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OPTIMIZING CARCASS MANAGEMENT IMPLEMENTATION USING SENSITIVITY ANALYSES FROM EXPOSURE ASSESSMENTS

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Background

- Exposure Assessment of Livestock Carcass Management Options During Natural Disasters, (EPA, 2017) in collaboration with the U.S. Department of Homeland Security and the U.S. Department of Agriculture
- Exposure Assessment of Livestock Carcass Management Options During a Foreign Animal Disease Outbreak (EPA, 2017) in collaboration with the U.S. Department of Homeland Security and the U.S. Department of Agriculture
- Both documents are highly detailed and comprehensive assessments, publicly available in their entirety online; this presentation only focuses on the most significant points from the assessments in the presenter's opinion
- The base scenario assumes management of 50 tons of carcasses or (100) 1,000 lb cows, (565) 177 lb hogs, (25,000) 4 lb broiler chickens, or (5,000) 20 lb turkeys. Carcass management is assumed to take place at a hypothetical farm in Iowa.
- There are two types of contaminants of concern; chemical and microbial.

Options Considered

On-Site	BURNING 	BURIAL 	COMPOSTING 
Off-Site	INCINERATION 	LANDFILL 	RENDERING 
Other	STORAGE 	TRANSPORT 	

Offsite Options Controlled through Regulation – Risks not Evaluated

Tier 1 Ranking	Management Options	Chemical Exposure Pathways	Microbial Exposure Pathways	Controls and Limits to Environmental Releases
Rank 1: Negligible to minimal exposure — releases regulated to levels safe for human health and the environment	Incineration	6	6	Air emissions regulated under the Clean Air Act (CAA), including pollution control equipment (e.g., scrubbers, filters), with tall stacks to prevent localized deposition; residuals (i.e., ash) managed under the Resource Conservation and Recovery Act (RCRA); wastewater managed under the Clean Water Act (CWA).
	Rendering	3	2	Releases to air and to water regulated under the CAA and CWA, respectively.
	Landfilling	2	2	Landfill design and operation regulated under RCRA; controls include leachate collection and management and methane recovery.

Most Significant Exposure Pathways for Livestock Carcass Management - Chemicals

- Storage pile leaching to groundwater and surface water/fish ingested by humans/livestock

- Burning air inhalation, deposition on crops and deposition on surface water to fish consumed by humans
- Leaching from ash burial to groundwater ingested by humans/livestock

- Deep burial leaching to groundwater and surface water to fish ingested by humans/livestock

- Compost pile leaching to groundwater and surface water to fish ingested by humans
- Land applied compost leaching to groundwater and taken up by crops ingested by humans

Chemical Ranking Ratio Summary





- Storage Pile – top risks from Fe and Zn ingestion (median 3.9E-10)
- Open Burning – top risks from Mn and Ni inhalation (median 4.0E-02)
- Air Curtain – top risks from Mn and Cr inhalation (median 2.0E-02)
- Deep Burial – top risks from Fe and Zn ingestion (median 6.3E-09)
- Compost Windrow – top risks from Fe and Zn ingestion (median 3.1E-10)
- Compost Application – top risks from Fe and Cr ingestion (median 5.1E-02) can be mitigated with erosion control measures

Ranking of Onsite Options for Chemicals

Rank [a]	Management Option	Principal Rationale
1	Compost Windrow	Bulking material retains most chemicals
1	Burial	Soils filter out chemicals traveling toward groundwater
2	Air-curtain burning	Similar release profiles; emissions sensitive to type and quantity of fuels used and burn temperature
2	Open Pyre burning	
3	Compost Application	If no offset from lake; mitigate with offset and erosion controls

Most Significant Exposure Pathways for Livestock Carcass Management – Naturally Occurring Microbes

- Storage pile leaching to groundwater ingested by humans/livestock

- Burning leaching from ash burial to groundwater ingested by humans/livestock

- Deep burial leaching to groundwater ingested by humans/livestock

- Compost pile leaching to groundwater ingested by humans/livestock
- Land applied compost leaching to groundwater and taken up by crops ingested by humans/livestock

Ranking On-site Carcass Management Options by Relative Risk from Microbes

	Carcass Management Option	Rationale
1	Air-curtain burning	All microbes inactivated or destroyed, lowest relative risk
2	Open-pyre burning	Prions survive, other microbes inactivated or destroyed
3	Composting: windrow & application	Prions and spores survive, *E. coli* can be inactivated
4	Burial	No thermal destruction; leachate not impeded

Most Significant Exposure Pathways for Livestock Carcass Management – FAD Pathogens

- Storage pile
  - air inhalation
  - air deposition on plants ingested by humans/livestock
  - air deposition on soil and surface water incidentally ingested by humans/livestock
  - leaching to groundwater ingested by humans/livestock

- Deep burial leaching to groundwater ingested by humans/livestock

Ranking of Onsite Options for FAD Pathogens

Rank	Management Type	Principal Rationale
1	Open Burning and Air-curtain Burning	Thermal descruction of all FMDv.
2	Composting	Bulking material contains almost all FMDv from releases to air and soil. Thermal inactivation and biological decay eliminate FMDv before composting is complete.
3	Burial	Cover soil contains releases to air. If a number of conditions are met, leaching has the potential to infect cattle that drink water pumped from a ground water well.
4	Temporary Storage	Cattle can be infected by inhaling or ingesting FMDv emitted to air from a nearby storage pile. If a number of conditions are met, leaching has the potential to infect cattle that drink water pumped from a ground water well.

