Biological and Environmental Research

Program Mission

The Biological and Environmental Research (BER) program mission – For over 50 years BER has been investing to advance environmental and biomedical knowledge connected to energy. The BER program provides fundamental science to underpin the business thrusts of the Department's strategic plan. Through its support of peer-reviewed research at national laboratories, universities, and private institutions, the program develops the knowledge needed to identify, understand, and anticipate the long-term health and environmental consequences of energy production, development, and use. The research is also designed to provide science in support of the Energy Policy Act of 1992.

The high quality of the research in this program is continuously evaluated through the use of merit based peer review and scientific advisory committees.

Program Goal

To develop the information, scientific "know-how," and technology for identification, characterization, prediction, and mitigation of adverse health and environmental consequences of energy production, development, and use.

Program Objectives

- *To Contribute to a Healthy Citizenry* — Map the fine structure of the human genome by 2003 providing resources to the international research community needed to identify disease genes and develop broad diagnostic and therapeutic strategies, including the development of individual risk assessments; conduct fundamental research necessary for the development of advanced medical technologies and radiopharmaceuticals; and use the unique National Laboratory facilities to determine biological structure and function at the molecular and cellular level in support of this nation’s biomedical sciences, pharmaceutical interests, and environmental activities.
- *To Contribute to Cleanup of the Environment* — Conduct fundamental research necessary for the development of advanced remediation tools for containing wastes and cleaning up DOE's contaminated sites, particularly in support of the mission of DOE's Environmental Management (EM) office.
- *To Understand Global Environmental Change* — Acquire the data and develop the understanding necessary to predict how energy production and use can affect the global and regional environment.

Performance Measures

The quality and appropriateness of the Biological and Environmental Research (BER) program and individual research projects are judged by rigorous peer reviews conducted by internationally recognized scientific experts using criteria such as scientific merit, appropriateness of the proposed approach and qualifications of the principal investigator. Highest quality research is maintained by taking appropriate and, if needed, corrective management actions based on results of the reviews. A measure of the quality of the research is the sustained achievement in advancing knowledge as indicated by the publication of research results in refereed scientific journals, by invited participation at national and international conferences and workshops, and by awards received by BER-supported researchers. Progress in the field is also routinely compared to the scientific priorities recommended by the Biological and Environmental Research Advisory Committee and the National Science and Technology Council's (NSTC) committees on Environment and Natural Resources and on Fundamental Science.

An overarching and unique performance measure of the BER program is the diversity of program reviews conducted. This is particularly the case for BER program elements that are components of international research endeavors, e.g., the Human Genome Program and the Global Change Research Program. In addition to panel reviews that evaluate and select individual projects and programmatic reviews by the chartered Biological and Environmental Research Advisory Committee, these program elements are evaluated by interagency (and international) review bodies and by Boards and Committees of the National Academy of Sciences.

The BER program goes one step further in soliciting program reviews. Blue ribbon panels are charged with evaluating the quality of individual programs and with exploring ways of entraining new ideas and research performers from different scientific fields. This strategy is based on the conviction that the most important scientific advances of the new century will occur at the interfaces between scientific disciplines such as biology and information science. Groups like JASON and The Washington Advisory Group (TWAG), involving physicists, mathematicians, engineers, etc., are among the panels that have studied BER program elements such as the Atmospheric Radiation Measurement (ARM) program, climate change prediction activities, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), and the Human Genome Program.

Facility operations are also monitored by peer reviews and user feedback. These facilities are provided in a manner that meets user requirements (as indicated by achieving performance specifications while protecting the safety of the workers and the environment); facilities are operated reliably and according to planned schedules; and facilities are maintained and improved at reasonable costs.

Specific BER program performance measures are:

- Excellence in basic research: At least 80 percent of the research projects will be reviewed by appropriate peers and selected through a merit-based competitive process.
- Access to Human Genome research results: BER will complete sequencing of 50 million finished and 70 million high quality draft subunits of human DNA to submit to publicly accessible databases in FY 2000.
- Microbial Genomics: BER will complete the genetic sequencing of over 10 additional microbes with significant potential for waste cleanup and energy production.

- Discovering new biological structures with more than 60 percent of them published in the peer reviewed literature resulting from data generated at synchrotron user stations served by the BER structural biology support facilities program.
- Progress in Boron Neutron Capture Therapy (BNCT) Research: Phase I clinical trials of BNCT at reactor sources of neutrons will be completed for at least 100 patients, and research on a facility for accelerator-based BNCT will be underway. These activities will provide the basis for evaluating the efficacy of BNCT and for designing phase II clinical trials that include reactor and accelerator-based sources of neutrons.
- Atmospheric Radiation Measurement (ARM) accomplishments: BER will conduct five intensive operations periods at the ARM Southern Great Plains site. Data will be obtained from the second station on the North Slope of Alaska. The third station in the Tropical Western Pacific, on Christmas Island, will become operational.
- Work will proceed on the development of the next generation coupled ocean-atmosphere climate model, leading to better information for assessing climate change and variability at regional, rather than global scales. This next generation model will change grid size from the current 300-500 kilometers on a side to less than 200 kilometers on a side.
- Twenty-five AmeriFlux sites representing major types of ecosystem types and land uses in North and Central America, including forests, croplands, grasslands, rangelands and tundra ecosystems, will be operating and collecting data that will allow inter-site comparisons of (1) the atmosphere-terrestrial biosphere exchange of energy and water, (2) the net sequestration of carbon dioxide, (3) the effects of environmental factors such as climate variation on the net exchange of carbon, and (4) the role of biophysical process controlling this exchange. AmeriFlux is a network of instrumented research tower sites designed to provide consistent, quality assured, documented long-term measurements of carbon exchange between the atmosphere and terrestrial biosphere. These measurements are necessary to define the current global carbon dioxide budget, enable improved predictions of future carbon dioxide concentrations, and enhance understanding of how carbon sequestration by the terrestrial biosphere is affected by climate, pollution, land use, and other factors.
- Develop and implement, in cooperation with Basic Energy Sciences, a comprehensive program within the Climate Change Technology Initiative, where the focus areas are those that promise the maximum impact in the area of carbon management in addition to supporting fundamental research that addresses other diverse aspects of the problem.
- Coordinate with other federal agencies, Canada, and Brazil to maximize national and international capabilites to enhance understanding of the current global carbon dioxide distribution and the role of the terrestrial biosphere in that distribution.
- Develop collaborative partnerships between strong marine sciences research institutions and those with developing capabilities to advance innovative techniques in modern molecular biology to understand the coupling between carbon and nitrogen cycles in coastal waters and sediments.
- In cooperation with NASA, NSF, USDA/Forest Service, and the Smithsonian Institution, provide quantitative data on the annual exchange of carbon dioxide between the atmosphere and terrestrial ecosystem from 25 AmeriFlux sites representing major types of ecosystem and land uses in North

Central America. Provide data on both the effects of environmental factors, such as climate variation, on the net sequestration or release of carbon dioxide and the role of biophysical processes controlling the net exchange.

- Environmental remediation developments: The Natural and Accelerated Bioremediation Research (NABIR) program will continue to support fundamental research in environmental and molecular sciences that will underpin the development of bioremediation for containing hazardous waste and cleaning DOE sites. Site characterization of the first NABIR Field Research Center will proceed, and activities necessary to enable research sample distribution to investigators will commence.
- The William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) will be identified and cited as an important resource in research publications and research proposals written by investigators in academia and at National Laboratories.
- The development and upgrade of scientific facilities (including experimental stations) will be kept on schedule and within cost.
- The operating time lost at scientific user facilities due to unscheduled downtime will be less than 10 percent of the total scheduled possible operating time, on average.
- Independent assessments will judge BER research programs to have high scientific quality.
- Education accomplishments: The educational activities in the Global Change Research Program will continue to focus on bringing knowledge about the scientific questions and research needs surrounding global environmental change to students at the undergraduate and graduate levels, with an emphasis on DOE mission areas in global change research. Included in these activities are the Summer Undergraduate Research Experience, Graduate Research Environmental Fellowships, and participation in the multi-agency "Significant Opportunities in Atmospheric Research and Science" Program.
- Education accomplishments: Continuing to make 4 to 10 appointments each in the BER Alexander Hollaender Distinguished Post Doctoral Fellowship Program; and the Historical Black Colleges and Universities Faculty and Student Research Programs.

Significant Accomplishments and Program Shifts

Life Sciences

- **TIGR Takes the World of Biology by the Tail** - Three of the hottest eleven papers in biology in 1997 were published by DOE-funded scientist Craig Venter, the president of The Institute for Genomic Research (TIGR). The papers described the complete genomic sequencing of microbes, two of which were funded by the BER Microbial Genome Program. The impact these papers are having emphasizes one of the central principles of both the human and microbial genome programs, that complete genome sequences yield answers to fundamental questions in biology.
- **DOE Joint Genome Institute Second Leading U.S. Producer of DNA Sequence** - In only its first full year of operation, the DOE Joint Genome Institute (JGI) has set ambitious DNA sequencing goals based on international standards for DNA sequence quality. In FY 1998, the JGI became the second leading producer of high quality human DNA sequence among U.S. sequencing

centers. The JGI's monthly sequencing goals and progress are available to the entire scientific community at the JGI Web site, http://www.jgi.doe.gov/Docs/JGI_Seq_Summary.html.

DOE's Bold Human DNA Sequencing Scale Up:

Sequences Submitted to Public Database

FY 1998 Actual	FY 1999 Estimate	FY 2000 Estimate
21,000,000 finished	30,000,000 finished	50,000,000 finished
	40,000,000 draft	70,000,000 draft

The Human Genome Program (HGP) was initiated by the Department of Energy (DOE) in 1986 to map and determine the complete DNA sequence of the human genome. The principal goal of this international program is to determine a representative human DNA sequence of all 3 billion base pairs in the human genome. A Memorandum of Understanding was established with the National Institutes of Health (NIH) in 1988 to coordinate the U.S. Genome Project with the international efforts. The new 5 year plan, developed in 1998, calls for determining a draft sequence by FY 2001 and the complete finished sequence of the human genome by the year 2003. The U.S. is responsible for producing approximately 65 percent of the sequence information. The Department of Energy is sequencing 10-14 percent of the genome, a quantity that is proportional to its budget, with NIH responsible for the balance of the U.S. effort.

- **DNA Replication Uncovered** - A team of BER-funded Harvard Medical School researchers have established the 3 dimensional, atom-by-atom structure of an enzyme system responsible for DNA replication. The core enzyme, T7 DNA polymerase, has long been used as a key reagent for determining the sequence of DNA. This work contributes to the development of improved resources and technologies for microbial, human, and other genome sequencing projects and will aid in the rational design of antiviral regimens, whose DNA replication systems are promising targets for drug intervention.

