Engineered Barriers for Low-Level and Mixed Waste Containment

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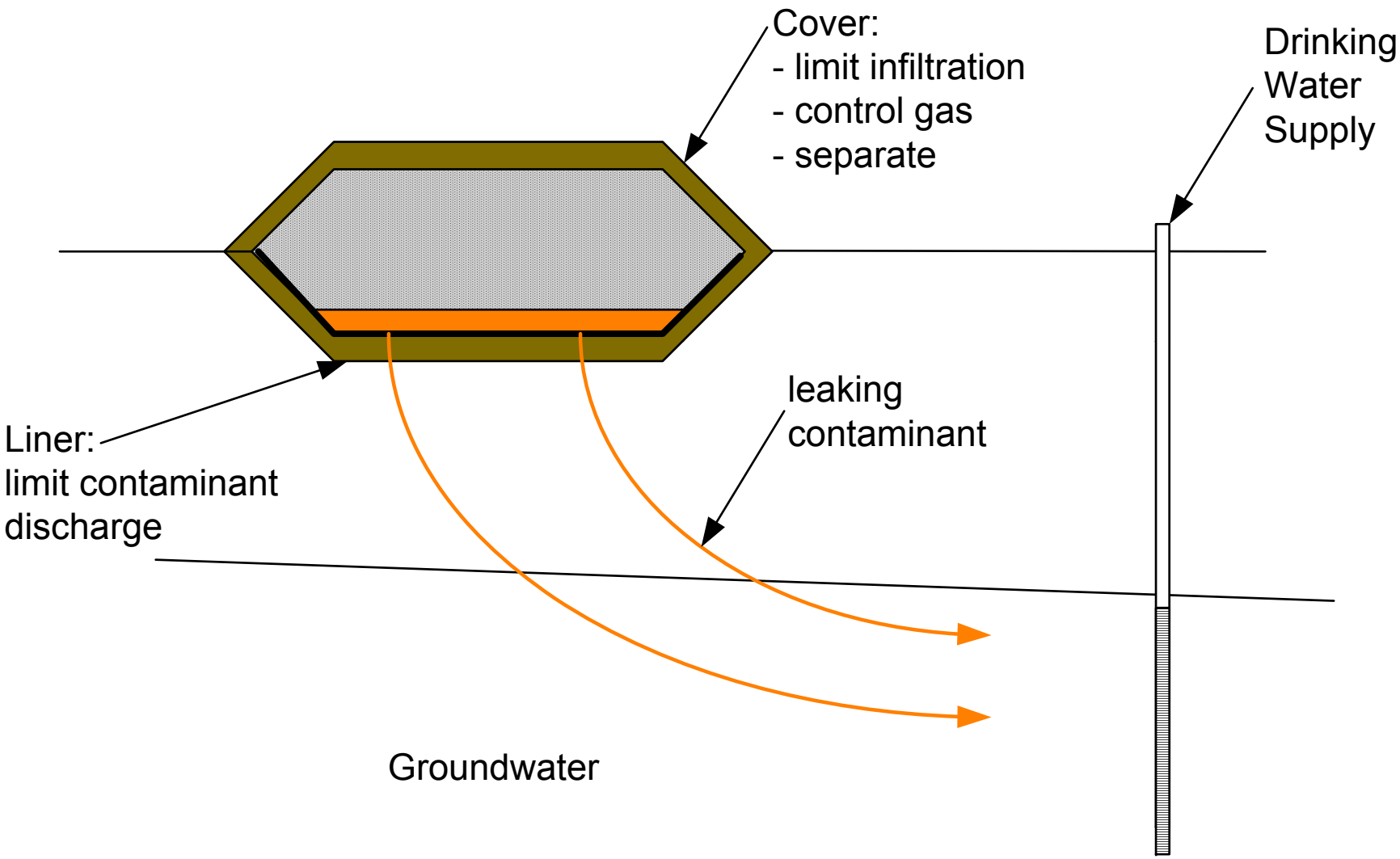
Modern Containment Systems



