



## The Remarkable Benefits of Recycling Biosolids to Soils

Ned Beecher • NEBRA

October 26, 2017

Northeast Residuals and Biosolids Conference • Burlington, VT



## Consider...

- Science, after having long groped about, now knows that the most fecundating and the most efficacious of fertilizers is human manure. The Chinese, let us confess it to our shame, knew it before us. Not a Chinese peasant--it is Eckberg who says this,--goes to town without bringing back with him, at the two extremities of his bamboo pole, two full buckets of what we designate as filth.... **There is no guano comparable in fertility with the detritus of a capital.** A great city is the most mighty of dung-makers.... Fleets of vessels are despatched, at great expense, to collect the dung of petrels and penguins at the South Pole, and the incalculable element of opulence which we have on hand, we send to the sea. All the human and animal manure which the world wastes, restored to the land instead of being cast into the water, would suffice to nourish the world.

Victor Hugo, *Les Miserables*, 1862

# Consider...

[http://  
www.waterburyjob  
server.org/node/  
2254](http://www.waterburyjobserver.org/node/2254)

## • RAW SEWAGE DUMPED INTO NAUGATUCK RIVER

Mon, 09/27/2017 - 09:00



Like · Reply ·  5 · 17 hrs



**Wallace Coles Jr.** · John F. Kennedy High School, Waterbury, CT  
That stupid plant should have never been built I always said and this is exactly why

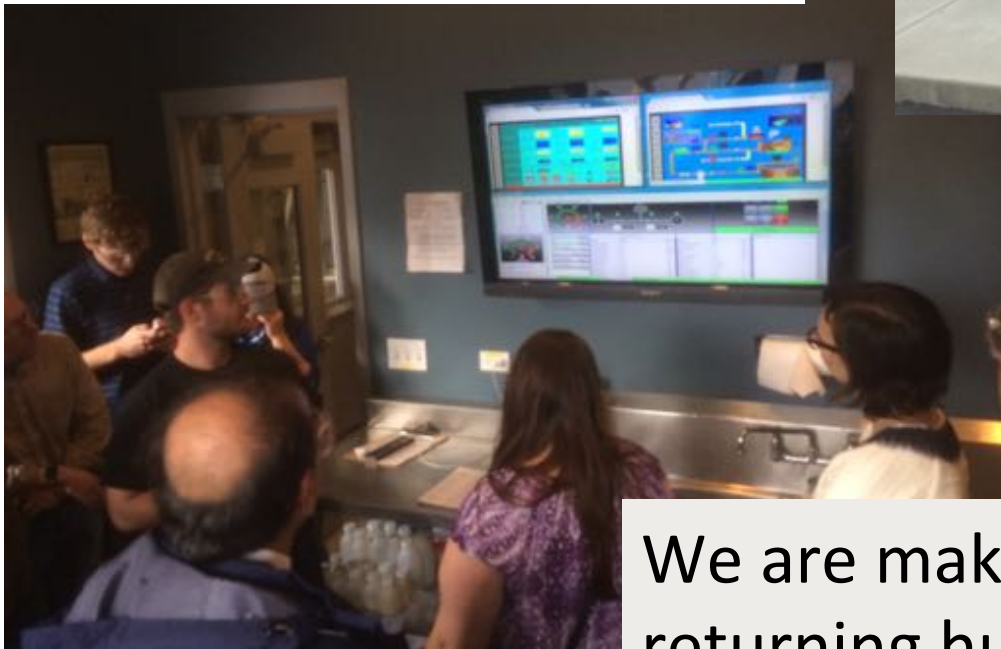
Like · Reply ·  1 · 18 hrs





# Consider:

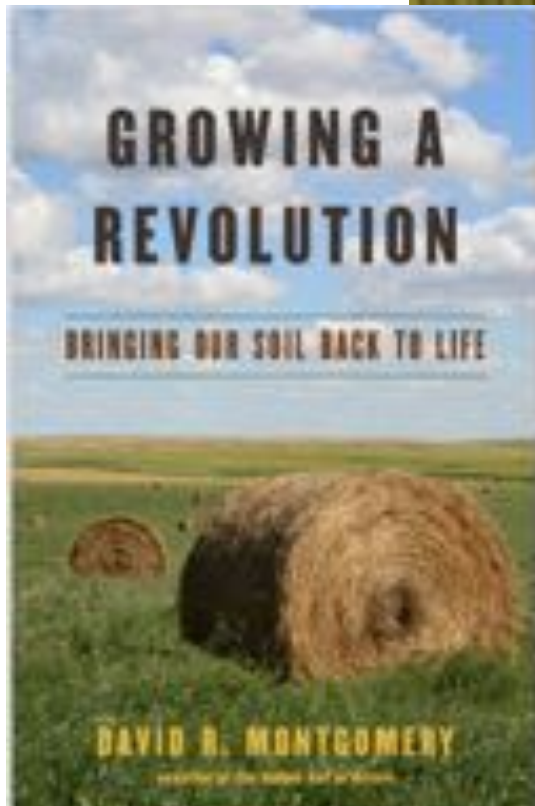
Magic Hat Brewery, So. Burlington, VT



Essex Junction, VT new CHP engine

We are making electricity AND  
returning human “guano” to soils.

