A CASE STUDY:

Phytoremediation

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SUMMARY

Phytoremediation (Using green plants to clean up contaminated soil, ground water and wastewater) an emerging cleanup technology for contaminated soils, groundwater, and wastewater that is both low-tech and low-cost, is defined as the engineered use of green plants (including grasses, herbs, and woody species) to remove, contain, or render harmless such environmental contaminants as heavy metals, trace elements, organic compounds, and radioactive compounds in soil or water. A greenhouse experiment on zinc uptake in hybrid poplar (*Populus* sp.) was initiated in 2008. These experiments are being conducted to confirm and extend field data from Applied Natural Sciences, Inc., indicating high levels of zinc (4,200 g/g) in leaves of hybrid poplar growing as a cleanup system at a site with zinc contamination in the root zone of some of the trees. Analyses of soil water from hypsometer pots that had received several doses of zinc indicated that the zinc was totally sequestered by the plants in about 4 hours during a single pass through the root system. The data also showed concentrations of sequestered metal of >38,000 g/g (ppm) Zn in the dry root tissue. Above-ground organs contained less metal. A similar experiment evaluating zinc uptake in Eastern gamagrass (*Tripsacum dactyloides*), a large, robust native grass was conducted in 2009. This study found similar patterns of partitioning and sequestration as the poplar experiments, but growth and transpiration were more suppressed at the highest levels of accumulation in gamagrass. These levels of sequestered zinc observed in both hybrid poplar and eastern gamagrass exceed the levels found in either roots or tops of many of the known "hyper accumulator" species. Because the roots sequester most of the contaminant taken up in most plants, a major objective of this programme is to determine the feasibility of root harvesting as a method to maximize the removal of contaminants from soils. Currently ongoing studies include heavy metal uptake and fate from soil by willow trees as influenced by natural and chemical chelating agents, rooting patterns in hybrid poplar, and the uptake and fate of halogenated organics in hybrid poplar. Other research includes the development and successful field demonstration of a plant bioreactor for processing the salty wastewater from petroleum wells; the demonstration is currently under way at a natural gas well site in Oklahoma, in cooperation with Devon Energy Corporation.

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At many hazardous waste sites requiring cleanup, the contaminated soil, groundwater, and/or wastewater contain a mixture of contaminant types, often at widely varying concentrations. These may include salts, organics, heavy metals, trace elements, and radioactive compounds. The simultaneous cleanup of multiple, mixed contaminants using conventional chemical and thermal methods are both technically difficult and expensive, these methods also destroy the biotic component of soils.

Phytoremediation, an emerging cleanup technology for contaminated soils, groundwater and wastewater, is both low-tech and low-cost. Phytoremediation can be defined as the engineered use of green plants, including grasses, herbs, and woody species, to remove, contain, or render harmless such environmental contaminants as heavy metals, trace elements, organic compounds, and radioactive compounds in soil or water. This definition includes all plant-influenced biological, chemical, and physical processes that aid in the uptake, sequestration, degradation and metabolism of contaminants, either by plants or by the free-living organisms that constitute the plant's rhizosphere. Phytoremediation takes advantage of the unique and selective uptake capabilities of plant root systems, together with the translocation, bioaccumulation and contaminant storage/degradation abilities of the