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Biological Resources Engineering **TOPICS**

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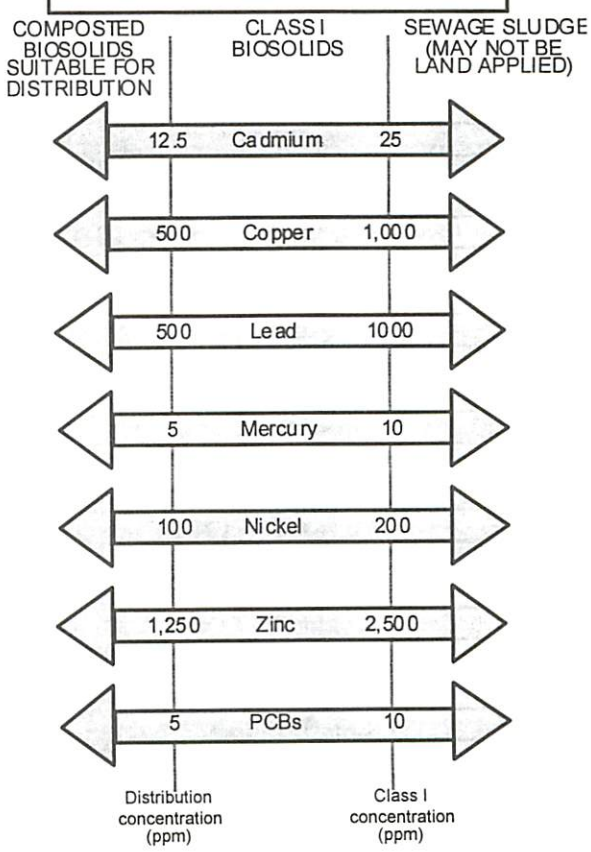
BIOSOLIDS: Requirements for Land Application

Biosolids are a valuable agricultural resource because of their soil conditioning properties and nutrient content. On the other hand, most people recognize that the sewage sludge from which biosolids are derived may contain pollutants and disease-causing organisms (pathogens). As a result, questions sometimes arise concerning the safety of applying biosolids to agricultural land. An article in the January-February 2001 issue of *Biological Resources Engineering TOPICS* started to address these questions by discussing key distinctions between the terms "biosolids" and "sewage sludge." The most important point made in the earlier article is that biosolids are sewage sludges that are treated to meet state and federal regulations established to protect human health and environmental quality, and therefore, are suitable for land application. Here, the criteria that land applied biosolids must meet are described to assist individuals in making decisions about the use of this agricultural resource.

FIGURE 1
Pollutant Concentration Limits for Biosolids That Are Land-Applied in Maryland



Specifically, biosolids that are land applied must meet limits on key pollutants and operational standards to control disease-causing organisms and reduce the attraction of potential disease-carrying organisms (vectors), such as flies and rodents. These limits must be met before a permit for land application or distribution of biosolids can be obtained from the Maryland Department of the Environment (MDE), as specified by Code of Maryland Regulation (COMAR) 26.04.06, *Sewage Sludge Management*. Biosolids (and materials that contain biosolids) that are applied or distributed for application to agricultural and other land supporting vegetative growth are subject

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to these regulations. These regulations also address the application of biosolids to so-called marginal lands, such as gravel pits, which do not support normal vegetation. However, the focus here is on land application on vegetated sites. Permits are issued to persons responsible for applying or distributing biosolids. Owners of property on which biosolids will be land applied must provide written authorization in support of these permits.

Pollutant concentration limits. In general, all biosolids that are land applied to agricultural lands in Maryland must meet the Class I concentrations for several heavy metals (cadmium, copper, lead, mercury, nickel, and zinc) and polychlorinated biphenyls (PCBs) shown in the right-hand column of Figure 1. If the Class I concentrations for any of these pollutants other than copper or zinc is exceeded, the material may not be land applied in Maryland. Biosolids that are land applied must also meet the ceiling concentrations for arsenic (75 ppm), molybdenum (75 ppm), and selenium (100 ppm) established by the U. S. Environmental Protection Agency (EPA). If only copper and/or zinc exceeds Maryland's Class I concentrations, it may still be possible to land apply the biosolids if the copper is present at less than 2,000 parts per million (ppm) and zinc levels are less than 4,000 ppm. The total amount of cadmium, copper, nickel, lead, and zinc that can be applied to land in the form of biosolids over time is also regulated. As shown in Table 1, the cumulative amount of each of these metals that can be applied is determined by the cation exchange capacity of the soil at the site. In addition, in any given year, the rate of cadmium application may not exceed 0.4 pounds per acre. Finally, regardless of the metals content, biosolids application may not exceed the rate calculated to provide proper site nutrient management.

Composted biosolids that are distributed to the general public must meet even stricter pollutant concentrations than those outlined above. Maryland's regulations specify pollutant concentrations that cannot be exceeded for distribution of composted biosolids containing less than 3% nitrogen. These pollutant levels are shown in the left-hand column of Figure 1. In addition, if distributed, these materials must contain at least ten percent (by weight) calcium carbonate ($CaCO_3$) equivalents. It may be possible to sell or give away other treated biosolids products to the general public if they meet state and EPA pollutant limits.

Table 1. Cumulative loading levels for biosolids pollutants.

