DRAFT LANDFILL GUIDANCE ON ALTERNATIVE FINAL COVER DEMONSTRATIONS

PERMITTING & COMPLIANCE DIVISION
WASTE & UNDERGROUND TANK MANAGEMENT BUREAU
SOLID WASTE PROGRAM
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INTRODUCTION

Montana closure criteria for Class II or IV landfill final covers [*ARM 17.50.1403(1) & -(2)*] allow alternative final cover (AFC) proposals that: (1) provide an "infiltration layer that achieves a reduction in infiltration at least equivalent to" the prescriptive final cover; and (2) match the hydraulic performance of the bottom liner as prescribed with a "permeability no greater than $1x10^{-5}$ cm/sec". This landfill cap allowance is identical to federal regulations [*40 CFR 258.60(a) & -(b)*] and "strictly" relies on the substitution of equivalent "barrier-type" final covers that retard the entry of moisture into the cap. Categorical exceptions to this U.S. EPA-based, resistive barrier standard are thereby not allowed according to the federal standards. Yet another alternative approach might instead rely on the percolation, storage, and extraction (store-and-release) of soil water from the final cover by "equivalent" evapo-transpiration (ET) processes. A performance demonstration is therefore required for final Solid Waste Program (Program or SWP) approval of store-and-release or ET cap designs for Class II or IV landfill unit closure.

These regulatory criteria require that the ET cap drainage derived by unsaturated flow is somehow compared to the EPA equivalent performance of a prescriptive composite final cover based on a saturated hydraulic conductivity standard. Several experiments have provided baseline data on natural (or stressed) unsaturated flow through final cover test profiles, as monitored by saturated drainage released to a geocomposite-HDPE geomembrane lysimeter at the base of the test plot. Because a capillary-break ET cap design is probably closer to the situation simulated by these experiments, *actual* landfill AFC field drainage after construction would likely exceed the range of drainage measured for several monolithic ET caps tested in the studies. This document provides guidelines for demonstration of site-specific AFC design, testing, and field performance evaluation that ensure compliance with regulatory expectations based on SWP interpretation of the "flexibility" allowed by the Montana closure rule.

Recognizing limitations of the original "regulatory allowance for AFC equivalence", EPA later promulgated (2004) an MSW landfill Research, Development, and Demonstration Permit (RD&D) regulation [*40 CFR 258.4*]. Now EPA allows categorical proposals for "phyto covers" (*i.e.* water-balance or ET or store-and-release caps), but it requires on-site testing and demonstration of their "equivalent" hydraulic barrier performance prior to its final approval for a site. Accordingly based on the Montana RD&D rule [*ARM 17.50.507*], any SWP final approval of a store-and-release final cover for lined Class II landfill units would rely on its evaluation of the field performance of a constructed cap based on data obtained from *in situ* AFC drainage monitoring during the required three-year demonstration period. EPA further recognized that landfill leachate head demonstrations must be updated due to site-specific changes in store-and-release cap drainage relative to the original breakthrough predicted for a prescriptive composite geomembrane final cover design. The Program has, however, reserved the application of complete RD&D license conditions to the *bioreactor* landfill demonstration process.

AFC DEMONSTRATION REQUIREMENTS

The Program evaluates AFC designs for closure of Class II or IV landfill units based on the definition of three fundamental types of soil cover profiles designed to manage moisture percolation, storage, plant root uptake, and evaporation: (i) a single monolithic layer of homogeneous soils, (ii) a monolithic soil layer underlain by a "capillary break" layer, and (iii) a polylithic or composite internal soil structure. Most AFC designs utilize a water balance approach to minimize drainage from the soil cover by the functional combination of water storage, plant uptake, and water extraction via ET processes. A capillary break or other internal layer may fulfill several functions depending on the AFC design, including: (a) a root barrier, (b) a lateral drainage layer, and (c) a gas collection layer. Geosynthetics can be specified to improve soil stability, intrusion, drainage, etc.

The AFC demonstration process for Class II or IV landfill final covers is based on five general phases for licensee submittal and Program evaluation of a site-specific petition for variance from the EPA prescriptive standard cap:

I. Site investigation, soil sampling, and lab testing
II. Numerical modeling of the AFC water-balance potential
III. Specification of the AFC design by function
IV. Construction and AFC performance
V. AFC field monitoring or petition for waiver from field monitoring.

I. <u>Site investigation, soil sampling, and lab testing</u>

- Representative samples of the proposed soil borrow areas must be analyzed for basic index parameters to evaluate soil suitability for the proposed AFC function. Index parameters must at least include soil type, texture and gradation, saturated hydraulic conductivity, water retention (*e.g.* van Genuchten parameters) and unsaturated hydraulic conductivity (*e.g.* Mualem) functions, and soil density under the conditions proposed for AFC construction.
- Representative on-site (or nearby) investigations must provide local *in situ* observations on natural soil properties, wetting and frost depths, indigenous plant communities and succession, species density, species rooting profiles and dormancy, and other critical factors of soil development that likely affect AFC performance.

II. <u>Numerical modeling of the AFC water-balance potential</u>

- Numerical models (*e.g.* Unsat-H or Hydrus 2-D) must indicate conservative performance to minimize AFC drainage (basis for site-specific standard).
- Model precipitation input must replicate the actual ten consecutive wettest years on average, giving natural climatic variations for the site.

- Model rooting profiles and plant uptake must represent the indigenous vegetation.
- Model unsaturated hydraulic conductivity must be based on soil testing data and scaled properly for critical properties affecting the predicted AFC drainage performance.
- Sensitivity analyses must evaluate the effects of variations in layer thickness, soil hydraulic properties, and plant uptake to determine the critical parameters (e.g. thickness, gradation, compaction, desiccation, freeze-thaw, etc…) affecting the predicted AFC drainage performance.
- A maximum site-specific AFC drainage standard must be submitted and approved based on the required storage, AFC profile design, and model performance.

III. <u>Specification of the AFC design by function</u>

- Design thickness and properties of the final cover must ensure compliance with the approved site-specific AFC drainage standard.
- Construction specifications (soil type, dry density, water storage potential, nutrients, mulch …) must optimize root growth for the selected indigenous plants.
- Seed stock for the indigenous plants must be chosen to match local species communities and to maximize ET throughout the local growing season.

IV. <u>Construction and AFC performance</u>

- The final cover survey must verify layer thickness(es) achieved at control points.
- In-place Proctor density, moisture content, saturated hydraulic conductivity, gradation, and other appropriate indices must be measured per final cover minimums.
- Selected plant species must provide 50% coverage by the end of the first season and complete revegetation by the end of the third season after construction.
- Final QA/QC must validate the conformance of actual AFC field drainage to the approved site-specific AFC drainage standard.
- Pre-construction demonstration and minimum 3-yr monitoring of an on-site, full-scale, lysimeter test plot based on the approved AFC profile design may substitute for the AFC field performance verification.

V. <u>Petition for waiver from AFC field monitoring</u>

- A licensee must submit for approval a certified petition to justify a waiver from direct verification that actual AFC field performance conforms to the site-specific drainage standard.
- The justification must be based on landfill site conditions, landfill design, on-site systems monitoring, observations from an on-site full-scale cover test plot, the calibration and level of predicted AFC performance, and other critical factors necessary to ensure consistent AFC field performance.
- An approved alternate method for evaluating the final cover field performance must be provided to assist in the effective evaluation of post closure care cessation.

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