Biosolids – What is it? Why should we care?

Bill Toffey, Effluential Synergies LLC

Presentation to the Pennsylvania News Media Ass.

Mid-Atlantic Biosolids Association

What Are Biosolids?

GOOD NEWS! Biosolids is the good and inevitable result of wastewater treatment and clean rivers and streams

Biosolids: is a primarily organic, accumulated solids separated from wastewater, that has been stabilized by treatment and that can be beneficially used.

Sludge: is the unstabilized solids separated from wastewater

Each person produces about 50 pounds of wastewater solids annually.

Today, every community has infrastructure producing biosolids.

Prior to about 1970, the city of Philadelphia had no sludges to dispose, because wastewater treatment was non-existent or minimal, and the result was serious river quality degradation.

The first practice of biosolids disposal from coastal municipal plants with only primary level of treatment was ocean dispersal

With construction of wastewater plants throughout the state, the mass of solids requiring disposal increased by far more than 100 percent, as new areas were sewered and as treatment increased to secondary and advanced levels to meet high standards for water quality.

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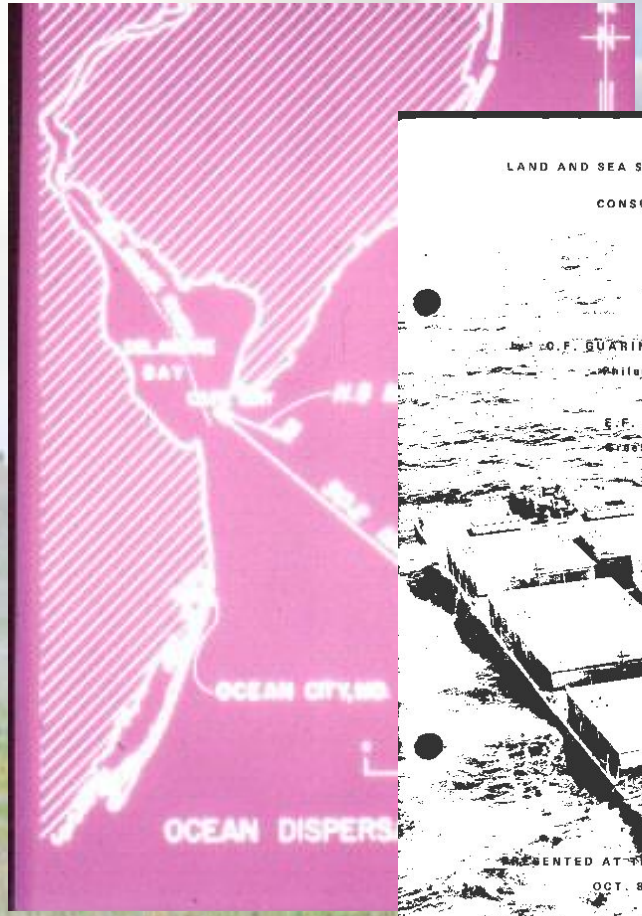
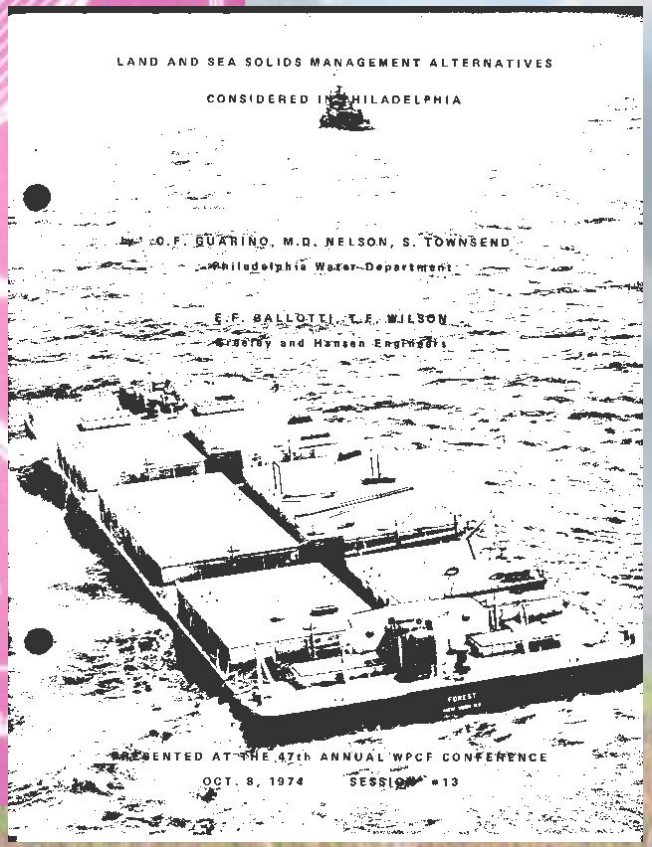
Transformation in Wastewater Management in 1970s and 1980s





For over a decade, sludges settled in lagoons, were periodically dredged, and barged for release at the edge of the deep ocean shelf off Cape May

As late as 1974, Philadelphia utility engineers argued that ocean dispersal was a benefit to ocean ecosystems.

