

Landfilling – If You are Going to Do it, Do it Right

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Landfilling – Do it Right – Background

- Continuation of a paper presented at RemTech in 2009 discussing liabilities associated with landfills
- Landfills often become the final resting place for material from remediation projects
- Reliance is placed by the generator, the regulator and the public that landfills are secure disposal locations
- Facilities that are designed, constructed and operated well have been shown to provide the desired containment
- So if landfills are used for disposal, insist that they are done right

Landfilling – Do it Right – Background

- Industrial development creates waste that needs to be managed
 - Process waste
 - Spills
 - Historic practices

- A significant percentage of remediation projects involve landfill disposal
 - Conventional dig and dump
 - “Source” removal
 - Failed insitu / exsitu remediation projects
 - Salt or metals
 - Heavy end hydrocarbons
 - Radionuclides



Landfilling – Do it Right – Liability

- Liability is long term, possibly in perpetuity
- Waste generator is ultimately responsible
- Problems can take decades to surface
 - Low moisture holding capacity of waste
 - More and stronger leachate than expected
 - Poor contaminant retardation
 - Limited number of groundwater monitoring wells that miss contaminant plumes
- Facility audits can miss important design, construction and operation details

Landfilling – Do it Right – Key Components

- The key components to “Doing it Right for Landfills” include:
 - Siting
 - Design
 - Construction
 - Operation
 - Closure and post-closure

Landfilling – Do it Right – Regulatory Requirements

- Standards exist in most provinces that provide requirements for
 - Siting – in an area that is naturally suitable
 - Design – complete with containment structures, liners and leachate collection systems, compatible with wastes, slope stability
 - Operation – waste placement, slope stability
 - Monitoring – groundwater quality and gas generation and control;
 - Closure of landfills – final caps; and
 - Post-closure – long term monitoring

Landfilling – Do it Right – Siting

■ Siting

- Take the time to find the right place to build a landfill
 - In an area that is relatively flat with thick deposits (>10 m) of very low permeable soils (clayey materials) and not over an aquifer
 - In some places there is no choice and engineering is used to compensate for the site limitations
 - If there is a choice, a natural setting has been shown to perform better

- Not in low lying poorly drained area - swamp
- Not on the edge of river valley that might get eroded away and collapse
- Not over an active fault
- Not in coarse soils or fractured bedrock

Landfilling – Do it Right – Design

- Design – Liner system
 - Liner is intended to provide containment of wastes and leachate generated from the wastes

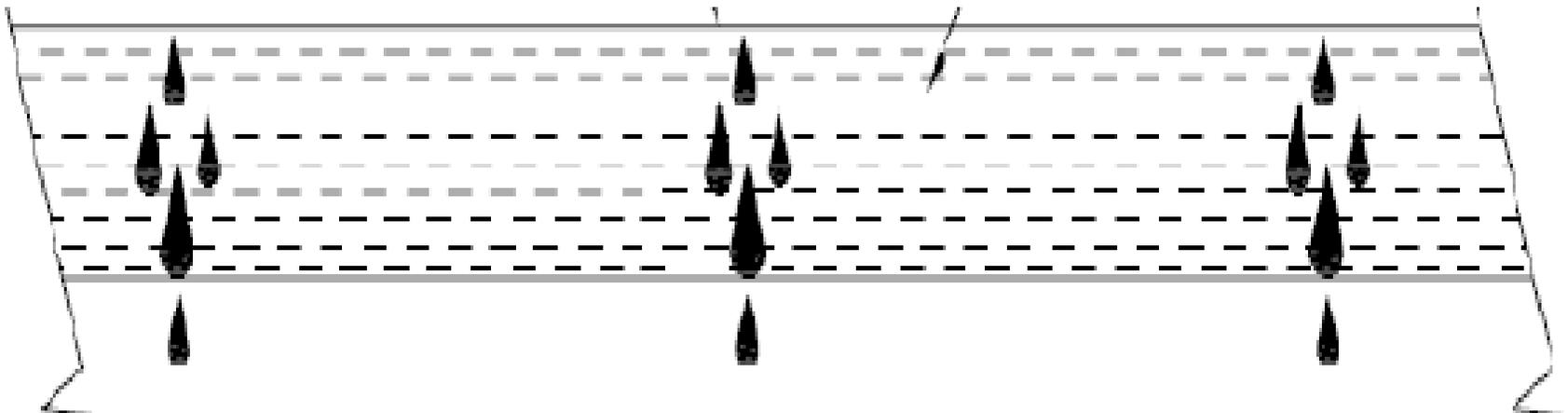
 - Liner Options range from: clay only, geomembrane only or a composite

