TechData Sheet

Naval Facilities Engineering Service Center
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Alternative Landfill Capping

Problem

The Navy and Marine Corps have over 450 landfills that require remediation. Over 200 of these landfills do not have a final remedy. Surface covers or caps are one of the most cost-effective methods to manage the human and ecological risks associated with these landfills. They will most likely be the chosen method of remediation, either alone or in combination with other technologies. The most common landfill covers currently being used are the Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) C or D caps. These multi-layered cap systems are usually very expensive when compared to alternative solutions.

As an alternative to the expensive RCRA caps, a variety of less costly caps have been developed. However, regulatory agencies are often reluctant to approve alternative landfill designs based on a lack of evidence that the technology will effectively limit the infiltration of water into the waste.

Solution

Research has led to a variety of alternative landfill caps which are being field tested to gain regulatory approval. There are many designs and components for these caps, including capillary breaks, geosynthetic clay liners (GCL), geo membranes, vegetative caps, enhanced runoff, soil or evapotranspiration (ET) caps, or combinations of these.

The Naval Facilities Engineering Service Center (NFESC) has been comparing the performance and costs of practical soil-based covers to the RCRA design. These soil-based covers enhance surface runoff and store precipitation in the soil until it is removed by evapotranspiration.

The risk manager now has cost-effective design alternatives to match the need for hydrologic control at a site.

Demonstration

To demonstrate the effectiveness of alternative caps, NFESC teamed with Los Alamos National Laboratory and Colorado State University to investigate the performance of a variety of vegetative caps. Demonstration caps were installed at Marine Corps Base Hawaii (MCBH) Kaneohe Bay in 1994 (Figure 1). The study used an innovative but simple concept to manipulate the fate of rain water falling on waste sites with moderate to high precipitation. The infiltration of water through the soil cap was controlled by combining the powerful forces of ET with engineered structures that limited infiltration of precipitation into the soil. This approach relied on diverting a sufficient amount of precipitation to controlled runoff so that any water that infiltrated into the soil was easily removed by ET. The study demonstrated three infiltration designs; one having a 20 percent enhancement of runoff, the other a 40 percent enhancement, and a conventional ET cap (control) to serve as a basis of comparison.

Figure 1. Landfill study at MCBH Kaneohe Bay, Hawaii.

The performance of the three designs was evaluated by comparing the field monitoring data with the predicted performance of the RCRA design using the EPA HELP model. After 16 months of performance monitoring, the data have supported the concept of infiltration control by increasing runoff and reducing percolation. The relative amount of percolation, as a percentage of the precipitation, averaged 2 percent and 5 percent for the enhanced runoff and control plots, respectively.

Technical Description

Vegetative caps or ET caps, combined with runoff control, govern the fate of precipitation falling on the surface of a landfill, which can be measured by determining the water balance of the site with the following equation (see Figure 2):

$$\Delta S/\Delta t = (P - Q - ET - L) / \Delta t$$

$\Delta S/\Delta t$	=	Time rate of change in soil moisture
P	=	Precipitation per unit area
Q	=	Runoff per unit area
ET	=	Evapotranspiration per unit area
L	=	Percolation below root zone per unit area
t	=	Unit of time used in solving the equation

Application of the concept of water balance in designing landfill caps takes advantage of the fact that there are strong interactions between the various components of the equation. For example, a reduction or elimination of the runoff term, Q, increases infiltration of water into the soil, resulting in increased soil moisture storage followed by an increase in evapotranspiration, ET, and/or percolation, L. The coupled nature of the processes comprising the water balance can be used to design landfill caps that minimize or eliminate leachate (percolation) by enhancing evapotranspiration and runoff.

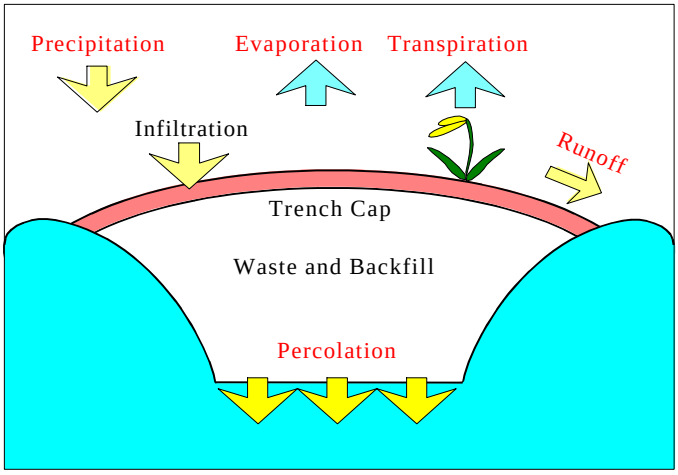

Figure 2. Water balance diagram.

Benefits

Vegetative caps can provide the following anticipated benefits:

- Significantly lowers capital costs:

RCRA C Cap	$0.5 - 1M/Acre
RCRA D Cap	$0.2 - 0.5M/Acre
Vegetative Cap	$0.05 - 0.1M/Acre

- Lower operation and maintenance costs compared to the conventional RCRA cap.
- Maintains integrity if land settlement occurs.
- Does not use clay layers which can provide a short circuit for percolation by drying, freezing, and cracking.

Will This Work at My Site?

The study at MCBH Kaneohe Bay supports the concept of using a vegetative cap with enhanced runoff in humid regions, where rainfall exceeds approximately 25 inches per year. There has also been much research in using alternative caps in semi-arid regions, where rainfall is approximately 10 to 25 inches per year. Therefore, alternative landfill caps can be designed for use in a wide range of climates. With the studies demonstrated at MCBH Kaneohe Bay and at various other Department of Defense (DoD) sites, evidence is now available to show regulators the effectivness of these alternative landfill caps.

The EPA allows an alternative landfill cap to be used for a RCRA D cap under 40 CFR 258.40. The EPA also allows an alternative cap to be used for a RCRA C cap, if the design is approved by the regional administrator under 40 CFR 264.301.

For more information about **alternative landfill capping technology**, contact:

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