Federal legislation stopped this practice and national policy actively promoted land-based use.

Philly's Ocean Dumping Days

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1970s Revolution in Regulations

The full weight of legislative and regulatory change resulted in ending all ocean disposal and moving to land application,

- The First **Earth Day** - April 22. 1970
  US EPA established - December 2, 1970
- **Marine Protection, Research and Sanctuaries Act (1972**) - bans ocean dispersal of sewage sludge
- **Surface Mining Control and Reclamation Act** (1973)
- **Resource Conservation and Recovery Act** (1976)

- **Clean Water Act** (1972) required Secondary Treatment and Industrial Pretreatment, provided construction grants for municipal facilities, and called for "**Standards for Use and Disposal of Sewage Sludge**"
- These "Part 503" standards were promulgated February 19, 1993.

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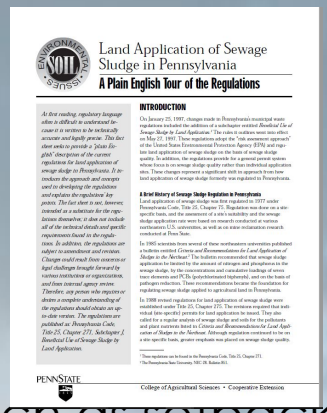
- Part 503 set minimum standards for all municipal biosolids and septage that is used on land. It set requirements for recordkeeping and reporting, and had 4 primary elements:
- 1. **Pollutant Standards**: Maximum levels of contaminant elements in biosolids
- 2. **Vector Attraction Reduction**: Pertains to treatment to reduce odors and attractiveness to flies
- 3. **Pathogen Reduction**: Two treatment levels for pathogens
  - Class B Pathogen Reduction
    - Lime (Alkaline) Stabilization
    - Anaerobic and Aerobic Digestion
  - Class A Further Pathogen Reduction
    - Composting
    - Advanced Alkaline Stabilization
    - Heat Drying


Land Application of Sewage Sludge in Pennsylvania
A Plain English Tour of the Regulations
INTRODUCTION
PENNSTATE
College of Agricultural Sciences • Cooperative Extension

- 4. **Standards for managing land application**, such as setbacks, erosion control, and nutrient limits.
- Most states, including Pennsylvania, adopted parallel standards, enforced and monitored by environmental agencies

Biosolids Treatment and Quality is Tested and Reported

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Throughout the U.S., a national practice was instituted in early 1980s to prevent discharge of industrial wastes into public sewers, **vastly decreasing pollutants** in municipal sludges and allowing for safe use as fertilizer..

Year	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
1973	33	712	700	1,261	148	2,031
1983	12.5	360	361	421	79	1,701
1993	7.3	209	764	225	51	1,444
2000	4.2	115	566	178	53	1,619

Concentrations shown above are in parts per million (milligrams/kilogram) of regulated elements in dry biosolids produced by the city of Philadelphia.

Industrial Pretreatment Was a Key to Recycling Success

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Published October, 1988

Municipal Sludge for Minespoil Reclamation: I. Effects on Microbial Populations and Activity

E. M. Seaker and W. E. Sopper*

ABSTRACT

A field study of five coal surface mine sites reclaimed with sewage sludge and one site reclaimed by conventional methods (chemical fertilizer) was conducted to assess the effects of sludge amendments and time on populations of bacteria, fungi, and actinomycetes, and on microbial respiration and organic matter decomposition. The sludge-amended sites ranged in age from 1 to 5 yr following sludge application at rates of 120 to 134 Mg ha^{-1} (dry wt. basis). All sites were planted to grass and legume cover. Populations of aerobic heterotrophic bacteria, fungi, and *Nitrobacter*, and soil respiration rate, were highest on the 1-yr-old site due to the high organic matter input. On the four older sites, values decreased, but remained within the ranges reported for undisturbed soils. Actinomycete populations peaked on the 3- and 4-yr-old sites, while populations of *Nitrosomonas* were not related to the age of the site. Decomposition rate was lowest on the 1-yr-old site, and increased significantly with site age. As measured by microbial populations and activity, ecosystem recovery on the sludge-amended sites appeared to be occurring at a more rapid rate than on the fertilizer-amended site, which after 5 yr, exhibited sparse microbial populations and low activity. The microbial populations in the sludge-amended spoil were not adversely affected by the heavy metals applied in the sludge, when compared with populations of soil microbes reported for undisturbed soils.