# Consider:

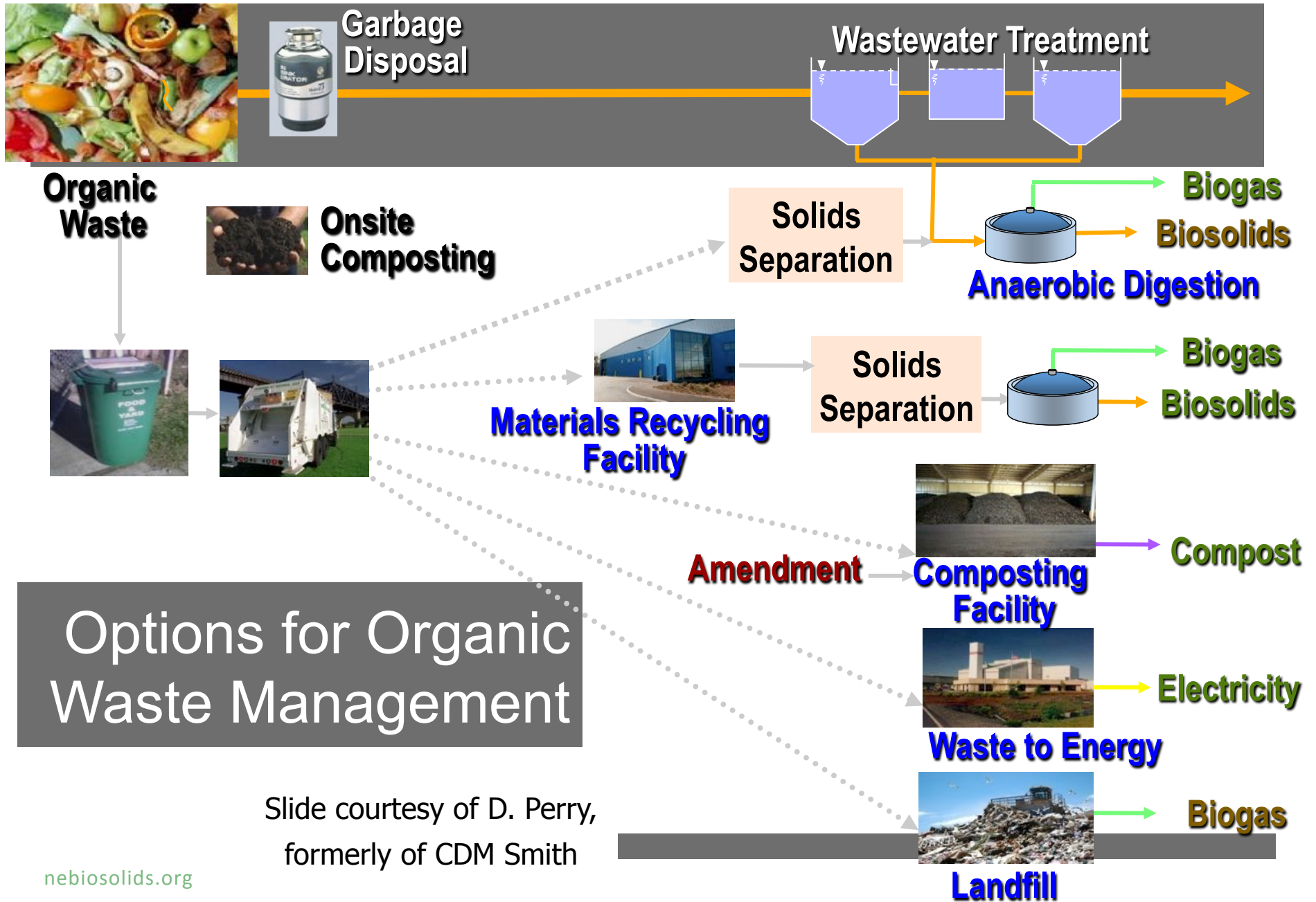


# Consider...

- California has a new “Healthy Soils Initiative”
- They have ambitious goals to reduce disposal of organic materials in landfills: cutting methane emission dramatically in the next 10 years.
- Biosolids are positioned to play a key role in these major initiatives, working with a variety of state agencies.
- Marin Carbon Project: SFPUC is talking with John Wick; biosolids are part of the pictures.







# Biosolids use: Agriculture



Moorhead, MN: Feed corn grown with liquid injected, Class B, anaerobically-digested biosolids, July 2012

- Bulk material markets: animal feed crops (corn, hay), grains (wheat, hops), soy, other commodity crops
- Prices:
  - Class B - \$0 - \$30 / wet ton
  - Class A – up to \$60 / ton
- Trend: increasing demand; waiting lists in some areas



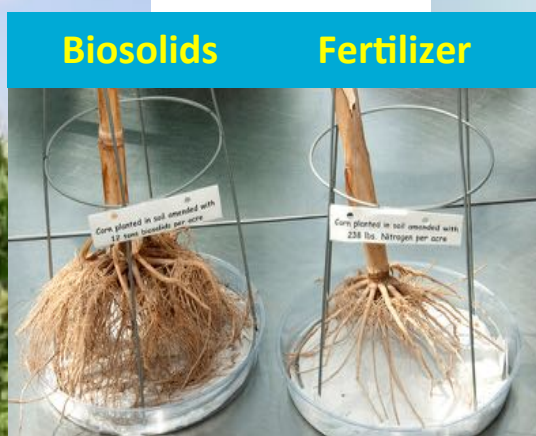
# Farmers Love Biosolids



Net Profit Increase = \$250 – \$500 per acre



10 ton biosolids/ac



Slide courtesy Lakhwinder Hundal, MWRDG Chicago

# Why Apply Biosolids To Farmland?

 To ensure sustainable farming

Being able to produce nutritious food to  
feed the growing population indefinitely  
without impacting the resource base of  
agriculture.

