NATIONAL biosolids PARTNERSHIP

Recognizing A Resource:

biosolids

A Roadmap for State & Regional Biosolids Coordinators

and other interested parties

Part 2: 40+ Years of Research & Experience

This and the other parts of this presentation are available at http://www.wef.org/Biosolids/page.aspx?id=7522

NATIONAL biosolids PARTNERSHIP

Audience

This presentation is intended for:

- U.S. EPA biosolids program staff
- U.S. EPA regional biosolids coordinators
- State biosolids regulatory agency staff (e.g. state biosolids coordinators)
- Managers of biosolids
- Wastewater treatment facility staff
- Biosolids program design engineers
- Distributers & users of biosolids products
- Other interested parties

Purpose

This presentation is intended to:

- Summarize the history and current status of federal and state biosolids regulations in the United States (U.S.)
- Summarize the state of the science & experience with biosolids management
- Summarize current trends & what can be expected in the future

So that all involved in setting policy & regulations and implementing biosolids management programs *recognize this resource.*

Sustainable biosolids management requires maximizing the utilization of resources in biosolids and minimizing landfill disposal & combustion without energy recovery.

Contents

This presentation, produced by the National Biosolids Partnership, consists of the following 3 parts:

Part 1: Federal & State Regulations (see separate file)

Part 2: 40+ Years of Research & Experience (presented here)

- Research has shown the benefits and manageable risks…
- …And the research goes back decades
- Examples of long-term research programs
- The research addresses the risks
- Three topics of greatest concern: trace elements (heavy metals), chemicals, pathogens
- 40+ years of experience
- What is critical for success? Best practices
- Proactive communications is a best practice

Part 3 (see separate file):

- Trends & Drivers in Biosolids Management
- Focusing on *Resource Recovery*

40+ Years of Research…

The amount of research that has been done regarding biosolids treatments and use on soils is substantial, dating back to the 1960s – thousands of published papers and several state-of-the-science reviews, including by the National Academy of Sciences (NAS) / National Research Council.

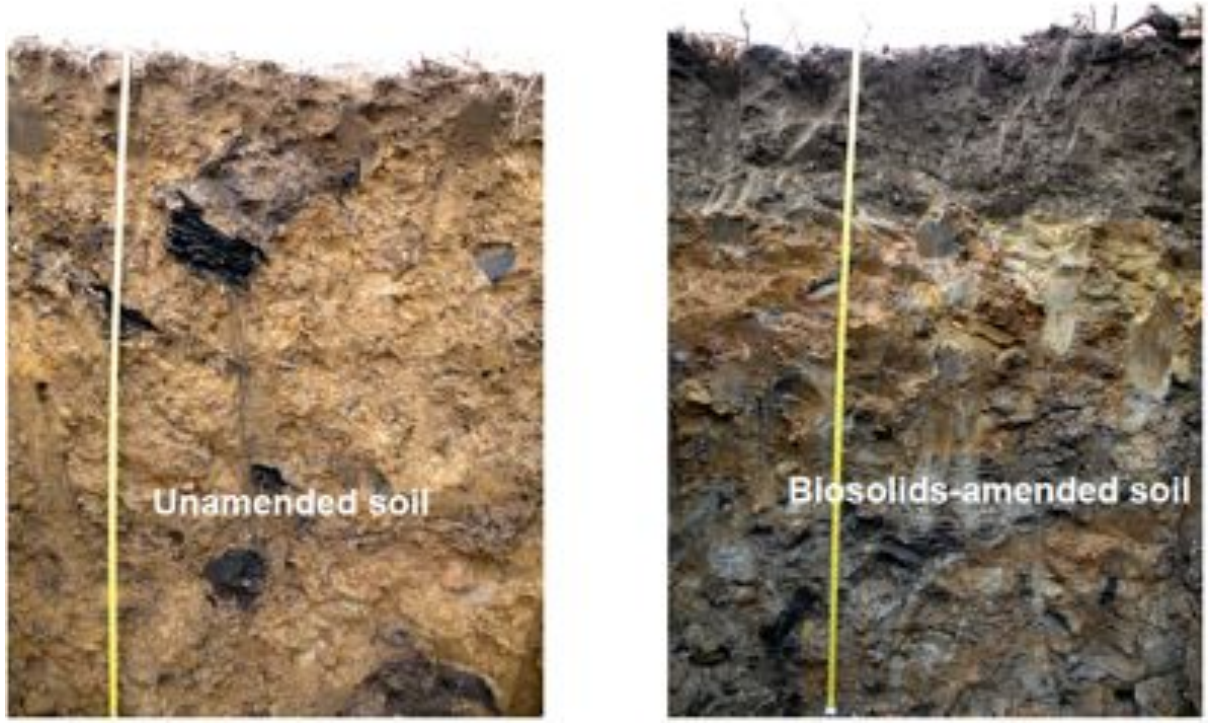
Universities involved in biosolids research

- Univ. of Maine
- Univ. of New Hampshire
- Univ. of Massachusetts
- Cornell Univ., New York*
- Penn State Univ.*
- Univ. of Delaware
- Virginia Tech*
- North Carolina State Univ.*
- Univ. of Georgia
- Univ. of Florida*
- The Ohio State Univ.*
- Univ. of MN* / USDA
- Tulane Univ.
- Univ. of Guelph / OMAFRA*
- Ryerson Univ. / OMAFRA
- Univ. of Nebraska*
- Univ. of Manitoba*
- Univ. of Alberta*
- Colorado State Univ.*
- Utah State Univ.*
- Univ. of Arizona*
- Univ. of California – Riverside*
- Washington State Univ.*
- Univ. of Washington*
- Univ. of British Columbia*
- *…and more…*

* long-term research; many papers

40+ Years of Research…

…has shown the benefits & manageable risks

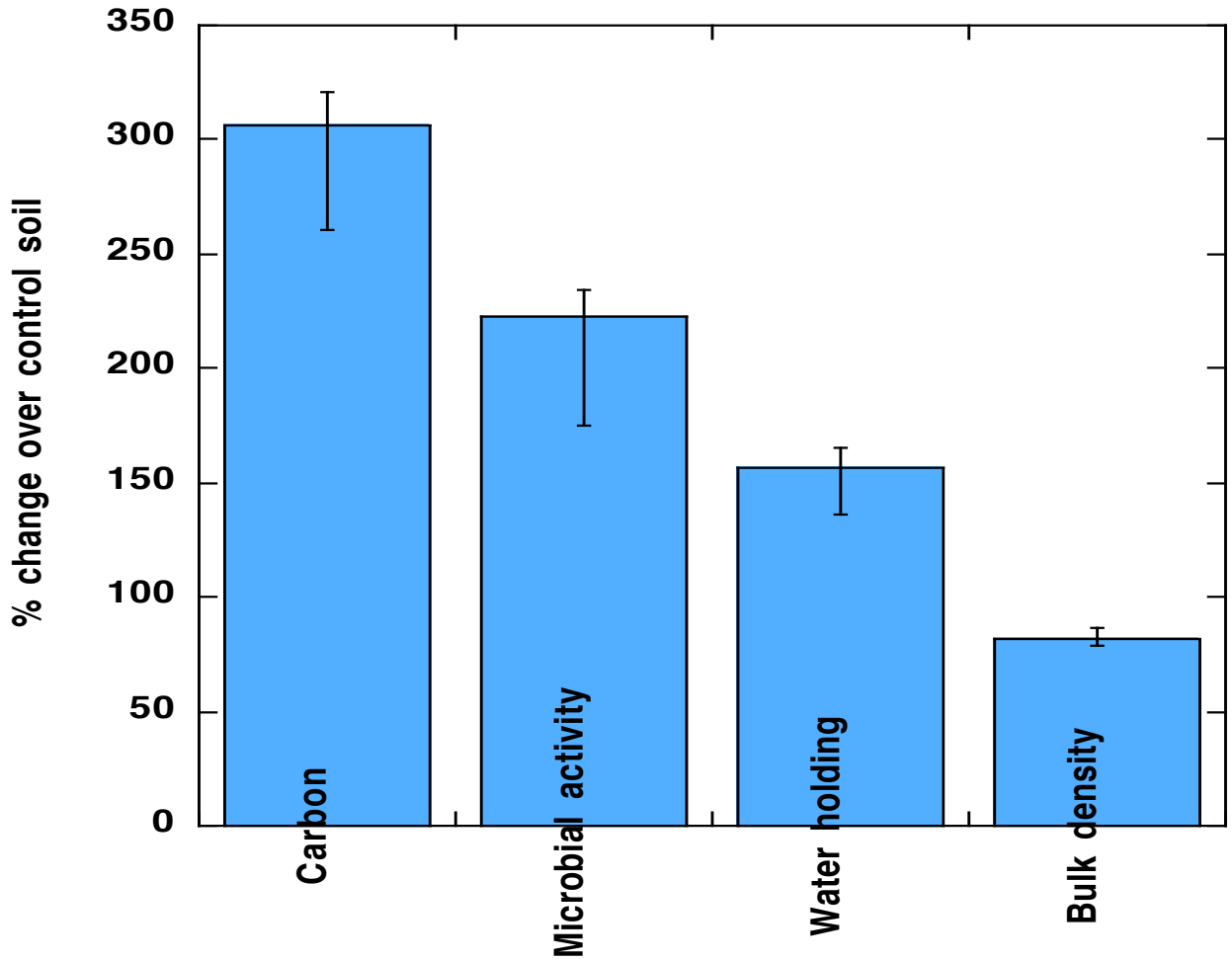


Biosolids improve soils.

40+ Years of Research…

Findings: Organic residuals improve soils

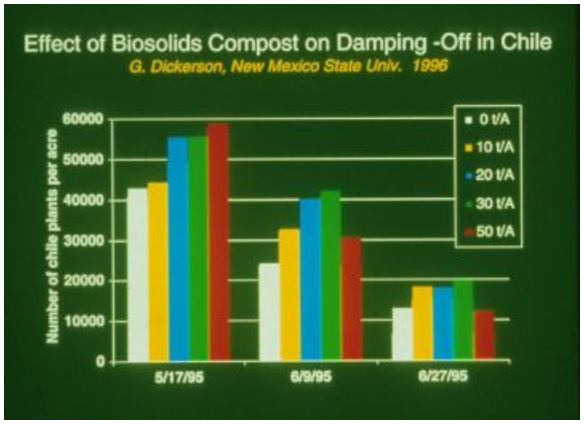
Univ. of Washington study, 2011



Numerous studies demonstrate the benefits derived from adding organic matter, such as biosolids, to soils: higher carbon content (carbon sequestration), increased microbial activity, increased water-holding capacity, and lower bulk density (which means easer tillage & handling).

40+ Years of Research…

Findings: Biosolids compost benefits

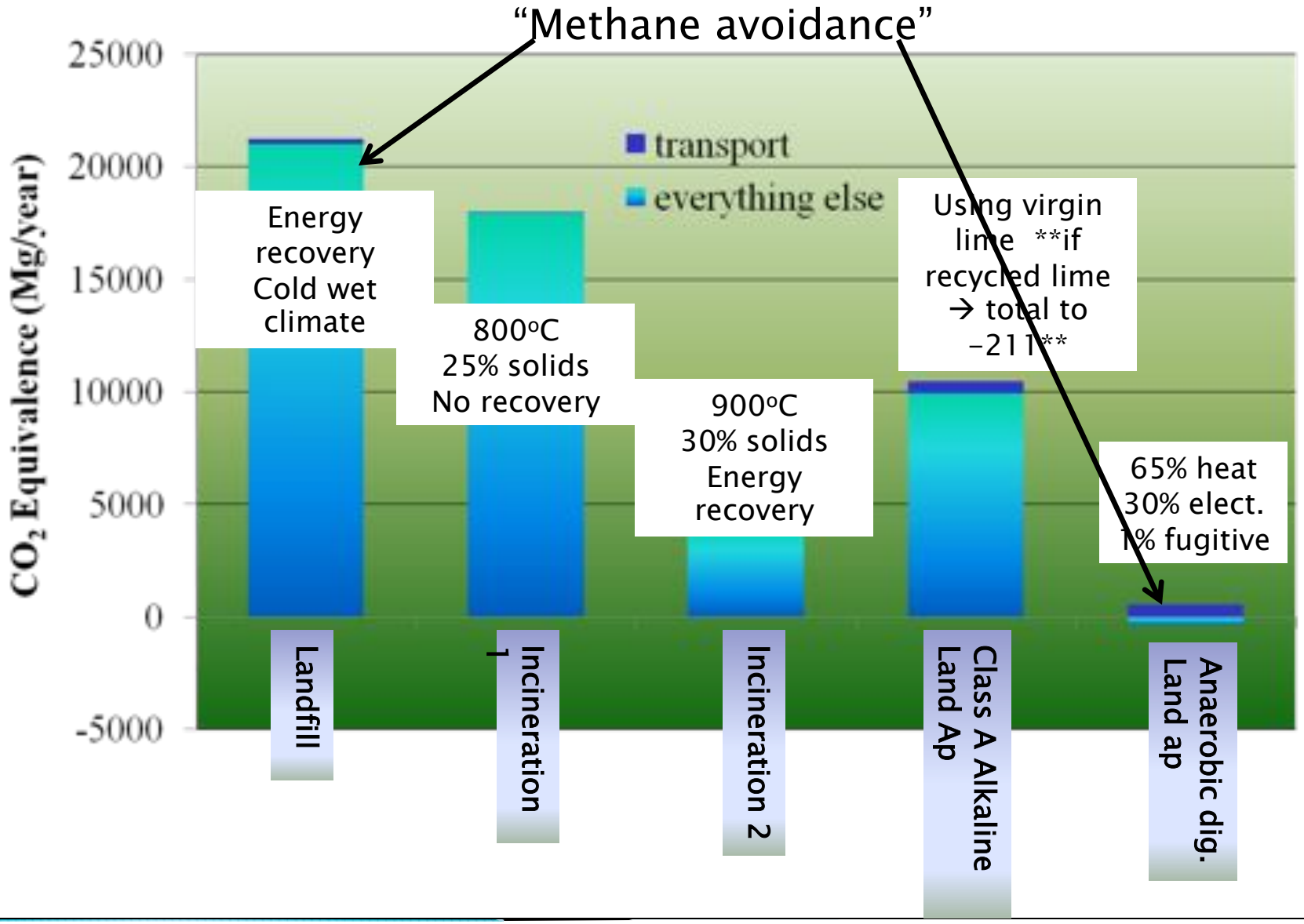


- Improved crop nutritional value (micronutrients)
- Slow release of nutrients = less nutrient pollution of ground & surface waters
- Reduced use of pesticides / fungicides (due to improved biological richness in soil & healthier plants)
- Improved water holding capacity of soil, reducing irrigation needs (adding 30% compost tosoil = an additional 1.9 gallons/cubic foot of water holding)
- Suppress plant diseases and pests.
- Reduce the need for chemical fertilizers.
- Promote higher yields of agricultural crops.
- Facilitate reforestation, wetlands restoration, and habitat revitalization efforts by amending contaminated, compacted, and marginal soils.
- Cost-effectively remediate soils contaminated by hazardous waste.
- Remove solids, oil, grease, and heavy metals from stormwater runoff.
- Capture and destroy 99.6 percent of industrial volatile organic chemicals (VOCs) in contaminated air.
- Provide cost savings of at least 50 percent over conventional soil, water, and air pollution remediation technologies, where applicable.

See also…
http://www.epa.gov/waste/conserve/rrr/composting/basic.htm

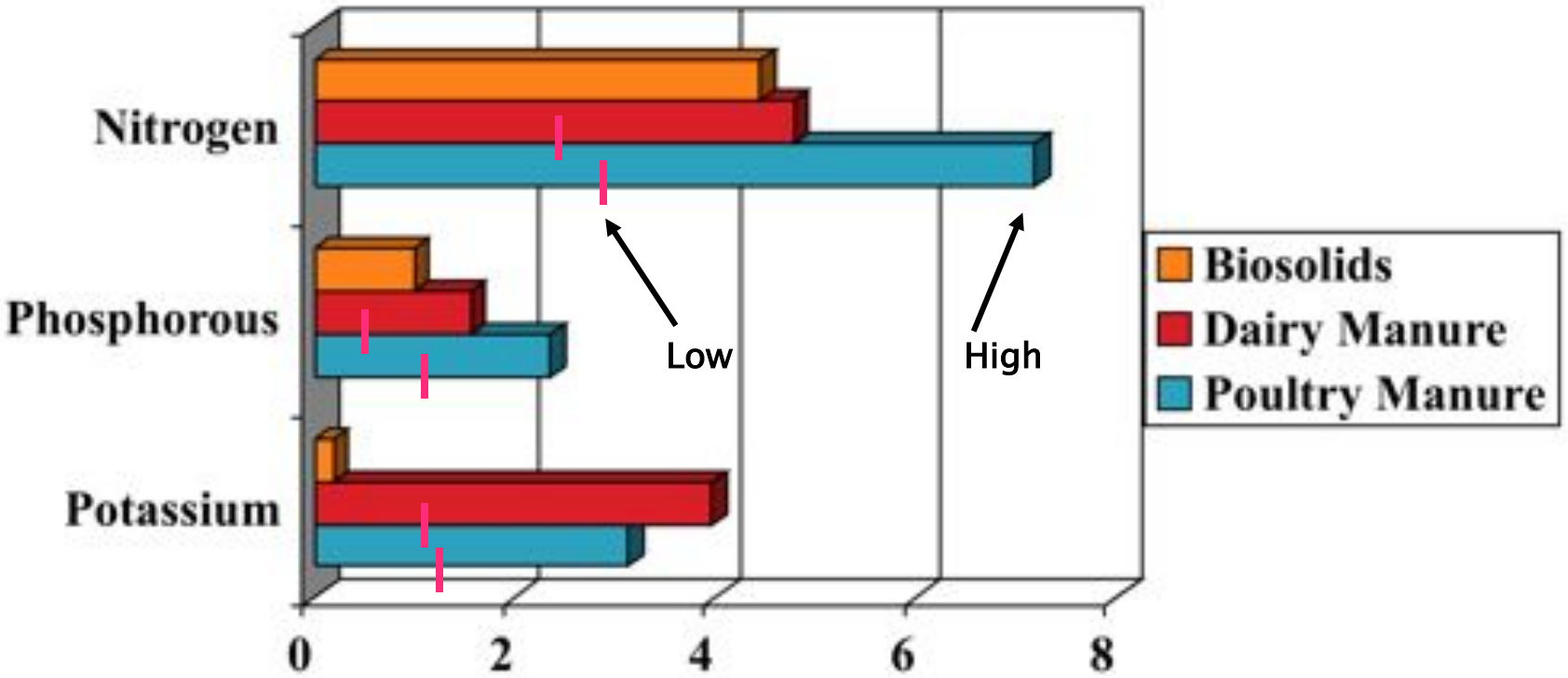
40+ Years of Research…

Findings: Lower GHG emissions from use on soils



40+ Years of Research…

And farmers use biosolids because they provide nutrients



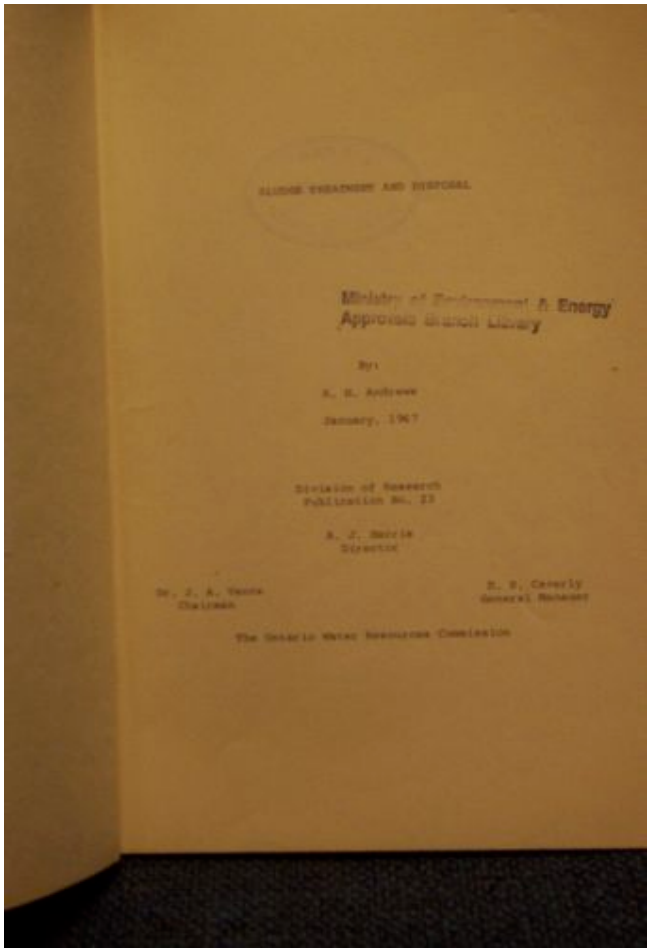
Biosolids values from *The Use of Biosolids in Maine: A Review* (report by the Mitchell Center)
Manure Values adapted from ASAE Standards 2000

