

23 September 2020

Alexander Sulkowski
 Director
 Noble Environmental Inc.
 m. 412.979.5493
asulkowski@nobleenviro.com

RE: Westmoreland Sanitary Landfill, Radium Throughput

Dear Mr. Sulkowski,

Noble Environmental Inc. (Noble) reached out to Perma-Fix Environmental Services, Inc. (Perma-Fix) requesting assistance with determining total radium concentrations at the Westmoreland Sanitary Landfill in Westmoreland, PA. This letter provides the calculations and assumptions to determine the *maximum* total radium (radium-226 + radium-228) in the sludge material and emitted through the evaporation process, based on limited knowledge of the process and sample results along with the manufacturer specifics.

Data based on analytical results provided to Perma-Fix showing maximum results of 8.74 pCi/L Ra-226 and 0.518 pCi/L Ra-228 of fluids influent to evaporator (9.258 pCi/L total radium).

Assumptions:

- 45,000 gal/day processed through system
- 90% volume reduction, resulting in 4,500 gal of sludge/day
- 99% of the radium goes into the sludge, 1% gets evaporated with the 40,500 gal/day (based on 99% manufacturer specification)
- 30,400 scfm vapor flow rate from stack (including 22% moisture content)

$$\frac{pCi}{day} \text{ of Total of Ra} = \frac{9.258 pCi}{L} Ra \times \frac{3.78 L}{gal} \times \frac{45,000 gal}{day} = \mathbf{1.575E^6 pCi/day}$$

$$\frac{pCi}{L} \text{ of Total Ra after evap.} = \frac{1.575E^6 pCi}{day} \times 0.01 \times \left(\frac{min}{30,400 cf} \right) \times \frac{day}{86,400 min} \times \frac{1 cf}{28.31 L} = \mathbf{2.118E^{-5} pCi/L}$$

$$\frac{pCi}{L} \text{ of Total Ra in sludge} = \frac{1.575E^6 pCi}{day} \times 0.99 \times \left(\frac{day}{4,500 gal} \right) \times \frac{gal}{3.78 L} = \mathbf{91.65 pCi/L}$$

$$\frac{pCi}{kg} \text{ of Total Ra in sludge} = \frac{91.65 pCi}{L} \times \frac{1 L}{0.0353 cf} \times \frac{1 cf}{75 lb} \times \frac{2.204 lb}{1 kg} = \mathbf{76.30 pCi/kg}$$

Technical Services Center

315 9th Street, 2nd Floor ♦ New Brighton, PA 15066

Phone: (724) 728-3960 ♦ Fax: (724) 728-3962 ♦ www.perma-fix.com



Please contact me if you have any questions or require further information.

Sincerely,

A handwritten signature in black ink that reads "Alex Lopez". The signature is written in a cursive, slightly slanted style.

Alejandro Lopez, CHP
Director, Health Physics Operations
(724) 728-3960
alopez@perma-fix.com

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