 - Lining system has to be compatible with wastes
 - clay only liners are not suitable for sodium rich leachate
 - HDPE not suitable for high concentrations of surfactants or PHCs
 - GCL's not suitable for hydrocarbon and salts

 - Type of lining system should be designed to maximize containment – all liners leak but the goal is to design a system that reduces leakage

Landfilling – Do it Right – Design

- Liner Design – clay
 - Compacted clay liner (CCL) is constructed of suitable soils
 - clay has to meet criteria for textural properties
 - has to be installed in controlled conditions that include thin lifts, and with proper compaction and moisture conditioning to achieve desired permeability
 - possibility for leakage through the entire surface of the liner



Landfilling – Do it Right – Design

- Liner Design – geomembrane
 - Geomembranes are synthetic materials that demonstrate good compatibility against a wide range of chemicals
 - geomembrane should be resistant to the chemical(s) that will be contained
 - has to be installed in controlled conditions that include quality control and quality assurance systems
 - potential for significant leaks through holes

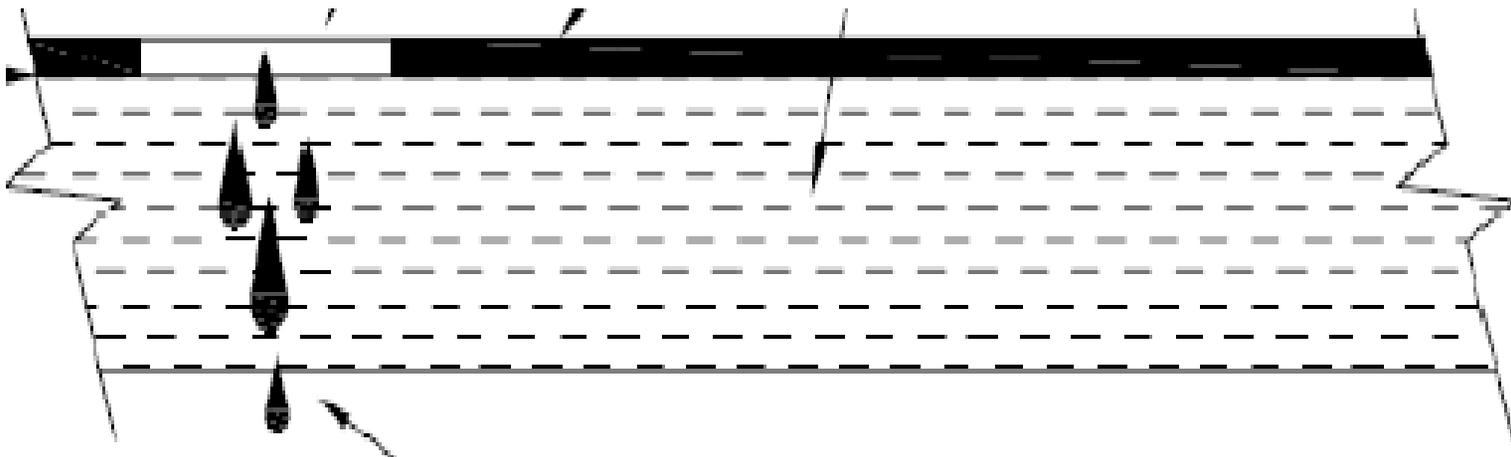


Landfilling – Do it Right – Design

- Liner Design - composites
 - Composite liners combine the benefits of both low permeability layers (clay or GCL) and geomembranes
 - not a double liner but one liner that consists of two components
 - get the benefits of geomembrane to chemical resistance and low flow through clay/GCL
 - each component has to be installed in controlled conditions that include quality control and quality assurance systems

