The Metropolitan
Water Reclamation District
of Greater Chicago

WELCOME
TO THE MAY EDITION
OF THE 2016
M&R SEMINAR SERIES

BEFORE WE BEGIN

- SAFETY PRECAUTIONS
  - PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVALUATION
  - AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE
- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www. MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2016 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

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"*Best Quality Research Award*" by Lincoln University

Trace Levels of Heavy Metals and Organic Pollutants in Edible Parts of Crops Grown in Exceptional Quality Biosolids Amended Soils: Human Health Risk Assessment

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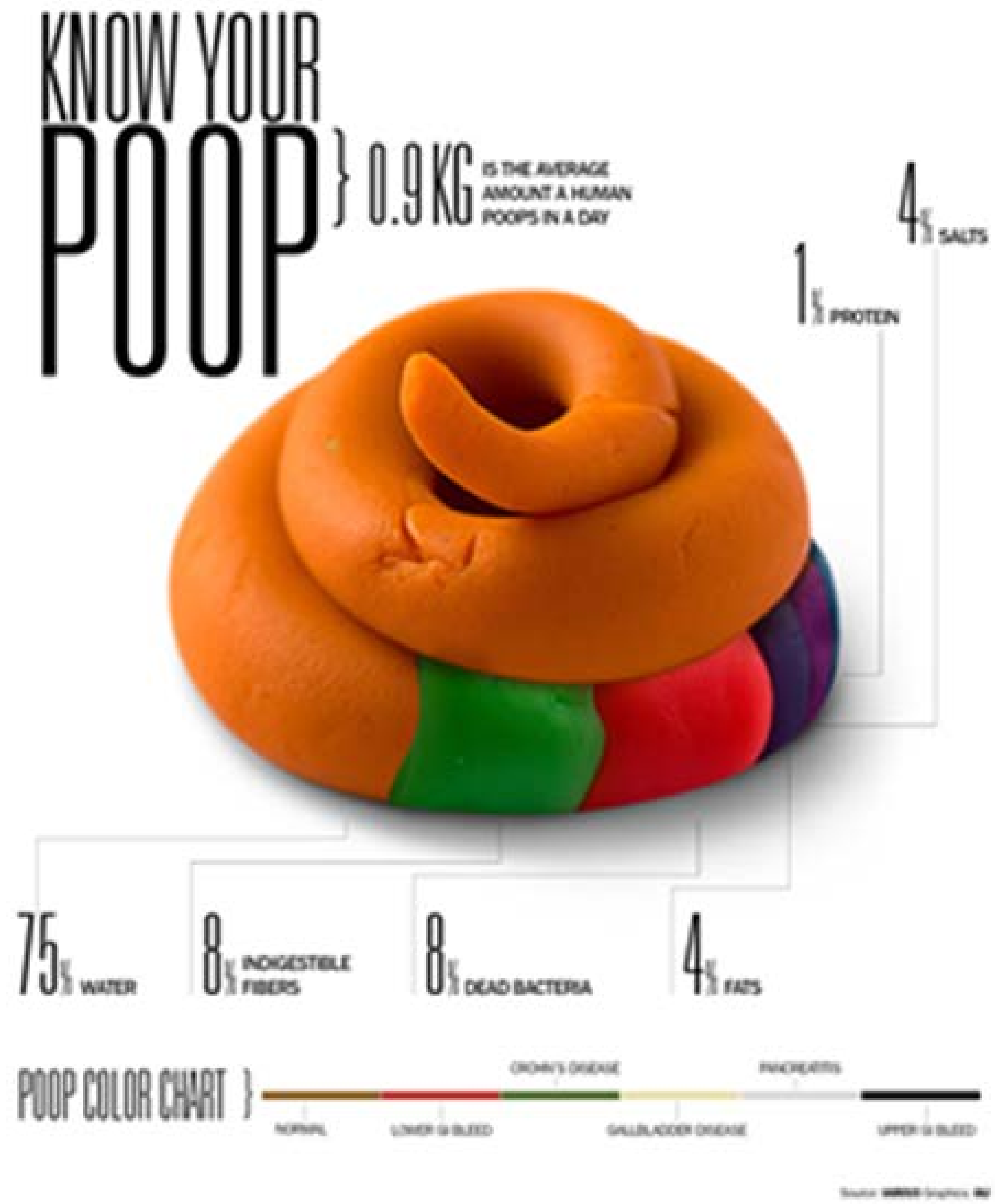
May 20th, 2016

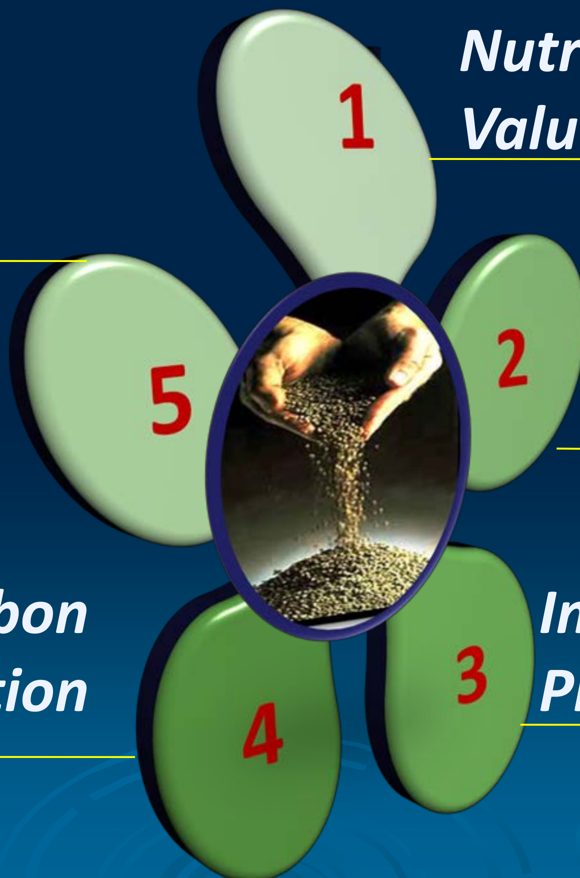
OUTLINE

- Biosolids Beneficial Use
- The Chemical Sea Around Us
- Basic Principle of Toxicology
- 40 CFR Part 503 Risk Assessment
- SWOT and PEST Analysis for the Sustainability of Beneficial Biosolids Use Program at MWRD
- Heavy Metals Exposure – MWRD Studies
- Organic Compounds (PPCPs etc) Exposure
- Take Home Message
- Acknowledgements

