Chapter 21

Federal Research and Development in Maryland

- Approximately $8.1 billion of federal R&D funds are spent each year in Maryland.
- Maryland ranks 2nd among the 50 states, District of Columbia, and Puerto Rico in terms of the amount of federal R&D dollars received annually.
- Approximately 34 percent of all federal funds received by Maryland for purposes other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance) is spent on R&D.

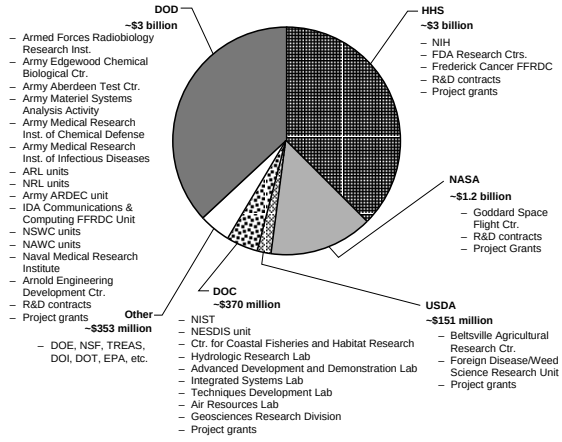

Figure 21.1 – Sources of Federal R&D Dollars Spent in Maryland (Total Federal R&D ~$8.1 billion)

Background

In recent years, the federal government has spent in the neighborhood of $8.1 billion annually in Maryland on research and development (R&D) activities. On average, federal dollars for R&D account for approximately 34 percent of all federal funds received by Maryland for purposes other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance).

Most major federal agencies that currently support R&D efforts fund significant R&D activities in Maryland. Foremost among these agencies are the Departments of Health and Human Services (HHS) and Defense (DOD), which account for 38 and 37 percent of all federal R&D dollars spent in the state. The National Aeronautics and Space Administration (NASA) and the Department of Commerce (DOC) account for an additional 15 and 5 percent of all federal R&D dollars spent in Maryland, respectively. The remaining federal R&D dollars come from the Department of Agriculture (USDA), the Department of Energy (DOE), the National Science Foundation (NSF), and several other federal agencies.[21]

All federal R&D dollars spent in Maryland either cover the costs of operating federal R&D units in the state, including paying the salaries of federal R&D personnel working at these units, or are awarded as grants or contracts to entities located in the state. The following is an overview of what becomes of these federal R&D dollars once they arrive in Maryland.

Federal R&D Units in Maryland

Aberdeen, Maryland, is home to DOD's Aberdeen Test Center, Edgewood Chemical Biological Center, Army Medical Research Institute of Chemical Defense, Army Materiel Systems Analysis Activity, a unit of the Army Research Laboratory, and a unit of the Armament Research, Development, and Engineering Center.

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[21] For a complete agency-by-agency breakdown of these R&D dollars, see Appendix C.

- The Army's Aberdeen Test Center is a unit of DOD. Its primary responsibility involves the testing of a broad spectrum of military weapon systems and equipment, including armored vehicles, guns, ammunition, trucks, bridges, generators, night vision devices, and underwater marine systems. In addition, it develops test procedures, methodologies, and instrumentation to meet the test requirements of advancing military technologies. This federal facility annually receives about $69 million of federal R&D funds, approximately $31.6 million of which are spent on in-house activities, and has about 850 civilian personnel, only a portion of whom are directly involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

- The Edgewood Chemical Biological Center is a unit of DOD. It is the Army's principal R&D center for chemical and biological defense technology and engineering. It consists of several laboratories, including ones focused on surface spectroscopy and electron microscopy; environmental sciences, pharmacology, toxicology, biosciences, biotechnology, and related life sciences; bioprocess engineering; and respirator design and prototyping. The center also conducts R&D on smoke/obscurant equipment. This federal facility annually receives about $144 million of federal R&D funds, approximately $52 million of which is spent on in-house activities, and has about 830 civilian personnel, only a portion of whom are directly involved in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