Slide courtesy Lakhwinder  
Hundal, MWRDG Chicago

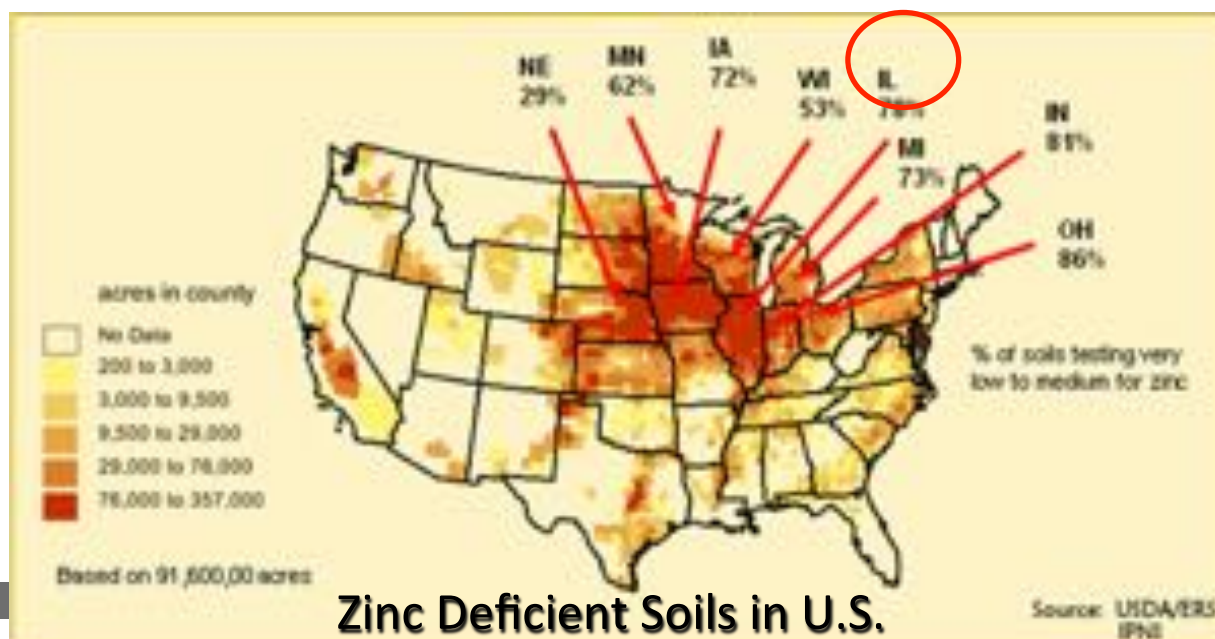


# Our Farmland Is Nutrient Deficient!

- Emphasis on application of NPK only
- Micronutrients are rarely applied to farmland
- Limited or no change in cropping pattern

Our soils are  
showing  
micronutrient  
deficiency

Slide courtesy Lakhwinder  
Hundal, MWRDG Chicago





# Essential Elements for Proper Plant Growth ↗

Carbon (C), Hydrogen (H), oxygen (O)

## ■ Major Nutrients

- Nitrogen (N)
- Phosphorous (P)
- Potassium (K)

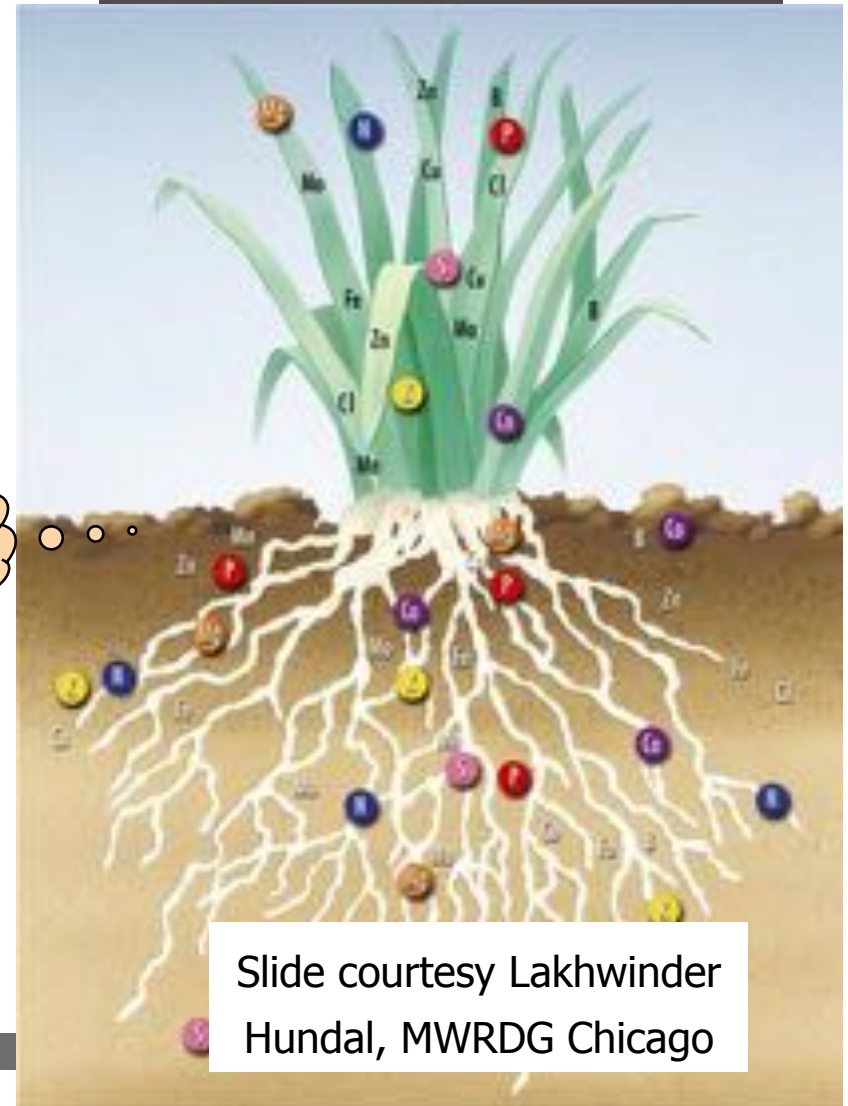
## ■ Minor Nutrients

- Calcium (Ca)
- Magnesium (Mg)
- Sulfur (S)