Conventional Containment System

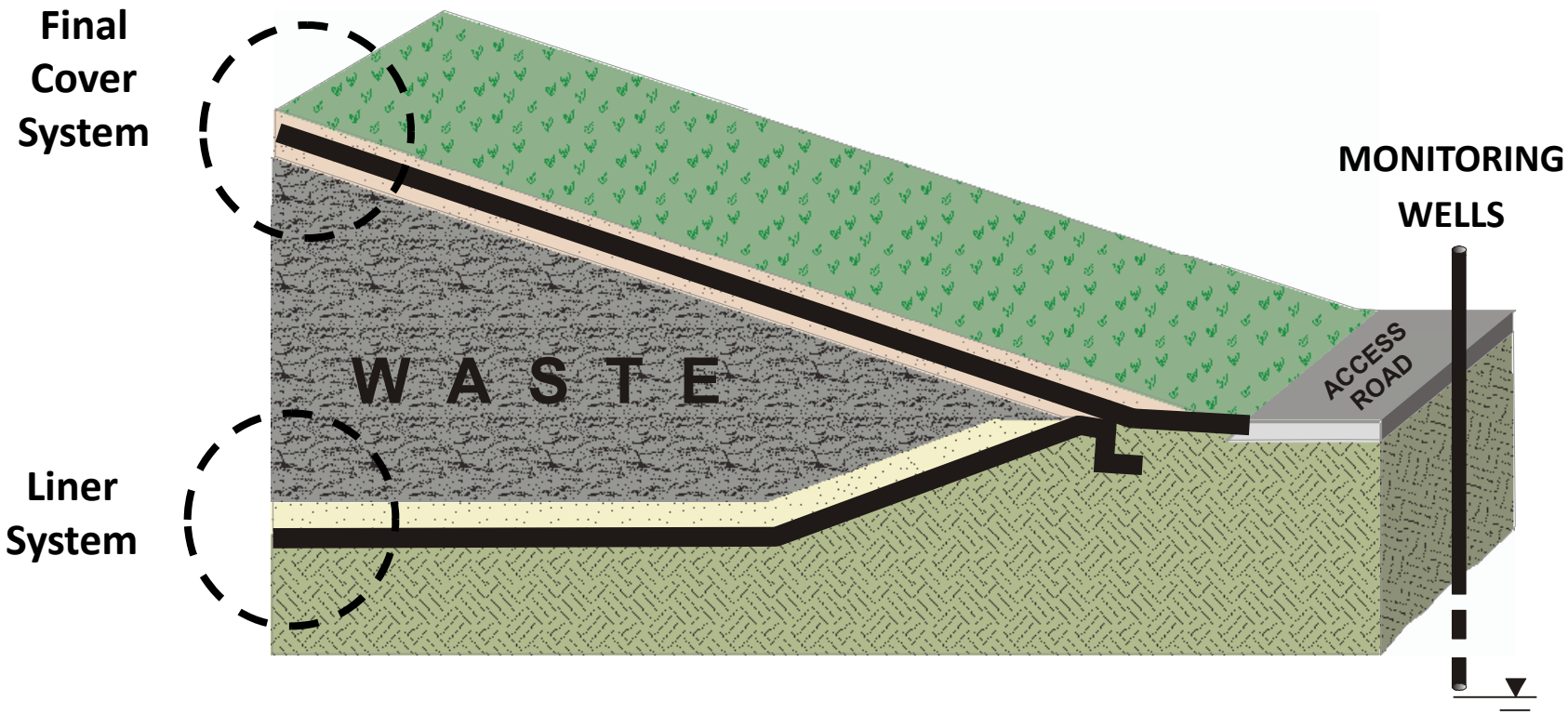


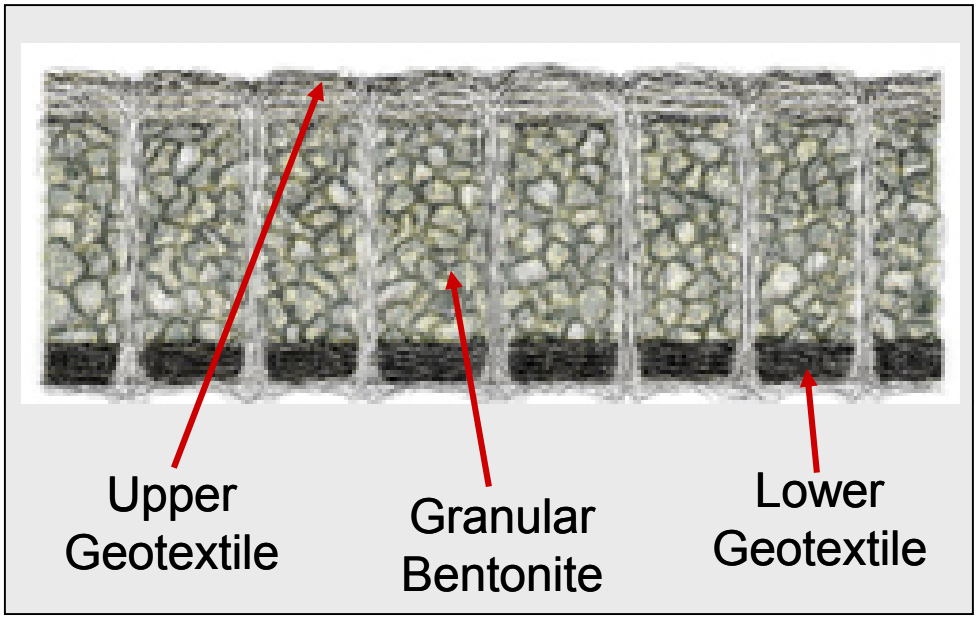
Figure courtesy M. Othman, Geosyntec Consultants

Barrier Materials

- Clay barriers

Barrier Materials

- Geosynthetic Clay Liners



Barrier Materials

- Geomembranes

- Common polymers include high and linear low density polyethylenes (HDPE, LLDPE), polypropylene (PP), and polyvinyl chloride (PVC)
- Virtually impermeable to water, but transmit organic compounds like VOCs via diffusion.
- Some defects present that transmit water and inorganic constituents.

Geomembrane Installation

Geomembrane Seaming

Extrusion Welding

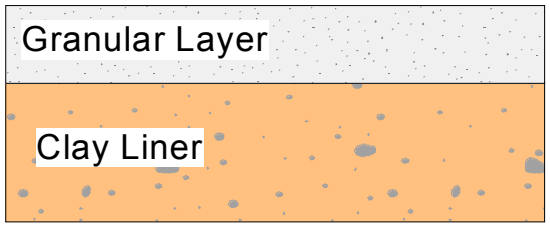
Dual-Track Wedge Welding

Geomembrane Seam Testing

Vacuum Testing of Extrusion-Welded Seams

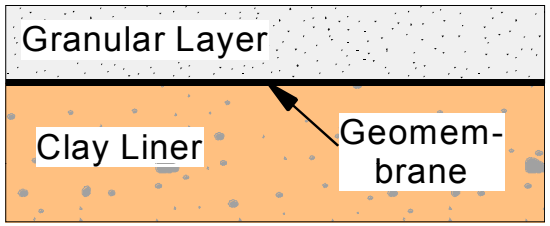
Non-Destructive Air-Pressure Testing of Wedge Welds

Single Liners vs. Composite Barrier Layers



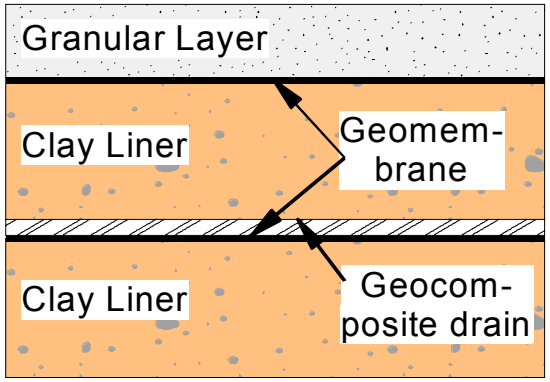
(a) Single Clay Liner

Compacted clay liner ($K < 10^{-7}$ cm/s), geosynthetic clay liner, geomembrane



(b) Composite Liner

Composite Liner - Very effective groundwater protection due to synergistic combination of clay and geomembrane



