


A nuanced approach to clean-up

A photograph showing a wide, shallow river with a rocky and sandy bed. The water is clear and flows from the left towards the right. On the right bank, there is a grid of monitoring points marked by vertical stakes. The background shows a hazy, overcast sky and distant hills.

Sally Brown

Mark Sprenger

Michele Mahoney

Mission evolving beyond human health protection

Restoration ecosystem services
Protection of wildlife



Ecosystem Example

Tri- State Mining District



http://www.kgs.ku.edu/Publications/pic17/pic17_1.html

Jasper County

- Tailings project started in 1999
- Extensive area of mine waste 'chat'



Large –scale demo

- Biosolids + lime applied at low and high rates to areas within the site
- Composts and other amendments included
- Topsoiling traditional remedy



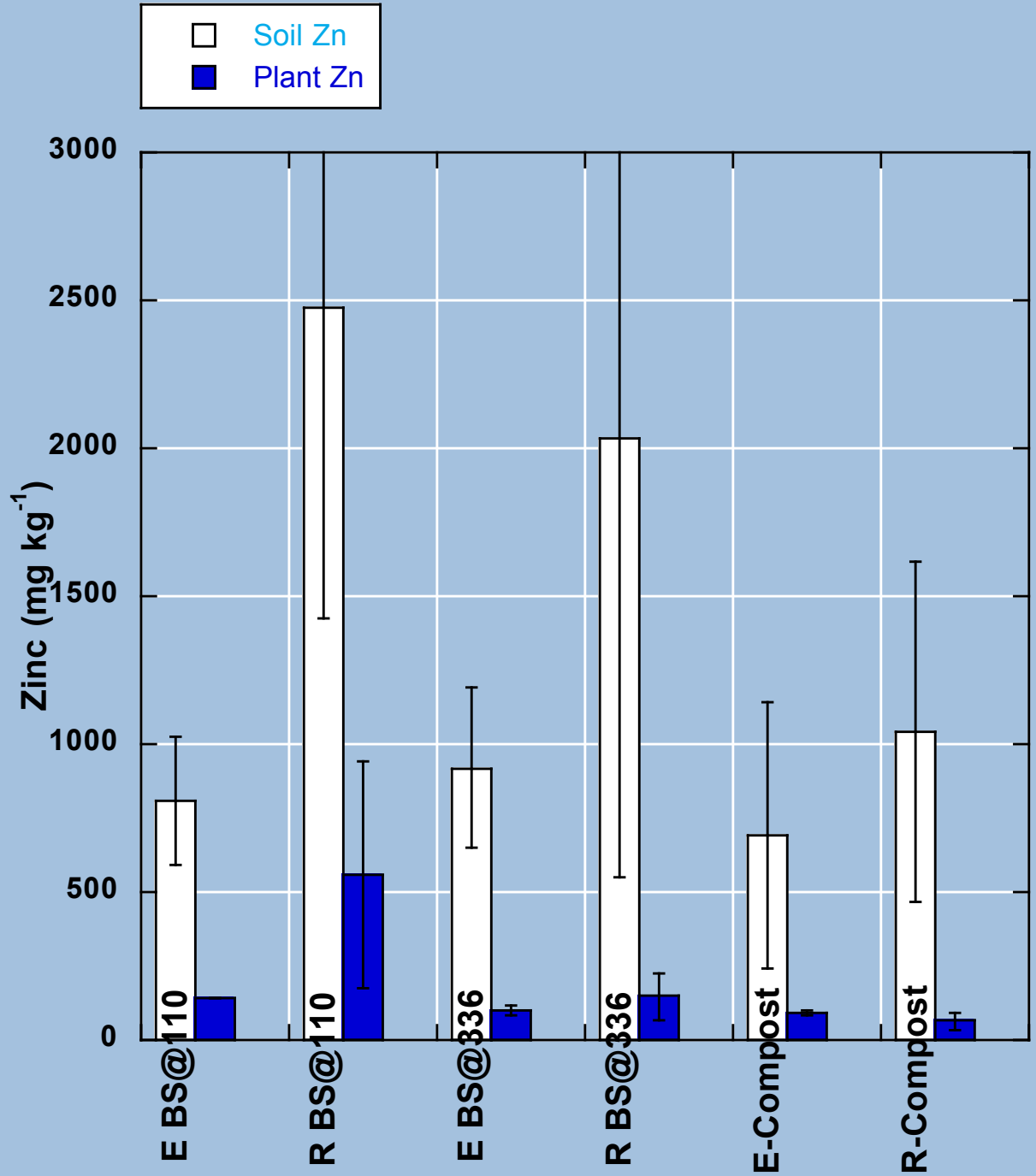
Short and long term sampling

Focus on ecosystem function/ safety

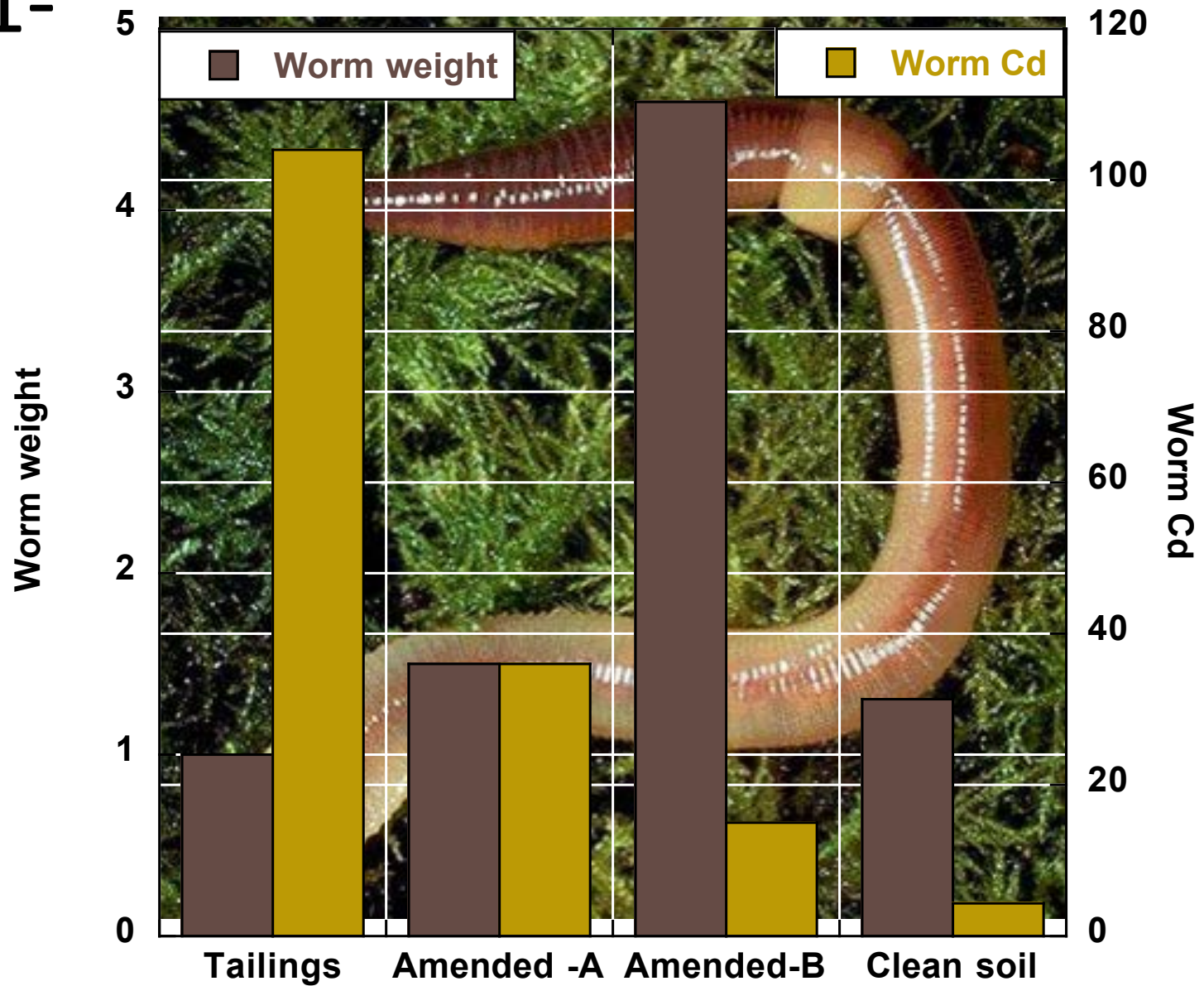


Soil Zn Plant Zn

2001
2012



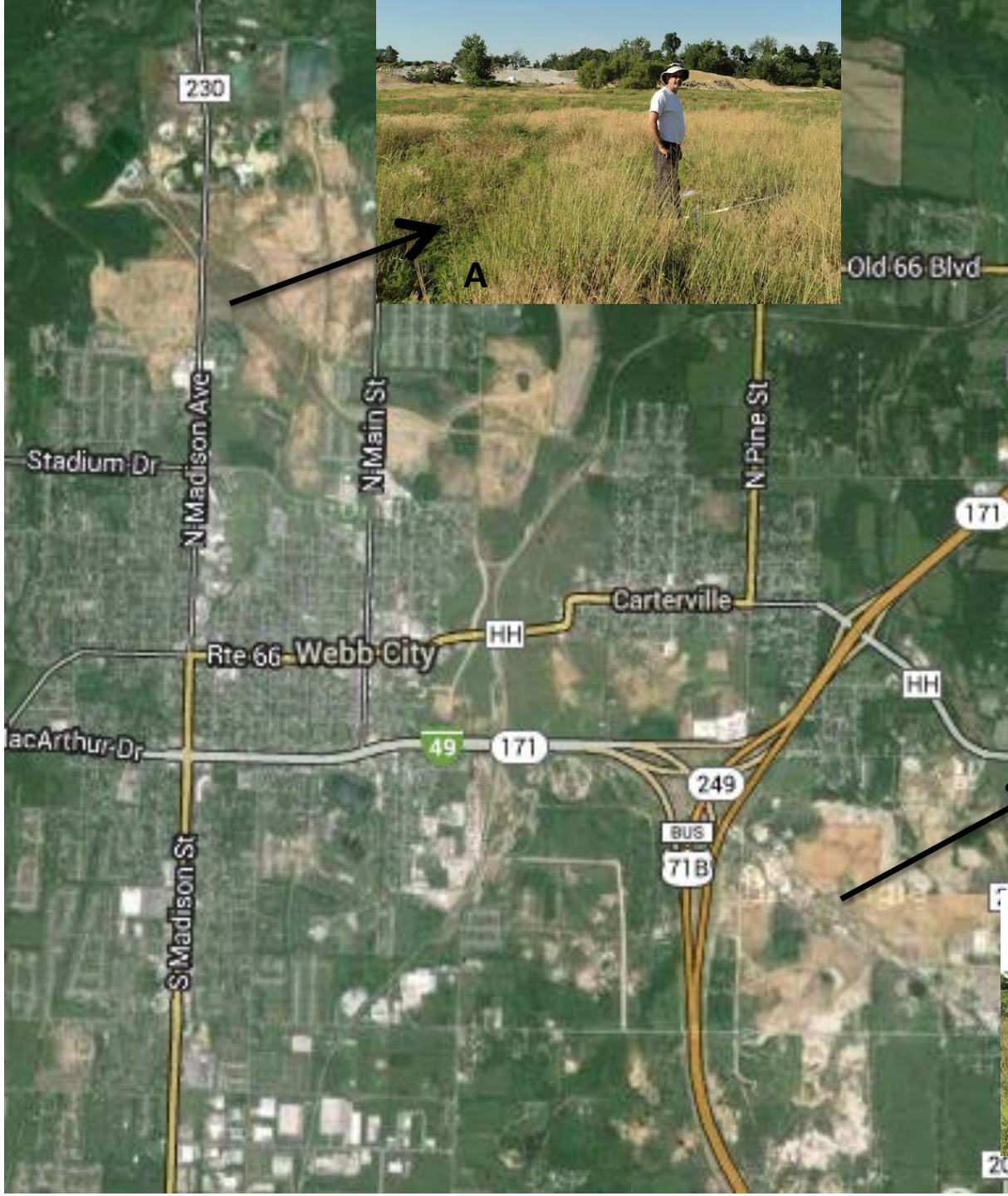
2001-



2002-

- Trapping rate 19%
 - Normal 3-5%
- 92 kidneys collected
 - 61 normal
 - 22 indication of Cd exposure
 - 4 potential function compromise
 - 9 not able to analyze