Landfilling – Do it Right – Design

- Liner Design – composites



- Improve containment at incremental cost increase – composite is in the order of 1000 times more effective than clay only at a relatively moderate overall incremental cost

Landfilling – Do it Right – Design

- Liner Design – slope stability
 - The use of geosynthetics or groups of geosynthetics will improve containment but requires attention during design for aspects such as slope stability and this is best proven by doing interface friction testing with intended materials



Courtesy of R. Thiel

Landfilling – Do it Right – Design

- Use the right materials in the right places to avoid long term problems such as separation in joints of GCL



Courtesy of R. Thiel

Landfilling – Do it Right – Design

- Use material that are less susceptible to shrinkage such as non-woven scrim reinforcement and heat seal panels together



Landfilling – Do it Right - Design

- Leachate collection systems (LCS)
 - All liners leak so removing leachate from a landfill is critical
 - the greater the head of leachate the higher the leakage rate through the lining system
 - in Alberta, the maximum allowable head of leachate is 0.3 m above the liner
 - LCS consist of combinations of layers of free draining gravel, geosynthetics (geonets and geotextiles) and collection pipes
 - Leachate is directed to a low point/sump for removal
 - Use geotextiles carefully to avoid clogging of system – don't wrap collection pipes
 - Use filters made of soils – more cost but likely more effective

Landfilling – Do it Right – Design



- Covering with geotextile could lead to potential clogging

Landfilling – Do it Right – Design

- Leachate removal systems
 - An effective method for removing leachate from a landfill is critical
 - leachate can be removed from a sump with side slope risers or a penetration through liner to a collection chamber
 - an automated pumping and monitoring system is desired for either system so that leachate is removed on a continuous basis
 - if using a penetration, it has to have same level of containment as the rest of liner – it is highest risk area for release as it is at the lowest point and is subjected to the highest heads
 - In all cases, there must be a place to send the leachate for treatment or disposal – or it ends up staying in the cell and building up over the liner