During surface mining in the eastern coal regions, soil is removed and stockpiled for later replacement. When the land is reclaimed, the final growing medium consists of a mixture of soil horizons and acidic spoil material, while abandoned mine sites may consist only of rocky overburden totally devoid of soil. In either case, the original soil ecosystem, structure, horizonation, microbial community, and fertility are drastically reduced or eliminated.

Although the immediate goal of reclamation is to establish a vegetative cover that will prevent soil erosion, the long-term goal is soil ecosystem development and stability. Minespoils lack microbial activity and organic matter (Visser, 1985; Mills, 1985; Fresquez and Lindemann, 1982). Microbial processes such as humification, soil aggregation, and N cycling are essential in establishing productivity in minespoils, and productivity should be evaluated not only on aboveground biomass, but also on the degree of development of functional microbial populations resembling those of an undisturbed soil. Microbial processes are so important to ecosystem recovery that the activity of microorganisms may be used as an index of the progress of soil genesis in minespoils (Schafer et al., 1980; Segal and Mancinelli, 1987).

If the premining organic layer (O horizon) has been destroyed, the only C source for microbial utilization is the plant biomass that is expected to accumulate over several growing seasons on the site. Until such accumulation occurs, microbial activity remains at a low level, with little improvement of adverse soil physical and nutrient conditions. Vegetation growth and maintenance are also inhibited. On sites reclaimed with chemical fertilizers and lime, vegetation may initially be established, but poor physical conditions result in deterioration of the vegetative cover before it can begin to ameliorate the spoil (Stroo and Jencks, 1982). On both alkaline and acidic minespoils, microbial activity, nutrient cycling, and spoil organic matter levels may take 30 to 300 yr to be reestablished (Segal and Mancinelli, 1987; Stroo and Jencks, 1982; Mills, 1985; Anderson, 1977; Schafer et al., 1980).

The use of sewage sludge as an organic amendment for minespoil reclamation has been extremely successful (Varanka et al., 1976; Fresquez and Lindemann, 1982; Visser, 1985; Seaker and Sopper, 1984) because of its immediate improvement of spoil chemical and physical conditions, acceleration of plant establishment and growth, and achievement of long-term productivity. The organic C and nutrient content of sludge is responsible for achieving a self-maintaining cover on minespoils, but very few studies have quantitatively measured the effects of sludge application on microbial populations and activity, compared to sites reclaimed with lime and chemical fertilizer.

It has been proposed that heavy metals, many of which may be present in sludge, could potentially disturb the population dynamics and general ecology of soil microbes in natural habitats (Babich and Stotsky, 1977a). At high levels, inorganic salts of Zn, Cu, Cd, Cr, and Pb have been shown to interfere with microbial metabolism in laboratory cultures. Most studies involved metal concentrations far in excess of those found in land application systems using "typical sludges" with median metal concentrations at agricultural rates (Mathur et al., 1979; Bhuiya and Cornfield, 1974; Lighthart et al., 1983). Numerous studies have indicated that binding of metals to organic materials and clay minerals, precipitation, complexation, and ionic interactions significantly decrease their inhibitory effects on microbial activity (Gadd and Griffiths, 1978), so that inhibition by metals is substantially less in a soil system than in pure culture media (Babich and Stotsky, 1977b; Tomlinson, 1966).

The objective of this study was to determine the effects of minespoil amendment with municipal sewage sludge on the populations and activity of aerobic heterotrophic bacteria, chemoautotrophic *Nitrosomonas* and *Nitrobacter*, fungi, and actinomycetes on sites ranging in age from 1 to 5 yr following reclamation with sludge. Microbial status was determined by population counts supplemented with measurements of respiration and organic matter decomposition rates.