- The U.S. Army Medical Research Institute of Chemical Defense is a unit of DOD. It develops medical countermeasures for use against chemical warfare agents. Specifically, the institute conducts research on medical defense against agents (neurotoxins) of biological origin. It also has a clinical training mission, teaching health care providers from all the armed services how to manage chemical casualties. This federal facility annually receives about $26 million of federal R&D funds, approx-

imately $19 million of which is spent on in-house activities, and has about 150 civilian personnel, virtually all of whom are directly involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

- The U.S. Army Materiel Systems Analysis Activity is a unit of DOD. It employs automated databases and models to characterize the functionality of Army materiel systems. It has developed unique models and methodologies to accurately predict critical performance variables, such as weapon accuracy, target acquisition, rate of fire, probability of inflicting catastrophic damage, and system reliability. It is also responsible for ensuring their standard use across Army and joint service studies. This federal unit annually receives about $12 million of federal R&D funds, virtually all of which is spent on in-house activities, and has about 275 civilian personnel, only a portion of whom are directly involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

- The Aberdeen Proving Ground is a unit of DOD's Army Research Laboratory. The laboratory is headquartered in Adelphi, Maryland, with additional sites in White Sands, New Mexico; Cleveland, Ohio; Hampton, Virginia; Eatontown, New Jersey; and Atlanta, Georgia. The laboratory's Directorate of Corporate Information and Computing, Directorate of Human Research and Engineering, Directorate of Survivability/Lethality Analysis, and Directorate of Weapons and Materials Technology are headquartered in Aberdeen. These directorates conduct research on the ballistics of projectiles, guns, and missiles; propulsion technology; munition lethality; armor protection; munition survivability; materials for armor, antiarmor, and soldier protection; soldier/machine interface; human interaction with military systems; networking and telecommunications; scientific visualization; and high-performance computing. Specific areas of research interest include theoretical mechanics, physics,

pulsed electromagnetic power, polymers, adhesives, composite materials, robotics, and computer-aided design. This unit annually receives about $220 million of federal R&D funds, approximately $93 million of which is spent on in-house activities, and employs about 953 civilians, only a portion of whom are directly involved in R&D activities.

- The Firing Tables Branch is a unit of the Army's Armament Research, Development, and Engineering Center inside DOD. The center is headquartered in Picatinny, New Jersey, with subordinate research activities in Rock Island, Illinois; Watervliet, New York; and Aberdeen, Maryland. The center's focus is on integrating complex armament technologies into guns, ammunition, and fire control systems through research, development, acquisition, and sustainment. This branch conducts research on aeroballistic design, with a particular focus on the development of aiming and ballistic fire control data for all unguided and some guided combat weapon systems. This federal unit annually receives approximately $980,000 of federal R&D dollars for in-house activities and has about 60 civilian personnel, only a portion of whom are involved in R&D activities.

Adelphi, Maryland, is home to a unit of DOD's Army Research Laboratory.

- The Adelphi Laboratory Center is the headquarters unit of DOD's Army Research Laboratory. The laboratory also has sites in Aberdeen, Maryland; White Sands, New Mexico; Cleveland, Ohio; Hampton, Virginia; Eatontown, New Jersey; and Atlanta, Georgia. The laboratory's Directorate of Information Science and Technology and Directorate of Sensors and Electron Devices are headquartered at the Adelphi Center. It conducts basic and applied research to provide the Army with the key technologies and analytical support necessary to ensure supremacy in future land warfare. Its research areas include flame chemistry, aerodynamics, transonic experimentation, properties of tungsten alloys, explosives mechanics, aircraft vulnera-

bility, robotics, composites, materials, electro-optics, ion implantation, sensors, and acoustics. This federal unit annually receives approximately $188 million of federal R&D funds, $79 million of which is spent on in-house activities, and has about 864 civilian personnel, all of whom are involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

Baltimore, Maryland, is home to the Department of Interior's (DOI) Maryland District Office of Water Resources and a Department of Veterans Affairs (DVA) R&D unit.

