GEOSCIENCES AND ENGINEERING DIVISION

TRIP REPORT

SUBJECT: Water Balance Covers Workshop for Solid, Industrial, and Hazardous Waste Landfills
AI No. 20.06004.01.007.702

DATE AND PLACE OF MEETING/TRIP: January 23–25, 2007
Riverside, California

AUTHOR: Gary Walter

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PERSONS PRESENT:

Approximately 90 attendees, primarily state and local regulators of municipal solid waste landfills were present at the Water Balance Covers Workshop. Other attendees were consultants involved in the design and construction of municipal solid waste and other types of landfills.

BACKGROUND AND PURPOSE OF MEETING/TRIP:

The Water Balance Covers Workshop is sponsored by the U.S. Environmental Protection Agency, the Desert Research Institute, and the University of Wisconsin. The workshop presented information on the performance and design of earthen landfill covers that may offer equal or better performance in resisting water contact with the wasteform than so called "prescriptive covers" consisting of compacted clay and geomembranes. I attended the workshop to obtain information on the current status of research related to water balance cover performance so I could better evaluate how such covers apply to shallow land disposal of radioactive waste.

The technical program consisted of 2½ days of lectures dealing with the performance, design considerations, and construction of water balance covers, with opportunities for group discussion. Specific lectures included

- Review of the findings of the Alternative Covers Assessment Project
- Review of unsaturated zone hydraulic processes affecting water balance cover performance including the effect of vegetation on cover performance
- Guidelines for water balance cover design based on the findings of the Alternative Covers Assessment Project
- Observations on the role of the ecological environment on short-term and long-term cover performance
- Comparison of water balance covers with prescriptive covers

- Bases for establishing the equivalency of water balance covers with prescriptive covers for regulatory compliance
- Performance monitoring techniques
- Considerations for water balance cover construction
- Effect of water balance covers on methane emissions from municipal solid waste landfills

SUMMARY OF PERTINENT POINTS:

The conference presented an overview of field experiences and design practices for evaluation of water balance covers. Water balance covers are earthen covers designed to reduce percolation of meteoric water into municipal solid waste and hazardous waste landfills. The water balance covers are intended to store infiltrating water during wet periods (rainy periods or periods of snow melt) and allowing the stored water to be evapotranspired during drying periods. Such covers are receiving increased attention and regulatory acceptance because they may be less expensive to construct than prescriptive covers consisting of compacted clay or very low permeability geomembranes and, in some circumstances, may have equal or better long-term performance limiting percolation into the waste. Prescriptive covers are essentially designed to divert infiltrating water from the waste. Water balance covers are intended to limit percolation by storing and releasing water using natural processes that are in harmony with the local climate. Although most of the workshop focused on using water balance covers for municipal solid waste landfill closure, such covers are also being considered for industrial and radioactive waste disposal sites.

Much of the workshop focused on the findings of the Alternative Covers Assessment Project. This project used large lysimeters {20 by 50 m [66 by 160 ft]} to directly measure the water balance of and percolation through water balance covers, prescriptive compacted clay covers, geomembrane liner covers, and composite covers. These lysimeters were installed at landfill sites in a variety of climate zones ranging from subtropical (South Carolina) to arid (Nevada). The lysimeters were designed to measure the as-built performance of the various cover types in terms of percolation over a 5-year performance period. The water balance covers were designed based on a comparison of their nominal water storage capacity and the anticipated net annual infiltration at the site. Although the presenters could not specifically explain the design basis for the water balance covers, it appears they were based on estimates of storage capacity from the difference in water content between the field capacity and wilting point of specific soils. The prescriptive cover designs used materials with laboratory or field as-built properties intended to meet regulatory requirements {permeability less than 10^{-6} cm/s [4×10^{-7} in/s] for municipal solid waste landfills and 10^{-7} cm/s [4×10^{-8} in/s] for hazardous waste landfills}.

Important findings of the Alternative Covers Assessment Project study were

- Percolation through most water balance covers exceeded prior estimates based on water balance calculations using standard laboratory measurements of soil water properties, except at arid sites. Percolation of arid sites was either zero or very small consistent with prior estimates.

- Compacted clay, geomembrane, and composite covers did not perform any better than water balance covers in limiting percolation over the timeframe of the experiment and, in some cases, performed worse.

- Empirical adjustments to laboratory-measured soil water properties are needed if numerical unsaturated flow models are used to design water balance covers to achieve a specific percolation rate. Even with such adjustments, the uncertainty in actual percolation rates may be significant.

- Vegetation plays a very important role in the performance of a water balance cover.

- Processes such as bioturbation and pedogenesis act relatively quickly (within a few years) to modify the structure and hydraulic properties of water balance covers resulting in an increase in the average saturated hydraulic conductivity within the disturbed zone of the cover to values in the range of 10^{-4} to 10^{-3} cm/s [4×10^{-5} to 4×10^{-4} in/s].

- Water balance covers are unlikely to prevent percolation except in very arid environments.

The Alternative Covers Assessment Project and subsequent data analysis established a basis for determining the "equivalence" of water balance covers and prescriptive covers. The concept of equivalency is important for permitting water balance covers. Conceptually, if the performance of a water balance cover (in terms of limiting percolation into the waste) is no worse than that of a prescriptive cover, the water balance cover meets the regulatory requirements. The concept of equivalency may not be appropriate when the requirements of the cover are based on a risk assessment as opposed to the physical properties specified in a regulation. For example, if percolation must be maintained below some threshold value to achieve specific groundwater protection standards, then the concept of equivalency between water balance covers and prescriptive covers has no meaning.

Regarding the long-term performance of water balance covers, studies reported by Jody Waugh (S.M. Stoller Corporation) indicate the cover design must accommodate the local climate and ecology. This means using soils that are amenable to the desired vegetation and accounting for plant community evolution, pedogenesis, and intrusion by burrowing animals.

The presentations on landfill gas migration and methane biodegradation in landfill covers were interesting, but not relevant to landfills containing radioactive waste unless the wasteform contains a significant fraction of biodegradable organic matter.

CONCLUSIONS:

My principal conclusions from the workshop are

- Accurate prediction of percolation rates through water balance covers using laboratory-measured soil water properties and assumed vegetation characteristics is probably not possible.

- Long-term, water balance covers probably allow percolation similar to that in local, upland areas with native soil and vegetation. For this reason, water balance covers are most appropriate for industrial, mining, or radioactive waste disposal sites in arid and semi-arid environments where natural percolation rates are very low.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

Staff should use the knowledge gained at this workshop in evaluating the long-term performance of cover designs for near-surface radioactive waste disposal sites and engineered covers proposed for tank waste remediation activities.

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