40+ Years of Research…

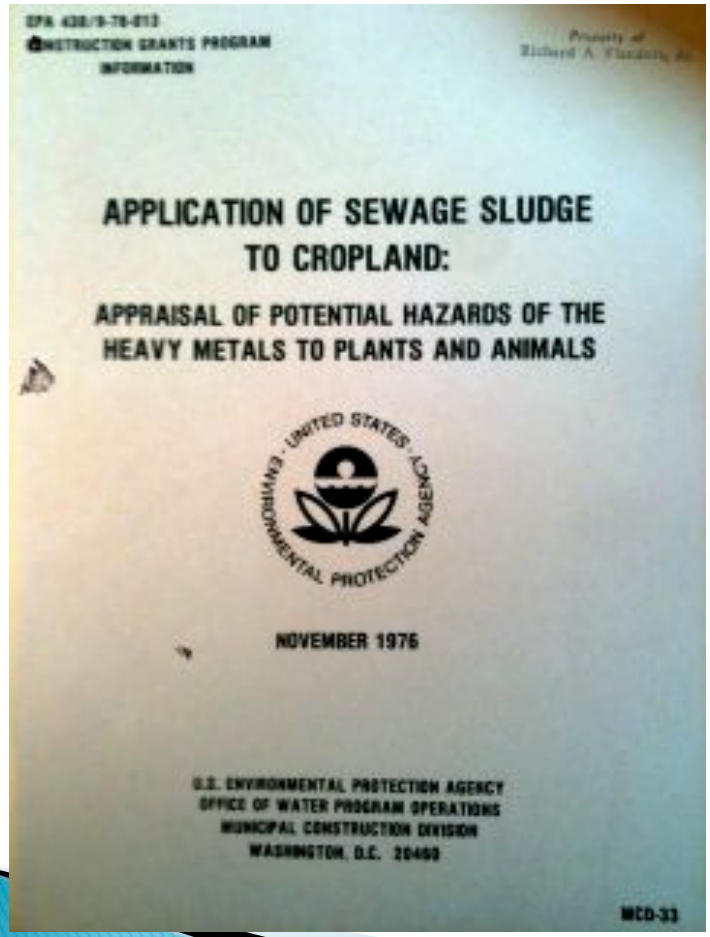
And the research goes back decades…

1967:

"Sludge Treatment and Disposal"
Ontario Water Resources Commission

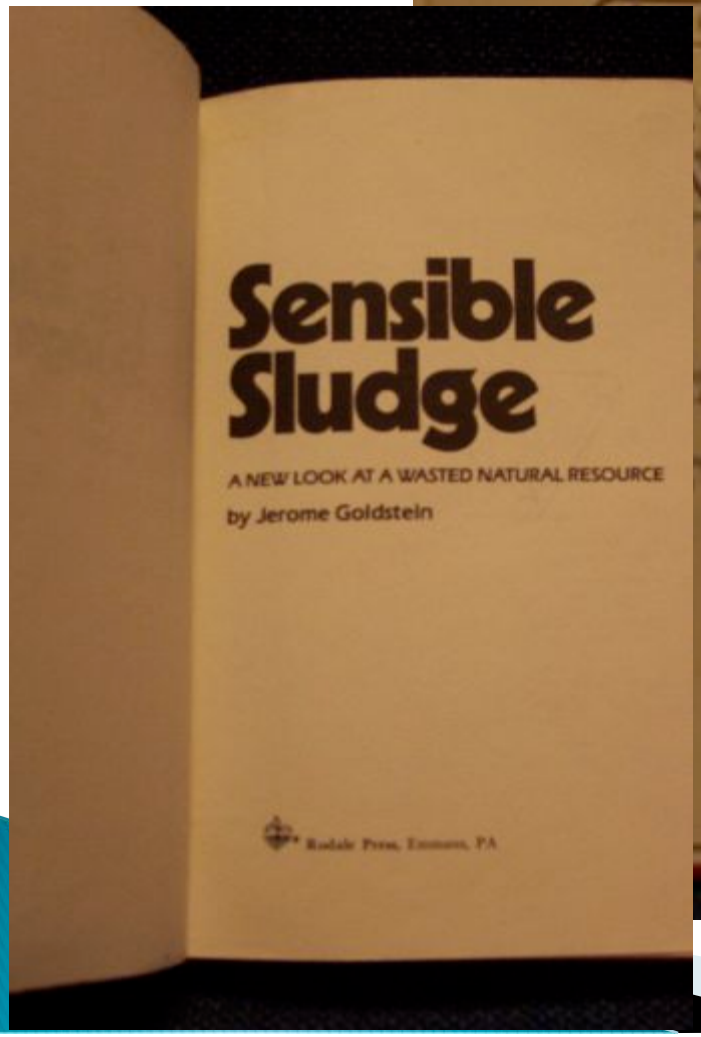


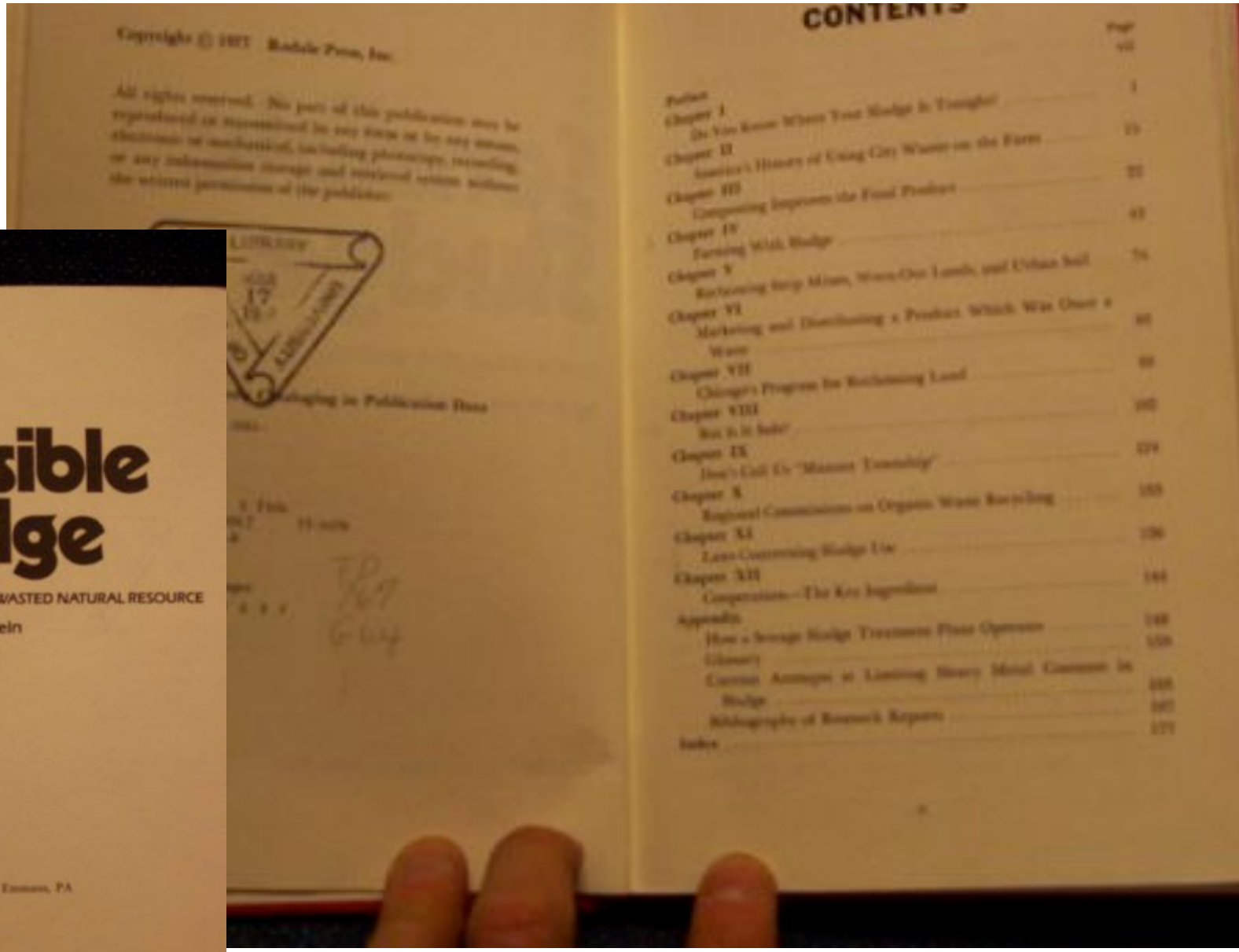
1976:


EPA 430/9-76-013
INSTRUCTION GRANTS PROGRAM
INFORMATION
APPLICATION OF SEWAGE SLUDGE
TO CROPLAND:
APPRAISAL OF POTENTIAL HAZARDS OF THE
HEAVY METALS TO PLANTS AND ANIMALS
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NOVEMBER 1976
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
MUNICIPAL CONSTRUCTION DIVISION
WASHINGTON, D.C. 20460
MCD-33


LAND
APPLICATION
OF WASTE
MATERIALS
SOIL CONSERVATION SOCIETY OF AMERICA

1977:


Sensible
Sludge
A NEW LOOK AT A WASTED NATURAL RESOURCE
by Jerome Goldstein


CONTENTS

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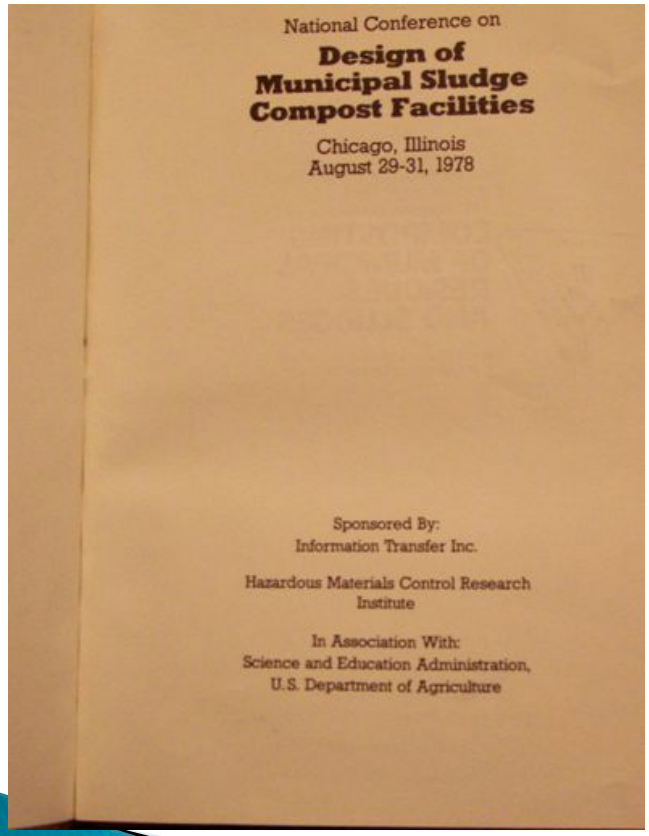


National Conference on

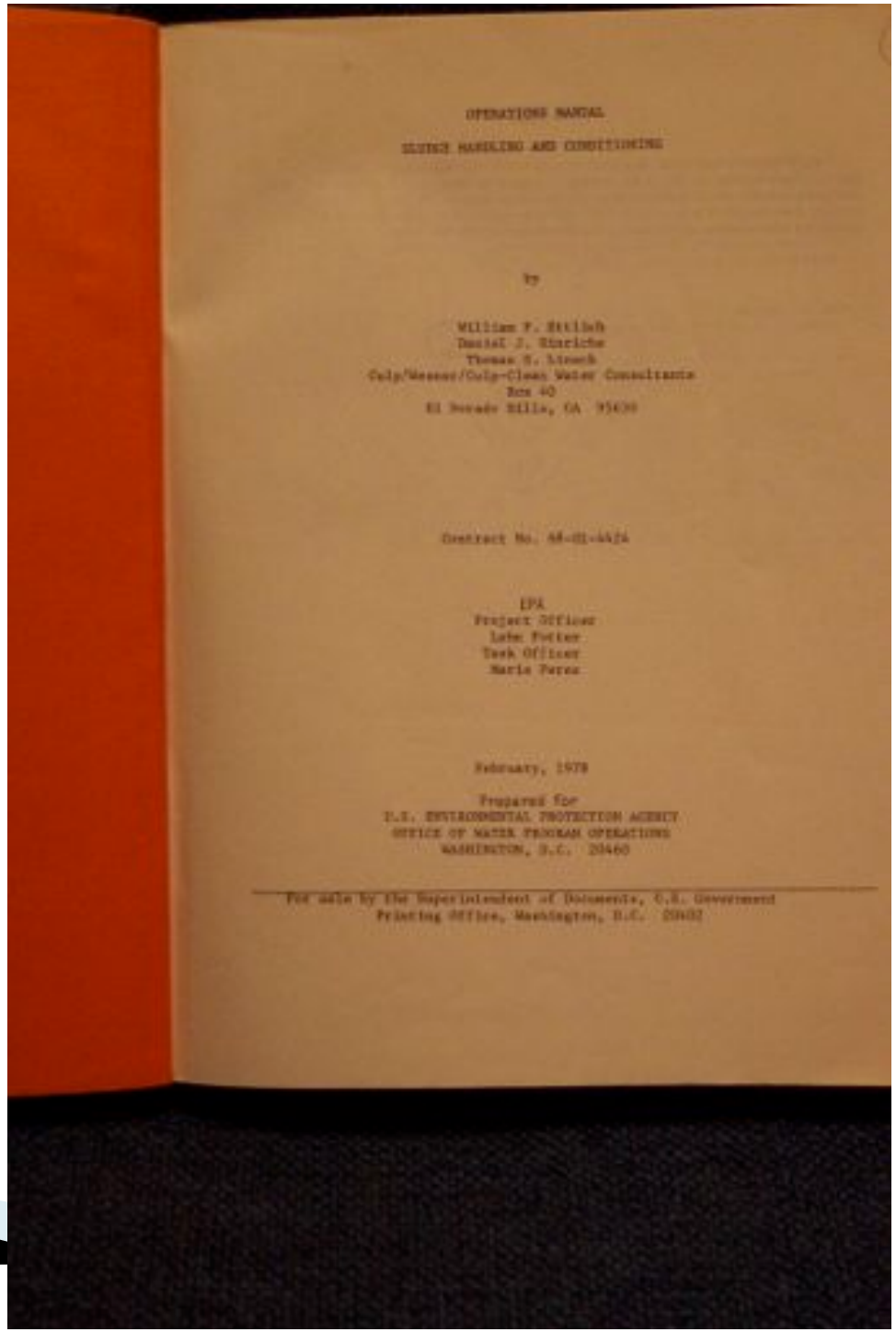
Design of Municipal Sludge Compost Facilities

Chicago, Illinois
August 29-31, 1978

Sponsored By:
Information Transfer Inc.

Hazardous Materials Control Research Institute

In Association With:
Science and Education Administration,
U.S. Department of Agriculture



OPERATIONS MANUAL

SLUDGE HANDLING AND CONDITIONING

by

William F. Ettlich
Daniel J. Stanicke
Thomas S. Leach
Culp/Wesner/Culp-Clean Water Consultants
Box 40
El Dorado Hills, CA 95630

Contract No. 68-01-4474

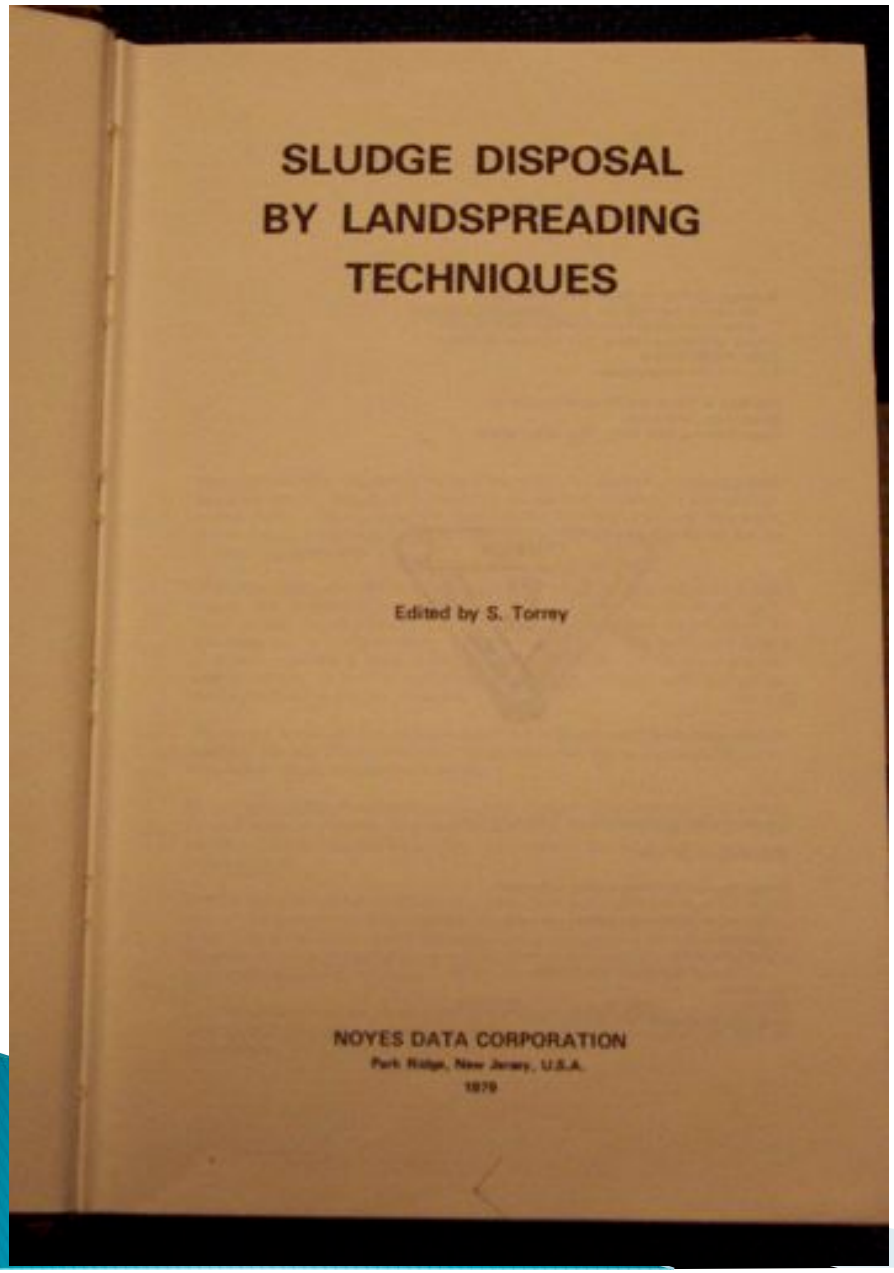
EPA
Project Officer
Lahe Fetter
Task Officer
Maria Perez