- The Maryland District Office of Water Resources is a unit of DOI's U.S. Geological Survey (USGS). It oversees the R&D activities of USGS's National Water-Quality Assessment (NAWQA), Ground-Water Resources Assessment, Toxic Substances Hydrology, and Federal State Cooperatives programs. The NAWQA program conducts research on the nation's surface and groundwater resources to better understand the effect of pesticides, erosion, and bacterial contamination on water quality. The Ground-Water Resources Assessment program studies groundwater systems to develop models and simulations to better understand the workings of these systems. The Toxic Substances Hydrology program studies the behavior of toxic substances in hydrologic environments. These research activities investigate subsurface contamination at local releases and aquatic ecosystem contamination on a watershed and regional scale. The Federal State Cooperatives program studies the effects of agricultural chemicals, floods, droughts, and waste disposal on water supply and groundwater quality. This federal unit annually receives approximately $1.3 million in federal R&D funds.

- While the principal focus of the Baltimore VA Medical Center is providing medical care to veterans, it is also the location of a number of research activities. In a recent year, this federally owned and operated facility was the site of 473 projects with total funding of approximately $5.9 million. These R&D ac-

tivities focus on a wide range of topics, including congestive heart failure, hypertension, drug therapy, arrhythmia, electric countershock, and neoplasms.

Beltsville, Maryland, is home to USDA's Beltsville Agricultural Research Center.

- The Beltsville Agricultural Research Center (BARC) is a unit of USDA's Agricultural Research Service (ARS) located on the campus of the University of Maryland. It consists of four research divisions focusing on plant science, livestock and poultry science, human nutrition, and natural resources. Specifically, the Plant Science Institute conducts research on developing environmentally safe ways of controlling undesirable plants through the use of conventional crop protection chemicals, biologically based approaches to controlling weeds and the development of alternative weed management systems for sustainable agriculture. The Livestock and Poultry Science Institute conducts research to increase production efficiency and quality of livestock products and consists of nine laboratories and three service divisions. The Beltsville Human Nutrition Research Center conducts research to better understand the relationship between diet and health. Specific research activities of this center focus on the role of food and its components in optimizing human health and in reducing the risk of nutritionally related disorders in the diverse population. The Natural Resources Institute conducts research in different areas, including water quality, climate change, food quality and safety, sustainable agriculture, and controlled release of genetically engineered microorganisms. This federal R&D unit annually receives approximately $123 million of federal R&D funds and has about 1,300 FTEs.

Bethesda, Maryland, is home to the HHS's National Institutes of Health and DOD's Naval Medical Research Institute and Armed Forces Radiobiology Research Institute.

- The National Institutes of Health (NIH) is a unit of HHS. NIH is a major medical research organization, supporting projects

conducted throughout the nation on cancer, Alzheimer's disease, diabetes, arthritis, heart disease, AIDS, and virtually every other human ailment and condition. NIH consists of 18 separate institutes, three centers, a handful of special project offices, and a library, virtually all of which are in Bethesda. Specifically, NIH includes the National Cancer Institute; the National Heart, Lung, and Blood Institute; the National Institute of Allergy and Infectious Diseases; the National Institute of General Medical Sciences; the National Institute of Diabetes and Digestive and Kidney Diseases; the National Institute of Neurological Disorders and Stroke; the National Institute of Mental Health; the National Institute of Child Health and Human Development; the National Institute on Drug Abuse; the National Institute on Aging; the National Eye Institute; the National Institute of Arthritis and Musculoskeletal and Skin Diseases; the National Institute on Alcohol Abuse and Alcoholism; the National Institute of Dental and Craniofacial Research; the National Institute on Deafness and Other Communication Disorders; the National Human Genome Research Institute; and the National Institute of Nursing Research. Co-located with these institutes are the National Center for Complementary and Alternative Medicine, the Fogarty International Center, the National Center for Research Resources, the Office of AIDS Research, the National Library of Medicine, and the Office of the Director, which contains the Offices of Research on Minority Health and the Minority Health Initiative, Research on Women's Health, Behavioral and Social Sciences Research, and Disease Prevention. The National Institute of Environmental Health Sciences is located in Research Triangle Park, North Carolina. In addition, special NIH laboratories are located in Phoenix, Arizona, and Hamilton, Montana. This federal R&D unit annually receives over $15 billion of federal R&D funds, approximately $1.6 billion of which is spent in Maryland to employ about 16,000 people on-site at the NIH facilities. The vast majority of these people work in NIH's laboratories, conducting the more than 2,000 research projects each year. Others are involved in