- **Game of 20 Questions (Actually 30) May Speed Hunt for Disease-Causing Genes** - A new research tool, developed at the University of Southern California (USC) by molecular biologist Dr. Norman Arnheim and mathematician Dr. Pavel Pevzner, promises to speed the hunt for disease-causing genes. By using a new technique that resembles a game of "20 Questions," genes can be found buried in human chromosomes in large volumes of so-called "junk DNA" that does not carry information for specific protein products. This new tool has direct applications for research into genetically based human disease.

- **DOE Human Subjects Research Database for FY 1997 on the Web** - The DOE's Human Subjects Research Database (HSRD) has been updated for FY 1997 and is publicly accessible on the World Wide Web at http://www.er.doe.gov/production/ober/humsubj/database.html. The database was begun in response to Congressional interest following the Secretary of Energy Openness Initiative in 1994. The database consists of a detailed description of 252 research projects at 31 facilities, involving the use of human subjects that are supported by DOE or conducted at DOE facilities, ranging from actual experimentation to simple questionnaires.

- **Kidney Disease Gene Discovered with Help of Livermore Scientists** - DOE's investment in building a highly detailed human genetic roadmap for Chromosome 19 is paying off. Lawrence Livermore National Laboratory scientists have teamed with international collaborators in Sweden and Finland to pinpoint the location of a gene on Chromosome 19 that causes congenital nephrotic syndrome, a deadly kidney disease. The disease usually leads to death by age 2 striking about one in 10,000 Finnish children. The discovery has led to a diagnostic tool to test for the gene in parents who may be carriers of the disease and may be a key to understanding how the human kidney filtration process works.

- **Next Generation of Genome Instrumentation -** The genome instrumentation research subprogram that supported basic research leading to widely used gene sequencing methods in capillary electrophoresis and mass spectrometry has been redirected to target needs of genomic science after the completion of the first human genome sequence.

- **New Light on Molecules** - Development of an experimental station for soft x-ray spectroscopy of biologically important molecules is completed at the Advanced Light Source and initial experiments are carried out to evaluate the power of this technology in elucidating biological structures.

- **Genomic Contributions to CCTI** - The BER microbial genome program has made significant investments in the technology that enables genome sequencing at rates previously unattainable. Capitalizing on these investments, the genomes of microbes that produce methane and hydrogen will be sequenced as part of the first awards under the Climate Change Technology Initiative (CCTI). This will enable the identification of the key genetic components of the organisms that regulate the production of these gases. The search for new fuel sources is a key element of a more comprehensive carbon management program. Planning for joint CCTI-related activities with the Office of Fossil Energy was initiated.

Environmental Processes

- **Data on Arctic Ocean Provided** - The Atmospheric Radiation Measurement (ARM) program provided the atmospheric research component of the multi-agency Surface Heat Budget of the Arctic Ocean (SHEBA) experiment. The SHEBA experiment addressed the interactions among sea ice, atmospheric radiation, and clouds in the Arctic and the corresponding effects on polar and global climate. The ARM equipment used during the SHEBA campaign will be modified and redeployed on the North Slope of Alaska in 1999.

- **Looking at Clouds from Both Sides** - The joint ARM-UAV and NASA study of tropical cirrus clouds will have been completed, providing new information on key cloud formations that moderate the radiation budget of the Earth in 1999.

- **Island Effects on Clouds** - The ARM-led, multi-agency and Japanese experimental campaign on Nauru (Tropical Western Pacific) will have obtained new data on the effects of islands in measuring solar radiation and cloud interactions with the oceans in 1999.

- **Lead Role for ARM** - In response to a request from the World Climate Research Program's Global Energy and Water Cycle Experiment (GEWEX) Water Vapor Project, ARM assumed the lead role in developing guidelines for GEWEX observation and data management of this international program.

- **Variance Among Models Decreases** - The Program for Climate Model Diagnosis and Intercomparison continued to be the world's most authoritative effort in analyzing improvements in global climate models with virtually all climate modelers in the world participating. Analysis of the output from 11 different coupled ocean/atmosphere climate models, using a common scenario for increasing atmospheric carbon dioxide, has found that nearly all of the models calculate similar magnitudes for global average warming--about 2 degrees Celsius at the time that carbon dioxide doubles. This is in contrast to earlier studies that found considerable variance among model predictions.

- **More FACTS** - The first phase of the Forest Atmosphere Carbon Transfer and Storage (FACTS-1) experiment was completed. Located in the Duke Forest and developed as a joint effort between Brookhaven National Laboratory and Duke University, FACTS-1 is the first fully operational forest Free Air Carbon Dioxide Enrichment experiment. Data obtained during this phase will be analyzed to provide systematic data necessary to predict the quantity of carbon sequestered by forest vegetation and to understand the response of forest systems when exposed to elevated atmospheric carbon dioxide concentrations.

- **Changing Interannual Variation in Precipitation Impacts Forest Growth** - Experiments at the Throughput Displacement Experiment at the Walker Branch Watershed, Oak Ridge, Tennessee, suggested that if climate change resulted in a 30 percent decline in precipitation, it would alter the regeneration and species composition of deciduous forests in the southeastern U.S. Data also suggest that changes in interannual variation in precipitation, such as increases in drought intensity or frequency, will affect the growth and productivity of forest ecosystems more than would a 30 percent reduction in mean annual precipitation.

- **Data Center Serves the World** - In addition to serving as the international World Data Center for Atmospheric Trace Gases, the Carbon Dioxide Information Analysis Center (CDIAC) serves as the primary global-change data and information analysis center of the U.S. Department of Energy. More than just an archive of data sets and publications, CDIAC enhances the value of its holdings through intensive quality assurance, documentation, and integration. In recognition of this, CDIAC continued to serve as the Quality Systems Science Center for the tri-national North American Research Strategy for Tropospheric Ozone (NARSTO).

- **New Environmental Meteorology Program Initiated** - Capitalizing on the experience and data obtained in prior meteorological studies, the Atmospheric Sciences Program established a new Environmental Meteorology Program, initiating research in vertical transport and mixing and the coupling of these effects to atmospheric chemistry processes involving ozone and small particulate matter. Such research continues to support both the national and international aims of the NARSTO program.

- **Subsurface Science Program Completed** - Phaseout of the Subsurface Science Program activities will be completed in 1999, including the transition of basic research performed under BER sponsorship to the NABIR program and to applied activities supported by the Office of Environmental Management at the Test Area North, Idaho National Engineering and Environmental Laboratory. It was possible to capitalize on these earlier Subsurface Science Program field research activities to provide chemical and microbiological samples for fundamental research in bioremediation to investigators supported under the BER NABIR program.

- **Research on Long-Term Survival of Bacteria Completed** - In partnership with the Seboyetta Spanish Land Grant in rural New Mexico, research on environmental factors that control the long term survival of bacteria that are hundreds of meters deep was completed. The fact that surviving bacteria are also the most starvation-resistant bacteria has important implications for maintaining *in situ* microbial populations for bioremediation at Departmental sites. In completing the research, DOE, Land Grant authorities and residents have jointly reclaimed the drilling site, ensuring full compliance with State and Federal laws.

- **Carbon Sequestration Research Begins Under CCTI** - The carbon sequestration research program will focus on understanding the natural terrestrial sequestration cycle and the natural oceanic sequestration cycle as part of the first awards under the Climate Change Technology Initiative. The ultimate goal is to enhance the natural carbon cycle in both the terrestrial and the oceanic systems. Carbon sequestration is a key element of a more comprehensive carbon management program. Planning for joint CCTI-related activities with the Office of Fossil Energy was initiated.

Environmental Remediation

- **EMSL Attracts Wide Range of Users** - The William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) will have completed its second full year of operation as a research laboratory and user facility. In its first three months of operation, the EMSL attracted over 300 users from PNNL, other government laboratories, private industry, and academia, with over half the users coming from academia.

- **First NABIR Field Research Site** - Located at a Departmental site, the first Field Research Center for the Natural and Accelerated Bioremediation Research (NABIR) program will have been selected and field site characterization will have commenced in 1999. In addition to funding the second round of three year awards under the NABIR program, funded investigators are developing research teams that build on the strengths of the individual projects and that begin the process of integrating individual research efforts across the program elements.

Medical Applications and Measurement Science

- **New Tool for Treatment of Stroke** - A Technology Transfer Success: A multi-disciplinary team of scientists and engineers from Lawrence Livermore National Laboratory were honored after receiving the 1998 Federal Laboratory Consortium (FLC) Award for their efforts to develop a new laser technique for the treatment of stroke. The project is an excellent example of how the technology developed for national security missions can be applied successfully in the field of medical devices. The corporate partner involved in this project was EndoVasix, Inc. in Belmont, CA.

- **This is Your Brain on...** - Greater understanding of brain function is being achieved through the application of modern nuclear medicine imaging techniques such as positron emission tomography. Recent work has shown damage to brain function in persons addicted to drugs such as cocaine, this damage reinforces the craving for these drugs.

Scientific Facilities Utilization

The Biological and Environmental Research request includes $40,390,000 to maintain support of the Department's scientific user facilities. Facilities used for structural biology research, such as beam lines at the synchrotron light sources and research reactors are included. The request also includes operation of the William R. Wiley Environmental Molecular Sciences Laboratory where the research activities will underpin environmental remediation. This funding will provide for the operation of the facilities, assuring access for scientists in universities, federal laboratories, and U.S. companies. It will also leverage both federally and privately sponsored research consistent with the Administration's strategy for enhancing the U.S. National science investment.

Climate Change Technology Initiative

Overview

The FY 2000 budget contains two carbon related programs, each of which cut across several agencies. The first is the Climate Change Technology Initiative (CCTI). That part of the CCTI that is within the Office of Science is a joint activity between the Biological and Environmental Research (BER) and Basic Energy Sciences (BES) programs. The second program is the U.S. Global Change Research Program (US/GCRP) that spans eleven agencies and is coordinated through the National Science and Technology Council's Committee on Environment and Natural Resources. Within DOE, the BER program plays the lead role in US/GCRP activities. Although the two programs, CCTI and US/GCRP, are synergistic, they are quite different. US/GCRP research focuses on developing the fundamental understanding of the comprehensive climate system and the global and regional adaptations to it. CCTI focuses on the underpinning fundamental science that will enable mitigation of climate change while maintaining a robust National economy. All research in the CCTI will be peer-reviewed fundamental scientific research; no funds will be devoted to policy studies.