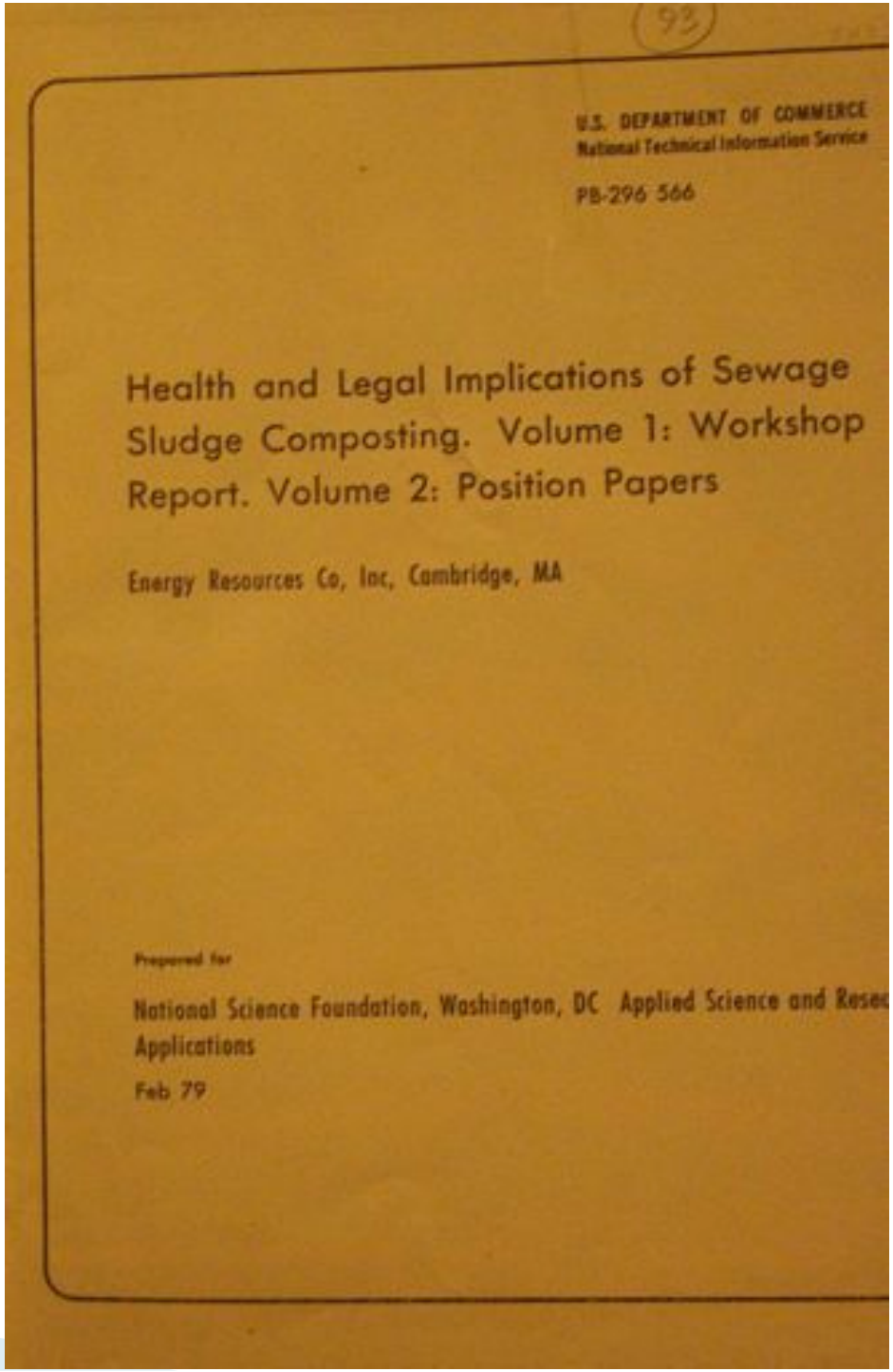
February, 1978

Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
WASHINGTON, D.C. 20460

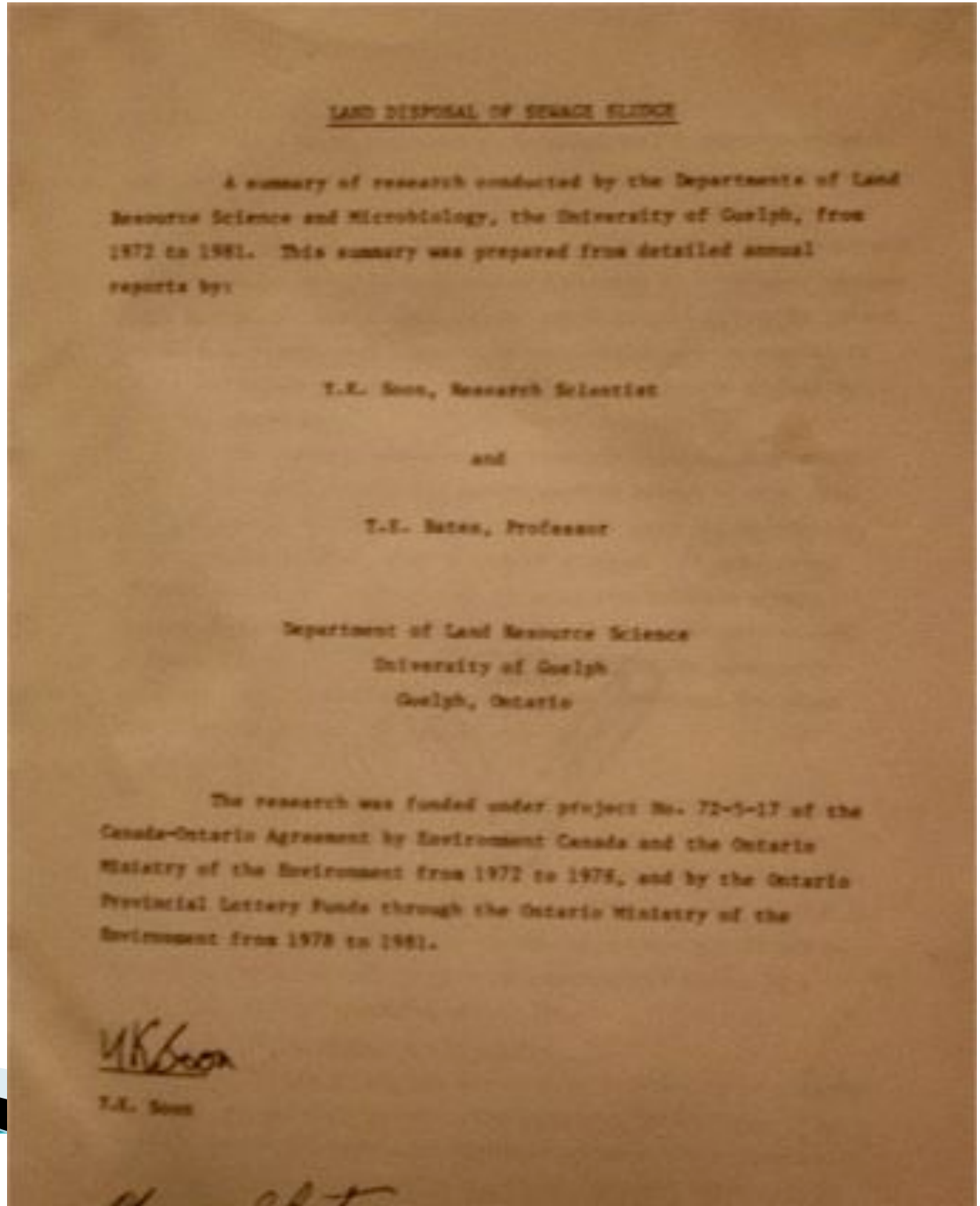
For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

1979:


SLUDGE DISPOSAL
BY LANDSPREADING
TECHNIQUES
Edited by S. Torrey
NOYES DATA CORPORATION


U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-296 566
Health and Legal Implications of Sewage Sludge Composting. Volume 1: Workshop Report. Volume 2: Position Papers
Energy Resources Co, Inc, Cambridge, MA
National Science Foundation, Washington, DC Applied Science and Rese
Applications
Feb 79

Univ. of Guelph research, 1972-1981



LAND DISPOSAL OF SEWAGE SLUDGE

A summary of research conducted by the Departments of Land Resource Science and Microbiology, the University of Guelph, from 1972 to 1981. This summary was prepared from detailed annual reports by:

T.E. Soon, Research Scientist

and

T.E. Bates, Professor

Department of Land Resource Science
University of Guelph
Guelph, Ontario

The research was funded under project No. 72-5-17 of the Canada-Ontario Agreement by Environment Canada and the Ontario Ministry of the Environment from 1972 to 1978, and by the Ontario Provincial Lottery Funds through the Ontario Ministry of the Environment from 1978 to 1981.

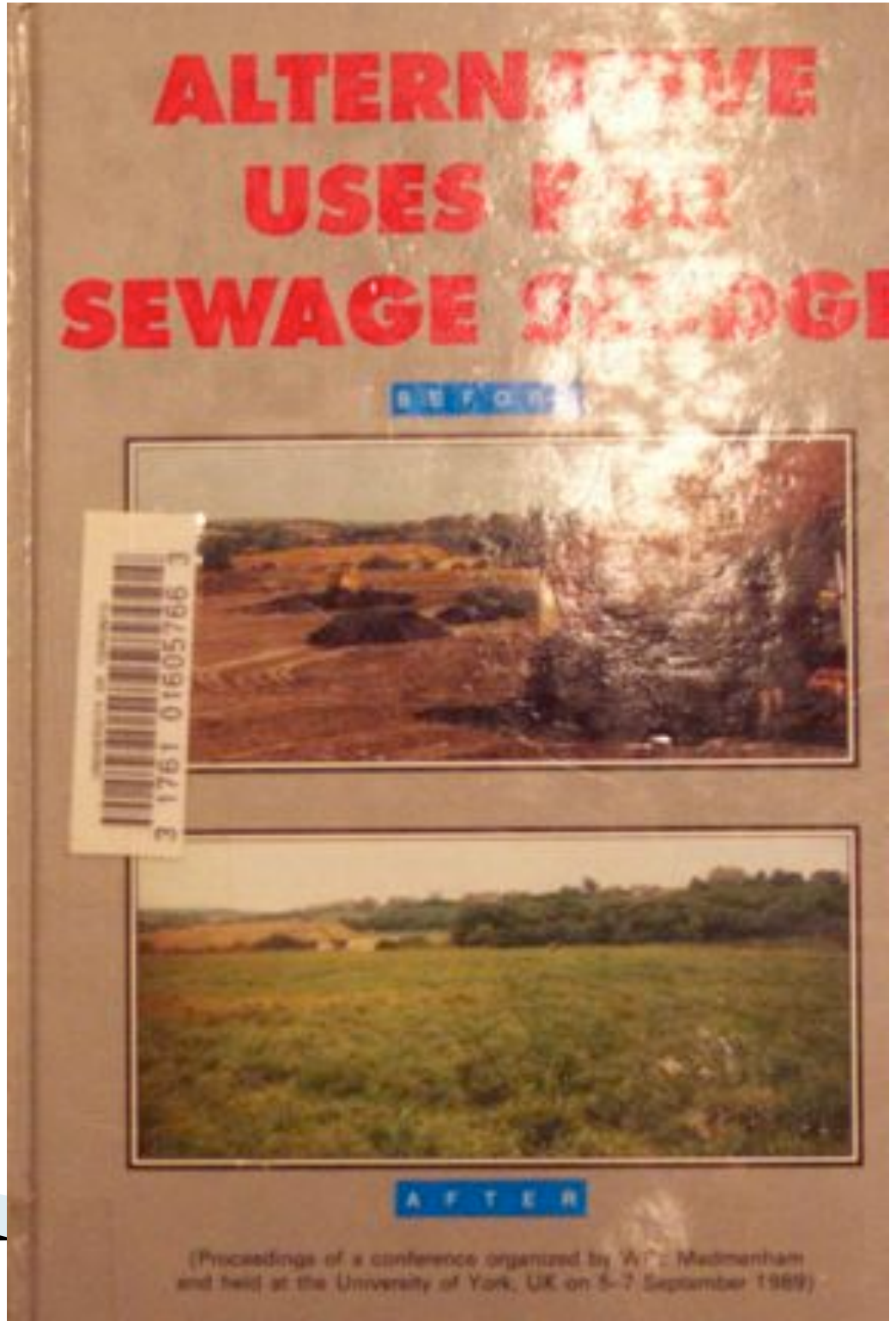
T.E. Soon

1984:


EPA
Environmental Regulations and Technology
Use and Disposal of Municipal Wastewater Sludge
Sept 84

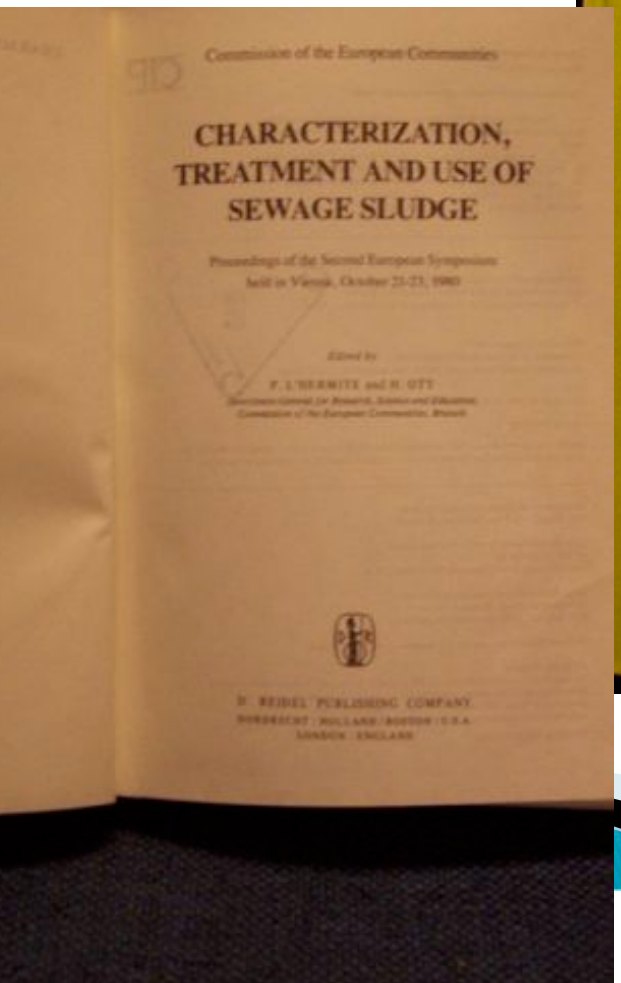
1989:

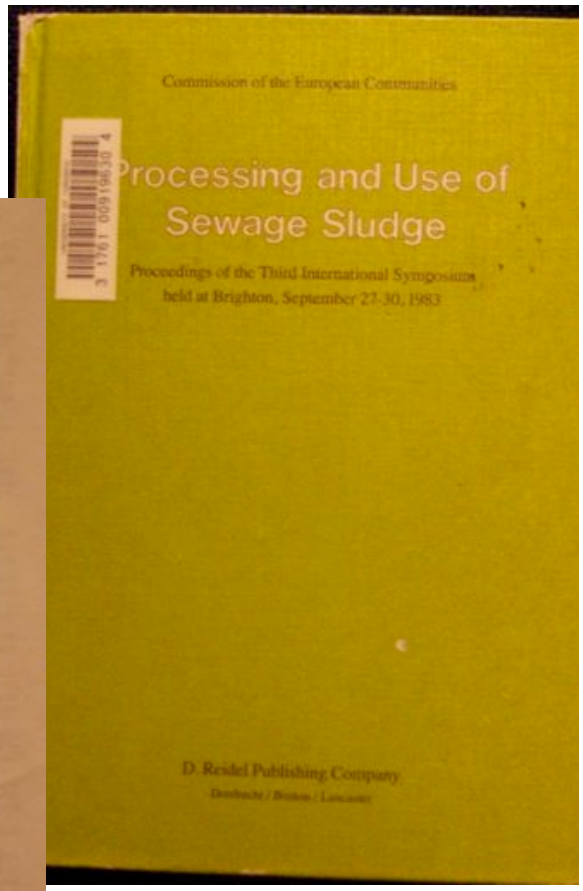
Proceedings of technical conference at University of York, UK



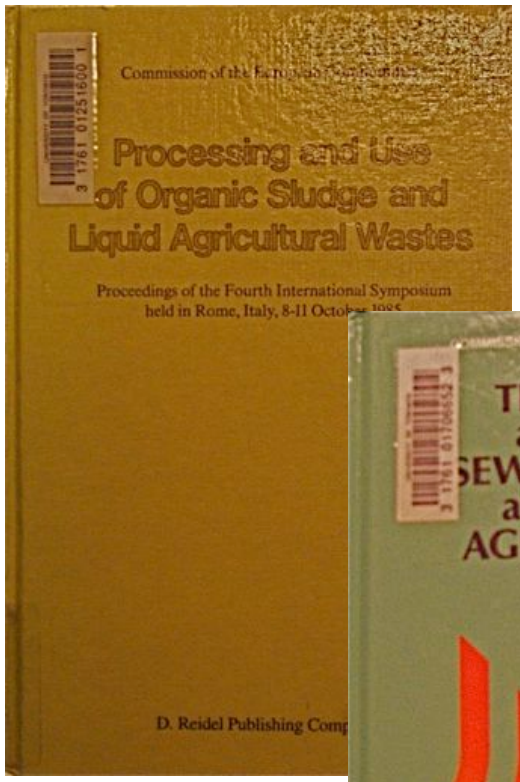
Commission of the European Communities:

1980

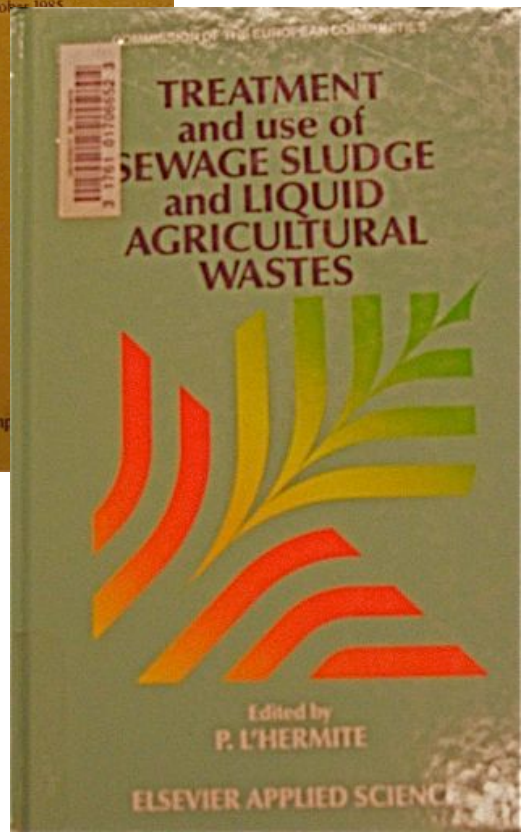




1983

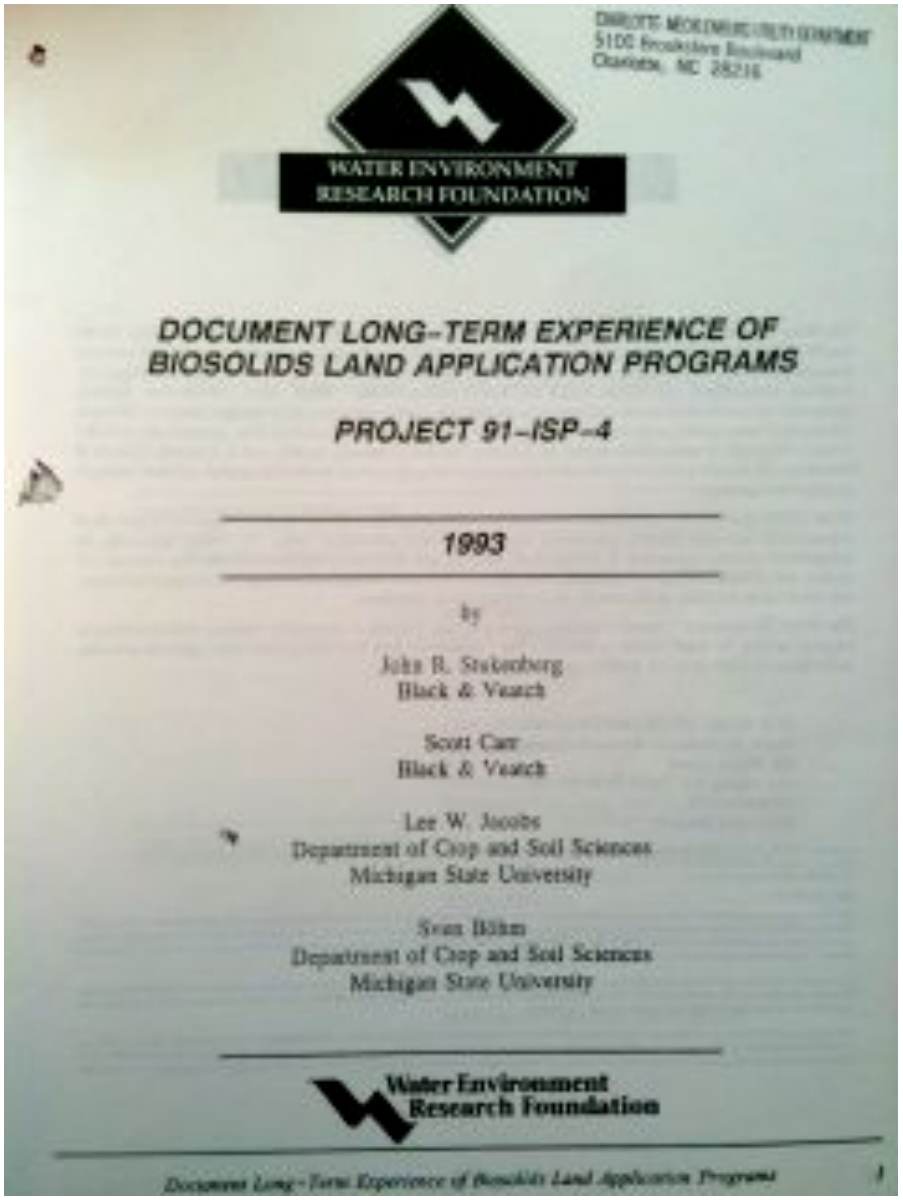


1985



1991

1993:



WATER ENVIRONMENT RESEARCH FOUNDATION

DOCUMENT LONG-TERM EXPERIENCE OF BIOSOLIDS LAND APPLICATION PROGRAMS

PROJECT 91-ISP-4

1993

by

John R. Stukenberg
Black & Veatch

Scott Carr
Black & Veatch

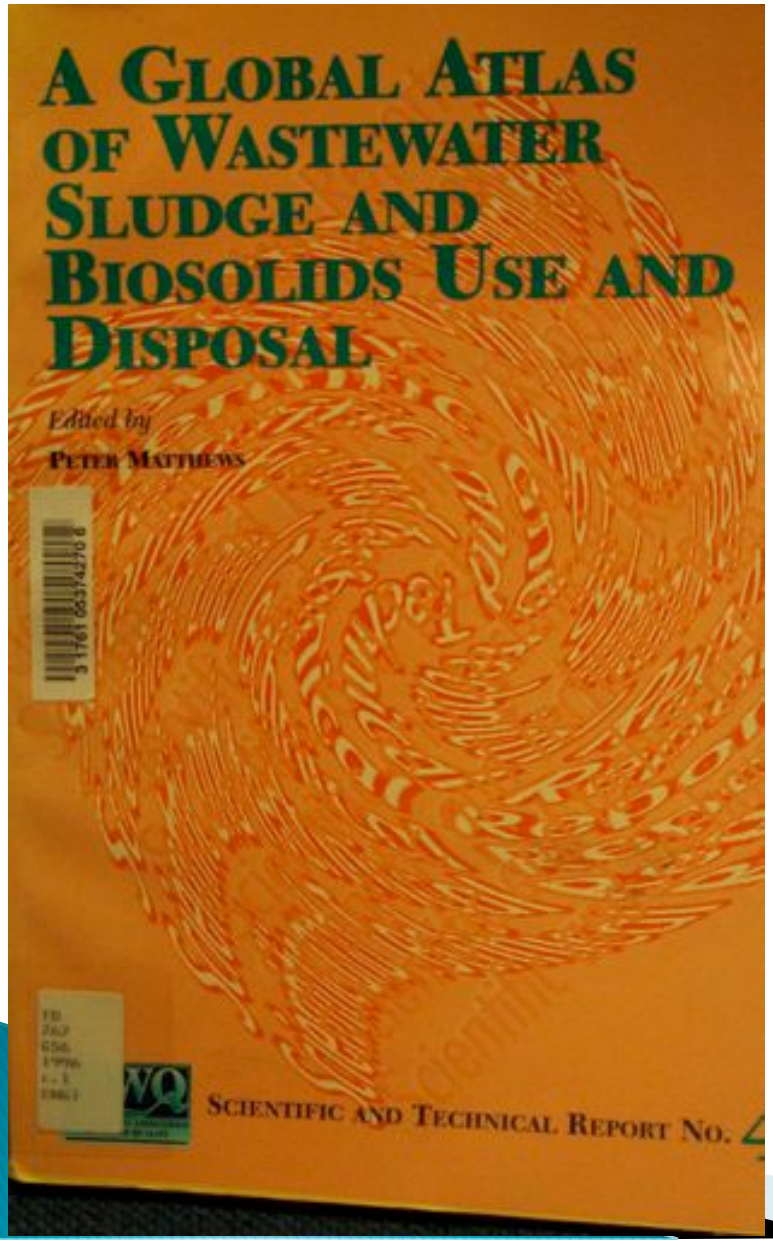
Lee W. Jacobs
Department of Crop and Soil Sciences
Michigan State University

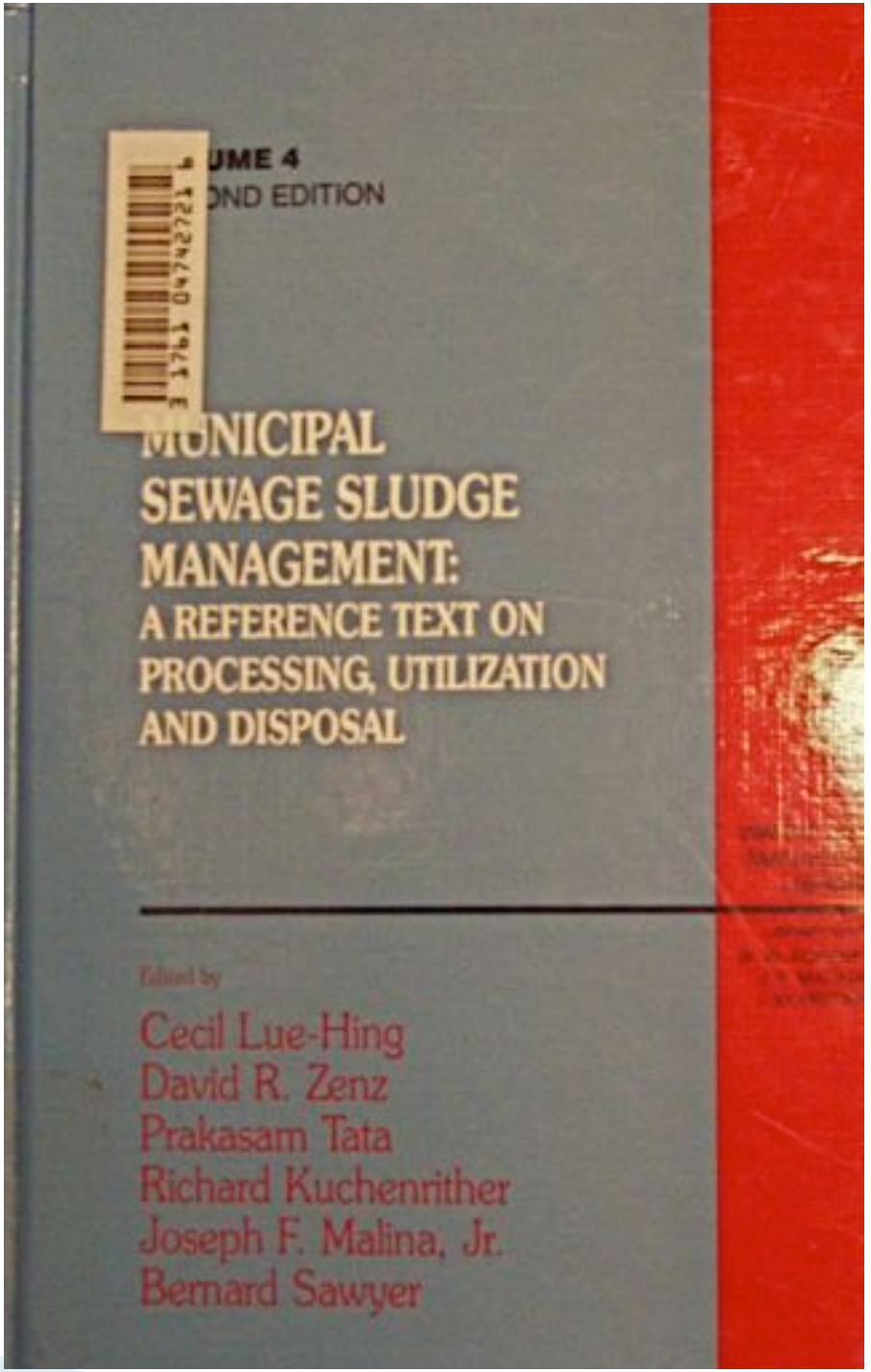
Sven Bihn
Department of Crop and Soil Sciences
Michigan State University

Water Environment Research Foundation

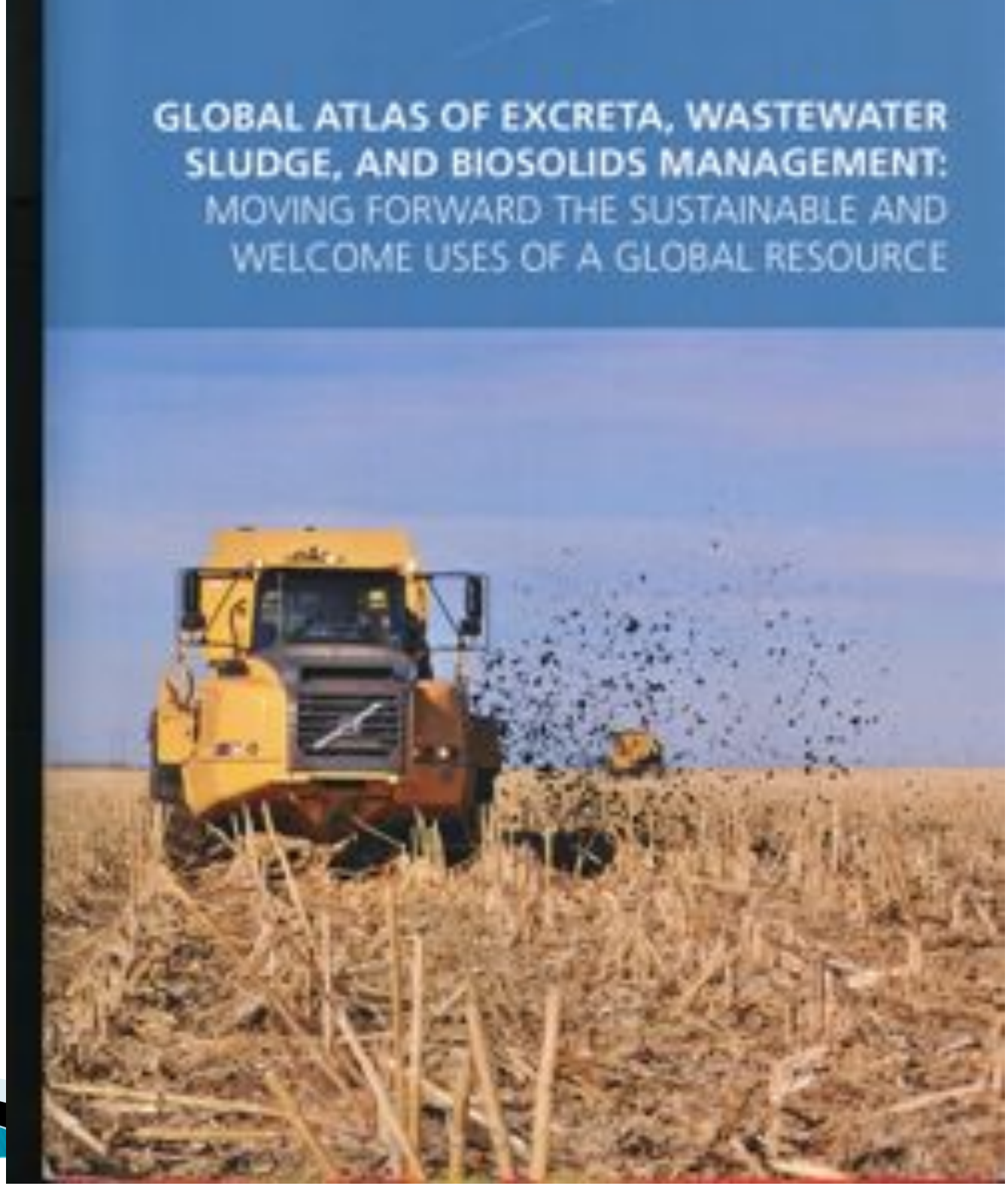
Document Long-Term Experience of Biosolids Land Application Programs 1

1998:


A Global Atlas of Wastewater Sludge and Biosolids Use and Disposal
Edited by
Peter Matthews
Scientific and Technical Report No.


UME 4
ND EDITION
MUNICIPAL SEWAGE SLUDGE MANAGEMENT:
A REFERENCE TEXT ON PROCESSING, UTILIZATION AND DISPOSAL
Edited by
Cecil Lue-Hing
David R. Zenz
Prakasam Tata
Richard Kuchenrither
Joseph F. Malina, Jr.
Bernard Sawyer

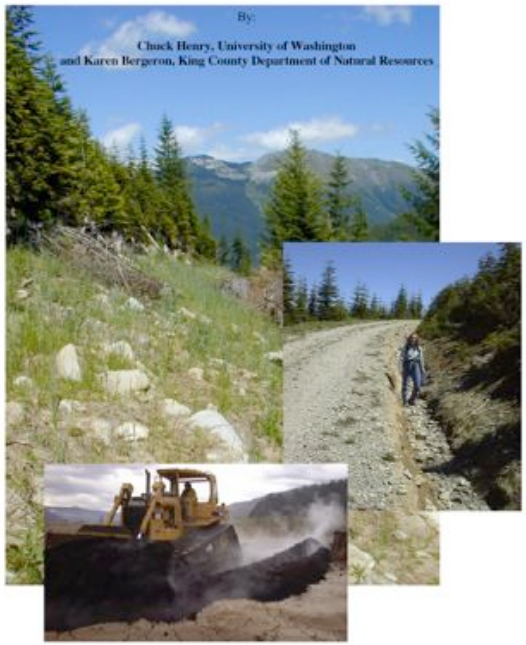
2008 Global Atlas



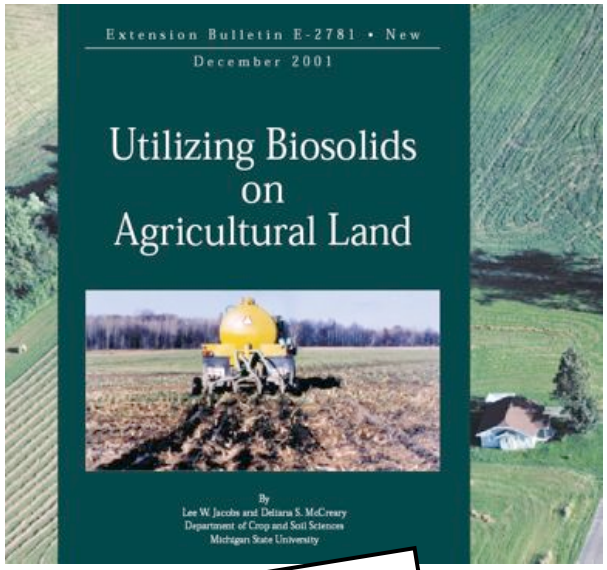
Univ. of WA

EPA United States Environmental Protection Agency

COMPOST USE
IN FOREST LAND RESTORATION



By:
Chuck Henry, University of Washington
and Karen Bergeron, King County Department of Natural Resources



Michigan State

Bulletin 143
December 1984

**Agricultural Use of Sewage Sludge:
A Literature Review**

W. D. Kelley
D. C. Martens
R. B. Reneau, Jr.
T. W. Simpson

Virginia Tech

The Use of Biosolids in Maine: A Review.

Univ. of Maine

Oregon State

Developing Human Health-related Chemical Guidelines for Reclaimed Waster and Sewage Sludge Applications in Agriculture

Prepared for
World Health Organization

By

Andrew C. Chang[1], Genxing Pan[2], Albert L. Page[1], and Takashi Asano[3]

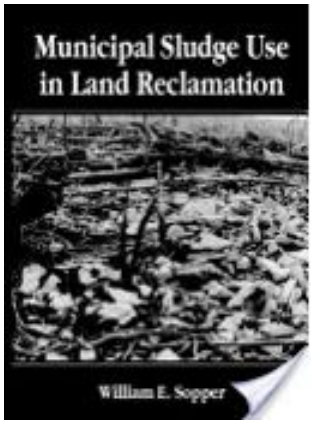
[1]University of California, Riverside, California, USA
[2]Nanjing Agricultural University, Nanjing, People's Republic of China
[3]University of California, Davis, California, USA

September 30, 2001
Revised May 17, 2002

World Health Organization

40+ Years of Research…

Example: Pennsylvania Mine Reclamation



William E. Sopper:
Municipal Sludge Use in Land Reclamation
Penn State University.
1993

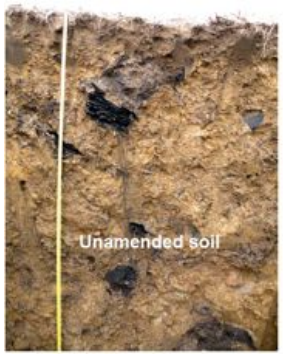
This book, published 20 years ago, reports 20 years of research into the impacts to surface and ground waters, small mammals, birds, and soil and plant quality from the use of biosolids in reclaiming the spoils of coal mining in western Pennsylvania. Among other findings, animals eating only plants growing in 100% biosolids-amended soils displayed no significant differences from controls.

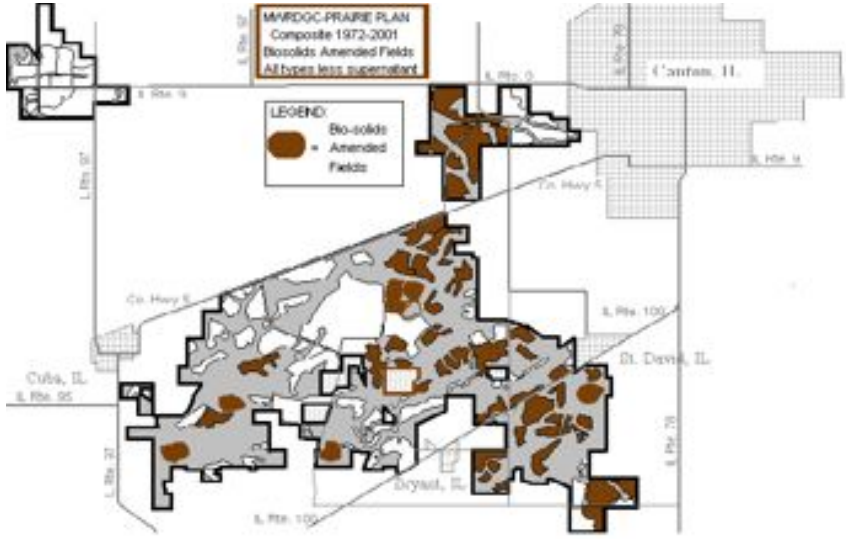
40+ Years of Research…

Example: Chicago - Fulton County

- Land application of Chicago biosolids for land reclamation and growing crops was started in the early 1970s, with continual monitoring and research.
- These sites provide opportunities for evaluation of long-term impacts, such as accumulation of pollutants.
- Many published papers.

From liquid to dewatered and air-dried biosolids (1972-2004)



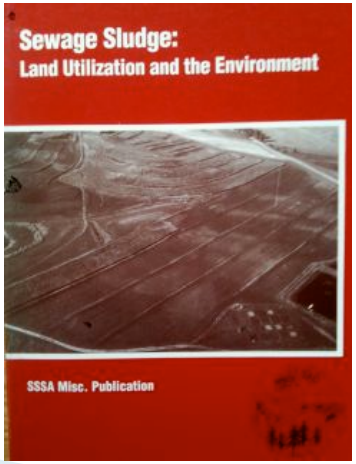


40+ Years of Research…

Example: Rosemount, MN

- 20+ years of research, beginning in 1973
- Dozens of published papers
- Closed watershed where biosolids were applied
- Monitoring and testing found:
  - increased yields of corn and other crops
  - negligible uptake of heavy metals in corn and other crops
  - negligible uptake of heavy metals in milk & meat of goats fed crops
  - no significant heavy metals, nutrients, and other pollutants in ground & surface waters

http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=99649

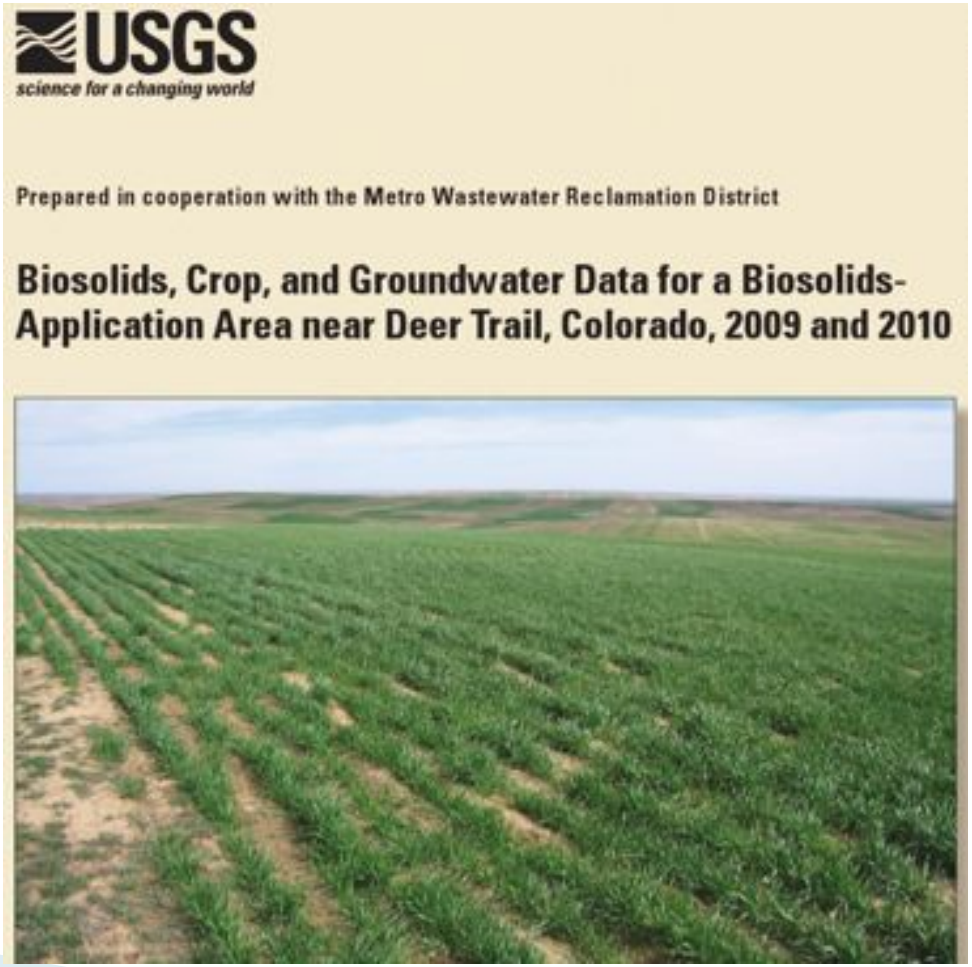


40+ Years of Research…

Example: Denver Metrogro Farm

- Long-term monitoring by U. S. Geological Survey

http://pubs.usgs.gov/ds/379/
http://pubs.usgs.gov/ds/664/



40+ Years of Research…

Example: King County (Seattle)

- Utilizing Seattle, WA area biosolids since 1973 in forestry, agriculture, and more.
- Ongoing research by Univ. of WA, Washington State Univ., Univ. of Arizona, etc.
- Mine reclamation research in association with EPA and USDA.

http://www.kingcounty.gov/environment/wastewater/Biosolids/Research.aspx

Biosolids Research and Demonstration

Since 1973, our biosolids program has worked with local universities to develop and test biosolids recycling methods. Research has included effects of biosolids on soils, crops, wildlife and water quality, as well as developing new markets and testing application techniques. Results provide the technical basis for appropriate site management, environmental monitoring, development of regulations, public acceptance and quality assurance for landowners. University scientists act as technical advisors to our projects, providing third party review and oversight.