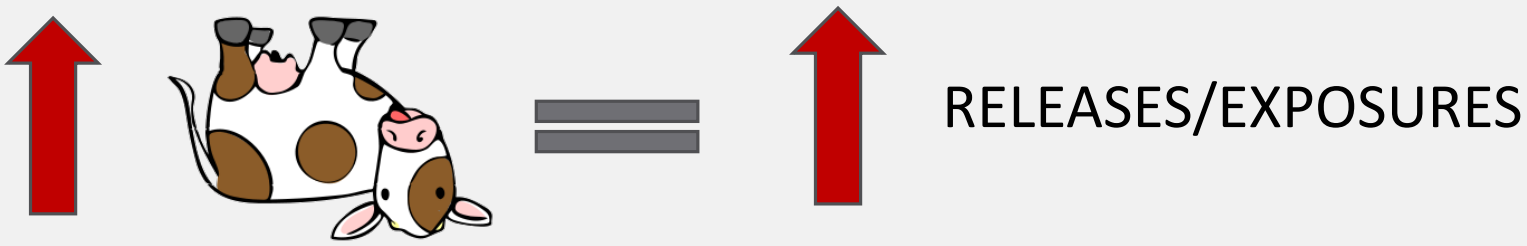
FMDv = foot and mouth disease virus

Livestock FMD Exposure Pathways

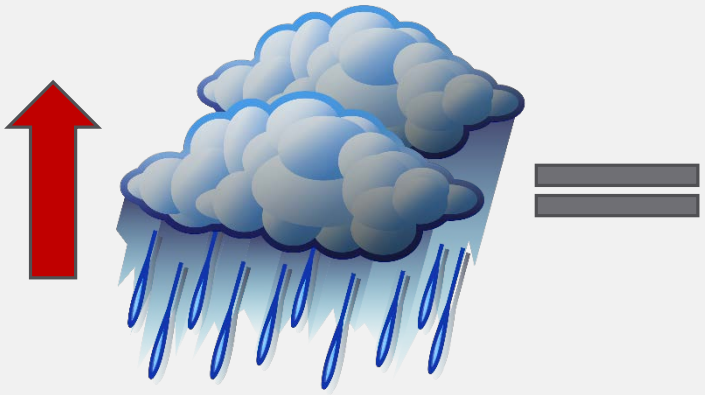
Exposure Source	Carcass Management Options	
	Temporary Storage Pile	Burial
Air Inhalation	1) Air[a]	1) Air[b]
Direct Ingestion	2) Air → Plants[a]	2) Air → Plants[b]
Incidental Ingestion	3) Air → Soil[a]	3) Air → Soil[b]
Incidental Ingestion	4) Air → Surface water[a]	4) Air → Surface water[a]
Ground-water Ingestion	5) Leachate → Ground water[a]	5) Leachate → Ground water[a]
Vectorborne Transmission	6) Airborne vectors → Livestock[c]	6) Airborne vectors → Livestock[b,c]

Variables
and
Effects on Exposure

Scale of Mortality

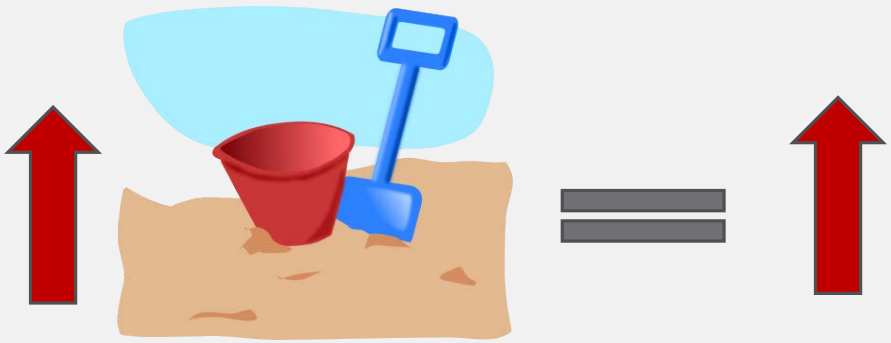


Meteorology



RELEASES/EXPOSURES

Soil Particle Size and Type

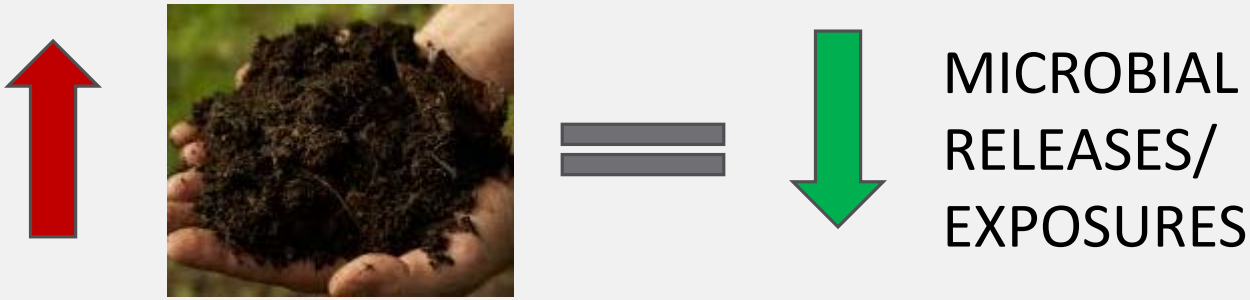


RELEASES/EXPOSURES

Table 3-2. Average Downward Travel Velocities and Time to 1 m Depth in Unsaturated Soils