A



B



C



D



E

Old 66 Blvd

171

HH

Carterville

HH

49

171

249

BUS

71B

F

20

11

Control
5% Cover
0 Yield



Low Biosolids
50% Cover
14.5 Yield



High Biosolids
94% Cover
47 Yield



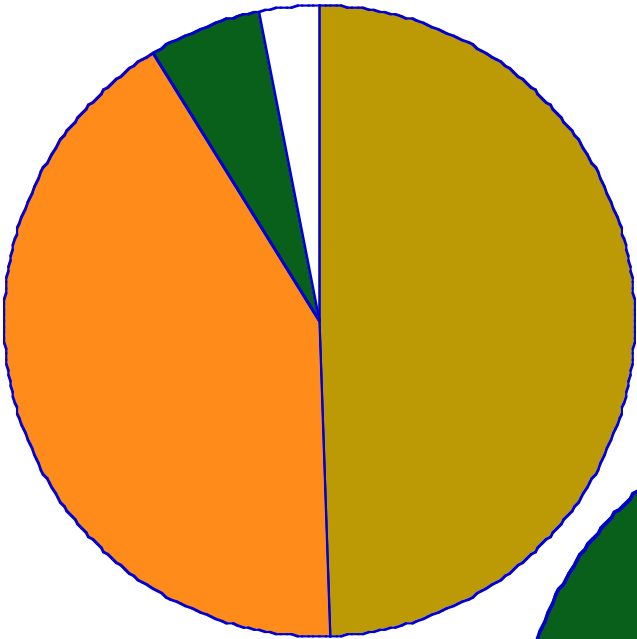
Topsoil
92.5% Cover
44 Yield



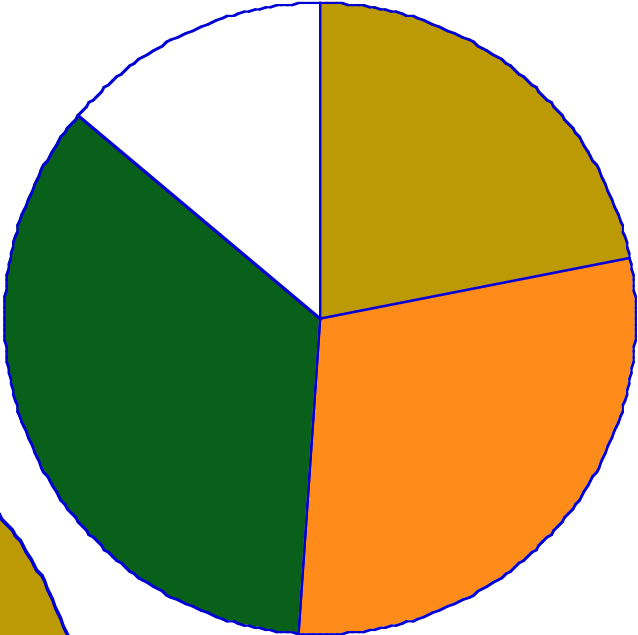
Soil measures

Treatment	M3 P	Total C	Bulk Density	% H₂O
		%	g cm⁻³	0.1 bar
Control	133	0.56	1.52	3.63
Biosolids high	738	6	0.82	30.5
Topsoil	17	2.75		