## ■ Micro Nutrients

- Iron (Fe)
- Manganese (Mn)
- Boron (B)
- Chlorine (Cl)
- Molybdenum (Mo)
- Zinc (Zn)
- Copper (Cu)

Soil



Slide courtesy Lakhwinder  
Hundal, MWRDG Chicago

## Nutrients in Common Manures and Biosolids

Nutrient	Beef Manure	Poultry Manure	Swine Manure	Biosolids <sup>1</sup>
<hr/> <b>lbs/wet ton</b> <hr/>				
<b>Nitrogen</b>	<b>46-76</b>	<b>36-72</b>	<b>44-62</b>	<b>25</b>
<b>Phosphorus (P<sub>2</sub>O<sub>5</sub>)</b>	<b>28-102</b>	<b>72-180</b>	<b>44-98</b>	<b>22</b>
<b>Potassium (K<sub>2</sub>O)</b>	<b>30-42</b>	<b>34</b>	<b>14-34</b>	<b>0.6</b>
<b>Sulfur</b>	<b>0-6</b>	<b>10-12</b>	<b>10-16</b>	<b>10</b>
<hr/> <b>g/wet ton</b> <hr/>				
<b>Zinc</b>	<b>20-200</b>	<b>200-550</b>	<b>50</b>	<b>237</b>
<b>Copper</b>	<b>100-300</b>	<b>200-500</b>	<b>450-900</b>	<b>108</b>

<sup>1</sup>MWRD's centrifuge cake biosolids.  
[nebiosolids.org](http://nebiosolids.org)

Slide courtesy Lakhwinder Hundal, MWRD Chicago




# Why We Must Land Apply Biosolids?

## To ensure agricultural sustainability

Slide courtesy Lakhwinder  
Hundal, MWRDG Chicago

Being able to produce nutritious food to feed the growing population indefinitely without impacting the resource base of agriculture.

## To ensure environmental sustainability

-  Reduce stormwater runoff and protect water quality.
-  Reduce ecological footprint.
-  Mitigate global warming – Conversion of atmospheric  $N_2$  into ammonia (Haber-Bosch Process) to produce N fertilizers uses enormous amount of fossil fuel.



# We have such good stories to share...



Slide courtesy of Rufus Chaney, PhD, USDA ARS

**Early growth of corn on control (left) and compost amended (right) plots on Woodstown silt loam soil (Epstein and Chaney, 1974).**

