Program Announcement
To DOE National Laboratories
LAB 06-12

Environmental Remediation Science Program

SUMMARY: The Office of Biological and Environmental Research of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces interest in receiving proposals for research in the Environmental Remediation Sciences Program (ERSP). The goal of the ERSP is to support innovative, fundamental research investigating coupled chemical, biological and physical processes affecting the transport of DOE-relevant contaminants within the subsurface at DOE sites leading to new or improved subsurface remediation techniques and a sound foundation for remedial action decisions important to long-term site stewardship. This solicitation addresses several science elements previously addressed under the Natural and Accelerated Bioremediation Research (NABIR) program and the Environmental Management Science Program (EMSP) and reflects the merger of these two programs into the ERSP. Proposals should address hypothesis-driven research to define biologically-mediated and/or hydrogeochemical processes influencing the form and mobility of DOE contaminants and provide the basis for development of new remediation concepts or strategies for long term stewardship. **Proposals should address the applicability of the proposed research to DOE relevant contaminant transport processes occurring in the field.** The environment of interest is the terrestrial subsurface below the zone of root influence including both the vadose zone (unsaturated) and the saturated zone (groundwater and sediments). Phytoremediation is not addressed in this solicitation. Specific Science Elements of interest to this solicitation include: 1) Subsurface Biogeochemistry; 2) Subsurface Microbial Ecology and Community Dynamics; 3) Innovative Field-scale Remediation and Long-Term Stewardship Research; 4) Novel Measurement and Monitoring Concepts, and; 5) Exploratory Research.

DATES: Researchers are strongly encouraged to submit a preproposal addressing a specific Science Element of interest for programmatic review. Preproposals should be submitted by April 14, 2006, to allow sufficient time for evaluation of programmatic relevance by DOE and for subsequent preparation of the full proposal. The preproposal narrative of no more than two pages should consist of a description of the research objectives, hypotheses, approach, and relevance to DOE needs. The preproposal should also include a list of the key investigators, their disciplines and their institutions using at most one page. If no response to the prepropsal is received by May 5, 2006 please contact the Program Manager.

Full proposals submitted in response to this Announcement must be submitted to the DOE Electronic Proposal Management Application (ePMA) system (https://epma.doe.gov) no later than 8:00 p.m., Eastern Time, June 15, 2006, to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2007. It is important that the entire peer reviewable proposal be submitted to the ePMA system as single PDF file attachment. Please see the "Addresses" section below for further instructions on the methods of submission for the full proposal.

ADDRESSES: Preproposals referencing Program Announcement LAB 06-12, and the Science Element of interest should be sent via E-mail attachment to Kim.Laing@science.doe.gov. Use "Program Announcement LAB 06-12, preproposal to [Science Element]" as the subject of the email.

A complete formal FWP in a single Portable Document Format (PDF) file must be submitted through the DOE ePMA system (https://epma.doe.gov) as an attachment. To identify that the FWP is responding to this program announcement, please fill in the following fields in the "ePMA Create Proposal Admin Information" screen as shown:

Proposal Short Name:
Fiscal Year:
Proposal Reason:
Program Announcement Number: Lab 06-12 *
Program announcement Title: Environmental Remediation Science Program, DOE Research Program Announcement *
Proposal Purpose:
Estimated Proposal Begin Date:
HQ Program Manager Organization:

* Please use the wording shown when filling in these fields to identify that the FWP is responding to this Program Announcement.

In order to expedite the review process, please submit a CD and two copies of the proposal and FWP using the following, by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand-carried to:

Kim Laing
U.S. Department of Energy
Office of Biological and Environmental Research, SC-23.4/GTN
19901 Germantown Road
Germantown, MD 20874-1290
ATTN: Program Announcement LAB 06-12

In the proposal package, include an extra copy of the one-page abstract.

DOE National Laboratories should submit using ePMA as instructed above. Applicants from U.S. Colleges and universities, non-profit organizations, for-profit commercial organizations, state and local governments, and unaffiliated individuals should respond to Program Notice DE-FG02-06ER06-12 using Grants.gov. Researchers from other Federal agencies and Non-DOE Federally Funded Research and Development Centers (FFRDCs) should follow the format at http://www.science.doe.gov/grants/fed_prop.html and submit the proposal as a CD and two paper copies using the following, by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand-carried to:

Kim Laing
U.S. Department of Energy
Office of Biological and Environmental Research, SC-23.4/GTN
19901 Germantown Road
Germantown, MD 20874-1290
ATTN: Program Announcement LAB 06-12

FOR FURTHER INFORMATION CONTACT: Dr. Robert T. Anderson of the Environmental Remediation Sciences Division (SC-23.4) within the Office of Science, U. S. Department of Energy at telephone: (301) 903-5549, E-mail: Todd.Anderson@science.doe.gov, fax: (301) 903-4154. The full text of Program Announcement LAB 06-12 is available via the Internet using the following web site address: http://www.science.doe.gov/grants/grants.html.

BACKGROUND INFORMATION

The Department of Energy oversees some of the largest environmental cleanup operations in the world. Cold War Era processing of uranium for nuclear power and weapons has left an enduring legacy of over 6 billion cubic meters of contaminated soil, groundwater and other environmental media requiring innovative solutions to cleanup, manage and monitor contaminants found at DOE sites (NRC, 2000). The Environmental Remediation Sciences Division (ERSD) within the Office of Biological and Environmental Research (BER) is tasked with developing the fundamental scientific basis for understanding the fate and transport of contaminants in the subsurface. This task is guided by the ERSD long term performance measure to "provide (by 2015) sufficient scientific understanding to allow a significant fraction of DOE sites to incorporate coupled biological, chemical and physical processes into decision making for environmental remediation." In order to meet this measure the ERSD will fund multi-disciplinary research in a variety of science areas investigating key processes affecting the mobility of subsurface contaminants found at DOE sites. On October 1, 2005, ERSD's Natural and Accelerated Bioremediation Research (NABIR) program and the Environmental Management Science Program (EMSP) were merged to create the Environmental Remediation Sciences Program (ERSP), in accordance with Congressional direction. This is the first solicitation of the new ERSP and represents DOE's interest in continuing to support and build on the substantial research progress developed under the former NABIR and EMSP programs to address some of the nation's most difficult environmental problems.

Subsurface Contamination Research Needs

Legacy subsurface contamination at current and former processing and storage sites of radioactive materials presents an enormous technical, scientific and financial challenge for the Department of Energy and the nation as a whole. While technologies exist for dismantling and decommissioning physical surface structures such as contaminated buildings and former support structures, contaminants that have entered the subsurface are exceptionally difficult to clean up. This is particularly true for those contaminants spread over wide areas and whose potent toxicity and persistence requires removal to very low levels. Radionuclides, products of nuclear fuel and weapons manufacture, fall into this category of contaminants and are of particular concern to

DOE cleanup operations in addition to other contaminant metals and non-aqueous phase liquids (NAPLs) also found at DOE sites.

