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Land Application of Sewage Sludge

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In its simplest form, sludge is an accumulation of the solids generated during the treatment of wastewater. As the sewer gathers wastewater from the city and takes it to the treament plant, it serves homes, schools, hospitals, restaurants, food processing plants, and light and heavy industry. Each person in the city generates about 100 gallons of sewage a day, and when this is treated it produces about 1/4 of a gallon of sludge. The chemical and biological characteristics of the sludge refiect the sources of wastewater discharging into the collector sewer.

Once the wastewater arrives at the treatment plant it undergoes a variety of physical, biological, and chemical treatment processes. Screening and settling are used to remove large and heavy solid particles. This solid matter is called primary sludge because it is the first form of sludge generated in the treatment plant. Secondary sludge is produced when a biological component allows microorganisms to grow by removing dissolved carbohydrates, fats, and proteins. These microorganisms and remaining suspended solids are then removed from the wastewater in settling tanks. In some treatment plants, chemicals are added to help settle very small particles in the wastewater. The resulting chemicals and solids are another form of sludge generated in some treatment plants.

Some systems include a thickening or dewatering device to increase the amount of solids contained in the liquid-solid slurry (sludge). This thickening can be done by adding chemicals or by mechanical means. It reduces the amount of water that must be handled with the solids. The Department of Environmental Quality (DEQ) has classified sludge in three groups, based on the percent of solids in the slurry. Any slurry containing less than 10 percent solids (10 pounds of dry solids plus 90 pounds of wastewater) is called a *liquid slurry.* Slurry containing from 10 to 20 percent solids is called *dewatered sludge,* and slurry containing more than 20 percent is *dried sludge.*

Characteristics of sludge from any two treatment plants will differ according to the waste sources and the type of treatment plant. Table 1 lists the concentration of several commonly measured components.

Table 1. Character of Typical Liquid Digested Sludge

Constituent	Concentration*
	ppm
Total nitrogen	2,500
Ammonia nitrogen	800
Organic nitrogen	1,700
Phosphorus	1,350-3,050
Potassium	600-950
Zinc	24-610
Copper	7-500
Nickel	0.75-85
Cadmium	0.25-20
Aluminum	180-600
Barium	26-67
Boron	7.5-38
Chromium	2.5-1,600
Iron	400-3,900
Manganese	9-57
Mercury	0.03-1.55
pH	6.5-7.5
Total solids, percent of total (wet basis)	4-6

* Values or range, parts per million on a dry basis.

Past disposal methods of sludge have included landfill or burial, incineration, and dumping at sea. Because of increased concern over energy use and environmental quality, none of these methods provides an acceptable solution for the future.

Sludge contains valuable plant nutrients, and soil-plant utilization of sludge gives an opportunity to treat and recycle waste. Both federal (EPA) and state (DEQ) agencies encourage land application of sludge. Information regarding regulatory definitions, permits, responsibility, limitations and use restrictions, site selection and approval, monitoring and reporting requirements, and permit application procedures is available in a DEQ publication "Guidelines for the Handling, Disposal and Use of Sewage Sludge."

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Beneficial use

Land application of both raw and treated sludges has been practiced in the United States and elsewhere for many years. Sludge contains enough major plant nutrients (nitrogen and phosphorus) to be of value as a fertilizer replacement or supplement. Sludge is approximately equivalent to a 5-4-1 commercial fertilizer on a dry-weight basis. In addition to its major nutrient value, sludge contains many beneficial micronutrients for crop production. The organic matter in sludge improves the soil's tilth, its water- and nutrient-holding capacity, and its infiltration characteristics.

The positive benefits of land application of sludge for crop utilization vary according to nitrogen content of the sludge and the N requirements of the crop. Many other factors influence the beneficial impact of sludge, including type and age of sludge, mode of application (sprinkled or injected), soil type, and crop.

Potential problems

In addition to the resource potential of its nutrients, sludge has other aspects that cause concern in handling and application. These include pathogens, heavy metals, runoff, and odors.

Pathogens. While a potential health problem is present, sensible handling will reduce this potential. Under certain environmental conditions, bacteria in the sludge have remained in the soils up to 6 months after application, but the natural die-off rate usually reduces their numbers to acceptable levels within 3 weeks. Disease problems have been reported in connection with truck crops and other produce that is eaten raw. On lands that are used to grow crops for direct human consumption, sludge should be applied a year before cropping. Root crops and vegetables that are consumed raw should not be planted until 18 months after sludge application unless the sludge has been heat-treated or composted to further reduce pathogens.

Heavy metals. The heavy metals in sludge that cause the greatest concern are cadmium, zinc, copper, lead, and nickel. Cadmium accumulates in some plants and can cause health problems. The other heavy metals may reduce crop production. The extent of these problems depends on the quantity and quality of the sludge applied, the crops grown, and the soil type. Operators of wastewater treatment plants are required to analyze the sludge for heavy metals and provide this information to the agricultural operator and DEQ. With proper planning and monitoring, use of sludge containing heavy metals will not limit the quality or quantity of the crops grown.

Runoff. Potential runoff problems are site-specific and under the control of the application management system. The infiltration rate of the soil should be matched with the application rate and slope of the field when liquid sludge is applied on the surface. If the sludge is injected or plowed under soon after the surface application, runoff problems are reduced.

Odors. Treated sludge generally has some odor, although extent of the problem is difficult to measure. Individual and public attitudes are important in evaluating an odor problem. Even a well-managed spreading operation may cause occasional odors. The most effective means of dealing with this problem is through education and public involvement in decisions.

Selecting a sludge disposal method will involve consideration of the quantity and composition of the sludge; availability and cost of alternative disposal methods; transportation, labor, and equipment needs for land disposal; availability, cost, and location of receiver land; storage facilities to permit seasonal applications; potential for odor and runoff problems; and availability of management to operate an efficient, safe, and nuisance-free land application system.

Community planners and managers should inform and involve the residents in decisions involving sludge management.

Something must be done with the sludge. While spreading sludge on land has pollution potentials, a well-designed and properly managed system will allow you to dispose of the sludge, utilize the resource, and be a good neighbor in your community.