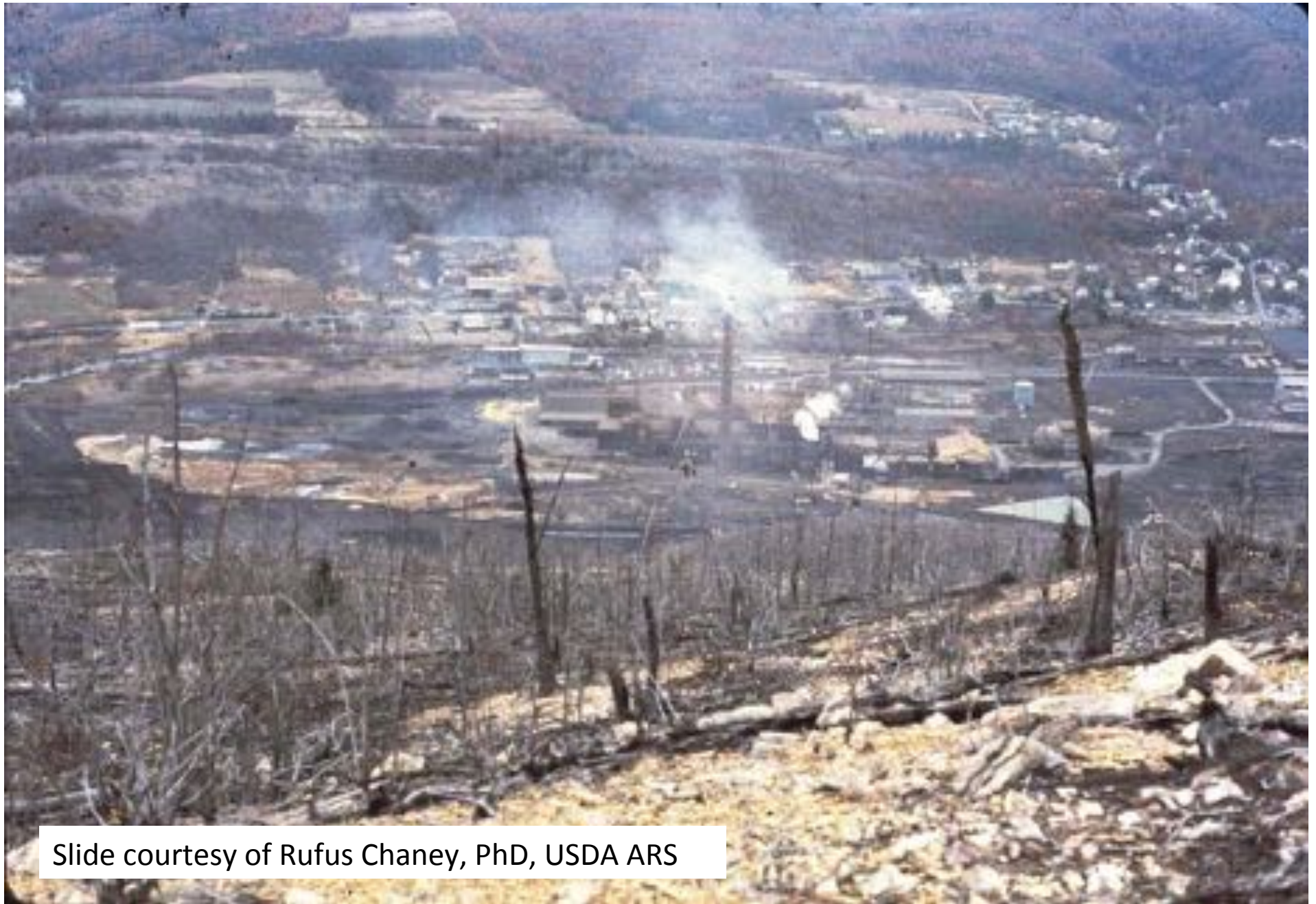




Slide courtesy of Rufus Chaney, PhD, USDA ARS

**Revegetated coal mine spoil at Frostburg, MD, treated with composted biosolids (Armiger et al., 1975).**





Slide courtesy of Rufus Chaney, PhD, USDA ARS



## Appalachian Trail (“protected” area)

Slide courtesy of Rufus Chaney, PhD, USDA ARS

**Palmerton, PA: Blue Mountain – 1999**

**Foreground = Biosolids+Limestone+FlyAsh; Background = untreated Control**

# Reclamation is still in demand



## GROWING SUCCESS WITH RECYCLED RESIDUALS FOR LAND RECLAMATION

**Major projects in eastern provinces demonstrate the value of biosolids and paper mill residuals**

**By Neil Lecker, M.S., Executive Director, Northeast Biosolids & Residuals Association**

**W**hile documented successes during the 1970s using municipal biosolids and other materials have proven to be an environmental win-win, providing rapid ecosystem restoration while putting to use materials once considered "waste."

Today, the variety of acceptable methods includes biosolids, wood ash, steel sludges, industrial effluents, rice dross, and numerous others long forgotten. This variety allows environmentalists to select the specific elements and needs of the project. The challenge comes in applying reclamation work with the materials locally available. And, especially when municipal biosolids are involved, projects must consider potential negative public perceptions.

Across Canada, high-profile waste reclamation projects with methods are ongoing. For example:

- Several existing works at Sault Ste. Marie, B.C., where biosolids are used to support poplar plantations.
- Prince William in British Columbia - the first reforestation in Ontario using

© Nebrasolids Association - 2010



# Biosolids use: Forestry

Photos courtesy of King  
County, WA

[http://dnr.metrokc.gov/  
WTD/biosolids/](http://dnr.metrokc.gov/WTD/biosolids/)

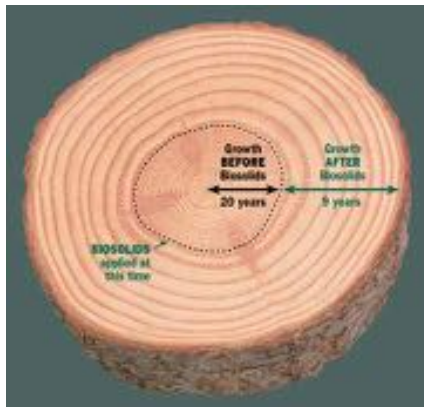


Photo courtesy of  
Philadelphia  
Water Dept.

- Only in some areas
- Speeds up harvest cycle in actively managed stands
- Price:
  - Class B \$0 - minimal

[nebiosolids.org](http://nebiosolids.org)





# Biosolids use: Horticulture / Landscaping / Turf

Biosolids  
compost  
use on my  
home  
garden –  
raspberries,  
May 2014



- Class A bulk material markets: potting mixes (e.g. Tagro), golf courses (e.g. Milorganite), parks, lawns, growing turfgrass (e.g. in RI), sports fields (hi-spec turf)
- Prices:
  - Class A bulk – up to \$60 / ton
  - Class A bagged/retail – up to \$450 / ton
- Trend: increasing demand for quality, consistent products

# Biosolids Use: Topsoil Blending



Topsoil blending with paper mill residuals and biosolids, central MA, 2006

- Bulk biosolids given or sold to topsoil blenders
- Prices: vary, often \$0
- A way to use less processed material
- Topsoils used for reclamation, landfill cover, highway embankments, construction sites
- Trend: steady use

# Reclamation of Disturbed Sites



Spectacle Island in Boston Harbor was reclaimed with biosolids compost and other recycled organics, 2004.

- Bulk material market
- Used to restore healthy soil ecosystem and either native vegetation or cropland
- Prices: vary, often \$0
  - Uses a lot of biosolids
- Trend: increasing use, because of huge benefits – biosolids use is best practice for this kind of reclamation

# Reclamation of Disturbed Sites



Pennsylvania mine  
before



Same Pennsylvania mine  
after



# Biosolids Use: Landfill Leachate Treatment



Slide courtesy of Sylvis,  
Vancouver, BC

# Biosolids Use: Energy

## Anaerobic digestion (followed by use or disposal)



Greater  
Lawrence  
San. Dist.,  
Andover,  
MA



Essex Junction WWTF  
60 kW CHP Application

Nashua, NH

➤ A biosolids treatment process that results in biosolids to be used or discarded.

➤ Trend: Huge interest & activity now, across the continent.

