Historical wastewater management recorded in river-lake sediment and porewater using major elements, ^{7}Be, ^{210}Pb, ^{87}Sr/^{86}Sr, and ^{226}Ra/^{228}Ra

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Inadequate treatment and discharge of high-salinity wastewater to fresh water streams can result in surface water contamination with radionuclides, metals, and organic constituents that could pose risks to aquatic and human health[1-4]. However, little is known about the potential accumulation of these contaminants in river and lake sediments or the risk they could possibly pose to ecosystem services. We hypothesize sediment cores can be used as forensic tools that record discharges of oil & gas (O&G) treated effluent over time, which will help quantify risks and guide future O&G wastewater management strategies. The sediments may preserve unique chemical signatures of O&G wastewater as well as changes in watershed energy development. We analyzed 2-3m sediment cores in a river-lake 10 km downstream of one wastewater facility that historically and currently discharges treated O&G wastewater brines with TDS> 150,000 mg/L. Major element chemistry (e.g., Cl, Br, Na, Sr, Ba) and isotope ratios (e.g., ^{87}Sr/^{86}Sr and ^{228}Ra/^{226}Ra) from both sediments and porewater identify the relative impact of unconventional wastewater versus conventional O&G wastewater. Using ^{7}Be, ^{210}Pb, and ^{228}Ra activities, the sediment intervals were age-dated. An interval with higher TDS, Cl, Sr, Ba, and Ra corresponds to a period of time of maximum volume of unconventional wastewater disposal (2009-2011). Radium is present in this interval at activities 3-4 times background with high ^{226}Ra/^{228}Ra ratios that likely reflect disposal of Marcellus Shale flowback and produced waters [5]. Other changes in sediment and water quality were also observed including, elevated ^{137}Cs, Hg, Mn, and Pb.

[1] Warner, et al., *ES&T* (2013) **47**, 11849–11857. [2] Ferrar, et al., (2013) *ES&T* **47**, 3472–3481. [3] Getzinger, et al., (2015) *ES&T* **49**, 8347-8355. [4] Skalak, et al., *In. J. Coal Geo.* (2014) **126**, 162-170. [5] Rowan, et al., (2011) U.S. Geological Survey Report–5135.