

Considerations of Biointrusion

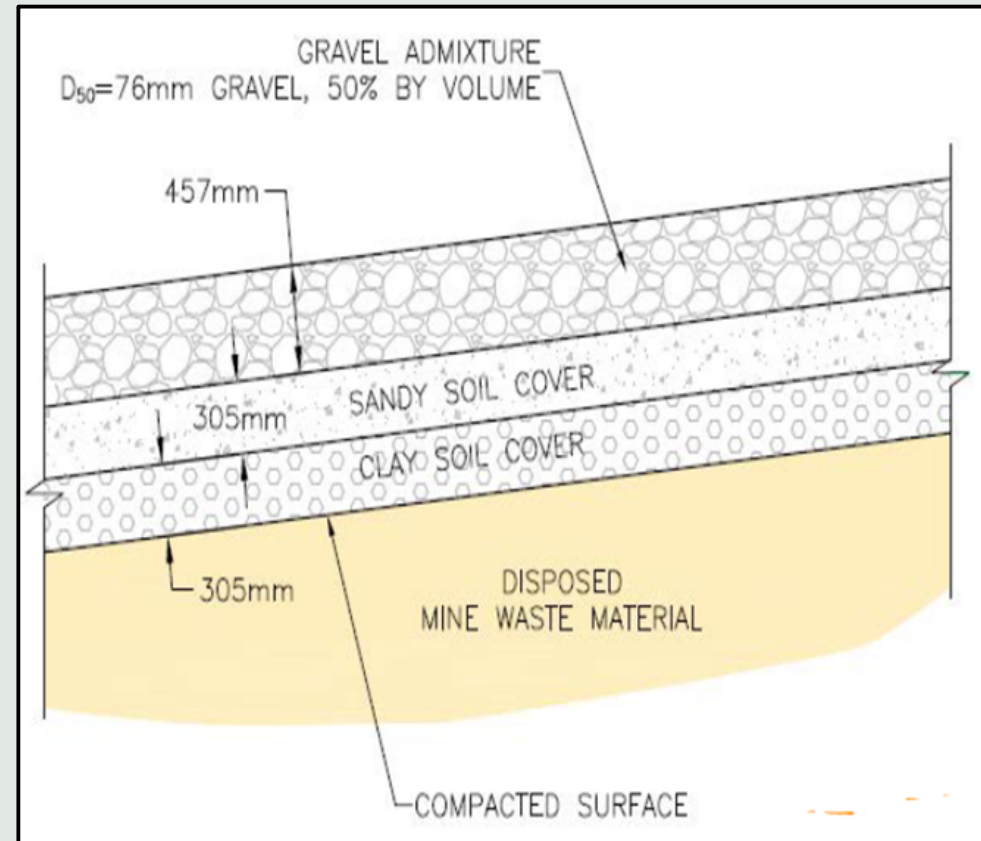
*small mammal and insect implications on
isolated waste cover systems*

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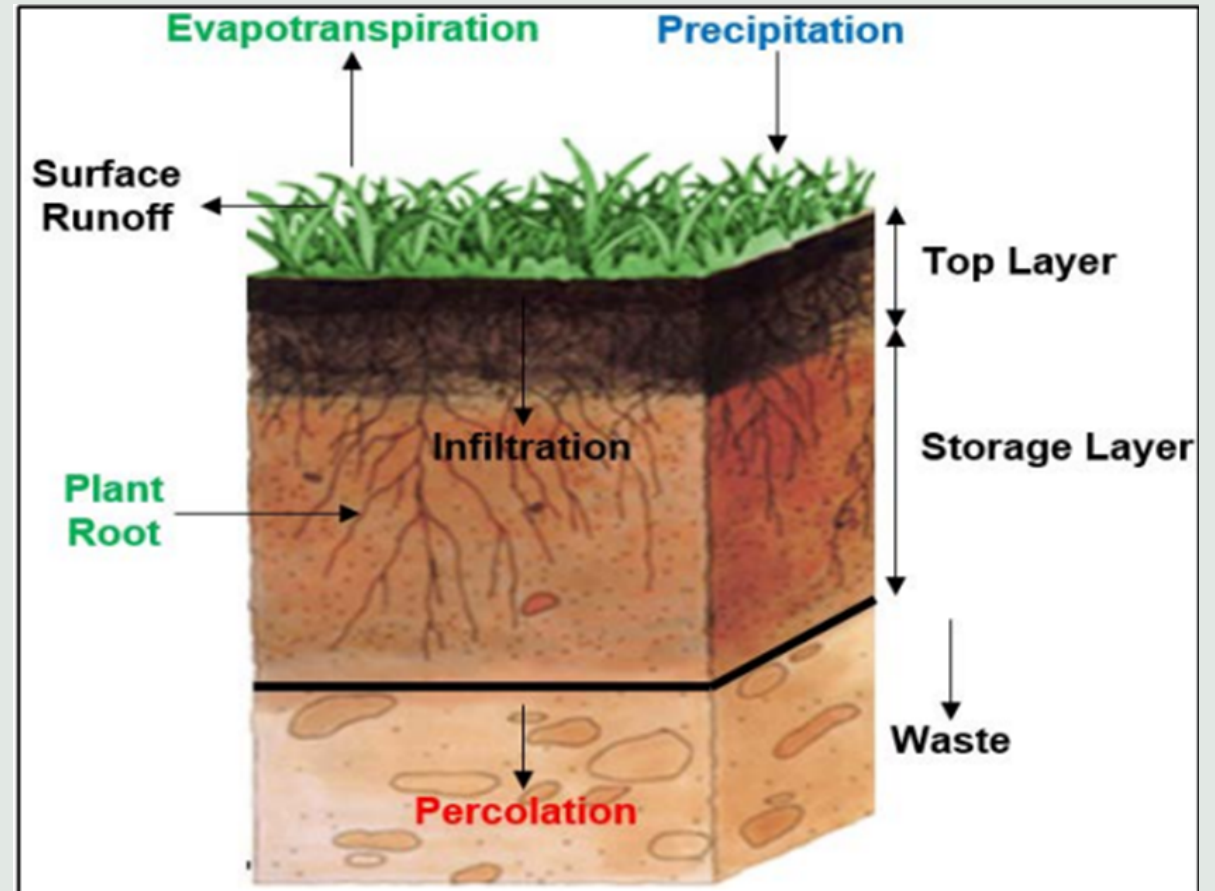
Isolated waste cover systems

