

EVALUATION OF VARIABILITY OF STORMWATER RADIONUCLIDE CONTAMINATION LEVELS IN A HOLDING BASIN

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The Basement of the former C-410 Building at the Paducah Gaseous Diffusion Plant has been used as a basin to store stormwater. Four sampling events in 2014 and one in 2015 showed significant changes in uranium and technetium-99 concentrations which led to concerns about possible leakage of contamination out of the holding basins. The water and sludge analytical data were reviewed and evaluated relative to analytical data issues and uncertainties and for indications of the chemical and physical changes that may be occurring in the stormwater over time. The sparsity of supporting data for the environmental conditions and for measurements on both the dissolved and suspended fractions of the water and on the sludge over time made it difficult to obtain definitive answers. However, likely causes of the variability in the concentration measurements have been proposed.

In review of the data packages, the main issue found was that the total uranium was calculated from the sum of the individual alpha isotopes and that the total propagated uncertainty (TPU) for that sum was calculated in quadrature which requires that the measurements be independent of each other. However, all of the uranium isotopic analyses were corrected for recovery based on the same tracer, and therefore are not independent. Many of the uranium recoveries were very low, which resulted in the uncertainty in the total uranium results being significantly under-reported.

A review of summer sampling data showed dissolved and suspended gross alpha/beta results from the first sampling, most of the uranium is in the suspended fraction (insoluble) whereas the Tc-99 at that time was mostly in the dissolved fraction (soluble). This accounts for the fact that there is more variability between the different samples taken at the same sampling event for uranium than there is for Tc-99. Stirring of the sludge by temperature inversions likely accounts for the large changes in uranium concentrations from sampling event to sampling event.

The solubility of Tc-99 depends on its oxidation state, which depends on the redox potential depends on the oxidation environment, such as the presence or absence of oxygen. Dissolved oxygen levels at the surface may increase while at depth they may not because of thermal stratification. Also, levels of algae and microorganisms impact oxygen levels of dissolved oxygen during their life cycles. Cooler temperatures and less sunlight temperatures can cause algae die-off in the winter and resulting lower dissolved oxygen levels. The data show that the sludge is serving as a reservoir for technetium in the winter months that will likely become soluble in the summer months as temperatures and oxygen levels in the held stormwater rise.

The varying solubility of the radionuclides and the stirring of the sludge by temperature inversions were considered the likely causes of the variability of the data.