(b) Double Composite Liner with Leak Detection

Multiple composite liner – Very effective and redundant system

Drainage Materials

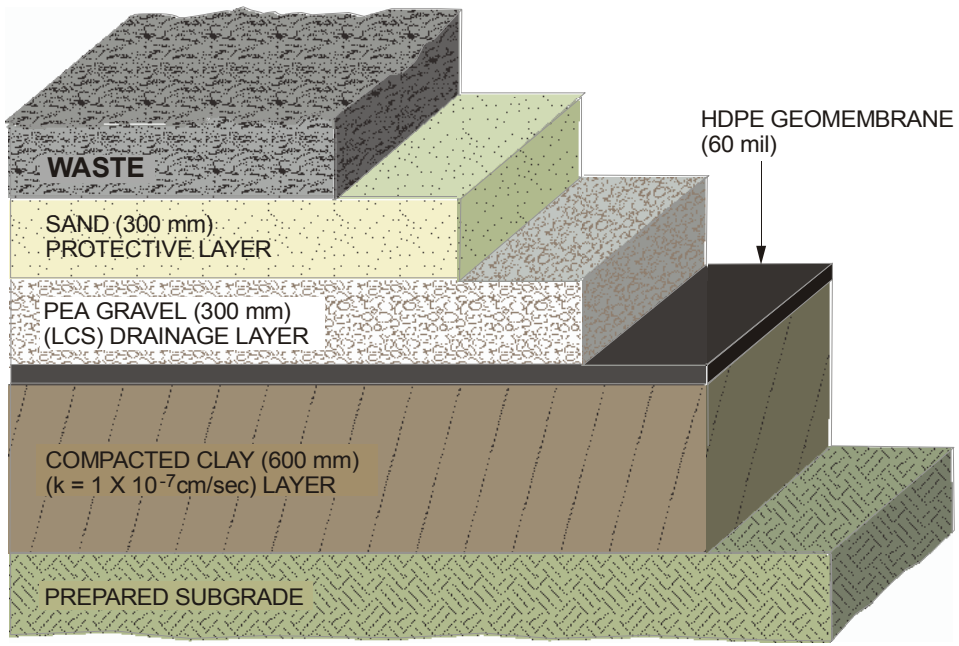
Natural materials: gravel

Geocomposite drainage layer

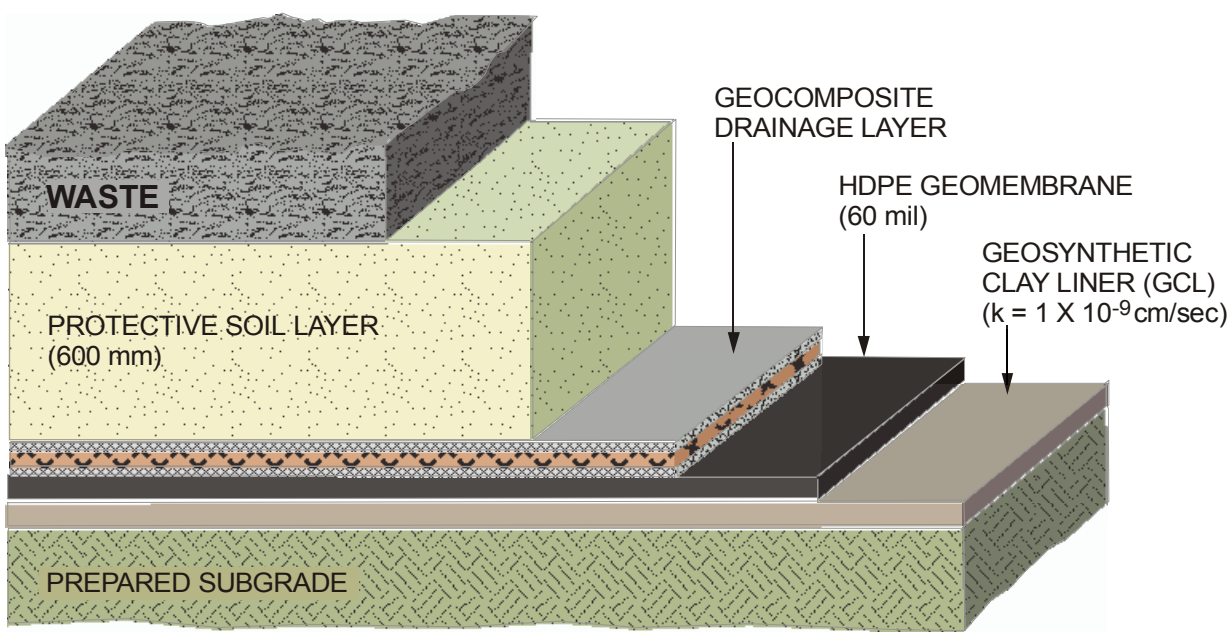
Placing Gravel Above Geocomposite Drainage Layer

Sump in Leachate Collection System

RCRA Subtitle D Liner (Non-Hazardous)