- **Overall goal: isolate waste that could cause environmental harm**



Evapotranspiration (ET) cover systems

- ET covers support vegetation communities on top surface - with the goal of preventing percolation
- Used for waste isolation at mines, landfills, remediation sites
- Shown to be successful in arid environments, potentially lower cost, aesthetics

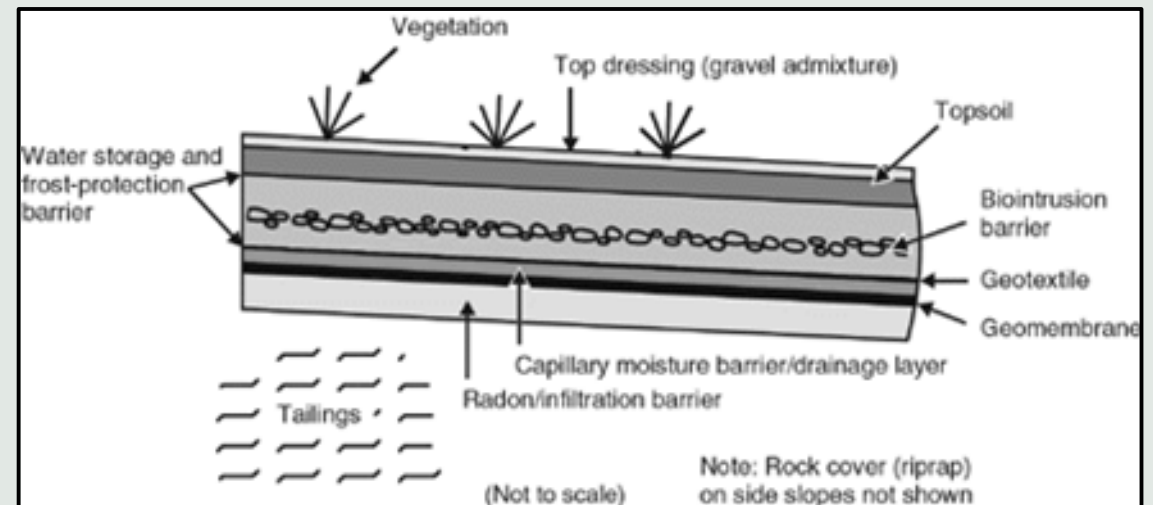


Why we care

- Agencies have increasing interest in all details of ET covers, as they are somewhat new technology
 - Creation of a sustainable ecosystem
 - Accurate quantification of transpiration
 - Efficacy in variable climatic conditions over 1,000 years
 - **How biointrusion could affect performance and success**

Biointrusion affects cover performance

- The creation of macropores by rooting vegetation and animal burrows significantly affect hydraulic properties of covers within a few years of implementation (3 yr ant study, 8x faster percolation)
- **Biointrusion creates preferential pathways in which water can flow**
- Affects soil structure and permeability, encourages erosion
- Certain species burrow deep enough to contact waste, which could be introduced into the environment through castings or ingestion - radon flux
- Burrowing activity can be quite high in and around reclaimed cover systems



