

**Office of Science**  
**Notice 99-06**

***Environmental Management Science Program:  
Research Related to Subsurface  
Contamination/Vadose Zone Issues***

**Department of Energy  
Office of Science and  
Office of Environmental Management**

**Office of Science Financial Assistance Program Notice 99-06; Environmental  
Management Science Program: Research Related to Subsurface  
Contamination/Vadose Zone Issues**

**Agency:** U.S. Department of Energy

**Action:** Notice inviting grant applications.

**SUMMARY:** The Offices of Science (SC) and Environmental Management (EM), U.S. Department of Energy, hereby announce their interest in receiving grant applications for performance of innovative, fundamental research to support specifically innovative, fundamental research to investigate DOE surface contamination/vadose zone issues.

**DATES:** Potential applicants are strongly encouraged to submit a brief preapplication. All preapplications, referencing Program Notice 99-06, should be received by DOE by 4:30 P.M. E.S.T., February 9, 1999. A response encouraging or discouraging a formal application generally will be communicated by electronic mail to the applicant within three weeks of receipt. The deadline for receipt of formal applications is 4:30 P.M., E.D.T., April 19, 1999, in order to be accepted for merit review and to permit timely consideration for award in Fiscal Year 1999.

**ADDRESSES:** All preapplications, referencing Program Notice 99-06, should be sent to Dr. Roland F. Hirsch, SC-73, Mail Stop F-237, Medical Sciences Division, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290. Preapplications will be accepted if submitted by U. S. Postal Service, including Express Mail, commercial mail delivery service, or hand delivery, but will not be accepted by fax, electronic mail, or other means.

After receiving notification from DOE concerning successful preapplications, applicants may prepare and submit formal applications. Applications must be sent to: U.S. Department of Energy, Office of Science, Grants and Contracts Division, SC-64, 19901 Germantown Road, Germantown, MD 20874-1290, Attn: Program Notice 99-06. The above address for formal applications must also be used when submitting formal applications by U.S. Postal Service Express Mail, any commercial mail delivery service, or when hand carried by the applicant.

**FOR FURTHER INFORMATION CONTACT:** Dr. Roland F. Hirsch, SC-73, Mail Stop F-237, Medical Sciences Division, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, telephone: (301) 903-9009, fax: (301) 903-0567, E-mail: roland.hirsch@science.doe.gov, or Mr. Mark Gilbertson, Office of Science and Risk Policy, Office of Science and Technology, Office of Environmental Management, 1000 Independence Avenue, SW, Washington, D.C. 20585, telephone: (202) 586-7150, E-mail: mark.gilbertson@em.doe.gov. The full text of Program Notice 99-06 is available via the Internet using the following web site address: <http://www.er.doe.gov/production/grants/grants.html>.

**SUPPLEMENTARY INFORMATION:** The Office of Environmental Management, in partnership with the Office of Science, sponsors the Environmental Management Science Program (EMSP) to fulfill DOE's continuing commitment to the cleanup of DOE's environmental legacy. The program was initiated in Fiscal Year 1996 and funding for the program has been provided in the Conference Report for Fiscal Year 1999 Appropriations for Energy and Water Development, Report 105-749, September 25, 1998, page 107.

The DOE Environmental Management program currently has ongoing applied research and engineering efforts under its Technology Development Program. These efforts must be supplemented with basic research to address long-term technical issues crucial to the EM mission. Basic research can also provide EM with near-term fundamental data that may be critical to the advancement of technologies that are under development but not yet at full scale nor implemented. Proposed basic research under this notice should contribute to environmental management activities that would decrease risk for the public and workers, provide opportunities for major cost reductions, reduce time required to achieve EM's mission goals, and, in general, should address problems that are considered intractable without new knowledge. This program is designed to inspire breakthroughs' in areas critical to the EM mission through basic research and will be managed in partnership with SC. The Office of Science's well-established procedures, as set forth in the Office of Science Merit Review System, as published in the Federal Register, March 11, 1991, Vol. 56, No.

47, pages 10244-10246, will be used for merit review of applications submitted in response to this notice.