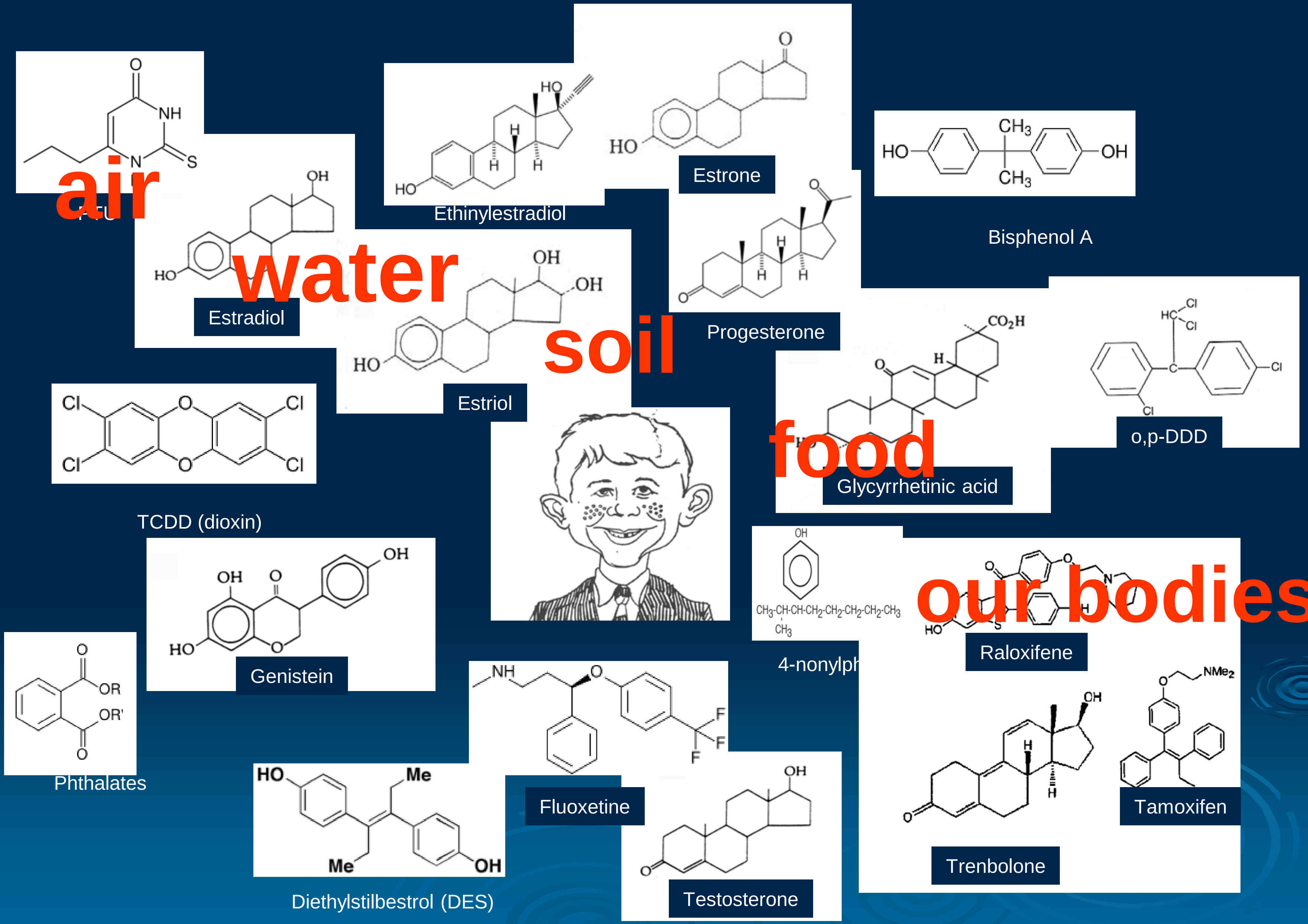
Most Exciting Time for Wastewater Treatment and Resource Recovery



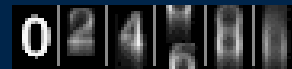
Benefits of Using Biosolids in Agriculture



The Chemical Sea Around Us



The Chemical Universe



The *KNOWN* Universe

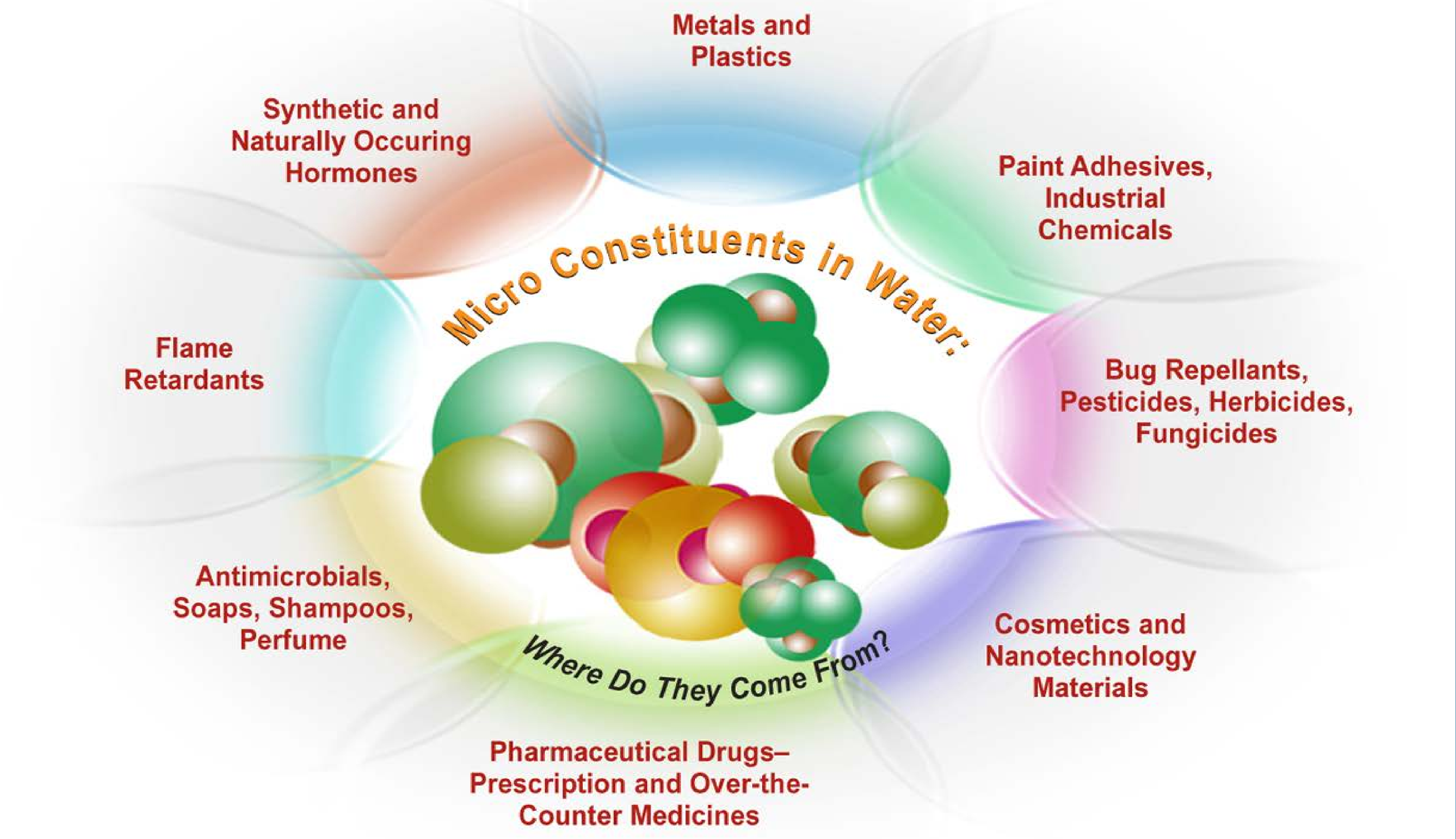
- As of October 2005, over 26 million organic and inorganic substances had been documented.