Project Profile	
	<p><b>Project Overview</b></p> <p>Until 2001, the Essex Junction wastewater treatment facility used half the waste methane gas produced by its anaerobic digester to fire the boiler that heated the digester. (Anaerobic digestion stabilizes wastewater sludge, reduces sludge volume, and eliminates pathogens.) The remaining waste methane gas was flared, because methane is a greenhouse gas that is 20 times as effective at trapping heat as carbon dioxide, the gas produced when methane is burned.</p>
	<p><b>Quick Facts</b></p> <p><b>Location:</b> Essex Junction, Vermont  <b>Installation Date:</b> October 2001  <b>CHP Equipment:</b> Two 304kW dual-fuel Capstone C-30 Micro-methane  <b>MicroCen MUCCL heat recovery system</b>  <b>Type of Fuel:</b> Self-generated methane gas, natural gas</p> <p>Although facility officials had been interested in combined heat and power since 1992, high initial costs failed to satisfy the requirement of the facility's governing board, but all projects have a simple payback of no more than seven years. Furthermore, it was unclear whether sufficient digester temperatures could be maintained when methane was used to fire a CHP system. The system was also required to emit no more pollutants than flaring methane did.</p> <p>In order to satisfy the payback period requirement, the facility was able to obtain additional funding from Efficiency Vermont, The Biomass Energy Resource Center, Northeastern and the U.S.</p>

VT

## The potential of AD & biogas use

3%

Approximate total of U.S. electricity consumption used by water and wastewater operations (~100 billion kWh annually)

35%

Amount of municipal energy consumption used by water / wastewater systems

~17,000

POTWs in the U.S. (< 4000 produce 90%+ of U. S. solids)

40,000,000,000

Gallons of wastewater treated in the U.S. every day

8,000,000

Approximate amount of dry tons of biosolids generated per year by U.S. POTWs

730,000

Amount of cars equivalent to offset emissions if digestion facilities installed energy recovery\*

600

MW of CHP Potential from POTWs over 1 MGD\*



Recycled organics: Tools for sustainable Technology

# Renewable energy from biogas

Biogas



Boilers

I.C. Engines

Blowers

Fuel Cells

Heat Dryers

Micro-Turbines

Natural Gas

Vehicle Fuel

- There is a long history of generating electricity by using biogas as a reliable, renewable fuel in engines, turbines, fuel cells, as well as for combined heat and power (CHP).
- CHP, electricity generation with the capture of the historically wasted heat energy, is an efficient, clean, and reliable approach to generating power and thermal energy.
- Biogas CHP can greatly increase many facilities' operational efficiency and decrease energy costs. At the same time, CHP reduces the emission of greenhouse gases.





Biosolids are products.

[loopforyoursoil.com](http://loopforyoursoil.com)

[nebiosolids.org](http://nebiosolids.org)



The screenshot shows the Loop website homepage. The header features the 'loop' logo in white on a red background with a close-up of a flower. A navigation bar includes links: 'What is Loop?', 'The Science', 'Gardens & Landscapes', 'Commercial Growers', 'About Us', 'FAQs', and 'Contact'. The main banner reads 'TURN YOUR DIRT AROUND' in white text. Below the banner are three columns: 'GARDENS & LANDSCAPES' with a photo of green plants, 'VIDEOS' with a video player showing a worker in a hard hat, and 'CLIMATE IMPACTS' with a diagram of a tree and text explaining the benefits of carbon-rich Loop. The footer contains three paragraphs of text.

**loop**

What is Loop? | The Science | Gardens & Landscapes | Commercial Growers | About Us | FAQs | Contact

# TURN YOUR DIRT AROUND

## GARDENS & LANDSCAPES



Enrich any landscape or garden by using OnCo compost made with Loop. Add it to your garden soil, containers, trees, or indoor pots to get lush vibrant plants.

## VIDEOS



What are biosolids and how are they made? Staff from King County Wastewater Treatment Division show how they transform raw wastewater into useful products.

## CLIMATE IMPACTS

Fertilizing with carbon-rich Loop allows us to:

- 1 Increase plant growth, which captures CO<sub>2</sub> from the atmosphere and releases more plant biomass to the soil.
- 2 Reduce the use of synthetic fertilizers, which are fossil fuel intensive to produce.
- 3 Increase soil carbon storage, a key climate change strategy.

Loaded with nutrients and organic matter Loop helps us to fight climate change by sequestering carbon in the soil and offsetting carbon emissions associated with...



# BLOOM

GOOD SOIL,<sup>®</sup>  
BETTER EARTH.

An exceptional  
soil amendment



[bloomsoil.com](http://bloomsoil.com)