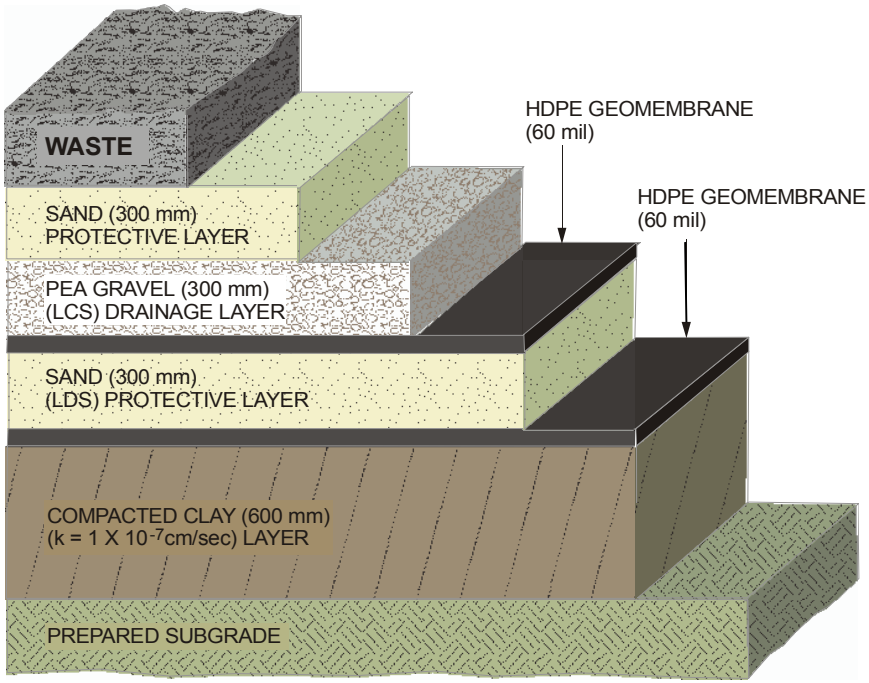
Conventional Liner System



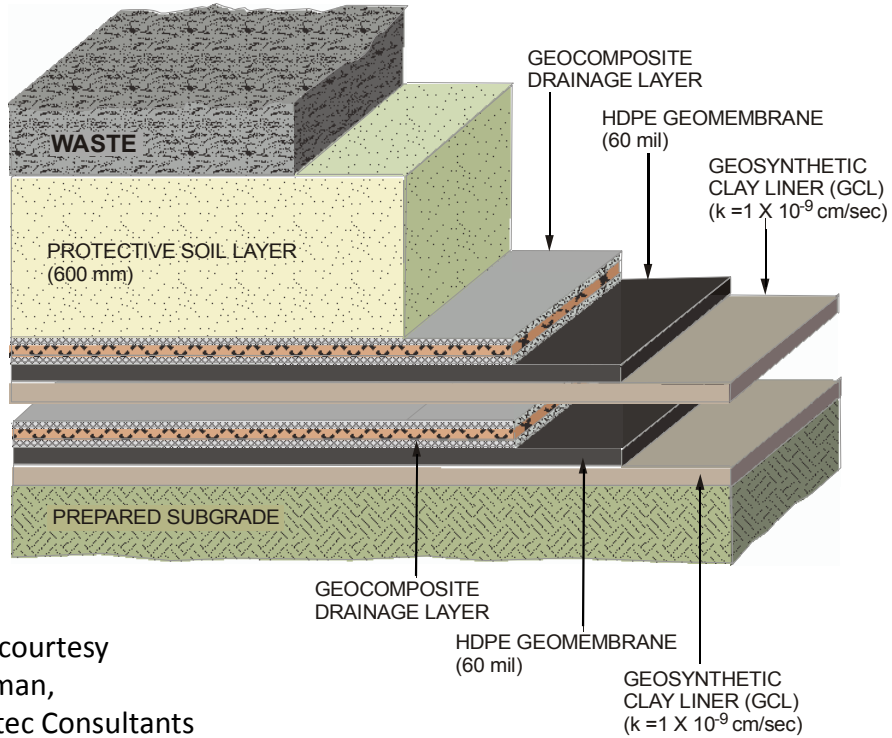
Alternative Geosynthetic Liner System

Figures courtesy M. Othman, Geosyntec Consultants

RCRA Subtitle C Liner (Hazardous)



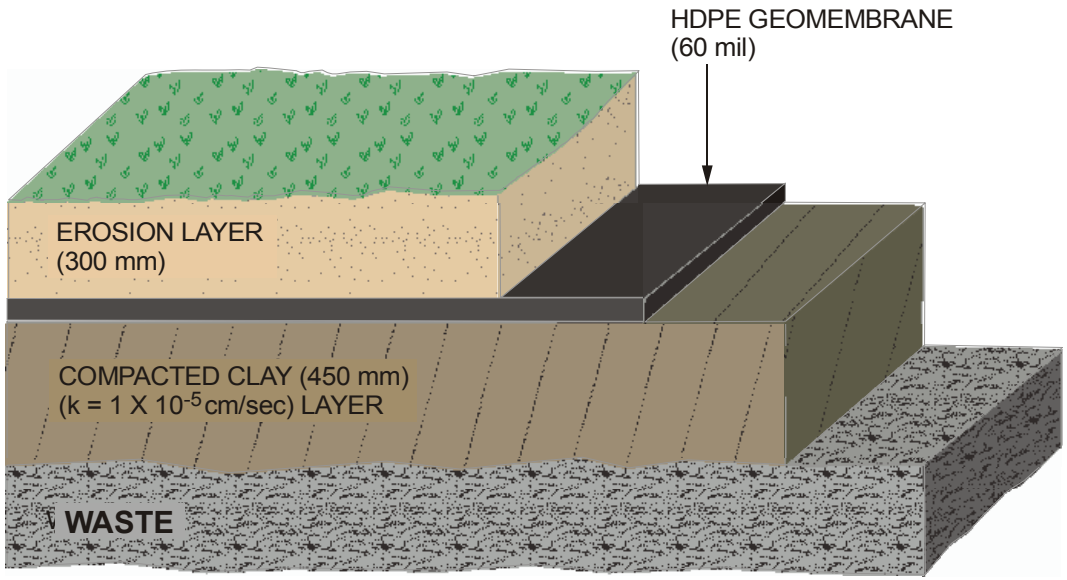
Conventional Liner System



Alternative Geosynthetic Liner System

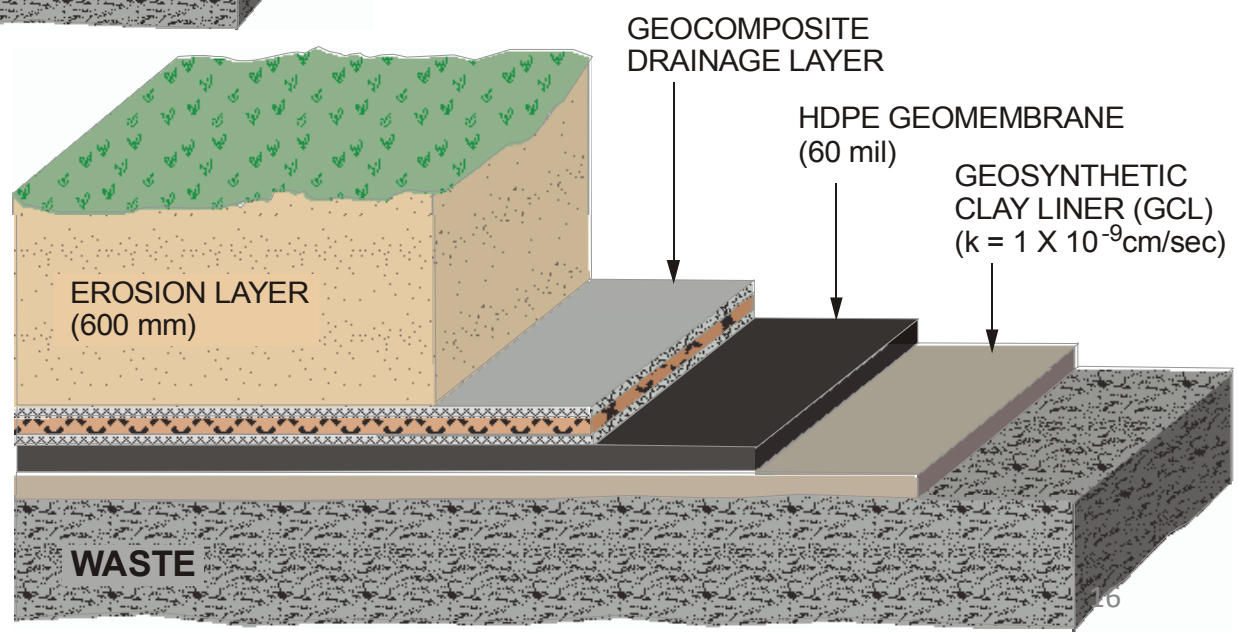
Figures courtesy
M. Othman,
Geosyntec Consultants