Subsequent to the formal scientific merit review, applications that are judged to be scientifically meritorious will be evaluated by DOE for relevance to the objectives of the Environmental Management Science Program. Additional information can be obtained at <http://www.em.doe.gov/science>.

Additional Notices for the Environmental Management Science Program may be issued during Fiscal Year 1999 covering other areas within the scope of the EM program.

### **Purpose**

The need to build a stronger scientific basis for the Environmental Management effort has been established in a number of recent studies and reports. The Galvin Commission report ("Alternative Futures for the Department of Energy National Laboratories," February 1995) also provided the following observations and recommendations:

"There is a particular need for long term, basic research in disciplines related to environmental cleanup" ... "Adopting a science-based approach that includes supporting development of technologies and expertise" ... "could lead to both reduced cleanup costs and smaller environmental impacts at existing sites and to the development of a scientific foundation for advances in environmental technologies."

The Environmental Management Advisory Board Science Committee (Resolution on the Environmental Management Science Program, May 2, 1997) made the following observations:

"EMSP results are likely to be of significant value to EM" ... "Early program benefits, include: improved understanding of EM science needs, linkage with technology needs, and expansion of the cadre of scientific personnel working on EM problems" ... "Science program has the potential to lead to significant improvement in future risk reduction and cost and time savings."

The purpose of the EMSP is to foster basic research that will contribute to successful completion of DOE's mission to cleanup the environmental contamination across the DOE complex.

The objectives of the Environmental Management Science Program are to:

- Provide scientific knowledge that will revolutionize technologies and clean-up approaches to significantly reduce future costs, schedules, and risks;

- "Bridge the gap" between broad fundamental research that has wide-ranging applicability such as that performed in DOE's Office of Science and needs-driven applied technology development that is conducted in EM's Office of Science and Technology; and
- Focus the Nation's science infrastructure on critical DOE environmental management problems.

"Although the focus of the EMSP is on basic research, as noted above, the objective of this research program is to generate new knowledge to support DOE's mission to remediate its contaminated sites. Some of the Department's most significant contamination problems involve soil and groundwater that contain dense nonaqueous-phase liquids, metals, and radionuclides. The Department's ability to identify and quantify contaminant sources, predict and monitor contaminant fate, and carry out appropriate remediation remains elusive at many sites across the DOE complex." (National Research Council, Committee on Subsurface Contamination at DOE Complex Sites: Research Needs and Opportunities, December 10, 1998).

### **Representative Research Areas**

Basic research is solicited in all areas of science with the potential for addressing problems in subsurface contamination and transport processes in the vadose (unsaturated) zone. Processes and problems in the vadose zone constitute important subjects of concern to the Department's Environmental Management Program. Relevant scientific disciplines include, but are not limited to: Geological sciences, (including geochemistry, geophysics, hydrogeologic transport modeling, and hydrologic field-studies), plant sciences (including mechanisms of contaminant uptake, concentration and sequestration), chemical sciences (including fundamental interfacial chemistry, computational chemistry, actinide chemistry, and analytical chemistry and instrumentation), engineering sciences (including control systems and optimization, diagnostics, transport processes, fracture mechanics and bioengineering), materials science (including other novel materials-related strategies), and bioremediation (including microbial science related to ex situ treatment of organics, metals and radionuclides and in situ treatment of organics). The Natural and Accelerated Bioremediation Research (NABIR) program of the Office of Biological and Environmental Research in the Office of Science may issue a Notice relating to in situ treatment of metals and radionuclides during FY 1999. Research projects relating to this area should be submitted to NABIR rather than to EMSP.