  (indexed by the American Chemical Society's Chemical Abstracts Service in their CAS Registry; excluding bio-sequences such as proteins and nucleotides)

- ~ 9 million were commercially available.
- Fewer than a quarter million (240,000) were inventoried or regulated by numerous government bodies worldwide - -
  - representing less than 3% of those that are commercially available or less than 1% of the known universe of chemicals.

On One Hand We Humans Use All these Chemicals?

*includes pharmaceuticals, personal care and consumer products

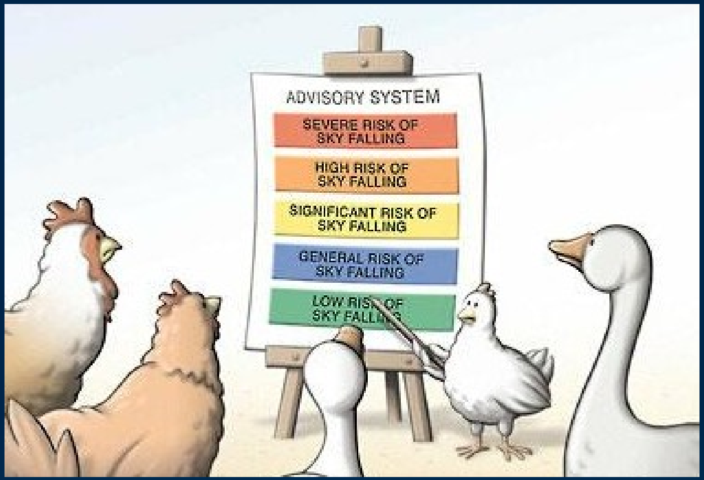


Courtesy of CH2MHill

On The Other Hand Our Attitude Towards OCs in Biosolids

The sky is falling!

- We're awash in evermore dangerous chemicals
- Unknown toxicity, mutagenicity, and carcinogenicity



Modified from Allen Rubin

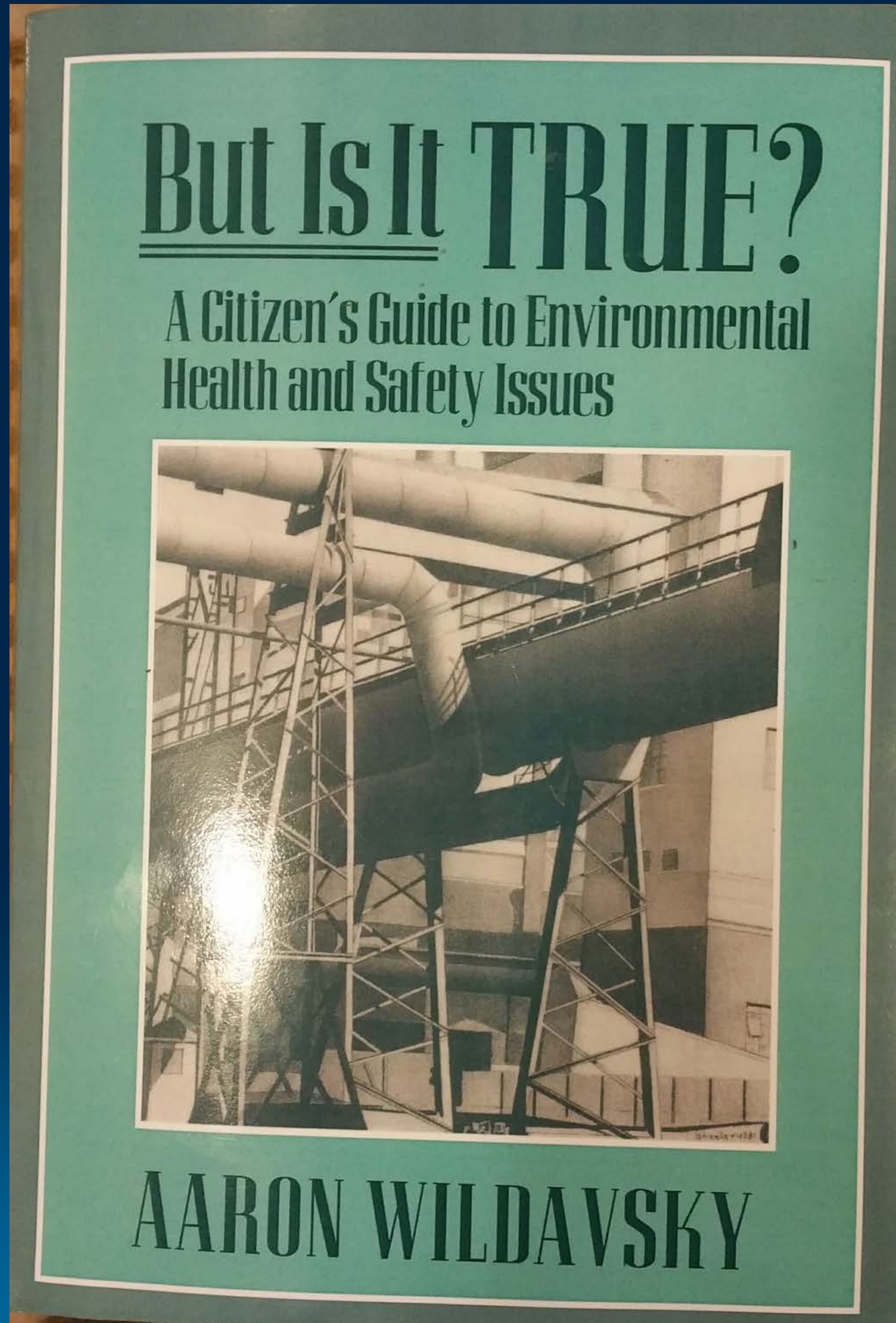
Most Expensive Coffee in the World

Kopi Luwak Cost: $~ 700/kg --- collected from feces of Asian Civet Cats

Black Ivory Coffee Cost: $1100/kg -- collected from feces of Elephants

---On One Hand …We Love to Have a Cup of Kopi Luwak Coffee…

---On the Other hand …. We worry about contaminants in Biosolids



But Is It TRUE?
A Citizen's Guide to Environmental Health and Safety Issues
AARON WILDAVSKY

