ALABAMA COOPERATIVE Extension SYSTEM

ANR-790-3.1.2

ALABAMA A&M AND AUBURN UNIVERSITIES

# Municipal Wastewater Treatment

## Land Application Of Municipal Wastewater

Applying wastewater to agricultural land from municipal treatment plants, agricultural processing plants, and industrial sources is not new. This application has been practiced in foreign countries and in the United States for many years. It offers potential benefits to both the agency or industry, which has wastewater to treat and discharge, and to agriculture, which can use some of the water and nutrients for crop production. When wastewater is applied to the soil-plant environment, suspended solids and nutrients are filtered out, and the water is either used by crops or percolates to the groundwater.

### Why Is There Increased Interest In Land Application Of Wastewater?

In 1972, Congress passed amendments to the Federal Water Pollution Control Act which established a goal for "zero discharge" of pollutants into navigable water by 1985. This law required the EPA to encourage water treatment management, which results in the recycling of potential sewage pollutants. As a result of this law, many communities have been upgrading their wastewater treatment plants. Land application of wastewater is one of the treatment alternatives which provides for recycling and is economically attractive to small rural communities.

Energy costs, a continuing awareness of environmental protection, and a growing recognition among farmers of the moisture and nutrients in wastewater are also responsible for the increased interest.

### How Can Wastewater Be Applied?

Land application techniques consist of three categories: slow-rate irrigation, overland flow, and rapid infiltration. Wastewater is usually applied by spraying, flooding, or running between ridges and furrows. Municipal wastewater, usually treated to some extent, is applied to land mainly by the irrigation and rapid-infiltration methods.

Irrigation is the most widely used type of land application. As many as 3,000 communities in the United States practice this approach. In rapid infiltration, wastewater quickly moves through the soil until it becomes part of the groundwater. In overland flow the wastewater is applied to sloping land. The water runs downhill to a collection ditch. The crop of vegetation is not always harvested.

Other land application techniques include subsurface adsorption beds, deep-well injection, and evaporation ponds. Such techniques are limited in their applicability.

### What Nutrients And Other Components Does Wastewater Contain?

Wastewater contains beneficial crop nutrients as well as suspended organic materials, microorganisms, and in some cases, heavy metals. Wastewater contains many nutrients needed for plant growth including nitrogen, phosphorus, potassium, zinc, and copper. The amounts of nutrients in wastewater vary from source to source based on treatment process, origin, types, and quantities of wastewaters treated. However, 1 inch of wastewater from a municipal treatment plant having secondary treatment might supply 1 acre with about 5 pounds of nitrogen, 2 pounds of phosphorus, and 4 pounds of potassium.

### What Are The Public Health And Environmental Concerns With Land Application Of Wastewater?

**Disease-Causing Organisms**. Wastewater contains varying levels of pathogenic, disease-causing organisms based on the degree of treatment provided. Municipal wastewater generally undergoes the equivalent of secondary treatment prior to land application. Secondary treatment provides for stabilization of organic materials and partial destruction of disease-causing organisms. Lagoon treatment and storage systems are frequently used for this purpose.

Only treated wastewater with few or no disease-causing organisms can be applied to land. Land application exposes the organisms to sunlight, soil conditions, and drastic temperature changes which destroy any remaining pathogens.

**Insects And Odors.** Wastewater treatment greatly reduces odors. The term **stabilization** is used to describe the controlled decomposition of organic material in wastewater. In most cases, stabilization of the wastewater will be necessary before application in order to avoid odor and insect problems.

**Water Quality**. Excess nitrogen and potassium applied as plant nutrients have a tendency to seep into groundwater, and excess phosphorus may flow into surface water supplies with eroded sediment. To prevent surface water and groundwater pollution, wastewater nitrogen should be applied in amounts that will be utilized by actively growing plants. To prevent surface water pollution, conservation practices should be used to reduce erosion of soil particles and nutrients into nearby ponds, streams, or lakes.