The projected performance of subsurface remediation techniques and long term stewardship strategies is often based on insufficient knowledge of the transport behavior of contaminants in the subsurface and the mechanisms of contaminant transformation. As a result, many *in situ* strategies often do not meet performance expectations and exceed both cost and time schedule estimates. Consequently, it is likely that at many sites subsurface contamination will remain long after surface remediation measures have been completed (DOE, 2001; NRC, 2000). It is therefore imperative that DOE understand the factors that affect contaminant mobility and transformation within the subsurface in order to devise new remediation and long term monitoring strategies and to provide realistic assessments of the threat posed by subsurface contamination. These tasks will require significant advances in our understanding of key factors affecting the mobility and fate of contaminants in the subsurface. Additionally, these tasks will require the development of innovative tools for detecting, monitoring, modeling and stabilizing contaminants *in situ*, as well as novel techniques for removing contaminants from the subsurface.

Within the former NABIR and EMSP programs substantial progress has been made in evaluating the biogeochemical relationships among DOE relevant contaminants and the subsurface environment. Numerous applications of analytical techniques at the molecular scale have revealed previously unknown aqueous and solid phase-associated complexes of DOE-relevant contaminants, binding mechanisms to naturally-occurring minerals or organic matter and sequestration deep within pore structures of subsurface materials. At larger scales, applications of advanced subsurface detection techniques and isotope analyses have provided new insights into the location, mobility and speciation of subsurface contaminants. Mineral transformation studies have yielded a wealth of information on the potential for chemical additives and native microorganisms to transform geochemical conditions within subsurface materials to reduce, transform and/or sequester contaminants. These examples and many others have contributed to a growing body of literature on the speciation, transformation, sorption chemistry and precipitation/dissolution behavior of contaminants found in the subsurface at DOE sites. These analyses are crucial to understanding the transport behavior of contaminants under a variety of biogeochemical conditions likely to be found in the contaminated subsurface and have contributed new insights into potential techniques for immobilizing or transforming contaminants *in situ*. The ERSP will continue to support research activities that contribute to a better understanding of the biogeochemical nature of DOE relevant contaminants in the subsurface.

In addition to geochemical effects on transport, the activity of subsurface microbial communities can have a profound affect on the mobility of the contaminants in the subsurface. Many microorganisms are known to directly and/or indirectly facilitate the complexation, reduction, transformation, biomineralization and sequestration of DOE relevant contaminants. Stimulating microbial activity *in situ* is the basis for several promising subsurface remediation techniques (http://www.lbl.gov/NABIR/generalinfo/03_NABIR_primer.pdf). However, these techniques are still largely guided by empirical knowledge of the functioning of the subsurface microbial communities. While detailed physiological studies of subsurface isolates continue to provide new insights into the potential mechanisms of contaminant transformation by subsurface

microorganisms much remains to be done. Recent advances in molecular biology continue to provide new insights into the genetic basis for microbially mediated subsurface processes and there is a need to understand the functioning of subsurface microbial communities from a more mechanistic perspective. Several projects associated with the former NABIR program are conducting detailed studies of the metabolism of metal-reducing bacteria in order to understand and model the microbial respiration of insoluble metal oxides and radionuclides. Similar studies are being conducted with sulfate-reducing organisms found in the subsurface, which also are known to reduce metals and radionuclides, as well as fermentative organisms and organisms capable of respiring halogenated organics. These detailed physiological studies of microbes native to contaminated environments coupled with advanced techniques for detecting whole communities of organisms, or even a subset of targeted genes, are providing mechanistic descriptions of microbial processes in subsurface environments.

The application of these genome-enabled techniques to environmental processes at the field scale is an important link between the ERSP, the Genomics:GTL program (http://doegenomestolife.org/) and microbial genome sequencing efforts at the Joint Genome Institute (JGI, http://www.jgi.doe.gov/). Gene expression techniques coupled with genomic information and in silico modeling of multiple species could ultimately provide new tools to understand how microorganisms grow in the subsurface, how growth relates to contaminant transformation activity, nutrient limitations, stress responses, electron donor and acceptor utilization and a host of other metabolic processes likely to be important for understanding and modeling the biological impacts on subsurface contaminant fate and transport. The application of molecular biology and genomics-enabled techniques to a mechanistic understanding of microbially-mediated contaminant transformation processes within the contaminated subsurface will continue to be a focus of the new ERSP.

While understanding the functioning of subsurface microbial communities in the context of the DOE environmental remediation mission is of importance, that mission requires that the ERSP take a broad view of subsurface remediation science. Innovative physical/chemical processes to transform or stabilize DOE relevant contaminants *in situ*, as well as methods to monitor these processes have been a focus within the former EMSP program. Several projects have explored the potential of various oxidants, reductants and nano-sized materials to transform and/or immobilize contaminants of concern to DOE. Additional projects have investigated the fate and transport characteristics of contaminants under conditions of extreme pH, ionic strength and radioactivity found beneath leaking high level waste storage tanks. ERSP will continue to support innovative applications of physical/chemical-based remediation techniques and research that impacts the long term stewardship concerns associated with Legacy Management sites. Coupled projects involving combinations of physical/chemical processes and biological processes are also of interest whether configured together or sequentially. For those sites where contaminants have been stabilized, sequestered or transformed, assessment of the long term stability of contaminants is also of interest to the new program. Additionally, the ERSP will continue to facilitate development of characterization and monitoring techniques designed to track contaminant migration, delineate subsurface structure and monitor subsurface processes in the field. The intent is to foster close coordination among a diverse suite of subsurface science disciplines to address DOE's subsurface science needs and to meet the ERSD long term performance measure.

Coincident with an improved understanding of subsurface geochemical, biological physical/chemical processes affecting contaminant transport is the need to incorporate this knowledge into models of contaminant transport. Conceptual models, including computational simulation are important elements of the decision-making process for environmental remediation and should reflect current state-of-the-science understanding of factors affecting subsurface fate and transport of contaminants. Additionally, conceptual and computational model development synthesizes current understandings of subsurface processes in a centralized manner and serves as a valuable research tool for exploring new hypotheses of contaminant mobility. Subsurface transport modeling has been a component within both the former EMSP and NABIR programs and will figure prominently in the new ERSP program. This will be particularly true for large, multi-disciplinary projects where the opportunity to synthesize concepts from many scientific disciplines at once is greatest. Recent workshops on reactive transport modeling (Davis et al., 2004) describe the need for multi-disciplinary research projects that incorporate modeling as an essential element of subsurface research. The ERSP portfolio maintains a diverse suite of projects ranging from molecular scale science to field scale investigations. This multi-disciplinary approach should facilitate diverse collaboration among subsurface researchers and advance our understanding of the critical processes that influence or control contaminant fate and transport at the field scale.

