and market residuals from several Broward County wastewater treatment plants. Treatment plants located in Davie, Fort Lauderdale, Hollywood, Margate, Pembroke Pines, Plantation, and Sunrise were included as potential participants in the regional system.

All of the wastewater treatment plants included in the study area currently rely upon private contractors to use their biosolids on agricultural land. Concerns over this use method have increased in recent years as growing urbanization in southern Florida has diminished the amount of local agricultural land and increased hauling distances for agricultural application to 110 to 160 km (70 to 100 mi) or more.

Adding to these concerns was the threat of new, more stringent federal regulations (40 *CFR* 503) that were under development at the inception of the study and later promulgated. As a result, the long-term future of agricultural application was considered uncertain at best.

At the same time, technologies have evolved for developing biosolids that are suitable for urban area distribution and marketing. Implementation of one of these technologies was considered a potential solution to increase the reliability of biosolids marketing in urban southern Florida. Moreover, the economy of scale of a large regional system could increase the cost-effectiveness of these technologies.

The uncertain future of agricultural application coupled with the availability of promising alternative technologies prompted this study. The goals of the study were to identify a preferred technology for the regional facility, taking into account both monetary and nonmonetary factors, and to outline an implementation strategy. Based on a technology assessment performed for Broward County by others, only proven technologies that could meet Class A pathogen reduction requirements under federal rules were evaluated, including alkaline stabilization, thermal drying, and composting.

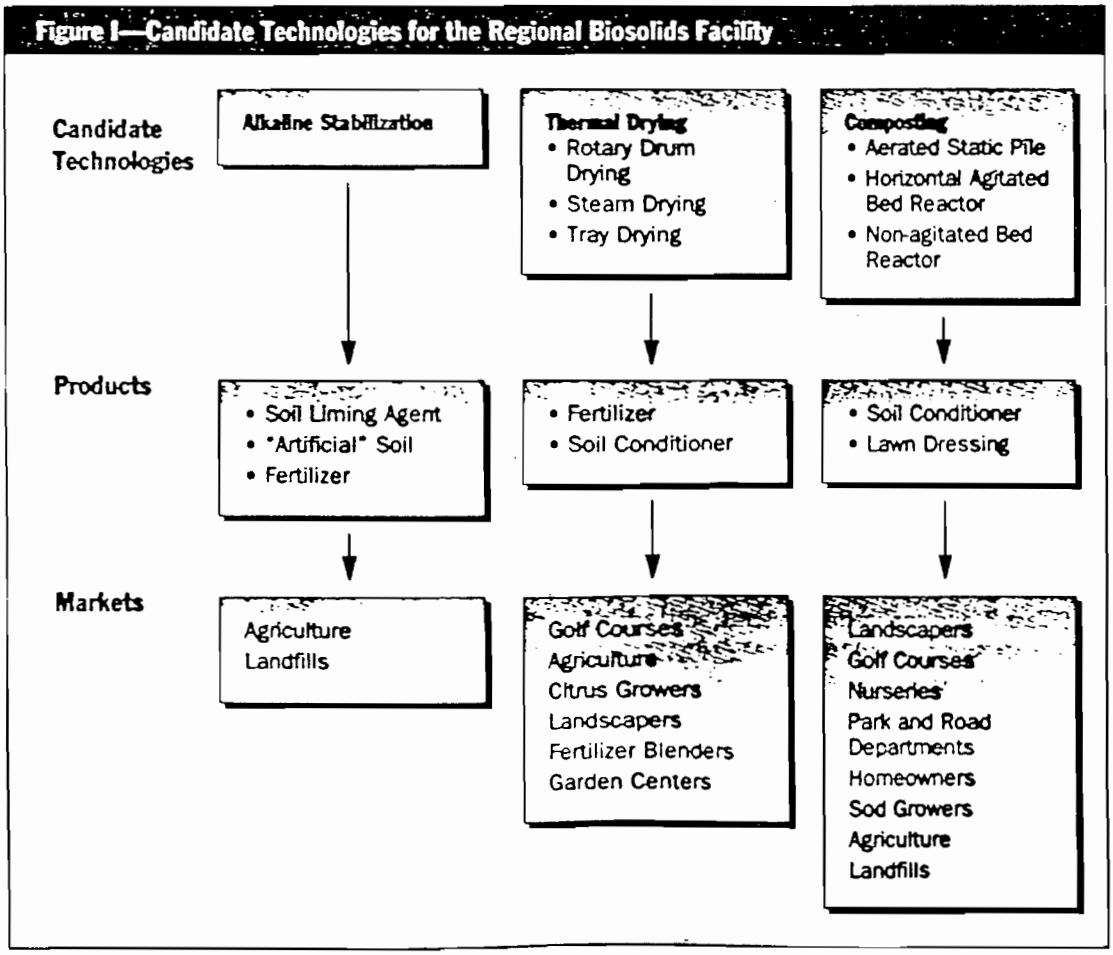
RESIDUALS PRODUCTION

Residuals quantities were estimated separately with a spreadsheet model for each wastewater treatment plant through the year 2020 on the basis of service area populations or flows, influent wastewater characteristics, and treatment works process considerations.