"Sola Dosis Facit Venenum (Latin)"

IN 1500s SWISS DOCTOR

- ***Philippus Aureolus Theophrastus Bombastus von Hohenheim*** (commonly called Paracelsus) pointed out in 1538
  - "All things are poison and nothing is without poison; only the dose makes a thing not a poison"

BASIC PRINCIPLE OF TOXICOLOGY

The Dose Makes the Poison

PUBLIC HEATH

- All chemicals—even water, oxygen, coffee and spinach—can be toxic if too much is eaten, drunk, or absorbed
- This finding provides the basis for public health standards, which specify maximum acceptable concentrations of various contaminants in food, public drinking water, and the environment

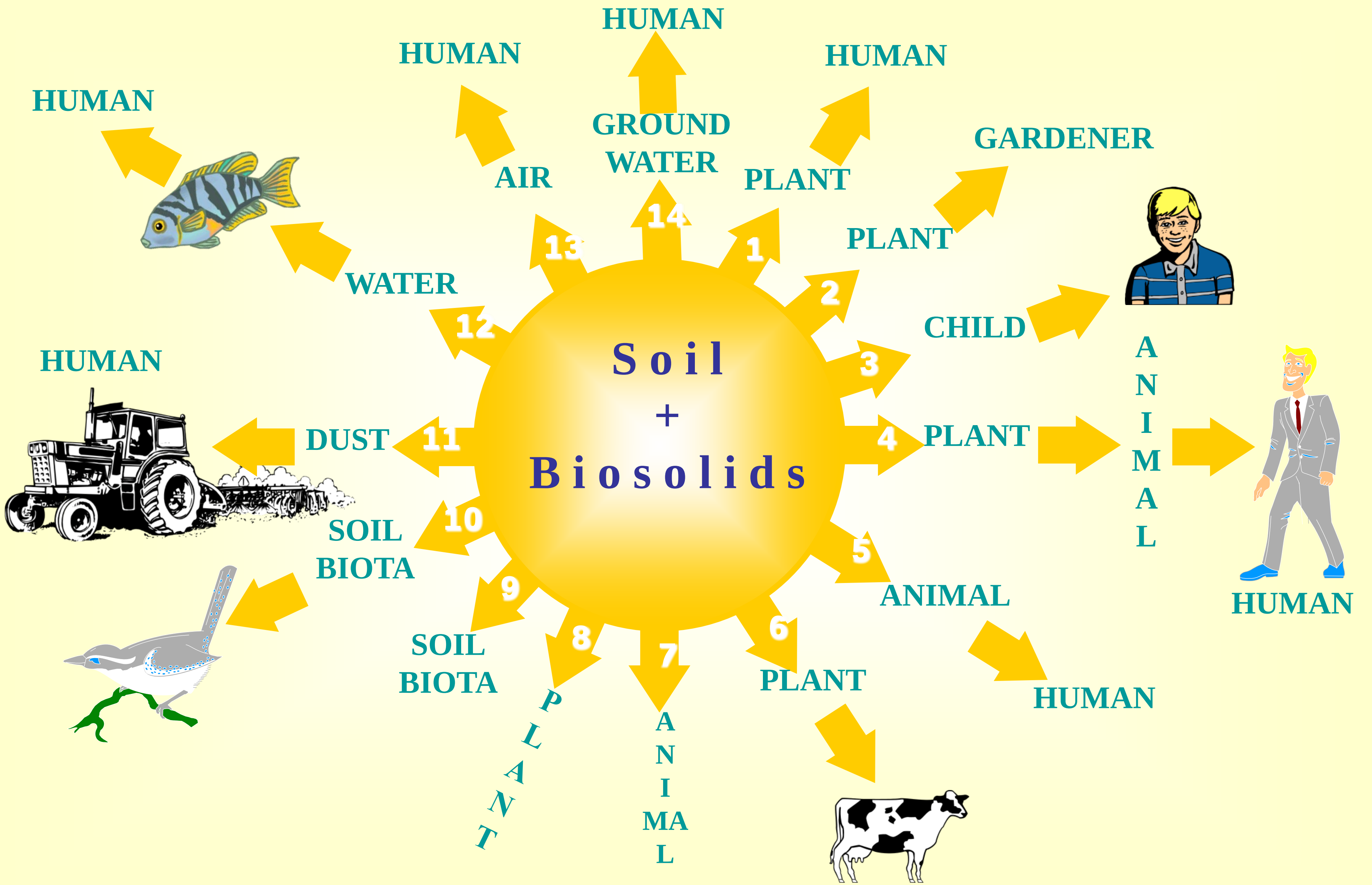
Known and Probable Human Carcinogens (few examples)

Known Human Carcinogens	Probably Human Carcinogens
Aflatoxins	Acrylamide
Alcoholic Beverages	Biomass Fuel Burning
Analgesic mixtures with Phenacetin	Diazinon
Asbestos	Chloramphenicol
Benzene	Ethyl Carbamate (Urethane)
Coal Tars	Glyphosate
Cyclosporin	Hairdresser or Barber (workplace)
Estrogen, Steroidal	Melathion
Solar Radiation	Mate, Hot
Vinyl Chloride	
Wood, Dust	

CWA & 40 CFR Part 503 Risk Assessment Included:

- Heavy Metals
- PCBs
- Furans/dioxins
- Benzo(a)pyrene
- Benzo(a)anthracene
- Phenanthrene
- Chlordane
- Aldrin/Dieldrin
- Toxaphene
- Malathion
- DDT/DDD/DDE
- Methylenebis(2-chloroaniline)
- Bis(2-ethyl hexyl)phthalates
- n-nitrosodimethylamine
- Vinyl Chloride
- Pentachlorophenol
- Trichloroethylene
- Chloroform
- Heptachlor
- Carbon tetrachloride
- Benzene
- Hexachlorobenzene
- Hexachlorobutadiene

14 - Pathway Risk Assessment



Trace Metals In MWRD Biosolids Compared With The Part 503 Limits

	USEPA's Part 503 Limits		
	Allowable Limit	EQ Limit	MWRD Biosolids
	---------------------------- mg/kg	----------------------------	
Arsenic	75	41	5
Cadmium	85	39	4
Copper	4,300	1,500	422
Mercury	57	17	0.5
Molybdenum	75	---	16
Nickel	420	420	37
Lead	840	300	86
Selenium	100	36	6
Zinc	7,500	2,800	900

EQ = Exceptional Quality

POLLUTANT	CONTROLLING PATHWAY	PATHWAY SCENARIO
Arsenic Cadmium Lead Mercury Selenium	3	Child Eating Biosolids
Molybdenum	6	Animal Eating Plants
Copper Nickel Zinc	8	Plant Phytotoxicity

Biosolids Beneficial Reuse Programs:

SWOT and PEST Evaluations to Ensure Sustainability

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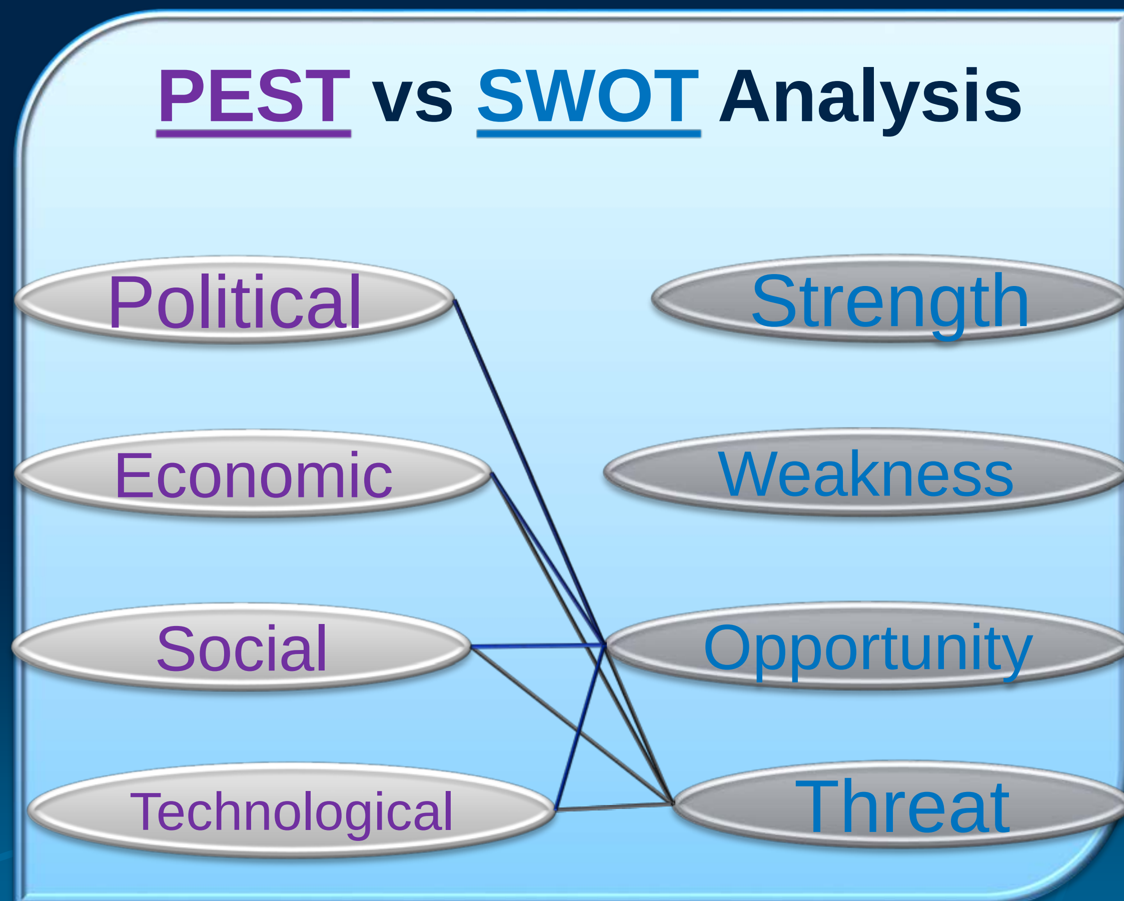
Kuldip Kumar
Dan Collins

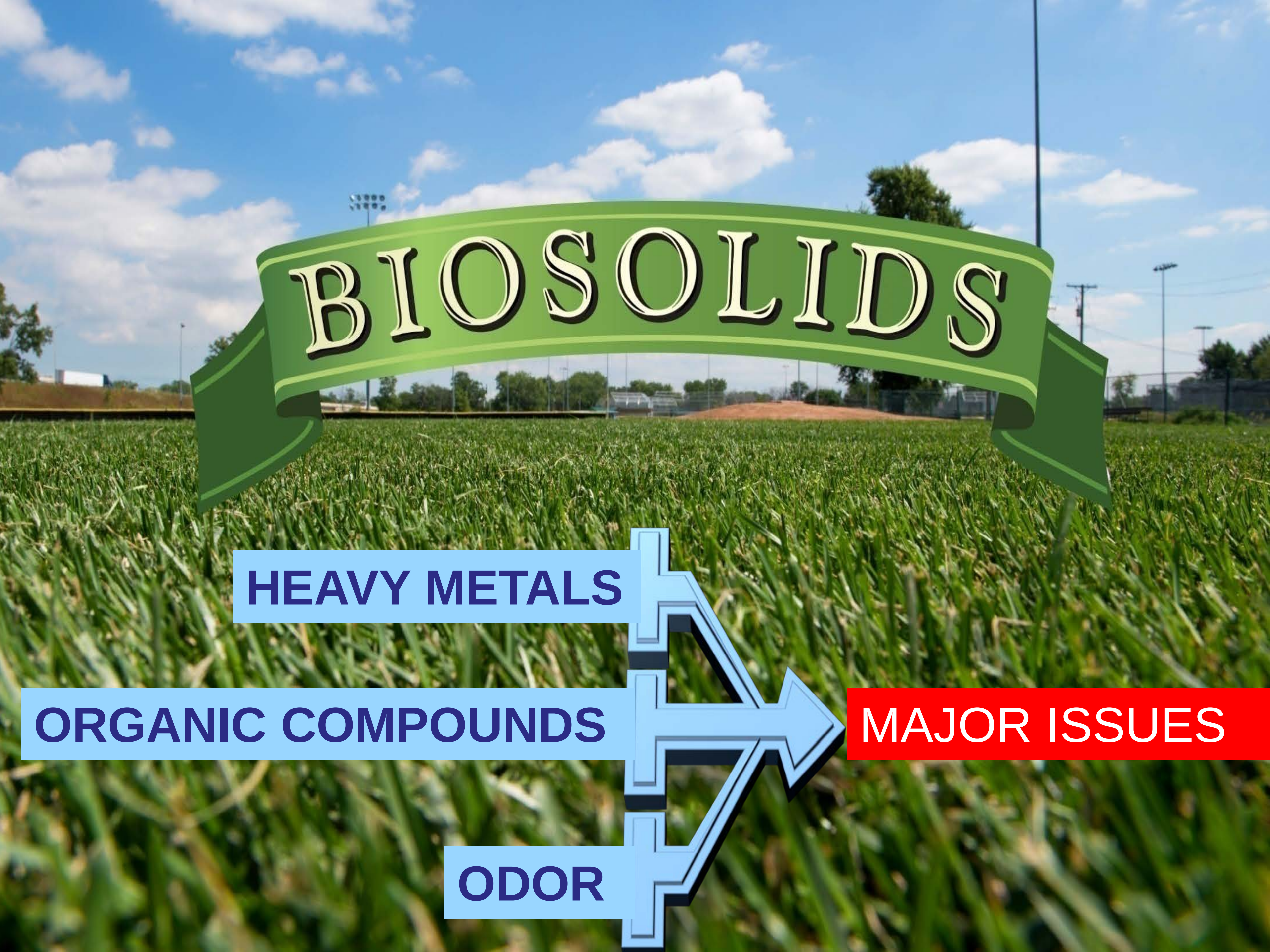
PEST and SWOT Analysis

1. **PEST analysis**
   - Political factors
   - Economic factors
   - Social-cultural factors
   - Technological factors