Conventional Final Covers



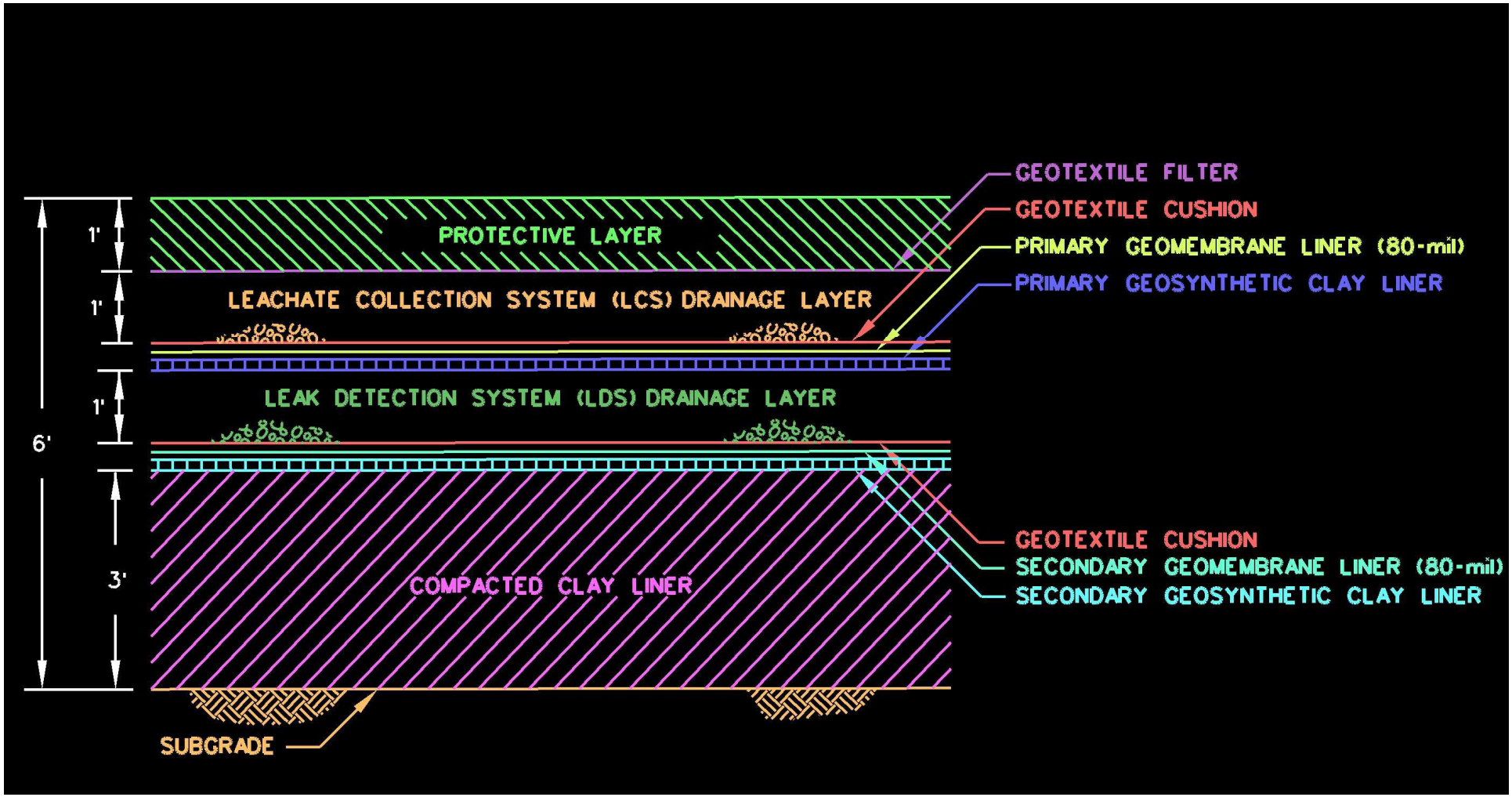
Conventional Cover System

Conventional Cover with Geosynthetics

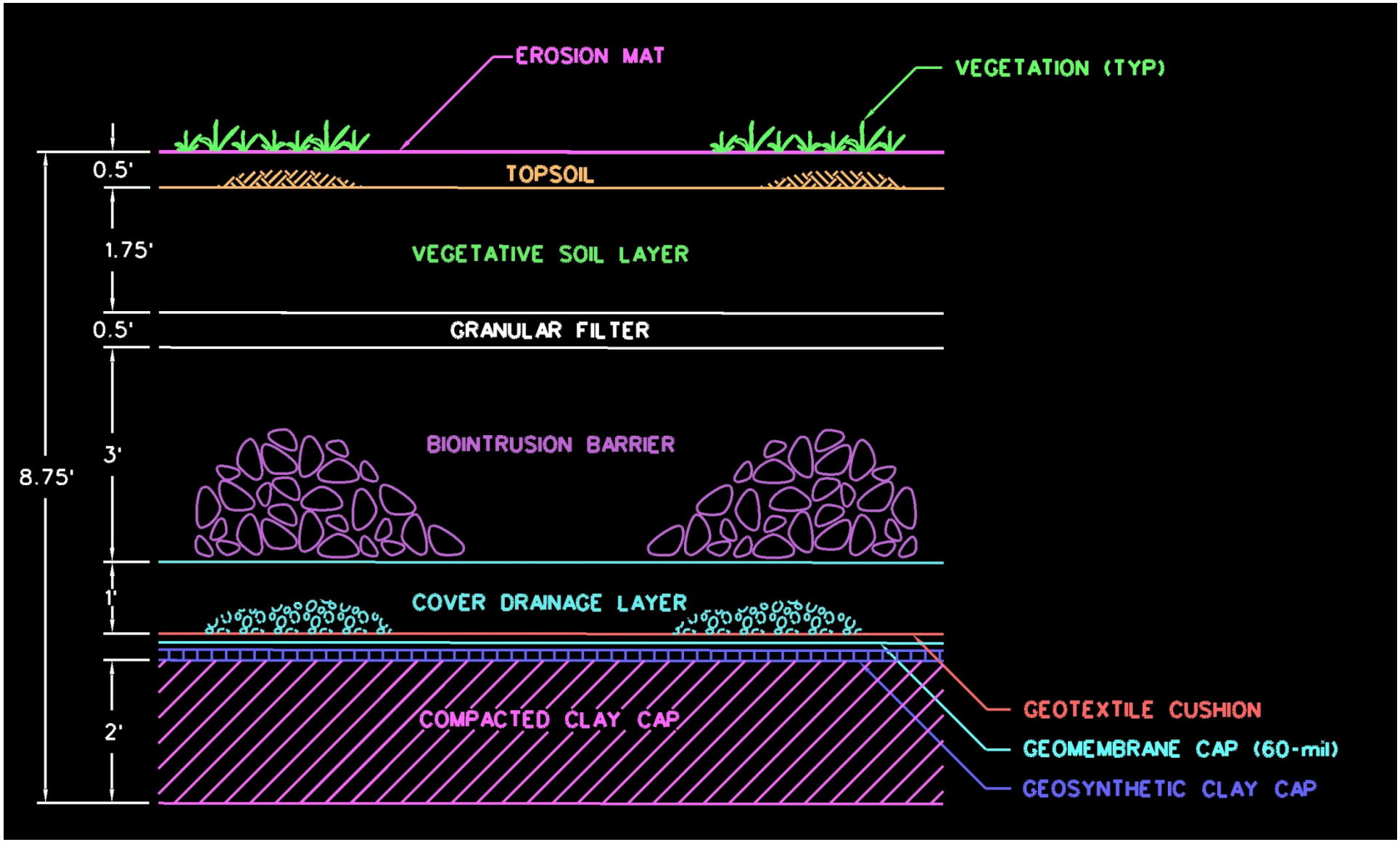


Figures courtesy M. Othman, Geosyntec Consultants

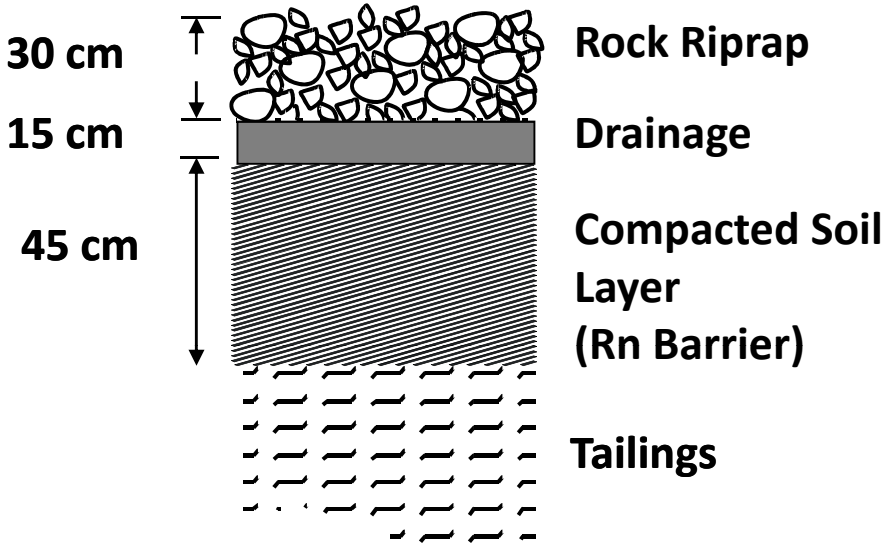
Double Composite LIner: Fernald On-Site Disposal Facility for Mixed Waste