### **Program Funding**

It is anticipated that up to a total of \$4,000,000 of Fiscal Year 1999 Federal funds will be available for new Environmental Management Science Program awards resulting

from this Notice. Multiple-year funding of grant awards is anticipated, contingent upon the availability of appropriated funds. Award sizes are expected to be on the order of \$100,000-\$300,000 per year for total project costs for a typical three-year grant. Collaborative projects involving several research groups or more than one institution may receive larger awards if merited. The program will be competitive and offered to investigators in universities or other institutions of higher education, other non-profit or for-profit organizations, non-Federal agencies or entities, or unaffiliated individuals. DOE reserves the right to fund in whole or part any or none of the applications received in response to this Notice. A parallel announcement with a similar potential total amount of funds will be issued to DOE Federally Funded Research and Development Centers. All projects will be evaluated using the same criteria, regardless of the submitting institution. Additionally, relevant innovative basic research pertaining to other sites will be considered.

### **Collaboration and Training**

Applicants to the EMSP are strongly encouraged to collaborate with researchers in other institutions, such as universities, industry, non-profit organizations, federal laboratories and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories, where appropriate, and to incorporate cost sharing and/or consortia wherever feasible.

Applicants are also encouraged to provide training opportunities, including student involvement, in applications submitted to the program.

### **Preapplications**

A brief preapplication may be submitted. The original and five copies must be received by February 9, 1999 [not January 28, 1999 as published in the Federal Register 1/11/99], to be considered. The preapplication should identify on the cover sheet the institution, PI name, address, telephone, fax and E-mail address for the principal investigator, title of the project, and the field of scientific research (using the list in the Application Categories section). The preapplication should consist of up to three pages of narrative describing the research objectives and the plan for accomplishing them, and should also include a paragraph describing the research background of the principal investigator and key collaborators if any.

[Updated 1/14/99 at this site. Correction was published in the Federal Register 1/29/99, Vol. 64, No. 19, page 4643.]

Preapplications will be evaluated relative to the scope and research needs of the DOE's Environmental Management Science Program by qualified DOE program

managers from both SC and EM. Preapplications are strongly encouraged but not required prior to submission of a full application.

Notification of a successful preapplication is not an indication that an award will be made in response to the formal application.

## **Application Format**

Applicants are expected to use the following format in addition to following instructions in the Office of Science Application Guide. Applications must be written in English, with all budgets in U.S. dollars.

- SC Face Page (DOE F 4650.2 (10-91))
- Application classification sheet (a plain sheet of paper with one selection from the list of scientific fields listed in the Application Categories Section)
- Table of Contents
- Project Abstract (no more than one page)
- Budgets for each year and a summary budget page for the entire project period (using DOE F 4620.1)
- Budget Explanation. Applicants are requested to include in the travel budget for each year funds to attend the annual National Environmental Management Science Program Workshop, and also for one or more extended (one week or more) visits to a cleanup site by either the Principal Investigator or a senior staff member or collaborator.
- Budgets and Budget explanation for each collaborative subproject, if any
- Project Narrative (recommended length is no more than 20 pages; multi-investigator collaborative projects may use more pages if necessary up to a total of 40 pages)
- Goals
- Significance of Project to the EM Mission
- Background
- Research Plan
- Preliminary Studies (if applicable)
- Research Design and Methodologies
- Literature Cited
- Collaborative Arrangements (if applicable)
- Biographical Sketches (limit 2 pages per senior investigator)
- Description of Facilities and Resources
- Current and Pending Support for each senior investigator

## **Application Categories**

In order to properly classify each preapplication and application for evaluation and review, the documents must indicate the applicant's preferred scientific research field, selected from the following list.

**Field of Scientific Research:**

1. Actinide Chemistry
2. Analytical Chemistry and Instrumentation
3. Bioremediation
4. Engineering Sciences
5. Geochemistry
6. Geophysics
7. Hydrogeology
8. Interfacial Chemistry
9. Materials Science
10. Plant Science
11. Other

**Application Evaluation and Selection**

**Scientific Merit.** The program will support the most scientifically meritorious and relevant work, regardless of the institution. Formal applications will be subjected to scientific merit review (peer review) and will be evaluated against the following evaluation criteria listed in descending order of importance as codified at 10 CFR 605.10(d).

1. Scientific and/or Technical Merit of the Project,
2. Appropriateness of the Proposed Method or Approach,
3. Competency of Applicant's Personnel and Adequacy of Proposed Resources,
4. Reasonableness and Appropriateness of the Proposed Budget.