Soil Type	Average Downward Water Velocity (cm/day)	Average Time to Breakthrough (day)
Sand	100[a]	1.0
Loam	18[b]	5.6
Clay	2.5[c]	40

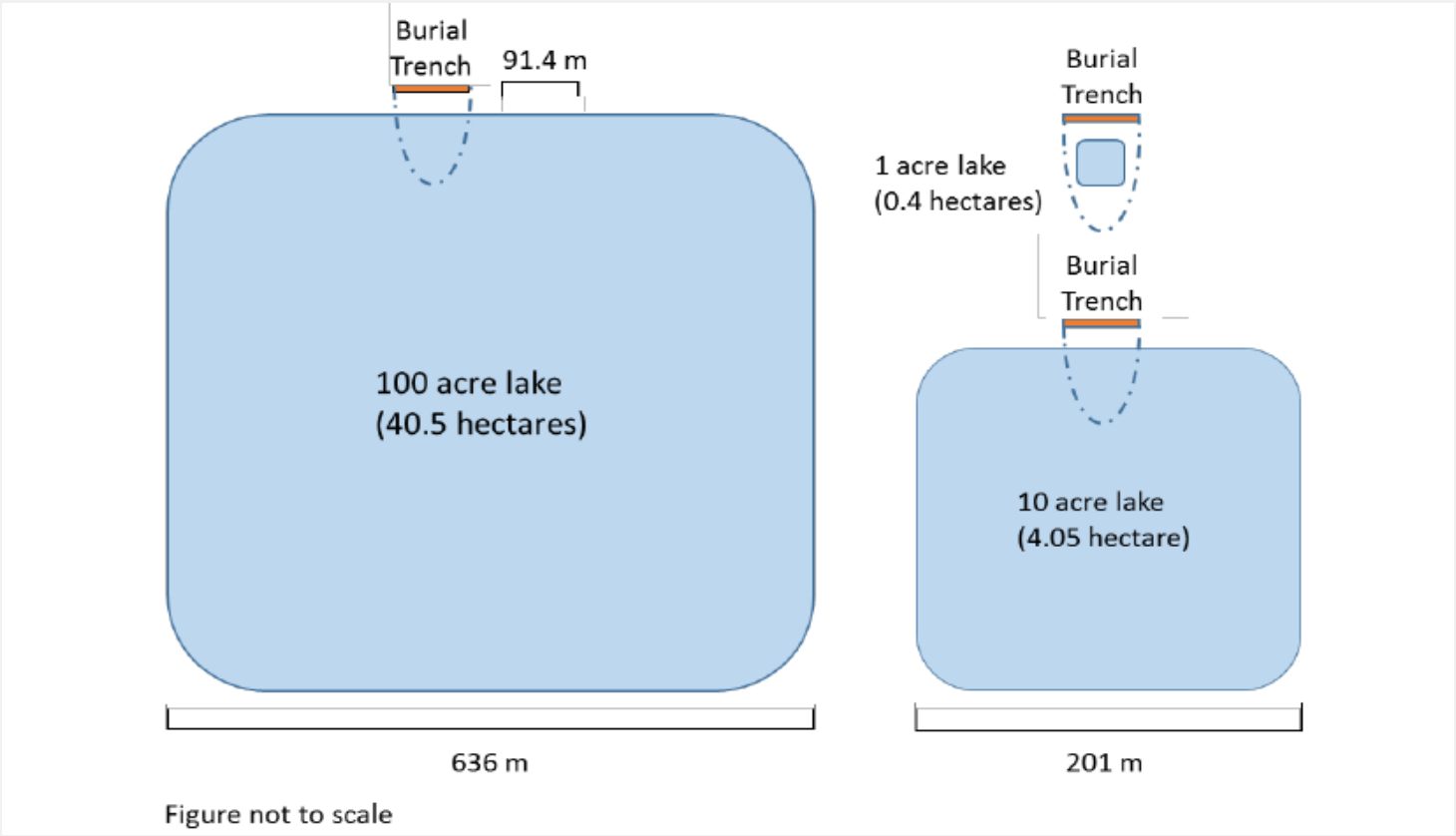
Soil Organic Content



