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The Impacts of Thermal and Smouldering Remediation on Soil Properties Related to Rehabilitation and Plant Growth

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Tens of thousands of sites worldwide are contaminated with toxic non-aqueous phase liquids (NAPLs) reducing their economic and environmental value. As a result a number of treatments involving heat and smouldering have been developed to desorb and extract or destroy these contaminants including; steam injection (<110°C), electrical heating (<110°C), microwave heating (ambient to 400°C),conductive heating (ambient to 800°C) and in-situ smouldering (800°C to 1200°C). Implemented correctly these treatments are efficient enough for the soil to be safe for use, but the heating may unintentionally reduce the capability of the soil to act as a growing media. To investigate the effects of elevated temperature soils samples were heated at fixed temperatures (ambient to 1000°C) for one hour or smouldered after artificial contamination. Temperatures up to 105°C resulted in very little change in soil properties but at 250°C nutrients became more available. At 500°C little organic matter or nitrogen remained in the soil and clay sized particles started to decompose and aggregate. By 1000°C total and available phosphorus were very low, cation exchange capacity had been reduced, pH had increased and the clay fraction had been completely lost. Similar changes were observed in smouldered soils with variations dependent upon remediation conditions. As a result the smouldered soils will require nutrient supplementation to facilitate plant growth. Nutrient addition will also improve the physical properties of the soil and serve to re-inoculate it with microbes, particularly if an organic source such as compost or sewage sludge is used. The soils may remain effective growing media during lower temperature treatments; however some sort of soil inoculant would also be beneficial as these temperatures are sufficient to sterilise the system, which may impact nutrient cycling. Further work involving months-long exposure to the elevated temperatures that are typical of thermal remediation would be necessary to evaluate these changes relative to treatment conditions. Using this information rehabilitation packages can be developed and tailored to specific treatments as part of a holistic soil regeneration process.