Eighty-five percent of our Nation's energy results from the burning of fossil fuels, a process that adds carbon to the atmosphere — principally in the form of carbon dioxide -- from the sequestered fossil reservoir. Because of the potential environmental impacts of increases in atmospheric carbon dioxide, carbon management has become an international concern and has become the focus of CCTI. A comprehensive carbon management research and development program that meets the needs of the CCTI addresses the diverse aspects of this problem. The Office of Science is well positioned to make significant contributions to the many solutions needed for this problem, as it is set to build on the fundamental discoveries of its core programs and extend them to the new discoveries needed to make carbon management practical and efficient. The Office of Science core programs include research on both carbon and non-carbon energy sources and on both carbon sequestration and carbon recycling. These core activities can now be exploited in the generation of the science that will underpin the technologies of the future. The theme of efficiency in energy production and use must span the entire range of research activities. Research on carbon energy sources, and their impacts, is a focal point of interagency activity through the US/GCRP. Research on non-carbon energy sources is also a focal point of intra-agency activities and is led by the DOE Office of Energy Efficiency and Renewable Energy. The DOE Office of Science, through activities in both the BES program and the BER program, supports research that underpins both efforts.

A research program in carbon management would include research directed at the following themes:

(1) science for efficient technologies,

(2) fundamental science underpinning advances in all low/no carbon energy sources, and

(3) sequestration science.

The Office of Science has long standing programs in fundamental research that already impact these three categories. In FY 2000, resources of $12,656,000 are being requested by BER specifically for the CCTI. The research will be a natural extension of the complementary, ongoing work in several programs in the Office of Science. It will build on the foundation of excellent and relevant research already underway and focus on those areas that build on strengths of the current Office of Science programs and promise maximum impact in the area of carbon management. Within the BER program, the Life Sciences subprogram activities in genomics underpin studies on microorganisms that may form the core of new fuel sources. Core activities within the Environmental Processes subprogram, particularly in terrestrial carbon cycle and in ocean sciences research, open up the possibility of exploiting Nature's own carbon sequestration processes to enhance sequestration.

Immediate Impacts of Expanded Effort in the Science for Climate Change Technology

Additional Office of Science efforts will not only address an immediate societal problem, but will also have a major effect on many scientific disciplines by advancing the state of knowledge and by training students in areas of research that are important to carbon management. For example, biochemistry, molecular and cellular biology, structural biology, and genome science will be impacted, because the production of fuels and chemicals by plants and microorganisms and the interconversion of greenhouse gases requires a better understanding of metabolism, of the structure and function of sub-cellular components, and of enzymes. Similarly, the state-of-the-art in biochemistry, molecular biology, and ecology will be impacted. All of these biological processes are important in understanding the role of marine microorganisms in sequestering carbon. Improvements in combustion to reduce carbon emissions require a fundamental understanding in chemical dynamics and theoretical chemistry and physics. Conversion of sunlight to energy requires an understanding in many areas of science, including photochemistry, photosynthesis, metabolism, and solid state physics. The search for increased efficiency in energy production and use requires fundamental knowledge in ceramics, metals, polymers, solid state chemistry, and condensed matter physics for materials that can withstand higher temperatures, have lower coefficients of friction, and are stronger and lighter. Enhanced recovery of fuel resources and of disposal of carbon dioxide requires a fundamental understanding of geometric, structural, and hydrologic properties of reservoirs and of multiphase, nonlinear transport of fluids in porous and fractured structures. Crosscutting programs in nano- and meso-phase materials involve research at the forefront of materials science, chemistry, engineering, surface science, and semiconductor physics.

The new research efforts supporting advances in low/no carbon energy technologies as well as existing activities, will be closely coordinated with DOE's technology programs and will provide the knowledge base for the development of advanced technologies to reduce carbon dioxide emissions. Many of the activities will impact the Office of Energy Efficiency and Renewable Energy (EE) by providing options for increasing efficiency in automobiles by reducing weight; for increasing efficiency in the use of electricity by increasing the efficiency of electric motors and generators with better magnets; for increasing efficiency in the transmission of electricity by using superconductors; and for reducing energy consumption in manufacturing with improved sensors, controls, and processes. Much of this research

program will provide the knowledge base needed to increase the use of renewable resources with research aimed at understanding the metabolism of carbon dioxide and the metabolic pathways to the production of methane and other biofuels. Other aspects of the research program impact the Office of Fossil Energy (FE) by providing a foundation for effective and safe underground sequestration, new materials, a better understanding of combustion, and improved catalysts.

Funding will be provided for areas of research in carbon cycle management including appropriate areas that will be jointly identified and implemented by the BER and BES programs. Solicitations will be issued for individual research projects. Additionally, proposal notifications may be developed jointly with the DOE energy technology programs with the intention of establishing multi-disciplinary centers at universities and national laboratories that will use the full capabilities of the institutions for a research program in carbon cycle management encompassing, for example, topics in the following areas: integration and assessment; separations; efficiency; clean fuels; bioenergy; storage and conversion; sequestration; enhanced natural terrestrial cycles; and enhanced use of major scientific user facilities to support carbon management research.

Interagency Environment

The SC program in fundamental science supporting energy technologies will be closely coordinated with, and synergistic to, the activities in its sister agencies (e.g., NASA, NSF, NOAA, USDA, DOI, and EPA) within the US/GCRP. Through its leadership role in decade to century climate prediction, BER has developed the research capability for comprehensive and large scale modeling of carbon dioxide impacts on climate, ecology, and ocean sciences, and this expertise is augmented by complementary activities in the other agencies. Similarly, the network of carbon flux measurements and ecological experiments that BER has developed serve as a backdrop to those of many other agencies, and the state-of-the-art can thus be pushed ahead more rapidly by capitalizing on the more rapidly growing base of knowledge. BER also has a leadership role within the US/GCRP on consequence evaluation of increased greenhouse gases in global climate change, including integrated assessments that address both scientific and societal (including economic) impacts of carbon management. Finally, through its pre-eminent role in the Human Genome Program and its development of the complementary Microbial Genome Program, the BER program is ideally placed to support research that will focus on the application of genetic information of microorganisms to increase metabolic efficiency related to carbon dioxide and methane production or consumption.

BER Activities

Climate Change Technology Initiative

(dollars in thousands)

	FY 1999	FY 2000
Life Sciences	2,434	5,841
Environmental Processes	2,921	6,815
Total	5,355	12,656

The BER program has the opportunity to take advantage of the unique research capabilities within the Environmental Processes subprogram and to determine which natural systems of forest, other plant, and marine microorganisms can be induced to increase their natural carbon sequestration capabilities. This will help to position the Department and the Nation to build new energy efficient technologies that capitalize on Nature's own processes. Additionally, through its pre-eminent role in the Human Genome Program and its development of the complementary Microbial Genome Program within the Life Sciences subprogram, the BER program is ideally placed to support research that will focus on the production of genetic information on methane-producing and hydrogen-producing microorganisms that can be exploited in the development of useful and efficient non-fossil fuel sources. Where appropriate, these efforts will be coordinated with activities within the US/GCRP. When combined with complementary activities within the BES program, this initiative will lead to the comprehensive carbon management research program described, above.

Funding of Contractor Security Clearances

In FY 1999, the Department divided the responsibility for obtaining and maintaining security clearances. The Office of Security Affairs, which was responsible for funding all Federal and contractor employee clearances, now pays only for clearances of Federal employees, both at headquarters and the field. Program organizations are now responsible for contractor clearances, using program funds. This change in policy enables program managers to make the decisions as to how many and what level clearances are necessary for effective program execution. In this way, it is hoped that any backlog of essential clearances that are impeding program success can be cleared up by those managers most directly involved. The Office of Science is budgeting $101,000 and $90,000 for estimated contractor security clearances in FY 1999 and FY 2000, respectively, within this decision unit.

Scientific Simulation Initiative

This budget also includes the BER program's contribution to DOE's Scientific Simulation Initiative (SSI), an integrated effort bringing together computational and communication resources, focused research in scientific disciplines, and research in computer science and other enabling technologies to solve the complex problems that characterize DOE's scientific research needs. The SSI couples research in advanced scientific applications in the programs of the Office of Science with research in computer science and enabling technologies and advanced computing and communications facilities. It is a joint program between the Computational and Technology Research (CTR) program and the other programs in SC. The overview of the integrated program is given in the overview of the CTR budget; however, the specific contributions of the BER program are described below.

BER, which has been for many years the primary supporter of research in global systems in the DOE, will manage the global systems applications research effort. These efforts are the result of a successful interagency program to study global systems as a part of the U.S. Global Change Research Program (USGCRP), in which the Department plays a major role. These efforts will also contribute to the broader Presidential initiative in information technology. The goal of this effort is to dramatically advance the development, testing and use of fully coupled global system models with sufficient resolution to encompass the complete range of interactions from global to regional spatial scales over time periods of

tens to hundreds of years. Currently, too coarse spatial resolution, inadequate representation of key processes, such as cloud effects, and an inadequate number of short-duration model runs limit simulations and predictions of the global system. The computational and informational technology developed in the global systems research effort will be used to create a bridge that enables fully collaborative research between multi-institutional teams of computational scientists, global modelers and experts in the acquisition and interpretation of observational measurements. High fidelity component models, such as general circulation simulation codes of the atmosphere and ocean will be developed and tested first, then coupled for full system simulation. The data from these simulations as well as the individual component models themselves will be employed for more disciplinary-focused research related to environmental variability and change.

In addition, the simulation products of these models will provide a valuable and unique database for the study and understanding of long-term environmental variability and change. In order to make the best possible use of this data, the global systems component will develop and employ advanced collaborative and data management technology to enable the broad and diverse base of researchers and users from the many areas of environmental and earth science to advance the knowledge in their fields with the unprecedented volume and quality of the new information about the workings of the global environment.

To accomplish its goals the Global Systems applications research effort must: (1) accelerate progress in coupled general circulation model development and application; (2) reduce substantially the uncertainties in decade-to-century model-based projections of global environmental change; and (3) increase the availability and usability of global change projections to the broader environmental research and environmental assessment communities.

Funding Profile

(dollars in thousands)

	FY 1998 Current Appropriation	FY 1999 Original Appropriation	FY 1999 Adjustments	FY 1999 Current Appropriation	FY 2000 Request
Biological and Environmental Research					
Life Sciences	163,792	179,492	-3,177	176,315	163,664
Environmental Processes	105,780	120,262	-3,397	116,865	133,838
Environmental Remediation	64,497	67,435	-93	67,342	65,757
Medical Applications and Measurement Science	61,607	76,411	-245	76,166	47,911
Subtotal, Biological and Environmental	395,676	443,600	-6,912	436,688	411,170
Construction	0	0	0	0	0
Subtotal, Biological and Environmental	395,676	443,600	-6,912	436,688	411,170
Use of Prior Year Balances	-4,580 [a]	-3,798 [a]	0	-3,798 [a]	0
General Reduction for Policy Papers for CCTI	0	-5,500	5,500	0	0
General Reduction	0	-1,412	1,412	0	0
Total, Biological and Environmental Research	391,096 [b]	432,890	0	432,890	411,170

Public Law Authorization:

Public Law 95-91, “Department of Energy Organization Act”

[a] Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.

[b] Excludes $9,614,000 which was transferred to the SBIR program and $577,000 which was transferred to the STTR program.