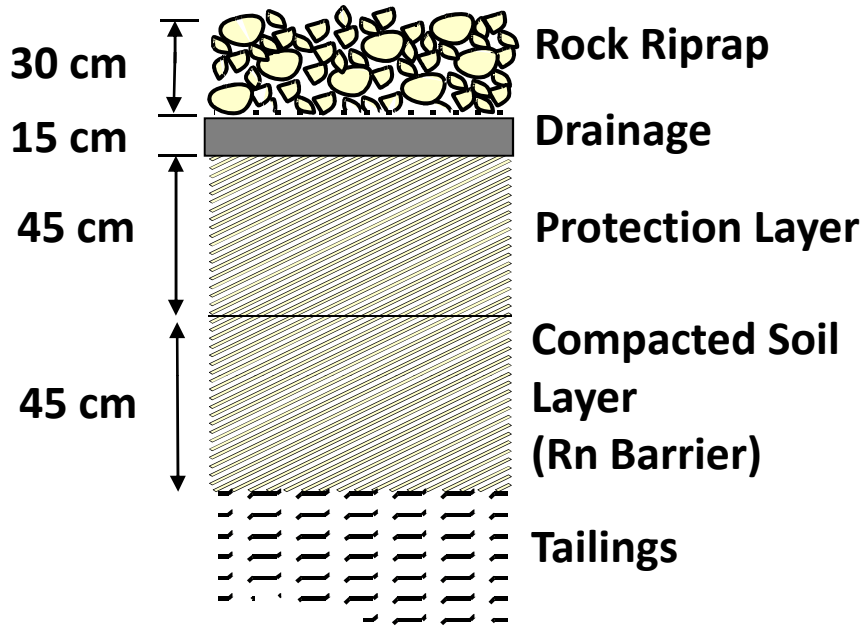
Conventional Cover: Fernald On-Site Disposal Facility for Mixed Waste



UMTRA Earthen Covers



Lakeview, OR

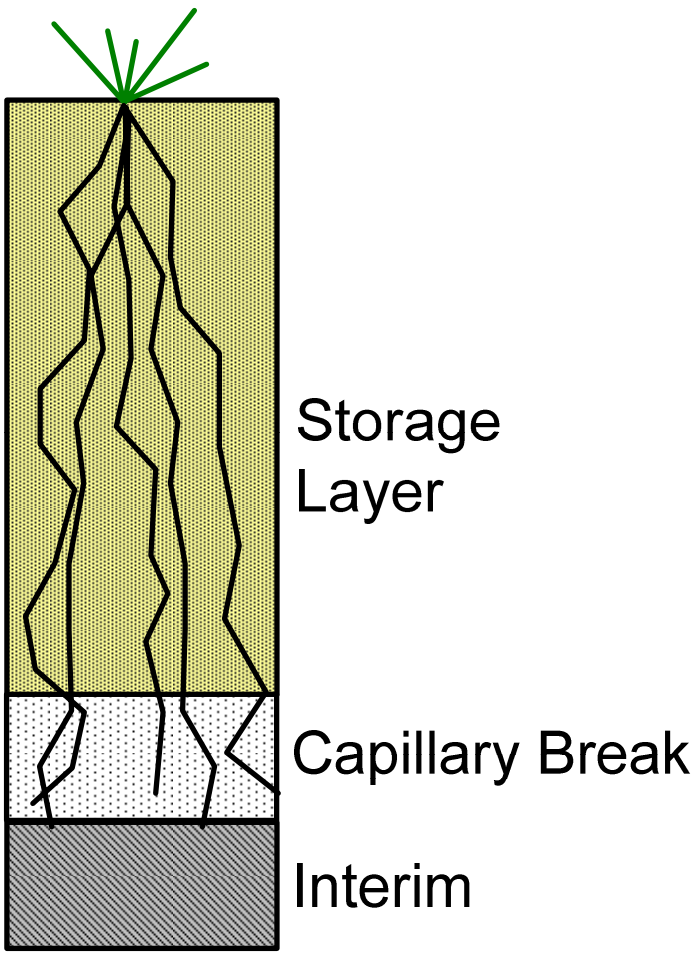


Grand Junction, CO

Conceptual model: rip-rap layer prevents erosion; clay layer restricts percolation and limits radon egress.

