Quality of Groundwater, Proceedings of an International Symposium, Noordwijkerhout, 305
The Netherlands, 23–27 March 1981, W. van Duijvenbooden, P. Glasbergen and H. van Lelyveld (Eds.),
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POTENTIAL HEALTH IMPACTS OF SUBSURFACE SEWAGE SLUDGE DISPOSAL UPON GROUNDWATER RESOURCES

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ABSTRACT

A literature search was conducted to determine the impacts of subsurface sewage sludge disposal upon groundwater quality in the United States. Of the water quality parameters studied, nitrate, chloride, and selected trace metals, (e.g., cadmium, iron, mercury, and lead) appear to represent the greatest potential hazard. Microbial survival rates in sewage sludge were found to be proportional to their detection in underlying aquifers. Time and distance were also influential variables in microbial survival rates. Trench and co-disposal leachates represent a greater hazard to indigenous water quality than other disposal methods.

INTRODUCTION

The potential health impacts from subsurface municipal sewage sludge disposal and co-disposal practices are directly related to (1) the available pathways for disease transmission, (2) the nature of the contaminants, and (3) disposal site design. Detailed pathway charts were developed for the following potential pollutants:

- o general water quality contaminants;
- o elemental contaminants;
- o biocidal contaminants;
- o synthetic organic contaminants; and
- o biological contaminants.

Sludge disposal options examined in terms of their contribution to groundwater degradation included: (1) sludge only trenching (e.g., narrow and wide), (2) sludge only area fill (e.g., area fill mound, layer fill, and diked contaminant), and co-disposal (e.g., refuse or soil).

RESULTS

General water quality pathway charts developed from the available literature indicated that nitrate represented the greatest threat to groundwater degradation.

Phosphorus was found to be readily leached, although it is not considered a major hazard. Soil adsorption, followed by fixation by iron and aluminum oxides for acidic soils and precipitation by calcium phosphate for base soils effectively immobilized the phosphorus in most investigations. Of the major ions, chloride was readily leached from the sludge; chloride concentrations as high as 3000 ppm have been attributed to sludge leaching. TOC (total organic carbon) and sulfate appears to pose a potential threat although the data is highly conflicting as to the extent.

Elemental contaminant migration into groundwater was found to be minimized with lime addition to the bottom of the disposal site. While most elements were found to be bound in the soil column immediately underlying a site, cadmium, iron, mercury, and lead were reported to have migrated into groundwaters in several studies (1).

Identified biocidal contaminants which have been traced to the subsurface disposal of sludge have included DDT, dieldrin, 2,4-D, and parathion (2). While biocidal pathways have been identified, their concentrations appear to represent no health impact. Synthetic organic pathways which have been studied include PCB and chloroform. Conflicting data exists as to their impacts upon groundwaters.

Pathogen survival from subsurface sludge disposal has received little studv in the United States. Existing research indicates that bacteria as measured by coliform densities decrease logarithmically with time and distance from the disposal site (3). The majority of bacteria were removed in the first meter of soil although a study of eight sites which used fecal coliform and fecal streptococcus as indicators attributed increased bacteria populations in the groundwater 91.4 m (300 ft.) downgradient at one site (1). Quasim, et al. found that the highest bacterial populations using the standard plate count correlated well with maximum pH values (4).

Sludge disposal designs have a pronounced effect upon the pathways available for groundwater deterioration. A trench operation provides a conducive pathway for groundwater degradation primarily due to its greater proximity to groundwater resources than area fill methods. Slumping, mound erosion, and surface runoff inherent with area fill methods provide increased surface water infiltration into groundwater downgradient from the site. Co-disposal practices were found to provide the greatest potential for groundwater pollution resulting primarily from the mixing process. Co-disposal leachate also exhibits a lower pH (≅4.5), a higher maximum COD (chemical oxygen demand) concentration (≅90,000 ppm) and higher levels of iron (≅8000 ppm) and zinc (≅250 ppm) than for sludge only leachates. Disposal methods which contain only sludge were found to generate greater leachate volumes than co-disposal approaches.

SUMMARY

Subsurface disposal of municipal sewage sludge appears to affect groundwater

quality from increased concentrations of nitrate, chloride, and selected trace metals (cadmium, iron, mercury, and lead). Increased bacterial populations in groundwaters were also found to increase. Data addressing the impact of biocides and synthetic organic contaminants upon groundwaters is lacking. Trench disposal and co-disposal practices provide a greater threat to groundwater contamination than area fill methods.

REFERENCES

1 R.T. Lofy, H.T. Phung, and R.P. Stearns, Investigation of Groundwater Contamination from Subsurface Sewage Sludge Disposal, Vol. I., EPA No. 68-01-4166, Environmental Protection Agency, Washington, D.C., 1978, pp. 340.
2 L.J. Sikora, C.M. Murray, N.H. Frankos, and J.M. Walker, Water Quality at a Sludge Entrenchment Site Groundwater, Vol. 16, No. 2, March-April, 1978, pp. 96-104.
3 R.C. Cooper, Virus Survival in Solid Waste Treatment Systems, In: "Virus Survival in Water and Wastewater Systems, " J.F. Maline and B.P. Sagik (eds.), University of Texas at Austin, 1974, pp. 341.
4 S. P. Quasim, and J.C. Burchinal, Leaching from Simulated Landfills, Journal of Water Pollution Control Federation, Vol. 42, No. 3, 1978.