Our high standard of living requires use of the land, water, and mineral endowments of the earth. Explosive population growth, expansion of material needs, and rapidly changing technology have placed great demands on the nation's natural resources. In using these resources, we may affect our environment and alter our options for land and resource use in the future. Satisfying present and future needs for food, water, energy, living space, shelter, transportation, recreation, and other requirements of a modern civilized society creates many complex environmental problems. Solutions to these problems demand application of earth-science technology to guide the development, conservation, and management of land, mineral, and water resources within their existing natural, chemical, physical, and biological constraints.

Established in 1879, the U.S. Geological Survey's primary responsibility has been to provide information about the nation's mineral, energy, land, and water resources. Almost from its beginning, the survey has been involved in studying environmental issues raised by land and water resource development. To meet today's challenges, the Geological Survey has placed a high priority on programs and activities that have application to environmental issues important to the nation's future well-being. Professionals connected with the Geological Survey are active in land, water, and atmospheric research and development relevant to natural resource use and environmental issues. Such activities are described below.

1. Geologic hazards studies—earthquakes, volcanoes, and landslides—are conducted by the Geological Survey under its organic act and in some cases with specific authorization such as the National Earthquake Hazards Reduction Program. Activities of this program allow for research, monitoring, and instrument development which can be applied to the study of more than one geologic hazard, and provide federal, state, and local governments with technical assistance and earth-science data on geologic hazards for land-use planning, engineering design, and emergency management. The current earthquake programs consist of five elements: (1) regional tectonics and earthquake potential; (2) earthquake prediction research; (3) regional earthquake hazards assessment; (4) earthquake data and information service; and (5) engineering seismology. The direction of future efforts will concentrate more on those techniques and approaches that have enjoyed the greatest success in the past as well as new techniques resulting from research programs. These include detailed geologic studies of fault zones, upgrading of the seismometer network, and research in areas of earthquake prediction and regional earthquake hazard assessment. The USGS Volcano Hazards Program consists of monitoring active volcanic centers for the purposes of issuing timely warnings, conducting volcano hazards assessments in areas of geologically recent activity, and basic research in volcanic processes. Volcano monitoring activities are conducted mainly at the Hawaiian Volcano Observatory on the island of Hawaii (Kilauea and Mauna Loa Volcanoes), at the Cascades Volcano Observatory in Vancouver, Washington (Mount St. Helens Volcano and Spirit Lake area), and at the Long Valley caldera-Mono Lake area, California. Also included are landslide hazards studies that comprise landslide hazards assessment, landslide process and prediction, landslide mitigation and control, and fundamental research in Arctic surficial processes and engineering geology in Alaska.

2. Basic research on the geologic framework and geologic mapping provides much of the geologic information used by other federal and state agencies, as well as the academic community and private industry; for example, a new series of geologic quadrangle maps has been started which depicts the Quaternary Geology of the United States at a scale of 1:1,000,000. These maps represent a synthesis of data compiled as part of a joint effort involving state and university scientists and should serve as a valuable starting point in characterizing surficial material for possible storage of toxic wastes and potential sites of unstable ground related to landslides and land subsidence. In addition, we recognize the need of medium- and large-scale general purpose geologic maps that are critical to the work of earth scientists from every major scientific organization in the United States as well as a wide spectrum of land-use planners and other users of geologic information. In an effort to meet this need and to improve the quantity and quality of geologic mapping throughout the nation, the Geological Survey has started a new program of cooperative geologic mapping with state geological surveys. The main goals of the program are: (1) to begin new large- and intermediate-scale geologic mapping projects in areas where only very limited geologic mapping presently exists;
(2) to begin mapping in areas of uncertain but suspected mineral or energy potential (where limited mapping has impeded exploration); and (3) to cooperate in the conception and compilation of new state geologic maps.

3. Traditionally, maps have played a key role in earth-science analysis and environmental management. The increasing use of computers to store and analyze earth-science data has sparked the growth in demand for computerized map information by state and federal agencies, as well as the private sector. Recognizing the wide range of applications of digital cartographic data, we are moving aggressively to build a National Digital Cartographic Data Base and to develop the necessary data standards, computer techniques, and equipment capacities for its support. One of the first major interagency efforts underway was a joint pilot project by the Geological Survey and the Bureau of the Census to digitize all hydrography and transportation data at the 1:100,000 scale for the state of Florida. This project was the first step in digitizing the hydrography and transportation systems at that scale for the conterminous United States. The data resulting from this latter effort will not only be useful for the 1990 decennial census but also will be useful for such purposes as determining optimum routes for transporting hazardous waste in order to minimize risks to major population centers. Cartographic and geographic data are also being digitized at other scales to meet the needs of many users including those developing geographic information systems. The National High Altitude Photography Program has acquired for public use dormant season, small-scale, black-and-white and color infrared photography of virtually the entire conterminous United States since 1980. Recently, a follow-up program was begun to acquire similar coverage during the growing season. This photographic data base has proven highly useful for addressing a variety of environmental issues.

4. In 1979, we began a focused research program on the use of the geologic environment to isolate high-level radioactive wastes. Part of the research is concerned with locating areas where the geologic and hydrologic conditions provide a series of natural, relatively independent, multiple barriers to radioactive waste transport. This concept was adopted to overcome deficiencies in our ability to characterize adequately the masses of rock around a repository and to predict waste-rock-water reactions, natural events, and radioactive waste transport. Another aspect of the research is to improve our ability to predict future geologic and climatic events. We are conducting a variety of geologic and hydrologic investigations on behalf of the Department of Energy in regions where possible repository sites are being considered: these include the Nevada Test Site, the waste isolation pilot plant in southeastern New Mexico, the Paradox Basin in Utah, and the salt dome region in northern Louisiana and Mississippi. One major accomplishment within this program has been the development of the concept of waste disposal in thick unsaturated zones in arid regions, from studies now underway at the Nevada Test Site. Technical support is provided to other federal and state agencies to assist them in the development of criteria, standards, and regulations for the management of low-level radioactive waste. Recently, we have completed detailed field studies of the processes controlling leaching and migration of radionuclides at six existing commercial low-level waste burial sites in Illinois, Kentucky, Nevada, New York, and South Carolina, and at Department of Energy disposal sites in Idaho, Illinois, and Tennessee.

5. As the magnitude of groundwater contamination problems became clearer in recent years, as well as the disparity in the levels of attention devoted to assessing the environmental impacts from radioactive wastes versus chemical wastes, we moved in 1982 toward treating these problems as one integrated interdisciplinary concern. Also begun was a new program on toxic waste and ground- and surface-water contamination to carry out new research efforts and to provide better and more timely answers to related questions regarding major land uses. These land uses include irrigated and nonirrigated cropland, forestland, active and abandoned mining areas, areas of oil and gas production, and regions of extensive industrial development.

6. The acidity of precipitation is thought to have caused acidification of certain forestlands, streams, and lakes in the northeastern United States, eastern Canada, and elsewhere over the past 30 years. In 1982, as part of the National Acid Precipitation Assessment Program (an interagency research investigation into the acid-rain phenomenon) the USGS began an intensified program to collect and interpret data to help formulate national policy regarding the control or abatement of acid rain. The Department of the Interior's lead-agency responsibility for atmospheric deposition monitoring has been assigned to the Geological Survey. A major element of this responsibility is coordination of the design, implementation, and operation of the National Trends Network, composed of 150 stations for sampling atmospheric deposition in the United States. The purpose of the network is to determine the variability, both in location and in time, of the composition of atmospheric deposition, which