making approximately $13.4 billion of federal R&D awards to colleges, universities, and other eligible institutions across the nation to support R&D projects at their campuses and facilities.

- The Naval Medical Research Institute is a unit of DOD. It conducts basic and applied research on infectious diseases, tissue transplantation, diving and hyperbaric medicine, casualty care, and environmental medicine and human factors directly related to military requirements and operational needs. The institute's R&D is specifically designed to enhance the health, safety, and readiness of Navy and Marine Corps personnel in the effective performance of peacetime and contingency missions. This federal unit annually receives about $16.5 million of federal R&D funds, approximately $12.4 million of which are spent on in-house activities, and has about 145 civilian personnel.

- The Armed Forces Radiobiology Research Institute is a unit of DOD. It conducts research in the field of radiobiology and related matters essential to the operational and medical support of the military services. The specific R&D activities of the institute include biological and biophysical dosimetry, health effects of embedded depleted uranium, nuclear-biological-chemical interactions and countermeasures, and radiation casualty management. This federal unit annually receives a total of about $11 million of federal R&D funds, all of which is spent on in-house activities, and has about 101 civilian personnel.

Bowie, Maryland, is home to a unit of DOD's Institute for Defense Analyses Communications and Computing Federally Funded Research and Development Center (FFRDC).

- The Center for Computing Sciences is one of three units constituting the Institute for Defense Analyses Communications and Computing FFRDC. This FFRDC, which is nominally headquartered in Alexandria, Virginia, is sponsored by DOD's National Security Agency and operated by the Institute for Defense Analyses. It conducts R&D in such areas as parallel processing, network security, signal processing, discrete and continuous

optimization, and symbolic computation. In addition to the center in Bowie, it has two Centers for Communications Research located in Princeton, New Jersey, and La Jolla, California. The three units of this federally owned and contractor-operated R&D center together annually receive approximately $35 million of core funding, all of which is federal R&D funds, and have about 150 employees. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

Camp Springs, Maryland, is home to DOC's National Environmental Satellite, Data, and Information Service Office of Research and Applications.

- The National Environmental Satellite, Data, and Information Service Office of Research and Applications is a unit of DOC's National Oceanic and Atmospheric Administration (NOAA). The office contains three divisions—the Atmospheric Research and Applications Division, the Climate Research and Applications Division, and the Oceans Research and Applications Division—in Camp Springs. The R&D activities of all three divisions are focused on developing forecasting models for predicting changes in the atmosphere, climate, and oceans. This federal unit annually receives approximately $8 million of federal R&D funds and has about 85 employees.

Carderock, Maryland, is home to the DOD's Naval Surface Warfare Center Carderock Division.

- The Naval Surface Warfare Center Carderock Division is a unit of DOD. It conducts R&D on hydrodynamics, propulsor acoustic and nonacoustic signatures, ship signatures, ship structures and protection, aerodynamics, logistics, mathematics, and systems engineering. This federal unit annually receives approximately $181 million of federal R&D funds for in-house activities and has about 3,769 civilian personnel, only a portion of whom are involved in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

Chesapeake Beach, Maryland, is home to DOD's Naval Research Laboratory Chesapeake Bay Detachment.

