nebra

Recycled organics: Tools for sustainability.

Bury, QU compost site processing Chittenden County solids, ~2000s

Egg-shaped anaerobic digesters, Deer Island, Boston.

# Biosolids: A Community Resource

## Why Recycle? • Trends • Opportunities for VT

Ned Beecher • NEBRA (North East Biosolids & Residuals Association

April 13, 2015 • Vermont Citizens Advisory Committee • Montpelier WRRF

# Presentation Outline

- Recycling organics is a worthy goal (e.g. ACT 148)
  - The spectrum of organic residuals (biosolids is one)
  - Options for management
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    - Competing sources of nutrients
    - Excess nutrients
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# Organic Residuals:
## Sources of organic matter needed by soils

- Farm residuals: manure, crop residues, spoiled hay or silage or feed
- Municipal residuals ("wastes"): yard & leaf debris, biosolids
- Food processing & retailer residuals: vegetable, dairy, meat, fish
- Wood residuals: paper & pulp mill residuals, bark products, sawdust, shavings
- Post consumer food scraps – growing policy pressure to divert from landfills (e.g. laws in MA, VT)

Garbage Disposal

Wastewater Treatment

Organic Waste

Onsite Composting

Solids Separation

Biogas

Biosolids

Anaerobic Digestion

Materials Recycling Facility

Solids Separation

Biogas

Biosolids

Amendment

Composting Facility

Compost

Electricity

Waste to Energy

Biogas

Landfill

# Options for Organic Waste Management

Slide courtesy D. Parry, CDM Smith

# Organic matter is organic matter…

- Food waste
- Animal manures
- Biosolids
- Grass, green cropwaste
- Leaves, stalks

more putrescible
lower C:N ratio

less putrescible
higher C : N ratio

# Wet organics: food scraps, manures, biosolids

- Hard to manage (think leaking toters and trucks)
- Requires sealed containers
- Ideal for anaerobic digestion (mixable)
- Usually needs to be dewatered for useful product
- Wastewater facilities are designed to manage this!
- Some wastewater facilities have anaerobic digesters.
- Co-digestion is growing fast; already common in Europe.

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# Organics management options

Landfill

Incineration

Energy recovery is possible with any option.

Use on soils (land application, fertilizers & soil amendment products)

# Options: Landfill Disposal

- Simple, well-known
- Moderate cost
- Does not utilize nutrients & organic matter
- Limited energy potential
- Generates greenhouse gas (methane)
- Landfill space is limited.
- UNDESIRABLE.

# Options: Incineration

- Well-known, well-tested
- Large reduction in solids volume; manage lots of solids
- Some energy recovery potential
- Ash is inert, some fertilizer value (P) possible
- High capital cost – large facilities & merchants only
- Air emissions regulations
- Does not utilize nutrients & organic matter
- NOT A LIKELY OPTION IN VT

# Options: Use on Soils

- Puts to use nutrients & organic matter
- Cost-efficient
- Requires careful attention to many details, including regulations, best management practices, public outreach – can be a hassle
- More sustainable

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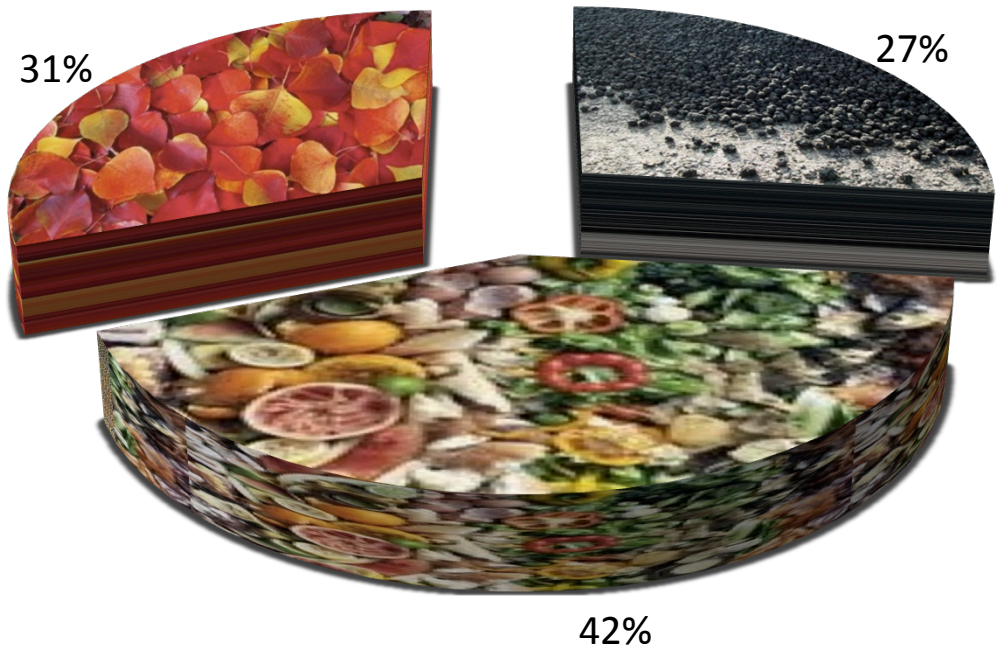
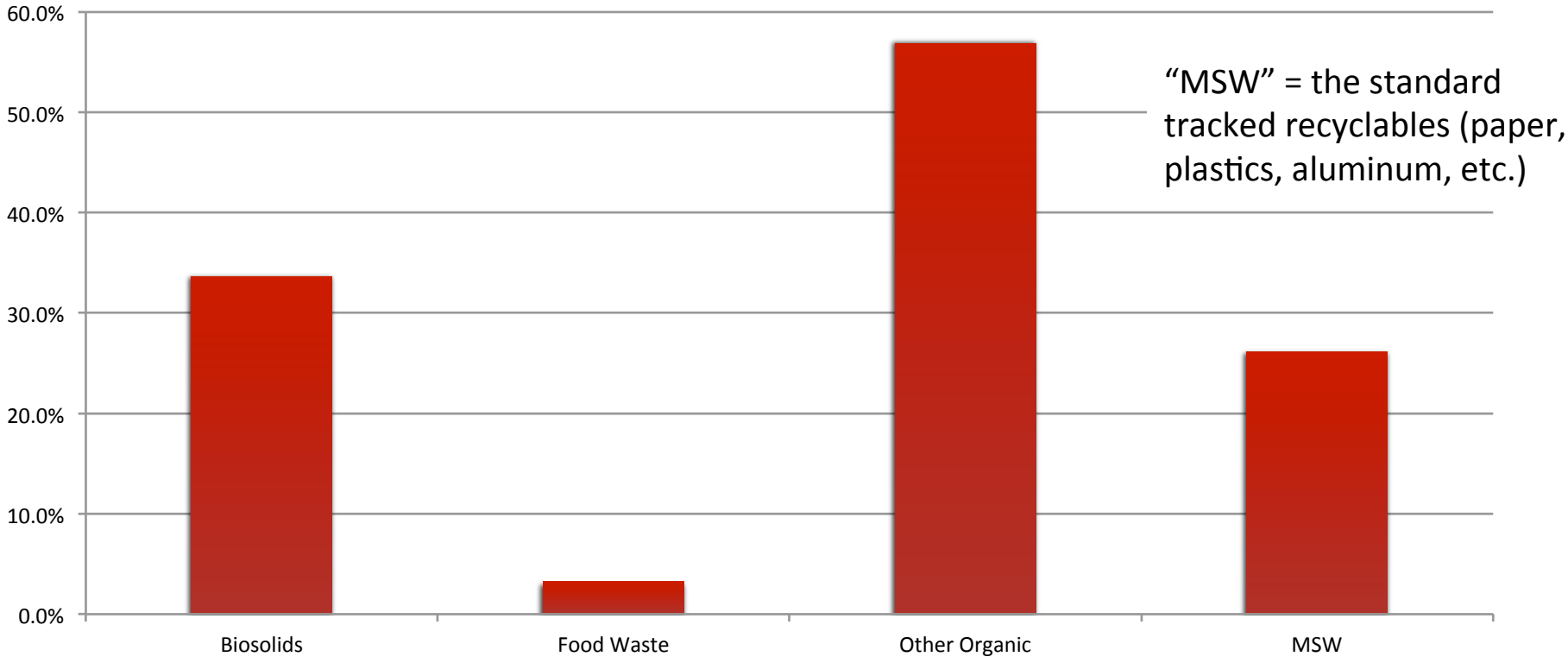
# Organics GENERATED in 10 Northeast Region States



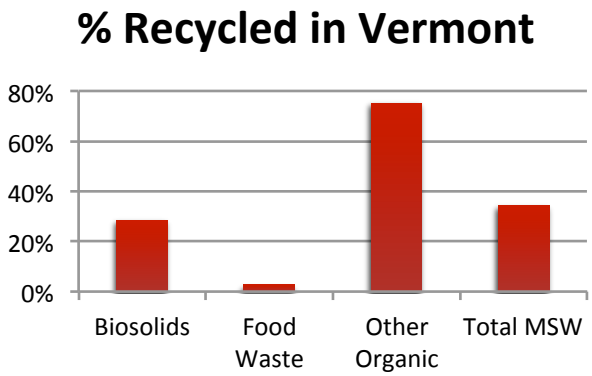

% of **the 24,514,000 wet tons/year organics GENERATED**

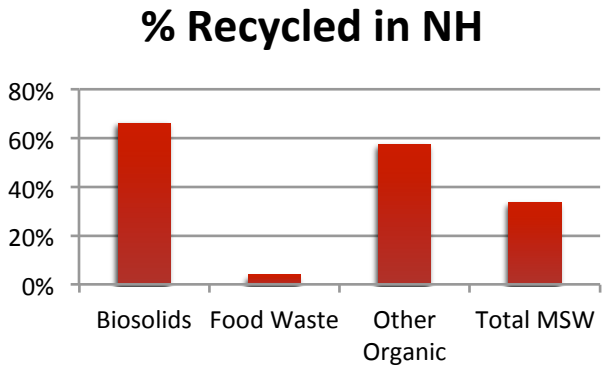
# Comparing RECYCLING RATES in 10 Northeast Region States

