ITRC PROJECT PROPOSAL: Attenuation Processes for Metals and Radionuclides

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Problem Statement (why is this project necessary?)

This project addresses a regulatory barrier and its associated technical issues. DOE sites, NRC sites and many Superfund and DoD sites are contaminated with radionuclides and/or metals. Presently, there are no regulatory compliance guidance documents that specifically address the use of attenuation-based remedies for metal and radionuclide contaminated groundwater and subsurface soils and sediments. This lack of guidance will contribute to inconsistent approaches and application of attenuation-based remedies and generally discourages the consideration of such remedies. The net result is that many sites face "intractable" closure problems. Metal and radionuclide contaminants are not subject to the traditional biological or chemical degradation reactions – they are either stable or subject only to radioactive decay. In a few cases, radionuclide decay or environmental transformation (e.g. formation of methylated metals) convert the contaminants into more toxic forms. The converse concept, conversion of contaminants to more stable and nontoxic species is the central opportunity for attenuation-based remedies. This stabilization can result from natural processes, geochemical gradients or biogeochemical manipulation. Contaminated sites face the challenge of protectively remediating metals and radionuclides to ensure they do not threaten human health or the environment for a very long period of time. The costs of ongoing conventional treatment, total removal, and/or management combined with the scale of potential health and environmental risks make the need for transformational alternatives urgent.

As a result of public perception, risk, and the current regulatory framework, many metals and radionuclides pose a remediation problem even when they are present at extremely low concentrations – levels that are orders of magnitude lower than many of the common toxic organic and inorganic contaminants. Despite over two decades of active research into developing technologies to remediate soils contaminated with radionuclides, most evaluations still conclude that the challenges of complete cleanup of these sites are daunting, and that a complete active cleanup and removal of contaminants to levels that satisfy all constituencies may not be achievable. The situation poses a major problem for DOE as well as other agencies and commercial entities. Currently DOE attempts to clean up radioactively-contaminated sites to the best level within the constraints of economic and technical feasibility. However, "clean" closure often cannot be achieved when low-level residual amounts of metals and radionuclides remain at contaminated sites.

This issue has broad national, as well as international, applicability. DOE has 16 major facilities throughout the country that are contaminated with radionuclides. Though DoD issues with radionuclides are generally fewer, the widespread use of depleted uranium (DU) for both munitions and armor, has already led to DU contamination becoming an issue at 10 facilities within the U.S.

EPA is currently completing a Technical Brief on remediation of depleted uranium contaminated sites, and EPA's Superfund Program is encountering growing problems with radionuclides; though often only a small fraction of the total contaminant inventory they can sometimes dominate the total clean-up costs. EPA is currently completing a draft series of technical support documents on monitored natural attenuation (MNA) of metals and radionuclides. EPA is expected to draft a policy guidance on MNA of inorganics with its technical support documents providing much of the rationale for its policy direction.

Solution / Impact (how will the project impact the environmental marketplace?)

The products of this project will provide guidance that will support a consistent approach to and application of attenuation-based remedies as part of the cleanup of sites with metal and radionuclide contaminated groundwater and subsurface soils/sediments. The results of such guidance will potentially save significant time for regulators and money for site owners/responsible parties while maintaining a high level of environmental stewardship.

This guidance will provide regulators with a consistent basis for evaluating whether an approach proposed by a site owner/responsible parties is technically sound and defensible when characterizing, implementing, and monitoring attenuation-based remedies for metal and/or radionuclide contaminated sites. This will allow regulators and site owners/responsible parties a level of comfort in their decisions. This guidance will also lead to a more efficient use of their time by providing a centralized location for guidance related to attenuation-based remedies.

Since attenuation-based remedies rely heavily on measuring what is occurring in the subsurface, new technologies will be needed to support characterization and long-term monitoring of attenuation-based remedies for metals and radionuclides. Any additional characterization and monitoring for such remedies, however, is expected to cost considerably less than implementing an engineered remedy. Also, because processes for the attenuation of metals and radionuclides are contaminant specific and are greatly affected by the biogeochemical conditions of the subsurface, companies will develop expertise to aid sites in assessing and implementing attenuation-based remedies for metals and radionuclides.

Success Measures (how you determine the project impact to the market place)

1. Use of the Tech-Reg Guidance by both states and federal agencies
2. Number of states concurring on tech-reg guidance document
3. Training attendance
4. Evidence of impacting decisions at cleanup sites
5. Follow on collaborative efforts with regulatory agencies (e.g., participation in conferences, meetings and working groups)

Summary of Deliverables (primary project outputs)

Expected products include:

- Web-based resource: *Resource Guide/Technology Overview of Attenuation Processes for Metals and Radionuclides*
- Case Studies Forum on attenuation and attenuation-related technical and regulatory issues.
- Document based on the Case Studies Forum: *Case Studies of Attenuation Processes for Metals and Radionuclides*
- Technology and regulatory guidance document: *Attenuation Processes for Metals and Radionuclides*
- Internet-based training (series): *Attenuation Processes for Metals and Radionuclides*
- *Revenue generating conference and workshop series*

Project Schedule

- Web-based resource: *Resource Guide/Technology Overview of Attenuation Processes for Metals and Radionuclides (December 2008)*
- Case Studies Forum on attenuation and attenuation-related technical and regulatory issues. (Fall, 2008)
- Document based on the Case Studies Forum: *Case Studies of Attenuation Processes for Metals and Radionuclides (June, 2009)*
- Technology and regulatory guidance document: *Attenuation Processes for Metals and Radionuclides (June, 2010)*
- Internet-based training (series): *Attenuation Processes for Metals and Radionuclides (Fall, 2010)*

Target Audience

As is typical with ITRC documents, the proposed products will primarily target state regulators and stakeholders. Because a successful attenuation option is so important to DOE, DoD, NRC, USEPA, tribes, communities, and any commercial facilities that manufactured or handled metals or radioactive contaminants, these products will also target that much broader audience. Another market (and possible funding source and/or partner) that the Team will explore is the Department of Homeland Security (DHS), specifically targeting the need for large scale and inexpensive decontamination or stabilization technologies in the event of a radiological dispersion device (RDD) event.