The annual average projected solids quantities and contents were projected for each wastewater treatment plant through the year 2010. Because it was not known which treatment plants might actually participate in a regional system, three different facility sizing scenarios were selected from the quantity projections. The design capacities selected were 39, 72, and 105 dry Mg/d (35, 65, and 95 dry ton/d).

Siting a regional solids-processing facility in an urban area is a major consideration in itself, particularly when the facility cannot be located on the site of an existing wastewater treatment plant as was the case in this project. The only two

Figure 1—Candidate Technologies for the Regional Biosolids Facility



potential sites identified in Broward County were an abandoned Fort Lauderdale compost plant and vacant property at a county landfill.

The estimated land area requirements for each of the technologies under consideration over the potential range of design processing capacities demonstrates the relative land-intensive nature of composting and the cement kiln dust process, which incorporates windrow drying. For this study, the estimates showed that the abandoned compost plant site was not large enough for any of the technologies other than thermal drying or lime pasteurization.

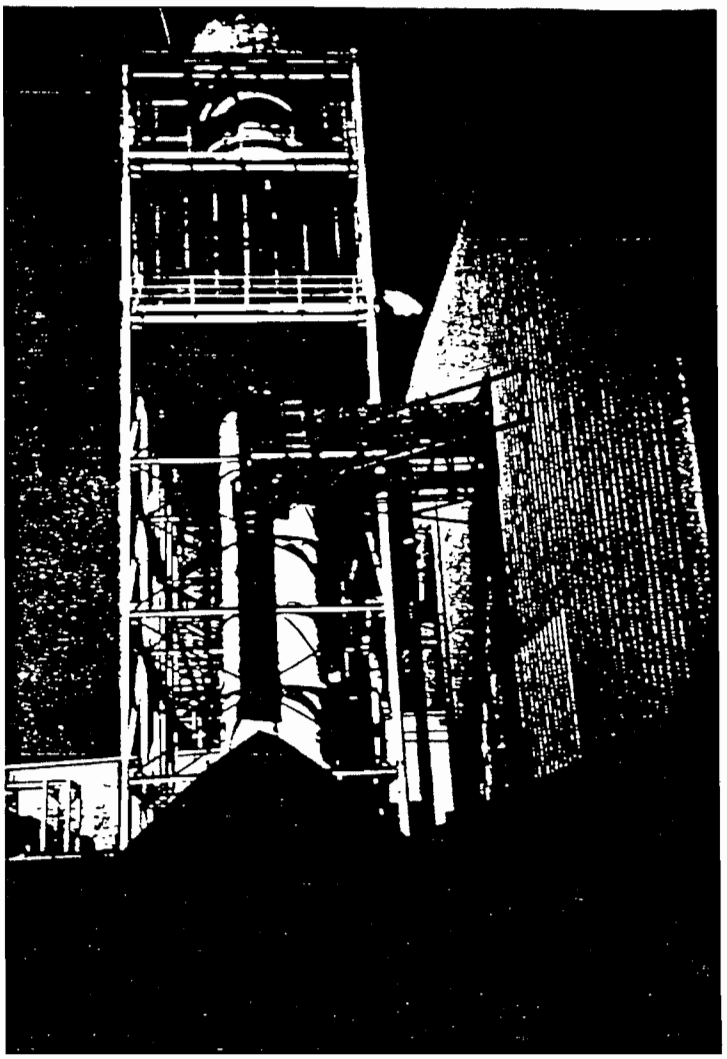
EVALUATION OF BIOSOLIDS MANAGEMENT ALTERNATIVES

Nine alternative conceptual designs, incorporating various proven proprietary systems, were developed around the three technologies of alkaline stabilization, thermal drying, and composting (See Figure, *Candidate Technologies for the Regional Biosolids Facility*). Brief descriptions of each system are given below.

Alkaline stabilization. This process uses elevated pH and temperature to produce a stabilized, disinfected product. The two alkaline stabilization systems evaluated were a lime pasteurization system and a cement kiln dust pasteurization system. The lime pasteurization product has a wet-cake consistency, while the kiln dust pasteurization product has a moist soil-like consistency. In this study, both products were assumed to be transported to agricultural areas for ultimate use. The kiln dust product was assigned a value of $6.60/Mg ($6.00/ton) to offset hauling costs, while the lime product was assigned zero credit for product revenue.

Thermal drying. This process uses heat to force moisture to evaporate from the solids and produces a dried, pathogen-free product suitable for beneficial use. Two rotary drum drying systems and two steam drying systems were evaluated. Thermally dried product is in the form of small granules or pellets. In this study, the product was assumed to be marketed in bulk to users such as golf courses and citrus growers, which currently use similar products primarily imported to Florida from other states. Thermally dried product was assigned a value of $44/Mg ($40/ton), which included a deduction for marketing and distribution costs.