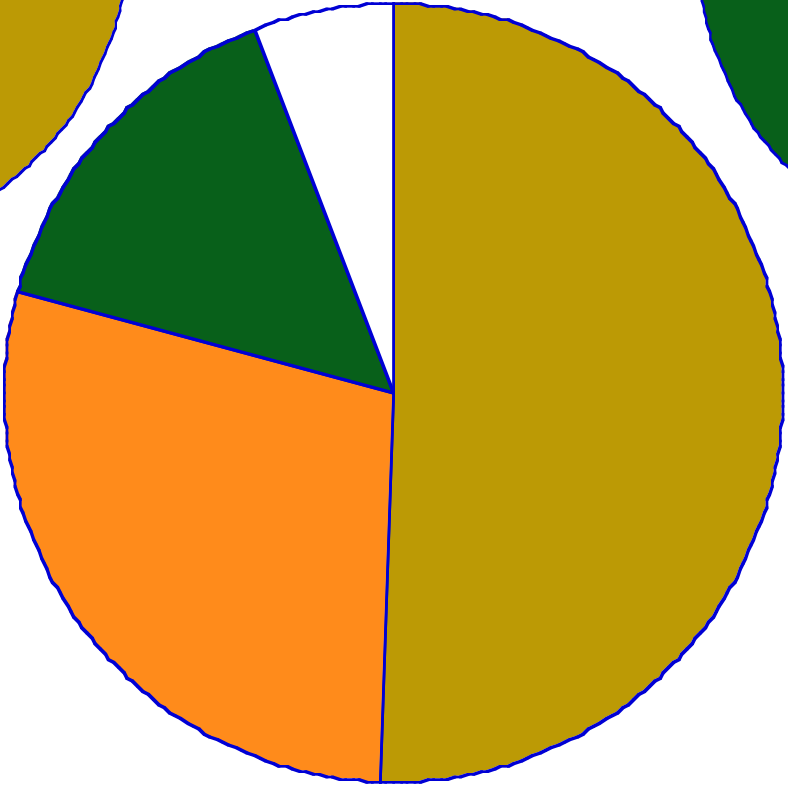
Building Soil



Control



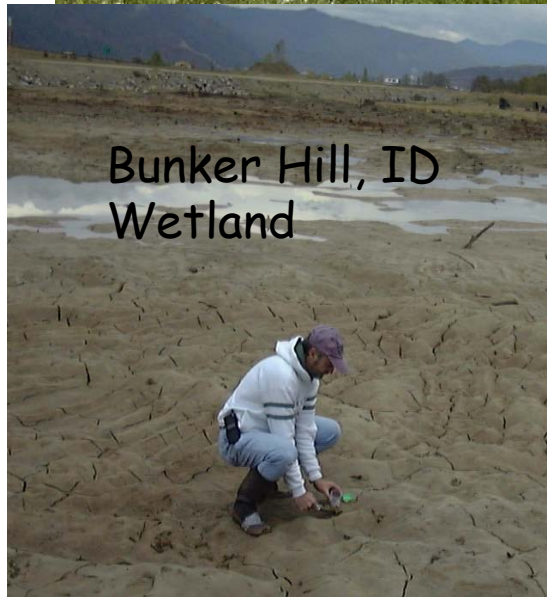
Topsoil



Biosolids high



Jasper one of many





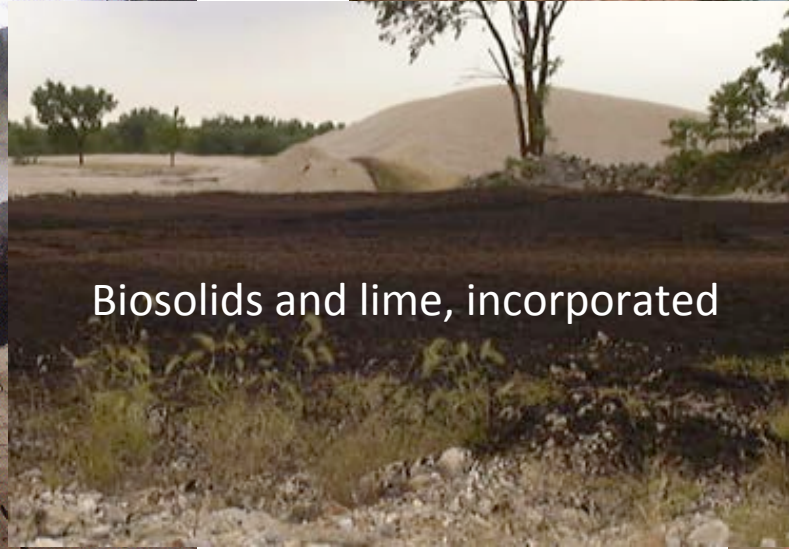
Surface application of biosolids and wood ash