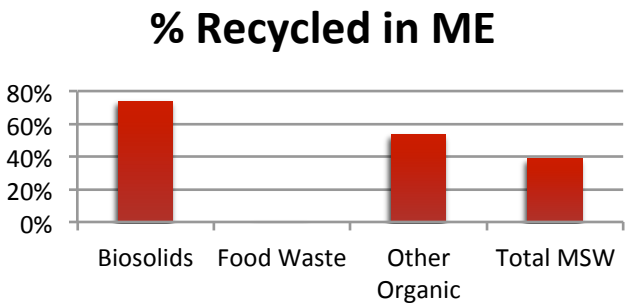


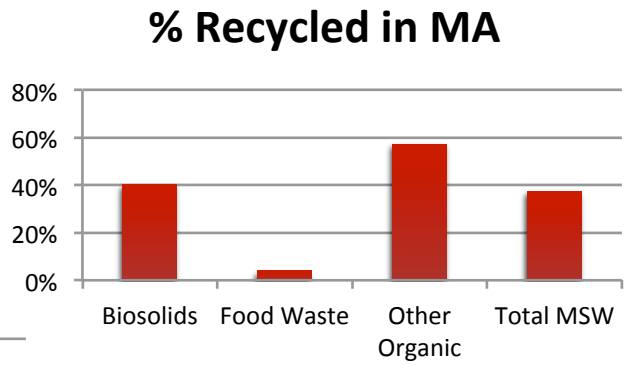

**6,817,000 wet tons/year organics RECYCLED**

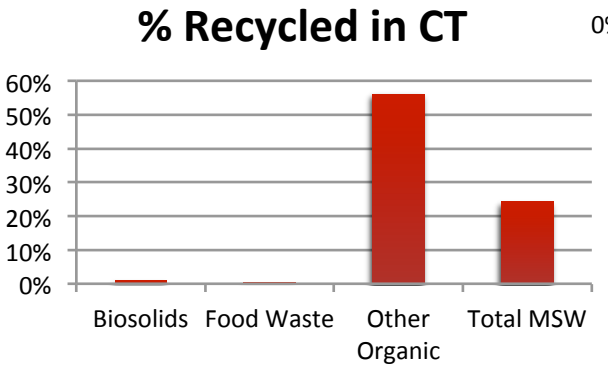
# State by state…

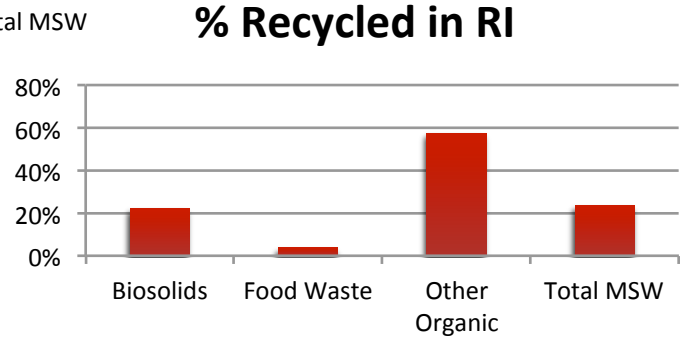


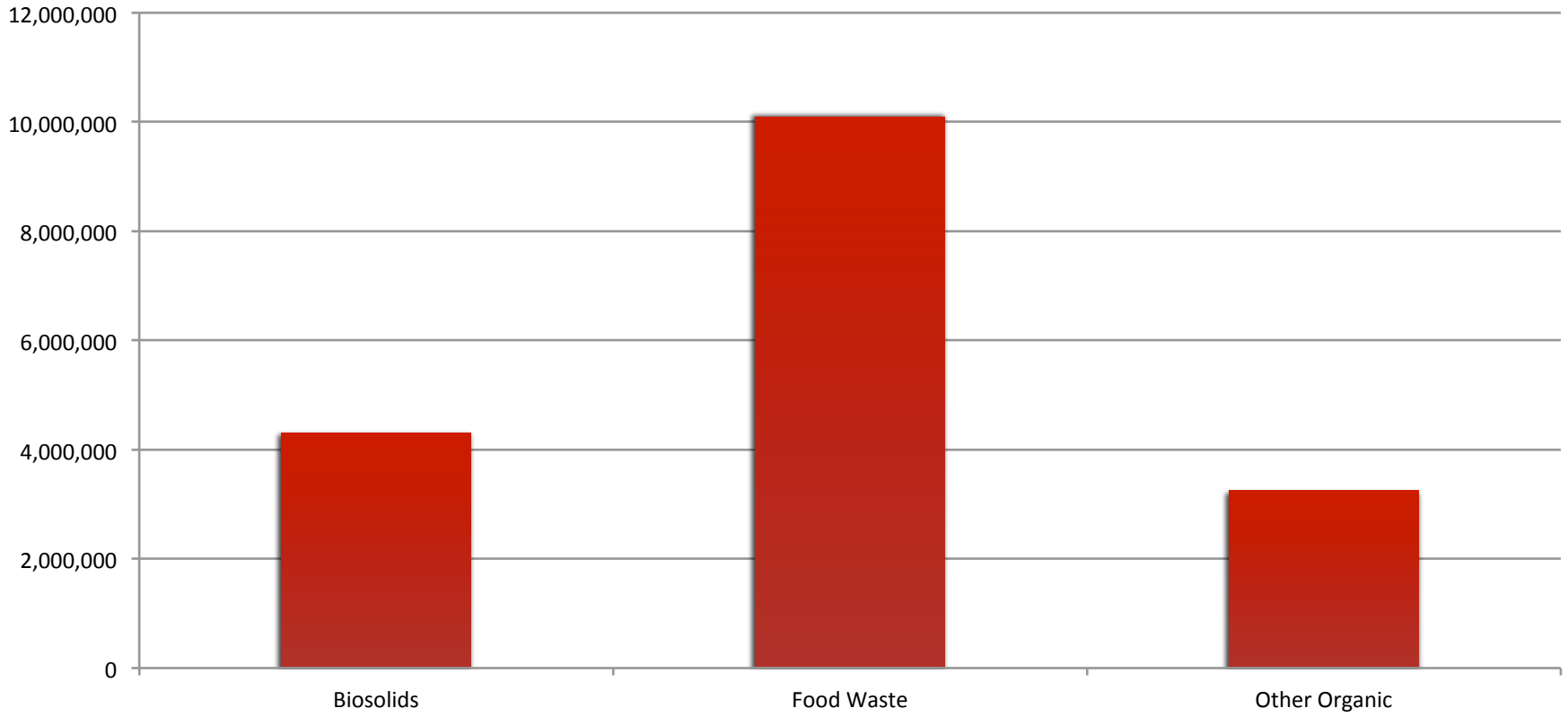



# Wet Tons Organics NOT RECYCLED in 10 Northeast Region States

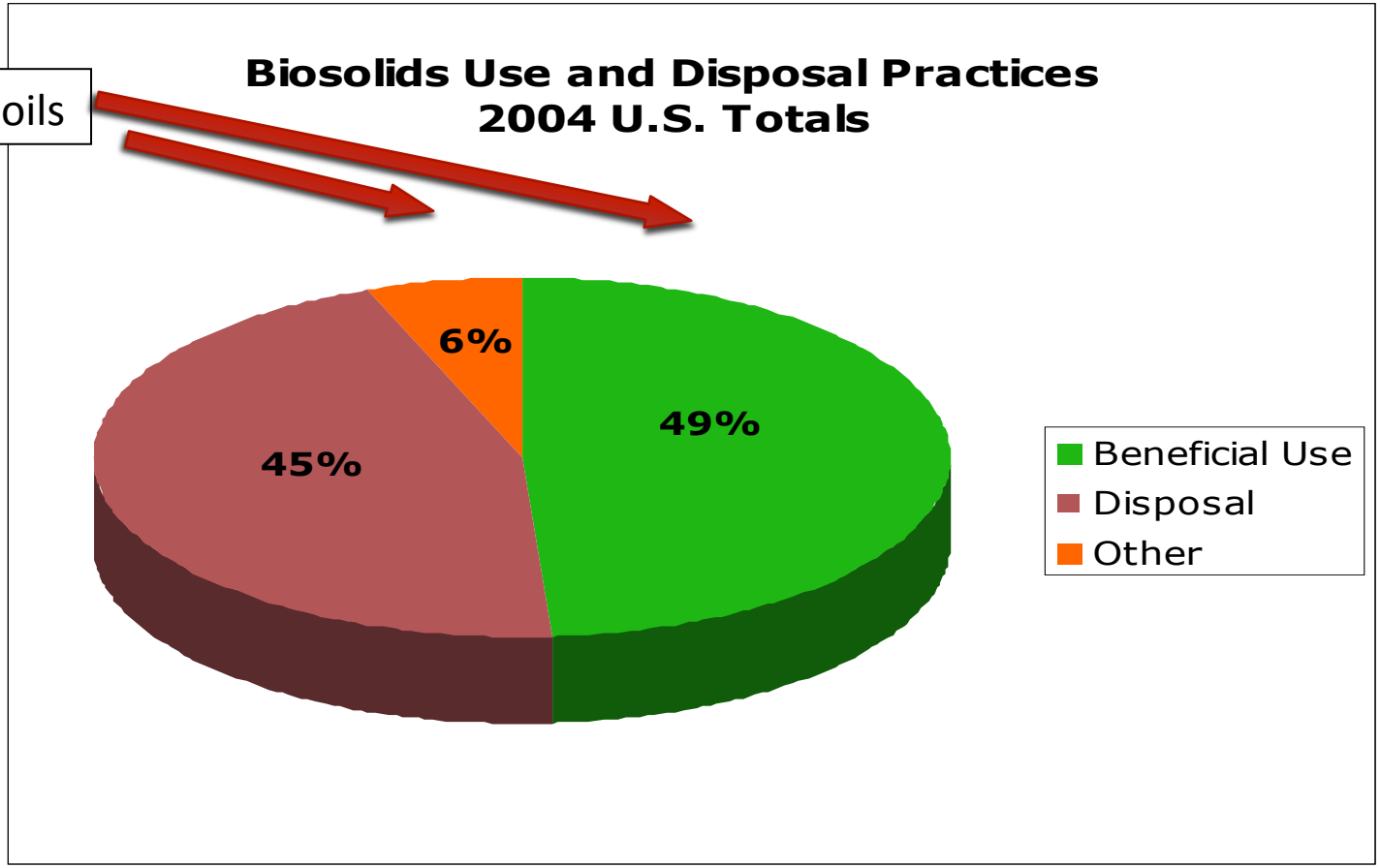



**17,649,000 wet tons/year organics NOT RECYCLED**

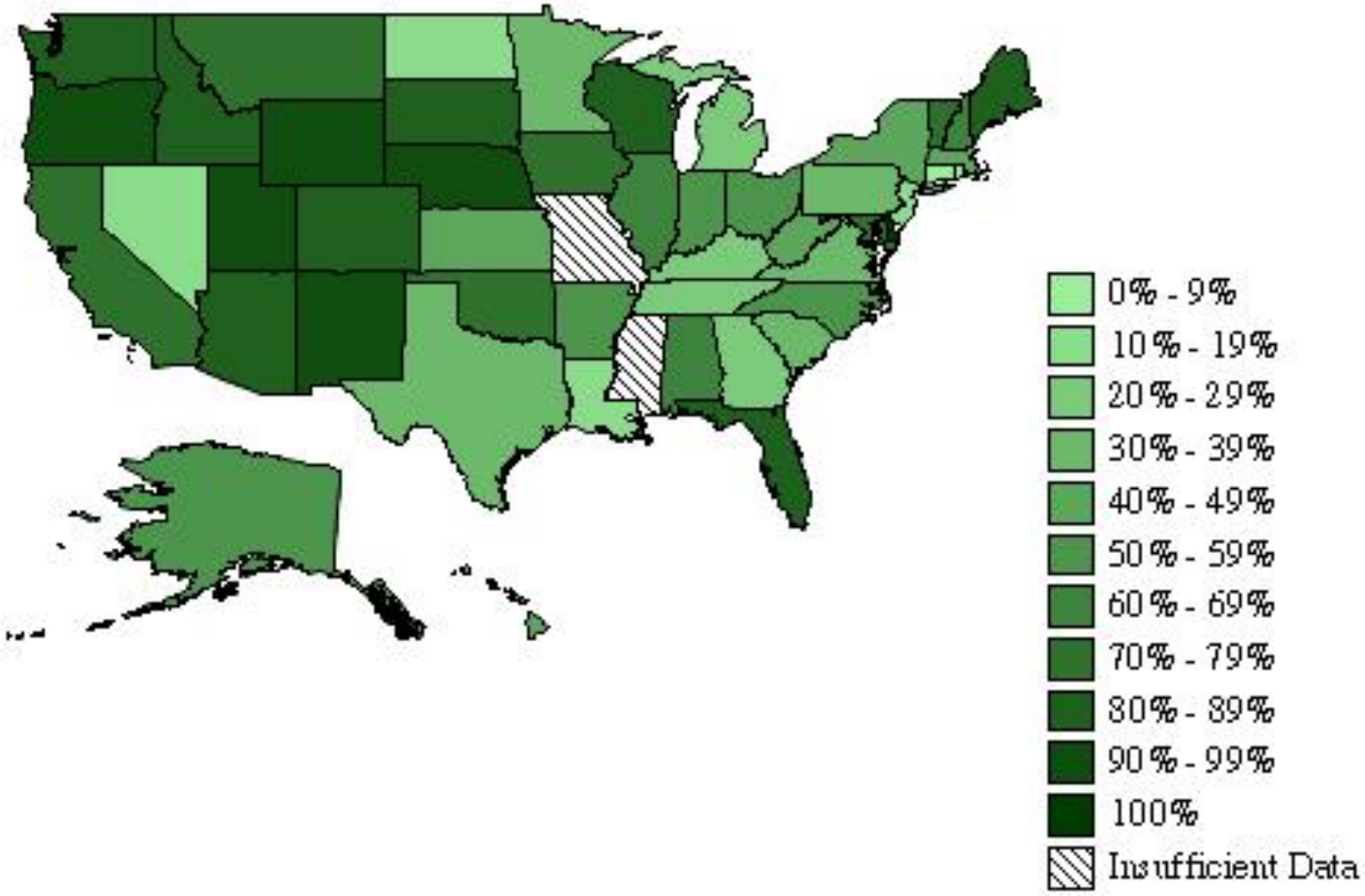
# Biosolids management in U. S.:

## 7,180,000 dry U. S. tons/year (~35.9 million wet tons)

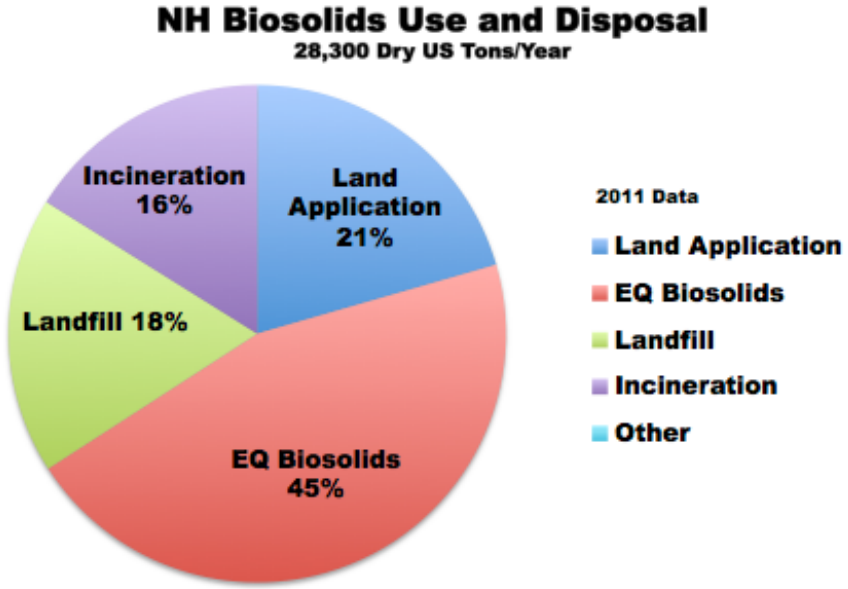
55% is used on soils



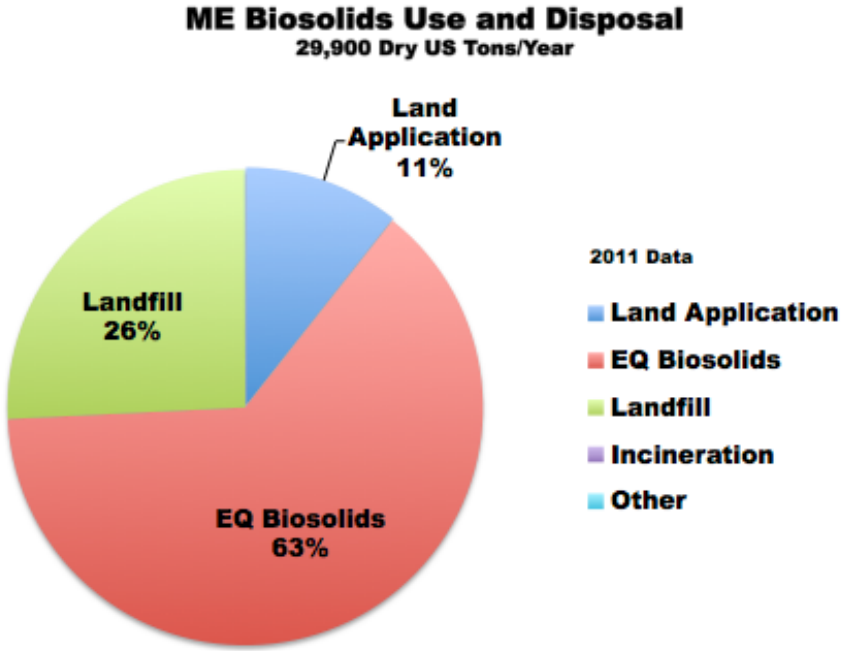
# Percent Biosolids Beneficially Used by State, 2004

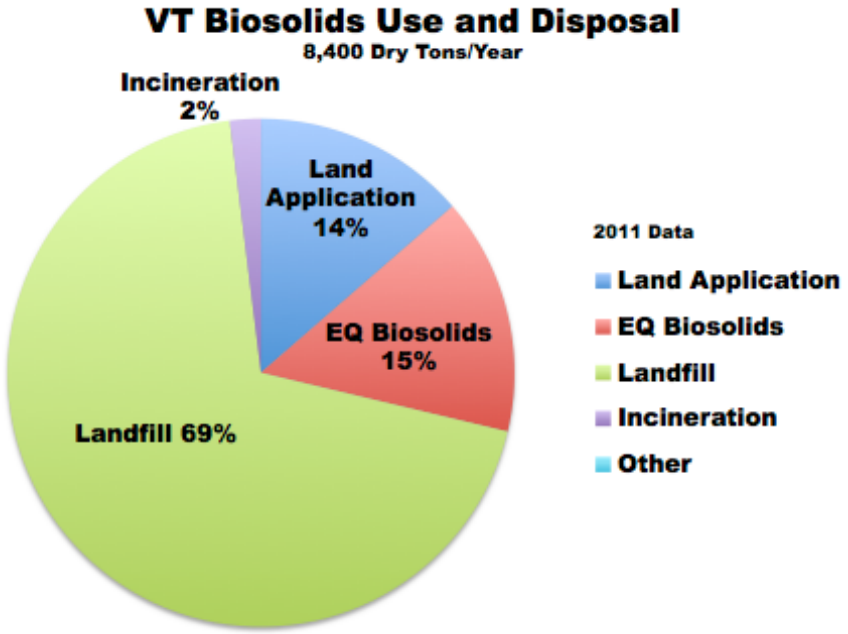


# Regional perspective: New England

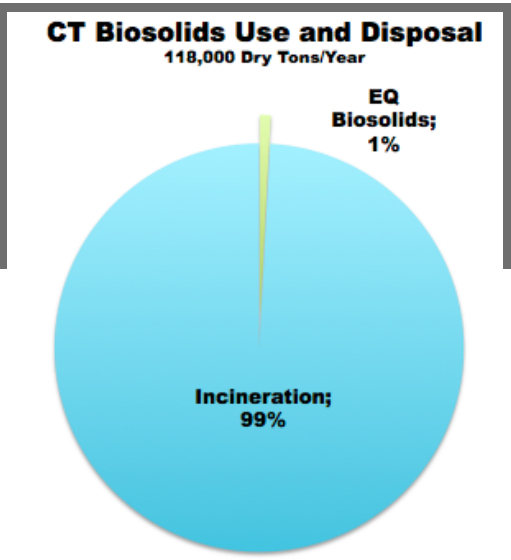



Maine has long had the highest biosolids recycling rate in New England, with NH close behind.

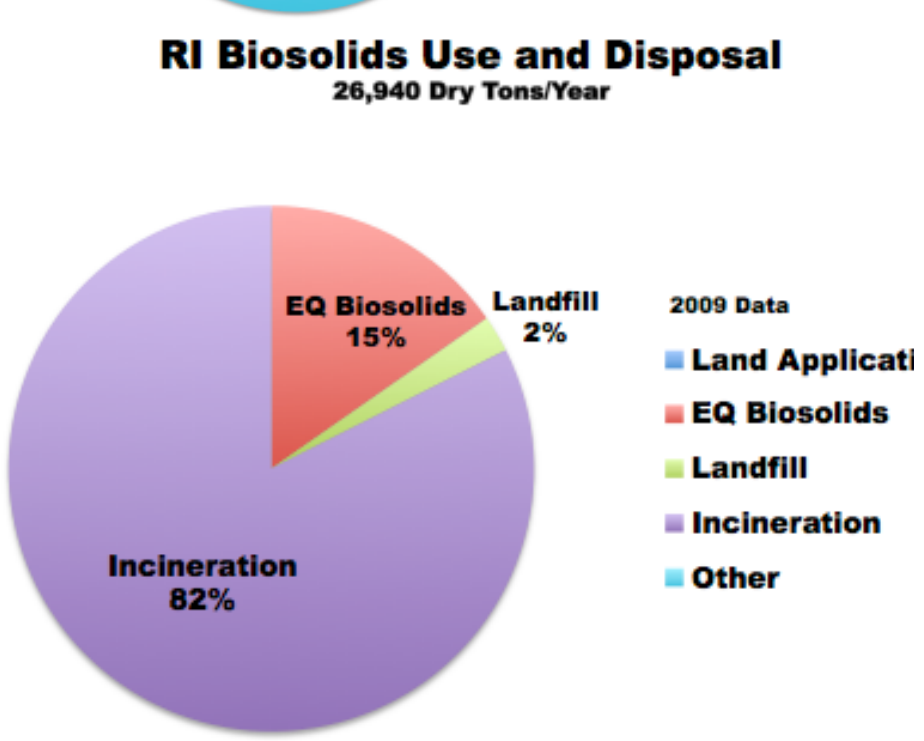


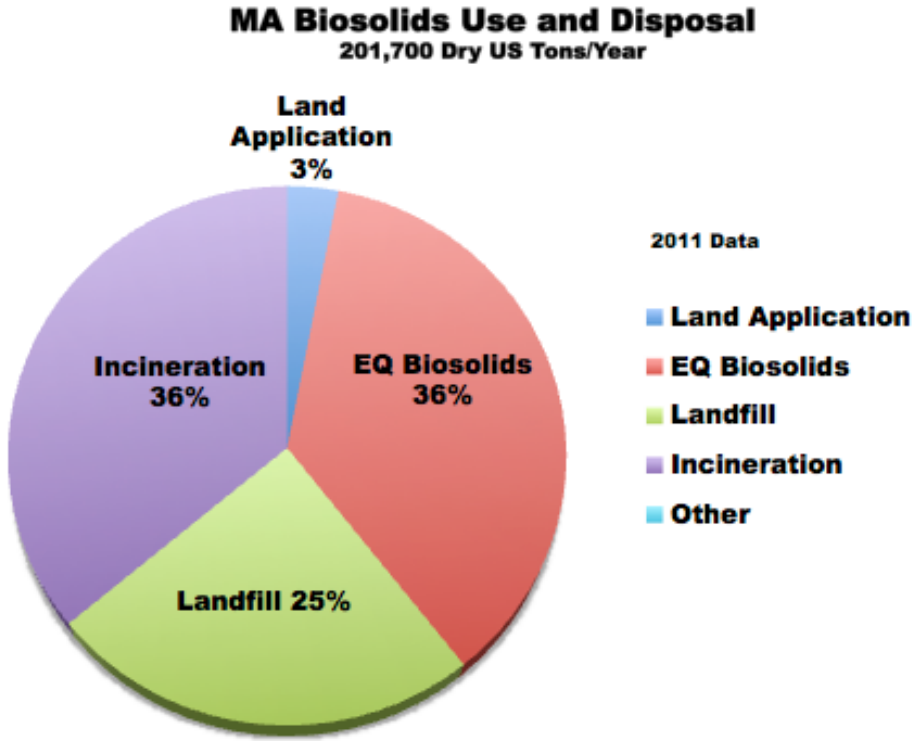



# Regional perspective:
## New England



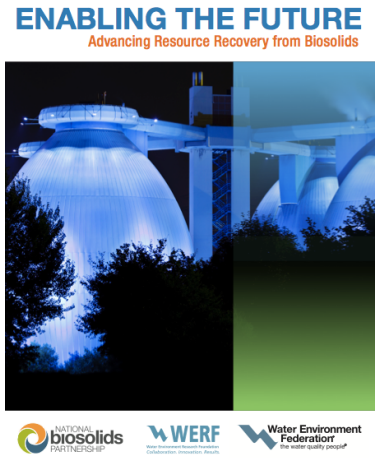

Southern New England relies heavily on incineration.