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 an application constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

**Relevance to Mission.** "Researchers are encouraged to demonstrate a linkage between their research projects and significant contamination problems at DOE sites. Researchers could establish this linkage in a variety of ways - for example, by elucidating the scientific problems to be addressed by the proposed research and explaining how the solution of these problems could improve remediation capabilities. Of course, given the nature of basic research, there will not always be a clear pathway between research results and application to site remediation." (National Research

Council, Board on Radioactive Waste Management, December 1998) Subsequent to the formal scientific merit review, applications which are judged to be scientifically meritorious will be evaluated by DOE for relevance to the objectives of the Environmental Management Science Program.

DOE shall also consider, as part of the evaluation, program policy factors such as an appropriate balance among the program areas, including research already in progress. Research funded in the Environmental Management Science Program in Fiscal Year 1996, Fiscal Year 1997, and Fiscal Year 1998 can be viewed at <http://www.doe.gov/em52/science-grants.html>.

### **Application Guide and Forms**

Information about the development, submission of applications, eligibility, limitations, evaluation, the selection process, and other policies and procedures may be found in 10 CFR Part 605, and in the Application Guide for the Office of Science Financial Assistance Program. Electronic access to the Guide and required forms is made available via the World Wide Web at <http://www.er.doe.gov/production/grants/grants.html>.

### **Major Environmental Management Challenges**

This research Notice has been developed for Fiscal Year 1999, along with a development process for a long-term program within Environmental Management, with the objective of providing continuity in scientific knowledge that will revolutionize technologies and clean-up approaches for solving DOE's most complex environmental problems. The following is an overview of the technical challenge facing the Environmental Management Program in the area of Subsurface Contamination/Vadose Zone which is the focus of this Notice. More detailed descriptions of the specific technical needs and areas of emphasis associated with this problem area can be found in the background section of this Notice.

Subsurface Contamination/Vadose Zone environmental problems associated with hazardous and radioactive contaminants in soil and groundwater that exist throughout the Department of Energy complex, include radionuclides, heavy metals, and dense, nonaqueous phase liquids. More than 5,700 known Department of Energy groundwater plumes have contaminated over 600 billion gallons of water and 50 million cubic meters of soil. Migration of these plumes threaten local and regional water sources and in some cases, has already adversely impacted off-site resources. In addition, the Department is responsible for the remediation of numerous landfills at Department facilities. These landfills are estimated to contain over three million cubic meters of radioactive and hazardous buried waste, some of which has migrated to the

surrounding soils and groundwater. Currently available cleanup technologies are inadequate or unacceptable due to excessive costs, increased risks, long schedules, or the production of secondary waste streams. A window of opportunity is thus provided for EMSP to inject new innovative research to help bridge the technological gap pertaining to the challenges in:

- Subsurface measurements, characterization and transport validation (distribution of contaminants) in soils and fractured rock
- Hydrology and geochemistry effects, including contaminant migration velocity, and immobilization applications
- Groundwater characterization and contaminant breakthrough models
- Surface water toxicological cumulative effects
- Inventory estimates and validation

### **Scientific Issues**

Recognized issues that pose challenges in inventories of the subsurface, vadose zone, groundwater, and surface water include:

#### *Subsurface*

- Complete estimates of chemical and radiological contaminant concentrations, volumes, and timing of releases need to be considered holistically.
- Model assumptions on distribution of contaminants among different waste processes and streams have not been extensively validated by measurement.
- Models of contaminant distribution are not sufficiently focused on a prioritized list of key chemical and radionuclide contaminants.
- Development of systems assessment capability involves integration of observations of contaminant distributions over a variety of spatial and temporal scales.
- Knowledge of mechanisms and rates of waste release important for system assessment.

#### *Vadose Zone*

- Spatial and depth distribution of inventory, its phase association and chemical speciation are not fully known.
- In-situ chemical/physical/hydraulic properties of sediments are not well characterized.
- Chemical and biologic reactions responsible for contaminant retardation, immobilization, and mobilization are insufficiently understood or lack data on key parameters.