It is expected that this guidance will complement the information in the EPA policy and technical support documents, for example by: (1) addressing enhanced attenuation processes, (2) addressing statutes other than CERCLA, and providing case study analysis of previous site decisions.

Resources Required

Personnel:

- Team Leader and Five States that are Interested in Supporting this Project:
  Carl Spreng, CO (TL); Ann Charles, NJ; Chris Yarnel, TN; Dib Goswami, WA; Hai Shen, NM
- Skill Mix of Team Members – radiation chemistry, physics, health physics, hydrology, regulatory, engineering.
- Sectors of Team Members – state regulators, community representatives/stakeholders, EPA (office of Radiation and ORD), DOE (national labs), DOD, regulated entities, other regulators such as NRC.

Financial Resources:

DOE has budgeted 100Kfor this project and EPA has shown great interest in this team effort. DOD/SERDP has identified Attenuation as a Thrust Area. Following is a breakdown of anticipated resource requirements:

2008:
Team Travel - $15,000, CPM - $2,500, Contractor Support - $82,500 TOTAL: $100,000
2009:
Team Travel -$15,000, CPM - $6,500, Contractor Support - $78,500, TOTAL: $100,000
2010:
Team Travel -$15,000, CPM -$6,500, Contractor Support - $76,500, TOTAL:$97,000

Related Work:

It is anticipated that the core of this Team may draw from experienced ITRC members from teams such as the Radionuclides, In Situ Bioremediation, Bioremediation of DNAPLs, Enhanced Attenuation of Chlorinated Organics, Remedial Process Optimization, and the Metals in Soils teams. The Team will include representatives from at least five states, DoD, EPA, DOE, and public and tribal stakeholders. From a technical perspective, many elements of an attenuation-based strategy are currently available but have not been effectively integrated or are not applicable to metals and radionclides. The following exemplify the existing perspectives:

1. EPA has a monitored natural attenuation (MNA) policy (Directive 9200.4-17P, April 21, 1999) that addresses three general categories of common pollutants susceptible to natural attenuation - petroleum-related products, chlorinated solvents, and inorganics. The policy recognizes that MNA may be an appropriate remediation option for all three categories, but emphasizes the application to petroleum-related products and chlorinated solvents. It does not have specific recommendations for applying MNA to metals or radionuclides.
2. DOE has an ongoing and longstanding interest in bioremediation of radionuclides. Quoting from a DOE publication: "Over the past few years, interest in bioremediation has increased. Waste-water managers and scientists have also found that microorganisms can interact with metals and convert them from one chemical form to another. Laboratory tests and ex situ bioremediation applications have shown that microorganisms can change the valence, or oxidation state, of some heavy metals (e.g., chromium and mercury) and radionuclides (e.g., uranium) by using them as electron donors or acceptors. In some cases, the solubility of the altered species increases, increasing the mobility of the contaminant and allowing it to more easily be flushed from the environment. In other cases, the opposite will occur, and the contaminant will be immobilized in situ, e.g., precipitated into an insoluble salt in the sediment. Both of these kinds of transformations present opportunities for bioremediation of metals and radionuclides — either to lock them in place, or to accelerate their removal." This work is encouraging, however for it to have application as an attenuation-based (MNA) remedy this change must be sustainable. The key to evaluating the sustainability is understanding the subsurface biogeochemical conditions within the agreed upon boundary conditions of the system.
3. A recent (2005) state regulators' workgroup provided DOE with a "State Regulators Consensus Workshop on the Use of Bioremediation to Treat Radionuclides and Metals." The workshop's consensus document declared that "state regulators should be viewed as partners for implementation of bioremediation for radionuclides and metals, not as obstacles" since they have "consistently demonstrated a willingness to consider innovations or alternative technologies that meet cleanup goals."
4. There are a host of contaminant stabilization, mobilization and transformation technologies that are in various stages of development that may be appropriate enhancements to the natural attenuation of metals and radionuclides. Also ongoing are development efforts associated with the long-term surveillance and maintenance of metal and radionuclide contaminated sites.

The concept of attenuation-based remedies (MNA and Enhanced Attenuation) is also closely related to the work being done by the ITRC Enhanced Attenuation of Chlorinated Organics Team from the perspective of that Team's generalized model of where enhanced attenuation fits into the spectrum of clean-up responses ranging from aggressive primary intervention through to monitored natural attenuation. Beyond bioremediation, ITRC Teams have worked on a number of related efforts including the Long-Term Stewardship work of the Radionuclides Team, the exit strategy concepts of the Remedial Process Optimization Team, the process flow concept of the Enhanced Attenuation of Chlorinated Organics Team and the In Situ Stabilization/Inplace Inactivation concepts of the Metals in Soils Team. However, even though some elements of an attenuation framework for metals and radionuclides exist, no document has integrated the critical technical and regulatory aspects together, particularly from a state perspective.