Biosolids sugar beet lime, CaO



Surface application of compost and wood ash



Biosolids and lime, incorporated



Lime stabilized biosolids + Fe



Amendments work



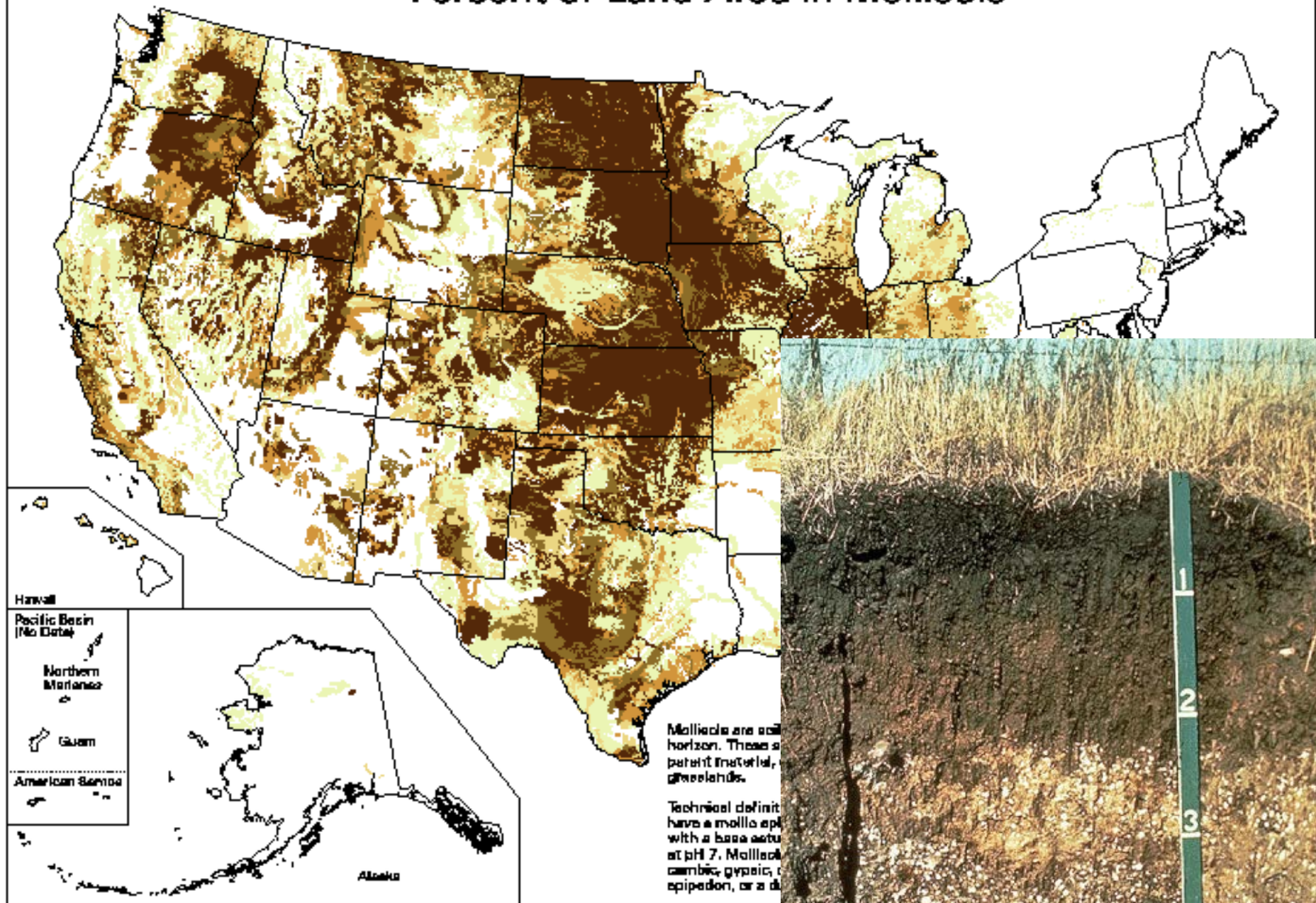
But they can be a pain

- Working with generators
- Regulatory issues
- Supply issues
- Transport issue

Harvesting topsoil- easy and proven alternative



Percent of Land Area in Mollisols



Environmental Costs

- Topsoil replacement
 - 15 cm
- Biosolids/residuals
 - 336 Mg



Topsoil

Current accounting

- Pay the farmer
- Pay the transport

Ecosystem accounting

- Attempt to put a value on the services we get from nature
- 1997 Ecosystem services worth \$33 trillion annually
- 17% of New Zealand GDP from soil



Rather than



- Rate of soil formation
 - 0.058 to 0.083 mm yr⁻¹
 - 1875-1900 years to replace top 15 cm
 - No farming during that time
- USDA Conservation Reserve Program
 - \$241,000 per ha

Gym membership - \$19 a month
Healthier food - added \$100 a month
New wardrobe - \$500