While both the former NABIR and EMSP programs made significant contributions to subsurface science and addressed DOE's needs in this area, major challenges remain. Of paramount importance is the linking of molecular scale processes to larger scale processes and ultimately, to processes occurring at the field scale. The ultimate goal of the ERSP is to provide DOE with field scale descriptions of subsurface processes affecting contaminant transport or transformation. Projects funded within the ERSP should progress toward demonstrating the field relevance of processes or techniques under investigation. In order to promote this approach, the ERSP is soliciting proposals in several targeted Science Elements addressing the investigation of contaminants of greatest concern to DOE.

The preceding discussion is based on the draft ERSP Strategic Plan, which is available for comment on the ERSD website at http://www.sc.doe.gov/ober/ERSD_top.html.

CURRENT REQUEST FOR PROPOSALS

Contaminants of Concern

Contaminants of concern across the DOE complex broadly include: radionuclides, metals, nitrates, and nonaqueous phase liquids (NAPLs). Key contaminants (and their mixtures) of interest for the ERSP are:

- Radionuclides: plutonium, strontium-90, cesium-137, technetium-99, iodine-129, neptunium-237, and uranium.
- Non-Radioactive Metals: chromium(VI) and mercury.
- Nitrate as a co-contaminant with the listed radionuclides or non-radioactive metals.
- NAPLs (i.e. carbon tetrachloride, trichloroethylene, dichloroethylene, tetrachloroethylene, chloroform, dichloromethane, and polychlorinated biphenyls) and

complexing agents (such as EDTA) as co-contaminants with the listed radionuclides or non-radioactive metals.

A description of the nature and extent of contamination at the principal DOE sites is available at http://www.nap.edu/books/0309065496/html/index.html/. More detailed information is available in some cases from the major DOE sites: Hanford (http://www.hanford.gov, http://www.hanford.gov/cp/gpp/, http://www.hanford.gov/cp/gpp/science/sandt.cfm) Idaho National Laboratory (http://www.inl.gov/subsurface/environmentalissues/vadosezone.shtml) Oak Ridge Reservation (http://www.oakridge.doe.gov/External/Default.aspx?tabid=42) and Savannah River Site (http://www.srs.gov/general/srs-home.html, http://www.srs.gov/general/programs/soil/extpage.html).

Science Elements

Proposals submitted in response to this Announcement must address at least one of the ERSP Science Elements listed below. **Each proposal must clearly identify the Science Element that is most closely aligned with the proposed research.** Both single investigator projects and multi-investigator projects are encouraged within each element. Multi-investigator projects are expected to integrate multiple disciplines into the project. All projects should clearly delineate a hypothesis-driven approach to research and describe how the results of the research would ultimately improve understanding of subsurface processes at the field scale in the context of the DOE cleanup mission. A specific and well documented DOE relevance justification will be an important component of successful proposals. Field projects are strongly encouraged to include a contaminant transport modeling component and an innovative monitoring component (such as geophysical methods) as integral parts of the overall research plan.

Subsurface Biogeochemistry

Objective: Develop a fundamental and quantitative understanding of the coupling of biogeochemical processes affecting contaminant transport, reactivity and stability in subsurface environments.

Many factors affect the transport and/or transformation of contaminants found in subsurface environments. Often several competing reactions occur simultaneously and/or produce intermediates of undetermined stability, further complicating overall quantitative descriptions of reactive transport. Additionally, at many DOE sites, DOE-relevant contaminants are found under unusual conditions of pH, ionic strength and redox potentials, and in unusual mixtures. These extreme conditions attenuate as the contaminants travel down gradient resulting in a change in the transport behavior of contaminants. Likewise, various *in situ* remediation techniques produce changes in local geochemical conditions in groundwater or vadose zone settings that directly influence contaminant transport. Also, the metabolic activity of subsurface microorganisms or biofilm communities can profoundly change the geochemical character of contaminants and subsurface materials, either intentionally as part of a remediation technique or as a consequence of the local subsurface conditions.

The ERSP seeks understanding of the most important of the myriad biological and abiological interactions that affect contaminant transport in subsurface environments. This requires the identification and prioritization of key biogeochemical processes needed to predict the extent and rate of reactions affecting contaminant transport at DOE sites. Insight gained at the molecular scale should be used to interpret or predict processes occurring at larger scales and ultimately along groundwater flowpaths in the subsurface. Refinement of conceptual and/or computational models of contaminant transport based on new geochemical understanding of contaminant mobility and insight of cellular metabolic processes at the microbe-mineral interface is of interest. The emphasis of this science element is on understanding the integral relationships among biological and geochemical processes influencing contaminant transport and/or remediation. Coordination with an ERSP field project is encouraged. The diversity and dynamics of microbial communities in the subsurface are addressed in the *Subsurface Microbial Ecology and Community Dynamics* Science Element. However, multi-investigator projects are encouraged to be cross-cutting across these Science Elements. The contaminants of interest for this Science Element for this Announcement are the radionuclide and non-radionuclide metal contaminants listed above as well as nitrate and complexing agents as co-contaminants with the listed radionuclide and non-radionuclide metals. NAPL contaminants are not considered at this time for this Science Element for this Announcement.

Areas of interest in this Science Element include:

- Understanding the fundamental chemical nature of reactive mineral surfaces, the biologically induced chemical and redox gradients across mineral-water interfaces and interactions with DOE relevant subsurface contaminants.
- Advanced techniques to assess the form, stability and distribution of immobilized DOE relevant contaminants in subsurface sediments.
- Research to identify and quantify the dominant biogeochemical mechanisms leading to the immobilization and/or remobilization of DOE relevant contaminants within the subsurface.
- Scaling of biogeochemical reactions and gradients, important for understanding the fate and transport of DOE relevant contaminants in the subsurface, occurring at the molecular, mineral surface and pore levels to larger scales.

Funding for single investigator projects under this element up to $450K/yr is available for a maximum of 3 years. Multi-investigator projects may apply for up to $600K/yr for a maximum of 3 years. Continued funding is contingent upon progress of the research and on the availability of funds.

Subsurface Microbial Ecology and Community Dynamics

Objective: Develop a quantitative understanding of the growth, activity and structure of subsurface microbial communities affecting contaminant transport.

Microorganisms detected in the subsurface can profoundly alter geochemical conditions along groundwater flowpaths. In addition to indirectly creating conditions hindering contaminant mobility, many microorganisms are known to directly biotransform contaminants to innocuous

or immobile forms. This is the basis for several *in situ* bioremediation technologies and natural attenuation mechanisms and may also play a role in the effectiveness of some *in situ* barrier systems. However, the sustained manipulation of subsurface microbial communities to affect contaminant transport and/or degradation is still largely an empirical exercise. Likewise the microbially-mediated mechanisms of natural attenuation processes and potential microbial involvement in other more physical/chemical *in situ* remediation techniques remain poorly understood. Much remains to be learned about the identity and functioning of subsurface microbial communities relevant to contaminant biotransformation processes. Of particular concern for *in situ* remediation and natural attenuation processes is a mechanistic understanding of how microbial growth and activity quantitatively relate to mineral and contaminant biotransformation. This requires a mechanistic understanding of how microorganisms access/obtain essential nutrients, electron donors and electron acceptors in order to sustain activity. Also, interactions among groups of active microorganisms need to be better understood in order to more fully explain competitive processes and shifts in community structure. Additional techniques are needed to evaluate the distribution of active microbial communities in the contaminated subsurface as well as identification of novel mechanisms of microbially mediated contaminant transformation.

