



**U.S. Environmental Protection Agency**

## **Superfund Innovative Technology Evaluation**

**EPA 540/R-05/004**

**Technologies for Monitoring & Measurement of Dioxin and Dioxin-like Compounds in Soil and Sediment (CAPE Technologies LLC, DF1; Dioxin/Furan Immunoassay Kit; PCB TEQ Immunoassay Kit) (PDF, 1,437 Kb, 110 pp) March 2005**

### **Abstract:**

A demonstration of technologies for determining the presence of dioxin and dioxin-like compounds in soil and sediment was conducted under the U.S. Environmental Protection Agency's (EPA's) Superfund Innovative Technology Evaluation Program in Saginaw, Michigan, at Green Point Environmental Learning Center from April 26 to May 5, 2004. This innovative technology verification report describes the objectives and the results of that demonstration, and serves to verify the performance and cost of the CAPE Technologies DF1 Dioxin/Furan and PCB TEQ Immunoassay kits. Four other technologies were evaluated as part of this demonstration, and separate reports have been prepared for each technology. The objectives of the demonstration included evaluating each technology's accuracy, precision, sensitivity, sample throughput, tendency for matrix effects, and cost. The test also included an assessment of how well the technology's results compared to those generated by established laboratory methods using high-resolution mass spectrometry (HRMS). The demonstration objectives were accomplished by evaluating the results generated by the technology from 209 soil, sediment, and extract samples. The test samples included performance evaluation (PE) samples (i.e., contaminant concentrations were certified or the samples were spiked with known contaminants) and environmental samples collected from 10 different sampling locations.

The CAPE Technologies DF1 Dioxin/Furan and PCB TEQ Immunoassay kits are immunoassay techniques that report the total toxicity equivalents (TEQ) of dioxin/furans and polychlorinated biphenyls (PCBs), respectively. As part of the performance evaluation, the technology results were compared to TEQ results generated by a reference laboratory, AXYS Analytical Services, using EPA Methods 1613B and 1668A, which involve the use of HRMS. It should be noted that the results generated by the CAPE Technologies kits may not directly correlate to HRMS TEQ in all cases because it is known that the congener responses and cross-reactivities of the kits are not identical to the toxicity equivalency factors that are used to convert congener HRMS concentration values to TEQ. The effect of cross-reactivities may contribute to this technology's reporting results that are biased high or low compared to HRMS TEQ results. Therefore, these kits should not be viewed as producing an equivalent measurement value to HRMS TEQ, but as a screening value to approximate HRMS TEQ. As described in CAPE Technologies literature, the best results for immunoassay screening are obtained on a single site basis. The ideal approach involves partially characterizing a site by HRMS, using those results to develop a site specific immunoassay calibration, and refining

that calibration over time, based on an ongoing stream of confirmatory HRMS samples. This approach was not evaluated during this demonstration; samples from multiple sites were pooled and a single calibration was used.

A summary of the performance of the CAPE Technologies DF1 Dioxin/Furan and PCB TEQ Immunoassay kits is as follows: The CAPE Technologies kits generally reported data higher than the certified PE and reference laboratory values. The technology's estimated method detection limit [12 to 35 picogram per gram (pg/g)] was higher than what was reported by the developer (1 pg/g TEQ). The CAPE Technologies TEQD/F results that were generated in the laboratory and in the field for replicate samples were statistically different for 19% of the samples, and of these samples, CAPE Technologies laboratory results were more comparable to the reference laboratory results. No significant effect was observed for the reproducibility of CAPE Technologies results by matrix type (soil vs. sediment vs. extract) or by sample type (PE vs. environmental vs extract). A slight effect was observed for total TEQ values by PAH concentration, but the effect was not statistically significant for TEQD/F or TEQPCB. The technology had a rate of false negative results of 3 to 5% around 20 pg/g TEQ, with false positive rates ranging from 11 to 14%. However, CAPE Technologies's false positive and false negative rates around 50 pg/g were generally lower for all three TEQ types, ranging from 4 to 10%. These data suggest the CAPE Technologies kits could be an effective screening tool for determining sample results above and below 20 pg/g TEQ and even more effective as a screen for samples above and below 50 pg/g TEQ, particularly considering that both the cost (\$59,234 vs. \$398,029) and the time (three weeks vs. eight months) to analyze the 209 demonstration samples were significantly less than those of the reference laboratory.