Landfilling – Do it Right – Design

- LCS side slope riser



Landfilling – Do it Right – Design

- Penetration through liner to an external leachate collection chamber

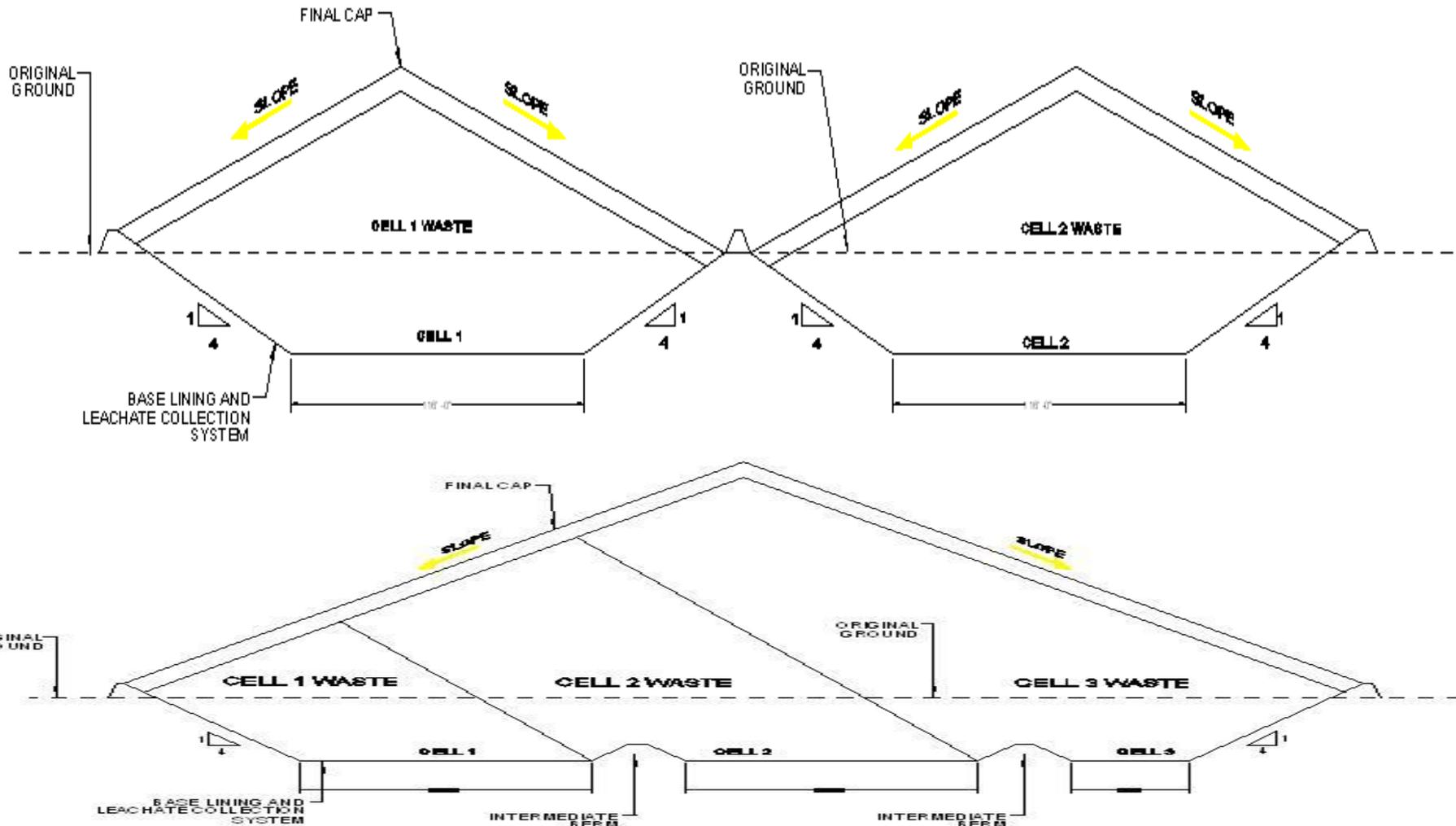


MacLeod Boot – patent pending



Landfilling – Do it Right – Design

- Cell Planning – maximize airspace



Landfilling – Do it Right – Design

- If it is necessary to drive equipment on side slopes to place material, then it must be considered in the slope stability assessment



Before



After

Landfilling – Do it Right – Construction

- Compacted Clay Liner – use the right equipment



Landfilling – Do it Right – Construction

- Compacted Clay Liner – do the right testing and at the right time



Landfilling – Do it Right – Construction

- Compacted Clay Liner – do the right testing



Landfilling – Do it Right – Construction

- **Compacted Clay Liner - do it at the right time of year**
- prepare the surfaces the right way



Do not construct in frozen conditions



Remove rocks and protrusions from final surface

Landfilling – Do it Right – Construction

- Geomembranes – Use the right equipment and installers for the material



Landfilling – Do it Right – Construction

- Geomembranes – do the right QA/QC checks and make the right repairs right away



Landfilling – Do it Right – Operations

- Operate leachate management systems as designed to reduce leachate head



Landfilling – Do it Right – Operations

- Operate leachate management systems to remove leachate from cell and avoid releases



Landfilling – Do it Right – Operations

- Develop (and follow!) a waste placement plan to show how and where wastes should be placed to keep waste and leachate in containment areas



Landfilling – Do it Right – Operations

- Develop (and follow!) a waste placement plan to show how and where wastes should be placed to avoid dumping waste from tops of slope that will put stresses on materials



Landfilling – Do it Right – Operations

- Train operators to keep safe distances from geosynthetics to avoid damage to containment system



Landfilling – Do it Right – Operations

- Train operators to keep safe distances from synthetics to avoid damage to geomembranes