# Our Changing View of "Water Resource Recovery Facilities"

"There is growing awareness that wastewater treatment plants are not waste disposal facilities or polluters, but rather water resource recovery facilities that produce clean water, recover nutrients (such as phosphorus and nitrogen), and have the potential to reduce the nation's dependence upon fossil fuel through the production and use of renewable energy."



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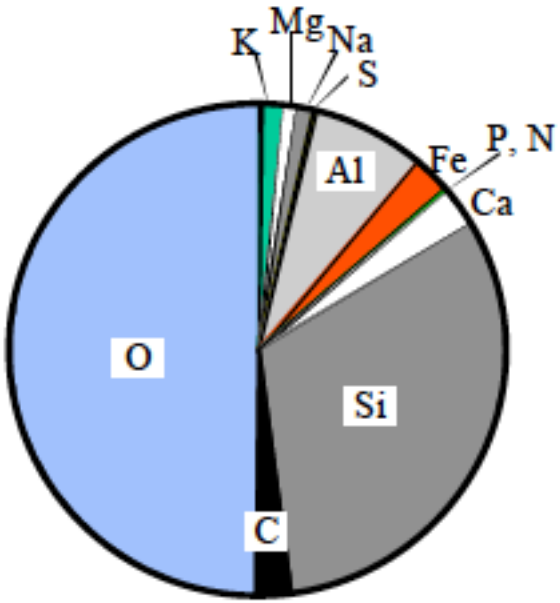
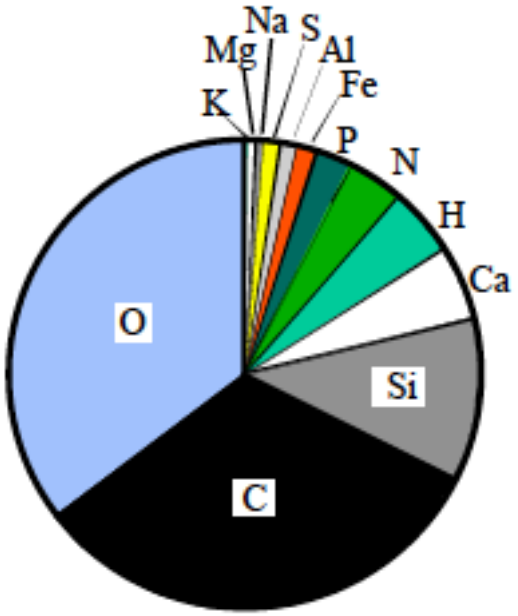
# What's in municipal biosolids?




soil




biosolids

# What's in municipal biosolids?

- **Water** ~ 5% (heat dried pellets) to ~ 95% (liquid biosolids)
- **Organic matter** ~ 20% to 70% dry weight biological molecules from foods, human waste, runoff, etc., including lipids, proteins, sugars, starches, etc., dissolved and suspended, *which contain…*
- **Nutrients** ~ 12% dry weight N, P, K, Ca, Fe, & micro-nutrients (Cu, Zn, etc.)
- **Binding Sites** reducing bioavailability of Pb, As, etc.
- **Energy** ~ 5,000-10,000 Btu/d lb. (when dry, similar to low grade coal)

Also:

- Inert sand, silt, grit, and synthetic particles
- Trace elements (mostly in compounds)
- Pathogenic micro-organisms
- Synthetic and natural organic chemical compounds (e.g. including polymers)

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# Organics management challenges:

- **Odors / stability** – wastewater solids, manures, & food residuals are putrescible and can stink
- **Wet, gunky stuff** - wastewater solids, some manures, & food waste are mostly water
- **Pathogens / Vectors –** wastewater solids (and some manures) have more and need more treatment (required for biosolids use)
- **Contaminants** – heavy metals, chemicals, and plastics/trash contamination is a challenge for all organic residuals recycling (biosolids contaminants are strictly regulated based on scientific risk assessment)
- **Nutrient-rich** – wastewater solids. Manures, & food waste, more than other organics, have considerable N and P – a good thing, except that end product use may be restricted by nutrient management restrictions
- **Regulatory challenges for final products & uses**
- **Public acceptance of final products & customer education on proper uses**

# Microconstituents / PPCPs / TORCs / EDCs, ESOCs, trace chemicals…

- Public interest remains high regarding chemicals in the environment….
  - What is their fate?
  - Do they have any impact?
  - They illustrate the connection of individuals' activities with the environment
- What does it mean for biosolids management?
  - There are similar reactions / processes for all chemicals
  - Persistent chemicals present highest level of concern; others will be decomposed in soils
- Biosolids land application as a tool for managing these
  - Assimilative capacities of soils
  - Best management practices, such as limited application rates

# Nutrients

- A main reason to recycle organics!
- Phosphorus (P) is a limited resource from mined rock sources (peak P this century)
- Nitrogen (N) fertilizer is energy-intensive and expensive to produce (Haber-Bosch process)
- Potassium (K) comes from mined rock sources.
- Why not recycle what's in our food waste (that which has and has not gone through us?)
- Excess nutrients on soils can cause environmental concerns.
- Nutrient management is the norm on farms in most states.
- States are severely restricting use of P fertilizers on turf: this applies to biosolids, composts, food residual-based products, etc.

# Odors / Stability

- Most common cause of organics recycling program failure.
- Best management practices have been developed, especially for biosolids.
- Research in biosolids field provides helpful information for management of any putrescible organics.

## Unbearable Smell Forcin Residents Inside

April 1, 2013 10:14 PM

Like 163 Tweet 4 Share 10

**Related Tags:** Boyd, FM 730, Fort Worth, Fort Worth water treatme
Commission on Environmental Quality

**Jason Allen**
Jason came to North Texas after working as a reporter for four y...
Read More

**BOYD (CBS 11 NEWS) -** Spring is in the air, but in one North Texas community, that's not necessarily a good thing. Residents in Boyd are organizing to fight a smell they say gets so bad at times that they stay captive inside their homes.

Inside his woodshop, with sawdust flying, and the windows closed, Don Dixon can still smell it. At first, he

# Public Acceptance & Customer Education:

## challenges shared by all organics recycling programs

nebiosolids.org

http://digital.vpr.net/post/beyond-ick-factor-wastewater-treament-vt

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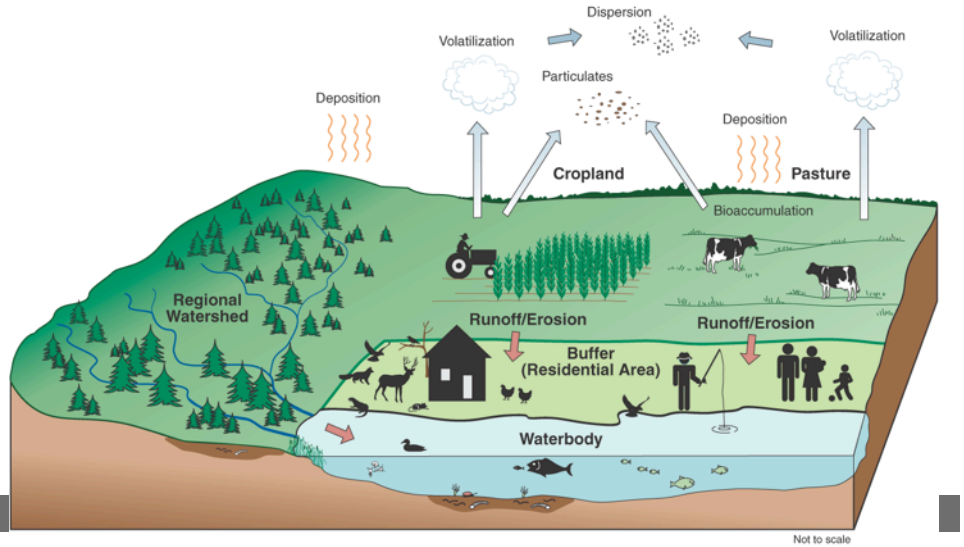
# 45+ years of research
## on using biosolids and other organic residuals

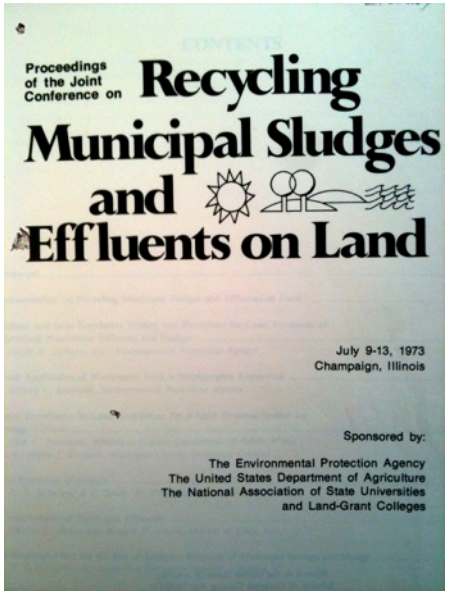
- Treatment processes
- Beneficial use options
- Potential impacts on environment, soils, crops, & public health
  - Trace elements / heavy metals
  - Synthetic chemicals
  - Pathogens

EPA Risk Assessment for U. S. EPA regulations (Part 503):
Exposure Pathways Assessed
Agricultural Land Application Scenario to Assess Human Exposure



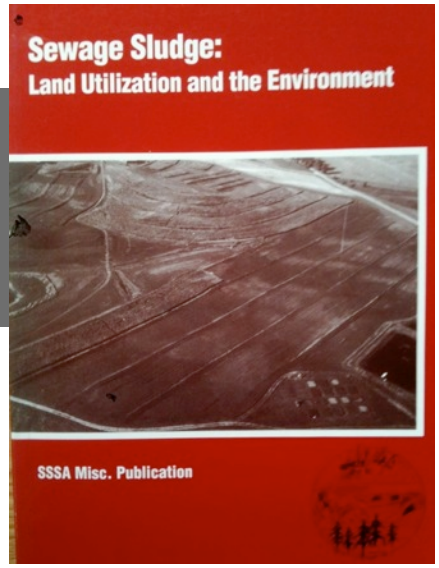
# Every 10 years –

The EPA and major universities hold a conference on the state of the science:

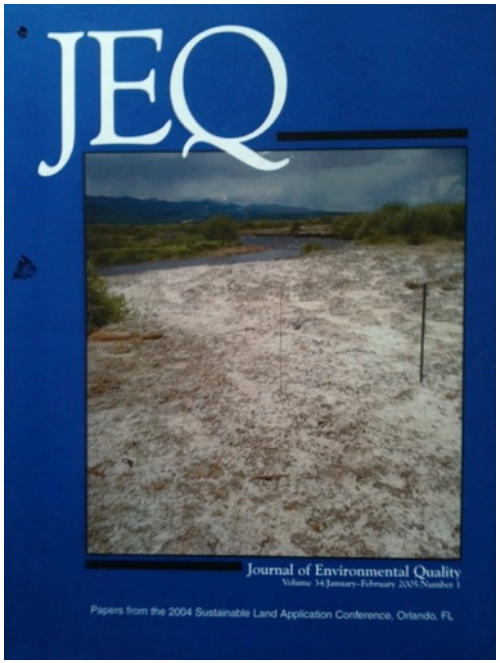



1973 – Univ. of Illinois

1983 – Colorado



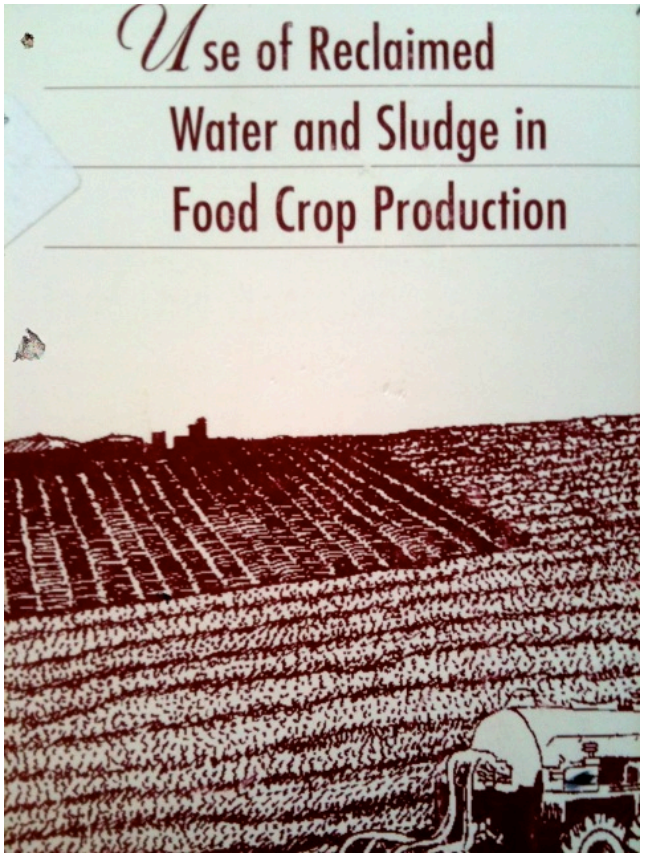

1993 – Univ. of Minnesota – proceedings published by Soil Science Society of America




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

# National Academy of Sciences Review, 1996

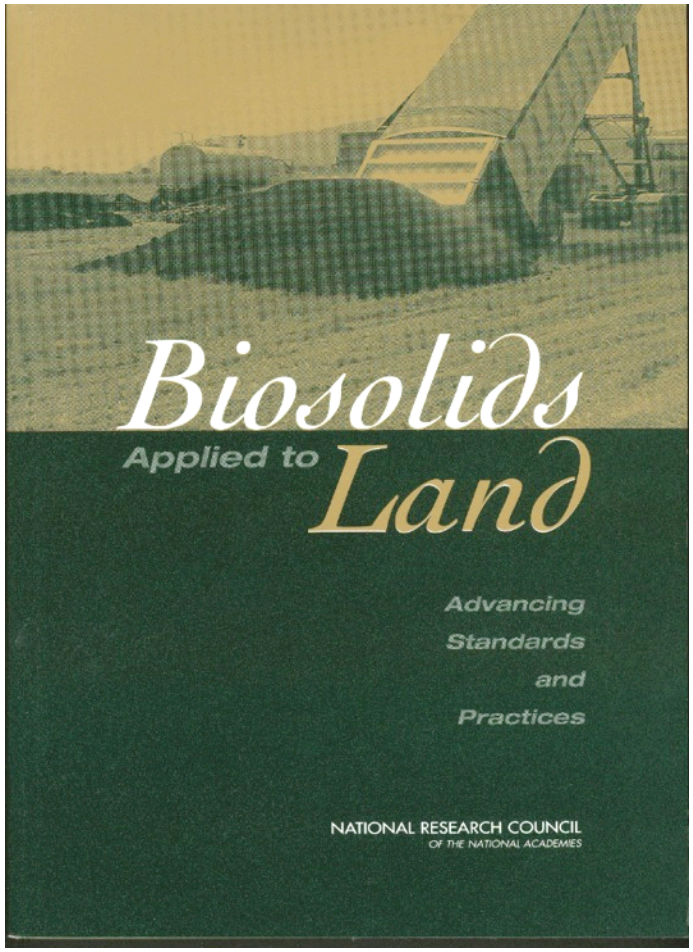
**"In summary, society produces large volumes of treated municipal wastewater and sewage sludge that must be either disposed of or reused. While no disposal or reuse option can guarantee complete safety, the use of these materials in the production of crops for human consumption, when practiced in accordance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



# A second review by the NAS in 2002…

## The finding:

”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.”



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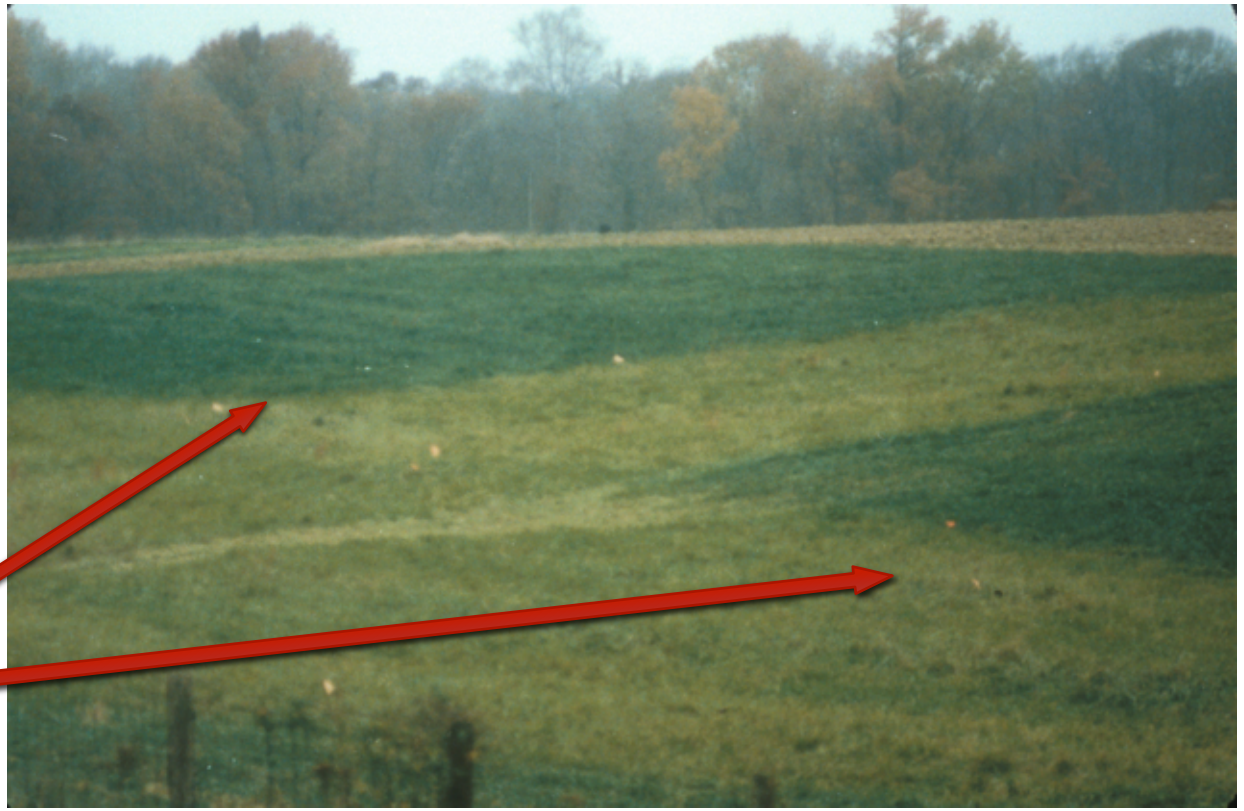
# Why farmers use biosolids…

Biosolids make a difference in crop quality & yield.

Darker grass crop is where biosolids were applied.



# Biosolids

- 3 – 6% N,  1 – 4% P,  .2 – 1% K
- 50 – 60% organic matter
- Plus trace nutrients
- Only “Class A” – pathogen-free – biosolids allowed on home gardens:  compost (e.g. Merrimack, NH) and heat-dried pellets (e.g. Milorganite, Bay State)