The emphasis of this Science Element is on understanding the functioning of subsurface microbial communities and how their growth and activity affects contaminant fate and transport. Successful proposals will address communities involved in metal and radionuclide immobilization/stabilization processes in environments of relevance to DOE. The more geochemical aspects of microbial processes affecting contaminant transport are addressed in the *Subsurface Biogeochemistry* Science Element. However, multi-investigator projects are encouraged to be cross-cutting across both Science Elements. The contaminants of interest for this Science Element for this announcement are the radionuclide and non-radionuclide metal contaminants listed above as well as nitrate and complexing agents as co-contaminants with the listed radionuclide and non-radionuclide metals. NAPL contaminants are not considered at this time for this Science Element for this Announcement.

Areas of interest in this Science Element include:

- Techniques to quantitatively identify active members of subsurface microbial communities and relate growth and activity to rates of biogeochemical reactions.
- Methods to quantify rates of contaminant biotransformation by active subsurface microbial communities.
- Molecular or biochemical techniques that assess the nutritional, metabolic activity or specific stress indicators of subsurface microorganisms aiding approaches to understanding the *in situ* biological contributions to contaminant transformation.
- Understanding the biogeochemical factors that govern the distribution and functioning of subsurface microbial communities.
- Improved understanding of the metabolic potential and physiology of subsurface microorganisms catalyzing contaminant transformation and/or the transformation of subsurface materials.

Funding for single investigator projects under this element up to $450K/yr is available for a maximum of 3 years. Multi-investigator projects may apply for up to $600K/yr for a maximum of 3 years. Continued funding is contingent upon progress of the research and on the availability of funds.

Innovative Field-scale Remediation and Long-Term Stewardship Research

Objective: Conduct integrative, multi-disciplinary field investigations to test hypotheses of contaminant transformation in the subsurface, measurement and monitoring tools, and conceptual and computational models of contaminant transport.

Field investigations are a crucial component of the ERSP. New insights into the behavior of contaminants under different natural or stimulated biogeochemical conditions in the subsurface ultimately require validation via experimentation in the field. This is an important part of assessing the accuracy of conceptual and/or computational models of subsurface contaminant transport and for determining the relative importance of various biogeochemical mechanisms postulated to affect contaminant transport and/or transformation. *in situ* field investigations also provide an opportunity to test measurement and monitoring tools developed to describe subsurface processes and the functioning of microbial communities. Field research is an inherently multi-disciplinary endeavor encompassing elements of geology, hydrology, geochemistry, geophysics, microbiology, environmental engineering, and/or computer science. Elements of molecular biology and genome-enabled techniques are also increasingly applied to environmental studies.

Of particular concern for this Science Element is the development of integrative, multidisciplinary field investigations of key biogeochemical processes affecting the subsurface transport of DOE relevant contaminants. Proposals submitted to this Science Element must be multi-disciplinary in scope and are encouraged to incorporate a contaminant transport modeling component and an innovative monitoring and/or measurement component as integral parts of the project. Researchers should identify sites for investigation that encompass contaminants and conditions relevant to DOE interests, including DOE sites or sites for which DOE retains remediation responsibility. Investigations at other sites will not be considered for funding. Information is available for the principal DOE sites of interest at the web sites listed above (Contaminants of Concern section). Researchers are reminded of the availability of field sites such as the ERSD Field Research Center (FRC) located in Oak Ridge, TN (http://www.esd.ornl.gov/nabirfrc/) and of current field research studies at the Old Rifle, Colorado, Uranium Mill Tailings Remedial Action (UMTRA) sites (http://www.pnl.gov/nabir-umtra/index.stm) and at the Hanford site (http://esd.lbl.gov/ERT/hanford100h/index.html). Field activities such as drilling needs or other infrastructure support will need to be detailed and estimated in proposals for work at sites other than the FRC. Investigators intending to submit a proposal for a field project at the FRC should coordinate with the FRC Manager (http://public.ornl.gov/nabirfrc/frcadd3.cfm) for information on current projects and potential collaborations. The contaminants of interest for this Science Element for this announcement are the radionuclide and non-radioactive metal contaminants listed above, as well as nitrate and complexing agents as co-contaminants with the listed radionuclide and non-radioactive metals.

NAPL contaminants are not considered at this time for this Science Element for this Announcement.

Areas of interest in this Science Element include:

- Integrative field scale experiments testing conceptual models of coupled biological and geochemical processes affecting contaminant fate and transport in the subsurface including immobilization and/or transformation processes.
- Field investigations of the stability of previously immobilized subsurface contaminants.
- New concepts for predicting the long-term performance of *in situ* contaminant immobilization processes.

Multi-investigator, multi-disciplinary projects may apply for up to $750/yr for a maximum of 3 years. Proposals for work at the FRC need not include drilling and infrastructure support because these are funded separately by ERSD. Continued funding is contingent upon progress of the research and on the availability of funds.

Novel Measurement and Monitoring Concepts

Objective: Develop innovative measurement and monitoring techniques for detecting contaminant concentration and speciation, delineating the extent of subsurface contamination and detecting subsurface processes affecting contaminant transport.

Remediation and long term containment or monitoring (e.g. monitored natural attenuation) strategies require innovative measurement and monitoring tools in order to track performance and/or verify containment measures. Proposals submitted under this Science Element should describe the applicability of innovative approaches to subsurface measurement or monitoring techniques to the problem of delineating contaminant transport processes in the subsurface and/or evaluating the potential for the long-term success of *in situ* remediation concepts. Areas of interest include non-invasive techniques to delineate subsurface structure, track migration of contaminants in the subsurface, detect groundwater flow and evaluate the rate and progression of biogeochemical processes. Proposals examining in-well or subsurface techniques for quantifying the concentration and speciation of contaminants, the extent of microbial activity and rates of biogeochemical processes are also within the scope of this Science Element. All proposals should emphasize development of new techniques relevant to the field setting that address crucial measurement needs in support of conceptual/computational models of the subsurface transport processes or *in situ* remediation. Coordination with an ERSP field project is encouraged. The intent is to develop novel measurement and monitoring techniques under situations where direct relevance to conceptual and/or computational model development in a field setting can be demonstrated. Field testing of existing prototype monitoring devices or autonomous sampling systems is not within the scope of this Science Element. The contaminants of interest for this Science Element for this announcement are the radionuclide and non-radionuclide metal contaminants listed above as well as nitrate and complexing agents as co-contaminants with the listed radionuclide and non-radionuclide metals. NAPL contaminants are not considered at this time for this Science Element for this Announcement.

