BEYOND BUFFERS

ODOR CONTROL FACTORS IN COMPOST SITE SELECTION

Strategies for evaluating the potential for odor generation and neighborhood impact include air dispersion modeling and estimation of odor concentrations and flow rates from each source.

Michael D. Giggey, Jeffrey R. Pinnette and Christopher A. Dwinal

The odor problems that have plagued many composting facilities over the past 20 years have provided valuable lessons to new facilities, many of which have a much better track record with respect to off-site impacts. Still, the potential for odor generation gives project opponents a basis to try to stop the construction of even properly sited and well designed facilities. Furthermore, state and local regulators often exhibit a great deal of conservatism with regard to facility permitting to ensure that past failures due to odors are not repeated.

Odor problems can be traced to one or more of four basic causes — composting process control; containment of odorous areas; odor control technology; and siting. Even with perfect process control, complete containment, and effective odor control technology, siting must be considered. Adequate buffers are needed to allow the odors emitted to be diluted to below objectionable levels before reaching off-site receptors. Problems can arise if the facility is in the wrong place, either because it was sited improperly to begin with, or development around the site has encroached on buffer areas that were expected to remain undeveloped.

Also to be considered are residual emissions from odor control devices. High tech solutions can allow a successful project on a relatively small site, but it must be recognized that some level of odorous emissions will occur which only natural air dispersion can mitigate. Off-site odor impacts also can occur due to occasional equipment problems, normal maintenance periods, and fugitive emissions if the site does not have adequate buffers.

All four causes of odor problems should be thoroughly evaluated before constructing any composting facility as part of the site selection process. A generalized approach to site selection will be illustrated in this article through four case studies documenting both successes and failures. Each case study involves composting of biosolids from either wastewater or septage treatment plants. However, the siting process is basically the same for composting of other waste streams, such as yard trimmings or source separated organics. The odor emission potential, however, is generally lower for yard trimmings operations.

Evaluating Odor Impacts

Many composting facilities have been sited based on factors other than the ability to provide adequate buffers and dispersion. For example, composting facilities are often constructed at or near the point of waste generation. In many cities and towns, composting of yard trimmings takes place at the landfill, and biosolids composting at the wastewater treatment plant. In these cases, site selection is based solely on convenience and economics. Use of existing town facilities avoids land purchase and hauling costs, and may reduce permitting time and expense. Composting facilities at these sites are sometimes not successful because inadequate attention was paid to off-site odor impacts. One of the foremost issues in compost facility development should be estimating the level of odorous emissions, and the ability of the atmosphere to disperse these odors before they adversely impact the neighbors.

The atmosphere around a site is a resource with limited assimilative capacity, which must be considered in determining allowable discharges. A good analogy is the process by which wastewater treatment plant effluent discharges are licensed. Some treatment plants must provide a higher than normal level of treatment, or are restricted to a certain effluent flow, based on the assimilative capacity of the river or stream to which they discharge. Permitting agencies work backwards from the stream to the treatment process. The maximum allowable discharge is determined by the ability of the receiving stream to dilute the effluent to the point where, at a certain distance downstream, a certain contaminant concentration is below a threshold level. The capacity of composting facilities needs to be determined in a similar fashion, based on the characteristics of the exhaust air stream and the receiving atmosphere.

Predicting odor impacts in advance is not an easy task. Not only is the modeling of air dispersion more complex than the modeling of water quality impacts, but measurement of the impact is more subjective. While there may be agreement in the scientific communi-
ty that the concentration of a specific pollutant in a receiving water should be below a specific concentration, there is much less agreement as to the appropriate property line odor concentration (say 7 D/T or dilutions to threshold no more than five percent of the time), or whether the impacts should be measured at the property line or the nearest receptor.

Effective odor modeling is difficult because odor perception is not a time averaged phenomenon, but rather a near instantaneous reaction. Typical Gaussian dispersion models generate results based on averaging times of 15 minutes or longer. Appropriate air dispersion models should determine near instantaneous values of odor concentration and the frequency of occurrence of such odors. One example is fluctuating plume puff models which have been used effectively to evaluate odor impacts.