Funding By Site

(dollars in thousands)

	FY 1998	FY 1999	FY 2000	$ Change	% Change
Albuquerque Operations Office					
Los Alamos National Laboratory	19,661	20,651	18,251	-2,400	-11.6%
National Renewable Energy Laboratory	250	0	0	0	NA
Sandia National Laboratories	3,486	3,239	2,903	-336	-10.4%
Total, Albuquerque Operations Office	23,397	23,890	21,154	-2,736	-11.5%
Chicago Operations Office					
Ames Laboratory	766	631	500	-131	-20.8%
Argonne National Laboratory, East	11,278	9,181	8,487	-694	-7.6%
Brookhaven National Laboratory	26,501	22,142	19,228	-2,914	-13.2%
Total, Chicago Operations Office	38,545	31,954	28,215	-3,739	-11.7%
Idaho Operations Office					
Idaho National Environmental & Engineering Laboratory	2,158	2,034	1,736	-298	-14.7%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	34,358	31,587	29,003	-2,584	-8.2%
Lawrence Livermore National Laboratory	30,004	36,148	28,446	-7,702	-21.3%
Stanford Linear Accelerator Center (SSRL)	3,323	2,450	2,550	+100	+4.1%
Total, Oakland Operations Office	67,685	70,185	59,999	-10,186	-14.5%
Oak Ridge Operations Office					
Oak Ridge Inst. For Science & Education.	5,575	2,673	4,046	+1,373	+51.4%
Oak Ridge National Laboratory	25,422	21,617	19,153	-2,464	-11.4%
Total, Oak Ridge Operations Office	30,997	24,290	23,199	-1,091	-4.5%
Richland Operations Office					
Pacific Northwest National Laboratory	77,466	73,913	70,434	-3,479	-4.7%
All Other Sites [a]	155,428	210,422	206,433	-3,989	-1.9%
Subtotal, Biological and Environmental Research	395,676	436,688	411,170	-25,518	-5.8%
Use of Prior Year Balances	-4,580	-3,798 [b]	0	+3,798	+100.0%
Total, Biological and Environmental Research	391,096 [c]	432,890	411,170	-21,720	-5.0%

[a] Funding provided to laboratories, universities, industry, other Federal agencies and other miscellaneous contractors.

[b] Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.

[c] Excludes $9,614,000 which was transferred to the SBIR program and $577,000 which was transferred to the STTR program.

Site Description

Ames Laboratory

Ames Laboratory is a Multiprogram Laboratory located on 10 acres in Ames, Iowa. At Ames, BER supports research into new biological imaging techniques such as fluorescence spectroscopy to study environmental carcinogens.

Argonne National Laboratory

Argonne National Laboratory (ANL) in Argonne, Illinois, is a Multiprogram Laboratory located on a 1,700 acre site in suburban Chicago. ANL has a satellite site located in Idaho Falls, Idaho. At ANL, BER supports the operation of the Structural Biology Center, a high-throughput national user facility for protein crystallography at the Advanced Photon Source, and research in protein structure relating to the process of photosynthesis. In support of Global Change research, ANL coordinates the operation and development of the Southern Great Plains ARM site. The principal scientist for the Atmospheric Chemistry program is at ANL, providing broad scientific integration to the program.

Research is conducted to understand the molecular control of genes and gene pathways in both microbes and mammalian cells and molecular factors that control cell responses to low doses of radiation.

Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) is a Multiprogram Laboratory located on a 5,200 acre site in Upton, New York. BER supports the operation of beam lines for protein crystallography at the National Synchrotron Light Source and High Flux Beam Reactor for use by the national biological research community, research in biological structural determination, research and operation of the protein structure database, and research into new instrumentation for detecting x-rays and neutrons. Technology development research is conducted to improve current methods for high throughput DNA sequencing. Research is also conducted on the molecular mechanisms of cell responses to low doses of radiation and chemicals.

The Boron Neutron Capture Therapy (BNCT) program supports early clinical trials of this concept for treatment of brain cancers that do not respond to conventional treatment. The nuclear medicine program supports research into novel techniques for imaging brain function in normal and diseased states and funds the operation of the Brookhaven Imaging Center as a user facility for research in many branches of medicine.

Global change activities at BNL include the operation of the ARM External Data Center, a resource that provides ARM investigators with data from non-ARM sources, including satellite and ground-based systems. BNL scientists form an important part of the science team in the Atmospheric Sciences program, providing special expertise in atmospheric field campaigns and aerosol research. BNL scientists play a

leadership role in the development of, and experimentation at, the Free Air Carbon Dioxide Enhancement (FACE) at the Duke Forest.

Idaho National Engineering and Environmental Laboratory

Idaho National Engineering and Environmental Laboratory is a Multiprogram Laboratory located on 572,000 acres in Idaho Falls, Idaho. BER supports research into boron chemistry, radiation dosimetry, analytical chemistry of boron in tissues, and engineering of new systems for application of this treatment technique for brain and other tumors. Research into the analytical chemistry of complex environmental and biological systems using the technique of mass spectrometry is also supported.

Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory (LBNL) is a Multiprogram Laboratory located in Berkeley, California. The Laboratory is on a 200 acre site adjacent to the Berkeley campus of the University of California. LBNL is one of the major national laboratory partners that comprise the Joint Genome Institute (JGI) whose principal goals are high throughput human DNA sequencing and studies on the biological functions associated with newly sequenced human DNA. A significant component of the JGI's sequencing goal is the development and integration of instrumentation, automation, biological resources, and data management and analysis tools into a state-of-the-art DNA sequencing assembly line that is highly efficient and cost effective. The laboratory also conducts research on the molecular mechanisms of cell responses to low doses of radiation and chemicals and on the use of model organisms to understand and characterize the human genome.

LBNL operates beam lines for determination of protein structure at the Advanced Light Source for use by the national biological research community, research into new detectors for x-rays, and research into the structure of membrane and other proteins.

Research is conducted into the use of accelerators to produce neutrons for boron neutron capture therapy, an alternative treatment for highly malignant brain tumors. The nuclear medicine program supports research into novel radiopharmaceuticals for medical research and studies of novel instrumentation for imaging of living systems for medical diagnosis.

LBNL supports the Natural and Accelerated Bioremediation Research (NABIR) program and the field geophysical - biophysical research capabilities for NABIR field sites. BER supports research into new technologies for characterization of complex environmental contamination. LBNL also develops scalable implementation technologies that will allow widely used climate models to run effectively and efficiently on massively parallel processing supercomputers.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) is a Multiprogram Laboratory located on a 821 acre site in Livermore, California. LLNL is one of the major national laboratory partners that comprise the Joint Genome Institute (JGI) whose principal goals are high throughput human DNA sequencing and studies on the biological functions associated with newly sequenced human DNA. A significant component of the JGI's sequencing goal, is the development and integration of instrumentation, automation, biological resources, and data management and analysis tools into a state-of-the-art DNA sequencing assembly line that is highly efficient and cost effective. LLNL also conducts research on the molecular mechanisms of cell responses to low doses of radiation and chemicals, on the use of model organisms to understand and characterize the human genome, and on the development of new technologies for determining the structures of many more proteins than is currently possible.

Through the Program for Climate Model Diagnostics and Intercomparison, LLNL provides the international leadership to understand and improve climate models.

Los Alamos National Laboratory

Los Alamos National Laboratory (LANL) is a Multiprogram Laboratory located on a 27,000 acre site in Los Alamos, New Mexico. LANL is one of the major national laboratory partners that comprise the Joint Genome Institute (JGI) whose principal goals are high throughput human DNA sequencing and studies on the biological functions associated with newly sequenced human DNA. A significant component of the JGI's sequencing goal is the development and integration of instrumentation, automation, biological resources, and data management and analysis tools into a state-of-the-art DNA sequencing assembly line that is highly efficient and cost effective. LANL also conducts research on the molecular mechanisms of cell responses to low doses of radiation and to understand the molecular control of genes and gene pathways in microbes.

Activities in structural biology include the operation of an experimental station for protein crystallography at the Los Alamos Neutron Science Center for use by the national biological research community and research into new techniques for determination of the structure of proteins.

LANL coordinates the operation and development of the Tropical Western Pacific ARM site. LANL also has a crucial role in the development, optimization, and validation of coupled atmospheric and oceanic general circulation models on massively parallel computers.

LANL also conducts research into advanced medical imaging technologies for studying brain function and research into new techniques for rapid characterization and sorting of mixtures of cells and cell fragments.

Oak Ridge Institute for Science and Education

Oak Ridge Institute for Science and Education (ORISE) is located on a 150 acre site in Oak Ridge, Tennessee. ORISE coordinates several research fellowship programs for BER including minority faculty and student research fellowships, Hollaendar postdoctoral fellowships, and humanitarian research awards

to scientists in the Former Soviet Union. ORISE also coordinates activities associated with the peer review of all BER-funded science.

ORISE conducts research into modeling radiation dosages for novel clinical diagnostic and therapeutic procedures.

Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is a Multiprogram Laboratory located on a 24,000 acre site in Oak Ridge, Tennessee. ORNL has a leadership role in research focused on the ecological aspects of global environmental change. The Throughput Displacement Experiment at the Walker Branch Watershed is a unique resource for long term ecological experiments. ORNL is the home of the newest FACE experiment supported by BER. ORNL is the home to the ARM archive, providing data to ARM scientists and to the general scientific community. ORNL scientists provide improvement in formulations and numerical methods necessary to improve climate models. ORNL is also home to the Carbon Dioxide Information and Analysis Center, an international resource for providing quality assured environmental data. ORNL scientists make important contributions to the NABIR program, providing special leadership in microbiology applied in the field.

ORNL conducts research on widely used data analysis tools and information resources that can be automated to provide information on the biological function of newly discovered genes identified in high throughput DNA sequencing projects. The laboratory also conducts research on the use of model organisms to understand and characterize the human genome and on the molecular mechanisms of cell responses to low doses of radiation and chemicals.

ORNL conducts research into the application of radioactively labeled monoclonal antibodies in medical diagnosis and therapy, particularly of cancer, as well as research into new instrumentation for the analytical chemistry of complex environmental contamination using new types of biosensors.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is a Multiprogram Laboratory located on 640 acres at the Department's Hanford site in Richland, Washington. PNNL is home to the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL). PNNL and EMSL scientists play important roles in both supporting the NABIR program and in performing NABIR research.

PNNL operates the unique ultrahigh field mass spectrometry and nuclear magnetic resonance spectrometry instruments at the Environmental Molecular Sciences Laboratory for use by the national biological research community.

PNNL provides the lead scientist for the Environmental Meteorology Program, the G-1 research aircraft, and expertise in field campaigns. PNNL provides the planning and interface for the Climate Change Prediction Program with other climate modeling programs. The ARM program office is located at PNNL, as is the ARM chief scientist and the project manager for the ARM data system; this provides invaluable logistical, technical, and scientific expertise for the program. PNNL is developing the Second Generation Model for predicting the benefits and costs of policy actions with respect to global climate change.