# Benefits are clear

nebra

# Biosolids improve soils.

# SAVING OUR SOILS

inclusive **policies and governance**

investment in **sustainable soil management**

targeted soil **research**

**stopping soil degradation** & restoring degraded soils

effective **education & extension programmes**

**soil information** systems

## sustainable soil management

increasing **soil organic matter** content

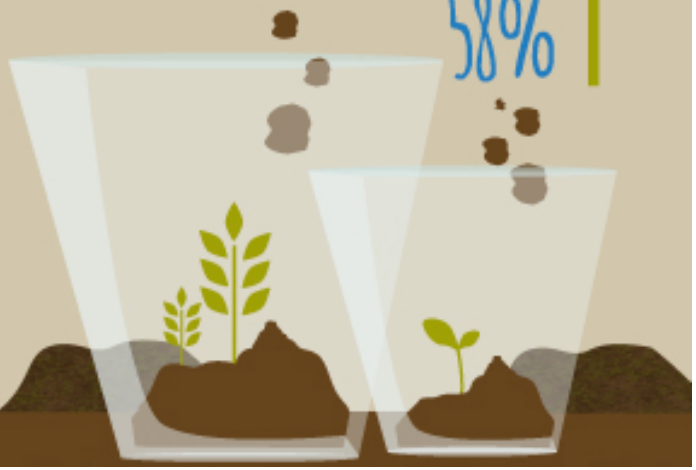
keeping soil surface **vegetated**

using **nutrients** wisely

promoting **crop rotations**

reducing **erosion**

can lead to an average **crop yield increase** of **58%**



**See more – look up International Year of Soils 2015**

**See Soil & Water Quality Video (April video here: https://www.soils.org/iys/monthly-videos )**

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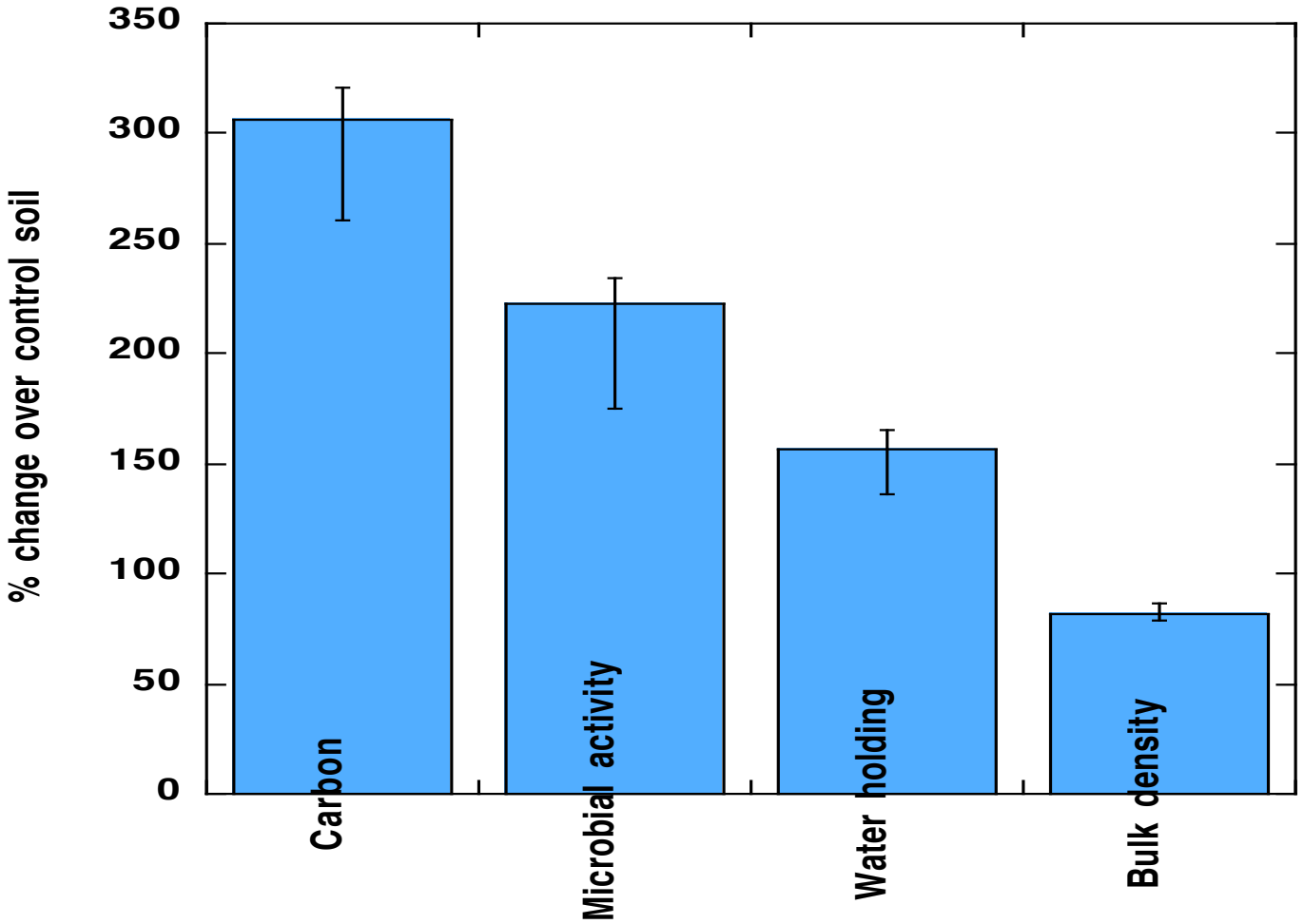
# Organic matter improves soil quality.




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).

– Dr. Sally Brown, Univ. of WA, 2011 research

# My garden: biosolids compost

April 2012

May 2, 2013

# Presentation Outline

- Recycling organics is a worthy goal (e.g. ACT 148)
  - The spectrum of organic residuals (biosolids is one)
  - Options for management
  - What's done with organics (& biosolids specifically)
  - What's in them
  - Challenges
  - Science has addressed challenges
  - Why use biosolids (and other organics)?
  - What's ideal for sustainability?
  - Vermont biosolids policy & recycling ups & downs & ups
  - What it means for water quality - discussion
    - Competing sources of nutrients
    - Excess nutrients
    - Nutrient management (current Water Quality Act)

# What's in municipal biosolids?

- **Water** ~ 5% (heat dried pellets) to ~ 95% (liquid biosolids)
- **Organic matter** ~ 20% to 70% dry weight biological molecules from foods, human waste, runoff, etc., including lipids, proteins, sugars, starches, etc., dissolved and suspended, *which contain…*
- **Nutrients** ~ 12% dry weight N, P, K, Ca, Fe, & micro-nutrients (Cu, Zn, etc.)
- **Binding Sites** reducing bioavailability of Pb, As, etc.
- **Energy** ~ 5,000-10,000 Btu/d lb. (when dry, similar to low grade coal)

Also:

- Inert sand, silt, grit, and synthetic particles
- Trace elements (mostly in compounds)
- Pathogenic micro-organisms
- Synthetic and natural organic chemical compounds (e.g. including polymers)

Managing biosolids & other organic residuals:

# What's ideal for sustainability?

## MAXIMIZE BENEFICIAL USES OF RESOURCES

| Constituent | Benefits | Concerns |
|---|---|---|
| Water | valuable in agriculture in dry times | cost of transport |
| Organic matter | vital to soils | putrescible, odor |
| Nutrients | plant & animal food | impacts to water |
| Energy | renewable, displaces oil/gas | air emissions, no use of nutrients & organic matter if incinerated |

## MANAGE TO MINIMIZE POTENTIAL RISKS

Reduce/control/mitigate trace elements (e.g. metals), pathogens, synthetic and natural organic chemical compounds, odors, nuisances

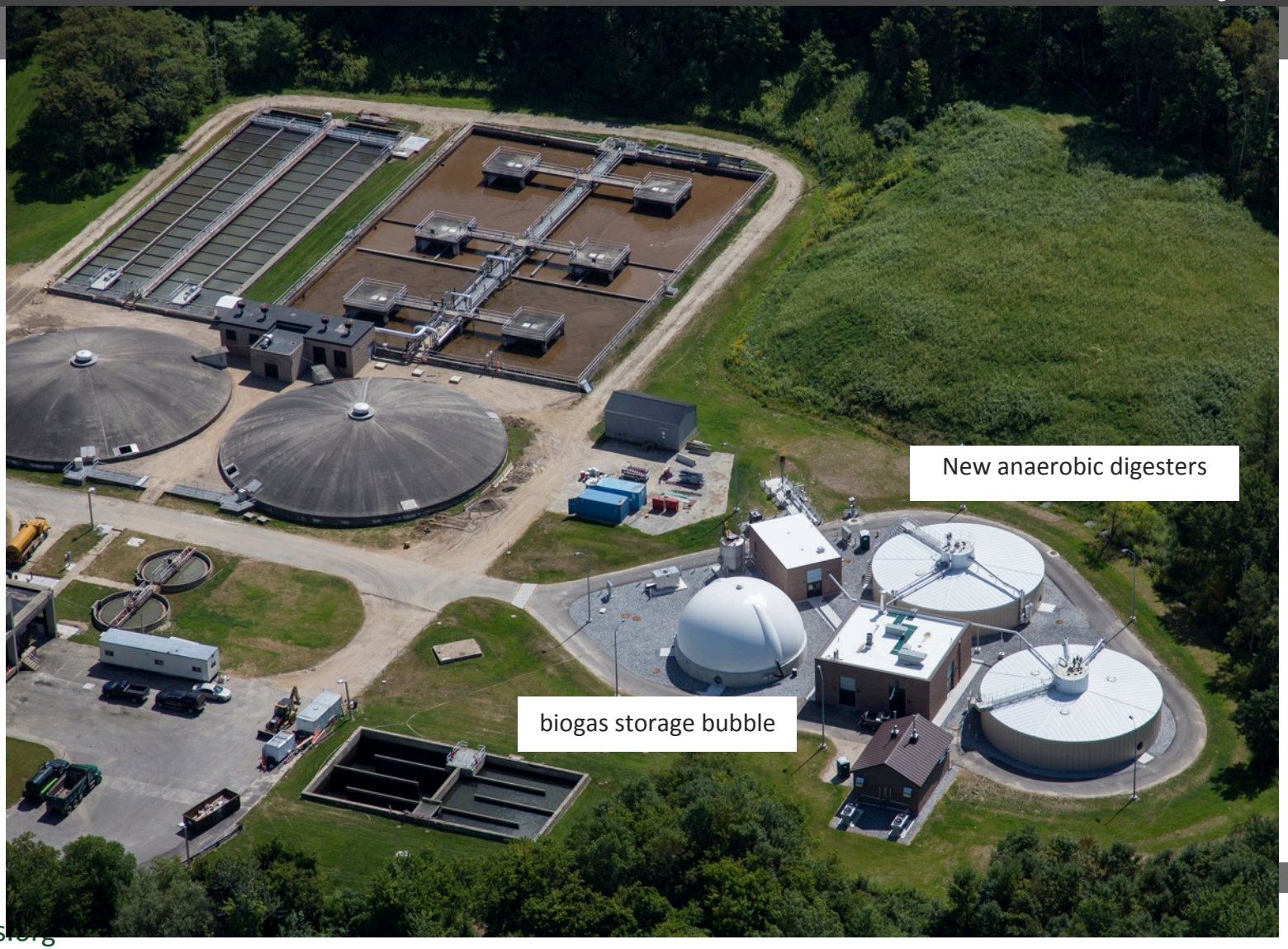
Digester

# Co-digesting biosolids & other organic residuals
# Essex Junction, VT

# AD at WRRFs: Boston

Deer Island Wastewater Treatment Plant Boston: 12 digesters; has generally been operating just 8.

# The new resource recovery facility at the Lewiston-Auburn Water Pollution Control Authority, Maine



# AD at WRRFs: Other examples

Nashua, NH

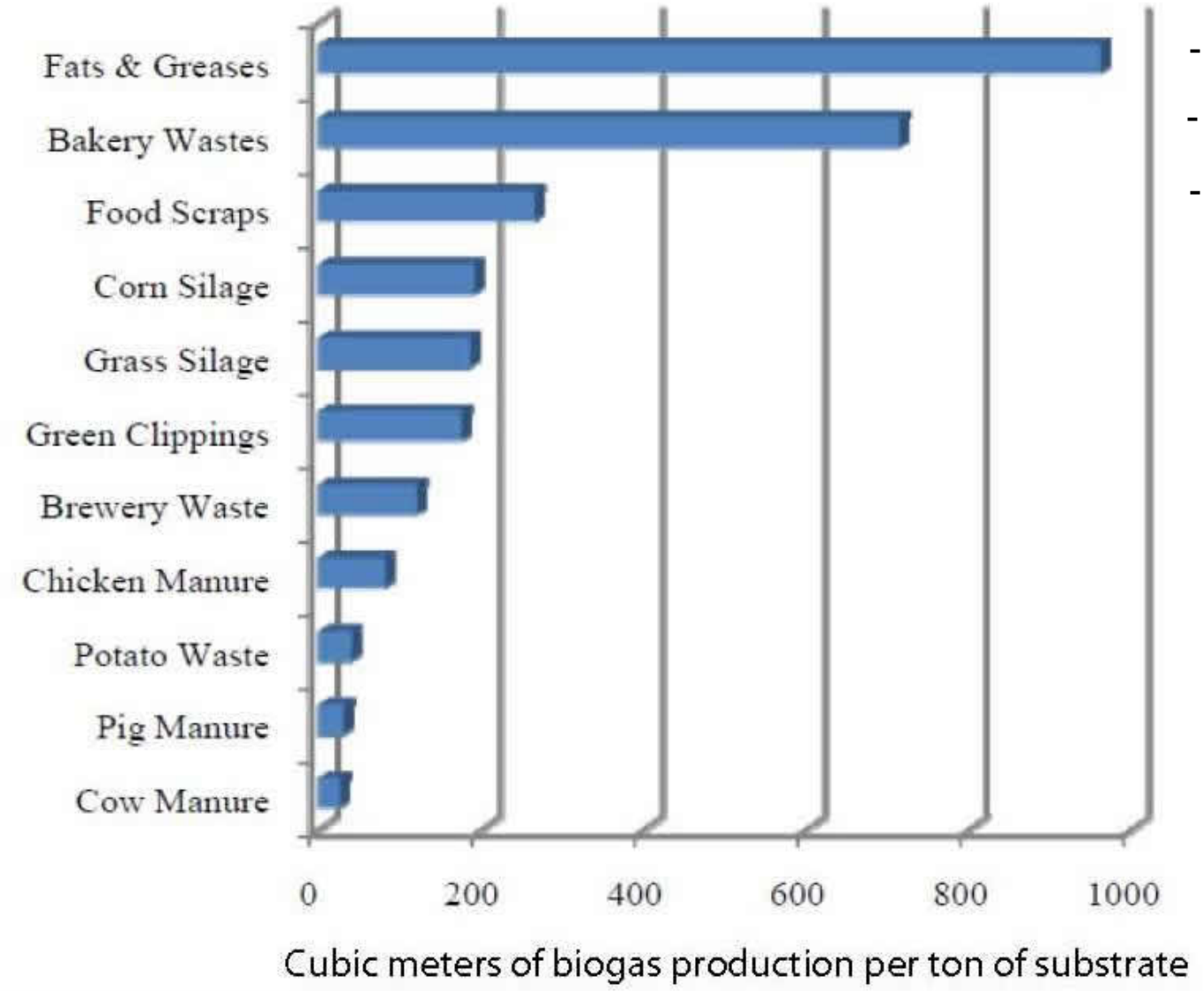
Greater Lawrence San. Dist.,
North Andover, MA