Despite the uncertainties, a systematic scientific approach is needed to address the likely odor impact before a composting facility is built. In some states, air dispersion modeling is mandated by the regulators as part of the air quality permitting process. Other states do not have a formal approach, but require that general air quality concerns be addressed. Even where formal permitting is not required, and regulatory approval can be obtained merely by proposing to install a standard odor control device, project proponents should go a step beyond, and conduct some level of air dispersion modeling to address in advance the magnitude and frequency of potential off-site impacts. With increasing privatization of composting facilities, it is expected that funding entities will insist on such analyses, even if regulatory agencies do not.

Modeling requires quantification of all odor emission sources from the composting operation including high rate composting, amendment storage, preprocessing and post-processing, curing and long-term storage. A plan should be developed that identifies a range of potential containment and treatment options depending on the sensitivity of the site. Enough odor containment and control must be provided to reduce odor levels after dispersion to below objectionable levels. If this results in excessive costs, then the size of the discharge must be reduced usually by decreasing the size of the facility, or an alternative site must be found.

Quantification of the odor emission rate requires estimation of the odor concentration and flow rate from each source. Each area of a composting facility will have distinctly different odor emission potential. The odor concentration in composting process air can vary greatly depending on the level of process control. Unless data are available to prove otherwise, a minimum odor concentration of 2000 D/T should be assumed in process air from biosolids or source separated organics composting operations. Higher levels may be appropriate for systems with less process control. Curing or finished compost areas will have much lower odor concentrations. For controlled sources, the question arises about what performance level can reliably be achieved by a given odor control device. For composting facilities, the most common means of odor control are wet scrubbing and biofiltration. Multistage wet scrubbers typically reduce the odor concentration in a composting exhaust to between 60 and 120 D/T and a well designed biofilter can reduce odor levels to between 20 and 30 D/T routinely, with occasional excursions up to about 50 D/T. Dispersion of odor emissions can be enhanced by locating sources on the site as far away from sensitive receptors as possible or by discharging through an elevated stack.

When evaluating odor impacts, a range of emission and odor control performance levels should be examined to consider impacts under both typical and worst case conditions. Just as wastewater treatment plants must meet maximum day discharge limits — not just monthly averages — design and permitting of composting facilities must address air quality issues during periods of equipment breakdown, normal maintenance, or periods of nonoptimum performance.

MEET OUR TWO NEW WASTE HAULERS

WASTE TRANSFER TRAILER FEATURES: Lengths to: 53' Heights to: 102" Includes Patented SST Floor Other custom features available!

LIVE FLOOR TRAILER FEATURES: Available with Keith or Halico floors Includes Patented SST Floor Other custom features available!

Travis has recently completed an expansion of our facility with the addition of a 20,000 square foot building. This new capacity will be exclusively for the production of LIVE FLOOR and WASTE TRANSFER trailers.

For years Travis has been known for our outstanding quality and innovation in the end dump business. This same dedication to quality and innovation has been applied to our new waste trailers, such as the patented SST floor system. Call us today for more information or a quote.

TRAILERS AVAILABLE FOR FEBRUARY AND MARCH DELIVERIES!

Travis BODY & TRAILER, INC.
FACTORY: 800-635-4372
TULSA BRANCH:800-398-3767
ATLANTA BRANCH:800-622-3867
High tech solutions can allow a successful project on a relatively small site, but it must be recognized that some level of odorous emissions will occur which only natural air dispersion can mitigate.

There are no homes within 1,000 feet and only five within 2,000 feet of the Lewiston-Auburn composting site.

Consideration also must be given to fugitive emission sources like open doors at an enclosed facility or delivery trucks.

