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Re-use of Oil and Gas, Municipal, and Livestock Wastes on the Agricultural Landscape

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Solid and liquid wastes from oil and gas development are increasingly viewed as a reusable resource, particularly in regions of water scarcity or where disposal options are limited. As part of a comprehensive study of land-applied re-use materials to farmland, a multidisciplinary team of scientists is examining the application of oil- and water-based drilling fluids (DFs), as well as wastes from municipal (biosolids) and livestock sources, to cropped fields to determine if land application results in an increased risk to environmental and human health. Land-applied re-use materials were characterized for a broad suite of inorganic and organic compounds and potential toxicities. Our approach includes analysis of solids and the leachates of re-use materials to simulate real-world contaminant transport and environmental exposures. Initial results document that organic carbon content of these materials was as large as 11% in DFs, 42% in livestock waste, and 45% in biosolids. Median leachable dissolved organic carbon concentrations (10 mg/L) and ammonium concentrations (2.0 mg/L) were 2-3 orders of magnitude less in DFs than from biosolids and livestock manure. Median total inorganic nitrogen and phosphorus concentrations in livestock manure (21 mg/g and 13.5 mg/g, respectively) and biosolids (5.3 mg/g and 26.4 mg/g, respectively) were up to three orders of magnitude greater than concentrations in DFs. Drilling fluids contained the greatest concentrations of hydrocarbons, with total polycyclic aromatic hydrocarbon concentrations as large as 171,000 ng/g, and total alkylbenzenes as large as 46,000 ng/g; whereas, biosolids contained the greatest total maximum concentrations of PFAS (338 ng/g) and pharmaceuticals (10,260 ng/g). No pesticides were detected in DFs, but they were detected in biosolids and livestock manure at ~2,500 ng/g levels. Rare-earth elements were greatest in DFs, with median concentrations that ranged from 0.5 mg/g of holmium to 33 mg/g of cerium. Median barium (25,100 mg/g) and strontium (578 mg/g) concentrations were greatest in DFs, whereas median zinc (804 mg/g) and manganese (617 mg/g) concentrations were greatest in biosolids. The compositions, concentrations, and associated quantitative toxicological effects will provide stakeholders, industry, and regulatory authorities insight into the potential for the beneficial re-use and best disposal practices for these land-applied materials.