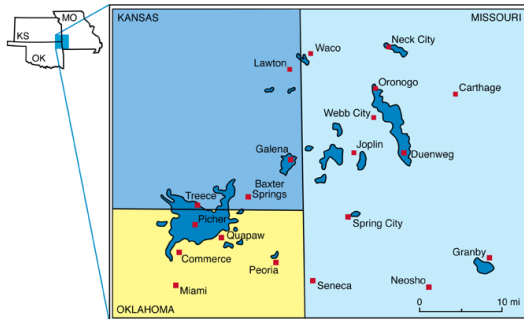


The look on their faces when they see me and regret:

Priceless



607,000 hectares of mine impacted lands =
6700 km² = 0.5 Los Angeles



6700 km² = 670,000 ha
670,000 * \$ 241 000

\$160.8 Billion



Residuals instead then

- Biosolids
 - MO produces 227,000 dry tons annually
 - 60% are incinerated
 - 136,200
 - Enough for 402 ha per year



\$\$ of biosolids (as CO₂e) per 336 tons or 1 ha

- Combustion

- Energy to dry 1.2
- Fugitive N₂O emissions
483
- Transport 0.6

- Total emissions

- 485 tons CO₂ per ha

- Restoration

- Fertilizer credit -80
- Soil carbon storage -89
- Transport 8

- Total sequestration

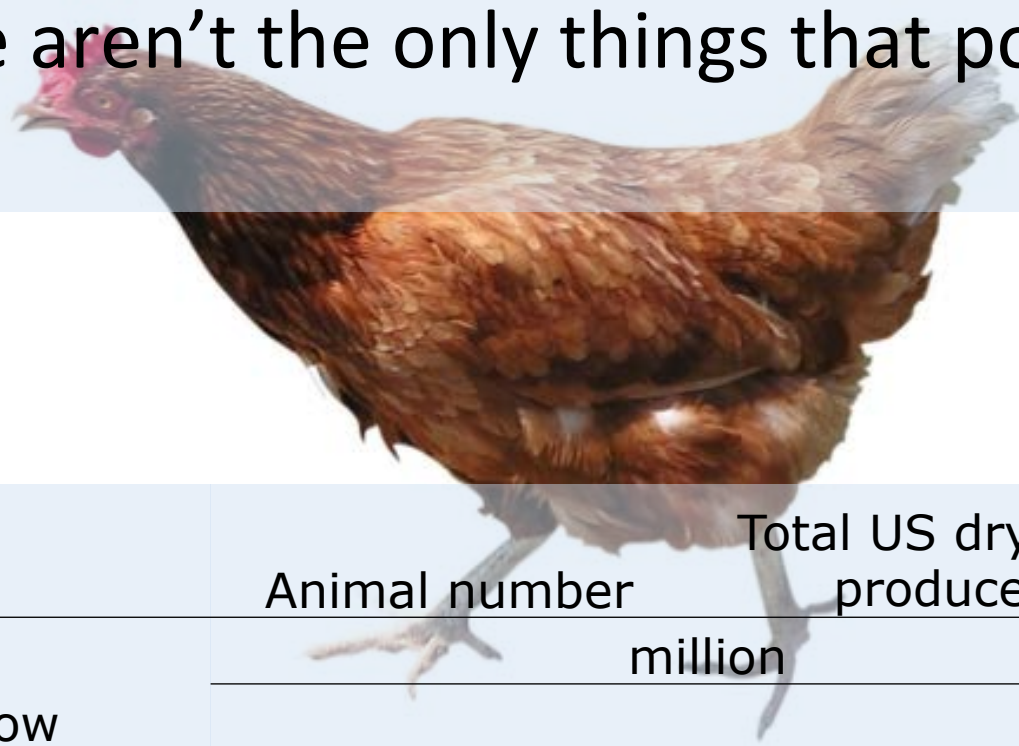
- -156 tons CO₂ per ha

607,000 hectares / 402 ha biosolids per year
 1 667 years



7.2 million tons produced annually
50% beneficially used = 3.6 million tons available
10,714 acres per year = 57 years

People aren't the only things that poop



Animal	Animal number million	Total US dry tons produced
Dairy Cow	9	18.6
Beef Cattle	25.8	32.8
Swine		
Finish	120	26.4
Poultry		
Layer	292	2.8
Broiler	8 600	55.4

Conclusions



- Residuals based restoration effective over long term
 - Animal endpoints
 - Plant endpoints
- Alternate accounting
 - True cost of soil harvesting
 - True value of residuals based approaches