Surface Slope

Faster and farther surface movement of leachate from storage piles

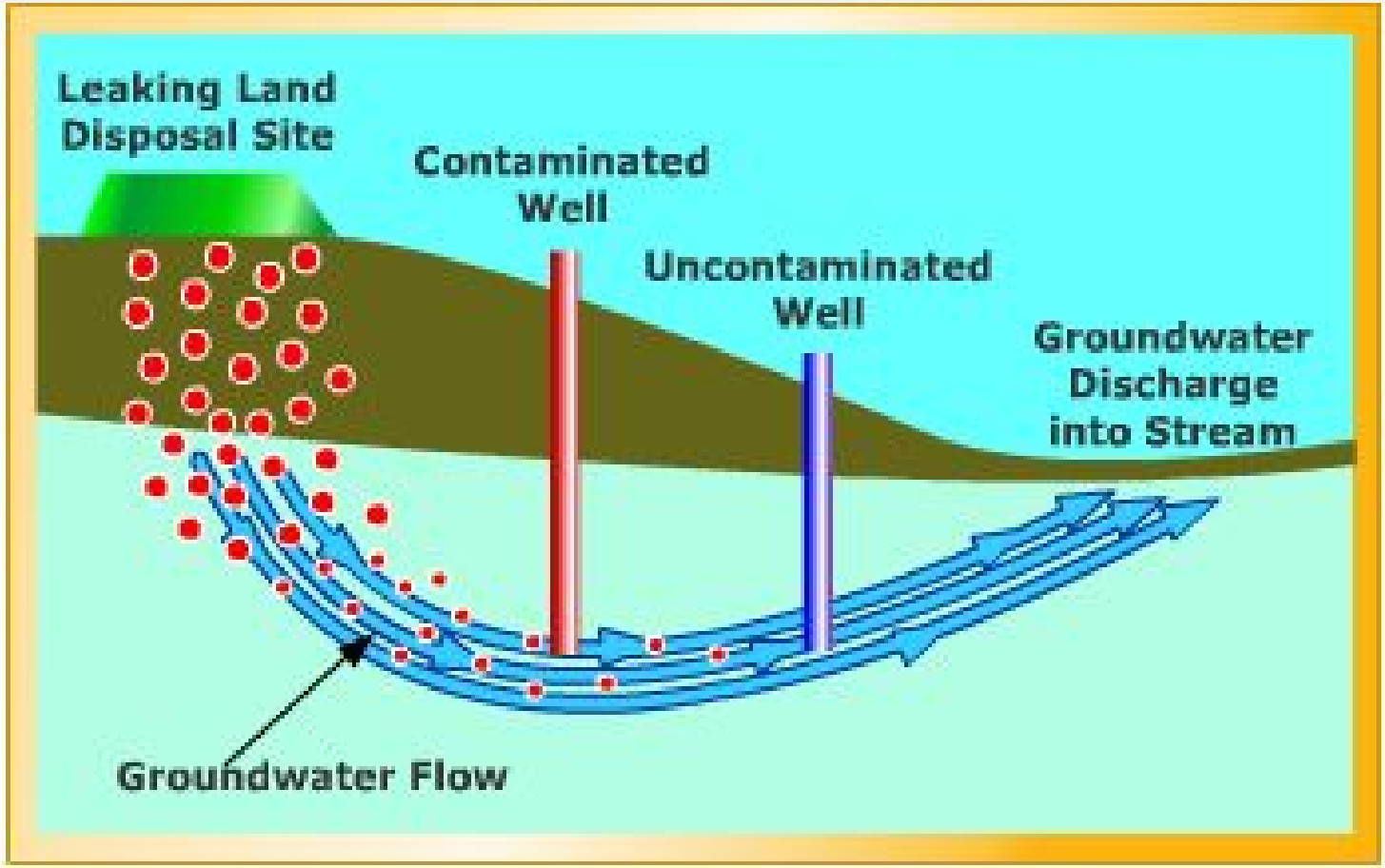
Relationship Between Burial Trench Groundwater Plume and Lakes of Various Sizes