2. **SWOT analysis**
   - Strengths
   - Weaknesses
   - Opportunities
   - Threats



Use PEST to identify opportunities and threats for SWOT


BIOSOLIDS
HEAVY METALS
ORGANIC COMPOUNDS
ODOR
MAJOR ISSUES

Heavy Metals Issue

- Promulgation of the CWA & 40 CFR Part 503 Rule (Part 503) resulted in a substantial reduction in the levels of trace elements in biosolids (Successful Pre-Treatment Program).
- Public concerned have continued even after Part 503 limits.
- Information of metals uptake from ‘Exceptional Quality’ biosolids is lacking.

Improvements in Biosolids Quality Resulting from the Clean Water Act

Lakhwinder S. Hundal[1] *, Kuldip Kumar[1], Albert Cox[1], Heng Zhang[1], Thomas Granato[1]

(POTWs) and promulgated General Pretreatment Regulations in 1978. This study analyzed trace metals data from the National Sewage Sludge Surveys conducted by U.S. EPA and the American Metropolitan Sewage Agencies (AMSA) to evaluate the effect of implementation of the national industrial pretreatment standards on concentrations of trace metals in sludges generated by POTWs in the United States. The data showed that implementation of pretreatment programs has been highly effective in reducing the amount of pollutants that enter POTWs and has resulted in a substantial reduction in the levels of trace metals in the municipal sludges. Concentrations of chromium, lead, and nickel in sludge declined by 78, 73, and 63%, respectively, within a year after promulgation of General Pretreatment Regulations. Resulting from these measures, metal concentrations in the sludges generated by a majority of POTWs in the United States are sufficiently low that the sludges can be classified as biosolids and also meet the U.S. EPA's exceptional quality criteria for trace metals in biosolids. This improvement gives POTWs the option to use their biosolids beneficially through land application. *Water Environ. Res.*, **86**, 134 (2014).

KEYWORDS: Clean Water Act, industrial pretreatment standards, trace metals, sludge, land application of biosolids.

doi:10.2175/106143013X13807328849099

Introduction

The 1972 Federal Water Pollution Control Act, commonly known as the CWA, authorized the U.S. Environmental Protection Agency (U.S. EPA) to regulate quality standards for surface waters and establish regulations limiting the amounts and types of pollutants entering the nation's waters. As a result, publicly owned treatment works (POTWs) are required to obtain National Pollution Discharge Elimination System (NPDES) permits from U.S. EPA, which specify the concentration limits of various pollutants in the effluent discharged by POTWs. Compliance with NPDES permits required a greater

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priority pollutants, especially trace metals in the sludge. Disposal or recycling of sludge in environmentally responsible manners has always been a challenging task for POTWs in the United States and throughout the world. The POTWs realized a long time ago that the common sludge disposal options, including landfill, incineration, and ocean dumping, are neither suitable nor sustainable as quantities of sludge generated by POTWs continue to increase resulting from increasing population and stringent water quality regulations (Chase, 1964; Jewell and Seabrook, 1979). Agricultural utilization of sludge has always been an attractive option for POTWs as the U.S. EPA and scientific community continued reevaluation and regulation of sludge.

While agricultural utilization provides a cost-effective and reliable outlet for municipal sludge, essential plant nutrients (e.g., nitrogen, phosphorus, calcium, zinc, etc.) and organic matter added to the soil create favorable agronomic conditions for plant growth. Thus, agricultural utilization of sludge is among the most cost-effective and sustainable alternatives for POTWs to manage the increasing quantities of sludge. However, there were concerns that high levels of trace metals in sludge could be harmful to plants and consumers. Therefore, reducing the concentrations of trace metals in sludge became an important challenge for the POTWs and U.S. EPA to increase the safety and suitability of sludge for land application.

Concentrations of trace metals in sludge are related to the quality and quantity of domestic and industrial discharges to the wastewater system and the amounts of trace metals added in the conveyance and treatment systems. Inputs of trace metals in the domestic wastewater are associated mainly with human excreta and disposal of consumer and personal care products, whereas in industrial wastewater they are associated mainly with waste materials and wastewater discharges from production processes and routine cleaning activities. Therefore, the levels of trace metals in sludge depend heavily on the use of trace metals in household and personal care products and industrial processes. Potential sources of commonly found trace metals in sludge (Page, 1974) are described below.

Trace metals are widely used in many industrial processes and are vital components of many manufactured products. Arsenic (As) compounds are used in rodenticides, insecticides, fungicides, and wood preservatives. Compounds of arsenic are also used in the manufacture of glass, ceramics, and linoleum, and in

Beneficial Biosolids Use

Wastewater

- *Heavy Metals*
- **Organic Pollutants**
- *Nano-g/L to micro-g/L*

Biosolids

- *Concentrate in Biosolids*
- *Degrade During Processes*
- *Metals in mg/L and Organics < micro-g/L*

Soil

- *Agronomic Rates*
- *100 Times Dilution*
- *Biotic & Abiotic Processes*

Edible Grain Or Fruit

- *Root Uptake Barriers*
- *Plant Requirement*
- *Very Low Accumulation in Edible Parts*
- *With Exception of Few Chemicals*

Study Objective & Treatments

- To evaluate trace metals uptake by three vegetables fertilized with EQ biosolids.
  - lettuce (*Lactuca sativa* L.)
  - zucchini (*Cucurbita pepo* L.)
  - tomatoes (*Lycopersicum esculentum Mill*.)
- Three Rates of EQ Biosolids
  - Control (Fertilized)
  - 10 t/ac (30 t/ac by 2013)
  - 20 t/ac (60 t/ac by 2013)
- Replications: 3

Characteristics of Biosolids and Soil

Basic Properties	Value	Nutrients Conc. -------(g/kg)---------		Trace Metals Conc. (mg/kg) -- Metal	Soil	Biosolids	EQ 503 Limits, mg/kg
pH	6.8	TKN	16.3	Al	27,629	19,810	-
TS (%)	77	NH3-N	1040	As	3.7	10	41
VS (%)	40	NO3-N	0.10	Cd	0.1	3	39
		Total P	16.1	Co	7.6	7	-
		Ca	35.8	Cr	27.6	142	-
		Mg	17.5	Cu	13.5	444	1500
		K	1.88	Fe	17,956	17,036	-
		Na	0.39	Hg	-	1	17
				Mn	386	544	-
				Mo	0.8	8	-
				Ni	14.0	40	420
				Pb	12.1	13	300
				Se	0.4	5	100
				Zn	38.4	853	2800

Metals Uptake

Part 503 Metals

- Increased biosolids loading did not result in increased metal concentration in edible tissues of any of the three crops studied.
- Lead concentration in zucchini declined with increasing biosolids loading.

