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Remediation of Heavy Hydrocarbon-Impacted Soils by Soil Washing: Assessment of TPH Removal in Coarse versus Fine Fractions

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Background/Objectives. The objective of this research is to explore the use of soil washing to reduce levels of total petroleum hydrocarbons, TPH, on soils impacted by heavy hydrocarbons (TPH in the range of C8-C40). Soil washing can remove TPH from the soil particles, and this process can be enhanced with the use of various chemical extractants. Soil washing may also be effective simply by reducing the volume of soil that needs to be treated, if the coarse fraction of the soil meets environmentally acceptable TPH levels and can be readily separated. As a volume reduction process, soil washing allows for separation of fine particles from coarse particles during settling after mixing with aqueous solution. These experiments can be used to determine the effectiveness of soil washing in removing TPH from soil as well as assess the suitability of management of soils by volume reduction (separating low TPH coarse particles from high TPH impacted fines).

Approach/Activities. In this study, experiments were first conducted on soils impacted by heavy hydrocarbons with treatment by water containing a surfactant/cosolvent mixture. Additionally, experiments were conducted to characterize the distribution of TPH between coarse and fine particle fractions. Finally, separate soil washing experiments with the same surfactant/cosolvent mixture were conducted on the coarse fraction. Laboratory experiments were conducted on four field soils containing TPH levels ranging from 6,700 to 20,900 mg/kg. Soil washing experiments were conducted on the as received soils at room temperature with a soil to water ratio of 1:1 using a 0.005 M $CaCl_2$ aqueous solution that included 0.5 vol.% Brij O10 and 0.2 vol.% pentanol. (This surfactant/cosolvent mixture represents one of several soil washing extractants that have recently been evaluated to optimize TPH removal for these soils).

Results/Lessons Learned. Experiments on the soils as received (without separation of fines from coarse particles) resulted in TPH removals ranging from 22-32% for three of the soils and 64% for one of the soils. From the TPH delineation experiments for all four soils, the fraction of TPH that was in the coarse fraction ranged from 25-36% of the total TPH in the soil, similar to the TPH removals for three of the soils. Subsequent soil washing experiments on the separated coarse fractions resulted in high TPH removals from the coarse particles ranging from 67% to 90% for the four soils; also consistent with a hypothesis that TPH removal occurs from coarse particles. These results indicate that TPH removal on as received soil (without separation of coarse from fines) for three of the soils occurred primarily due to reduction in TPH from the coarse fraction of the soil. For the fourth soil, some of the TPH reduction may have been due to removal from the fine fraction also. The final TPH on the treated coarse fractions ranged from 700 to 1,200 mg/kg, substantially lower than the levels of 2,100-11,000 mg/kg for untreated coarse fractions and 6,700-20,900 mg/kg for the untreated as received soils (fines and coarse). Also significant for these four soils is that the coarse fraction accounted for 68% to 94% of the mass of the as received soil, suggesting that treatment and backfilling of the coarse fraction would significantly reduce the volume of soil requiring further treatment/disposal.