Forestry

The University of Washington College of Forest Resources(external link) pioneered the the use of biosolids to enhance forest growth and developed the technical information that was necessary for guiding biosolids use in forests of the Pacific Northwest .

Many aspects of biosolids recycling in forests have been studied by UW faculty and graduate students. Research projects have included managing nitrogen and phosphorus, soil quality, identifying and managing odor, and long term effects of biosolids, including fate of metals and ecosystem response. The University's C. L. Pack Experimental Forest (external link), near Eatonville, was the setting of numerous research and demonstration projects.

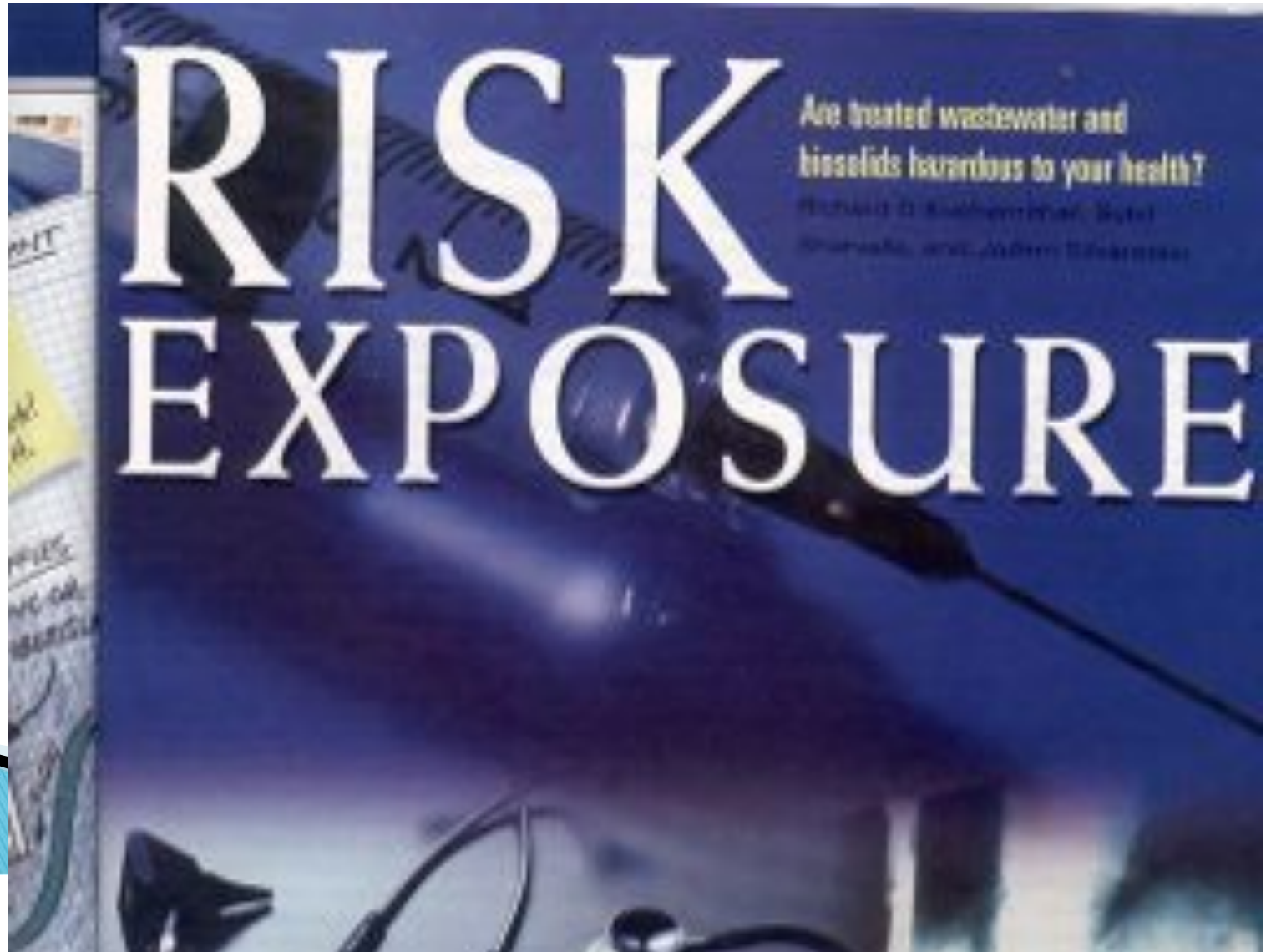
A scientist, a forestland manager and an environmentalist examine tree foliage response to biosolids fertilization.

Winter wheat

At the Boulder Park project, Washington State University scientists studied the effect of biosolids on soils and plant growth and yield. Four treatments were compared: control (nothing added); commercial fertilizer (inorganic anhydrous ammonia) at a rate of 50 lbs/acre of nitrogen; and two rates of biosolids supplying nitrogen at 50 and 100 lbs per acre. Results consistently show increased crop yields. Other benefits include reduced soil erosion and faster plant

40+ Years of Research…

The research addresses the risks…



40+ Years of Research…

3 topics of greatest concern:

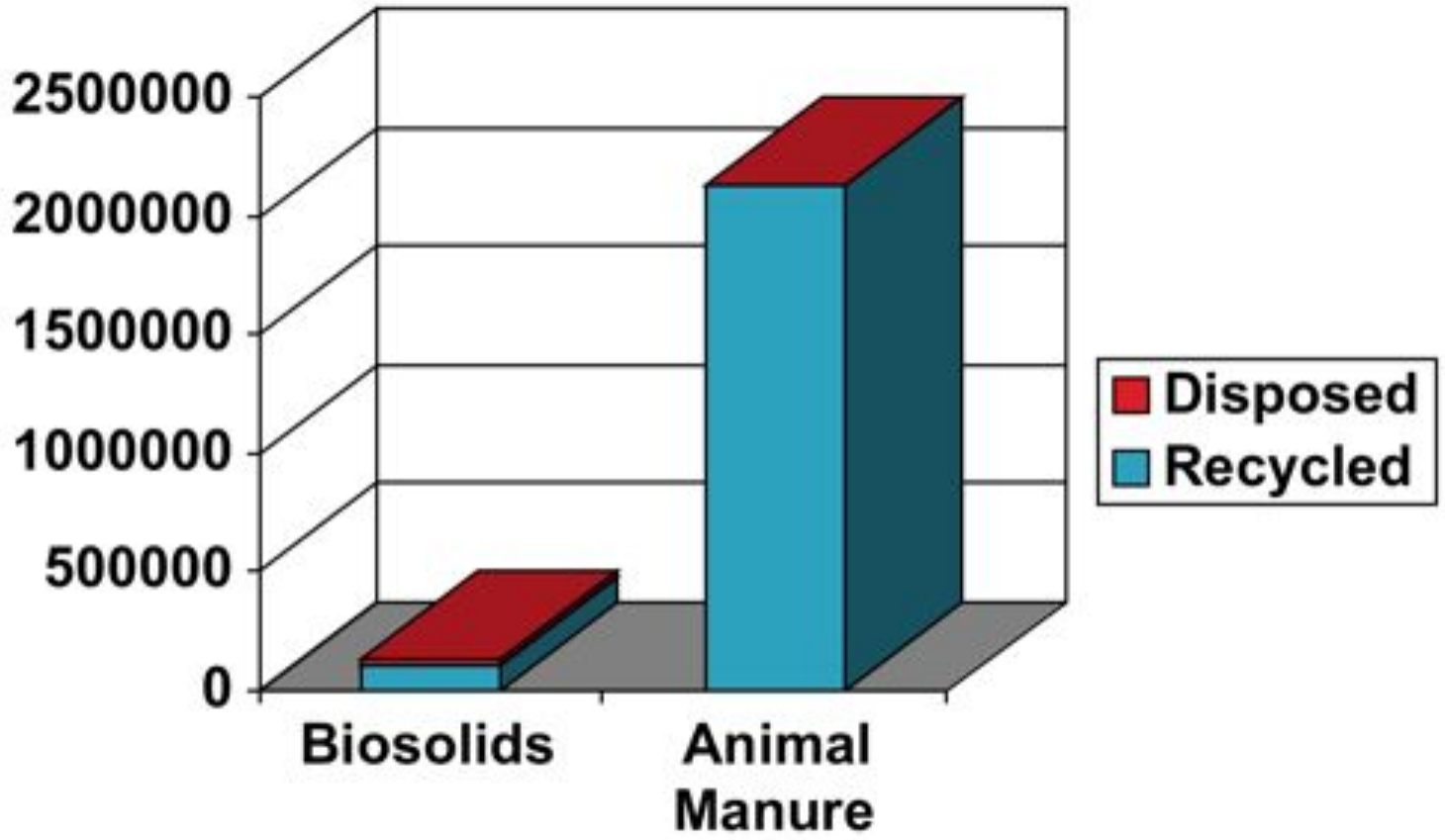
- "**heavy" metals**: regulated, non-regulated
- **chemicals**: PCBs, legacy, priority pollutants, microconstituents, PPCPs, radioactivity…
- **pathogens**: traditional, "emerging," endotoxin, prions, antibiotic resistance, reactivation & regrowth…

40+ Years of Research…

When considering risk, remember the relative amounts of biosolids vs. manures

(and manures have heavy metals, chemicals, & pathogens too)

State of Maine as an example:
Wet tons generated annually



40+ Years of Research…

Resource: Comparing biosolids to other agricultural practices

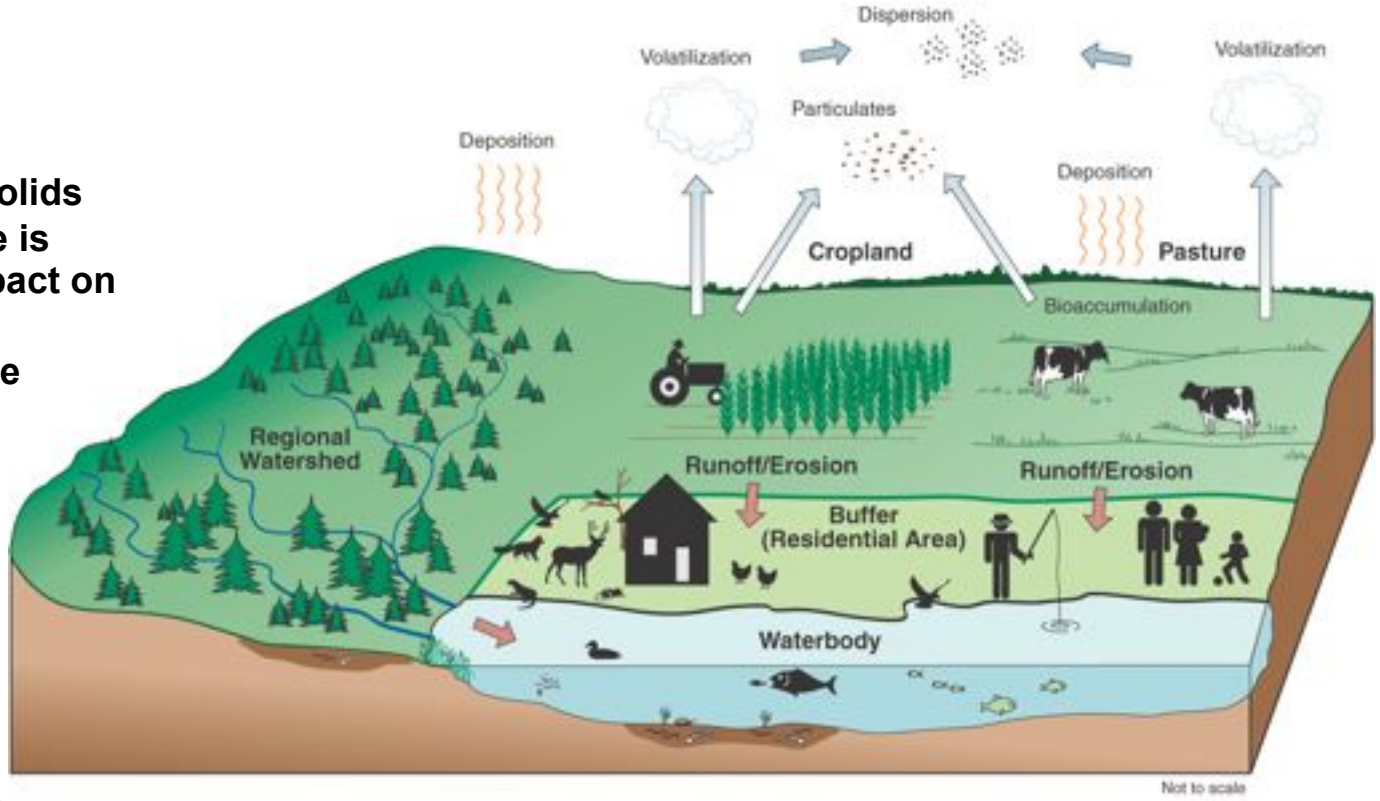
Evaluating Risks and Benefits of Soil Amendments Used in Agriculture

40+ Years of Research…

Risk Assessment

EPA Risk Assessment for Part 503:
Exposure Pathways Assessed
Agricultural Land Application Scenario to Assess Human Exposure

The presence of a contaminant in biosolids does not mean there is risk; its fate and impact on humans and the environment must be evaluated.



40+ Years of Research…

Risk Assessment

Pathways for Part 503 Risk Assessment of Elements in Soils and Highly Exposed Individuals - 1

Pathway	Highly Exposed Individual
1. Soil➔Plant➔Human	Farm markets; 2.5% of food
2. Soil➔Plant➔Human	Home gardens; 60% of garden foods for lifetime
3. Soil➔Human	200 mg/day soil/dust ingestion
4. Soil ➔Plant➔Animal➔Human	Farms; 45% home-grown meat
5. Soil➔Animal➔Human	Grazing ruminants; soil is 2.5% of annual diet; 45% home-grown meat.
6. Soil➔Plant➔Animal	100% of livestock feeds grown on soils
7. Soil➔Animal	Grazing ruminants; 2.5% soil in diet.

40+ Years of Research…

Risk Assessment

Pathways for Part 503 Risk Assessment of Elements in Soils and Highly Exposed Individuals - 2

Pathway	Highly Exposed Individual
8. Soil➔Plant	Sensitive crops; strongly acidic.
9. Soil➔Soil Biota	Earthworms; microbes; metabolic function of soil.
10. Soil Biota➔Soil Biota Predator	Shrews; 1/3 of diet presumed to be earthwroms full of Soil
11. Soil➔Airborne Dust➔Human	Tractor operator.
12. Soil➔Surface water➔Human	Subsistence fishers.
13. Soil➔Air→Human	Farm households
14. Soil➔groundwater→Human	Well water on farms.

40+ Years of Research…

Resources: Metals in biosolids

A TECHNICAL REVIEW OF:

"THE CASE FOR CAUTION

RECOMMENDATIONS FOR LAND APPLICATION OF SEWAGE SLUDGES

AND

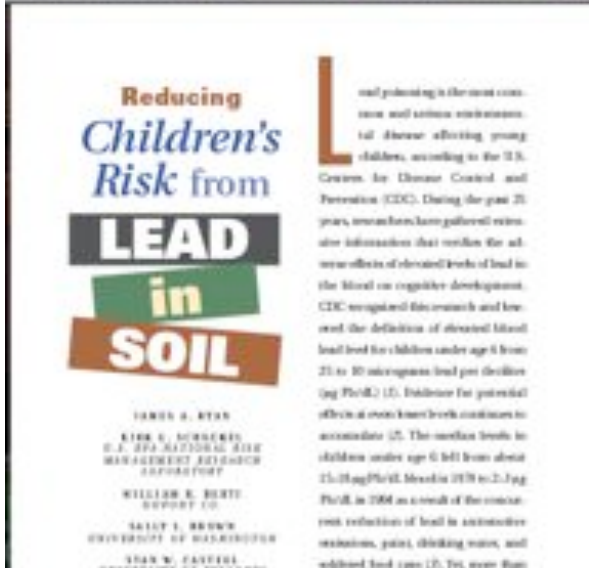
AN APPRAISAL OF THE USEPA'S PART 503 REGULATIONS"

August 1997 Working Paper
Cornell Waste Management Institute

NOVEMBER 1997
[Includes changes based on EPA review]

New York State Department of Environmental Conservation
Division of Solid & Hazardous Materials

A video of Dr. Rufus Chaney, USDA, presenting information on trace elements (heavy metals) in biosolids is available here: http://e2.ma/click/xa2ks/dz7he/hid6si



Reducing
Children's Risk from
LEAD in SOIL

40+ Years of Research…

Perspective on metals land applied

Table 5
Estimated Total Metals Applied to Land From Various Products
Applied Metals (tons/year)

Metal	Biosolids	Swine Manure	Poultry Manure	Phosphate Fertilizer
Arsenic	14.2	33.3	189	40.7
Cadmium	12.59	22.5	33	180
Chromium	168	NA	NA	369
Copper	1,852	3,749	6,193	249
Lead	215	68.8	86.1	53.7
Mercury	5.07	NA	NA	0.3
Molybdenum	34.2	NA	NA	NA
Nickel	94.1	264	NA	1.71
Selenium	10.89	NA	NA	NA
Zinc	2,081	4,995	8,129	1,063

Notes
(1) Based on metal concentrations presented in Table 3.
(2) Assumed application of 2.83 million dry tons annually (USEPA, 1999a)
(3) Assumed application of 9 million dry tons annually (USEPA, 1999)
(4) Assumed application of 16.3 million dry tons annually (EPA, 1999)
(5) Assumed application of 4.4 million tons annually (USDA, 1991)

40+ Years of Research…

Metals in other agricultural materials, for comparison

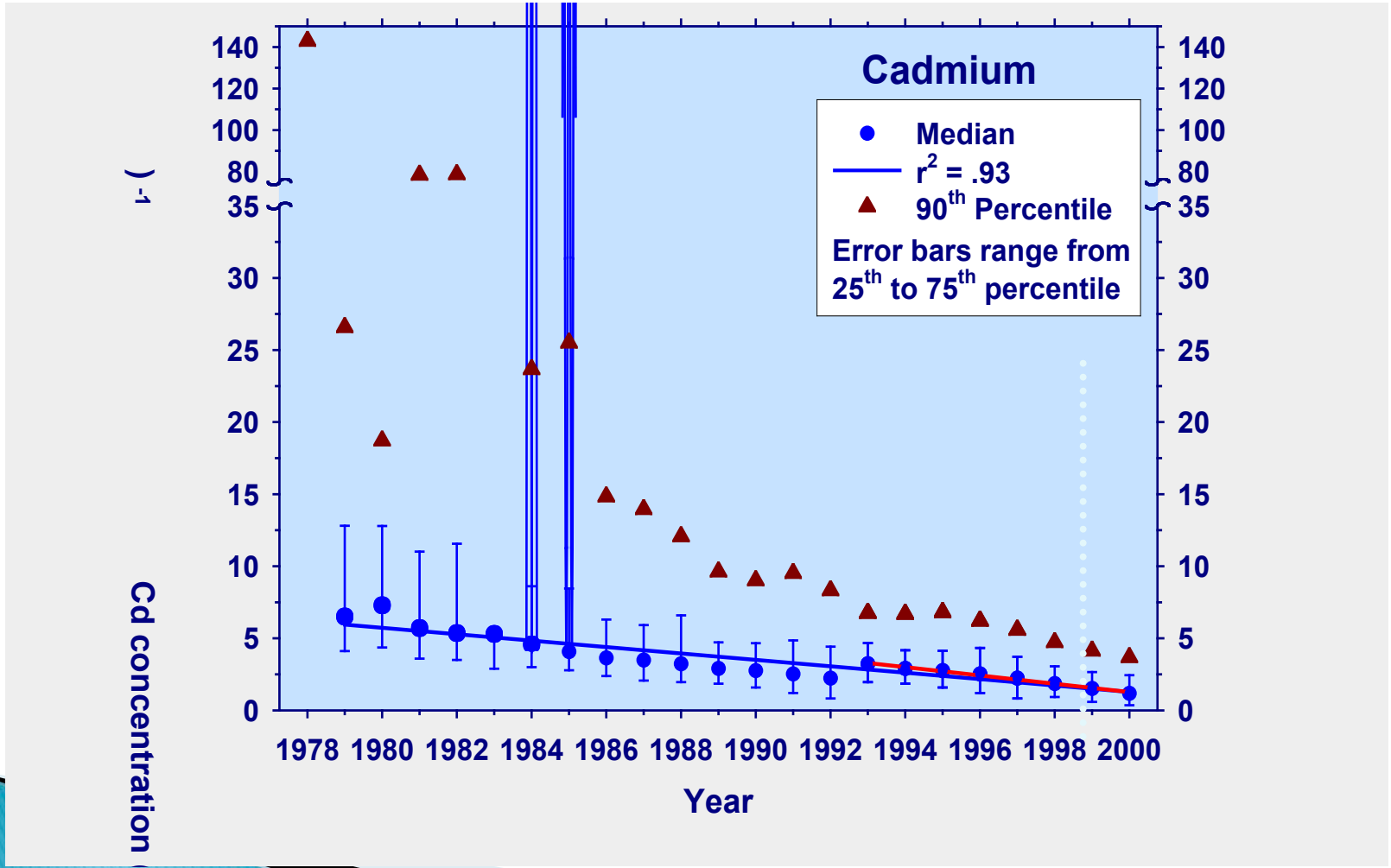
Chart 3.2: Reported Averages (or Ranges) of Trace Metals Levels in Other Materials (ppm or mg/kg)