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SPECIAL SUBMISSIONS

Sustainable Land Application: An Overview

G. A. O'Connor,* H. A. Elliott, N. T. Basta, R. K. Bastian, G. M. Pierzynski, R. C. Sims, and J. E. Smith, Jr.

ABSTRACT

Man has land-applied societal nonhazardous wastes for centuries as a means of disposal and to improve the soil via the recycling of nutrients and the addition of organic matter. Nonhazardous wastes include a vast array of materials, including manures, biosolids, composts, wastewater effluents, food-processing wastes, industrial by-products; these are collectively referred to herein as residuals. Because of economic restraints and environmental concerns about land-filling and incineration, interest in land application continues to grow. A major lesson that has been learned, however, is that the traditional definition of land application that emphasizes applying residuals to land in a manner that protects human and animal health, safeguards soil and water resources, and maintains long-term ecosystem quality is incomplete unless the earning of public trust in the practices is included. This overview provides an introduction to a subset of papers and posters presented at the conference, "Sustainable Land Application," held in Orlando, FL, in January 2004. The USEPA, USDA, and multiple national and state organizations with interest in, and/or responsibilities for, ensuring the sustainability of the practice sponsored the conference. The overriding conference objectives were to highlight significant developments in land treatment theory and practice, and to identify future research needs to address critical gaps in the knowledge base that must be addressed to ensure sustainable land application of residuals.

Since the early 1970s, scientists, engineers, regulators, and interested parties in the waste management field have met each decade to access the body of knowledge on land application of municipal wastewaters and sludges. Past themes include: "Recycling Municipal Sludges and Effluents on Land" (1973, Champaign-Urbana, IL); "Utilization of Municipal Wastewater and Sludges on Land" (1983, Denver, CO); and "Sewage Sludge: Land Utilization and the Environment" (1993, Bloomington, MN). Each conference resulted in major publications (National Association of State Universities and Land Grant Colleges, 1973; Page et al., 1987; Clapp et al., 1994) describing and critically evaluating the science that ultimately formed the basis for national regulations and guidelines for waste management. In January 2004, we convened what we intended to be a similarly effective, international conference, "Sustainable Land Application," in Orlando, FL. The conference addressed soil reactions of constituents in biosolids, effluents, manures, and other nonhazardous wastes (e.g., composts, water treatment residuals, food residues). The inclusion of manures and other nonhazardous wastes (referred to collectively hereafter as residuals) was an intentional broadening of the previous conference themes mentioned above. Often, residual constituent reactions in soils depend much more on the soil, and basic biogeochemical reactions therein, than on the residual. Thus, we felt that focusing on fundamental reactions, rather than specific residuals, would further sustainable land application of the residuals of modern society and would engage a wider array of scientists.

Mullin (2004) defines sustainability as the "triple bottom line" of economic prosperity, environmental stewardship, and corporate social responsibility. He argues that industries' newly focused plans for "reengineering" and "globalization" will ultimately fail without public trust in the safety of what the industries produce and/or do. Therefore, a more traditional description of sustainability that emphasizes applying residuals to land in a manner that protects human and animal health, safeguards soil and water resources, and maintains long-term ecosystem quality (Crites et al., 2000) is incomplete unless the earning of public trust is included. Thus, while the "Sustainable Land Application" conference focused on traditional "hard" science (e.g., soil chemistry, microbiology, and fertility), various speakers and conference participants also addressed public education, involvement, and trust issues.

This overview provides an introduction and partial synthesis of several papers and posters presented at the conference, as well as comments offered by conference participants. A complete listing of abstracts from all conference presentations is available on the conference website (www.conference.ifas.ufl.edu/landapp; verified 25 Aug. 2004). The conference was primarily sponsored by the USEPA, but a multitude of other national and state organizations and regulatory agencies provided generous support as well.

CONFERENCE OBJECTIVES AND TOPICS

The conference objectives were to:

- Review fundamental and specific soil reactions of nonhazardous residuals constituents.