Other Metals

- Uptake of other metals (Mn, Be, Ba, Co, Ag, Fe, Al etc.) was also not affected by biosolids loading rate.

Relative Uptake of Cd and Zn Using Lettuce as a Reference Crop for Representative of Major Food Crops Grown on Biosolids Amended Soils

Crop	2011 Biosolids Loading (Mg/ha)			2013 Biosolids Loading (Mg/ha)			Mean
	0	25	50	0	25	50	
	Cadmium						
Lettuce	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Zucchini	0.07	0.10	0.09	0.05	0.06	0.08	0.08
Tomato	0.15	0.32	0.16	0.09	0.20	0.15	0.18
	Zinc						
Lettuce	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Zucchini	0.39	0.46	0.53	0.41	0.48	0.52	0.47
Tomato	0.34	0.48	0.46	0.25	0.35	0.29	0.36

Uptake Coefficients Used in the Part 503 Risk Assessment

Metal	Uptake Coefficients Leafy Veg.	 Fruit
	----(mg/kg)/(kg/ha)----	
Cd	0.032	0.045
Ni	0.004	0.003
Zn	0.022	0.023

Comparison of Safe Lifetime Consumption Concentration (SLC) with Actual Concentration in Edible Tissue

Year	Biosolids Loading, Mg/ha	Metal	Lettuce			Zucchini			Tomato		
			SLC	Act.	Act./SLC	SLC	Act.	Act./SLC	SLC	Act.	Act./SLC
2011	25	Cd	4.7	1.8	0.39	1.9	0.2	0.09	2.4	0.6	0.24
		Ni	3.3	1.3	0.40	2.4	0.9	0.36	2.2	0.9	0.41
		Zn	144	67	0.46	97	31	0.32	92	32	0.34
	50	Cd	4.7	2.2	0.70	1.95	0.20	0.10	2.4	0.35	0.14
		Ni	3.3	1.33	0.41	2.40	1.2	0.48	2.2	0.92	0.42
		Zn	144	68	0.47	97	36	0.37	92	31	0.34
2013	75	Cd	4.7	2.9	0.62	1.9	0.2	0.09	2.4	0.6	0.24
		Ni	3.3	0.9	0.3	2.4	0.9	0.38	2.2	0.9	0.41
		Zn	144	81	0.57	97	39	0.41	92	28	0.31
	150	Cd	4.7	2.4	0.52	1.9	0.2	0.10	2.4	0.4	0.14
		Ni	3.3	1.0	0.31	2.4	0.9	0.40	2.2	0.9	0.42
		Zn	144	78	0.54	97	41	0.42	92	23	0.25

Health Risk from Consuming vegetables

Hazard Quotient (HQ)

HQ = (DIV*Cm)/RfD*Bo

- DIV – Daily Intake of Vegetables (kg/capita/d)
- Cm – Conc. of Metal in Edible Tissue (mg/kg)
- RfD – Oral reference Dose mg/kg/d)
- Bo – Human Body Mass (kg)

HQ < 1 No Obvious Risk Over Lifetime Consumption

Metal	HQ
Arsenic	< 0.1
Cadmium	< 0.1
Copper	0.2
Mercury	< 0.1
Nickel	< 0.1
Molybdenum	RfD N/A
Lead	< 0.1
Selenium	< 0.1
Zinc	0.3

Summary – Heavy Metals

- The present study corroborates many previous studies that metals are poorly accumulated in edible portion of the plants.
- EQ biosolids can be safely utilized for fertilizing vegetable crops including leafy greens at the recommended agronomic rates without any potential risks due to translocation of toxic metals in the human food chain.

Recent Concerns!
Organic Compounds (OCs)

- **Concerns raised regarding the presence of *“emerging organic contaminants”* or *“endocrine disrupting compounds”* in biosolids.**
- **Majority of these so called *endocrine disrupting compounds (EDCs)* are basically “everyday domestic use compounds”.**
- **These compounds enter the environment mainly *via* regular or everyday domestic use and routine activities.**

Targeted National Sewage Sludge Survey (TNSSS)

- 84 samples at 74 POTWs in 35 states (**Aug. 2006 – Mar. 2007**)
- Measured 145 analytes, including:
  - 117 trace organic chemicals
    - 97 pharmaceuticals, steroids and hormones
      - 72 antibiotics and drugs (Rx and OTC)
      - 25 steroids and hormones
    - 11 polybrominated diphenyl ethers (PBDEs)
    - 4 polycyclic aromatic hydrocarbons (PAHs)
    - 3 inorganic ions
    - 2 semi-volatile organics

TNSSS Findings – Occurrence

Wide variation in minimum and maximum levels

Wide variation in detection frequency:

- 16 analytes (11%) not detected
- 129 analytes (89%) detected in at least one sample
- Most non-pharmaceuticals were detected in more than 50 of 84 samples
- Pharmaceuticals/steroids/hormones ranged from 0 to all 84 samples
- 42 analytes detected in 100% of samples (3 pharmaceuticals; 3 steroids & hormones; 36 metals, inorganic ions, organics)

Hazard Quotient (HQ) of OCs in The Edible Tissue

- Prosser and Sibley (2015) Based on Extensive Review on Plant Uptake of OC Calculated HQs:
- Estimated Daily Intake (EDI) for OCs for Adult or Toddler
- EDIs compared to ADI (Acceptable Daily Intake)
- ADI Were calculated :
  - Drugs = Lowest Therapeutic Dose (LTD, mg/d)/1000
  - Drugs (Endocrine Disruptors) = LTD/10,000
  - Other OCs = NOAEL/300

Calculated HQs for Various OCs

OCs	Crop	Adult HQ	Toddler HQ
Atenolol	Tomato	0.01	0.02
Carbamazepine	Collard	1.5*[a]	3.7*[a]
Ciprofloxacin	Carrot	0.0001	0.0003
Diphenhydramine	Tomato	0.03	0.07
Naproxen	Corn	0.0001	0.0002
Norfloxacin	Carrot	0.0002	0.0004
Progestrone	Corn	0.01	0.04
Salbutamol	Cabbage	1.5*[b]	3.8*[b]
Testosterone	Tomato	0.08	0.2*[c]
Triamterene	Carrot	0.0001	0.0002
Triclocarban	Collard	0.002	0.005
Triclosan	Radish	0.05	0.1*[d]

*Hazard quotient >0.1; [a]Conc. in biosolids used were ~2 to 4 times of maximum concentration in TNSSS (USEPA, 2009); [b]Conc. in biosolids used were ~1.3 times of a single outlier out of 84 biosolids samples that had sulbutamol in TNSSS ; [c]The study also reported detecting testosterone from control plots at similar concentrations so analysis was questionable; [d]Pot study, concentration was much higher than would occur with single application of biosolids.