Areas of interest in this Science Element include:

- New techniques for detecting and evaluating the rates of key biogeochemical activities of subsurface microorganisms affecting contaminant transport.
- Sensors for evaluating redox, chemical gradients and, mineral or contamination speciation at crucial biogeochemical interfaces.
- Quantitative techniques to measure the distribution and contaminant sorption characteristics of minerals in natural materials.
- High(er) resolution geophysical techniques for evaluating subsurface structure, groundwater flow paths and contaminant transport.
- Novel, field-readable techniques for contaminant detection, speciation and quantification.

Funding for single investigator projects under this element up to $300K/yr is available for a maximum of 3 years. Multi-investigator projects may apply for up to $450K/yr for a maximum of 3 years. Continued funding is contingent upon progress of the research and on the availability of funds.

Exploratory Research

Objective: Stimulate initiation of research into new concepts in subsurface science and *in situ* remediation.

The intent of this Science Element is to catalyze the study of new concepts, tools and approaches that could lead to breakthroughs in subsurface remediation science. Emphasis will be on new ideas that offer exceptional promise (high payoff) but also involve substantial risk of failure and hence might not receive funding in the other Science Elements in competition with more established techniques and concepts. Eligible areas include the development of novel insights into subsurface contaminant transport processes, new *in situ* remediation techniques, innovative *in situ* detection and monitoring techniques and novel mechanisms of contaminant removal from the subsurface. Exploratory research projects will be of short term duration and funding. These projects should be viewed as providing an opportunity to conduct preliminary research and to develop novel ideas for later, more substantial funding opportunities within ERSP. Proposals submitted to this Science Element should address topics that could lead to breakthroughs in one or more of the other Science Elements in the program and align with the ERSP focus on subsurface processes occurring below the zone of root influence. The contaminants of interest for this Science Element for this announcement are the radionuclide and non-radioactive metal contaminants listed above, as well as nitrate and complexing agents as co-contaminants with the listed radionuclide and non-radioactive metals. NAPL contaminants are not considered at this time for this Science Element for this Announcement.

Areas of interest in this Science Element include:

- Novel insights/techniques/methods of relevance to subsurface contaminant detection, transport, remediation or removal.

Funding for single investigator projects under this Science Element should not exceed two years, and should not exceed $100K per year over the 1-2 year cycle. Continued funding is contingent upon progress of the research and on the availability of funds.

SUPPLEMENTARY INFORMATION

Related Programs

ERSD strongly encourages investigators to familiarize themselves with the resources and potential partnering opportunities provided by ERSD. Leveraging of these resources is strongly encouraged. ERSD funds basic research on subsurface contaminant transport and remediation processes ranging from molecular scale processes to field scale processes via a unique set of program resources and partnering. Programmatic resources include the Environmental Molecular Science Laboratory (EMSL, http://www.emsl.pnl.gov/) located at Pacific Northwest National Laboratory. EMSL is a National Scientific User Facility that supports an array of integrative experimental and computational science resources that are made available to the scientific community. Investigators are strongly encouraged to consider EMSL capabilities in developing proposals.

ERSD jointly funds several Environmental Molecular Science Institutes (EMSIs) with the National Science Foundation (NSF.) ERSD supported EMSIs are located at Stanford University, Penn State University and Stony Brook University, and are focusing on the fundamental nature of chemical and biological processes occurring at important environmental interfaces (http://pangea.stanford.edu/research/emsi/index.html), the kinetics and scaling of biogeochemical processes (http://www.ceka.psu.edu/) and the behavior of environmental contaminants in natural and engineered systems (http://www.cems.stonybrook.edu/). ERSD also provides support for experimental work at the national synchrotron light sources (see Availability of User Facilities and Other Specialized Resources below).

Biological processes profoundly influence contaminant transport at a variety of scales in the subsurface. ERSD maintains a close relationship with the Genomics:GTL program (http://doegenomestolife.org/) and the microbial genome sequencing efforts at the Joint Genome Institute (JGI, http://www.jgi.doe.gov/) in order to take advantage of revolutionary genome-enabled and systems biology techniques that promise a more mechanistic understanding of subsurface microbial metabolism affecting contaminant transport.

DOE's substantial computational resources are now being applied to simulations of subsurface reactive transport through ERSD's participation in the SciDAC (Scientific Discovery through Advanced Computing, http://www.osti.gov/scidac/) program. The SciDAC program funds computationally intensive research on fundamental science questions using some of the world's most powerful computers.

Integrative research on subsurface biogeochemical processes affecting contaminant metal and radionuclide transport conducted under the former NABIR program (http://www.lbl.gov/NABIR/index.html) has brought new insights into the stimulation of subsurface microbial communities to affect contaminant transport from the laboratory to *in situ*

field experiments of radionuclide bioremediation at the ERSD Field Research Center (http://www.esd.ornl.gov/nabirfrc/), at uranium mill tailing sites (UMTRA, http://www.pnl.gov/nabir-umtra/index.stm) and at the Hanford site (http://esd.lbl.gov/ERT/hanford100h/index.html). Technology development in support of DOE's subsurface and high level waste cleanup programs to reduce costs and improve efficiency was the focus of the former EMSP program (http://www.sc.doe.gov/ober/ERSD/ersd_emsp.html).

Program Funding

It is anticipated that up to a total of $10 million of Fiscal Year 2007 Federal funds will be available for awards in the Science Element categories described above. Three-year funding is anticipated for most awards (with the exception of exploratory awards, 2 yr maximum) in each Science Element of interest, contingent upon the availability of appropriated funds and successful annual progress. Award sizes will be determined by the scope and collaborative nature of the project. Exploratory projects should not exceed $100K per year over a 1-2 year cycle. Single investigator projects should not exceed $450K per year over the three year cycle. Collaborative projects involving several research groups or more than one institution conducting integrated research may be funded up to a limit of $600K per year over the three year cycle of the project. Multi-disciplinary, multi-institution field projects may range up to $750K per year over a three year cycle. Investigators early in their careers and/or new to DOE's Environmental Remediation Sciences Division are encouraged to apply. The Program Manager is available to discuss new ideas and their alignment with the program.

Collaboration and Training

Multi-disciplinary and inter-institutional collaborations are strongly encouraged to enhance and strengthen research capabilities as needed. Collaboration could include institutions such as universities, industry, non-profit organizations, federal laboratories and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories. All proposals should include letters of agreement to collaborate from included collaborators. These letters should specify the contributions the collaborators intend to make if the proposal is accepted and funded. The proposal should present a management structure for integrating collaborating investigators. DOE may encourage collaboration among prospective investigators by promoting joint proposals or joint research projects based on review of the preproposal or through other forms of communication. Involvement of students and post doctoral scientists is encouraged. Refer to http://www.science.doe.gov/grants/Colab.html details.

Availability of User Facilities and Other Specialized Resources

The ERSD within the DOE Office of Biological and Environmental Research (http://www.science.doe.gov/ober/ERSD_top.html) has responsibility for programs and facilities that offer unique and complementary resources for the conduct of ERSP research. Potential researchers are encouraged to consider use of these programs/facilities in development of proposals.