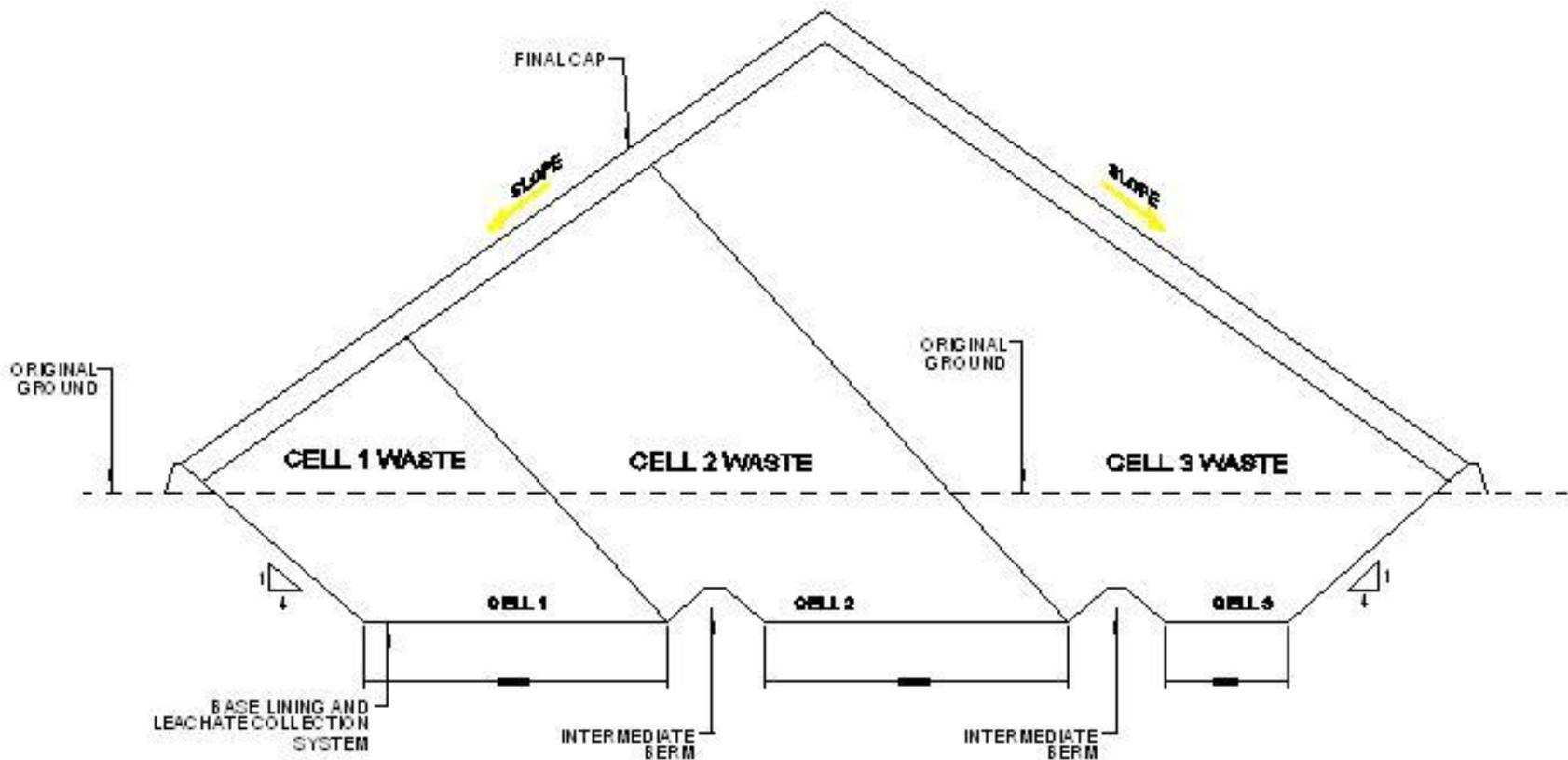
Landfilling – Do it Right – Operations

- Make repairs as quickly as they are found to maintain integrity of design



Landfilling – Do it Right – Operations

- Wastes should be placed to achieve final slopes that meet regulatory requirements and will promote run-off of precipitation and reduce infiltration



