APPENDIX E
ATTACHMENT 2

Site-Wide Soil Gas Human Health Risk Assessment

This attachment provides supplemental documentation supporting the proposed site-specific input parameters for the Johnson & Ettinger (J&E) model. Specifically, this attachment documents the calculation of soil water-filled porosity based on data for percent moisture (conducted in support of using a site-specific value for this parameter).

Percent Moisture to Soil Water-Filled Porosity Calculations

As noted in the *Site-Specific Input Parameters for the Johnson & Ettinger Model* Memorandum, nearly 300 soil samples collected at the site were analyzed for percent moisture. These data were converted to soil water-filled porosity as a check of the direct measurements of soil water-filled porosity in 16 samples. The following equations/relationships were used to convert percent moisture to soil water-filled porosity.

$$Percent\ Moisture\ \left[\frac{g}{g}\%\right] = \frac{Mass\ wet\ sample - mass\ dry\ sample}{Mass\ wet\ sample} \times 100\%$$
$$= \frac{Mass\ water}{Mass\ Total} \times 100\% = \frac{M_w}{M_t} \times 100\%$$

$$Dry\ Bulk\ Density\ \left[\frac{g}{cm^3}\right] = \rho_d = \frac{Mass\ of\ Soil}{Volume\ Total} = \frac{M_s}{V_t}$$

$$Water\ Filled\ Porosity\ \left[\frac{cm^3}{cm^3}\right] = \theta_w = \frac{Volume\ of\ Water}{Volume\ Total} = \frac{V_w}{V_t}$$

Wet bulk density was estimated as shown below based upon measured values of dry bulk density and water-filled porosity (also called volumetric moisture content[1]) from 16 samples. A site-wide averaged wet bulk density was estimated as the mean of the 16 samples. This information is shown in Table E-5.

$$Density\ of\ Water\ \left[\frac{g}{cm^3}\right] = \rho_w = \frac{Mass\ of\ Water}{Volume\ of\ Water}$$

[1] Page 52 of J&E Model User's Guide (EPA 2004) uses "volumetric soil moisture content" interchangeably with "soil water-filled porosity".

$$Wet\ Bulk\ Density\ \left[\frac{g}{cm^3}\right] = \rho_t = \frac{M_t}{V_t} = \frac{Mass\ of\ Soil + Mass\ of\ Water}{Volume\ Total}$$
$$= \frac{M_s}{V_t} + \frac{M_w}{V_t} = \rho_d + \left(\frac{V_w}{V_t} \times \frac{M_w}{V_w}\right) = \rho_d + (\theta_w \times \rho_w)$$

$$Site\ Wide\ Averaged\ Wet\ Bulk\ Density\ \left[\frac{g}{cm^3}\right] = \rho_{t_{avg}} = \frac{\sum_{i=1}^{16} \rho_{t_i}}{16}$$
$$= \frac{\sum_{i=1}^{16} (\rho_{d_i} + \theta_{w_i} \times \rho_w)}{16}$$

$$Estimated\ Water\ Filled\ Porosity\ \left[\frac{cm^3}{cm^3}\right] = \frac{Percent\ Moisture}{100\%} \times \frac{\rho_{t_{avg}}}{\rho_w}$$
$$= \frac{\frac{M_w}{M_t} \times 100\%}{100\%} \times \frac{\frac{M_t}{V_t}}{\frac{M_w}{V_w}} = \frac{V_w}{V_t}$$

The summary of the results from this calculation are given in Table E-3. The full dataset used is attached to this supplemental memorandum (*MoisturePercent.xlsx*).