- The Environmental Molecular Science Laboratory (EMSL) at the Pacific Northwest National Laboratory, (http://www.emsl.pnl.gov), is operated by ERSD as a National Scientific User Facility with state-of-the-art instrumentation in environmental spectroscopy (http://www.emsl.pnl.gov/capabs/esbf.shtml), high field magnetic resonance spectroscopy (http://www.emsl.pnl.gov/capabs/hfmrf.shtml), high performance mass spectrometry (http://www.emsl.pnl.gov/capabs/hpmsf.shtml), high resolution electron microscopy (http://www.emsl.pnl.gov/capabs/insf.shtml), and high performance computing (http://www.emsl.pnl.gov/capabs/mscf.shtml).

  The EMSL's high performance supercomputer is available for computational research in the physical, chemical and biological sciences, including geochemistry, groundwater flow and transport simulations, molecular thermodynamics and kinetics, heavy element chemistry, geochemistry, and surface chemistry (http://www.emsl.pnl.gov/capabs/mscf.shtml). Remote and on-site access to the 11+ TeraFlops, Linux-based Hewlett-Packard (HP) system and associated software, and visualization and data storage capabilities is available through a separate proposal and external peer review process. Proposals for allocations of large blocks of time on the EMSL's HP system are solicited annually (usually in February or March for allocations beginning in October). Awards typically average 500,000 hours for multi-investigator teams (http://mscf.emsl.pnl.gov/about/allocation.shtml).

  DOE also provides compute cycles to the scientific user community at other high performance computing centers. For example, the National Energy Research Scientific Computing Center (NERSC) at the Lawrence Berkeley National Laboratory provides an 888 processor IBM cluster system plus extensive data storage capabilities (http://www.nersc.gov). NERSC usually solicits proposals for time allocations in June or July. Proposals are externally peer reviewed and time awards are announced in December. The National Center for Computational Sciences (NCCS) at the Oak Ridge National Laboratory has several supercomputers available to users, including the Cray X1E Phoenix system, the Cray XT3 Jaguar system, and an SGI Altix system (http://nccs.gov/). Proposals for time allocations on the various systems at the NCCS may be submitted throughout the year, but 95% of the awards are for "high-impact, grand challenge type projects" (see http://nccs.gov/accounts/index.html, for additional information.)

- The ERSD Field Research Center (FRC) at Oak Ridge National Laboratory (http://www.esd.ornl.gov/nabirfrc/) provides a DOE site where scientists can conduct field-scale research and obtain DOE relevant samples of soils, sediments, and ground waters for laboratory research. A useful general orientation for prospective investigators is available at http://public.ornl.gov/nabirfrc/workshop2005_posters.cfm
- ERSD (http://www.sc.doe.gov/ober/ober_top.html) provides user support for experiments at synchrotron light sources that are capable of providing structural and chemical information often unavailable with conventional sources of x-rays. DOE laboratories with synchrotrons supporting ERSD research and points of contact include: Argonne National Laboratory (http://www.aps.anl.gov/index.html), contact Ken Kemner (kemner@anl.gov); Brookhaven National Laboratory (http://www.nsls.bnl.gov/), contact

Jeffrey Fitts (fitts@bnl.gov); Lawrence Berkeley National Laboratory (http://esd.lbl.gov/als_environmental_program/), contact Susan Hubbard (sshubbard@lbl.gov); and Stanford Synchrotron Radiation Laboratory (http://www-ssrl.slac.stanford.edu/mes/remedi/index.html), contact John Bargar, bargar@slac.stanford.edu). Use of the synchrotron light sources requires a separate approval process.

Relevance to Mission

A key consideration in the evaluation of research proposals will be applicability to the Environmental Remediation Sciences Division (ERSD) mission of environmental remediation and long term stewardship of DOE sites. Researchers will need to identify specific areas of scientific need and make a strong case for the value of the proposed research in helping resolve those needs. The proposal should explain how resolution of these needs could improve capabilities in site stewardship and/or understanding/controlling subsurface contaminant fate and transport. Therefore, **all proposals submitted in response to this Announcement must explicitly state how the proposed research will support the accomplishment of the BER Long Term Measure "to provide sufficient scientific understanding to allow a significant fraction of DOE sites to incorporate coupled biological, chemical and physical processes into decision making for environmental remediation."** DOE will also consider, as part of the evaluation, program policy factors including balance among the program areas and research already in progress. Previous research solicitations, abstracts, and research reports of projects funded under the former EMSP can be viewed at: http://emsp.em.doe.gov/search.jsp. Previously funded projects and abstracts from the former NABIR program can be viewed at: http://www.lbl.gov/NABIR/researchprogram/awards/index.html.

Submission Information

For this announcement, the research description must be **20 pages or less,** exclusive of attachments, and must contain an abstract or summary of the proposed research (to include the hypotheses being tested, the proposed experimental design, and the names of all investigators and their affiliations). Proposals with Project Narratives longer than 20 pages will be returned to researchers and will not be merit reviewed or considered for award. Attachments should include short (2 pages) curriculum vitae, QA/QC plan, a listing of all current and pending federal support and letters of intent for proposed collaborators (when applicable). Curriculum vitae should be submitted in a form similar to that of NSF. **Researchers who have current ERSD support must include a Progress Section with a description of results, the funding history (i.e. number of years and amounts per year for all PIs and co-PIs), and a list of publications derived from that funding.**

REFERENCES

Note: World Wide Web locations of these documents are provided where possible. For those without access to the World Wide Web, hard copies of these references may be obtained by contacting Robert T. Anderson at the electronic mail address listed in the FOR FURTHER INFORMATION CONTACT section.

Note: World Wide Web locations of these documents are provided where possible. For those without access to the World Wide Web, hard copies of these references may be obtained by contacting Robert T. Anderson at the electronic mail address listed in the FOR FURTHER INFORMATION CONTACT section.

National Research Council, 2000. Research Needs in Subsurface Science, U.S. Department of Energy's Environmental Management Science Program. National Academy Press, Washington, DC. http://www.nap.edu/browse.html

Department of Energy, 2001. A Report to Congress on Long-Term Stewardship. Office of Environmental Management. Washington, DC.
http://www.lm.doe.gov/documents/3_pro_doc/lts_study/rpt_to_congress_vol_I.pdf

Davis, J.A.; S.B. Yabusaki; C.I. Steefel; J.M. Zachara; G.P. Curtis; G.D. Redden; L.J. Criscenti; B.D. Honeyman 2004. Assessing Conceptual Models for Subsurface Reactive Transport of Inorganic Contaminants EOS 85, 449-455.
http://www.iscmem.org/Documents/Publication_Davis2004Eos.pdf

Submission Information

Any recipient of an award from the Office of Science, performing research involving recombinant DNA molecules and/or organisms and viruses containing recombinant DNA molecules shall comply with the National Institutes of Health "Guidelines for Research Involving Recombinant DNA Molecules," which is available via the World Wide Web at: http://www.niehs.nih.gov/odhsb/biosafe/nih/rdna-apr98.pdf, (59 FR 34496, July 5, 1994), or such later revision of those guidelines as may be published in the Federal Register.

