

Assessing Risks of Using Soils in Landfills as Cover



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Federation of New York Solid Waste Associations Conference
Bolton Landing, New York
May 22, 2018

Overview

- ▶ Contaminated soils must often be managed off-site
- ▶ Landfills by regulation must cover waste on a daily basis
- ▶ Using contaminated soils as daily cover is a logical synergy
 - Landfills can avoid use of other cover materials
 - Landfill space is saved by not treating contaminated soils as waste
 - Contaminated soils are secluded
- ▶ But ... are landfill workers put at risk from handling the contaminated soils?

Materials Used As Cover at Landfills

Table 1. Materials approved for beneficial reuse at landfills in 1 or more states.

Auto Shredder Residue	Foundry Sand—Green Sand
Circulating Fluidized Bed Ash	Glass
Coal Bottom Ash	Gypsum Wallboard
Coal Fly Ash	Slag—Foundries
Construction and Demolition Debris	Slag—Steel
Contaminated Soil	Stormwater Sediments
Dredge Material	Street Sweepings
Drinking Water Treatment Sludge—Aluminum	Waste Tires
Drinking Water Treatment Sludge—Ferric	Waste-to-Energy Ash
Drinking Water Treatment Sludge—Lime	Wastewater Treatment Plant Filter Sand
Flue Gas Desulfurization Sludge	Wood Ash
Foundry Sand	

Source: <http://www.envcap.org/statetools/brsl/>.

Partial List of States Approving Contaminated Soils as Daily Cover

Table 2. States that allow the reuse of contaminated soils at landfills.

Florida	New York
Hawaii	North Carolina
Iowa	North Dakota
Kentucky	South Dakota
Maryland	Texas
Massachusetts	Virginia
Michigan	Wyoming
Mississippi	

Source: <http://www.envcap.org/statetools/brsl/>.

What Are Applicable Regulations?

- ▶ Landfill workers are the primary concern re: exposure to cover soils at a landfill
- ▶ OSHA regulates worker safety
- ▶ What is the role of hazardous chemical/waste site regulations based on EPA-type risk assessment?



or



Soil Limits to Meet OSHA PELs

- ▶ Assume respirable dust is limited to the OSHA PEL of 5,000 $\mu\text{g}/\text{m}^3$
- ▶ Calculate implied levels in soil to meet chemical-specific PELs assuming all dust is from soil

Chemical	OSHA PEL ($\mu\text{g}/\text{m}^3$)	Implied Concentration in Soil (mg/kg)
Arsenic	10	2,000
Chromium VI	5	1,000
Lead	50	10,000

- ▶ For comparison, EPA's National Ambient Air Quality Standards
 - PM_{10} : 150 $\mu\text{g}/\text{m}^3$
 - Lead: 0.15 $\mu\text{g}/\text{m}^3$

Risk Assessment Considerations

- ▶ Exposure Pathways
 - Incidental ingestion
 - Dermal contact
 - Inhalation
- ▶ Types of Risk
 - Carcinogenic - Increased chance of getting cancer
 - Non-carcinogenic - Any/every other potential adverse effect

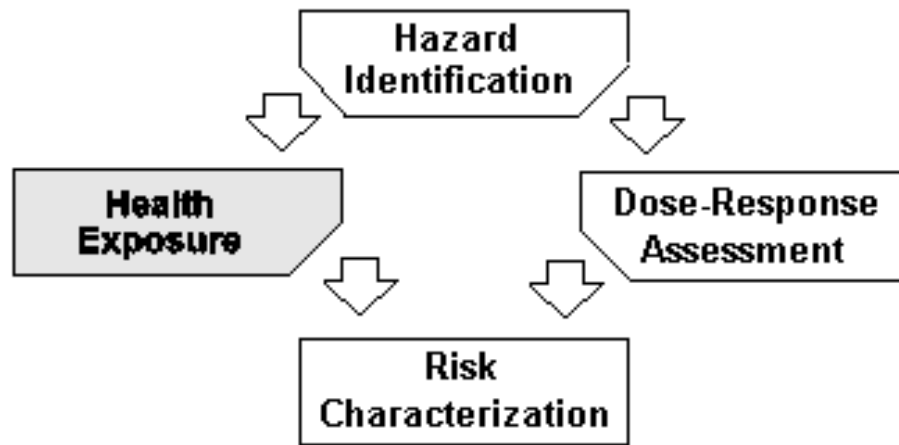
$$SL_{\text{rec-soil-ca-der}} \left(\frac{\text{mg}}{\text{kg}} \right) = \frac{TR \times AT_{\text{rec}} \left(\frac{365 \text{ days}}{\text{year}} \times LT (70 \text{ years}) \right)}{\left[\frac{CSF_0 \left(\frac{\text{mg}}{\text{kg-day}} \right)^{-1}}{GIABS} \right] \times DFS_{\text{rec-adj}} \left(\frac{\text{mg}}{\text{kg}} \right) \times ABS_d \times \left(\frac{10^{-6} \text{ kg}}{\text{mg}} \right)}$$

