Soil, Sediment, Bedrock and Sludge

Landfill Cap

Introduction:

For the management and subsequent containment of a contaminant source, landfill caps are employed.

Description:

Landfill caps can:

- Stop vertical infiltration of water into wastes that would create contaminated leachate.
- Contain waste whilst treatment is applied.
- Control gas emissions from underlying waste.
- Creates a land surface that can support vegetation or be used for other purposes in the future.

Landfill capping is the most commonly used form of remediation, as it is typically less costly than other technologies and efficiently manages the human and ecological risks associated with the remediation of a contaminated site.

The design of caps is site specific and dependant on intended functions of the system. They can range from a single layer system of vegetated soil to a multi layer system of soils and synthetic geo-membranes. Generally, less complex systems are needed in dryer climates and more complex systems for climates that tend to be wetter.

The most vital component of a landfill cap is the barrier and drainage layer. The barrier layer can be a low-permeability soil (clay) or a geo-synthetic clay liner. A flexible geo-membrane liner is put on top of the barrier layer. Geo-membranes are supplied in large rolls and are available in several thickness (20 to 140 mm), widths (15 to 100 ft), and lengths (180 to 840 ft). Some polymers regularly used include polyvinyl chloride (PVC), polyethylenes of various densities and polypropylene. Soils used as barrier materials are clays that are compacted to a hydraulic conductivity no greater than 1 x 10-6 cm/sec. A composite barrier utilises both soil and a geo-membrane. The geo-membrane is impermeable, but, if a leak develops, the soil component assists in preventing leakage into the underlying waste. Controlling of methane, carbon dioxide and greenhouse gases, should an important consideration when designing the facility and its operation.

Asphalt/Concrete Cap:

The most effective single-layer caps are concrete or bituminous asphalt. It forms a surface barrier between the landfill and the surrounding environment and reduces leaching through the landfill into adjacent aquifers.

RCRA Subtitle C Cap:

The RCRA C multilayered landfill cap is a baseline design that is used in RCRA hazardous waste applications. The caps typically involve an upper vegetative layer, a drainage layer, and a low permeability layer consisting of a synthetic liner over 2 feet of compacted clay. The compacted clay liners remain efficient if certain moisture content is maintained. However they are prone to cracking if the clay material is desiccated. As a consequence alternate cap designs are normally considered for arid environments.

RCRA Subtitle D Cap:

RCRA Subtitle D relate to non-hazardous waste landfills. The design of a landfill cover is a function of the base liner system or natural subsoil's present. The cover has to have the following specifications:

- Material should have permeability no greater than 1 x 10-5 cm/s.
- The infiltration layer must consist of at least 45 cm of earthen material.
- The erosion control layer has to be a minimum of 15 cm of earthen material and capable of sustaining plant growth.

Alternative design may be considered, but must be of equivalent specifications listed above. The prevention of what is known as the bathtub effect is vital. This occurs when a more permeable cover is placed on top a less permeable bottom liner or subsoil. As a consequence the landfill fills with water - like a bathtub.

Applicability:

Landfill caps may be temporary or final. Temporary caps can be installed before final closure to minimise generation of leachate until a better remedy is selected. They are usually used to minimise infiltration when the underlying waste mass is undergoing settling. A more stable base will thus be provided for the final cover, reducing the cost of the post-closure maintenance. Landfill caps also may be applied to waste masses that are so large that other treatment is impractical. At mining sites for example, caps can be used to minimise the infiltration of water to contaminated tailings piles and to provide a suitable base for the establishment of vegetation. Landfill caps have the potential to be designed in a way that routes surface water away from waste areas, whilst minimising the effect of erosion.

Limitations:

Landfilling does not lower toxicity, mobility, or the volume of hazardous waste, but does mitigate migration. Caps are most effective when much of the underlying waste is above the water table. A cap cannot stop the horizontal flow of ground water through the waste, only the vertical leaching into the waste. In most situations landfill caps are used in combination with vertical walls to lessen horizontal flow and migration. The life of landfill components including the cap can be enhanced through long-term inspection and careful maintenance. Vegetation with the potential for deep root penetration should be removed from the cap area immediately. Precautions must also be taken to ensure the integrity of the cap is not compromised by other land use activities.

Data Needs:

Tests to assess the suitability of soil to capping comprise of grain size analysis and compaction characteristics. Knowledge of the interface friction properties between all material layers, natural or synthetic, can assist in preventing landfill instability. Soil properties that must be known are the shear strength and hydraulic conductivity. Shear strength is assessed by means of an unconfined compression test, direct shear test, or triaxial compression test. Hydraulic conductivity of soils may be measured in the laboratory, whilst field hydraulic conductivity tests on test pads are recommended before cover construction to ensure that the low-permeability requirements can be met under construction conditions.

Any geo-synthetic materials used must also meet cap requirements, for instance, they may be subjected to tensile stresses met by subsidence and by the gravitational tendency of a geo-membrane or material adjacent to it to, slide down slopes in extremely wet conditions.

Performance Data:

Monitoring well systems or infiltration monitoring can offer some information, but it is often difficult to say whether the water or leachate originated as surface or ground water.

Cost:

Landfill caps are one of the least costly ways to protect human health and ecological risks. Rough industry costs begin at around £ 180 k per ha.