Composting. The composting processes evaluated utilize a mixture of solids and yard waste under controlled environmental conditions to produce a disinfected, humus-like product. The three composting systems evaluated included a horizontal agitated reactor, a horizontal nonagitated reactor, and an aerated static pile system (nonproprietary).



A regional facility such as this one would offer advantages to participating cities, but at higher cost.

Compost would be marketed as a soil conditioner in and around Broward County in competition with such products as peat, soil, and mulch. A market study conducted for Broward County by others indicated that, although a large potential market exists, significant effort would be required to penetrate this market. Yard waste revenue of $6.50/m^3 ($5/yd^3) and product revenue of $2.00/m^3 ($1.50/yd^3) was assumed for this study.

COMPARISON OF ALTERNATIVES

The alternatives were compared on the basis of both quantitative and qualitative factors. Quantitative factors included capital cost, annual operation and maintenance costs, total 25-year present worth, and land requirements. Qualitative factors included public acceptance, reliability, flexibility, operability, and product marketability.

To compare the alternatives, a numerical classification system was developed wherein both sets of factors were indexed on a scale of 1 to 4 and then multiplied by the weighting factors to reach the final point totals.

Results. The lime pasteurization alkaline stabilization system and a steam drying system ranked the highest. The lime stabilization system achieved its high ranking through low capital costs and favorable ratings with respect to process reliability, flexibility, and operability. The main disadvantage attributed to this system was questionable product marketability because of the uncertain availability of suitable agricultural land.

The steam drying alternative achieved its high ranking through small facility land requirements, a relatively high rating on public acceptance, and favorable product marketability. The disadvantages of this system included relatively high capital costs, reduced expansion flexibility, and complex operational requirements. These advantages and disadvantages applied to all of the thermal drying alternatives. At the level of detail of the evaluation, there was little difference between the thermal drying alternatives.

The aerated static pile and horizontal agitated reactor composting systems ranked favorably on the basis of quantitative factors. However, this high ranking was not able to transcend a poor public acceptance rating, which was a heavily weighted qualitative factor. As a result, the composting alternatives ranked last overall.

A comparison of alternatives based on annual cost per ton of residuals processed illustrates the relative cost differences between the various systems, as well as the economy of scale that could be achieved with a larger regional facility.

PUBLIC VERSUS PRIVATE OWNERSHIP

Both public and private ownership of the regional biosolids facility were investigated.

Public ownership of a regional biosolids facility is the more traditional approach. A public facility can be owned by a single entity or by two or more entities joined through an authority or agreement. With private ownership, a private (taxable) vendor designs, constructs, operates, and owns the biosolids facility.

The joint public ownership option was ranked most favorable in this study because it would give each participant proportionate control. Public ownership by Broward County was ranked second because, even though Broward County does not own or operate a wastewater treatment plant in the study area, the county could bring expertise and management structure to a regional facility. Private ownership was not ranked high because costs would be higher than for public ownership, reflecting risks assumed by the private owner and profit.

Private operation was the preferred choice for a regional biosolids facility in this study, preferably by the same company that provided the stabilization technology. This approach would provide maximum expertise and incentives for smooth operation. Private operation would be most advantageous if thermal drying or composting were selected because of their more specialized operational and product marketing requirements.

With public ownership, the full-service contracting approach appeared most advantageous. This approach is similar to the turnkey approach, except that the same private vendor is contracted to provide facility operation as well as design and construction. The vendor is thereby encouraged to consider operational impacts of design decisions, generally resulting in a more reliable facility. The conventional contracting approach, use of a consulting engineer to prepare plans and specifications and a competitive bidding process to select a general contractor, could also be used with public ownership.

Assuming public ownership and a full-service contracting approach, contractor selection through a Request for Qualifications/Request for Proposals (RFQ/RFP) process was the preferred option. The RFQ would be used to identify qualified contractors, while the RFP would be used to select the preferred contractor based on detailed technical, financial, and contractual requirements. If different contractors were desired for construction and operation, the preferred approach would be to use the competitive bidding procedure to select the construction contractor and the RFQ/RFP procedure to select the operations contractor.

A regional biosolids facility accomplishing Class A pathogen reduction is technically feasible in Broward County, although siting and ownership issues would have to be resolved. A regional facility would offer potential advantages to participating cities in terms of economies of scale, capital financing requirements, facility siting, and long-term disposal reliability.

The main disadvantage of a regional system in this study area would be higher biosolids disposal costs for each of the participating cities. All of the Class A systems evaluated would be at least twice as costly as current Class B systems used in the study area. The higher costs of the Class A systems indicated that further study of

agricultural application of Class B biosolids is warranted before proceeding with a regional system based on Class A technology.

Class A pathogen reduction processes basically reduce pathogenic levels to below levels of detection. Subsequent site controls are not needed. Class B processes significantly reduce but do not eliminate all pathogens, and are used in conjunction with site controls to achieve the same levels of protection at a lower cost.

Public ownership was ranked ahead of private ownership in the study, in cases where a regional biosolids facility would be implemented. However, a full-service contracting approach wherein the same private contractor would provide design, construction, and operation appeared most favorable in this case. ■

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