Trace Metal	Dairy Manure (4)	Dairy Manure (3)	Feedlot Manure (2)	Pig Waste (2)	Swine Manure (3)	Poultry Litter (2)	Chicken Manure (3)
Arsenic (As)	0.26	0.88	NA	3.7	NA	30	0.66
Cadmium (Cd)	0.32	0.03	0.2	ND	0.32	ND	0.59
Chromium (Cr)	5.2	20	NA	61	NA	20	4.9
Copper (Cu)	41	11.6	2.0	501	14.3	1195	13
Lead (Pb)	6.6	2.1	0.2	ND	1	12	11.5
Mercury (Hg)	0.09	0.05	NA	ND	NA	NA	0.04
Molybdenum(Mo)	2.5	22.1	NA	7.9	22.6	NA	95.3
Nickel (Ni)	7.8	3.3	NA	29.3	NA	NA	3.9
Selenium (Se)	0.5	NA	5000	ND	NA	NA	NA
Zinc (Zn)	215	21	8	656	60	631	297

Phosphorus Fertilizer (5)	Phosphorus Fertilizers (ranges) (6)	MSW Compost (6)	Wood Ash (7)	Agricultural Soils (4)	Silty/Loam Soils (1)	Miracle-Gro® (fertilizer)	Rite-Aid Central Vite® (vitamins)

40+ Years of Research…

Example: Penn State Univ. research tracks reductions in heavy metal levels in biosolids caused by pretreatment & pollution prevention



Trace Element Chemistry in Residual-Treated Soil: Key Concepts and Metal Bioavailability

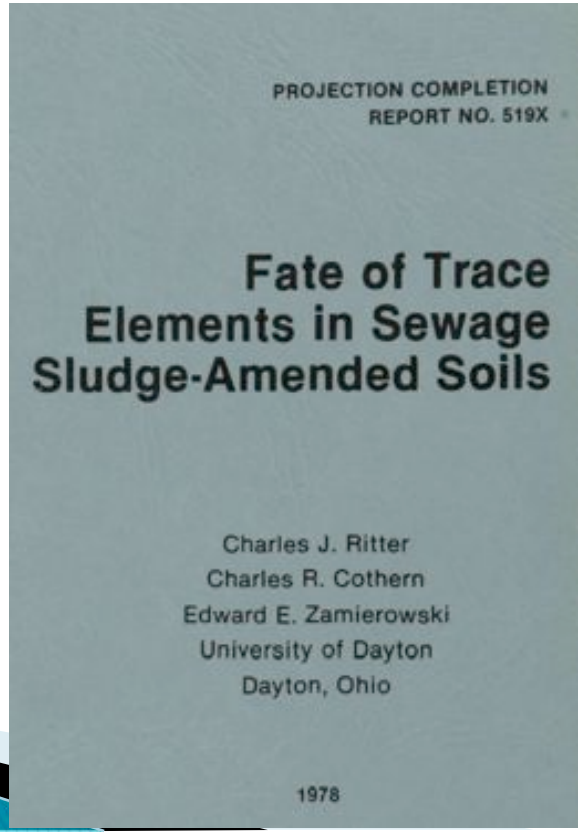
N. T. Basta,* J. A. Ryan, and R. L. Chaney

ABSTRACT

Trace element solubility and availability in land-applied residuals s governed by fundamental chemical reactions between metal constit- ients, soil, and residual components. Iron, aluminum, and manganese

based paints (The Conservation Fou bazari et al., 1989); land application c manures, biosolids, composts, pestici tion residues; and atmospheric dep

The research on metals in soils goes back decades; this topic is well studied.



A video of Dr. George O'Connor, Univ. of FL, presenting information on trace chemicals in biosolids is available here: http://e2.ma/click/xa2ks/dz7he/1pc6si

40+ Years of Research…

Resources: Chemicals in biosolids

PO Box 422 ■ Tamworth, NH 03886-0422
www.nebiosolids.org

nebra
North East Biosolids & Residuals Association
Cooperatively promoting the environmentally sound recycling of b

phone 603-323-7654
fax 603-323-7666
info@nebiosolids.org

Information Update:

Microconstituents in Biosolids: Current State of Knov

May 12, 2011

Introduction

The increased attention being paid to microconstituents (traces of synthetic chemicals
products and daily activities) in the environment has led to questions about the contri

BARKING UP WRONG TREE?

EVALUATING EXPOSURE RISK TO TRACE ORGANIC CHEMICALS IN BIOSOLIDS

Due to widespread use of TOrCs in manufacturing of personal care and consumer products, research finds that the greatest human exposure is in the household environment and not via land application of biosolids.

Mandal, K. Kumar, ... and A.E. Cas

Water Environment Federation®
Preserving & Enhancing the Global Water Environment

Microconstituents in Biosolids

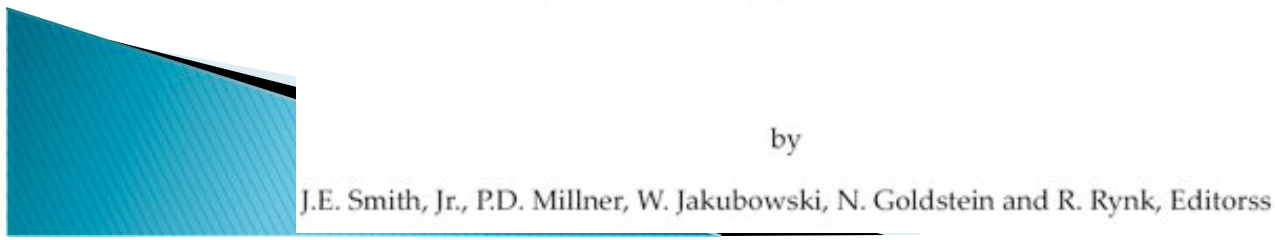
Technical Practice Update

Prepared by **Microconstituents Community of Practice** of th
Committee

Todd O. Williams, P.E., CH2M HILL, Richmond, Virginia, *Chair*

40+ Years of Research…

Resources: Pathogens in biosolids



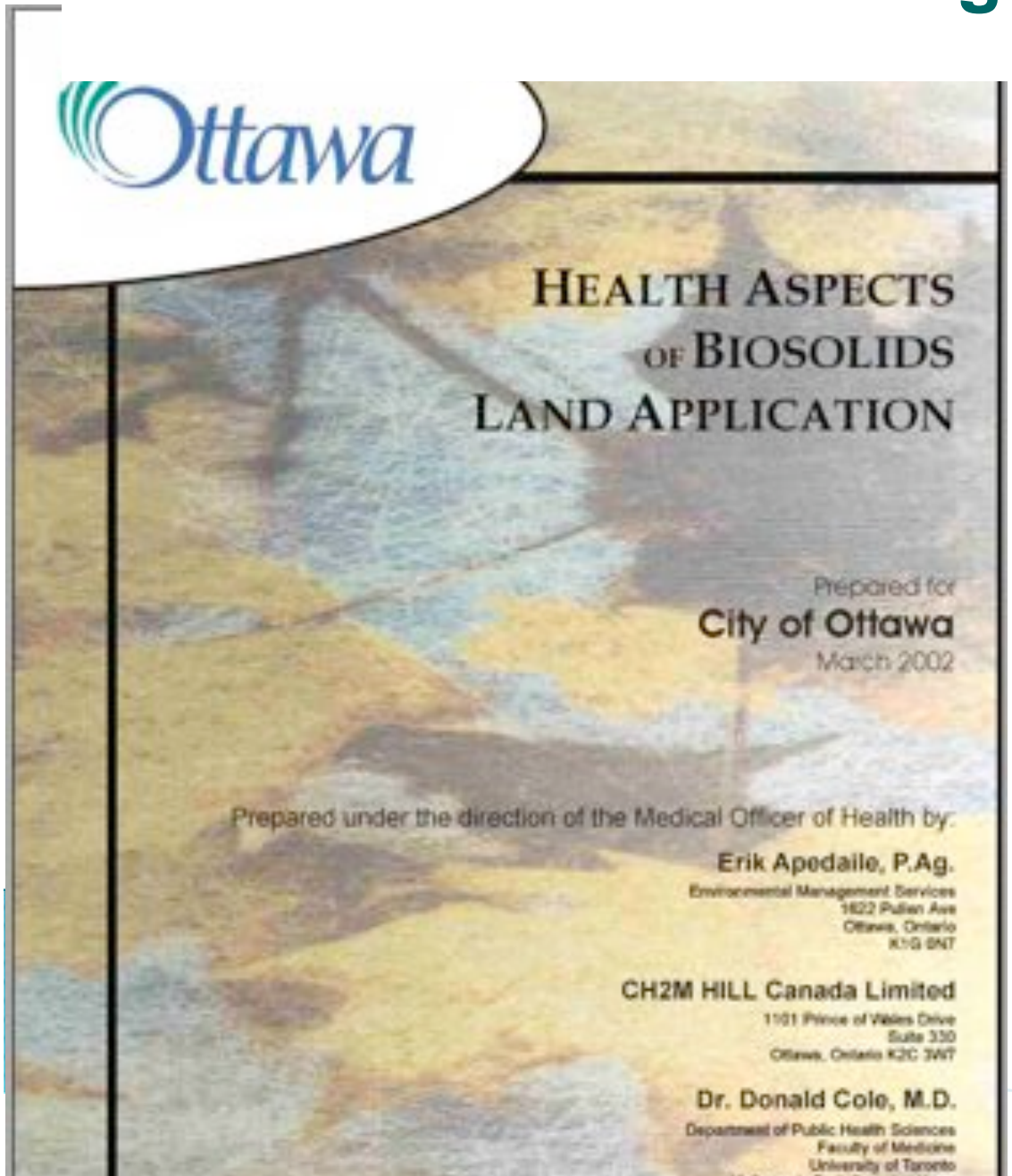
40+ Years of Research…

Resources: Pathogens in biosolids

Univ. of Arizona research on bioaerosols from biosolids land application, early 2000s

40+ Years of Research…

Resources: Evaluating health impacts



See also: Virginia state health department review, 2007:

http://www.virginiabiosolids.com/pdf/Biosolids_Available_Evidence_1107.pdf

40+ Years of Research…

Resources: Other concerns

Phytoavailability of Biosolids Phosphorus

G. A. O'Connor,* D. Sarkar, S. R. Brinton, H. A. Elliott, and F. G. Martin

ABSTRACT

Efficient utilization of biosolids P for agronomic purposes requires accounting for differences in the phytoavailability of P in various biosolids. Greenl grass grown in t

various biosolids to assure efficient ag
tion of biosolids P.
When P considerations dictate biosc
(USEP
ffectiv

nebra

Fact Sheet

PLAYING ON GRASS GROWN ON BIOSOLIDS PRODUCTS

QUESTION: *Is there any measurable risk to children or others playing on sports fields or parks where biosolids compost or biosolids fertilizer has been used to fertilize and build the soil?*

ANSWER: No. Scientists knowledgeable about biosolids recycling agree that:

40+ Years of Research…

More research of note: Bioassays

Dr. Linda McCarthy, Ryerson Univ, Ontario tested biosolids and biosolids run-off on numerous soil, terrestrial, and aquatic organisms for impacts. The results?

- Sub-acute, acute, chronic, and reproductive bioassays indicated no deleterious impact of selected biosolids on selected biota under controlled, laboratory conditions.
- Use of multi-organism, environmentally-relevant bioassays adds scientific veracity to assessing the sustainability of the land-application process

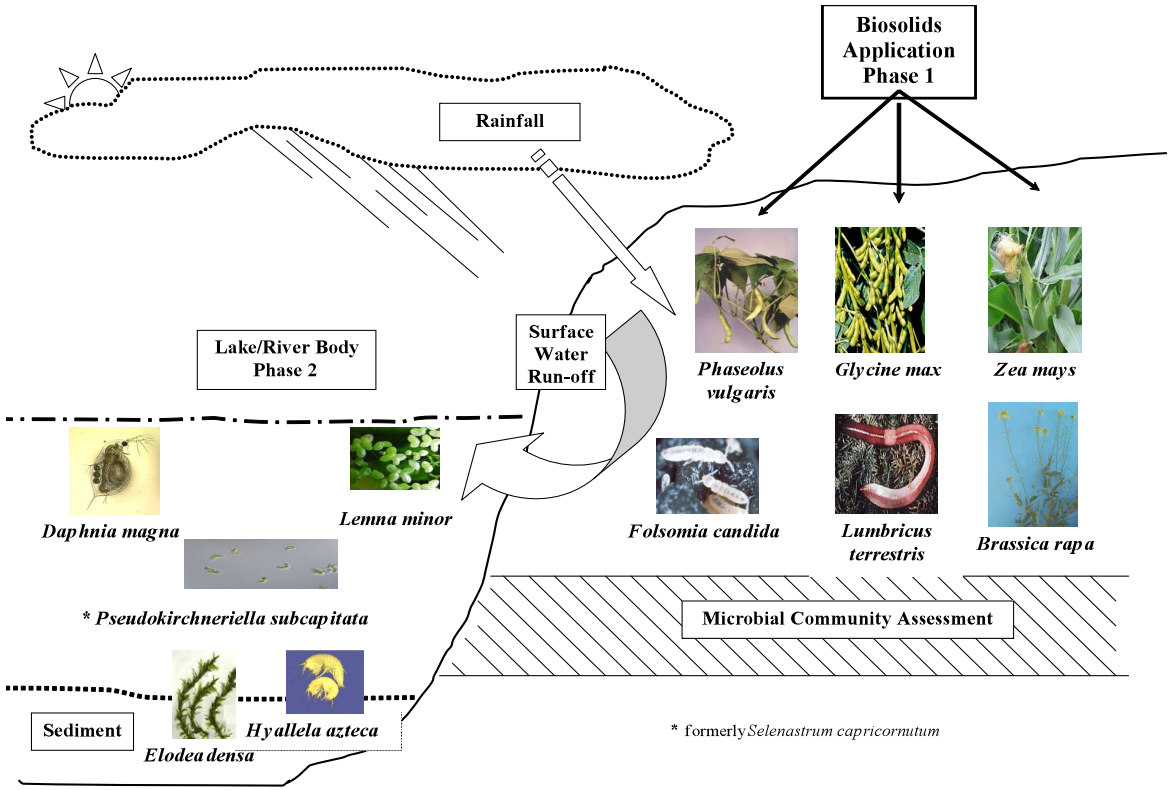


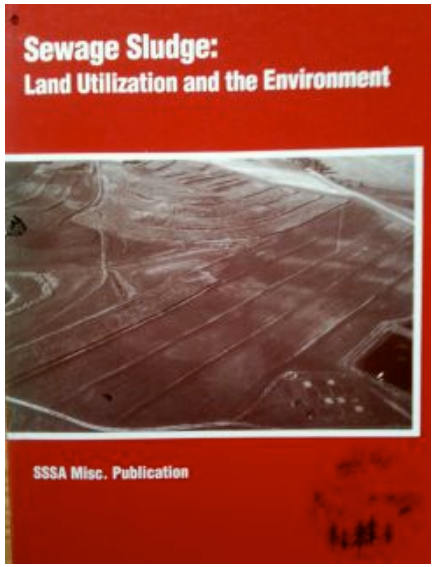
Figure 1. Possible contamination pathways and specific bioassays for the assessment of biosolids application impact.

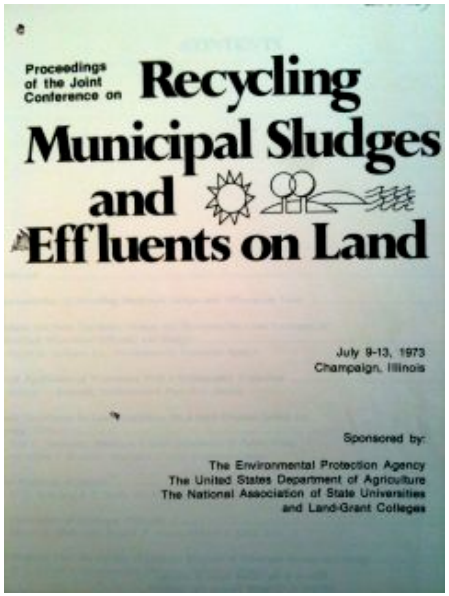
40+ Years of Research…

Every 10 years:

A state-of-the-science conference of EPA, US Dept. of Agriculture, and land grant & other university biosolids research scientists

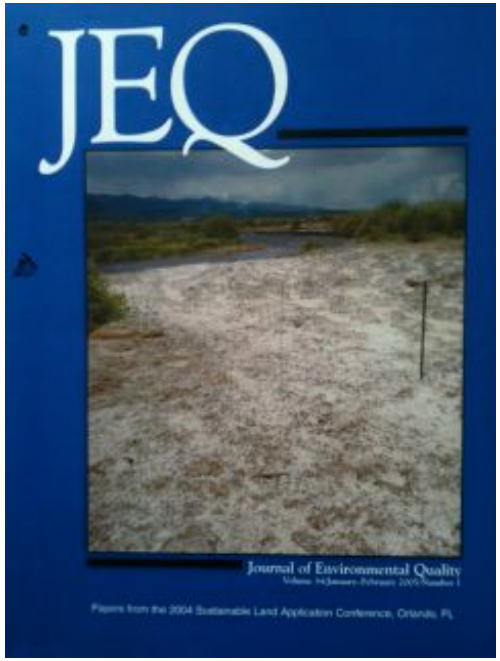
1993 – Univ. of Minnesota – proceedings published by Soil Science Society of America





1983 – Colorado

1973 – Univ. of Illinois



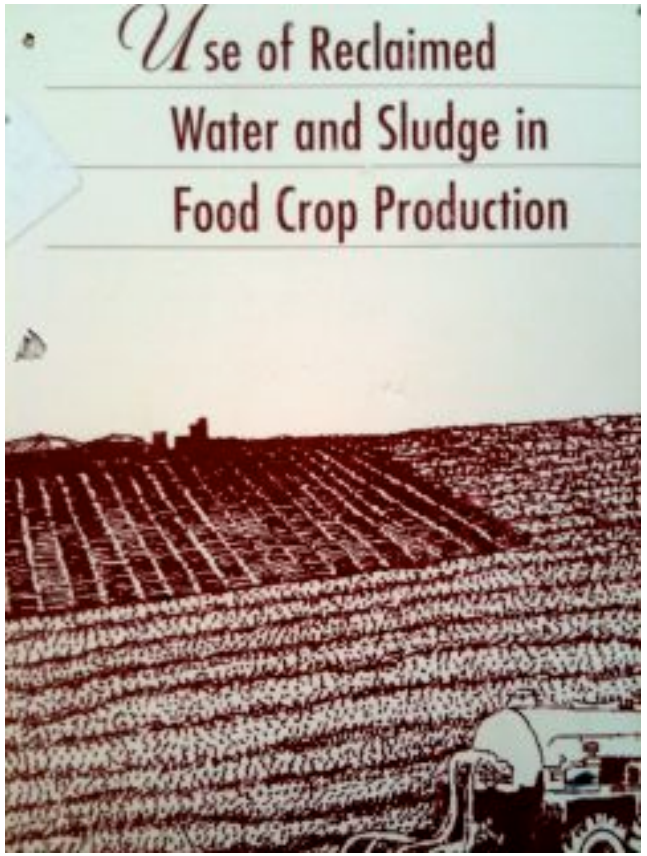
2004 – Univ. of Florida – proceedings in *Journal of Environmental Quality*

40+ Years of Research

National Academy of Sciences (NAS)

National Research Council Review, 1996

"In summary, society produces large volumes of treated municipal wastewater and sewage sludge that must be either disposed of or reused. While no disposal or reuse option can guarantee complete safety, the use of these materials in the production of crops for human consumption, when practiced in accordance with existing federal guidelines and regulations, present negligible risk to the consumer, to crop production, and to the environment."