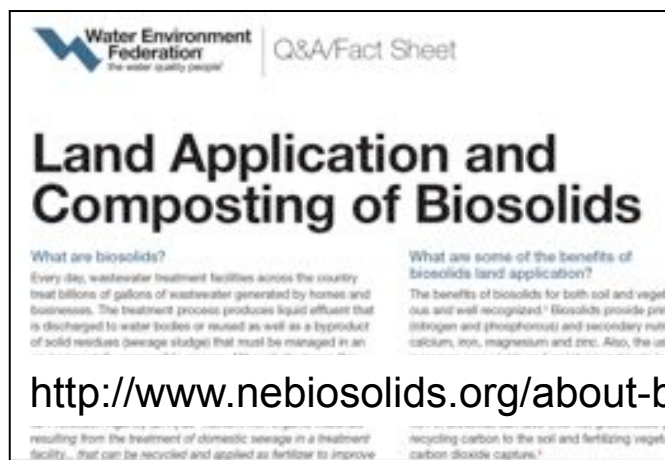
# General biosolids resources



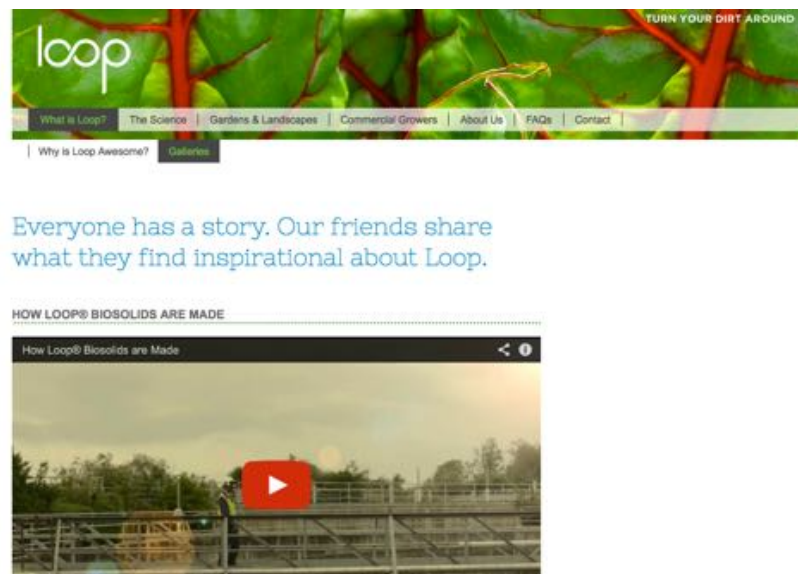
Biosolids: Naturally Sustainable

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

<http://www.loopforyoursoil.com>

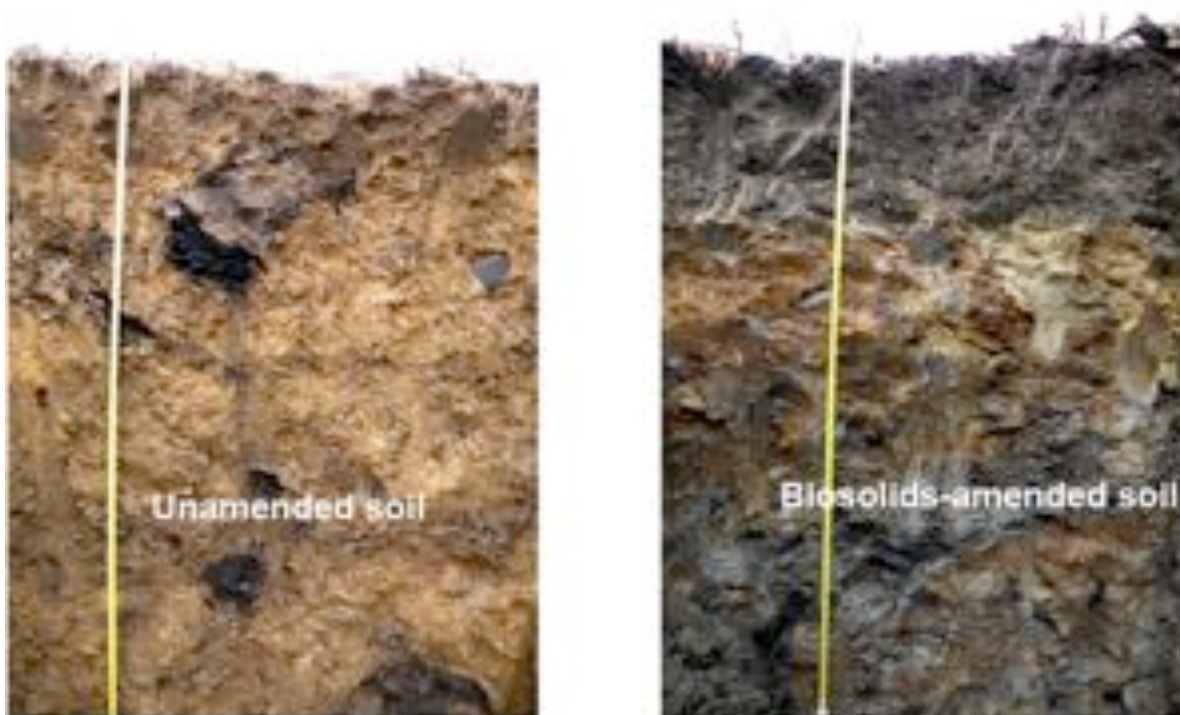


<http://www.nebiosolids.org/about-biosolids/>



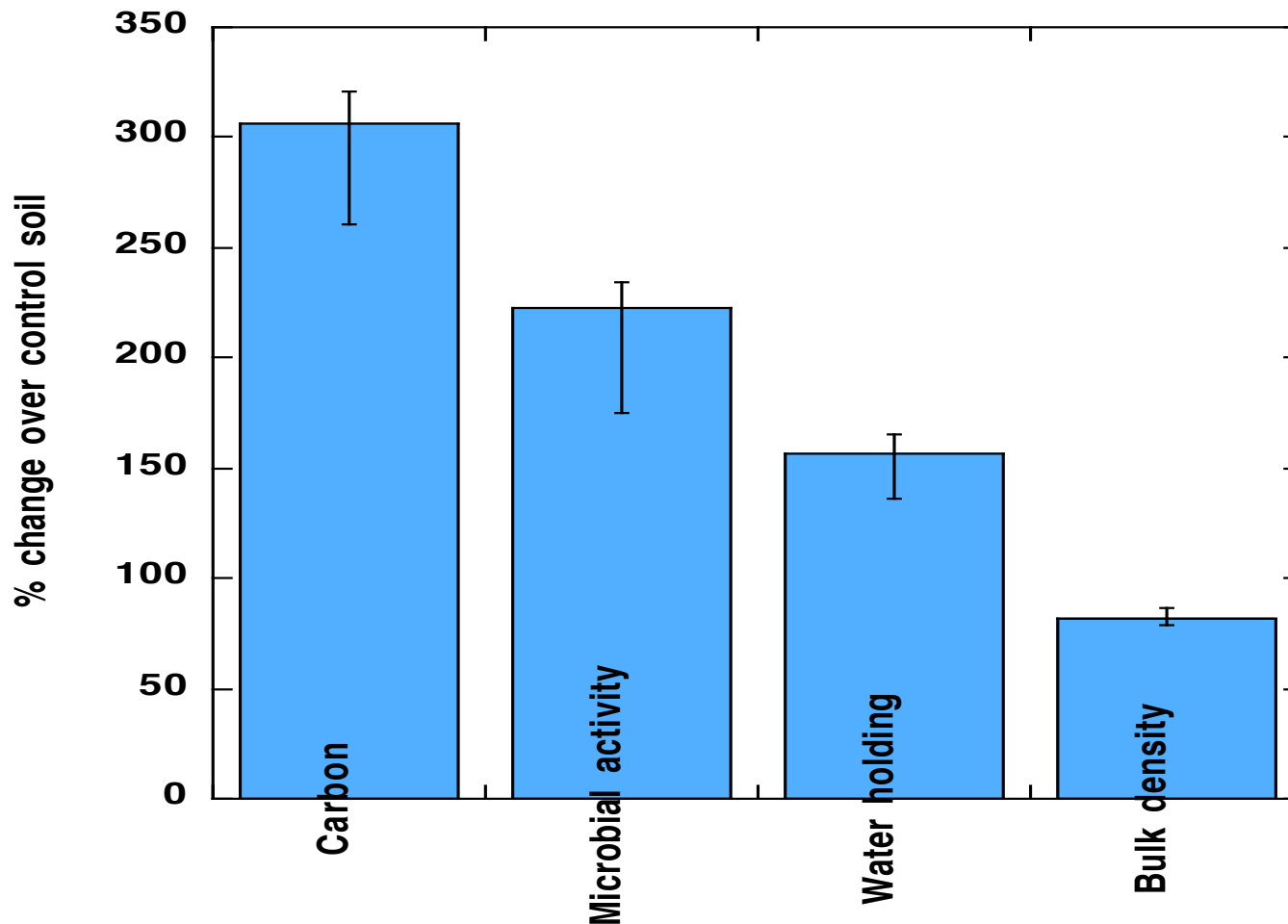


## Biosolids improve soils.



Biosolids improve soils.