**Heavy Metals.** Because high rates of wastewater are often applied to the land, there is concern about the presence of high levels of certain trace elements called "heavy metals." This group of elements includes cadmium, zinc, nickel, copper, chromium, lead, mercury, and others. These components usually occur in small amounts not harmful to plants. Some heavy metals, including zinc and copper, are micronutrients which are necessary for plant growth. Excessive amounts of some heavy metals (zinc, copper, nickel) can be damaging to plants, resulting in reduced yield or even plant death.

Heavy metals are not very mobile and tend to accumulate in surface soils. They are nearly impossible to remove once applied to the land. Plant uptake of heavy metals is very low and generally the only method of removal. Thus, the removal of metals from a heavily contaminated soil by years of cropping (crop removal) is impractical, and metal additions to soils should be controlled.

There is special concern for cadmium because it has a tendency to enter the food chain where high concentrations can be harmful. Over many years high levels of cadmium in the diet has been shown to cause kidney failure in human beings. Table 1 presents health effects of potential contaminants in wastewaters.

## What Can Be Done To Protect Our Soil And Crops While Utilizing The Benefits Of Wastewater?

In order to prevent buildup of heavy metals in the soil to unhealthy levels, the EPA and the USDA have conducted extensive research and have set safe maximum limits on trace metal concentrations. Unless heavy metal concentrations in wastewater are extremely high, occasional, limited application of wastewater should not be of major concern.

Since trace metals cannot be effectively removed from the soil, each application of wastewater results in an overall increase in their concentration in the soil. The total amount applied to a particular soil is referred to as the "loading rate." Depending on amount and frequency of wastewater application, over a period of years, these elements could reach regulatory loading rate restrictions, after which no further application is allowed.

Alternative regulations have been proposed as to the maximum amounts of wastewater that can be applied to agricultural land. Information from years of experimental data on plant uptake of metals from the soil suggests that many current limiting regula-

**Table 1. Potential Contaminants In Wastewater.**

| Contaminant | Concern |
|---|---|
| Pathogens (bacteria and virus diseases) | Human health. |
| Nitrates | Application in excess of plant needs; excess application entering groundwater. |
| Organics (chlorinated hydrocarbon pesticides), polychlorinated biphennyls (PCBs) | Health hazard if directly ingested by animals. |
| Heavy metals: | |
| Copper, zinc, and nickel | Accumulation in topsoil; toxic to plants at high levels. |
| Cadmium | Accumulation in topsoil; taken up by plant and accumulates in leafy material; accumulates in animal organs; human health. |
| Lead | Accumulation in topsoil; potentially harmful if excessive amounts are ingested with soil particles by animals. |
| Mercury, chromium, selenium, arsenic, and antimony | Little concern unless present in extremely high amounts. |

Source: Muse, Mitchell, and Mulens 1991.

tions are highly unrealistic. EPA is currently considering revising present regulations so that larger levels of metals may be applied to land in wastewaters and sludges.

## References


Almy, Albert A., et al. 1977. Land Application Of Municipal Wastewater: What Is It And What Are Its Potentials? Extension Bulletin E-1138. Michigan Cooperative Extension Service. Michigan State University. East Lansing, MI.

Long, David A. 1980. Land Treatment. Working For Clean Water: An Information Program For Advisory Groups. Institute Of State And Regional Affairs. The Pennsylvania State University. Middletown, PA.

Muse, J. K., C. C. Mitchell, and G. L. Mullens. 1991. Land Application Of Sludge. Circular ANR-607. Alabama Cooperative Extension System. Auburn University. Auburn, AL.

Rubin, A. R., L. M. Safley, and J. P. Zublena. 1990. Land Application Of Municipal Sludge—Advantages And Concerns. AG-439-3. North Carolina Cooperative Extension Service. North Carolina State University. Raleigh, NC.


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**ANR-790-3.1.2**


This publication, supported in part by a grant from the Alabama Department of Environmental Management and the Tennessee Valley Authority, was prepared by James E. Hairston, *Extension Water Quality Scientist,* assisted by Leigh Stribling, *Technical Writer.*


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UPS, **New June 1995,** Water Quality 3.1.2