What biointrusion data is important

Plants

- Rooting depths
- Root diameter
- Vegetation community dynamics



Animals/Insects

- Species
- Burrow/tunnel depths and widths
- Frequency



Biologist collects the data

- Establish list of potential species (state or federal agencies, USFWS IPaC queries, USGS data, etc.)
- Literature research burrow/tunnel habits - rearrangement, chambers/food caches, expansion by other species
- Baseline studies - Cedar Creek conducted burrow frequency transects through analog sites
 - characterized habitats that represent predicted plant succession on the ET cover

Species	Burrow Depth	Burrow Width
Harvester Ants	6 feet	<1 inch
Termites	30 feet	<1 inch
Pocket Gophers	4-6, up to 18 inches	3 inches
Kangaroo Rats	up to 48 inches	3 inches
Prairie Dogs	6-10 feet	5.5-6 inches
Badger	4-10 feet	10-12 inches
Coyote	-	12-24 inches



Actual level of bioinvasion expected

- How does the design of the cover encourage or discourage bioinvasion?
 - Ex: amount of topsoil, clay membrane, geomorphology
 - Ex: rock-armored sides of cover may be difficult/not worth traversing in search of a small area to inhabit
 - Ex: lack of food preferences or deep-rooting vegetation (termites)
- Reducing the potential for prey establishment, reduces the risk of predator presence and the tendency to enlarge burrows



Further considerations

- Ants have particle preferences, moving particles from B and C horizons vertically and can move approximately 330 pounds of material to the surface over course of a year - mounds can be concentrated with radioactive material
- Prairie dogs can excavate an average of between 7 and 10 tons of excavated material per acre

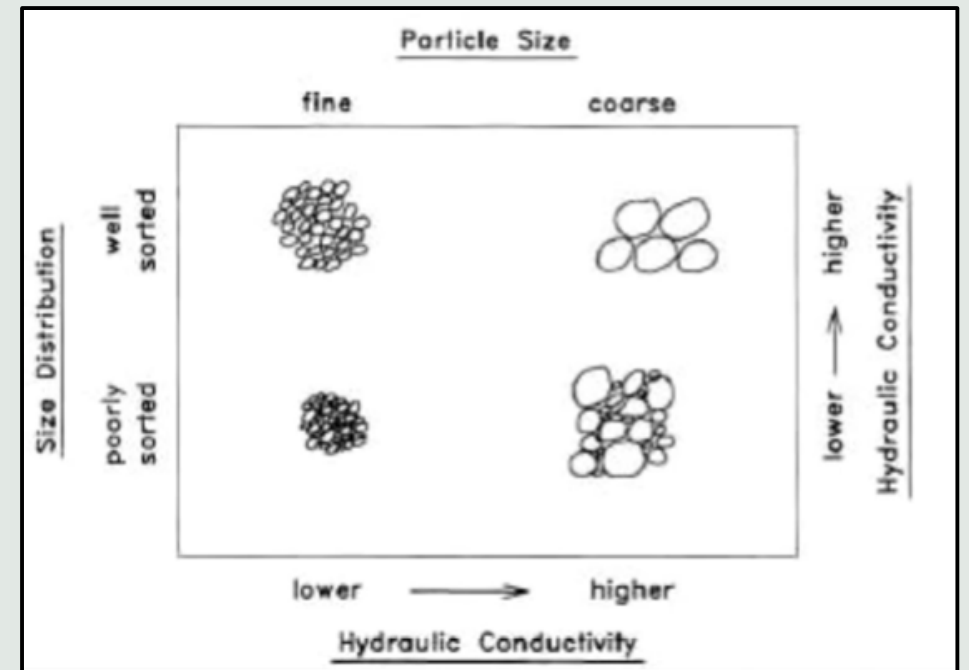


Work with modelers

- Indirect modeling of vegetation and animal biointrusion - constraints
- Estimate percolation rates based on expected biointrusion level
- Current models that attempt to describe vegetation biointrusion have shown that field evapotranspiration (ET) rates are lower, hydrologic conductivity (Ks) increased, and water infiltration increased significantly with frequent rainfall at high intensity in areas of increased biointrusion - impact percolation rate
- Need more research to inform potential modeling parameters
- High variability with animal biointrusion

Cover design protection measures

- You've evaluated the risks, now consider cover design features to lower risks
- Plenty of topsoil
- Biobarrier
- Rock admixture – particle sizes and amounts?
 - Prairie dogs were able to penetrate 1 to 1½ in. of crushed stone, while smaller mammals were unable to do so – some species use their teeth
- Finer grain soils have higher storage capacity, but greater risk for biointrusion



Standards evolve

- Evaluate all potential risks early as **standards and design measures will continue to evolve**
 - Vegetation biointrusion is considered, now it may be required to consider animal biointrusion
- Research needs to continue as standards increase
- Biointrusion is likely - burrowing animals and insects are everywhere, long-term
- Cost of failure is high - risk to the environment, wildlife and human health



Thank you!

Questions?