- Geohydrochemical effects such as chemical dissolution, clay dispersion, piping, colloid transport are not fully known.
- Preferred hydrologic pathways are not well characterized.
- Credible reactive transport models that include heterogeneity are not available.

### *Groundwater*

- Waste volumes, waste chemistry, timing of waste disposal, and vadose zone transport are not fully characterized to provide accurate flux from vadose zone into groundwater.
- Horizontal and vertical dimensions of contaminant plumes are not fully delineated.
- Plume structure near waterways is important to characterize.
- Variation in plume geometry due to important geologic features and temporal changes in recharge/migration can answer key questions.
- Contaminant transport and impacts of non-aqueous phase liquids in aquifer are not fully described.
- Innovative, low-cost characterization approaches to extending subsurface data are not routinely deployed.

### *Surface Water*

- Types, amounts, and spatial locations of contaminants within and entering waterways are not fully characterized.
- Temporal variation in contaminant input at groundwater discharge sites is not fully characterized.
- Extent of exposures of sensitive biota to contaminants is not known.
- Toxicological impacts on exposed species are insufficiently understood.
- Fate and transport modeling capabilities are not fully descriptive.

### *Inventory technical element*

- Estimates of radionuclides and chemical contaminants that have been or are expected to be released to the vadose zone (location, amount, concentrations, chemical form, and mobilization/release mechanisms are needed as input to a system assessment).
- Needed are complete estimates of chemical and radiological contaminant concentrations, and volumes.
- Methodologies to validate model assumptions are needed for determining the distribution of contaminants among different waste processes and streams.

## **Background**

The DOE has a 50-year legacy of environmental problems resulting from the production of nuclear weapons. Among the most serious are the widespread contamination of soils, sediments, and groundwater. Moreover, many of the contaminated soils, sediments, and groundwater are believed to be impossible to remediate with existing technology. Examples of sites with these intractable problems include the Snake River Aquifer in Idaho, contaminated groundwater at the 100, 200, and 300 areas at Hanford, Washington, Oak Ridge/Savannah River groundwaters and contaminated sediments at the Nevada Test Site. The huge cost, long duration, and technical challenges associated with remediating DOE facilities present a significant opportunity for science to contribute cost-effective solutions. DOE's environmental remediation problems are shared by other federal agencies and the private sector, but DOE faces a unique set of challenges associated with complex mixtures of contaminants especially those mixtures that contain radioactive elements. While the emphasis in the following discussion is on the Hanford Site, it is anticipated that basic research addressing these problems could lead to new technologies with widespread impact across the complex.

The total life cycle costs for the Office of Environmental Management cleanup projects have been estimated to be approximately \$147 billion in the year 2007 and beyond, when EMSP research results have the potential to begin making a significant impact. In that time period remedial action projects are estimated at \$6.1 billion (DOE, April 1998).

The Hanford Site has a high number of remedial action projects with the largest mortgage and covers 1450 square kilometers along the Columbia River in southeastern Washington State. The primary mission of the Hanford Site for nearly 50 years was to produce plutonium for national defense. Since 1943, nine plutonium production reactors, seven chemical separations plants, and various ancillary facilities were constructed and operated at the Hanford Site, with peak defense production activities occurring in the 1950s and early 1960s during the Cold War. Plutonium production, fuel processing, and fuel fabrication had a significant effect on the environment. The Hanford Site contains over 1600 contaminated waste sites; 670 occur within one half mile of the Columbia River. Defense production created over 625,000 cubic meters of solid/liquid wastes containing both radioactive and chemical contamination. Early waste disposal practices have resulted in groundwater contamination levels exceeding federal drinking water standards (DWS). Additional information on the subsurface contamination/vadose zone problems at the Hanford Site can be found in the Richland Environmental Restoration Project, "Groundwater/Vadose Zone Integration Project Specification", DOE/RL-98-48, Review Draft C, Appendix H, Applied Science and Technology Plan, and Appendix I, Science and Technology Roadmap on the world wide web at: <http://www.bhi->

[erc.com/vadose/pubrev.htm](http://erc.com/vadose/pubrev.htm). For further information regarding the Hanford Site please contact Mr. James P. Hanson, U.S. Department of Energy, Richland Operations Office, Science and Technology Programs Division, P.O. Box 550, MSIN K8-50, Richland, WA 99352, phone: (509) 372-4503, E-mail: james\_p\_hanson@rl.gov.