Quantitative Human Health Risk Analysis for OCs

Northwest Biosolids Management Association (NBMA, 2015) Conducted a quantitative exposure assessment for uses of biosolids using general risk assessment methodology by the USEPA. The following scenarios of exposure from dermal contact and ingestion were evaluated:

- Child exposed while playing in a home garden or lawn fertilized with Class A biosolids compost.
- Adult gardener exposed while working in a home garden fertilized with Class A biosolids compost.
- Occupational worker exposed while applying Class B biosolids to agricultural land.
- Adult hiker exposed while hiking in a forested area fertilized with Class B biosolids.

Representative concentrations of OCs in Class A compost biosolids (mg/kg) and resulting exposure without adverse effects in years (from NBMA, 2015)

OCs	Represe-ntative Conc.	Exposure Without Adverse Effects YEARS Adult Gardner	Child Resident
Acetaminophen	0.0015	142,576,343	4,494,188
Fluoxetine	0.036	91,395	2,881
17 –a ethinylestradiol	0.0011	3,119	98
Bisphenol A	9.0	436,635	13,763
Ibuprofen	0.35	94,006	2,963
Deca-BDE	0.24	1,470,486	159,343
Azithromycin	0.035	2,350,159	74,080
Ciprofloxacin	0.93	35,379	1,115
Erythromycin	0.0060	13,709,264	432,133
Ofloxacin	0.66	99,704	3,143
Sulphamethoxazole	0.001	131,608,932	4,148,482
Triclosan	1.2	4,935,335	155,568

Representative concentrations of OCs in Class B biosolids (mg/kg) and resulting exposure without adverse effects in years (from NBMA, 2015)

OCs	Represe-ntative Conc.	Exposure Without Adverse Effects YEARS	
		Adult Hiker	Occupational
Acetaminophen	0.29	4,334,286	292,391
Fluoxetine	0.087	222,271	14,994
17 –a ethinylestradiol	0.0011	18,329	1,237
Bisphenol A	9.0	2,566,226	173,118
Ibuprofen	0.35	552,502	37,272
Deca-BDE	4.1	555,672	10,668
Azithromycin	0.46	1,050,956	70,897
Ciprofloxacin	3.4	57,638	3,888
Erythromycin	0.020	24,171,981	1,630,642
Ofloxacin	1.8	217,032	14,641
Sulphamethoxazole	0.0056	137,340,798	9,265,012
Triclosan	17	2,023,701	136,519

Representative and acceptable concentrations of MCs in Class B biosolids (mg/kg) and resulting exposure without adverse effects in years (from NBMA, 2015)

OCs	Therapeutic Dose or Typical Daily Intake (mg)	Years of Exposure to Receive Equivalent Dose			
		Class A Compost		Class B Biosolids	
		Adult Gardner	Child Resident	Adult Hiker	Occup-ational
Acetaminophen (Analgesic)	1,000 2 Tylenols	90,143,104	50,514,235	2,740,328	147,890
17–aethinylestra-diol (Birth control)	0.01 Lo Loestrin	1,282	718	7,533	407
Ibuprofen (NSAID)	200 1 Tablet Advil	77,266	43,298	454,112	24,507
Ciprofloxacin (Antibiotic)	250 Lowest Daily Dose	36,348	20,369	59,217	3,196
Erythromycin (Antibiotic)	1,000 Lowest Daily Dose	22,535,776	12,628,559	39,734,763	2,144,406
Triclosan (Anti-microbial)	87 Soap Single Use	9,775	5,478	4,008	216

Other Recent Risk Assessments

Norwegian Risk Assessment - 2009

- Norwegian Food Authority evaluated
  - Six classes of organic pollutants
    - ✓ Phthalates, Octylphenols and ethoxylates, NP, NPEs
    - ✓ PCBs, PAHs
  - 14 pharmaceuticals (atorvastatin, carisoprodol, chlorprothixene, ciprofloxacin, dipyridamole, fexofenadine, gabapentin, levetiracetam, losartan, mesalazine, metoprolol, ranitidine, sotalol,tetracycline).

Conclusion

- Exposure risk from all pollutants evaluated
  - Well below PNEC
  - Promotion of antibiotic resistance in biosolids-amended soils unlikely

Other Recent Risk Assessments

Danish Government Risk Assessment - 2012

- Danish EPA evaluated
  - Five classes of organic pollutants
    - ✓ BFRs, Musks, PFCs
    - ✓ Pharmaceuticals
    - ✓ PCBs
  - Used margin of safety (MoS) to calculate quotient of predicted soil concentration and NOEL
  - Used MoS value of between 10 and 1000

Conclusion

- No significant risk to soil dwelling organisms and soil quality in general

Exposure Risks – What Do We Know!

- Levels of most OCs in biosolids are low
- Land application further results in 100 fold dilution
- OCs are sequestered in organic matrix of biosolids and thus have limited bioavailability
- Effects of relatively more water soluble OCs are likely to be seen effluent than biosolids
- Experience with similar organics from Part 503 Risk Assessment shows that risk to humans is *de minimis*
- However, ecological impact needs further evaluation
  - Ecological toxicity
  - Effect on soil microbes
  - Effect biochemical processes

Biosolids, Fertilizers, Compost, & Manure

Total Land in US – 2.3 Billion Acres

Under Agriculture – 315 Million Acres

7 Million Ton

0.2% Ag Land Receives Biosolids

30 Million Ton

55 Million Ton

140 Million Ton

7 % Ag Land Receives Manure

Take Home Messages

- **Land application of biosolids is a beneficial practice and it does not result in human exposure to Heavy Metals and OCs.**
- **We can minimize exposure to OCs by becoming smart consumers and reducing indiscriminate use of chemicals in our daily lives.**
  - **DEA released data on National Rx Take-Back Day (May, 2016)**
    - **PROUD to say that Illinois was at No. 5 and our efforts kept 24 tons of drugs out of our waterways and landfills**

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Gold Mined from Sewage Sludge

Japanese News Article – 30 Jan 2009

http://pinktentacle.com/2009/01/gold-mined-from-sewage-sludge/

- Wastewater Treatment Plant in Town of Suwa (central Nagano prefecture) started mining gold from sludge, earning a 5 million yen ($56,000) in 1st month of operation (Jan '09).
- **Not feasible for all WWTPs – mineralogical barrier**

- ~1.9 kg (4.2 lbs) of gold can be mined from each ton of molten fly ash generated when incinerating sludge at its facility.
- Unique situation: precision machining companies, metal plating facilities, and hot springs.
- Treats ~100,000 tons of wastewater each day, generating about 3 tons of ash in the process.