Facility impacts should be evaluated over the full range of meteorological conditions. The ability of a facility to avoid odor impacts on a cold windy day is not enough; neighbors will demand that they can enjoy picnics in their backyards on humid, summer days with little or no breeze. However, it is equally important not to compound worst case conditions, particularly when setting permit limits. The frequency of occurrence of meteorological conditions is critical to understanding the acceptability of odor impacts. However, when projected impacts exceed potential objectionable levels, project proponents must be prepared to reduce facility capacity or identify a more suitable site.

**RECOMMENDED SITING APPROACH**

To effectively address siting and permitting of composting facilities from an odor control perspective, the following steps are recommended:

1) One or more sites should be selected based on such factors as proximity to the organic source, existing ownership, natural buffers and adjacent land use.

2) A preliminary design of the proposed composting facility should be developed to determine approximate odor emission rates (process air volumes and odor concentration) for each source at the facility. A range of containment and odor control technology options should be considered.

3) Air dispersion modeling should be undertaken for a range of performance scenarios for each containment and odor control technology option.

4) Based on the results of the preliminary dispersion modeling, a reevaluation of site location, facility size, containment and odor control technology should be conducted.

5) Air quality permit limits can be determined that make the most sense for the selected site, facility size and type and chosen odor control device.

If properly completed, this approach should give project proponents reasonable assurances that a well operated plant will have known and minimal impacts on abutters, and give regulatory agencies a sound basis for air quality permitting.

**LEWISTON-AUBURN, MAINE**

In 1993, the Lewiston-Auburn Water Pollution Control Authority started operation of a 34 wet ton/day biosolids composting facility in Auburn, Maine. The facility is about five miles from the treatment plant, on 120 acres of land in an agricultural sector of Auburn. There are many dairy farms in this area, and manure is routinely spread on hayfields. The facility uses a Longwood agitated bin composting system that is enclosed and ventilated at 72,000 cubic feet per minute (cfm). The exhaust air is discharged through a 30,000 ft² biofilter. The facility also has an aerated curing area that is covered, but not enclosed.

Figure 1A is a site plan showing the composting facility in the center and all nearby receptors as dots. The concentric circles are at 1,000, 2,000 and 3,000 feet from the biofilter. This site is nearly ideal with respect to the buffers to nearby development, since there are no homes within 1,000 feet and only five within 2,000 feet. Many of the receptors are farmsteads that are closer to active manure-fertilized fields than they are to the composting facility.

The Lewiston-Auburn plant was permitted without formal dispersion modeling. Instead, a simple dispersion model was used to estimate order of magnitude odor levels that would be appropriate for the site. A permit limit of 100 D/T was established for the biofilter exhaust (measured directly at the biofilter surface) and the odor intensity at any of the nearby homes or roadways cannot exceed one butanol intensity unit over background. Since the plant began operating in March, 1993, there has been only one formal odor complaint.

During plant start-up, there was a period when the biofilter did not meet the 100 D/T permit limit. Off-site odors were minimal, due to the significant buffer zone which allows natural dispersion to mitigate occasional periods of less than optimum performance (such as start-up or during equipment maintenance). This is a major attribute that should be sought whenever a new facility is proposed. It should be not-
ed that the remote site is not served by public water or sewer resulting in special constraints on the design and operation of the facility.

YARMOUTH, MASSACHUSETTS

The Town of Yarmouth, Massachusetts, located on Cape Cod, has a 110,000 gpd septic tank treatment plant and a Royer agitated bin composting facility with a covered, but not enclosed, aerated curing area. The plant exhausts 115,000 cfm of air flow from the septic tank treatment and composting facilities through a 30,000 ft³ biofilter. The town has a landfill, a yard trimmings composting area and a solid waste transfer station on an adjacent site. The air quality discharge permit calls for a maximum of 25 D/T in the biofilter exhaust. Figure 1B is a site plan of the Yarmouth facility showing the location of residences and businesses within 3,000 feet.