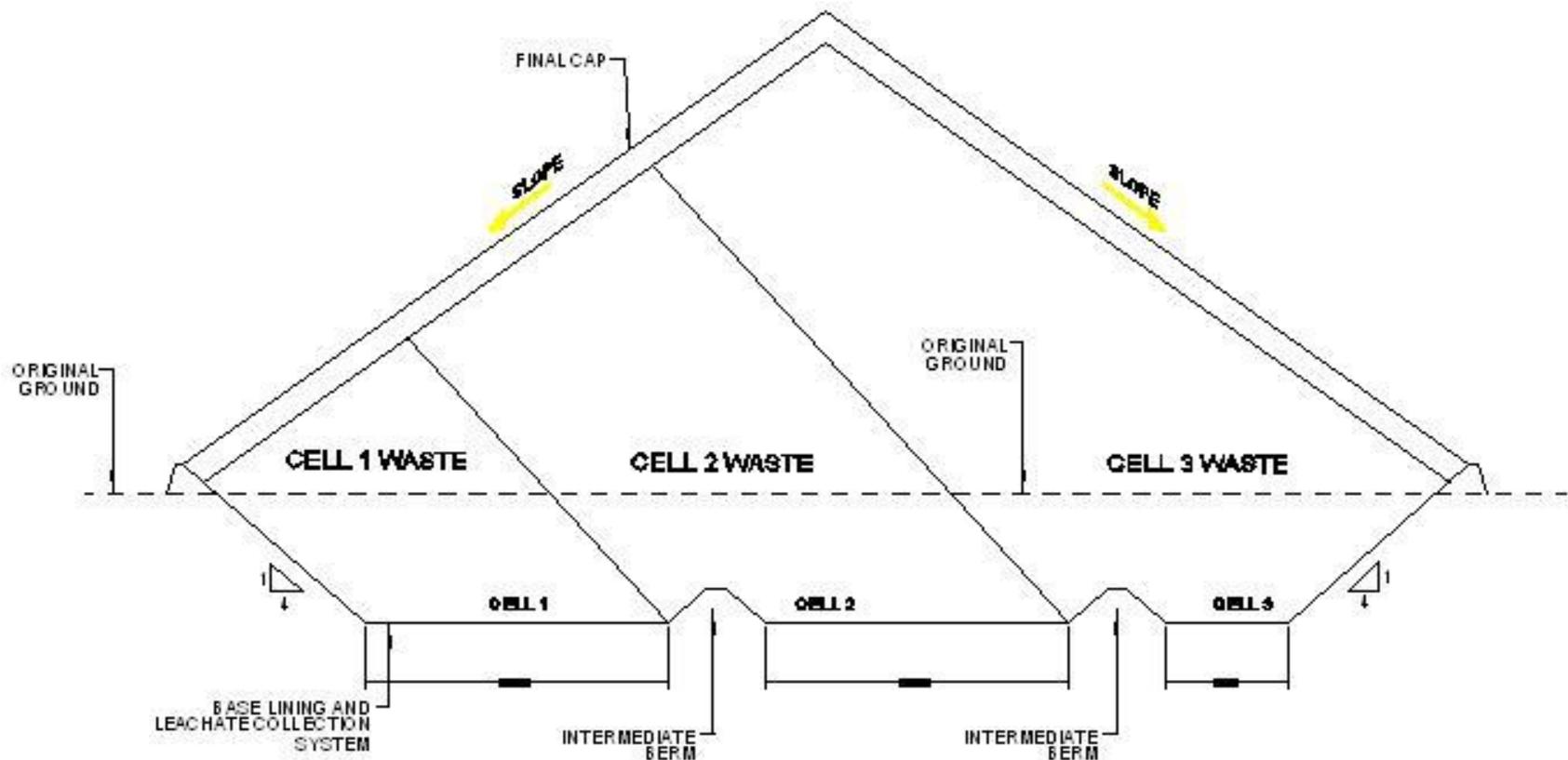
Landfilling – Do it Right – Operations

- Waste placement should include slope stability analyses of waste during operations! (Kettleman Hills)



Landfilling – Do it Right – Closure

- Final cap should meet the intent of the regulations to promote runoff, evapotranspiration and reduce infiltration
- Most common options for cap include low permeable soils (clay) and/or geomembranes



■ GOT GAS?



