

INEL-96/00274
CONF-961119--2

ROLE OF NATURAL PROCESSES AND RISK IN ENVIRONMENTAL
REMEDICATION DECISIONS

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ABSTRACT

Much attention is currently given to risk-based approaches to managing natural resources and hazardous waste. In order to apply a risk-based approach, input from the various stakeholders needs to be obtained early and updated throughout the effort. Applying a risk-based approach allows decisionmakers to evaluate options based upon sound scientific data. This paper discusses two examples of how risk-based approaches have been used to evaluate remediation options for management of natural resources and hazardous material problems in the Intermountain West. These examples demonstrate that without stakeholder involvement and using a risk-based approach, time and effort would have been wasted and decisions made to correct perceived rather than actual problems. The paper also describes the role that natural attenuation plays in making both risk and remedial action decisions.

1. INTRODUCTION

A risk-based approach to resource management and hazardous waste problems has received extensive attention since EPA started adapting the concept to the Resource Conservation and Recovery Act (RCRA) in 1992 (Chiang et al., 1995). It is interesting to note that Congress did not elect to use risk as a basis for developing the RCRA program. However, the philosophy of using a risk-based approach that EPA has adopted has become a cornerstone for many hazardous waste cleanup efforts. EPA philosophy is that risk assessment is the key to ensuring that each facet of the RCRA program is protective of human health and the environment.

In many of the areas of the country where waste processing, storage, or disposal facilities are located, ecological risk may be as important or more important than human risk. This is especially true at many of the Department of Energy's (DOE) National Laboratories and many Department of Defense (DOD) facilities located in isolated areas. EPA developed its Framework for Ecological Risk Assessment through a peer-reviewed workshop process (EPA, 1992). This framework provides a paradigm by which stressors and environmental conditions can be formulated via a conceptual model to identify important endpoints in the environment that could be affected by exposure to hazards. Since the development of the ecological risk framework, numerous books have been published (Suter, 1993; Maughan, 1993) on the subject that provide scientific

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methods for assessing risk and evaluate different procedures for presenting this to decisionmakers.

A critical component of the risk assessment framework that is often overlooked is the involvement of stakeholders in the development of the risk paradigm. Often risk assessments are done by scientists using sophisticated models without seeking stakeholder involvement and buy-in to the approaches. Stakeholders are often not involved until the risk assessment has been completed which encourages skepticism and reduces the validity of the risk assessment.

Another critical ancillary aspect to the risk-based framework is accounting for natural attenuation. Natural attenuation refers to the ability of natural processes to remediate a problem. Natural attenuation is usually a combination of intrinsic remediation (the combined biotic and abiotic degradation of a compound without engineered intervention) and other physical processes that affect the concentration of the compound in the environment (i.e., advection, dispersion, sorption, and volatilization). Natural attenuation should not equate to "do nothing" and leave the site alone. It has a direct link to the ecological risk decision process as shown in Figure 1. Consideration of natural attenuation issues needs to be carefully communicated and coordinated with stakeholders. This is critical if this remediation option is to be accepted by regional regulators and adopted by neighboring states.

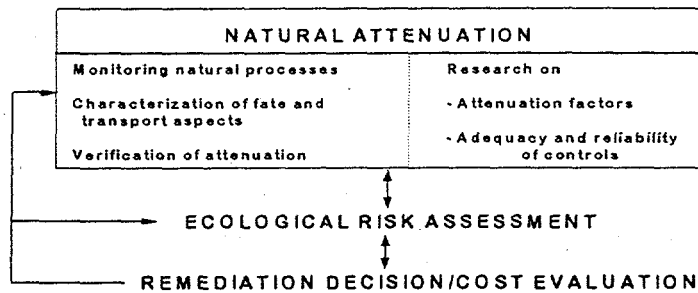


Figure 1. Natural attenuation links to the ecological risk decision process.

2. GOALS

The goal of this paper is to provide the reader with an understanding of how clear and accurate scientific information can be obtained from local stakeholders to develop risk paradigms that can be applied in a cost-effective and environmentally sound manner.

Science should address both technology and the role of natural processes in evaluating risk related to environmental remediation decisions. In many cases technology provides a viable solution, however, often the cure is worse than the disease. This is especially true in isolated areas where an extensive amount of disturbance is required to correct problems. Natural processes can play a critical role in environmental remediation and it is the responsibility of scientists to evaluate this role and accurately represent the ability of the natural system to address risk issues to decisionmakers.

3. CASE STUDIES

3.1 REMEDIATION OF A WORLD CLASS TROUT FISHERY

3.1.1 Problem. Henrys Lake, located in eastern Idaho is at risk due to development in the watershed. Man's activities in the basin are thought to be causing enhanced eutrophication that can lead to winter fish kills when thick ice and decaying plants resulted in depleted oxygen levels in the lake (Irving et al., 1992).

3.1.2 Approach. A group of scientists and stakeholders from state, federal, and local agencies, sportsmen's groups and local industries combined efforts to evaluate the overall risk to the fishery resource and select remediation decisions. The following activities were conducted over a two-year time period to address the perceived problem.

1. A workshop was held with all interested stakeholders to identify all known and suspected contaminant sources in the Henrys Lake watershed. This information was compiled into a database using a risk-based approach based on load and concentrations of the contaminants. The majority of contaminants in the watershed are nutrients, however, some hydrocarbons were present as a result of aviation, recreation, and agricultural fuel.
2. A conceptual model of the inputs to the lake was developed and mass loadings were determined.
3. Monitoring was conducted to verify estimated contaminant loadings based upon the conceptual model.