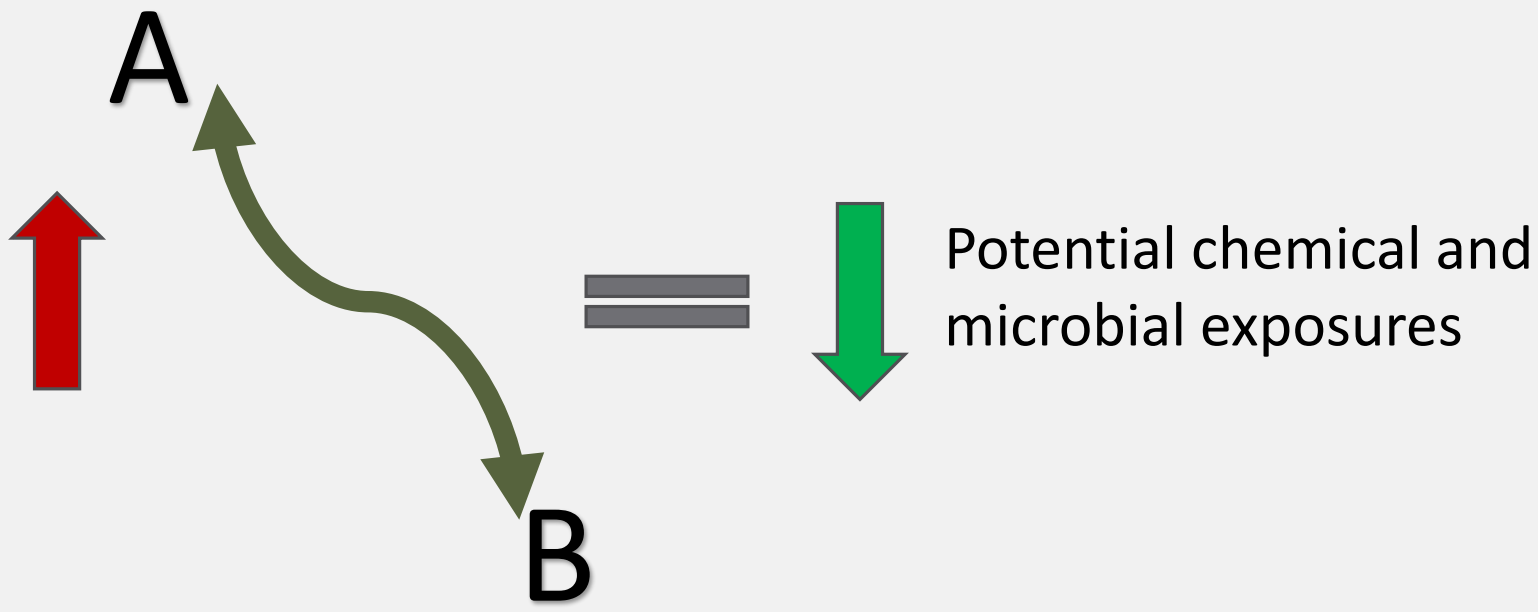
Home-Grown Foods

Potential chemical and microbial exposures

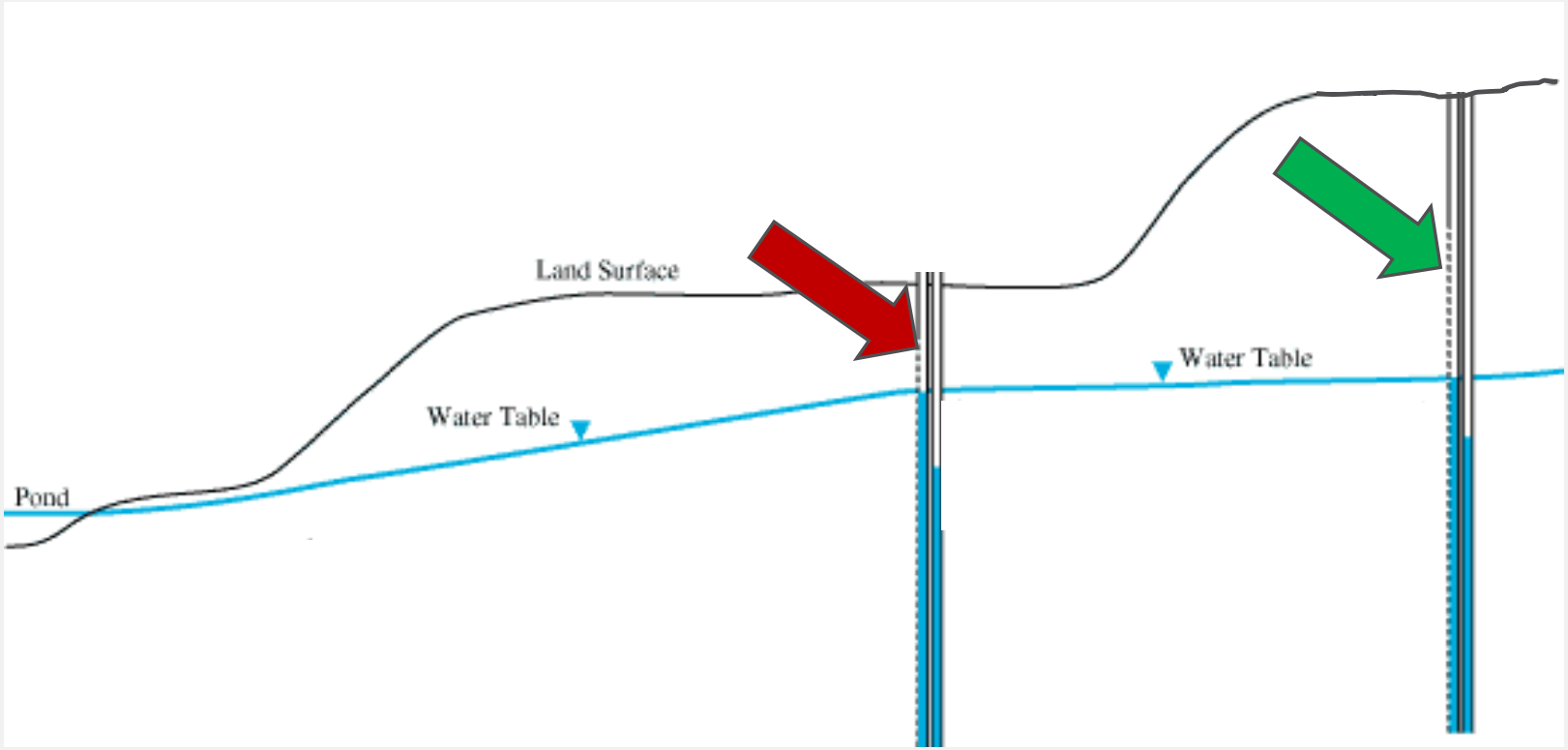
Groundwater Hydrology