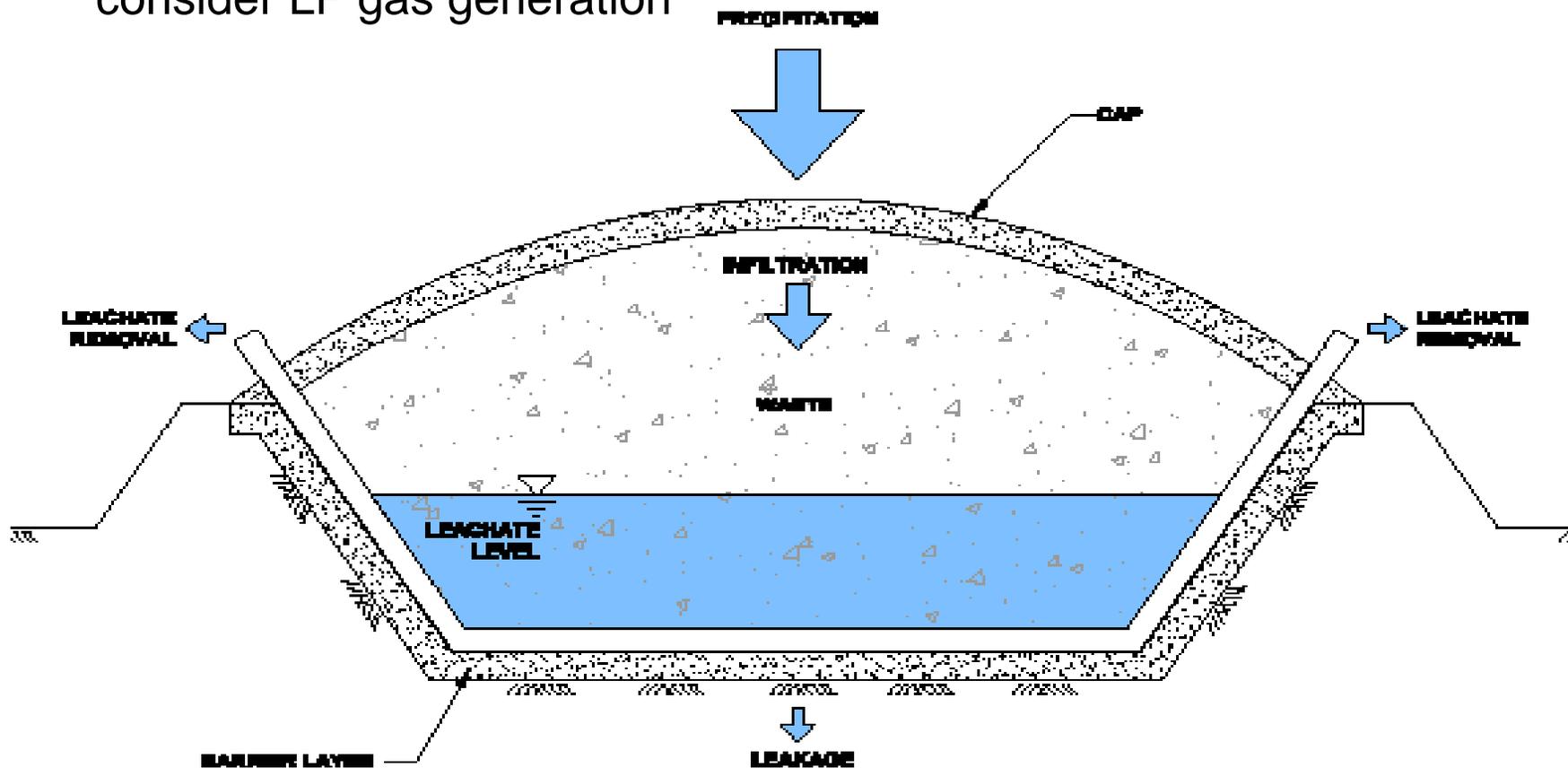
■ WHO WANTS IT?

Landfilling – Do it Right – Closure

- Landfill gases such as methane, carbon dioxide and even H₂S can be released from the wastes
- Becoming regulated item to identify quantity and quality
- Has to be controlled to protect the environment and elements of landfill caps (i.e. can cause uplift on membranes and veneer failures)

Landfilling – Do it Right – Closure

- Final cap should not be more permeable than base containment system or else LCS has to be operated in perpetuity
- As mentioned, the cap has to be designed to be stable and consider LF gas generation



■ REMEMBER

- Do it right from the start
- Do every step right
- Do the right checks along the way
- Fix problems quickly to make them right
- Doing it right is the only way to have confidence in the performance and to cover your asset!