Response to “Comments on ‘Evaluation of Evapotranspirative Covers for Waste Containment in Arid and Semiarid Regions in the Southwestern USA’”

The review comment by Gee et al. (2006) presents examples of failures in ET covers at different sites, suggesting design attributes similar to those described in our paper; however, it fails to point out the differences in seasonal precipitation patterns. Precipitation in the examples given throughout their comment (Ogden, UT; Altamont and Marina, CA) occurs primarily in the winter, when vegetation is dormant, whereas precipitation at the New Mexico and Texas sites evaluated in our study occurs primarily in the summer, when vegetation is active and ET is high. For example, 90% of precipitation occurs in winter (November–April) at the California sites, whereas 15 to 23% of precipitation occurs in the winter at the Texas and New Mexico sites, respectively. Seasonal distribution of precipitation is very important for performance of ET covers.

In their comment, Gee et al. (2006) suggested that our conclusion that “a 1-m-thick ET cover underlain by a capillary barrier should be adequate to minimize drainage to ≤1 mm yr⁻¹ in these arid and semiarid settings” appears to be unqualified. This is a data-specific conclusion, and “these arid and semiarid settings” refer to the New Mexico and Texas sites described in our paper. The “Southwestern USA” was included in the title to show the general location of the sites, but there are no statements in the paper that the results of our study should apply throughout this entire region. The conclusion related to appropriate cover thickness for these sites is one of several conclusions in the study, and each conclusion should not be considered in isolation but as part of the entire study. Another conclusion specifically refers to the suitability of ET covers of the climate at these sites with predominantly summer monsoonal precipitation that is readily removed by ET. Gee et al. (2006) referred to failure of ET covers at sites in Altamont and Marina, CA, but the Mediterranean climate at these sites is characterized by predominantly winter precipitation, when vegetation is dormant.

It is not clear whether the comment related to the importance of soil type and related soil water storage refers to our study. Available water storage was analyzed in detail for the different soils in the covers in our study. Calculated available water storage for the covers (Table 5 in Scanlon et al., 2005), based on monolithic soil properties and thickness, exceeded winter precipitation (November–April; Sierra Blanca 59 mm; Albuquerque 86 mm) by factors of 1.4 to 2.7.

We agree with Gee et al. (2006) that there is no generic design standard for ET covers. The examples from our study show the detailed characterization, field testing, and modeling analyses required to evaluate a proposed design. We agree that a large factor of safety is required because of uncertainties in cover-system performance based on monitoring and modeling analyses. The cover designs in our study provide a large factor of safety, based on available water storage relative to winter precipitation.

2.5 greater than that of an ET cover alone. Gee et al. (2006) did not address the fact that available water storage in ET covers monitored using a drainage lysimeter was greater than that of the capillary barriers. Monitoring results for the capillary barrier and ET covers in the Alternative Cover Assessment Program (ACAP) (Albright et al., 2004) show ET covers underlain by capillary barrier systems for different sites, whereas 15 to 23% of precipitation occurs in the winter at the Texas and New Mexico sites, respectively. Seasonal distribution of precipitation is very important for performance of ET covers.

We did not test cover performance at our sites under stressed conditions that would emulate climate change. Although the New Mexico and Texas sites were irrigated under stressed conditions. Enhanced precipitation using irrigation was also used at the Hanford site (Ward and Gee, 1997).

In their comment, Gee et al. (2006) did not seem to support the use of capillary barriers because of their performance and cost of installation. Unpredictable performance is related to unstable flow; however, comments indicate that the capillary barrier system at the Texas sites shows any drainage even after excessive irrigation (1881 mm in 3 d). Cover slopes at the New Mexico sites were negligible; therefore, comments related to sloping capillary barriers should not apply to these sites. Although the economics of capillary barriers are not addressed in our study, the conclusion related to capillary barriers in our paper is qualified by practical considerations including economics. Cost analyses for different cover designs at the New Mexico (1998). The costs per square meter were $92 for the capillary barrier and $74 for the ET cover. Differences in costs for these two designs should consider the increased thickness of monolithic ET covers, increased storage provided by a capillary barrier, and a limit to how thick a monolithic ET cover can be to how deep the vegetation roots can extend. We indicated that the underlying coarse layer in capillary barriers can be thin, which should reduce costs. Economic evaluations should be evaluated at a site-specific level relative to different materials and such evaluations should show differences between thicker, monolithic covers and thinner monolithic covers and capillary barriers.

Gee et al. (2006) suggested that vegetation should be known a priori to reduce uncertainty in the estimate of drainage. Ideally, vegetation parameters should be included in the model but should be simulated response to climate and soil water storage. Vegetation is being incorporated into land–atmosphere models, such as the C horizon model, which can be used to simulate vegetation growth and its effect on soil water storage.

This is a data-specific conclusion, and “these arid and semiarid settings” appears to be unqualified.