PNNL conducts research into new instrumentation for microscopic imaging of biological systems and for characterization of complex radioactive contaminants by highly automated instruments.

Sandia National Laboratories

Sandia National Laboratories (SNL) is a Multiprogram Laboratory, with a total of 3,700 acres, located in Albuquerque, New Mexico, with sites in Livermore, California, and Tonapah, Nevada. SNL coordinates the operation and development of the North Slope of Alaska ARM site. The chief scientist for the ARM-UAV program is at SNL, and SNL takes the lead role in coordinating and executing ARM-UAV missions.

To support environmental cleanup, SNL conducts research into novel sensors for analytical chemistry of contaminated environments.

Stanford Linear Accelerator Center

Stanford Linear Accelerator Center (SLAC) is a program-dedicated laboratory (High Energy Physics) located on 426 acres in Menlo Park, California. It is the home of the Stanford Synchroton Radiation Laboratory (SSRL) and peer-reviewed research projects associated with SSRL. The Stanford Synchrotron Radiation Laboratory was built in 1974 to take the intense x-ray beams from the SPEAR storage ring that was built for particle physics by the SLAC laboratory. Over the years, the SSRL grew to be one of the main innovators in the production and use of synchrotron radiation with the development of wigglers and undulators that form the basis of all third generation synchrotron sources. The facility is now comprised of 25 experimental stations and is used each year by over 700 researchers from industry, government laboratories and universities. Through Stanford Linear Accelerator Center, BER (in coordination with the National Institutes of Health) is funding the operation of Stanford Synchrotron Radiation Laboratory beam lines for structural biology. This program involves synchrotron radiation-based research and technology developments in structural molecular biology that focus on protein crystallography, x-ray small angle scattering diffraction, and x-ray absorption spectroscopy for determining the structures of complex proteins of many biological consequences.

All Other Sites

The BER program funds research at 70 colleges/universities located in 35 states. This line also includes funding of research awaiting distribution pending completion of peer review results.

BER supports a broad range of peer-reviewed research at America’s universities, including institutions that traditionally serve minority communities. Research opportunities are announced through public solicitations in the Federal Register for research applications from universities and the private sector.

Life Sciences research is conducted at a large number of universities in all aspects of the program. Research is conducted in support of high throughput human DNA sequencing at the JGI, on the sequencing of entire microbial genomes with value to the DOE mission, to understand the molecular control of genes and gene pathways in microbes, on the use of model organisms to understand and

characterize the human genome, and on the molecular mechanisms of cell responses to low doses of radiation and chemicals.

In structural biology, universities provide new imaging detectors for x-rays, research in computational structural biology directed at the understanding of protein folding, and research into new techniques such as x-ray microscopy.

Peer reviewed projects are supported in each element of the Environmental Processes subprogram, with very active science teams, in particular, in the Atmospheric Chemistry Program and the ARM programs. Academic investigators are essential to the Integrated Assessment portfolio. Through the National Institute for Global Environmental Change, academic scientists play essential roles in the establishment and maintenance of, and research at, the AmeriFlux sites.

NABIR research grants are awarded following the peer review of applications received in response to solicitations published in the federal register. Academic and private sector investigators are performing research in areas that include mechanistic studies of bioremediation of actinide and transition metal contamination, the structure of microbial communities in the presence of uranium and other such contaminants, gene function in microorganisms with degradative properties, geochemical and enzymatic processes in microbial reduction of metals, and the use of tracers to monitor and predict metabolic degradative activity.

In nuclear medicine, universities conduct research into new types of radiopharmaceuticals, particularly those based on application of concepts from genomics and structural biology. Emphasis is placed on radiopharmaceuticals that will be of use in advanced imaging techniques such as positron emission tomography. Research is supported into new instrumentation for medical imaging. Five centers of excellence for application of lasers in medicine are funded at medical schools by this program. The Boron Neutron Capture Therapy program supports studies of novel boron compounds for use in treating brain cancer, early clinical trials of the technique, and new instrumentation based on accelerators that could be used in hospitals and clinics. The Measurement Science program supports research into novel types of biosensors for application in analytical chemistry of contaminated environments.

Life Sciences

Mission Supporting Goals and Objectives

Research is focused on utilizing unique DOE resources and facilities to develop fundamental biological information and advanced technologies for understanding and mitigating the potential health effects of energy development, energy use, and waste cleanup. Research is conducted in five areas: structural biology, cellular biology, molecular biology, human genome, and health effects. The research:

- Integrates information and technologies from genome, structural biology, and molecular biology research with human health research to understand the complex relationships between genes, the proteins they encode, and the biological functions of these proteins in the context of the whole organism.
- Develops new biotechnologies, including those derived from microbial genome research, for bioremediation applications, and for the mitigation of potential health effects resulting from energy development, energy use, and waste cleanup.
- Supports DOE research at national user facilities for scientists to determine the molecular structure of enzymes, antibodies, and other important biological molecules. Computational structural biology research combines computer science, structural biology, and genome research to predict the functions of biological molecules. This information will enable the design or more efficient use of biological molecules for drugs, environmental cleanup, or energy-production and use.
- Develops and applies new technologies and resources to map and determine the sequence of the subunits of DNA found in a typical human cell, for analyzing and interpreting DNA sequence data, and for studying the ethical, legal, and social implications (ELSI) of information and data resulting from the genome program, especially issues of privacy, intellectual property, and education. Program emphasis is on high throughput, production sequencing of human DNA, rapid entry of data into public databases, and identifying the functions for a portion of the 100,000 genes that make up the human genome.
- Develops new molecular-based tools for health surveillance, biological dosimetry, and individual susceptibility determination to understand and characterize the risks to human health from exposures to low levels of radiation and chemicals both at home and at work. An emphasis is placed on research that utilizes the unique resources and tools developed in the Department's human genome, structural biology, and cellular and molecular biology programs.

Climate Change Technology Initiative

The Life Sciences subprogram's support of microbial genome research also underpins the climate change technology initiative. Knowing the genomic sequence of microbes that produce methane and hydrogen, will enable the identification of the key genetic and protein components of the organisms that regulate these gases. Understanding more fully how the enzymes and organisms operate, we will be able to evaluate their potential use to produce methane or hydrogen from either fossil fuels or other carbonaceous sources, including biomass or even some waste products. Recently discovered "extremophile" organisms could be used to engineer biological entities that could ingest a feedstock like methane, sequester the carbon dioxide, and give off hydrogen.

Performance Measures

- Determine the molecular structures of proteins with more than 60 percent of the new structures that are published in the peer reviewed literature resulting from data generated at synchrotron user stations by BER structural biology program.
- Complete the sequencing of 50 million finished and 70 million draft subunits of human DNA to submit to publicly accessible databases in FY 2000.

Funding Schedule

(dollars in thousands)

	FY 1998	FY 1999	FY 2000	$ Change	% Change
Structural Biology	29,962	27,086	28,145	+1,059	+3.9%
Molecular and Cellular Biology	30,402	36,140	23,380	-12,760	-35.3%
Human Genome	85,226	88,786	90,270	+1,484	+1.7%
Health Effects	18,202	19,975	17,854	-2,121	-10.6%
SBIR/STTR	0	4,328	4,015	-313	-7.2%
Total, Life Sciences	163,792	176,315	163,664	-12,651	-7.2%

Detailed Program Justification

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
Structural Biology			
■ Infrastructure support and development for the Nation's structural biologists. Development and operation of experimental stations at DOE national user facilities such as the synchrotrons and neutron beam sources. Completion of development and initial operation of the protein crystallography station at the Los Alamos Neutron Science Center. Support for the major three-dimensional structural database for proteins.	17,003	16,000	16,000
■ Basic research in structural biology including instrumentation research and research that cuts across basic biology, molecular biology, and computational biology. Completion of initial studies of inverse protein folding to understand the rules proteins follow to acquire the three dimensional structure that gives them their biological function. First prototypes of pixel array detectors for x-rays will be ready for field testing that will greatly increase the sensitivity and speed data collection needed for determining the structure and, ultimately, the function of proteins. Implementation of proteome research program to understand the structure, function, and interactions of all proteins encoded by an organism's genome.	12,959	11,086	12,145
Total, Structural Biology	29,962	27,086	28,145
Molecular and Cellular Biology			
■ The field of microbial genomics is one of the most exciting and high profile fields in biology today. Initiated by DOE in 1994, microbial genomics and microbial genomic sequencing were identified by *Science* magazine as one of the top 10 fields of discovery in both 1997 and 1998. The BER Microbial Genome Program has supported the complete genomic sequencing of 6 of the 18 bacteria whose DNA has			

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
been sequenced and published. At least 12 more are in progress. The broad impacts of this research emphasize a central principle of the BER genome programs - complete genomic sequences yield answers to fundamental questions in biology. Microbes are being sequenced and characterized in several parts of the BER program because of potential impacts across several DOE missions. These include the Climate Change Technology Initiative (sequencing methane or hydrogen producing microbes or microbes involved in carbon dioxide sequestration), environmental cleanup (microbes for bioremediation), alternative fuel sources (methane production or energy from biomass), industrial processes (industrial useful enzymes), and biological nonproliferation (understanding and detecting biowarfare agents). The microbial genome program continues to capitalize on DNA sequencing technology from the human genome program to determine the complete DNA sequence of microbes with potential environmental, energy, or commercial applications. While the program continues its emphasis on DNA sequencing it has expanded to include research in three additional areas: (1) microbial diversity, to identify a broader array of potentially useful microbes; (2) new strategies for determining the DNA sequence of microbes for which the complete sequence of a very closely related microbe is already known, to avoid the need for costly and time consuming sequencing of many important microbes from scratch; and (3) novel strategies and tools for characterizing, manipulating, and modeling entire reaction pathways or regulatory networks of microbes or groups of microbes to maximize the usefulness of these newly characterized microbes.	5,200	7,000	8,860