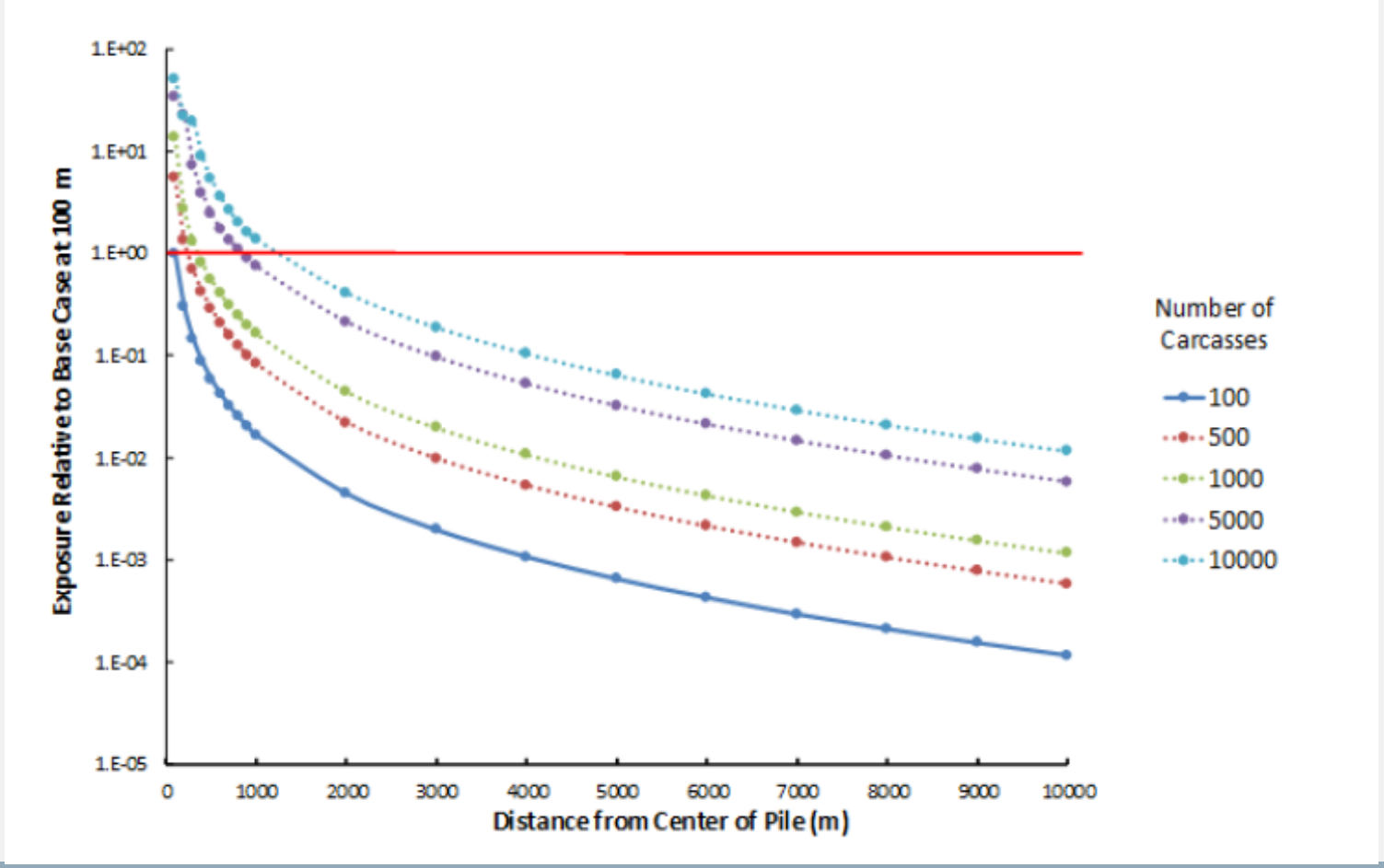
Distance from Source



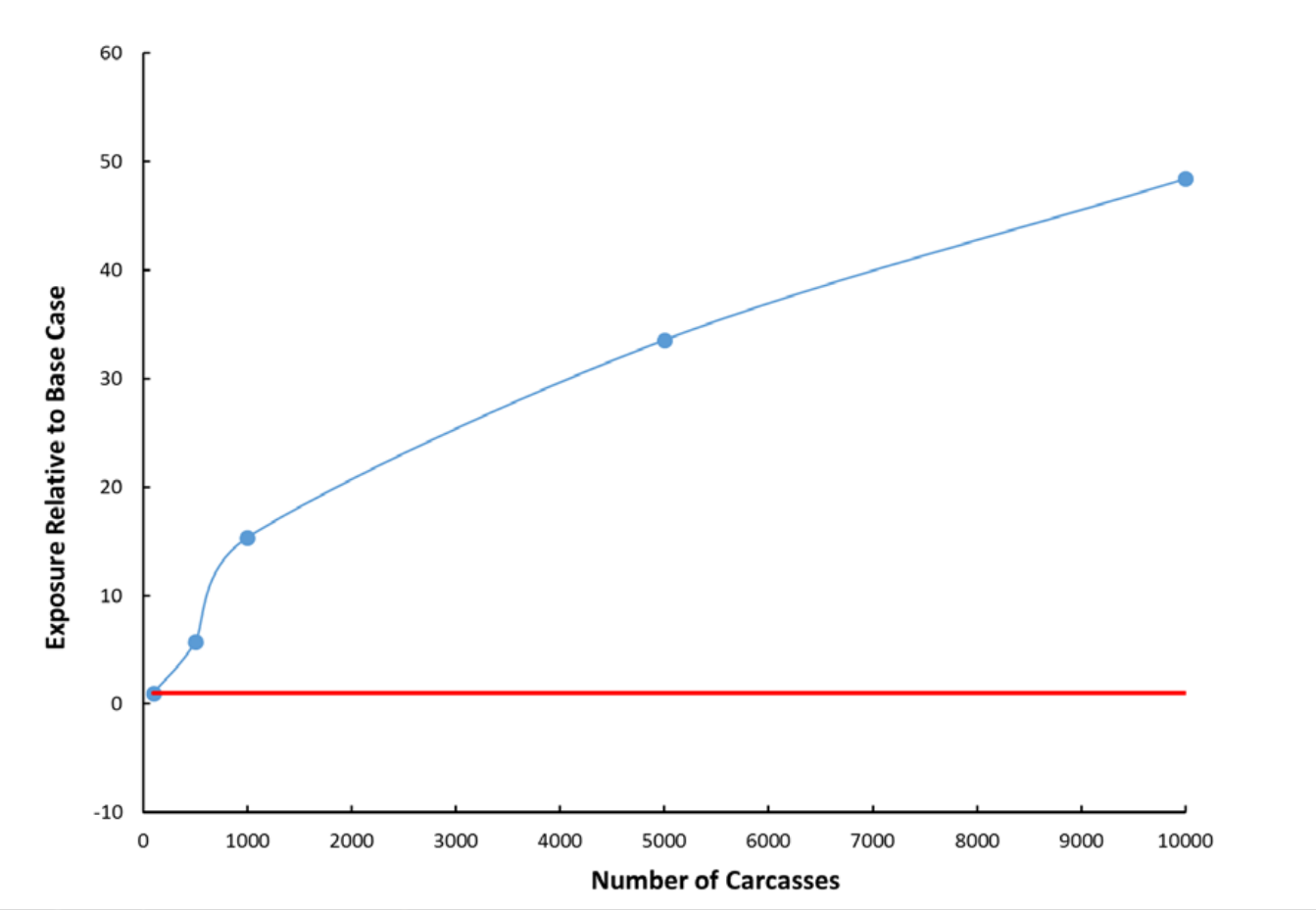
Depth to Groundwater



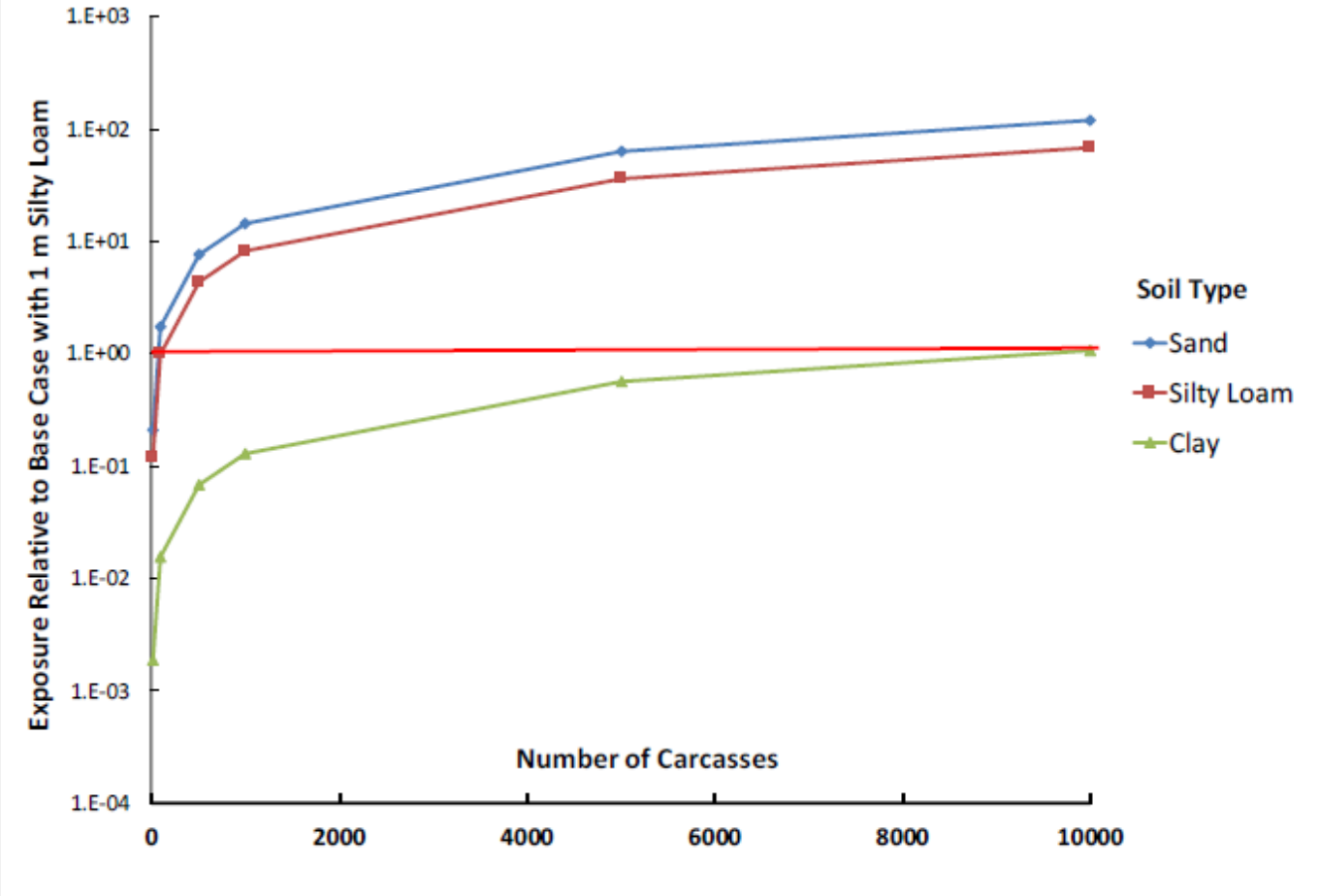
Uncertainty analysis for the number of carcasses, inhalation exposure for dairy cattle relative to the base case, with distance from the storage pile.