Unlike the Lewiston-Auburn site, where manure spreading occurs regularly, Yarmouth is an affluent resort community with a high degree of environmental sensitivity. Previous odor problems at other Cape Cod treatment plants caused the town to dictate that all facilities be enclosed, and that a high level of odor control be employed. Initially, a two-stage wet scrubber was proposed, followed by polishing in a biofilter. This choice was due partly to the dual nature of the odors (septage and composting), and partly because of a lack of widespread experience with large biofilters.

The high cost of this approach caused Yarmouth officials to reevaluate its concerns about maximum protection. Dispersion modeling was conducted by Odor Science & Engineering using a fluctuating plume puff dispersion model to evaluate the impact of the biofilter discharge at 20 D/T and 50 D/T. The model was calibrated against existing conditions and then used to predict impacts under the two future alternatives. The results were presented to the Board of Selectmen for concurrence on the level of impact. For the 20 D/T discharge, the modeling predicted that ambient air would be above 7 D/T out to 1,000 feet approximately six percent of the time. At 50 D/T, odor concentrations were above 7 D/T out to 1,500 to 2,000 feet under these atmospheric conditions. Based on the modeled impacts, the Selectmen agreed to proceed with only the biofilter. The Massachusetts Department of Environmental Protection (DEP) also agreed, but required that scrubbers be added in the future if the biofilter did not perform as predicted, or if the model results understated the true impacts. Two years of performance have shown that the wet scrubbers are not needed. The biofilter exhaust air odor concentration has been routinely less than 25 D/T, and the model predictions appear to be accurate or slightly conservative. This is a very good example of how air dispersion modeling, properly calibrated, can guide decision making on siting and odor control issues.

Although the biofilter has performed well, the Yarmouth facility has not been free of odors, receiving approximately 12 formal odor complaints per year. This was not unexpected, since the modeling indicated that odor levels of 7 D/T were expected out to 2,000 feet. The odor complaints have come from highway travelers and businesses within 2,000 feet of the facility and residents just beyond 2,000 feet. Many of the odors have been associated with fugitive emissions. The staff is working to address fugitive emission problems and expects fewer odor complaints in the future.

TRI-TOWN SEPTAGE TREATMENT

The Tri-Town Septage Treatment Facility in Orleans, Massachusetts was designed to process up to 45,000 gpd of septage, with the resulting high lime biosolids composted using aerated static piles in an open-sided building. The septage treat-

At the Tri-Town septage composting site, there are 37 commercial or residential buildings within 1,000 feet. The closest home (see inset on left) is only 200 feet from the open-sided composting building.
Off-site odors have never been documented at the Interstate Septic facility, even with eight homes or businesses within 1,000 feet of the site. Exhaust air is passed through a 3,200 ft$^2$ biofilter.

The facility began operating in early 1990. The composting operation was hampered by equipment problems and was the subject of many odor complaints. The entire composting facility was shut down in 1991 due to serious and persistent odor problems. A close look at the site plan (Figure 1C) shows that the composting operation in Orleans could have been expected to fail, given the choice of site and the decision not to enclose the facility.

While neither the Yarmouth nor Lewiston-Auburn plants has any homes within 1,000 feet, there are 37 commercial or residential buildings in Orleans within that distance. The closest home is 200 feet from the compost building. This site is simply unacceptable for an open composting operation. Even with full containment and a high level of odor control, off-site odor impacts would be expected here, due either to fugitive emissions, or the residual odor associated with a scrubber or biofilter. If the Tri-Town composting facility had been enclosed and ventilated at rates similar to Yarmouth and Lewiston-Auburn, the exhaust air flow rate would have been over 140,000 cfm. Odor modeling at this site might have prevented construction of the composting facility in favor of other biosolids management methods. The biosolids are now trucked to the Yarmouth facility for composting.

INTERSTATE SEPTIC SYSTEMS, INC.