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
■ The Climate Change Technology Initiative (CCTI) continues to determine the DNA sequence of microbes that produce methane or hydrogen from carbonaeous sources or that could be used to sequester carbon dioxide. New research is being initiated to characterize key reaction pathways or regulatory networks in these microbes following the determination of their DNA sequence. These new studies focus on the development of practical uses for microbes within the CCTI.	0	2,434	5,841
■ Funding was provided for the Northeast Regional Cancer Institute in Scranton, Pennsylvania per Congressional direction for FY 1998 and for the Institute for Molecular Biology and Medicine, University of Scranton, Scranton, Pennsylvania, per Congressional direction for FY 1999. . . .	9,735	10,189	0
■ Molecular biology research, as a general research area, comes to an end with the exception of continued funding for the Human Science Frontiers Program, an international program of collaborative research to understand brain function and biological function at the molecular level supported by U.S. government through the DOE, the National Institutes of Health, the National Science Foundation, and the National Aeronautics and Space Administration.	6,735	4,684	1,000
■ The low dose exposure program uses molecular level knowledge gained from the Department's human genome and structural biology research to ascertain the effects on humans, ranging from cells to the whole organism, that arise from low-dose-rate exposures to energy and defense-related insults such as radiation and chemicals. This information will provide a better scientific basis for remediating contaminated DOE sites and achieving acceptable levels of human health protection, both for cleanup workers and the public, in a more cost-effective manner that could save billions of dollars.	3,000	8,000	7,679
■ Cellular biology research, as a general research area, comes to an end and is replaced by the low dose exposure program.	5,732	3,833	0
Total, Molecular and Cellular Biology	30,402	36,140	23,380

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
Human Genome			
■ The Joint Genome Institute (JGI) and its Production Sequencing Facility (PSF) are primarily focused on high throughput sequencing of human DNA. The JGI is a virtual institute formed from the combined strengths and expertise of the DOE Human Genome Centers at the Los Alamos, Lawrence Livermore, and Lawrence Berkeley National Laboratories. FY 2000 is the third year of a major 3-5 year scale-up in DNA sequencing capacity for the PSF. In FY 2000 the PSF will complete the sequencing and submission to public databases of 50 million finished and 70 million high quality draft base pairs of human DNA.	46,300	50,000	53,894
■ Improvements in high throughput human DNA sequencing technology and sequence data management are needed to complete the first human genome by 2003 and to most efficiently and cost effectively use that new sequence information for future medical diagnoses and new scientific discovery. Research is conducted to continue the incremental improvements in current DNA sequencing technology by increasing throughput, increasing accuracy, and decreasing cost. New sequencing technologies, that have been investigated on a pilot scale, are tested and "hardened" in a DNA sequencing production environment. Research is conducted on the next generation of sequencing technology that will be needed to take advantage of the DNA sequence to be determined after 2003. Research on automated and robust approaches to analyze and manage the large amounts of DNA sequence being determined continues. These approaches will replace the hands-on, gene-by-gene analyses traditionally used by scientists to make their initial analyses of newly discovered or identified genes. A table follows displaying both DOE and NIH genome funding.	36,411	36,226	33,816

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
■ The Ethical Legal and Societal Issues (ELSI) program increases its emphasis on research related to the uses, impacts, and implications of genetic information in the workplace and the use of the workplace as a research environment.	2,515	2,560	2,560
Total, Human Genome	85,226	88,786	90,270

U.S. Human Genome Project Funding

(dollars in millions)

	Prior Years	FY 1998	FY 1999	FY 2000
DOE Total Funding (includes construction)	457.3	85.2	88.8	90.3
NIH Funding	1,234.4	218.0	240.1	TBD
Total U.S. Funding	1,691.7	303.2	328.9	TBD

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
Health Effects			
■ The low dose exposure program, also funded under Cellular Biology, uses molecular level knowledge gained from the Department's human genome and structural biology research to ascertain the effects on humans, ranging from cells to the whole organism, that arise from low-dose-rate exposures to energy and defense-related insults such as radiation and chemicals. This information will provide a better scientific basis for remediating contaminated DOE sites and achieving acceptable levels of human health protection, both for cleanup workers and the public, in a more cost-effective manner that could save billions of dollars.	0	0	2,321

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
■ Model organism research capitalizes on our understanding and the manipulability of the genomes of organisms, including yeast, nematode, fruitfly, Zebra fish, and mouse, to speed understanding of human genome organization, regulation, and function. Research is conducted at a genomic or near-genomic scale, i.e., not, for example, at the level of individual genes, and focuses on understanding of human genome organization, regulation, and function. Funding to be provided to ORNL to continue conceptual design activities for the Center for Functional Genomics.	0	9,000	11,027
■ Technology development research results in new approaches, tools, or technologies for determining the structures of many more proteins than is currently possible and includes more efficient strategies for protein expression and more efficient, high-throughput methods of protein sample preparation for protein crystallization. Research to develop and use protein microarray systems for functional screening of large numbers of proteins is also conducted.	0	3,000	4,506
■ Biological research, as a general research area, comes to an end.	18,202	7,975	0
Total, Health Effects	18,202	19,975	17,854
SBIR/STTR			
■ In FY 1998, $3,872,000 and $233,000 were transferred to the SBIR and STTR programs, respectively. The FY 1999 and FY 2000 amounts shown are the estimated requirement for the continuation of these programs.	0	4,328	4,015
Total, Life Sciences	163,792	176,315	163,664

Explanation of Funding Changes From FY 1999 to FY 2000

	FY 2000 vs. FY 1999 ($000)
Structural Biology	
■ Structural biology research increases as proteome research program is implemented	+1,059
Molecular and Cellular Biology	
■ Increase in Microbial Genome for new research on microbial diversity, gene networks, and strategies for DNA sequencing that capitalize on known DNA sequence.	+1,860
■ Increase in Climate Change Technology Initiative (CCTI).	+3,407
■ Decrease in Molecular Biology due to completion of traditional Molecular Biology research and development and expansion of new research programs and completion of Congressionally directed project.	-13,873
■ Continue low dose research at FY 1999 level	-321
■ Decrease in Cellular biology research due to completion of traditional Cellular Biology research and development and expansion of a new low dose research program in Cellular Biology	-3,833
Total, Molecular and Cellular Biology	-12,760
Human Genome	
■ Increase for Human Genome research due to increase in sequencing of human DNA to meet national program goals	+1,484
Health Effects	
■ Increase in low dose research due to continued expansion of new crosscutting program to understand the health impacts of low dose exposures to radiation and chemicals	+2,321
■ Increase in model organisms research due to increased emphasis on research to understand human genome organization, regulation, and function	+2,027

	FY 2000 vs. FY 1999 ($000)
■ Increase in technology development research due to increased emphasis on developing new methods for determining the structure and function of large numbers of proteins	+1,506
■ Decrease in Biological Research due to completion of traditional Biological Research program and development and expansion of new research programs	-7,975
Total, Health Effects	-2,121
SBIR/STTR	
■ Decrease in SBIR/STTR due to reduction in research funding.	-313
Total Funding Change, Life Sciences	-12,651

Environmental Processes

Mission Supporting Goals and Objectives

Research is focused on understanding the basic chemical, physical, and biological processes of the Earth's atmosphere, land, and oceans and how these processes may be affected by energy production and use, primarily the emission of carbon dioxide from fossil fuel combustion. A major part of the research is designed to provide the data that will enable an objective assessment of the potential for, and consequences of, global warming. The program is comprehensive with an emphasis on understanding the radiation balance from the surface of the Earth to the top of the atmosphere (including the role of clouds) and on enhancing the quantitative models necessary to predict possible climate change at the global and regional scales. The components of the Atmospheric Radiation Measurement (ARM) program continue to work in an integrated fashion to produce the experimental and modeling results that will be necessary to resolve the greatest uncertainty in climate prediction - the role of clouds and solar radiation. Climate modeling using massively-parallel supercomputers will simulate climate change, predict climate, and evaluate model uncertainties due to changes in atmospheric concentrations of greenhouses gases on decade to century time scales. The Carbon Cycle program is designed to study the natural carbon cycle and to assess the potential impacts of climate change on terrestrial systems. There are four contributing areas to this research program: Climate and Hydrology, Atmospheric Chemistry and Carbon Cycle, Ecological Processes, and Human Interactions. The National Institute for Global and Environmental Change (NIGEC) is included within these four areas. The Environmental Processes subprogram includes funding for DOE's contribution to the U.S. Global Change Research Program that was codified by Congress in the Global Change Research Act of 1990 and for part of the Energy Research activities under the Climate Change Technology Initiative.

Climate Change Technology Initiative

The Atmospheric Chemistry and Carbon Cycle category supports basic research that promotes an understanding of the role that the terrestrial biosphere and human activities play on the state and quality of the global climate. Complementing the activities in support of the U.S. Global Change Research Program, science for the Climate Change Technology Initiative seeks the understanding necessary to exploit the biosphere’s natural processes for use in sequestration of atmospheric carbon dioxide including the roles of marine microorganisms in ocean carbon sequestration and the mechanisms by which forest ecosystems sequester carbon.

Scientific Simulation Initiative

Building on the long-standing BER expertise in climate modeling, the Scientific Simulation Initiative will create a bridge between computational scientists, global modelers, and experts in the acquisition and interpretation of observational measurements to develop, test, and use highly advance fully coupled global system models. The focus will be on models that are of much higher spacial resolution than currently available, and model runs will simulate climate over time periods of tens to hundreds of years, at fidelities that cannot be achieved with current hardware or software. In doing so, the SSI will bring

together expertise from academia and the federal laboratories, and couple activities in a synergistic way to bring global system modeling to a broader spectrum of environmental research than is currently possible.

Performance Measures

- Proceed on the development of the next generation coupled ocean-atmosphere climate model, leading to better information for assessing climate change and variability at regional, rather than global scales. This next generation model will change grid size from the current 300-500 kilometers on a side to less than 200 kilometers on a side.
- Coordinate with other federal agencies, Canada, and Brazil to maximize national and international capabilities to enhance understanding of the current global carbon dioxide distribution and the role of the terrestrial biosphere in that distribution.
- Develop collaborative partnerships between strong marine sciences research institutions and those with developing capabilities to advance innovative techniques in modern molecular biology to understand the coupling between carbon and nitrogen cycles in coastal waters and sediments.
- In cooperation with NASA, NSF, USDA/Forest Service, and the Smithsonian Institution, provide quantitative data on the annual exchange of carbon dioxide between the atmosphere and terrestrial ecosystem from 25 AmeriFlux sites representing major types of ecosystem and land uses in North Central America. Provide data on both the effects of environmental factors, such as climate variation, on the net sequestration or release of carbon dioxide and the role of biophysical processes controlling the net exchange.
- Commence full operation at three Atmospheric Radiation Measurement (ARM) sites, providing unique climatological data necessary to improve climate prediction for use in energy policy development. Continue ARM accomplishments by conducting five intensive operations periods at the ARM Southern Great Plains site. Data will be obtained from the second station on the North Slop of Alaska. The third station in the Tropical Western Pacific, on Christmas Island, will become operational.
- Continue The Global Change Research Education Program which will continue to support graduate and undergraduate students conducting DOE-related global change research. It will continue to participate in the multi-agency “Significant Opportunities in Atmospheric Research and Science” Program (SOARS).

