

Quantitative Evaluation of Ecosystem Services for Superfund Cleanups

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Background/Objectives. The Superfund Program implements a green remediation strategy to reduce the environmental footprint of cleanup operations. Superfund guidance recommends that site teams conduct an environmental footprint analysis, as appropriate per site, to quantify site-specific metrics and better identify best management practices (BMPs) of green remediation. The Environmental Protection Agency's *Methodology for Understanding and Reducing a Project's Environmental Footprint* describes the analysis and the five core elements to consider in the analysis: energy, air, water, materials and waste, and land and ecosystems. To develop a quantitative approach to the land and ecosystems core element, EPA initiated a collaborative research project to examine how ecosystem services (ES), briefly defined as the contributions of ecosystems to human well-being, may be evaluated as a component of the environmental footprint of Superfund cleanups. Complementary to footprint reduction efforts, evaluation of ES at Superfund cleanups has implications for ecological revitalization and reuse of contaminated sites and community involvement.

Approach/Activities. Two Superfund cleanup sites, of different sizes and in different ecological regions, were selected for ES evaluations. The Lower Darby Creek Area is a 66-acre landfill, now covered in forest and wetland habitat, in metropolitan Philadelphia, whereas the Lower Basin of the Coeur d'Alene River is 18,000 acres of mining impacted wetlands in rural northern Idaho. A conceptual framework for ES evaluations at Superfund cleanups was developed and applied at both pilot sites. The framework consists of four steps: (1) identify site-specific ES, (2) quantify ES relevant to the cleanup effort, (3) examine ES affected by remedy implementation, (4) identify and implement green remediation BMPs that mitigate impact to ES or improve ES. At the pilot sites, ES were identified by using the Final Ecosystem Goods and Services Classification System (FEGS-CS) query tool and discussing the results with the remedial project managers (RPM) and their team. The Record of Decision (ROD) and Reuse Assessment for each site provided information to input into the FEGS-CS query tool. In order to quantify ES, publicly available tools were reviewed and assessed. The mapping tools, EnviroAtlas and InVEST, were applied to both sites. The i-Tree Eco tool was applied to Lower Darby Creek Area. The Wetland Ecosystem Services Protocol (WESP) tool was applied to selected wetlands in the Lower Basin of the Coeur d'Alene River. Quantitative results describing current ES at each site will be examined by the RPMs, so they may account for the impact of cleanup operations to ES and may determine BMPs to mitigate negative impact and support the potential ecological revitalization and reuse of each site.

Results/Lessons Learned. Understanding and quantifying ES may inform efforts to reduce the environmental footprint of Superfund cleanup and to promote ecological revitalization and reuse of contaminated sites. Identification of site-specific ES relies on input from the community and stakeholders, through Reuse Assessments or workshops, as well as the knowledge of the site team. Several publicly available, easily implementable tools may be utilized for ES quantification at contaminated sites. Use of a combination of tools, depending on the needs of the RPM and the prevalent ecosystem features, provides the full account of ES at a cleanup site. The ES evaluation process applied at the pilot sites will be provided as a replicable protocol in an update to the EPA *Footprint Methodology*.