# Why Codigestion?

- WRRFs use ~3% of U. S. electricity
- A typical WRRF uses 20 – 30% of a municipality's electricity
- Ability to shrink or eliminate fossil fuel usage at WRRF
- Minimize carbon footprint
- Innovative solution for hard-to-manage wet "wastes."
- Maximize beneficial use of "waste" materials

# Codigestion Source Materials for a Typical Municipality

- Biosolids
- Yellow Grease = Cooking Oil
- Brown Grease = Waste Trap Grease
- Food Waste = Green Bin
- Other Industrial Organics (e.g. off-spec food products)




- 35x manure
- 25x manure
- 10x manure

# What Wastes are BEST for Making Biogas?

*Image source: Basisdaten Biogas Deutchland*

# Benefits of Codigestion to a Municipality

- All types of organic waste can be treated in one plant
- Efficient recovery of biogas, a renewable energy source
- Closed system with a minimum of smell/odor
- Energy can be recovered as electrical power, combined heat & power, compressed biogas (CBG), upgraded to vehicle fuel
- Revenue from tip fees

# Co-composting examples:

Co-composting, Unity, ME

Ipswich, MA indoor composting

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# Vermont ANR planning for biosolids

- 1987: "nearly all biosolids being generated were land applied" (VT Agency of Natural Resources, State of Vermont Revised Solid Waste Management Plan, readopted in 2006).
- 1997: 40% of biosolids recycled to land.
- 1999: 74% recycling when CSWD sends Burlington area solids to Quebec for composting.
- 2004: 61% EQ production and 9% land application state – almost all out of state.
- 2006 Management Plan: "With the increase in regulatory oversight of land application and composing since 1987, and the improvements in biosolids quality, beneficial reuse options are more environmentally sound than ever before."
- The same report highlighted the benefits of composting biosolids, noting that the programs in Springfield, Bennington, Wilmington, and Johnson were processing 11% of the state's solids.
- DEC stated "The Agency will promote beneficial use of biosolids and encourage generators to consider beneficial use options for managing biosolids" and "The Agency will work with other departments and agencies to use biosolids and septage on state owned land." Stated goals include a revision of the biosolids rules and a rate of 75% biosolids recycling.

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# The ups & downs of recycling

- 2004 – 70% recycling
- 2013 – 17% recycling (almost all in state)
  - 81% landfilled = 46,000 wet tons
  - 2% incinerated out of state
- Estimated residential organics being targeted for diversion from landfills by 2020: 69,000 wet tons (ACT 148)
- The affects of landfilled wastewater solids are the same as landfilled food waste.
- 2014: Most Burlington area solids begin to be recycled via facility in Chateaugay, NY. Recycling rate back to ~ 70+%.

# Policies for Recycling

- Regulations are necessarily most stringent for biosolids – but some states go overboard, creating disincentives (e.g. VT, MA)
- Current focus on diverting organics (ACT 148) does not include biosolids, even though they have the same issues as food waste when landfilled or incinerated.

# Recent developments

Improving treatment processing and biosolids products: 2PAD arrives in Brattleboro & So. Burlington

Photo by Glenn Callahan

Public concerns in 2013 around Stowe permit renewal is leading to rulemaking. Public concerns still drive end use or disposal and stymy recycling in some places.

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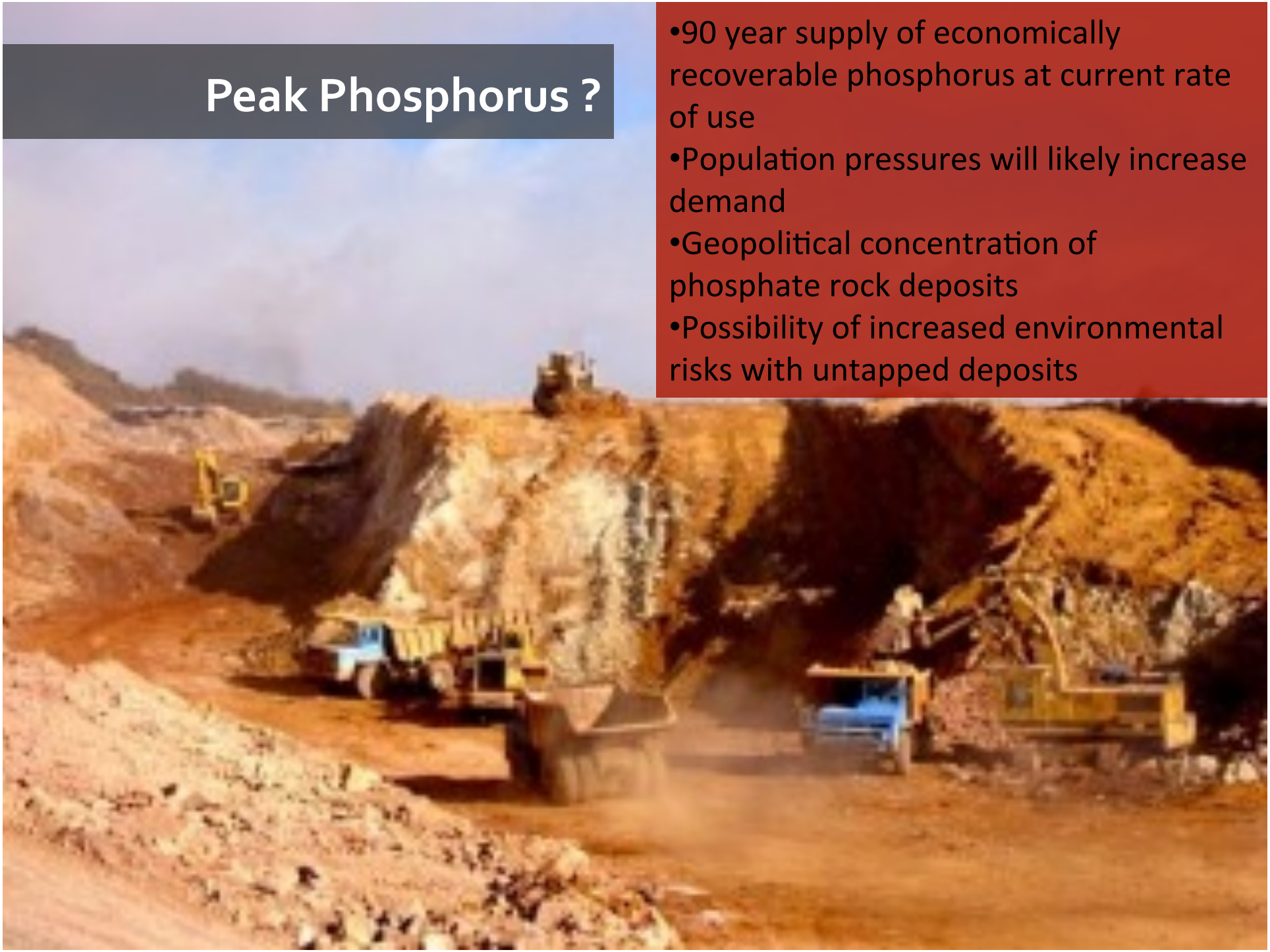
# Peak Phosphorus ?

- 90 year supply of economically recoverable phosphorus at current rate of use
- Population pressures will likely increase demand
- Geopolitical concentration of phosphate rock deposits
- Possibility of increased environmental risks with untapped deposits



# Best management is critical

- Compliance
- Focus on biosolids product quality
  - Test products regularly, including for microconstituents
  - Consider treatment processes that reduce trace chemical contaminants (e.g. biological, multiple processes)
- Follow best management practices
- Reduce potential contaminants upstream:
  - Enforce industrial pretreatment, source reduction
  - Support drug take-back programs http://www.nodrugsdownthedrain.org/NoDrugs/

# What biosolids managers can do…

## Focus on biosolids quality.

Source reduction works. Enforce industrial pretreatment. Support phase-outs of persistent pollutants.

| 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 |

Philadelphia Water District biosolids quality over time, courtesy of Bill Toffey.

# What biosolids managers can do…

## Focus on biosolids quality.

- When possible, use treatment processes that degrade trace chemicals: biological processes are most effective.
- Use multiple processes, e.g. anaerobic digestion followed by composting & application.

+

+

# What biosolids managers can do…

## Use Best Management Practices.

- Apply at agronomic rate, which limits total mass of trace chemicals while providing optimum level of benefits.
- Maintain setbacks from surface & groundwater, keeping contaminants out of the more sensitive aquatic environment.
- Apply to aerated soils &incorporate when possible, aiding decomposition (& avoids ingestion).
- Use the same BMPs for manures/other residuals.
- Follow research & update BMPs.

# Consideration: Remove P at WWTF

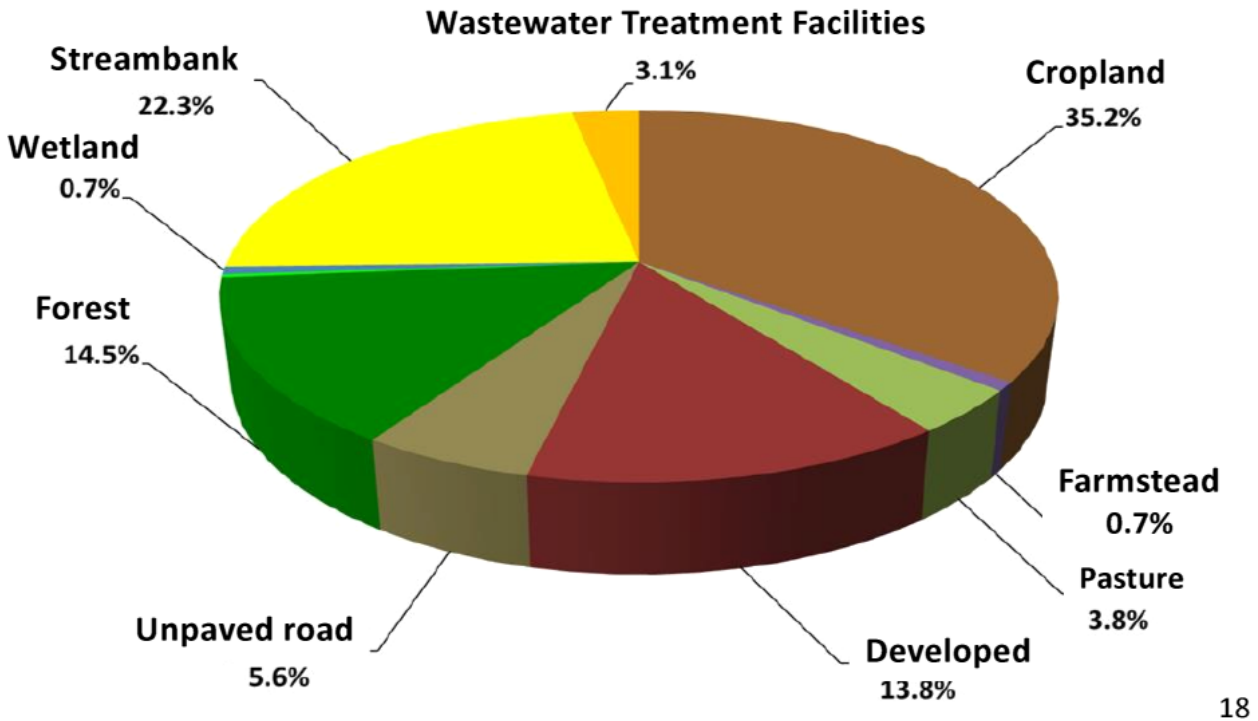
Struvite and other P minerals can be precipitated at wastewater treatment plants, usually by a treatment process applied to a digestate dewatering side-stream. This is a growing trend (Chicago has taken the lead).