Funding Schedule

(dollars in thousands)

	FY 1998	FY 1999	FY 2000	$ Change	% Change
Climate and Hydrology	63,150	64,093	74,383	+10,290	+16.1%
Atmospheric Chemistry and Carbon Cycle	20,675	29,972	32,924	+2,952	+9.8%
Ecological Processes	13,084	12,348	12,010	-338	-2.7%
Human Interaction	8,871	7,483	11,105	+3,622	+48.4%
SBIR/STTR	0	2,969	3,416	+447	+15.1%
Total, Environmental Processes	105,780	116,865	133,838	+16,973	+14.5%

Detailed Program Justification

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
Climate and Hydrology			
■ **Climate Modeling:** Improved simulations provide the scientific basis for predicting climate and its implications for future decades. Develop next generation coupled atmosphere-ocean general circulation models with improved resolution to approximately 200 km grid size. Additionally, develop improved climate observational databases for testing and verifying the models. Support will continue for needed computational resources on the supercomputers at the LANL Advanced Computing Laboratory.	20,469	21,336	20,274
■ **Scientific Simulation Initiative (SSI):** Regional Variability Associated with Global Changes: There is a need to analyze and downscale global climate model simulations to smaller scales for regional studies of environmental changes. Methodologies to do so will be developed and implemented using a hierarch of applied and engineering models. Technologies will be developed and employed that can quickly and efficiently work with large and distributed and archived sets of both observational and modeling data to produce data sets suitable for study of regional changes and their impacts. Two centers connected to the core SSP infrastructure will be established to access the primary data archive and computational facilities.	0	0	3,902

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
■ **Scientific Simulation Initiative (SSI):** Coupled Model Development, Testing and Application: With its partners in the multi-agency U.S. Global Change Research Program, DOE will establish two multi-institutional model development teams for research on fully coupled comprehensive models for simulating multi-decade and multi-century changes of the global environment at regional resolution. Included in these activities is implementation of collaboratory technology to facilitate interaction and speed progress.	0	0	2,930
■ **Scientific Simulation Initiative (SSI):** Component Model Research and Development: Initiate research to pursue improvements in predictability, numerical methods, and parameterizations needed for improving the fidelity and computational performance of the component models, such as atmospheric and ocean general circulation models, that integrate to form comprehensive, coupled climate models.	0	0	2,930
■ **Atmospheric Radiation Measurement (ARM):** The Atmospheric Radiation Measurement (ARM) infrastructure program develops, supports, and maintains the three ARM sites and associated instrumentation. Continue operation of over two hundred instruments at the Southern Great Plains site. Begin limited operations of the third Tropical Western Pacific station on Christmas Island. Redeploy ARM instruments used in the Surface Heat Budget of the Arctic Ocean (SHEBA) as the second North Slope of Alaska station. Provide data to scientific community through the ARM Archive.	28,017	28,224	27,371

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
■ **Atmospheric Radiation Measurement (ARM):** ARM research will support about 50 principal investigators working on cloud physics and on solar radiation interactions with water vapor and aerosols. Conduct the ARM-led, multi-agency and Japanese experimental campaign on Nauru (Tropical Western Pacific) to study the effects of islands in measuring solar radiation and cloud interactions with the oceans. Enhance interactions with prominent climate modeling centers, including those supported by the NSF and by NOAA. Additional field studies will focus on connection of ARM data with carbon cycle research	11,659	11,659	14,093
■ **Atmospheric Radiation Measurement (ARM)/Unmanned Aerial Vehicles (UAV):** The joint ARM-UAV and NASA field study of tropical cirrus clouds will provide new information on key cloud formations that moderate the radiation budget of the Earth.	3,005	2,874	2,883
Total, Climate and Hydrology	63,150	64,093	74,383
Atmospheric Chemistry and Carbon Cycle			
■ Atmospheric Science programs provide data that address the new air quality standards on tropospheric ozone and particulate matter. Conduct laboratory and field studies of the chemistry and reactivity of atmospheric species and transport. Support tropospheric ozone and aerosols studies, in conjunction with the North American Research Strategy for Tropospheric Ozone (NARSTO). Support air quality modeling and initiate pollution transport studies (and related aspects of weather forecasting). Complete the data analysis for the prototype megacity air quality study in Mexico City, Mexico. Partial support for the National Institute for Global Environmental Change (NIGEC) is included in this budget activity.	12,856	12,967	11,278

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
■ Field studies of major ecosystem types and land uses provide data to better understand the effects of environmental factors such as climate variation on the net exchange of carbon and the role of biophysical processes controlling this exchange. Operate the AmeriFlux network of twenty-five instrumented research towers for measurements of long-term carbon dioxide and water vapor fluxes and energy exchange from a large variety of ecosystems. Using tools of microbiology explore linkages between carbon and nitrogen cycles in marine microbes by partnering institutions with traditional research in oceans and those with emerging capabilities.	7,819	13,113	14,831
■ Funding was provided for the Marine Mammal Research and Education Center at the National Energy Laboratory at Keahole Point, Hawaii, per Congressional direction in FY 1999.	0	971	0
■ Under the Climate Change Technology Initiative, improve understanding of biochemical mechanisms of natural carbon sequestration in both terrestrial and ocean systems in order to, ultimately, enhance or augment these natural processes. Conduct studies on the cellular processes that lead to sequestration in forest ecosystems and the identification of the pathways by which marine microorganisms enhance carbon flow from the atmosphere to ocean surface and, ultimately, to the deep ocean.	0	2,921	6,815
Total, Atmospheric Chemistry and Carbon Cycle	20,675	29,972	32,924

Ecological Processes

- Improve understanding and modeling of the effects of elevated carbon dioxide on whole ecosystem structure and function that effect the nation's resources. Investigate the relationship between precipitation and the regeneration and species composition of deciduous forests in Tennessee's Walker Branch Watershed. Analyze the effects of precipitation changes on nutrient cycling, carbon

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
sequestration, forest growth, and decomposition in a southeastern deciduous forest. Free Air Carbon Dioxide Enrichment (FACE) experiments at Duke Forest; the Nevada desert; Oak Ridge, TN; Cedar Creek, MN; and Rhinelander, WI, will provide data on the effects of elevated carbon dioxide and other environmental changes on forest, desert, and grassland ecosystems. Partial support for the NIGEC is included in this budget activity.	13,084	12,348	12,010

Human Interactions

- The Integrated Assessment program investigates the diffusion of technology innovation into societal use and develops expanded economic models to include consideration of five additional greenhouse gases (nitrous oxide, methane, CFC 11, HCFC 22, and CF4) other than carbon dioxide. The Information and Integration program stores, evaluates, and quality-assures a broad range of global environmental change data and disseminates these to the broad research community. Included is the Quality Systems Science Center for the tri-lateral (Mexico, United States, and Canada) NARSTO. The educational activities support DOE mission-related research into global environmental change by students at the undergraduate and graduate levels. Included in these activities are the Summer Undergraduate Research Experience, Graduate Research agency "Significant Opportunities in Atmospheric Research and Science" Program. Partial support for the National Institute for Global Environmental Change is included in this budget activity. BER will provide opportunities for pre-college teachers that will participate directly in cutting-edge research at DOE science laboratories and will renew their understanding of scientific investigation. Where teachers do not possess sufficient background to participate directly in research, DOE will provide mediated research experiences where teachers can work with teams of scientists and science educators to understand the nature of DOE's scientific research. The goal is to provide educators with the tools to sharpen their science and math foundations and apply these tools to their classroom practice. Funds

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
will be provided to pay for teacher's stipends, travel, housing, and subsidize laboratory scientists' time for this activity ($1,947,000).	8,871	7,483	11,105
SBIR/STTR			
■ In FY 1998, $2,625,000 and $154,000 were transferred to the SBIR and STTR programs, respectively. In FY 1999 and FY 2000 amounts shown are the estimated requirement for the continuation of these programs.	0	2,969	3,416
Total, Environmental Processes	105,780	116,865	133,838

Explanation of Funding Changes from FY 1999 to FY 2000

	FY 2000 vs. FY 1999 ($000)
Climate and Hydrology	
■ Represents transition of some high end computing developments to activities under the SSI.	-1,062
■ SSI. Initiate activities to develop methodologies and research collaborations to increase fidelity and resolution of global systems simulations..	+9,762
■ Reflects that the ARM research sites are at increased stages of development	-853
■ Increase to provide for data collection to enhance scientific understanding of coupling between clouds, radiation, and atmospheric part of carbon cycle	+2,434
■ ARM-UAV to continue at FY 1999 level of effort	+9
Total, Climate and Hydrology	+10,290
Atmospheric and Carbon Cycle	
■ Represents completion of prototype megacity air quality study in Mexico City, Mexico.	-1,689
■ Increase to provide for data collection to validate carbon cycle.	+1,718
■ Decrease due to completion of Congressionally directed project.	-971

	FY 2000 vs. FY 1999 ($000)
■ CCTI. Increased focus on ocean and terrestrial sequestration by natural ecosystems.	+3,894
Total, Atmospheric and Carbon Cycle	+2,952
Ecological Processes	
■ Ecological Processes continues at FY 1999 level.	-338
Human Interactions	
■ Increase will allow new activities coupling educational opportunities with research in environmental meteorology and will allow pre-college teachers to participate directly in cutting-edge research at DOE science laboratories.	+3,622
SBIR/STTR	
■ SBIR/STTR increase due to increase in research funding.	+447
Total Funding Change, Environmental Processes	+16,973

Environmental Remediation

Mission Supporting Goals and Objectives

The research is primarily focused on gaining a better understanding of the fundamental biological, chemical, geological, and physical processes that must be marshaled for the development and advancement of new, effective, and efficient processes for the remediation and restoration of the Nation's nuclear weapons production sites. Priorities of this research are bioremediation and operation of the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL). Bioremediation activities are centered on the Natural and Accelerated Bioremediation Research (NABIR) program, a basic research program focused on determining the conditions under which bioremediation will be a reliable, efficient, and cost-effective technique. This subprogram also includes basic research in support of pollution prevention, sustainable technology development and other fundamental research to address problems of environmental contamination. Facility operations supports the operation of the EMSL national user facility for basic research that will underpin safe and cost-effective environmental remediation methods and technologies and other environmental priorities.

Unique EMSL facilities such as the Molecular Science Computing Facility, the High-Field Mass Spectrometry Facility, and the High-Field Magnetic Resonance Facility will be used by the external scientific community and EMSL scientists to conduct a wide variety of molecular-level environmental science research, including improved understanding of chemical reactions in DOE’s underground storage tanks, movement of contaminants in subsurface groundwater and vadose zone sediments, and atmospheric chemical reactions that contribute to global warming.