4. Research areas were identified for those locations where knowledge about contaminant loading to the system was inadequate.
5. A risk-based assessment was conducted to identify inputs of contaminants to the lake from various natural and anthropogenic activities.
6. Remediation decisions were made based on the results of the risk-based analysis.

3.1.3 Risk-based Analysis. At the conclusion of the workshop, the most obvious contributors of nutrients to the Henrys Lake basin were shoreline development, cattle grazing, and logging. Monitoring of these inputs was conducted during a year cycle and tracer studies were evaluated to determine the inputs from septic systems near the shoreline. Research activities were conducted in those drainages where information was lacking on nutrient loading. The risk-based analysis indicated that the greatest load of nutrients coming into the lake was associated with a natural deposit of phosphate located fairly high in one of the drainages. This deposit was being subjected to accelerated erosion due to disturbances occurring high in the watershed related to grazing and logging activities. Risks associated with grazing around the lake and shoreline development were low. The analysis indicated that the initial problem hypothesis was incorrect and that remedial action should be directed toward stabilizing the phosphate input from one specific sub-basin.

3.1.4 Remediation Decision. Using a risk-based approach and involving stakeholders in the process alerted many of the landowners and agencies associated with the lake of nutrient concerns. Decisions were made to address stabilization of the natural phosphate deposits and long-term grazing and development plans were established. Buffer zones were established around the lake and rotational grazing by landowners was voluntarily implemented. Regulations addressing future development were established to maintain a buffer zone between septic systems and the lake to ensure natural attenuation of nutrients. The bottom line was that using a risk-based approach, a costly remediation decision of putting in a wastewater treatment system for developments in the area was postponed. Landowners associated with the lake have adopted voluntary remediation practices to address problems because of their awareness and interest in maintaining the fishery and related recreational use of the lake. Stakeholder involvement early in the process allowed for extensive collaboration and the development of an integrated solution that would have otherwise been very difficult to orchestrate.

3.2 REMEDIATION OF A GROUNDWATER PLUME

3.1.1 Problem. A groundwater plume associated with an injection well that operated 25-40 years ago has produced a contaminant plume in a relatively isolated area that could migrate and present unacceptable risks to human health and the environment.

3.1.2 Approach. Stakeholders from state and federal agencies, and the operational facility combined forces to evaluate the most cost-effective option to address the groundwater plume and reduce risk to within a range of 10^{-4} to 10^{-6} and meet terms of a Consent Order Compliance Agreement (COCA). Several options were evaluated as part of this approach, including (1) the No-Action option of relying completely on natural degradation of the contaminants by solubilization of free products, dilution, dispersion, and decay of the contaminated groundwater; (2) relying on institutional controls to monitor the contaminants, alternate water supplies in the area until natural attenuation would reduce the risk to acceptable levels and restrict access, (3) look at containment using extraction and injection wells; (4) evaluate collection and removal of contaminants from the aquifer and (5) look at in-situ treatment of the contaminants.

Criteria were established to evaluate the effectiveness, implementability and cost-effectiveness of each option, as well as the ability of the option to meet requirements and the potential adverse impacts of each option to human health and the environment during the construction and implementation phase.

3.1.3 Risk-based Analysis. A risk-based analysis was used to evaluate how the various remedial action alternatives would meet a set of criteria developed by the stakeholders. By considering a combination of pump and treat of the most contaminated areas and natural attenuation of areas that could be held under institutional control for the next 30-70 years, the costs and impacts to the environment due to remediation activities were minimized. An innovative approach has been adopted by the state and federal regulators to review newly developing technologies every five years for possible application to enhance risk reduction in a cost-effective manner.

3.1.4 Remediation Decision. The final remediation decision has not been made on this project because a monitoring and research component is being conducted to determine the effectiveness of natural attenuation on the lower contaminated areas. Agencies and other stakeholders involved consider this to be a reasonable alternative to taking extensive actions to clean up the plume because risk analysis indicates that acceptable levels should be attained while the facility is still under institutional control.

4. SUMMARY AND CONCLUSIONS

Stakeholder involvement in evaluating remedial decisions for correction of environmental problems is critical. Natural processes can help to attenuate environmental problems in sparsely populated areas and often lead to less damage to ecological resources than extensive remediation activities. Often natural processes can be enhanced using a good understanding of the biological and ecological systems and the extent of a problem is different from initial perceptions. Scientific data is often not available to properly characterize the problem and identify the risks associated with contaminant sources. Scientists and decisionmakers must be open to consider natural attenuation in making risk-based decisions, but ultimately must take a conservative stance based upon acceptable risk to human health and the environment because natural processes are not well understood. Time and institutional controls are the most important factors in evaluating the acceptability of using natural processes to remediate problems and reduce risks to acceptable levels.

5. REFERENCES

C. Y. Chiang, P. D. Petkovsky, and P. M. McAllister, "A Risk-Based Approach for Managing Hazardous Waste", *Ground Water Monitoring Review*, Winter 1995, pp. 79-89.

J. S. Irving, R. C. Rope, and R. P. Breckenridge, 1992, "Contaminant Monitoring Strategy for Henrys Lake, Idaho", EGG-EEL-10523, EG&G Idaho, Inc., Idaho Falls, ID.

James T. Maughan, 1993, *Ecological Assessment of Hazardous Waste Sites*, Van Nostrand Reinhold, New York, NY.

Glenn W. Suter II, 1993, *Ecological Risk Assessment*, Lewis Publishers, Chelsea, MI.

U. S. Environmental Protection Agency, *Peer Review Workshop Report on a Framework for Ecological Risk Assessment*, EPA/625/3-91/022, February 1992, Risk Assessment Forum, Washington, DC.