Uncertainty analysis for number of carcasses, ingestion exposure for dairy cattle relative to the base case at 100 m from the storage pile.



Uncertainty analysis for the number of carcasses, water ingestion exposure for dairy cattle by soil depth, relative to exposure with 100 carcasses and silty loam.



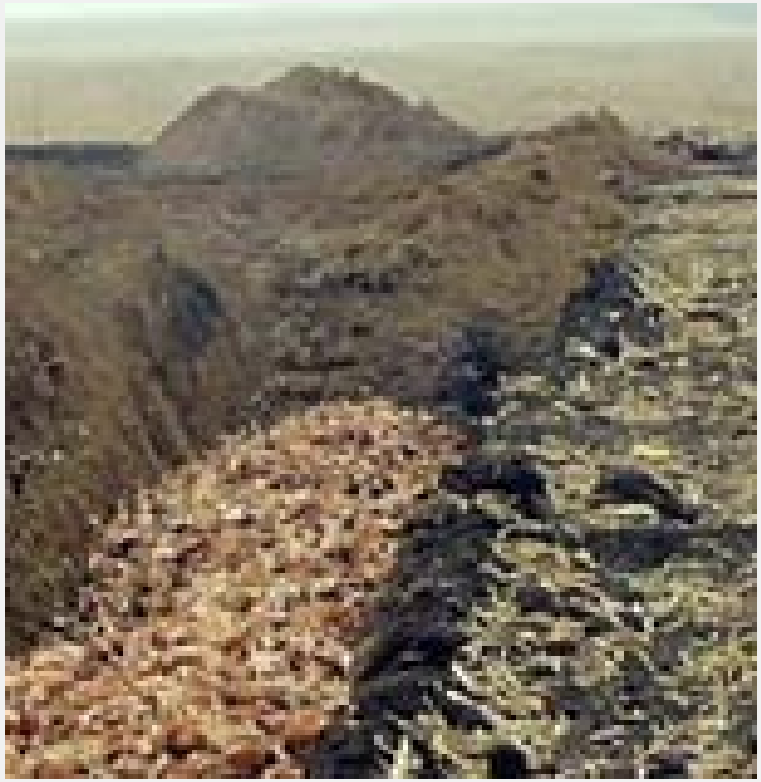
Mitigations

On-Site Combustion Mitigations

- Install units downwind or at least 1,000 m upwind from homes, businesses, farm buildings, crops, pastures, and surface waters
- Monitor burn piles to maintain even heating over time, and ample ratio of fuel to carcasses.
- Landfill ash or bury/encapsulate with clean soil.
- Isolate ash from root zone of plants.
- Wet the ash prior to burial, and minimize handling and processing.
- Do not use the ash as a surface soil amendment.

On-Site Burial Mitigations

- Place burial sites down-gradient of groundwater wells or surface water bodies;
- Comply with required setback distances and other site restrictions.
- Comply with minimum requirements for depth above the water table.
- Properly lime the carcasses if required by the jurisdiction.
- If feasible, include a liner of compacted clay in the bottom of the burial trench.
- Install ventilation shafts to release gas pressure and protect cover soil.
- Restrict access or minimize activity at the site to protect cover soil.
- Monitor and maintain cover soil over time



On-Site Composting Mitigations

- Maintain required temperature and time standards
- Use required quantity and quality of carbonaceous material
- Use required depth of cover and base material
- Test soil under windrow for chemical levels before growing food or allowing grazing.
- Leave required buffer distance between windrow and surface and ground water
- When land applying finished compost, prevent runoff to surface water; revegetate immediately

Off-Site Management Mitigations

- Maintain strict biosecurity at off-site facilities
- If rendering, ensure meat and bone meal is not used for animal feed if prions may be present

Carcass Handling Mitigations

- Do not handle carcasses with bare hands, especially if there are visible signs of bloating/leakage
- Use appropriate personal protective equipment based on a comprehensive job hazard analysis conducted by a qualified safety professional

Temporary Carcass Storage Mitigations

- Locate storage pile on impervious surface or liner
- Contain leakage and run-off
- Cover storage pile
- If storage indoors, provide adequate ventilation

Carcass Transport Mitigations

- Use leak-resistant vehicles and liners with absorbent material
- Cover load with secure tarp
- Load vehicles less than 60% full by volume
- Transport loads immediately

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