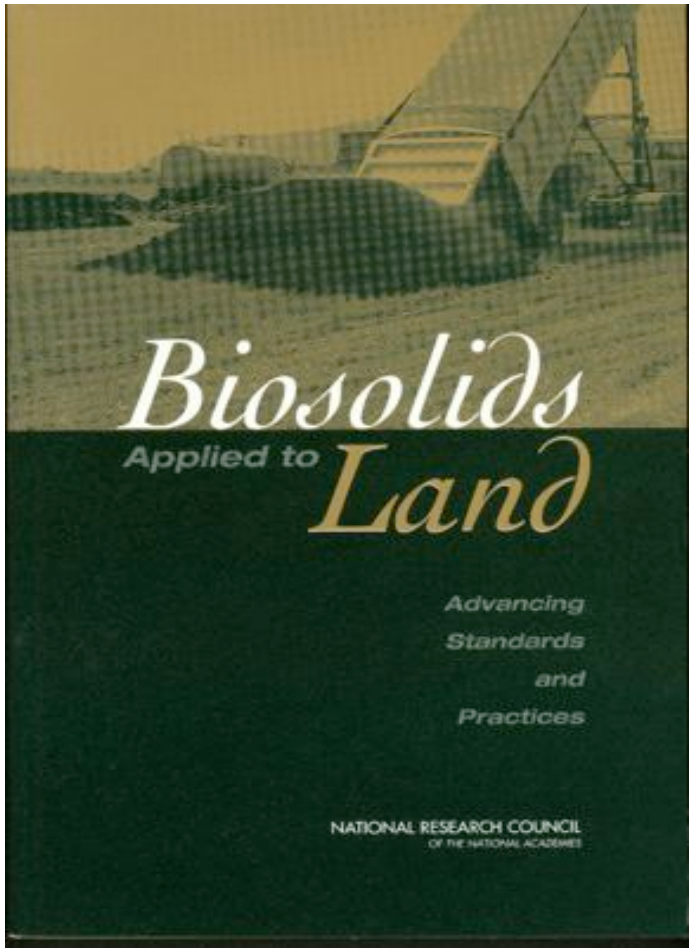


40+ Years of Research

National Academy of Sciences (NAS)

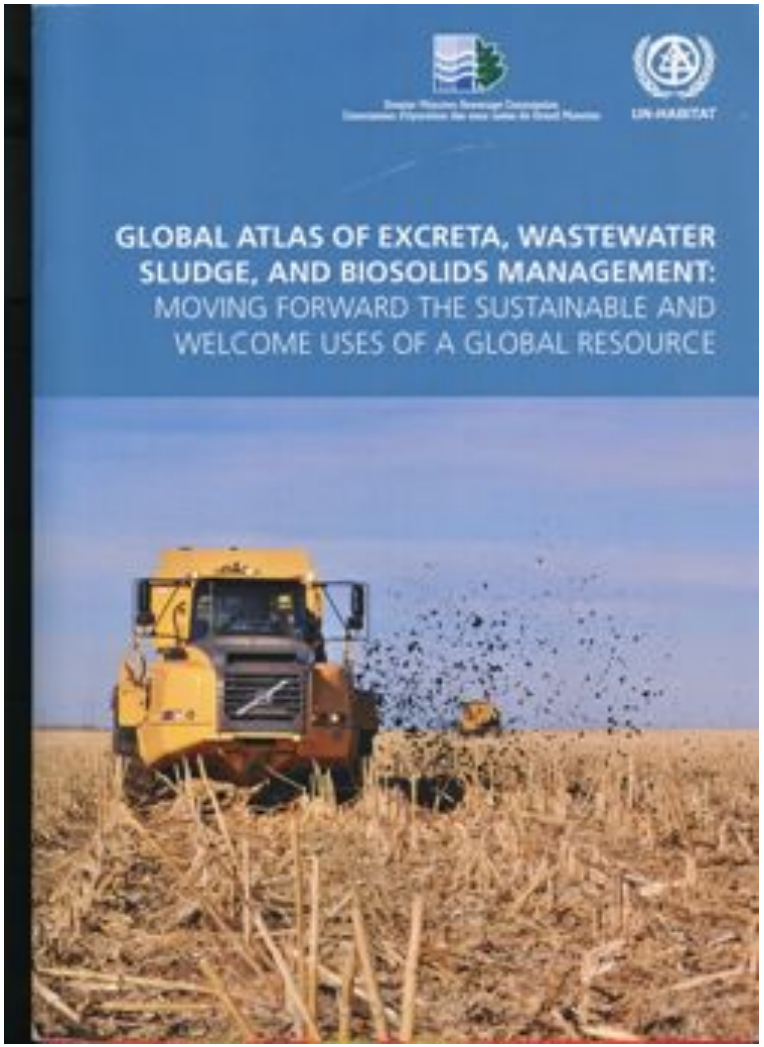
National Research Council Review, 2002

"There is no documented scientific evidence that the Part 503 rule has failed to protect public health. However, additional scientific work is needed to reduce persistent uncertainty about the potential for adverse human health effects from exposure to biosolids."

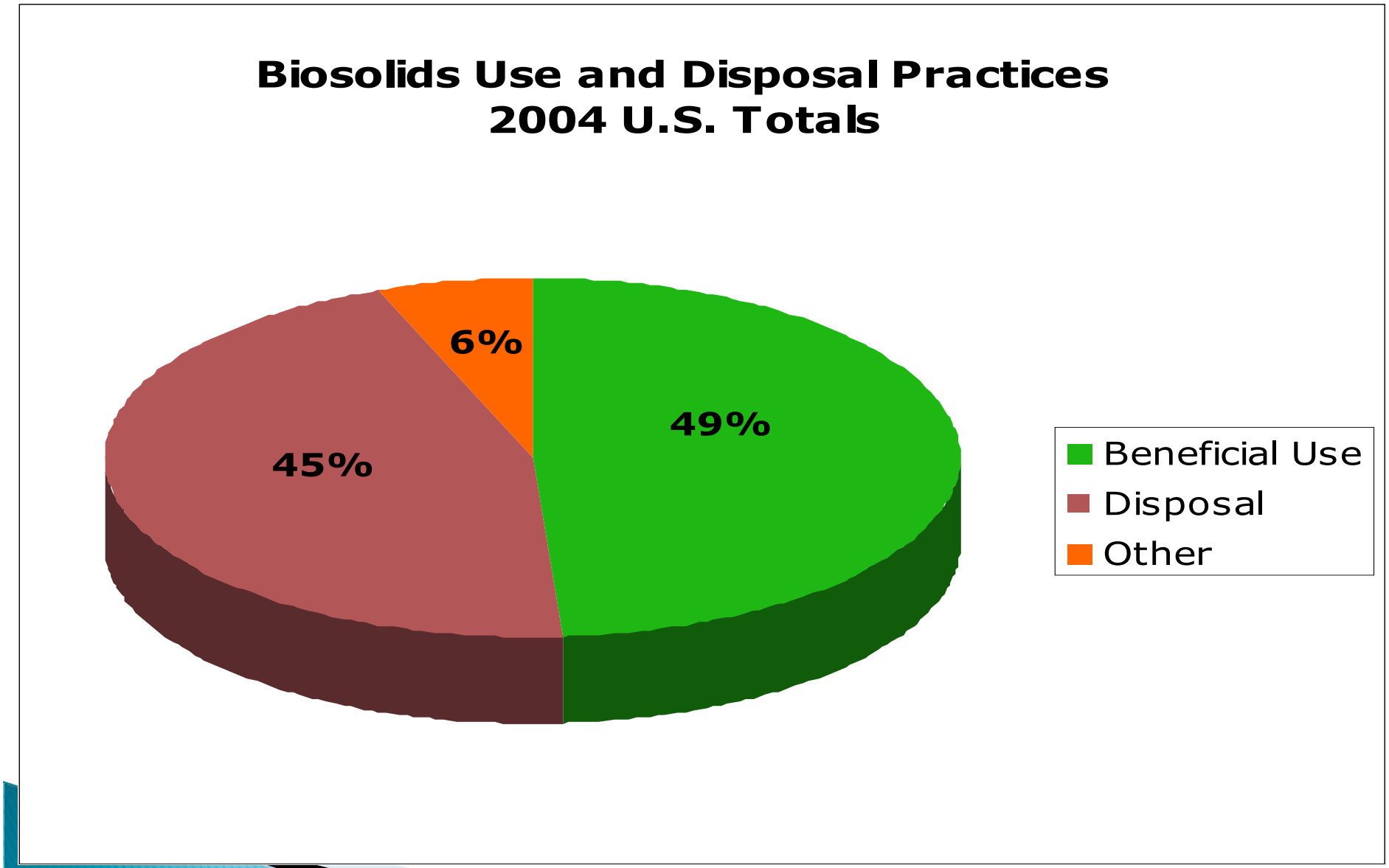


And….40+ Years of Experience

- Worldwide
- Agriculture
- Silviculture
- Land reclamation
- Horticulture, golf courses, turf, landscaping, etc.



40+ Years of Experience



40+ Years of Experience

Agriculture: still ¾ of U. S. beneficial use

University of Nebraska-Lincoln Extension in Lancaster County

The NEBLINE

May 2012

444 Cherrycreek Road, Suite A, Lincoln, NE 68528 • 402-441-7180 • http://lancaster.unl.edu

Lincoln's Biosolids Land Application Program is 20 Years Old

Burk Ogg
UNL Extension Educator
Dave Smith
UNL Extension Technologist

On May 12, 1992, the first truckload of the City of Lincoln's dewatered biosolids was delivered to farmland in Lancaster County. This event ended a decade of planning by Lincoln's sanitary engineers to dispose of this municipal organic waste in a more environmentally responsible, beneficial manner — rather than being buried in the landfill. In the last 20 years, more than 100 area farmers have applied nearly 600,000 tons of biosolids to their cropland, improving their soil and increasing yields.

Biosolids are organic solids separated from wastewater and biologically processed to make them safe to use as an organic fertilizer for crops not in the human food chain.

University of Nebraska-Lincoln Extension in Lancaster County has worked with cooperating farmers since the beginning of this program, taking soil tests, making sure biosolids are not applied too close to sensitive environmental features that might compromise surface and groundwater, determining application rates, and calibrating equipment. Program goals are to enhance the productivity of area soils through the environmentally-safe use of this material and to work with as many farmers as possible. We encourage farmers to apply biosolids as soon as possible and to take steps to reduce odors when they occur.

Nebraska farmers tend to be a conservative lot, but a few progressive farmers jumped into using biosolids wholeheartedly right away. Others adopted a wait-and-see attitude; their tail back and watched their neighbor's corn grow faster and larger and produce higher yields before they were convinced about biosolids.

What's in Biosolids That Makes it So Good?

Biosolids contains significant quantities of all macro and micronutrients needed for crop growth. One application typically increases organic matter in soil about 0.6%, which increases water infiltration and improves soil tilth. For highly eroded or excavated soils, a single biosolids application can immediately make them productive.

Demand for Biosolids

There is more demand than ever for biosolids, but most cooperating farmers are not using biosolids for nitrogen (N). It is the readily available phosphorus (P) that cooperators want. After a single application of biosolids, a P-deficient soil typically increases 30–40 ppm (Bray P test). With average crop removal rates, it will take 10-12 years for the soil tests to return to original levels.

Farmers are Paying for Biosolids

At the beginning of the program, it was tough to find farmers who were willing to use biosolids because they had to have a loader, spreader and enough time to apply the material. To encourage more farmers to use biosolids, in 1993, the city began paying cooperators to defray application costs. Twenty years later, there is so much demand for biosolids, cooperators are actually paying the city for it. Biosolids are delivered to field storage sites, but cooperating farmers are still responsible for application — either applying it themselves, or

see BIOSOLIDS on page 10

Soil samples are taken to determine the amount of biosolids to apply per field.

GPS/GIS technology is used to map storage (indicated above in purple) and application sites (indicated above in green).

A hauling contractor transports biosolids to approved fields.

Farmers either apply biosolids themselves or hire a custom applicator. Spreaders can be rented for a reasonable cost from the City of Lincoln.

Teaching An Old Guy New Tricks

My favorite biosolids story is about Wally Hansson, who lived in Walton, but had 145 acres on Ashland Road, just inside the Lancaster County line. In 1995, I met Wally at his farm to

came periodically and at just the right time for growing crops, but Wally credited the biosolids application for his best corn crop ever. Wally passed away in 2010 at age 88. He used to stop by the office sometimes just to pass the time.

—Burk Ogg

Biosolids Also Benefit

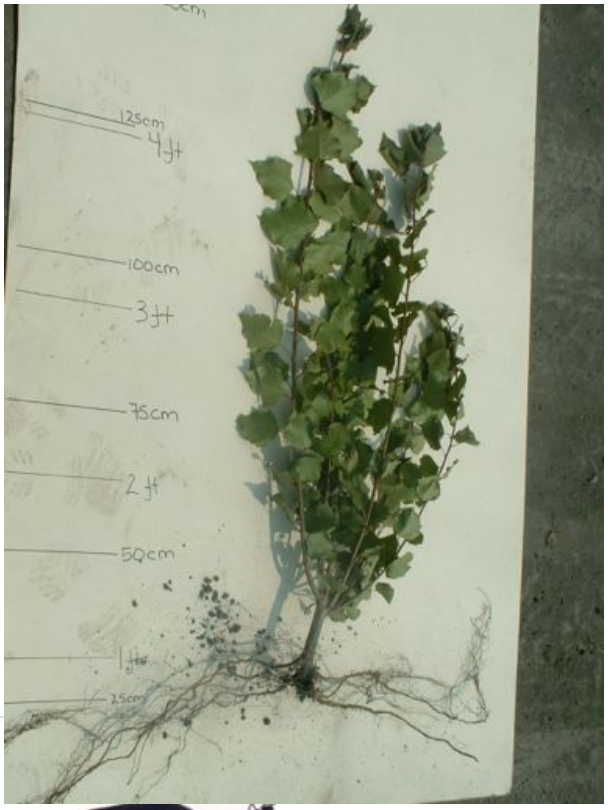
California, 2004

New Hampshire, 2006

Virginia

40+ Years of Experience

Forestry



40+ Years of Experience

Horticulture, landscaping: Class A products are 22+% of beneficial use in the U. S.

Québec, 2003

Maine, 2003

Columbus, OH

Boston, MA

Davenport, IA

Biosolids Composting Facilities in the U. S.

U. S. EPA Region	States with Biosolids Composting Facilities	Number of Facilities
1	New England (CT, MA, ME, NH, RI, VT)	35
2	New York, New Jersey, Puerto Rico	30
3	Delaware, Maryland, Penn, Virginia, W. Virginia	26
4	Florida, Georgia, Kentucky, N & S Carolina, Tenn	32
5	Indiana, Michigan, Ohio, Wisconsin	10
6	Arkansas, New Mexico, Oklahoma, Texas	31
7	Iowa, Kansas, Missouri, Nebraska	14
8	Colorado, Montana, S. Dakota, Utah, Wyoming	38
9	Arizona, California, Hawaii, Nevada	20
10	Alaska, Idaho, Oregon, Washington	30
None:	Alabama, Illinois, Louisiana, Minnesota, Mississippi, N. Dakota	
	TOTAL	266

40+ Years of Experience

Making & using biosolids compost

The Great Lawn, Central Park NYC

Central Valley, California

Spectacle Island, Boston, MA

Streambank stabilization, PA

Fabric-covered composting, Moncton, NB

Static pile composting, Southboro, MA

Co-composting w/ MSW, Marlboro, MA

40+ Years of Experience

Making & using biosolids compost

before

after

40+ Years of Experience

Land reclamation: 3+% of beneficial use

Massachusetts, 2006

Idaho

Massachusetts
2004

Washington

40+ Years of Experience

What Philadelphia accomplished…

- Restored the productivity of 4,000 acres of stripped mine lands
- Utilized 1,000,000 tons of biosolids
- Additionally benefited waters and habitats
- Supported the mining economy with $40 million in reclamation services

before

after

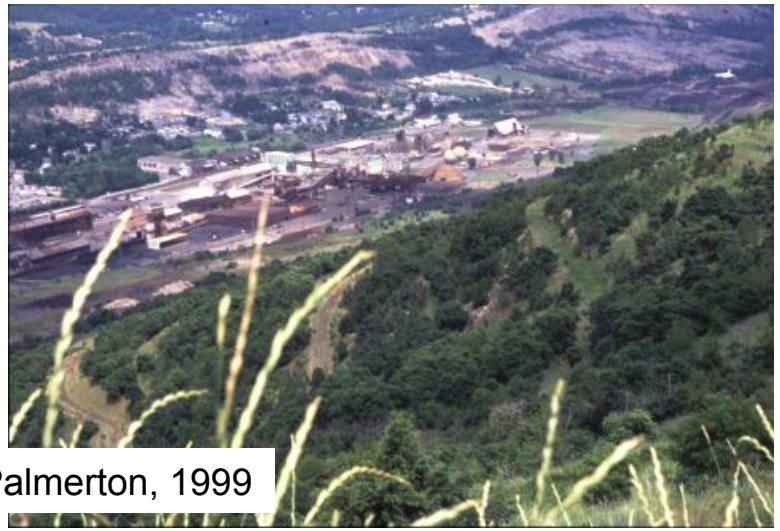
40+ Years of Experience

More mine reclamation experience in PA…

before

Palmerton, 1980

after



Palmerton, 1999

40+ Years of Experience

More mine reclamation experience in ID…

Highly Zn-phytotoxic smelter and mine waste contaminated soils at Bunker Hill, ID;

Background = Biosolids+Wood-Ash Remediated

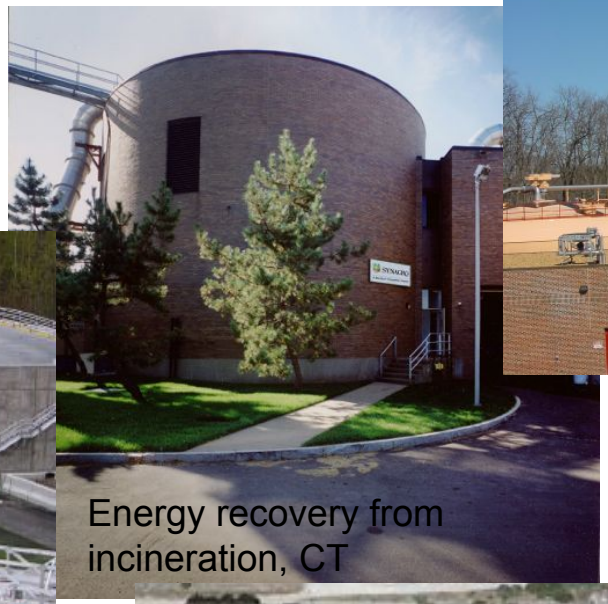
Foreground = Seeded control hazardous soil.

40+ Years of Experience

Mine reclamation in NE PA, including deep trench biosolids application and poplar planting

Biosolids were used for the plantings under the 2010 Vancouver Olympic rings.

Energy from biosolids



Energy recovery from incineration, CT

Egg-shaped digester, NH

Circular tank digesters, MA

East Bay MUD, Oakland, CA

Gasification

Energy from biosolids

Energy recovery from incineration, Metropolitan Council, Minnesota

Dried biosolids are used as alternative fuel in coal-fired cement kilns.

Biofuel crops grown with biosolids are pressed to make biodiesel to fuel biosolids transport trucks.