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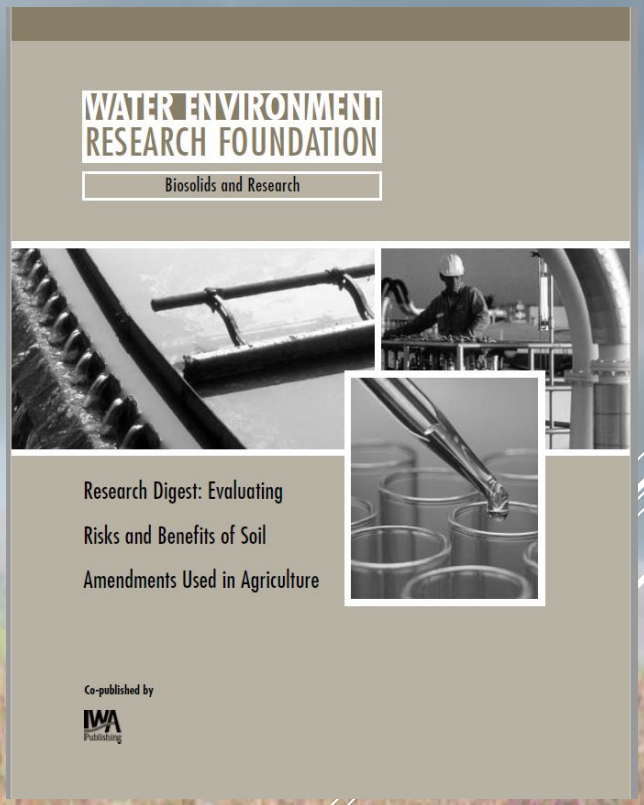
Agricultural scientists in the US and globally participated in research of biosolids effects on soils and plants to provide scientific basis for regulations. Rigorous research continues today.



Decades of Research Supports Use of Biosolids on Land

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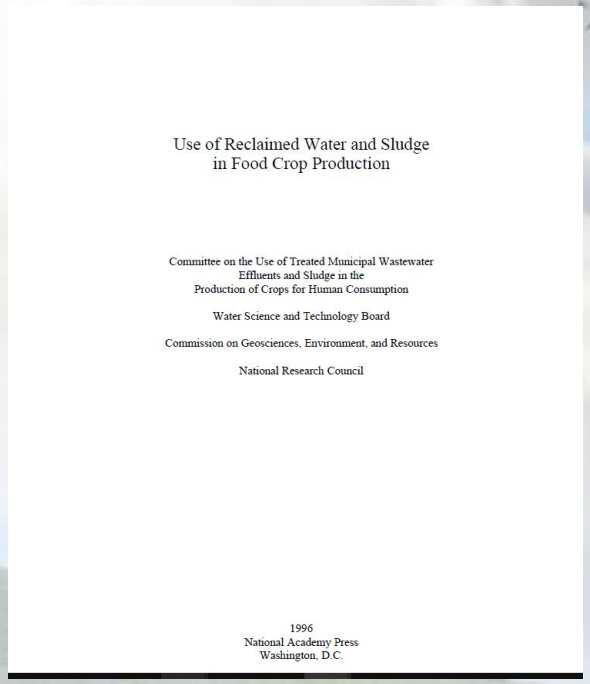
The soundness of land recycling of biosolids have been confirmed repeatedly at national and state levels by independent review of practices and environmental effects.


Use of Reclaimed Water and Sludge
in Food Crop Production

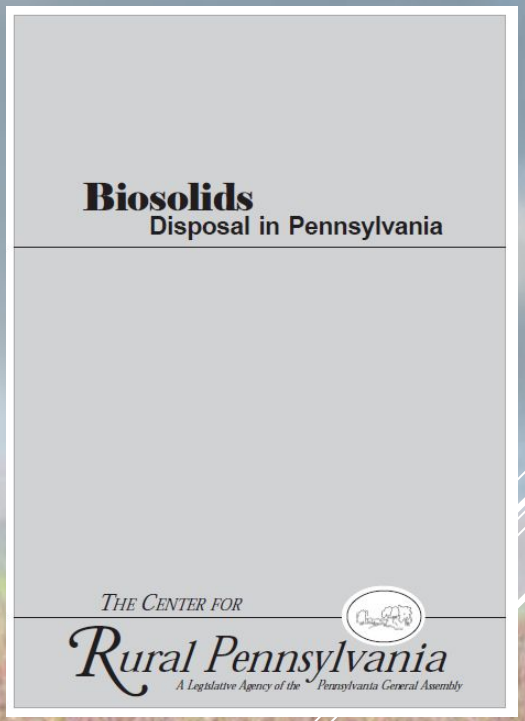
Committee on the Use of Treated Municipal Wastewater
Effluents and Sludge in the
Production of Crops for Human Consumption

Water Science and Technology Board

Commission on Geosciences, Environment, and Resources

National Research Council

1996
National Academy Press
Washington, D.C.



Over 200,000 peer reviewed science articles on biosolids between 1993 and 2023

Reviews Confirm Benefits of Biosolids Recycling

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A cooperative project from 2000 to 2003 for restoring wildlife habitat on abandoned mine lands using municipal biosolids for nutrients and organic matter lead to tremendous results for the land, for state game and for the watershed and its supporters. .

Biosolids Has Been a Success in Pennsylvania and Nation-wide

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