In the NABIR program, research advances will continue to be made from pore to field scales in the Biogeochemical Dynamics element; on genes and proteins used in bioremediation through the Biomolecular Science and Engineering element; in non-destructive, real-time measurement techniques in the Assessment element; in overcoming physico-chemical impediments to bacterial mobility in the Acceleration element; on species interaction and response of microbial ecology to contamination in the Community Dynamics and Microbial Ecology element; and in understanding microbial processes for altering the chemical state of metallic and radionuclide contaminants through the Biotransformation and Biodegradation element. In analogy with the Ethical, Legal, and Social Implications component of the Human Genome Program, the Bioremediation and Its Societal Implications and Concerns component of NABIR will explore societal issues surrounding bioremediation research and promote open and two-way communication with affected stakeholders, avoiding dictating solutions. Research in the Systems Integration, Prediction and Optimization element is being initiated to help define and develop an integrative model to aid collaboration and direction across research teams within the NABIR program.

Performance Measures

- Continue the Natural and Accelerated Bioremediation Research (NABIR) program to support fundamental research in environmental and molecular sciences that will underpin the development of bioremediation for containing hazardous waste and cleaning DOE sites. Site characterization of the first NABIR Field Research Center will proceed, and activities necessary to enable research sample distribution to investigators will commence.
- The William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) will be identified and cited as an important resource in research publications and research proposals written by investigators in academia and at National Laboratories.

Funding Schedule

(dollars in thousands)

	FY 1998	FY 1999	FY 2000	$ Change	% Change
Bioremediation Research	28,781	28,895	28,039	-856	-3.0%
Clean Up Research	5,527	6,817	6,773	-44	- 0.6%
Facility Operations	30,189	30,072	29,415	-657	-2.2%
SBIR/STTR	0	1,558	1,530	-28	-1.8%
Total, Environmental Remediation	64,497	67,342	65,757	-1,585	-2.4%

Detailed Program Justification

(dollars in thousands)

FY 1998	FY 1999	FY 2000

Bioremediation Research

- In NABIR, progress will be made in understanding both intrinsic bioremediation as well as manipulated, accelerated bioremediation using chemical/microbial amendments. Laboratory and field experiments will be in progress to understand the fundamental mechanisms underlying chemical processes, complexation/degradation, and microbial transport. Field site characterization of the first NABIR Field Research Center will proceed, in preparation for distribution of research samples to investigators. Three megabases of genomic DNA from microbes with potential utility in bioremediation will be sequenced. The interagency (DOE, National Science Foundation, Office of Naval Research,

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
Environmental Protection Agency) program on environmental biotechnology will continue to be supported, completing the current awards, to advance understanding of the fundamental processes that control the bioavailability of complex chemical mixtures in field situations.	22,437	22,915	22,059
■ General Plant Projects (GPP) funding is for minor new construction, other capital alterations and additions, and for buildings and utility systems such as replacing piping in 30 to 40-year old buildings, modifying and replacing roofs, and HVAC upgrades and replacements. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. This subprogram includes landlord GPP funding for Pacific Northwest National Laboratory (PNNL) and for Oak Ridge Institute for Science and Education (ORISE). The total estimated cost of each GPP project will not exceed $5,000,000.	5,194	4,811	4,811
■ General Purpose Equipment (GPE) funding for general purpose equipment for PNNL and ORISE such as updated radiation detection monitors, information system computers and networks, and instrumentation that supports multi-purpose research.	1,150	1,169	1,169
Total, Bioremediation Research	28,781	28,895	28,039
Clean Up Research			
■ A program will be maintained to develop cost effective and efficient biotechnology and bioremediation methods and approaches for pollution prevention in key energy and pollution intensive industries. This includes additional research to characterize the geological, chemical, and physical properties that affect the rate and effectiveness of environmental remediation and waste-stream cleanup methods, including bioremediation.	5,527	6,817	6,773

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
Facility Operations: William R. Wiley Environmental Molecular Sciences Laboratory (EMSL)			
■ EMSL became fully operational as a national user facility focusing on collaborative research, in FY 1998. Operating funds provide essential maintenance of instruments and associated support facilities, and the technical and Environmental, Safety and Health support needed by the wide-ranging user community to apply the EMSL scientific capabilities. EMSL will support about 600 users on an annual basis, with approximately half coming from academia to use such unique instrumentation as the 512- processor IBM SP computer system, the 750-MHZ and ultra high-field nuclear magnetic resonance spectrometers, the ultra-high vacuum scanning tunneling and atomic force microscopes, and the controlled atmosphere environmental chambers. . . .	27,057	28,083	27,426
■ Capital equipment support for the EMSL enables instrument modifications needed by collaborators and external users of the facility and helps to maintain the spectroscopic and computer equipment at state-of-the-art.	3,132	1,989	1,989
Total, Facility Operations	30,189	30,072	29,415
SBIR/STTR			
■ In FY 1998, $1,461,000 and $88,000 were transferred to the SBIR and STTR programs, respectively. In FY 1999 and FY 2000 amounts shown are the estimated requirement for the continuation of these programs.	0	1,558	1,530
Total, Environmental Remediation	64,497	67,342	65,757

Explanation of Funding Changes from FY 1999 to FY 2000

	FY 2000 vs. FY 1999 ($000)
Bioremediation Research	
■ Decrease in pollution prevention and sustainable development activities.	-856
Clean Up Research	
■ Decrease in pollution prevention and sustainable development activities.	-44
Facility Operations	
■ Decrease in Facility Operations will result in fewer hours of fully supported assistance for outside users working independently, rather than collaboratively, at the facility	-657
SBIR/STTR	
■ SBIR/STTR decrease due to reduction in research funding.	-28
Total Funding Change, Environmental Remediation	-1,585

Medical Applications and Measurement Science

Mission Supporting Goals and Objectives

The medical applications subprogram supports research to develop beneficial applications of nuclear and other energy-related technologies for medical diagnosis and treatment. The research is directed at discovering new applications of radiotracer agents for medical research as well as for clinical diagnosis and therapy. A major emphasis is placed on application of the latest concepts and developments in genomics, structural biology, computational biology, and instrumentation. Much of the research seeks breakthroughs in noninvasive imaging technologies such as positron emission tomography. The research in this activity is conducted in five specific areas: Radiopharmaceuticals, Instrumentation, Clinical Feasibility, Boron Neutron Capture Therapy (BNCT) and Molecular Nuclear Medicine.

The measurement science subprogram focuses on research in analytical chemistry to develop new instrumentation to meet the needs of the environmental and life sciences research programs of the Office of Biological and Environmental Research. Research is also supported that will meet needs for new instrumentation to characterize contaminated environments in support of the Department's environmental cleanup program.

Performance Measures

- Complete Phase I clinical trials of BNCT at reactor sources of neutrons for at least 100 patients.

Funding Schedule

(dollars in thousands)

	FY 1998	FY 1999	FY 2000	$ Change	% Change
Medical Applications	56,841	69,084	40,817	-28,267	-40.9%
Measurement Science	4,766	5,087	5,849	+762	+15.0%
SBIR/STTR	0	1,995	1,245	-750	-37.6%
Total, Medical Applications and Measurement Science	61,607	76,166	47,911	-28,255	-37.1%

Detailed Program Justification

(dollars in thousands)

	FY 1998	FY 1999	FY 2000
Medical Applications			
■ Complete Phase I human clinical trials of boron neutron capture therapy (BNCT), for at least 100 patients, at Brookhaven National Laboratory, Massachusetts Institute of Technology and the Ohio State University, including trials to assess the maximum safe dosages of boron compound and neutron radiation. Capital equipment funds will be used to support research on an accelerator-based facility for BNCT as an alternative to the use of nuclear reactors.	11,648	11,441	10,892
■ Develop new approaches to radiopharmaceutical design and synthesis using concepts from genomics as well as computational biology and structural biology. Complete research into radiolabeling of monoclonal antibodies for cancer diagnosis and therapy, including research at the Garden State Cancer Center in the diagnosis of cancer and infectious diseases. Evaluate clinical potential of imaging of gene expression using radiotracers. Redirect program elements to emphasize development of techniques for the simultaneous use of multiple radiotracers to study physiological processes.	18,360	20,233	24,700
■ Develop new concepts in multimodal imaging systems for study of human brain function and complete evaluation of combination of nuclear medicine imaging systems with magnetic resonance imaging. Research into new applications of lasers in medicine emphasizes transfer of technology from the DOE laboratories to clinical research facilities. Capital equipment funds are provided in support of development of new instrumentation such as a PET camera for small animal imaging.	4,946	5,877	5,225
■ Complete phase-out of research into new radioisotopes for nuclear medicine applications.	36	0	0

	(dollars in thousands)		
	FY 1998	FY 1999	FY 2000
■ Funding for the Medical University of South Carolina, Loma Linda Medical Center, the University of California-Davis, the University of Rochester Medical Center, Englewood Hospital in New Jersey, the University of Nevada, Las Vegas, and New Mexico Highlands University as included in Congressional direction for FY 1998. Funding for these projects is completed in FY 1998.	21,851	0	0
■ Funding for Gallo Prostate Cancer Research and Treatment Center, City of Hope National Medical Center, National Foundation for Functional Brain Imaging, State University of New York - Stony Brook, University of California - Davis, University of Alabama, New Mexico Highlands University, West Virginia National Education and Technology Center and the University of South Carolina Medical Center, as included in Congressional direction for FY 1999. Funding for these projects is completed in FY 1999.	0	31,533	0
Total, Medical Applications	56,841	69,084	40,817
Measurement Science			
■ Complete research into new sensor instrumentation for characterization of chemical composition of contaminated subsurface environments in support of the Department's environmental cleanup efforts of highly radioactive chemical wastes. Continue research into new imaging instrumentation for environmental and life sciences applications. Capital equipment funds are provided for components needed for research into new instrumentation.	4,766	5,087	5,849
SBIR/STTR			
■ In FY 1998, $1,656,000 and $102,000 were transferred to the SBIR and STTR programs, respectively. In FY 1999 and FY 2000, amounts shown are the estimated requirement for the continuation of these programs.	0	1,995	1,245
Total, Medical Applications and Measurement Science	61,607	76,166	47,911

Explanation of Funding Changes From FY 1999 to FY 2000

	FY 2000 vs. FY 1999 ($000)
Medical Applications	
■ BNCT—maintains program at FY 1999 level of effort.	-549
■ Increased funding for Radiopharmaceuticals allows for research efforts at the Garden State Cancer Center	+4,467
■ Decrease in instrumentation is attributable to complete development of imaging instrumentation	-652
■ Decrease due to completion of Congressionally directed projects.	-31,533
Total, Medical Applications.	-28,267
Measurement Science	
■ Increased funding for research in new sensor instrumentation for characterization of chemical composition of contaminated environments. .	+762
SBIR/STTR	
■ SBIR/STTR decrease due to reduction in research funding.	-750
Total Funding Change, Medical Applications and Measurement Science	-28,255

Capital Operating Expenses & Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 1998	FY 1999	FY 2000	$ Change	% Change
General Plant Projects	5,194	4,811	4,811	0	0.0%
Capital Equipment	19,089	18,988	21,150	+2,162	+11.4%
Total Capital Operating Expenses	24,283	23,799	25,961	+2,162	+9.1%