40+ Years of Experience

What has been learned?
What is most critical to success?
Best practices…

National Biosolids Partnership

Certified Management Program

40+ Years of Research…

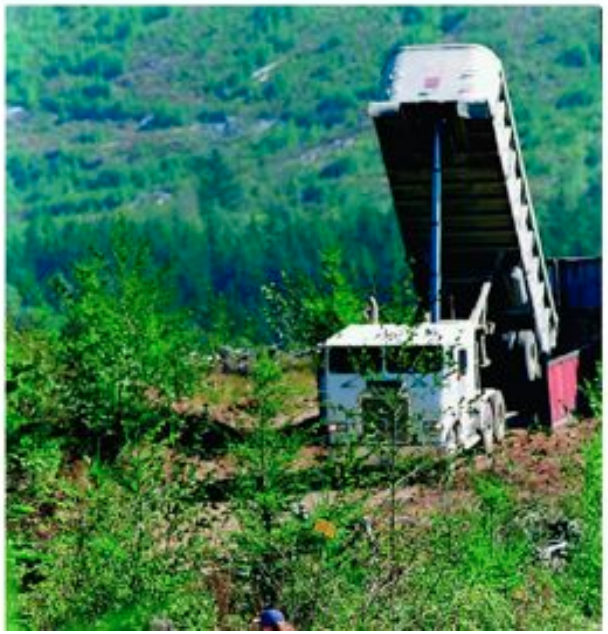
Resources: Research-informed best management practices

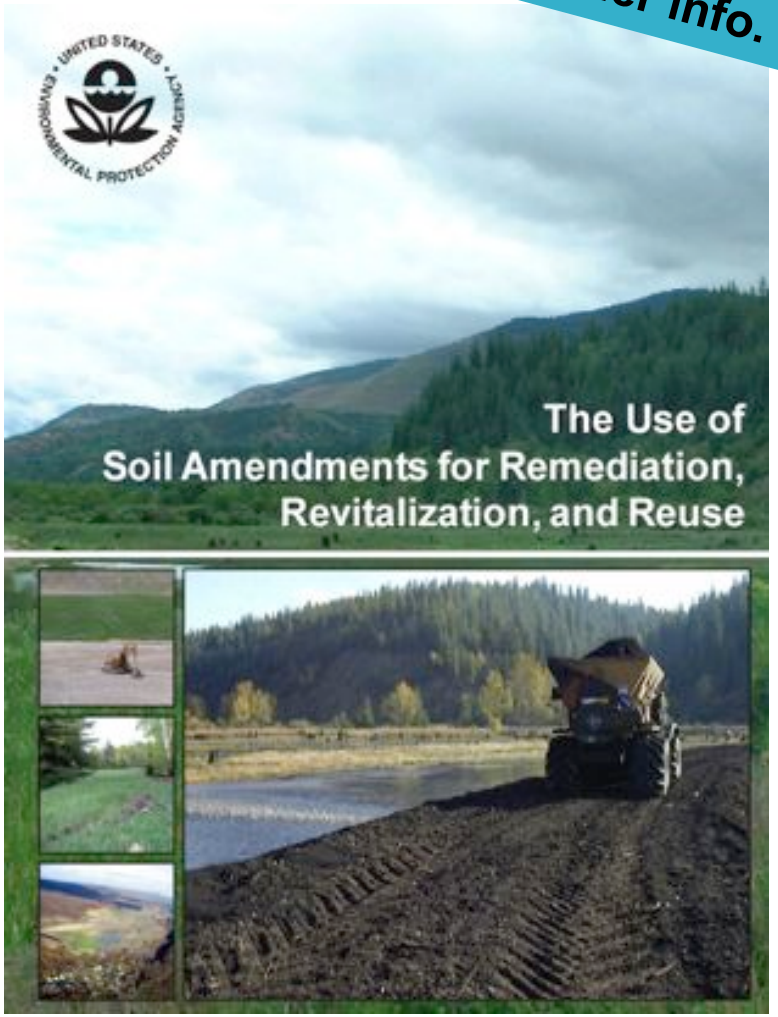
See "Resources" at end of slideshow for links to documents and other info.

United States Environmental Protection Agency | Office of Wastewater Management (4204) | EPA/832-B-00-007 July 2000

EPA

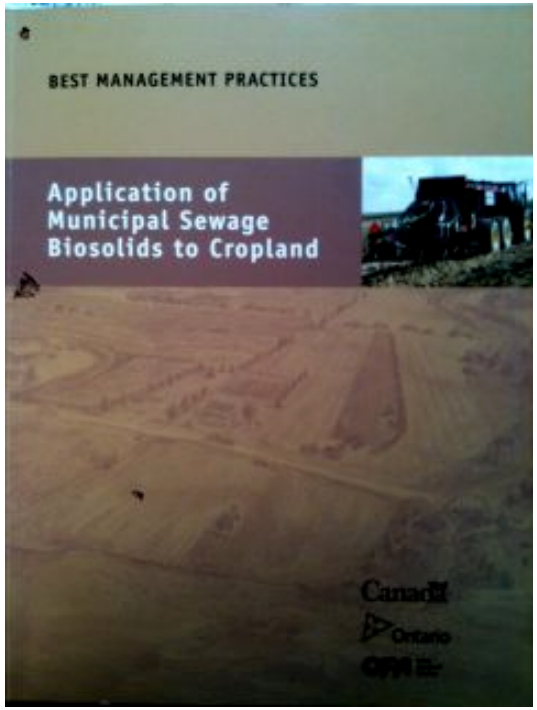
Guide to Field Storage of Biosolids





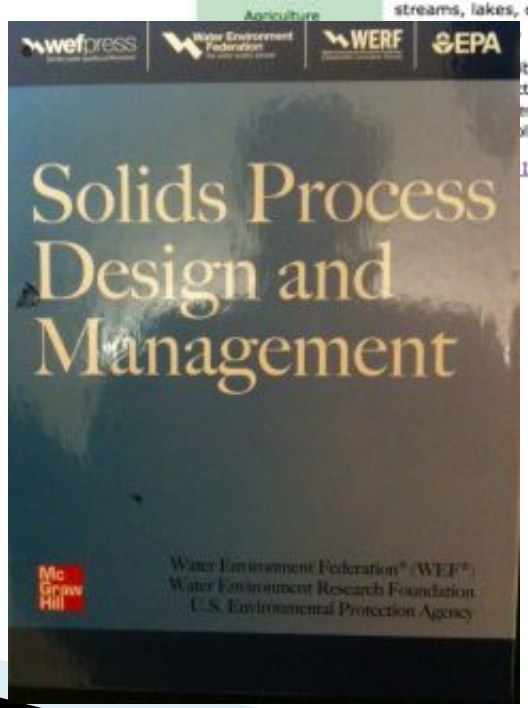
40+ Years of Experience

Resources: Best Practices



by the Province of Ontario, the Canadian government, & the Ontario Federation of Agriculture

NBMA is developing a “Best Practices” document.



The new 2012 WEF, WERF, EPA design manual includes many best practices.

40+ Years of Experience

Proactive communication is a best practice.

WERF has completed two studies (2004, 2011) of public perceptions and best public outreach processes.

40+ Years of Experience
Proactive communication is a best practice.

Ways to enhance trust

- Partner with credible third-party sources.
- Demonstrate trustworthy characteristics (empathy, honesty, competence, dedication).
- Practice organizational consistency and accessibility (solid track record).
- Start small and build, checking back with people to see how they think it is going.
- Involve the community in the development of acceptable health, environmental, & research studies procedures.
- Enhance monitoring by helping set up local oversight by trusted local people.

Resources

Biosolids Use & Trends

Charting the Future of Biosolids Management (2011)

Executive Summary: http://www.wef.org/CFBM_ExecutiveSummary
Full report: http://www.wef.org/CFBM_FinalReport

A National Biosolids Regulation, Quality, End Use, & Disposal Survey

A 2007 collaborative report by NEBRA, NBMA, *BioCycle*, and WI Dept. of Natural Resources

Report (with Executive Summary):
http://www.nebiosolids.org/uploads/pdf/NtlBiosolidsReport-20July07.pdf

State-by-state details (regulations and use & disposal data):

Alabama – Missouri
http://www.nebiosolids.org/uploads/pdf/NtlBiosldsRpt-AppD-AL-MO.pdf

Montana - Wyoming
http://www.nebiosolids.org/uploads/pdf/NtlBiosldsRpt-AppD-MT-WY.pdf

Water Environment Research Foundation (WERF)

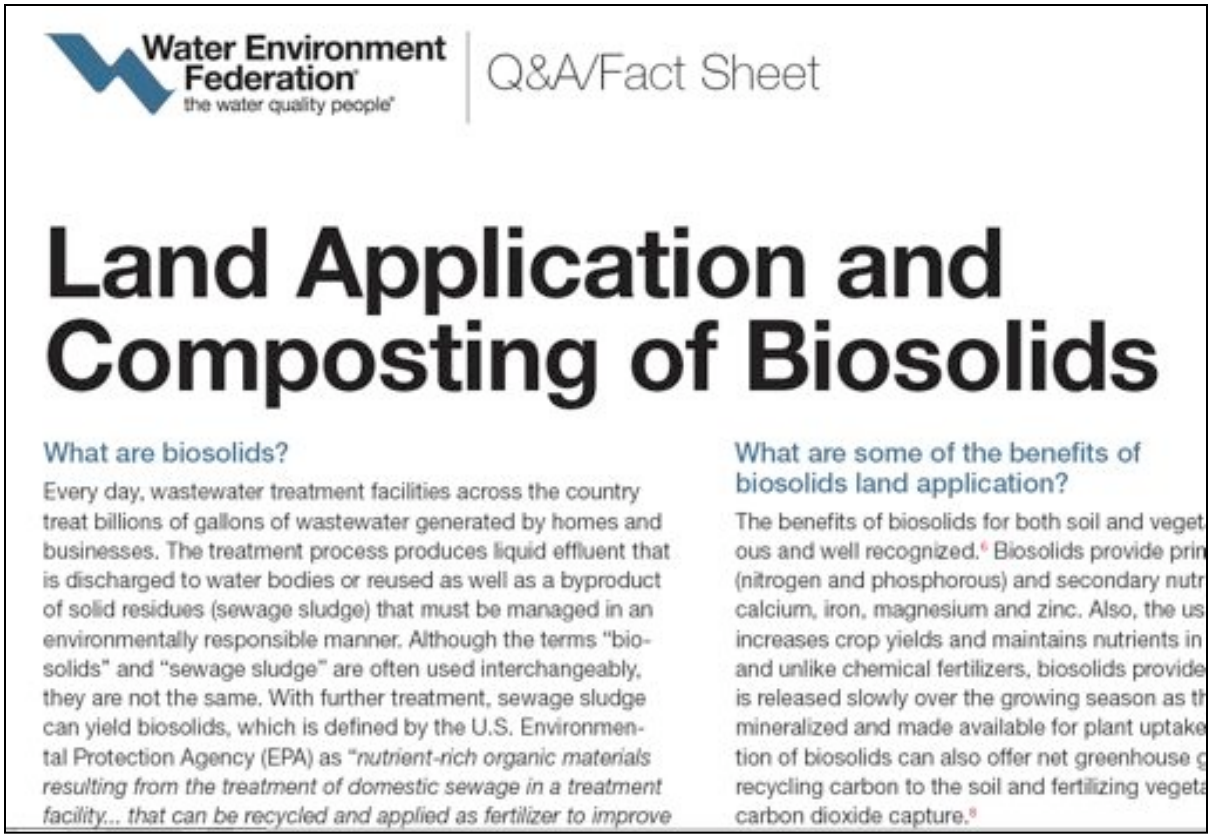
Biosolids Knowledge Area:
http://www.werf.org/i/ka/Biosolids/a/ka/Biosolids.aspx?hkey=884de809-dfbe-4960-9b31-473cbd14f770
Biosolids research at a glance:
http://www.werf.org/c/KnowledgeAreas/Biosolids/Biosolids_Research_at_a_Glance.aspx

Michigan DEQ Biosolids Land Application video
http://www.youtube.com/watch?v=vdw-fCHFtcg&feature=youtu.be

NATIONAL biosolids PARTNERSHIP

40+ Years of Experience

Resources



Water Environment Federation
the water quality people

Q&A/Fact Sheet

Land Application and Composting of Biosolids

What are biosolids?

Every day, wastewater treatment facilities across the country treat billions of gallons of wastewater generated by homes and businesses. The treatment process produces liquid effluent that is discharged to water bodies or reused as well as a byproduct of solid residues (sewage sludge) that must be managed in an environmentally responsible manner. Although the terms "biosolids" and "sewage sludge" are often used interchangeably, they are not the same. With further treatment, sewage sludge can yield biosolids, which is defined by the U.S. Environmental Protection Agency (EPA) as "*nutrient-rich organic materials resulting from the treatment of domestic sewage in a treatment facility... that can be recycled and applied as fertilizer to improve*

What are some of the benefits of biosolids land application?

The benefits of biosolids for both soil and veget
ous and well recognized.[6] Biosolids provide prin
(nitrogen and phosphorous) and secondary nutr
calcium, iron, magnesium and zinc. Also, the us
increases crop yields and maintains nutrients in
and unlike chemical fertilizers, biosolids provide
is released slowly over the growing season as th
mineralized and made available for plant uptake
tion of biosolids can also offer net greenhouse g
recycling carbon to the soil and fertilizing vegeta
carbon dioxide capture.[8]

Download many of the documents noted in this powerpoint, including this fine fact sheet, from the WEF/NBP website: http://www.wef.org/Biosolids/page.aspx?id=7522

NATIONAL biosolids PARTNERSHIP

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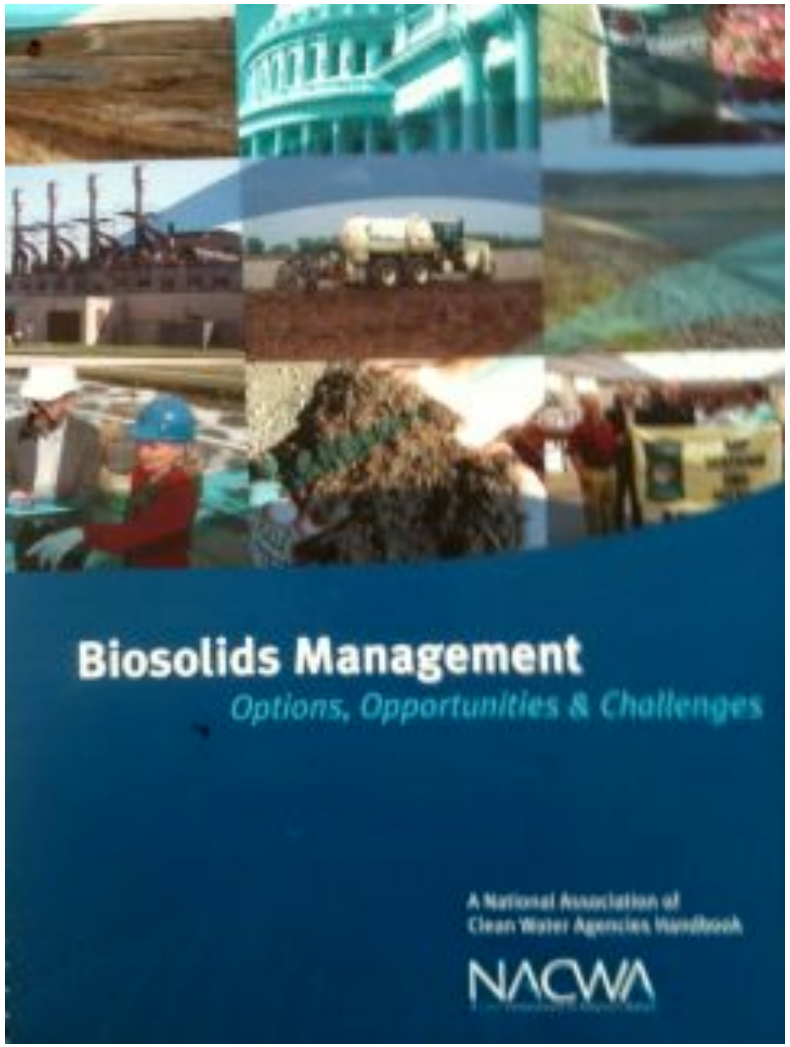
Resources

Order this 2006 document and see additional resources at the NACWA website: http://www.nacwa.org/index.php?option=com_content&view=article&id=338%3Abiosolids-management-options-opportunities-a-challenges-companion-online-library&catid=11%3Aoperation-utility-management&Itemid=27



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Resource

Biosolids: Naturally Sustainable

http://www.endless-films.com/site/?portfolio=biosolids

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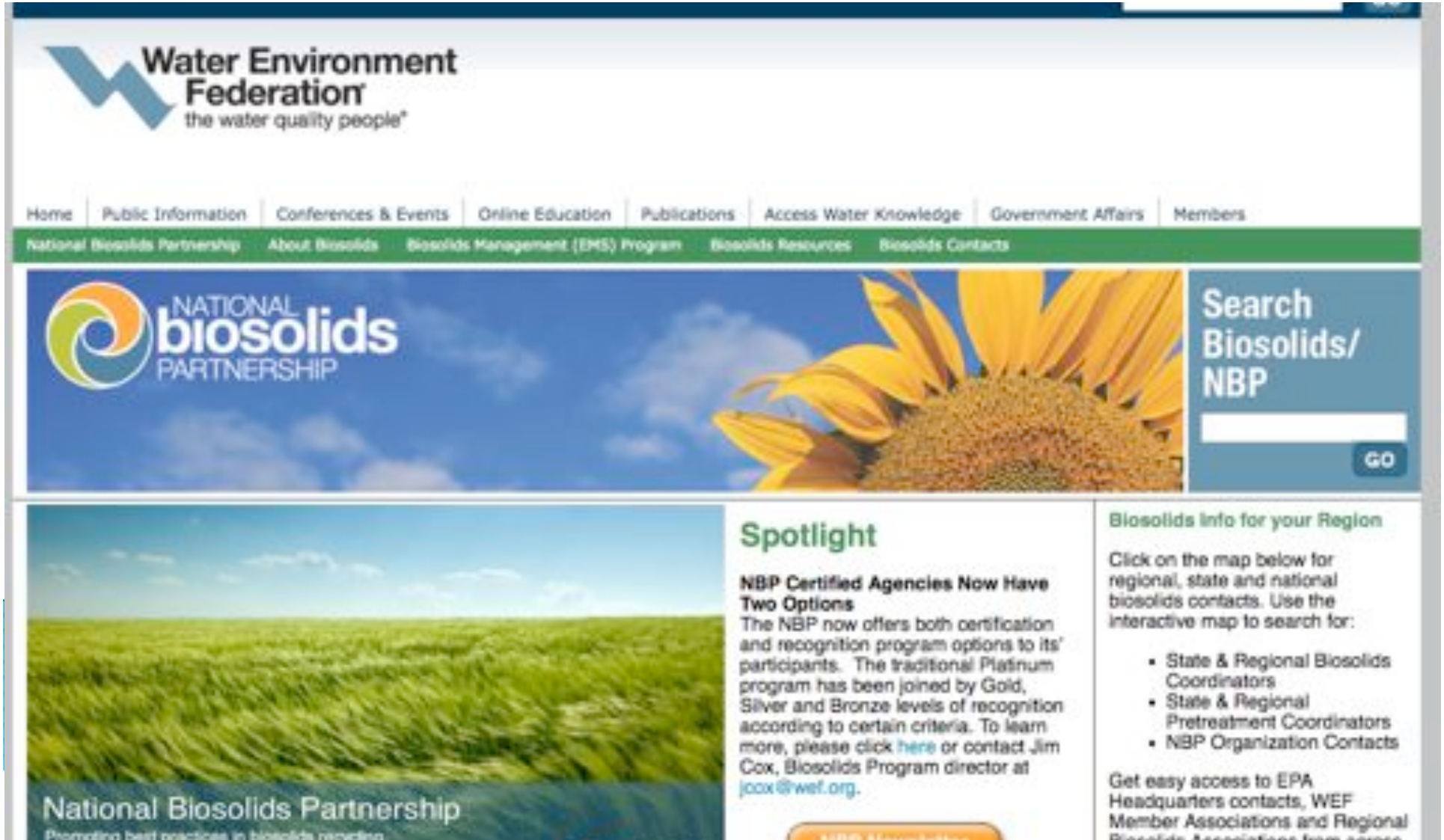
Resource: www.biosolids.org



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Additional web resources

WEF Technical Practice Updates (TPUs):
http://www.wef.org/TPUs/

WEF No Charge Webcasts:
http://www.wef.org/OnlineEducation/page_webcasts.aspx?id=124

WEFTEC Proceedings: Hosted on the IngentaConnect website *Proceedings of the Water Environment Federation* is an archival library of the papers presented at the annual WEF Technical Exhibition and Conference (WEFTEC) and other conferences held between 2000 and 2010. These proceedings are not peer-reviewed. No charge for WEF members.

This Week in Washington from WEF (no charge)
http://www.wef.org/GovernmentAffairs/ThisWeekInWashington/

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Additional web resources

- www.nebiosolids.org North East Biosolids & Residuals Association
- www.nwbiosolids.org Northwest Biosolids Management Association
- www.virginiabiosolids.com Virginia Biosolids Council
- www.mabiosolids.org Mid-Atlantic Biosolids Association
- http://www.ccme.ca/ourwork/waste.html?category_id=137 Canadian Council of Ministries of the Environment – Biosolids Task Force
- http://www.weao.org/committees/biosolids/biosolids.html Water Environment Assoc. of Ontario – biosolids page
- http://water.epa.gov/polwaste/wastewater/treatment/biosolids/index.cfm EPA Biosolids Page
- http://faculty.washington.edu/slb/biosolids_basics.html Univ. of Washington research
- www.loopforyoursoil.com King County biosolids brand "loop"

Acknowledgements

Thanks to the following for use of photographs & other assistance

American Biogas Council
Thomas Akin, USDA, NRCS
BioCycle
Black & Veatch
Sally Brown, PhD, Univ. of Washington
California Association of Sanitation Agencies (CASA) – Biosolids Program
CDM Smith
Andrew Carpenter, MS, Northern Tilth
Rufus Chaney, PhD, USDA
Chuck Henry, Univ. of Washington
King County, Washington
Mid-Atlantic Biosolids Association (MABA)
North East Biosolids and Residuals Association (NEBRA)
Northwest Biosolids Management Association (NBMA)
Orgro
Ian Pepper, PhD, Univ. of Arizona
Philadelphia Water Department
Water Environment Federation
WeCare Organics
Robert Brobst & Ernie Kelley (reviews)

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Recognizing A Resource:

biosolids

A Roadmap for State & Regional Biosolids Coordinators

and other interested parties

This has been Part 2; see also:

Part 1: **Federal and State Regulations**

Part 3: **Current Trends & Drivers in Biosolids Management & Focusing on *Resource Recovery***

Available at:
http://www.wef.org/Biosolids/page.aspx?id=7522