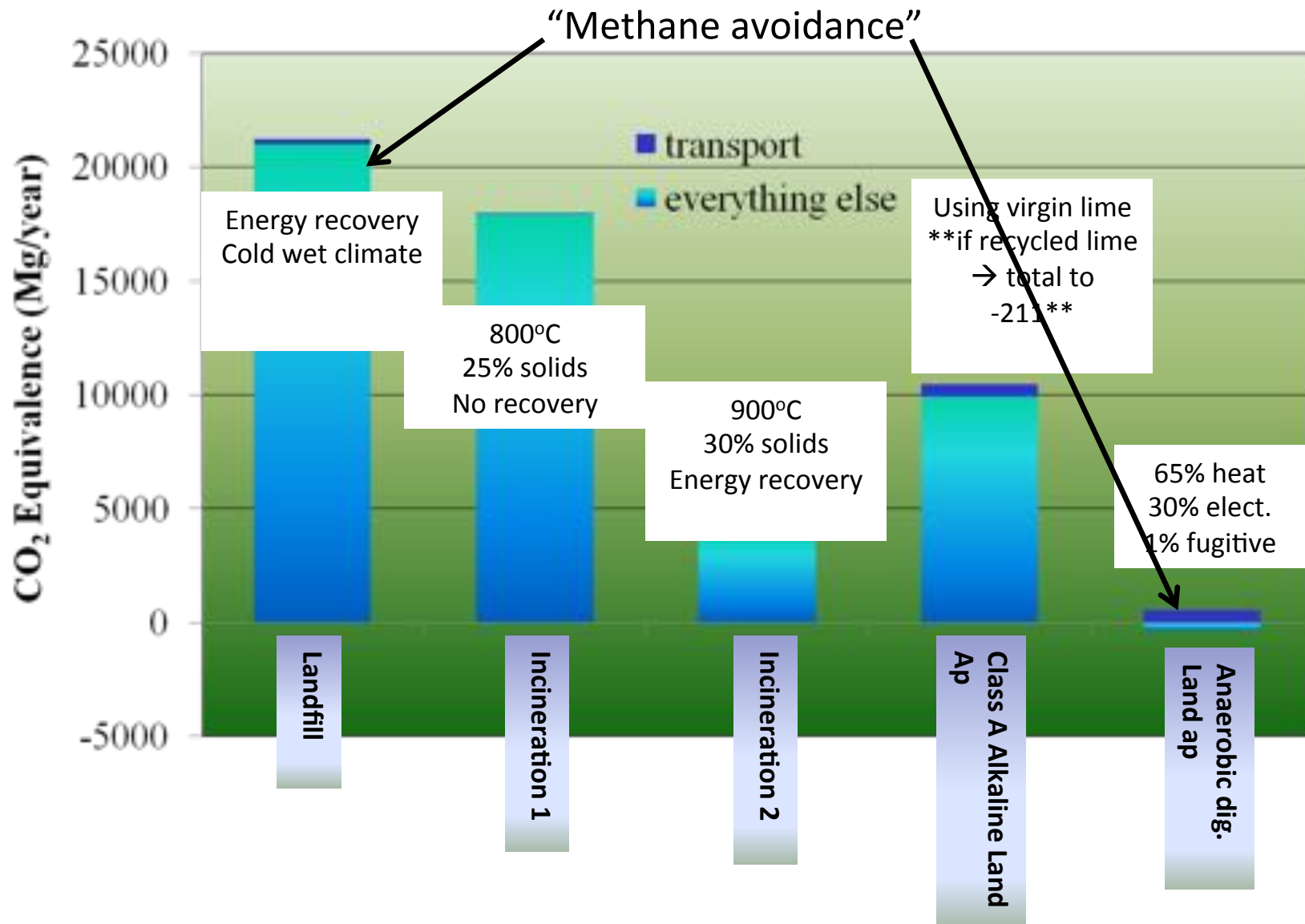
# Organic matter improves soil quality.



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 easier tillage & handling).

# Findings:

## Lower GHG emissions from use on soils





# Are you using biosolids?



April 2012



May 2, 2013

Sign up for free *NEBRAMail*:  
left side of [nebiosolids.org](http://nebiosolids.org)

**Ned Beecher**

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**603-323-7654**