	Soil Cation Exchange Capacity (meq/100 g)	
	Less than 5	5 or Greater
Metal	*Pounds Per Acre Limit*	
Cadmium	4.4	8.9
Copper	125	250
Nickel	125	250
Lead	500	1000
Zinc	250	500

Pathogen reduction requirements. In addition to meeting metal concentration limits, Maryland's regulations also require that land-applied biosolids are treated to reduce the levels of disease-causing organisms and their tendency to attract potential disease-carrying organisms. The regulations provide flexibility in how pathogen reduction requirements are met. The

possible treatment options for achieving pathogen reduction can be divided into two categories: *processes to significantly reduce pathogens* (PSRP) and *processes to further reduce pathogens* (PFRP). Both types of processes achieve considerable pathogen reduction, although pathogen levels in biosolids treated by PFRP are usually lower than in those treated by PSRP. However, both categories of pathogen reduction are equally protective of human health because land that receives applications of PSRP-treated biosolids is subject to restrictions with respect to grazing, production of crops that are consumed directly by humans, and public access. Thus, only biosolids that undergo treatment by a PFRP may be distributed to the general public. Application of biosolids, including those treated by PFRP, is not permitted on land used to grow tobacco.

The permissible treatment options, summarized in Table 2, reduce the pathogen content and vector attraction in a number of different ways. Most are based on one of the following approaches: reduction of the microbial food source in sewage sludge (measured as volatile solids content), application of high temperature and/or chemical disinfectants, and/or removal of nearly all of the moisture from sewage sludge. Treatment options that reduce the microbial food source in sewage sludge are themselves based on biological processes.

Table 2. Operational requirements for pathogen reduction treatment options.

Treatment Option	**Operational Requirements** *During treatment, sludge must:*
PSRP	
Aerobic Digestion	Be maintained at 15°C or higher for 60 d, OR at 20°C or higher for 40 d. Volatile solids content must also be reduced at least 38%.
Air Drying	Not exceed a depth of 9 inches AND must be dried for at least 3 months. During 2 of these months, the average daily sludge temperature must be above 0°C.
Anaerobic Digestion	Be maintained at 20°C or higher for 60 d, OR at 35°C to 55°C for 15 d. Volatile solids content must also be reduced at least 38%.
Composting	Be maintained at 40°C for 5 d AND exceed 55°C for 4 hr during this period.
Lime Stabilization	Reach a pH of 12 after 2 hr of contact with lime.
PFRP	
Composting	Be maintained at 55°C or greater for 3 d using in-vessel or static aerated pile composting OR for 15 d, during which compost is turned at least 5 times, in windrows.
Heat Drying	Be dried to 10% moisture or lower AND reach more than 80°C.
Heat Treatment	Be maintained at 180°C for 30 min.
Thermophilic Aerobic Digestion	Be maintained at 55–60°C for 10 d (hydraulic residence time). Volatile solids content must also be reduced at least 38%.
PSRP + Beta Ray Irradiation	Be irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature.
PSRP + Gamma Ray Irradiation	Same as above except irradiation is with gamma rays from isotopes like cobalt or cesium.
PSRP + Pasteurization	Be maintained at 70°C for at least 30 min.

Examples of biological treatment processes that are permissible PSRP include *aerobic digestion*, in which air or oxygen is distributed throughout the sewage sludge; *anaerobic digestion*, which, unlike aerobic processes, excludes air during sewage sludge treatment; and *composting*. However, these treatment options qualify as PSRP only if certain operational requirements are met. The operational requirements for aerobic digestion, anaerobic digestion, and composting, as well as additional PSRP and PFRP, are summarized in Table 2. *Air drying* and *lime stabilization* of biosolids are also permissible PSRP. *Composting* that attains high temperatures for extended periods of time qualifies as a PFRP. Other permissible PFRP include *heat treatment and drying*, and *thermophilic aerobic digestion*, which occurs at higher temperatures than required for PSRP. In addition, any of the PSRP coupled with beta or gamma ray irradiation or pasteurization, qualify as PFRP. Other methods or operating conditions may be accepted as PSRP or PFRP if it is demonstrated that the alternative approaches achieve pathogen and vector attraction reduction equivalent to the treatment by the methods listed in Table 2.

For more information on land application or distribution of biosolids in Maryland, contact the Sewage Sludge Utilization Section of the Maryland Department of the Environment at 410-631-3375.

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NRAES Publications

See more details on the web site (www.nraes.org).

Waterborne Pathogens in Agricultural Watersheds (NRAES-147). This publication covers disease-causing organisms in agricultural watersheds that may contaminate water. A section on pathogens in the environment discusses sources of waterborne pathogens, such as domestic livestock, land application of sewage and sludge, pets and companion animals, and wildlife like mammals and birds. Survival rates of pathogens in different environments, such as agricultural waste management systems, land application areas, and water, are also discussed. (68 pages, 2001)

Managing Nutrients and Pathogens from Animal Agriculture (NRAES-130). This proceedings is from a March 2000 conference. The papers are divided into eleven sections: nutrients and water quality, animal agriculture and nutrients, EPA and NCRS goals in nutrient management, waterborne pathogens, manure management practices, feed management to reduce excess nutrients, fate of land-applied nutrients and pathogens, phosphorus index, land application, site management, and nutrient management plans. (508 pages, 2000)

The topics in this newsletter are considered timely and of interest. Comments and suggestions are invited. The use of trade names in this newsletter is not an endorsement of any company or product by the Maryland Cooperative Extension, University of Maryland, College Park.

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