Full proposals adhering to DOE Field Work Proposal format (Reference DOE Order 412.1) are to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Laboratories may submit proposals directly to the SC Program Office listed above. A copy should also be provided to the appropriate DOE Operations Office.

The instructions and format described below should be followed. You must reference Program Announcement LAB 06-12 on all submissions and inquiries about this program.

OFFICE OF SCIENCE
GUIDE FOR PREPARATION OF SCIENTIFIC/TECHNICAL PROPOSALS
TO BE SUBMITTED BY NATIONAL LABORATORIES

Proposals from National Laboratories submitted to the Office of Science (SC) as a result of this program announcement will follow the Department of Energy Field Work Proposal process with additional information requested to allow for scientific/technical merit review. The following guidelines for content and format are intended to facilitate an understanding of the requirements necessary for SC to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviations could be cause for declination of a proposal without merit review.

1. Evaluation Criteria

Proposals will be subjected to formal merit review (peer review) and will be evaluated against the following criteria which are listed in descending order of importance:

(a) Scientific and/or technical merit of the project;

(b) Appropriateness of the proposed method or approach;

(c) Competency of the personnel and adequacy of the proposed resources; and

(d) Reasonableness and appropriateness of the proposed budget.

The evaluation process will include program policy factors such as the relevance of the proposed research to the terms of the announcement and the Department's programmatic needs. External peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Non-federal reviewers may be used, and submission of a proposal constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

A key consideration in the evaluation of research proposals will be applicability to the Environmental Remediation Sciences Division (ERSD) mission of environmental remediation and long term stewardship of DOE sites. Researchers will need to identify specific areas of scientific need and make a strong case for the value of the proposed research in helping resolve those needs. The proposal should explain how resolution of these needs could improve capabilities in site stewardship and/or understanding/controlling subsurface contaminant fate and transport. Therefore, **all proposals submitted in response to this Announcement must explicitly state how the proposed research will support the accomplishment of the BER Long Term Measure "to provide sufficient scientific understanding to allow a significant fraction of DOE sites to incorporate coupled biological, chemical and physical processes into decision making for environmental remediation."** DOE will also consider, as part of the evaluation, program policy factors including balance among the program areas and research already in progress. Previous research solicitations, abstracts, and research reports of projects funded under the former EMSP can be viewed at: http://emsp.em.doe.gov/search.jsp. Previously funded projects and abstracts from the former NABIR program can be viewed at: http://www.lbl.gov/NABIR/researchprogram/awards/index.html.

2. Summary of Proposal Contents

- Field Work Proposal (FWP) Format (Reference DOE Order 5700.7C) (DOE ONLY)
- Proposal Cover Page
- Table of Contents
- Budget (DOE Form 4620.1) and Budget Explanation
- Abstract (one page)
- Narrative (main technical portion of the proposal, including background/introduction, proposed research and methods, timetable of activities, and responsibilities of key project personnel)

- Literature Cited
- Biographical Sketch(es)
- Description of Facilities and Resources
- Other Support of Investigator(s)
- Appendix (optional)

2.1 Number of Copies to Submit

A complete formal FWP in a single Portable Document Format (PDF) file must be submitted through the DOE ePMA system (https://epma.doe.gov) as an attachment. To identify that the FWP is responding to this program announcement, please fill in the following fields in the "ePMA Create Proposal Admin Information" screen as shown:

Proposal Short Name:
Fiscal Year:
Proposal Reason:
Program Announcement Number: LAB 06-12 *
Program announcement Title: Environmental Remediation Science Program, DOE Research Program Announcement *
Proposal Purpose:
Estimated Proposal Begin Date:
HQ Program Manager Organization:

* Please use the wording shown when filling in these fields to identify that the FWP is responding to this program announcement.

In order to expedite the review process, please submit a CD and two copies of the proposal using the following, by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand-carried to:

Kim Laing
U.S. Department of Energy
Office of Biological and Environmental Research, SC-23.4/GTN
19901 Germantown Road
Germantown, MD 20874-1290
ATTN: Program Announcement LAB 06-12

3. Detailed Contents of the Proposal

Adherence to type size and line spacing requirements is necessary for several reasons. No researcher should have the advantage, or by using small type, of providing more text in their proposals. Small type may also make it difficult for reviewers to read the proposal. Proposals must have 1-inch margins at the top, bottom, and on each side. Type sizes must be 11 point. Line spacing is at the discretion of the researcher but there must be no more than 6 lines per vertical inch of text. Pages should be standard 8 1/2" x 11" (or metric A4, i.e., 210 mm x 297 mm). The research description must be 20 pages or less, exclusive of attachments, and must contain an

abstract or summary of the proposed research (to include the hypotheses being tested, the proposed experimental design, and the names of all investigators and their affiliations). **Proposals with Project Narratives longer than 20 pages will be returned to researchers and will not be merit reviewed or considered for award.**

3.1 Field Work Proposal Format (Reference DOE Order 5700.7C) (DOE ONLY)

The Field Work Proposal (FWP) is to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Additional information is also requested to allow for scientific/technical merit review.

Laboratories may submit proposals directly to the SC Program office listed above. A copy should also be provided to the appropriate DOE operations office.

3.2 Proposal Cover Page

The following proposal cover page information may be placed on plain paper. No form is required.

- Title of proposed project
- SC Program announcement title
- Name of laboratory
- Name of principal investigator (PI)
- Position title of PI
- Mailing address of PI
- Telephone number of PI
- Fax number of PI
- Electronic mail address of PI
- Name of official signing for laboratory*
- Title of official
- Fax number of official
- Telephone of official
- Electronic mail address of official
- Requested funding for each year; total request
- Use of human subjects in proposed project:
  - If activities involving human subjects are not planned at any time during the proposed project period, state "No"; otherwise state "Yes", provide the IRB Approval date and Assurance of Compliance Number and include all necessary information with the proposal should human subjects be involved.
- Use of vertebrate animals in proposed project:
  - If activities involving vertebrate animals are not planned at any time during this project, state "No"; otherwise state "Yes" and provide the IACUC Approval date and Animal Welfare Assurance number from NIH and include all necessary information with the proposal.
- Signature of PI, date of signature
- Signature of official, date of signature*

*The signature certifies that personnel and facilities are available as stated in the proposal, if the project is funded.

3.3 Table of Contents

Provide the initial page number for each of the sections of the proposal. Number pages consecutively at the bottom of each page throughout the proposal. Start each major section at the top of a new page. Do not use unnumbered pages and do not use suffices, such as 5a, 5b.