Interstate Septic Systems, Inc. is a private company that offers septage and wastewater sludge receiving, pretreatment, dewatering and in-vessel composting at its facility in Rockland, Maine. The 5,000 cfm exhaust air stream from the raw septage and filtrate tanks, belt filter press room and composting area is discharged to a 3,200 ft$^2$ biofilter. The facility is designed to treat an average of 23,000 gpd of septage and to compost six wet tons per day of dewatered biosolids in an agitated bin system supplied by Resource Optimization Technologies. The system is located in a building that was formerly a leather tannery in the Rockland Industrial Park. The suitability of the site was reviewed carefully — relative to the size of the proposed exhaust air discharge — before purchase by Interstate Septic. Only simplified odor modeling was considered necessary based on the proposed performance requirements for the biofilter. The facility permit restricts the maximum odor concentration to 100 D/T at the biofilter surface, with a long-term average of no more than 50 D/T.

Odor concentrations measured at the surface of the biofilter have been much less than 50 D/T. Off-site odors have never been documented at the Interstate Septic facility, even
with eight homes or businesses within 1,000 feet of the facility as shown in Figure 1D. The plant has operated successfully for over a year without odor complaints due, among other reasons, to a small air discharge rate, a properly functioning biofilter and a 500 to 1,000 foot industrial buffer zone. Within that buffer zone, community odor surveys have documented two sources of significant odor—a seafood processing plant and a fiberglass boat building facility. Off-site odors from these two sources have typically been greater than or equal to odor levels at the biofilter surface.

**EFFECTIVE STRATEGIES**

These case studies help illustrate what has worked and what has not worked regarding siting, odor control designs, and the composting of wastewater biosolids. Figure 2 is a site by site comparison of the number of residences and businesses within 1,000 and 2,000 feet. Lewiston-Auburn and Yarmouth have effective odor control systems treating large air volumes and no residential development within 1,000 feet. Lewiston-Auburn has only a few residences out to 2,000 feet, but Yarmouth has significant residential development beyond 1,500 feet. This is reflected by the number of odor complaints that have been received at the two facilities. The Yarmouth site probably has the minimum buffers needed for a viable operation with a 115,000 cfm discharge. In Orleans, the composting facility was not only too close to development in general, but also the most sensitive type of development—residential. At Interstate Septic, the presence of a 500 to 1,000 foot industrial buffer zone, complete enclosure and treatment of odor sources, and limited facility size have allowed the successful operation of a septage processing facility with residential development within 1,000 feet. A larger facility on this site may well have had off-site odor impacts.

In general, this survey of existing plant performance has shown successes with large enclosed composting facilities when residential development is no closer than 1,000 feet, and preferably fewer than a few dozen homes or businesses within 2,000 feet. These case studies serve as rules of thumb for initial site selection. However, these guidelines should be used cautiously because every project is different, and each site has its own topography and meteorology. Each site must be evaluated on its specific conditions.

**ODOR EVALUATION TERMINOLOGY**

**Odor Concentration:** Odor concentration is measured as the number of dilutions required to reduce an odor to a threshold level. At the threshold level, only 50 percent of a group of panelists are capable of detecting the odor. Accordingly, odor concentration is expressed in self explanatory dimensionless units of "dilutions-to-threshold" (D/T).

**Odor Intensity:** The odor intensity is a measure of odor objectionability. Odor intensity is most frequently quantified by comparison to a series of eight solutions of 1-butanol in air. The concentration of 1-butanol is 15 ppm at step one and double at each subsequent step of the butanol scale.

**Gaussian Dispersion Models:** Gaussian models predict plume growth from a source like a stack. The spread of pollutants is determined based on constant dispersion coefficients for a particular atmospheric condition. The EPA-approved UNAMAP series of models generates one-hour averaged concentrations.

**Fluctuating Plume Puff Models:** Fluctuating plume puff models divide the plume into short discrete segments which disperse individually. The dispersion coefficient includes a factor for expansion of the puff and for fluctuation of the centroid. Each time any of the randomly moving odor plume segments reaches a receptor, an odor event is recorded. The model predicts the concentration and frequency of such odor events.

The Lewiston-Auburn site is nearly ideal with respect to the buffers to nearby development, since there are no homes within 1,000 feet and only five within 2,000 feet.