Schematics courtesy of W. J. Waugh, Stoller Corp.

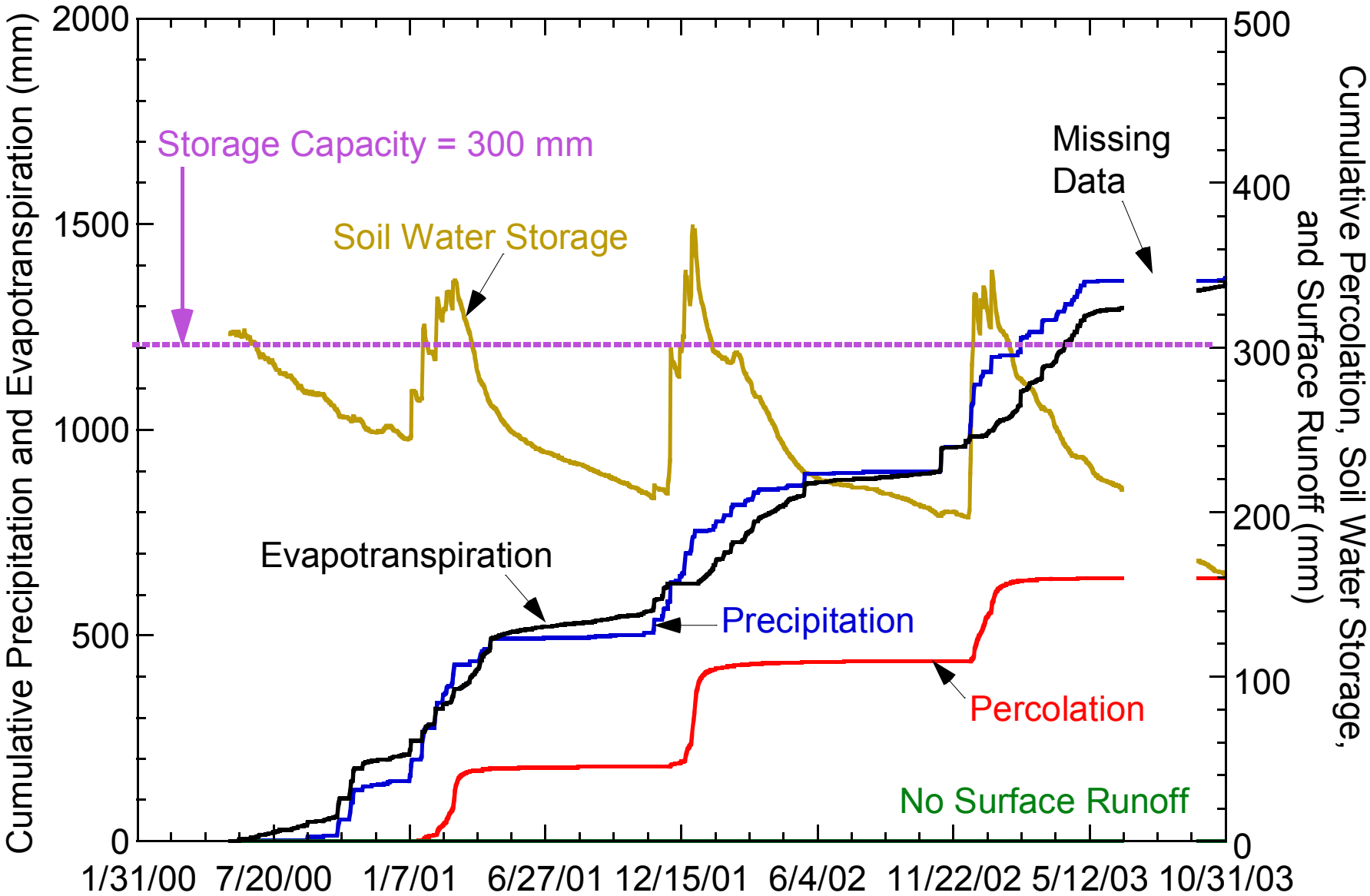
Water Balance Covers



- Rely on natural principles of water storage in unsaturated fine-textured soil and water removal via evaporation and transpiration (balance storage and removal)

- Also referred to as evapotranspirative covers, store-and-release covers, alternative covers.

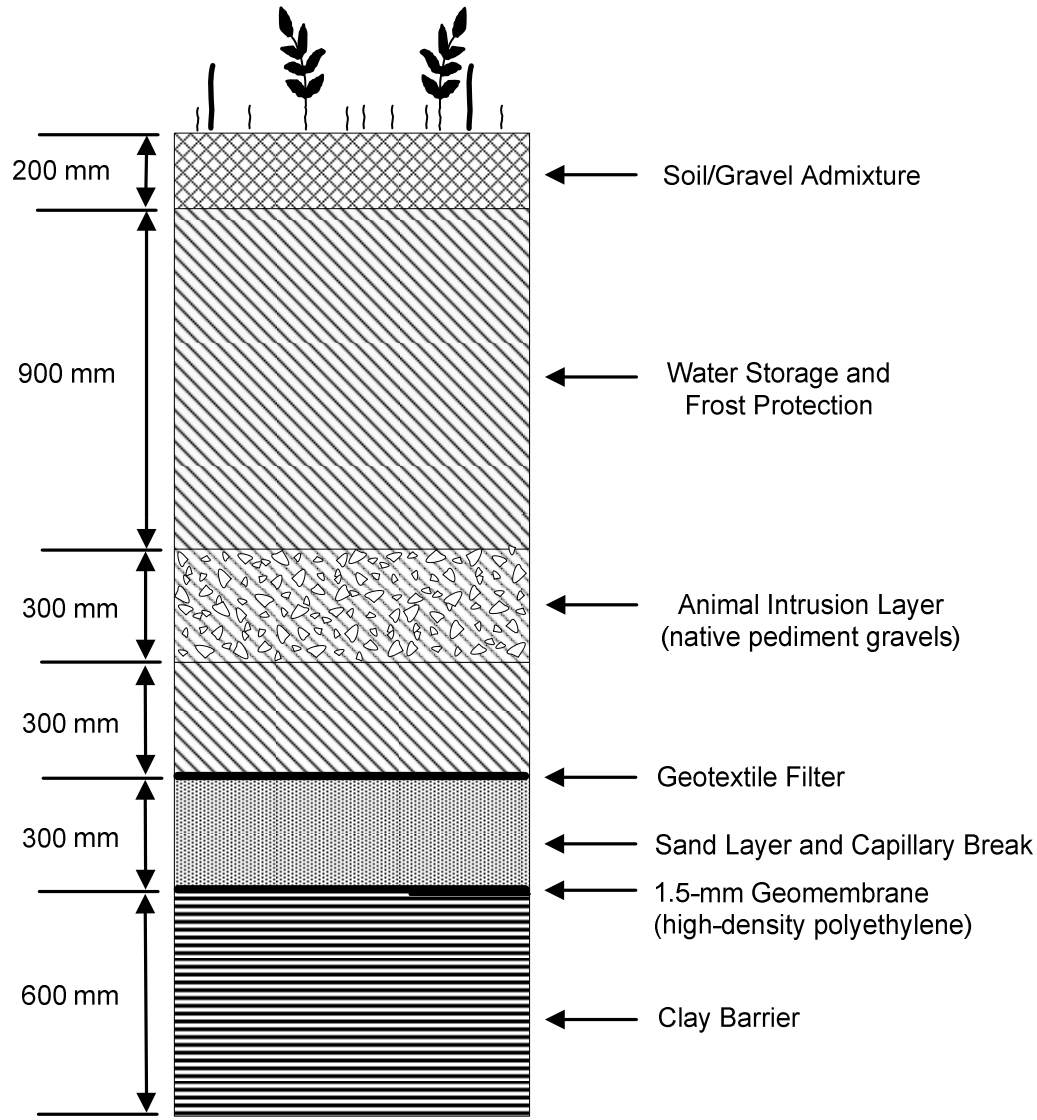
Water Balance of Capillary Barrier: Marina, CA