where:

$$DFS_{\text{rec-adj}} \left(\frac{\text{mg}}{\text{kg}} \right) = \left[\frac{ED_{\text{rec-c}} (\text{years}) \times EF_{\text{rec-c}} \left(\frac{\text{days}}{\text{year}} \right) \times SA_{\text{rec-c}} \left(\frac{2373 \text{ cm}^2}{\text{day}} \right) \times AF_{\text{rec-c}} \left(\frac{0.2 \text{ mg}}{\text{cm}^2} \right)}{BW_{\text{rec-c}} (15 \text{ kg})} + \frac{ED_{\text{rec-a}} (\text{years}) \times EF_{\text{rec-a}} \left(\frac{\text{days}}{\text{year}} \right) \times SA_{\text{rec-a}} \left(\frac{6032 \text{ cm}^2}{\text{day}} \right) \times AF_{\text{rec-a}} \left(\frac{0.07 \text{ mg}}{\text{cm}^2} \right)}{BW_{\text{rec-a}} (80 \text{ kg})} \right]$$



Risk Assessment Basics



$$I(\text{kg}) = \frac{TR \times AT_{\text{rec}} \left(\frac{365 \text{ days}}{\text{year}} \times LT (70 \text{ years}) \right)}{\left(\frac{CSF_0 \left(\frac{\text{mg}}{\text{kg-day}} \right)^{-1}}{GIABS} \right) \times DFS_{\text{rec-a}} \left(\frac{\text{mg}}{\text{kg}} \right) \times ABS_d \times \left(\frac{10^6 \text{ kg}}{\text{mg}} \right)}$$

where:

$$Dose = \left(\text{Concentration in Soil} \times \text{Contact Rate} \times \text{Exposure Frequency/Duration} \right) / \left(\text{Body Weight} \times \text{Averaging Time} \right)$$

$$\left(\frac{\text{days}}{\text{year}} \right) \times SA_{\text{rec-c}} \left(\frac{2373 \text{ cm}^2}{\text{day}} \right) \times AF_{\text{rec-c}} \left(\frac{0.2 \text{ mg}}{\text{cm}^2} \right) + \left(\frac{\text{days}}{\text{year}} \right) \times SA_{\text{rec-a}} \left(\frac{6032 \text{ cm}^2}{\text{day}} \right) \times AF_{\text{rec-a}} \left(\frac{0.07 \text{ mg}}{\text{cm}^2} \right)$$

$$\text{Incremental Cancer Risk (ICR)} = \text{Lifetime Average Daily Dose} \times \text{Potency}$$

$$\text{Noncancer Hazard Quotient} = \text{Average Daily Dose} / \text{Reference Dose}$$

(Some) Options for Risk Assessment

- ▶ EPA Superfund Guidance - risk-based Regional Screening Levels (RSLs)
- ▶ State contaminated site programs (examples)
 - NYSDEC's Soil Cleanup Objectives (SCOs) (6 NYCRR Part 375.2006)
 - MassDEP's Shortform Risk Assessment spreadsheets
 - CT DEP's Remediation Standard Regulations (RSRs)
- ▶ Considerations
 - Background concentrations - are they relevant?
 - Appropriateness of exposure assumptions

Worker Exposure Profiles

Scenario	Exposure Pathways			Exposure Assumptions		
	Ingestion	Dermal	Inhalation	Ingestion rate (mg/d)	Frequency (d/wk)	Duration (yr)
EPA RSLs Composite Worker	✓	✓	✓	100	5	25
NYSDEC SCOs Industrial Worker	✓	✓	✓	50	2	25
MassDEP Shortform Construction Worker	✓	✓	✓	100	5	0.5
Connecticut RSRs Industrial/Commercial Worker	✓			50	5	25

Not specifically designed for landfill workers!
Background explicit only in NYSDEC SCOs