Removing P at the WWTF makes the biosolids a more balanced fertilizer and allows use of the P in concentrated form on soils where it is needed.

# Phosphorus By Source

Sources of phosphorus in the Vermont portion of the Lake Champlain Basin

(from EPA – Tetra Tech, 2013)



# Resource: an excellent video from Ontario

Biosolids: Naturally Sustainable

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

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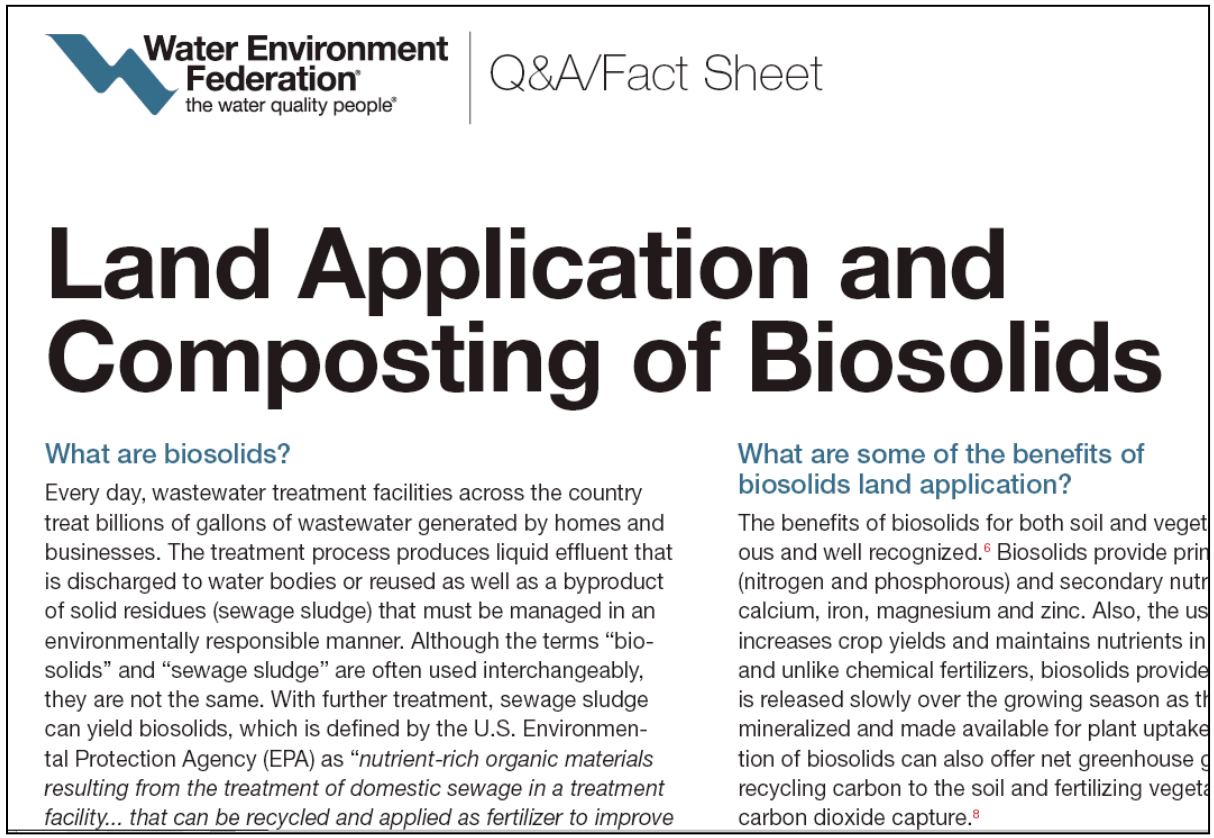
# A nice fact sheet…



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]

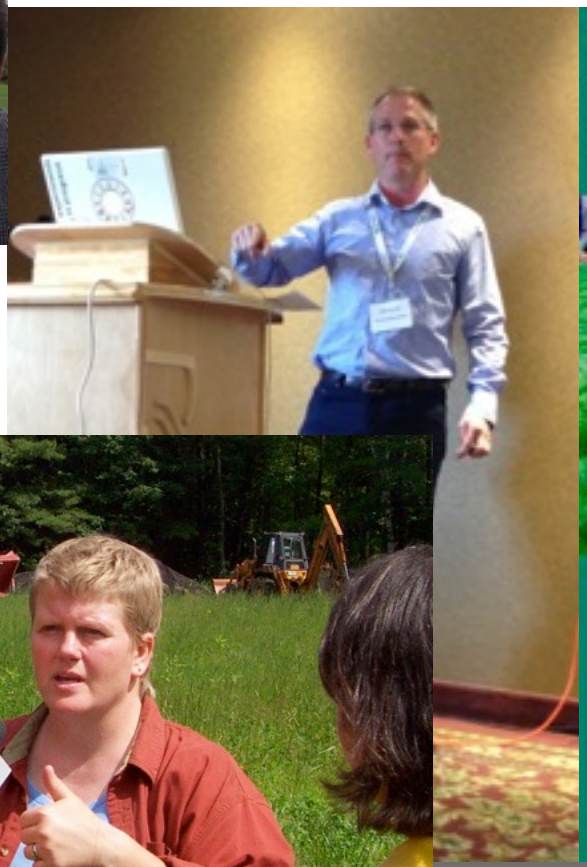
**http://www.nebiosolids.org/uploads/pdf/WEFLandApAndCompostFactSheet-Apr10.pdf**

# 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"

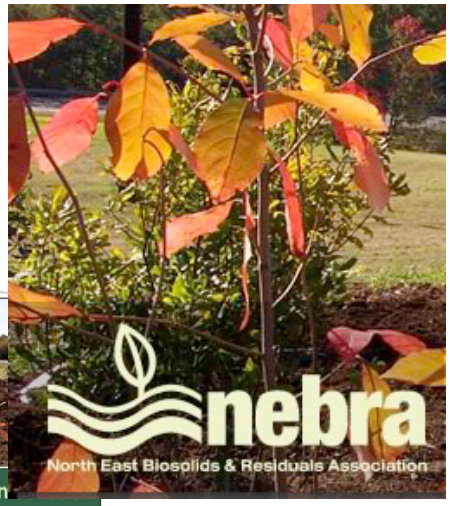
# What NEBRA Does For You

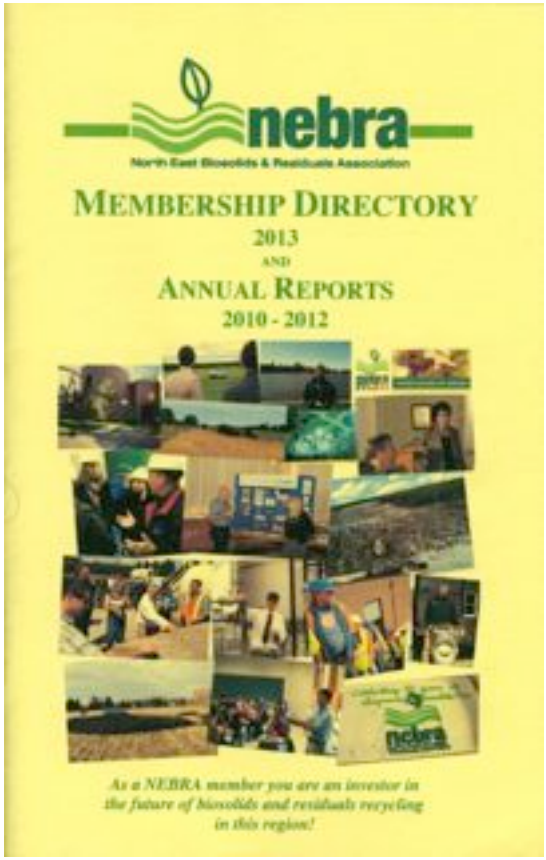
- **Tours, workshops, conferences, outreach**



# What NEBRA Does For You

- **Tracking news & research; advancing best practices**

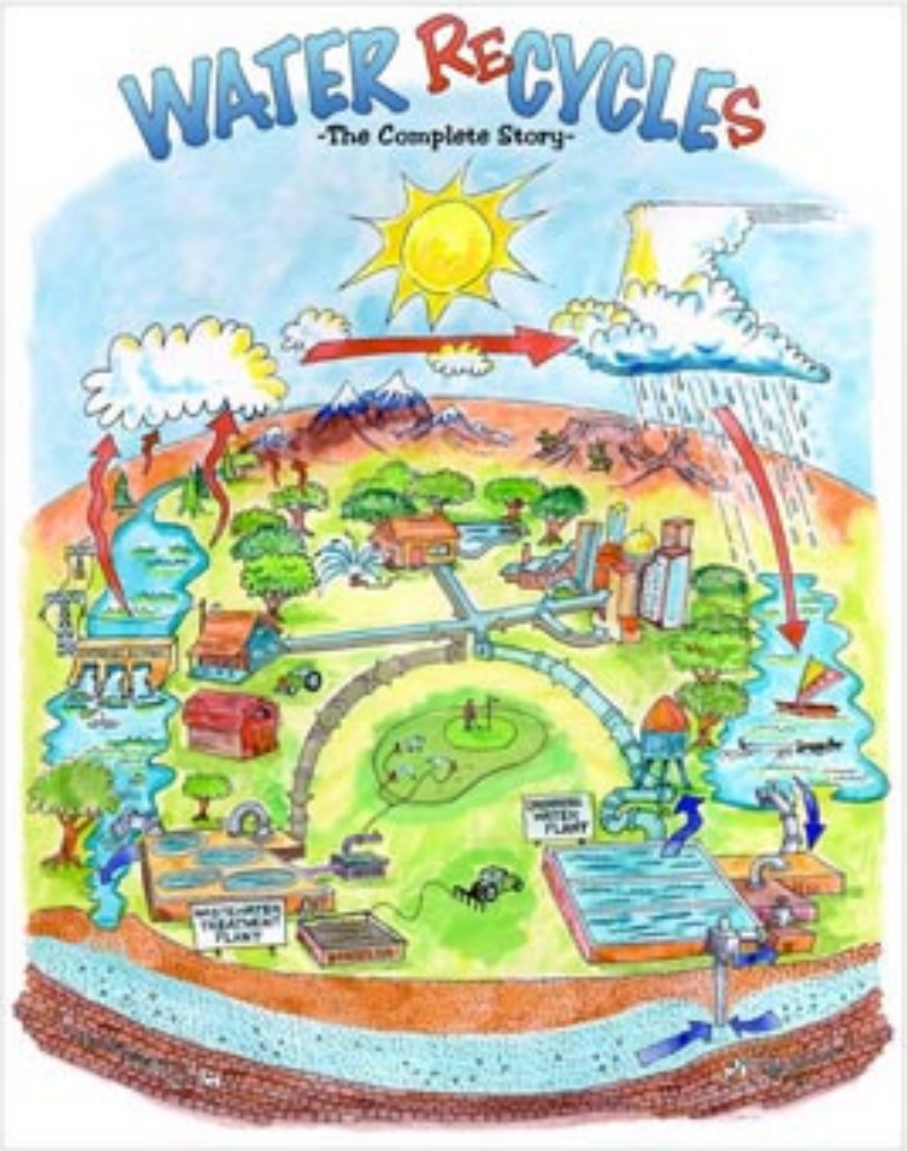



***NEBRAMail***

**Thanks for… your invitation, your attention, & your comments.**

**Ned Beecher**

**Contact NEBRA:**
**info@nebiosolids.org**
**603-323-7654**

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