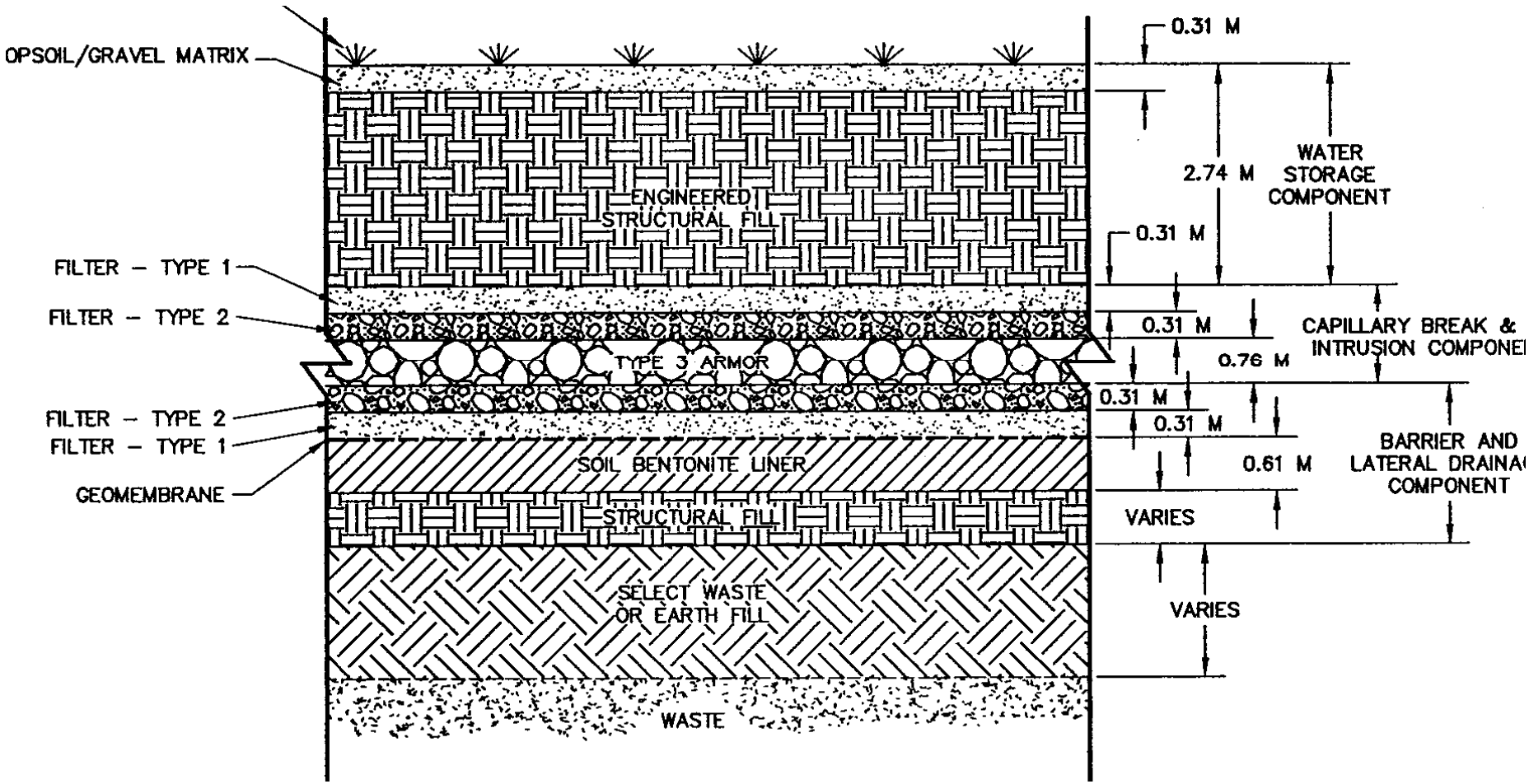
Percolation occurs every year when storage capacity is exceeded.

Hybrid Cover at Monticello Mill Tailings Site

- Water balance cover at surface
- Conventional cover with composite barrier at depth
- Gravel amended surface layer for long-term erosion control
- Biota intrusion layer



Hybrid Cover for Idaho CERCLA Disposal Facility (ICDF)



Conceptual design – not yet constructed

Questions to Ponder - 1

- Will systems continue to function as intended without maintenance for centuries or millennia?
- What is the lifespan of each material? Each element? Each system?
- How do the hydraulic and mechanical properties of barrier systems evolve over time?
- How will climate change affect the performance of these systems? Will the mechanisms change?

Questions to Ponder - 2

- Can we predict radionuclide transport in barrier systems over centuries or millennia?
- Can we predict hydrological performance over centuries or millennia?
- How will landform evolution affect integrity/performance over centuries or millennia?
- What type of monitoring systems are needed to confirm performance and ensure environmental protection?