Permissible Levels in Soil

Chemical	Concentrations in Soil (mg/kg)					
	Background (MassDEP)		Worker Target Levels/Limits (Lower of cancer or non-cancer)			
	Natural Soils	Fill	NYS Part 375 SCO	EPA RSL	MassDEP Shortform	CT RSR
Arsenic	20	20	16	3	90	10
Cadmium	2	3	60	980	300	1,000
Chromium III	30	40	6,800	1,800,000	8,000	51,000
Chromium VI	30	40	800	6.3	300 (200)*	100
Lead	100	600	3,900	800	1,000	1,000
Benzo(a)pyrene	2	7	1.1	2.1	30	1
Fluoranthene	4	10	1,000	30,000	61,000	2,500
Naphthalene	0.5	1	1,000	17	49,000	2,500

* Contact dermatitis criterion

Tailored Risk Assessment Assumptions

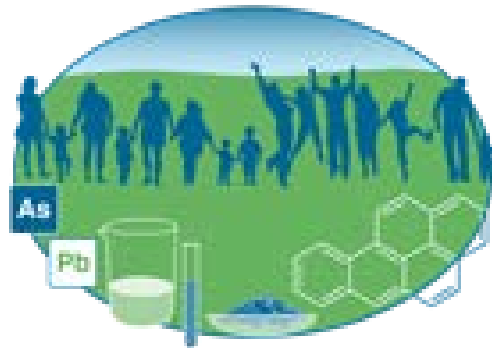
- ▶ Risk assessment assumptions can be tailored to landfill workers
- ▶ Some simple adjustments
 - Use EPA RSL Calculator with site-specific assumptions
 - Exposure for 2 hours per day to contaminated soils – scale/pro-rate 100 mg/d incidental soil ingestion rate to 25 mg/d
 - Assume 5 years exposure
 - Set incremental cancer target risk criteria = 10 per million, target hazard quotient = 1

Site-Specific Levels in Soil

Chemical	Concentrations in Soil (mg/kg)	
	EPA RSL defaults	EPA RSL Calculator site-specific assumptions
Arsenic	3	440
Cadmium	980	1,500
Chromium III	<i>1,800,000</i>	<i>6,300,000</i>
Chromium VI	6.3	1,300
Lead	800	-
Benzo(a)pyrene	2.1	230
Fluoranthene	30,000	160,000
Naphthalene	17	680

Bioavailability - An Additional Tool?

- ▶ Bioavailability relates to the fraction of a chemical absorbed from soil
- ▶ High concentrations are OK if tightly bound
- ▶ The Interstate Technology Regulatory Council (ITRC) has recently published guidance on using simple *in vitro* tests to apply bioavailability to develop risk-based target concentrations for Arsenic (As) and Lead (Pb)



Conclusions

- ▶ Not clear what regulations should apply to landfill workers exposed contaminants in cover soils
- ▶ Use of default risk-based concentrations from site remediation programs can result in stringent limits on contaminant concentrations in soils, but detailed exposure assumptions may be inappropriate for landfill workers
- ▶ Site-specific assumptions may yield less restrictive but still protective risk-based concentration limits



Quiz – Poll Everywhere Software

- ▶ Text SANBORNHEAD921 to 22333
 - ▶ Then choose letter options
- ▶ Alternative 1: Web responses to PollEV.com/sanbornhead921
- ▶ Alternative 2: Silent show of hands

Thank you for your attention!

- ▶ For more information, contact
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Review Question #1

- ▶ True or False - U.S. EPA Administrator Scott Pruitt has recently struck down regulations governing the safe use of contaminated soils as cover material at landfills?
 - ▶ True
 - ▶ False

Review Question #2

- ▶ True or False - OSHA regulations are generally more restrictive than risk-based soil standards developed under state regulatory programs such as NYS Part 375 Soil Cleanup Objectives?
 - ▶ True
 - ▶ False

Review Question #3

- ▶ Which of the following is an established carcinogen in humans?
 - ▶ Arsenic
 - ▶ Cadmium
 - ▶ Chromium III
 - ▶ Chromium VI
 - ▶ Lead
 - ▶ Benzo(a)pyrene
 - ▶ Fluoranthene

Review Question #4

- ▶ Which of the following is known to cause contact dermatitis?
 - ▶ Arsenic
 - ▶ Cadmium
 - ▶ Chromium III
 - ▶ Chromium VI
 - ▶ Lead
 - ▶ Benzo(a)pyrene
 - ▶ Fluoranthene