3.4 Budget and Budget Explanation

A detailed budget is required for the entire project period and for each fiscal year. It is preferred that DOE's budget page, Form 4620.1 be used for providing budget information*. Modifications of categories are permissible to comply with institutional practices, for example with regard to overhead costs.

A written justification of each budget item is to follow the budget pages. For personnel this should take the form of a one-sentence statement of the role of the person in the project. Provide a detailed justification of the need for each item of permanent equipment. Explain each of the other direct costs in sufficient detail for reviewers to be able to judge the appropriateness of the amount requested.

Further instructions regarding the budget are given in section 4 of this guide.

* Form 4620.1 is available at web site: http://www.science.doe.gov/grants/Forms-E.html

3.5 Abstract

Provide an abstract of less than 400 words. Give the project objectives (in broad scientific terms), the approach to be used, and what the research is intended to accomplish. State the hypotheses to be tested (if any). At the top of the abstract give the project title, names of all the investigators and their institutions, and contact information for the principal investigator, including e-mail address.

3.6 Narrative (main technical portion of the proposal, including background/introduction, proposed research and methods, timetable of activities, and responsibilities of key project personnel).

The narrative comprises the research plan for the project and is limited to **20 pages (maximum)**. It should contain enough background material in the Introduction, including review of the relevant literature, to demonstrate sufficient knowledge of the state of the science. The major part of the narrative should be devoted to a description and justification of the proposed project, including details of the methods to be used. It should also include a timeline for the major activities of the proposed project, and should indicate which project personnel will be responsible for which activities.

If any portion of the project is to be done in collaboration with another institution (or institutions), provide information on the institution(s) and what part of the project it will carry out. Further information on any such arrangements is to be given in the sections "Budget and Budget Explanation", "Biographical Sketches", and "Description of Facilities and Resources".

3.7 Literature Cited

Give full bibliographic entries for each publication cited in the narrative.

3.8 Biographical Sketches

This information is required for senior personnel at the institution submitting the proposal and at all subcontracting institutions (if any). The biographical sketch is limited to a maximum of two pages for each investigator.

To assist in the identification of potential conflicts of interest or bias in the selection of reviewers, the following information **must be provided in each biographical sketch.**

> **Collaborators and Co-editors:** A list of all persons in alphabetical order (including their current organizational affiliations) who are currently, or who have been, collaborators or co-authors with the investigator on a research project, book or book article, report, abstract, or paper during the 48 months preceding the submission of the proposal. Also include those individuals who are currently or have been co-editors of a special issue of a journal, compendium, or conference proceedings during the 24 months preceding the submission of the proposal. If there are no collaborators or co-editors to report, this should be so indicated.
>
> **Graduate and Postdoctoral Advisors and Advisees:** A list of the names of the individual's own graduate advisor(s) and principal postdoctoral sponsor(s), and their current organizational affiliations. A list of the names of the individual's graduate students and postdoctoral associates during the past five years, and their current organizational affiliations.

3.9 Description of Facilities and Resources

Facilities to be used for the conduct of the proposed research should be briefly described. Indicate the pertinent capabilities of the institution, including support facilities (such as machine shops), that will be used during the project. List the most important equipment items already available for the project and their pertinent capabilities. Include this information for each subcontracting institution (if any).

3.10 Other Support of Investigators

Other support is defined as all financial resources, whether Federal, non-Federal, commercial, or institutional, available in direct support of an individual's research endeavors. Information on active and pending other support is required for all senior personnel, including investigators at

collaborating institutions to be funded by a subcontract. For each item of other support, give the organization or agency, inclusive dates of the project or proposed project, annual funding, and level of effort (months per year or percentage of the year) devoted to the project.

3.11 Appendix

Information not easily accessible to a reviewer may be included in an appendix, but **do not use the appendix to circumvent the page limitations of the proposal**. Reviewers are not required to consider information in an appendix, and reviewers may not have time to read extensive appendix materials with the same care they would use with the proposal proper.

The appendix may contain the following items: up to five publications, manuscripts accepted for publication, abstracts, patents, or other printed materials directly relevant to this project, but not generally available to the scientific community; and letters from investigators at other institutions stating their agreement to participate in the project (do not include letters of endorsement of the project).

4. Detailed Instructions for the Budget

(DOE Form 4620.1 "Budget Page" may be used).

4.1 Salaries and Wages

List the names of the principal investigator and other key personnel and the estimated number of person-months for which DOE funding is requested. Researchers should list the number of postdoctoral associates and other professional positions included in the proposal and indicate the number of full-time-equivalent (FTE) person-months and rate of pay (hourly, monthly or annually). For graduate and undergraduate students and all other personnel categories such as secretarial, clerical, technical, etc., show the total number of people needed in each job title and total salaries needed. Salaries requested must be consistent with the institution's regular practices. The budget explanation should define concisely the role of each position in the overall project.

4.2 Equipment

DOE defines equipment as "an item of tangible personal property that has a useful life of more than two years and an acquisition cost of $25,000 or more." Special purpose equipment means equipment which is used only for research, scientific or other technical activities. Items of needed equipment should be individually listed by description and estimated cost, including tax, and adequately justified. Allowable items ordinarily will be limited to scientific equipment that is not already available for the conduct of the work. General purpose office equipment normally will not be considered eligible for support.

4.3 Domestic Travel

The type and extent of travel and its relation to the research should be specified. Funds may be requested for attendance at meetings and conferences, other travel associated with the work and

subsistence. In order to qualify for support, attendance at meetings or conferences must enhance the investigator's capability to perform the research, plan extensions of it, or disseminate its results. Consultant's travel costs also may be requested.

4.4 Foreign Travel

Foreign travel is any travel outside Canada and the United States and its territories and possessions. Foreign travel may be approved only if it is directly related to project objectives.

4.5 Other Direct Costs

The budget should itemize other anticipated direct costs not included under the headings above, including materials and supplies, publication costs, computer services, and consultant services (which are discussed below). Other examples are: aircraft rental, space rental at research establishments away from the institution, minor building alterations, service charges, and fabrication of equipment or systems not available off- the-shelf. Reference books and periodicals may be charged to the project only if they are specifically related to the research.

a. Materials and Supplies

The budget should indicate in general terms the type of required expendable materials and supplies with their estimated costs. The breakdown should be more detailed when the cost is substantial.

b. Publication Costs/Page Charges

The budget may request funds for the costs of preparing and publishing the results of research, including costs of reports, reprints page charges, or other journal costs (except costs for prior or early publication), and necessary illustrations.

c. Consultant Services

Anticipated consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate and number of days expected service. Consultant's travel costs should be listed separately under travel in the budget.

d. Computer Services

The cost of computer services, including computer-based retrieval of scientific and technical information, may be requested. A justification based on the established computer service rates should be included.

e. Subcontracts

Subcontracts should be listed so that they can be properly evaluated. There should be an anticipated cost and an explanation of that cost for each subcontract. The total amount of each subcontract should also appear as a budget item.

4.6 Indirect Costs

Explain the basis for each overhead and indirect cost. Include the current rates.