The Department is also concerned with its ability to confirm the performance of behavior of a physical, chemical, or geological process or a technology at a contaminated site. "Basic science can contribute to performance validation through the investigation and development of new or improved tools and methodologies for confirming behavior or performance in the field. There are a number of underlying theoretical and experimental issues of interest for example, understanding the pre-remediation conditions at a contaminated site and the fundamental hydrogeological, chemical, and biological controls on site or contaminant behavior, how these change during site remediation, and which tests or measurements are sensitive to the behaviors of concern. The inability to confirm such behavior or performance at a contaminated site is one of the primary reasons for the Department's difficulty in prescribing appropriate and cost-effective remediation and monitoring strategies. Moreover, once a remediation action is underway, the Department often lacks methods to measure and confirm the efficacy of the approach. Deployment of new remediation technologies may depend to a great extent on the Department's ability to validate their effectiveness and provide evidence of remediation efficacy to regulators and other stakeholders." (National Research Council, Committee on Subsurface Contamination at DOE Complex Sites: Research Needs and Opportunities, December 10, 1998).

Details of the programs of the Office of Environmental Management and the technologies currently under development or in use by Environmental Management Program can be found on the World Wide Web at <http://www.em.doe.gov> and at the extensive links contained therein. The programs and technologies should be used to obtain a better understanding of the missions and challenges in environmental management in DOE when considering areas of research to be proposed.

## **References for Background Information**

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 writing Mark A. Gilbertson at the address listed in the **FOR FURTHER INFORMATION CONTACT** section.

DOE. 1998. Accelerating Cleanup: Paths to Closure - June 1998.  
<http://www.em.doe.gov/closure>

DOE. 1998. Environmental Science Program, 1998 Project Summaries - June 1998. <http://www.doe.gov/em52>

DOE. 1998. Report to Congress on the U.S. Department of Energy's Environmental Management Science Program - April 1998. <http://www.doe.gov/em52/rtc.html>

DOE. 1997. Research Needs Collected for the EM Science Program - June 1997. <http://www.doe.gov/em52/needs.html>

DOE. 1995. Closing the Circle on the Splitting of the Atom: The Environmental Legacy of Nuclear Weapons Production in the United States and What the Department of Energy is Doing About It. The U.S. Department of Energy, Office of Environmental Management, Office of Strategic Planning and Analysis, Washington, D.C. <http://www.em.doe.gov/circle/index.html>

Environmental Management Advisory Board Science Committee. 1997. Resolution on the Environmental Management Science Program dated May 2, 1997.

National Research Council. 1998. Interim Letter Report, Committee on Subsurface Contamination at DOE Complex Sites: Research Needs and Opportunities, dated December 10, 1998.

National Research Council. 1997. Building an Environmental Management Science Program: Final Assessment. National Academy Press, Washington, DC. <http://www.nap.edu/readingroom/books/envmanage/>

National Research Council. 1995. Improving the Environment: An Evaluation of DOE's Environmental Management Program. National Academy Press, Washington, D.C. <http://www.nap.edu/readingroom/books/doemp/>

Richland Environmental Restoration Project, Groundwater/Vadose Zone Integration Project <http://www.bhi-erc.com/vadose/pubrev.htm>

Secretary of Energy Advisory Board. Alternative Futures for the Department of Energy National Laboratories. February 1995. Task Force on alternative Futures for the Department of Energy National Laboratories. Washington, D.C. <http://www.doe.gov/html/doe/whatsnew/galvin/tf-rpt.html>

1999 Hanford Site Technology Needs <http://www.pnl.gov/stcg/needs.stm>

The Catalog of Federal Domestic Assistance Number for this program is 81.049, and the solicitation control number is ERFAP 10 CFR Part 605.

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