- The Chesapeake Bay Detachment is a unit of DOD's Naval Research Laboratory. It conducts R&D on radar, electronic warfare, optical devices, materials, communications, and fire at its 169-acre campus on the Chesapeake Bay. The funding and staffing figures for the detachment are modest and are included in those for the main laboratory in the District of Columbia.

Edgewater, Maryland, is home to the Smithsonian Institution's Environmental Research Center.

- The Environmental Research Center is a unit of the Smithsonian Institution. It conducts research on the biological and physical processes that sustain life on earth. Specifically, the center examines linked ecosystems, especially those affected by human activities, in search of the mechanisms that regulate the structure and dynamics of the environment. The center annually receives approximately $2.5 million of federal R&D funds and has about 45 FTEs, the vast majority of whom are involved in R&D activities.

Frederick, Maryland, is home to DOD's Medical Research Institute of Infectious Diseases, USDA's Foreign Disease-Weed Science Research Unit, and HHS's Frederick Cancer Research and Development Center.

- The Army Medical Research Institute of Infectious Disease is a unit of DOD. It conducts research to develop strategies, products, information, procedures, and training programs for medical defense against biological warfare threats and naturally occurring infectious diseases that require special containment. Specific research areas include the development of medical countermeasures, such as vaccines, therapeutic drugs, diagnostic capabilities, and various medical management procedures, to protect military personnel against biological attack. The institute is the only biological containment laboratory in DOD for the study of hazardous diseases. This federal facility annually re-

ceives about $29 million of federal R&D funds, virtually all of which are spent on in-house activities, and has about 197 civilian personnel.

- The Foreign Disease-Weed Science Research Laboratory is a unit of USDA's ARS. It conducts research on new or emerging plant pathogens that are not yet established in the United States and that must be kept under containment. Specific research activities of the laboratory include the identification and control of pathogens that pose a potential threat to American agriculture and the use of foreign pathogens for biological control of introduced weeds. The overall goal of the unit's weed research is to support sustainable agriculture by helping American agriculture eliminate its reliance on chemicals for control of weeds. This federal R&D unit annually receives approximately $2.5 million of federal R&D funds and has about 27 FTEs.

- The Frederick Cancer Research and Development Center is an FFRDC sponsored by NIH's National Cancer Institute and operated jointly by three contractors—Charles River Laboratories, Data Management Services, Inc., and SAIC Frederick, a division of Science Applications International Corporation. The center conducts research on the causes of cancer and related diseases. The center provides research support for NCI's intramural programs, including clinical trials, vaccine development, and biomedical applications of supercomputing. This federally owned and contractor-operated facility has, in recent years, annually received an average of around $140 million of core funding and employed a staff of approximately 1,200 people.

Gaithersburg, Maryland, is home to DOC's National Institute of Standards and Technology.

- The National Institute of Standards and Technology (NIST) is a unit of DOC. It conducts research to develop measurements and set standards in its seven laboratories. NIST's Building and Fire Research Laboratory (BFRL) studies building materials; computer-integrated construction practices; fire science and fire

safety engineering; and structural, mechanical, and environmental engineering. The results of BFRL's research include measurements and test methods, performance criteria, and technical data that support innovations by industry and are incorporated into building and fire standards and codes. This federal R&D facility annually receives approximately $21 million of federal R&D funds and has about 108 FTEs. NIST's Chemical Science and Technology Laboratory (CSTL) conducts R&D on the chemical, biomolecular, and chemical engineering measurements, data, models, and reference standards required to enhance U.S. industrial competitiveness in the world market. The research areas of CSTL include analytical chemistry, surface chemistry and microanalysis, process measurements and modeling, and biotechnology. This federal R&D facility annually receives approximately $32 million of federal R&D funds and has about 242 FTEs. NIST's Electronics and Electrical Engineering Laboratory (EEEL) provides the basis for all electrical measurements in the United States; practical measurement methods for the electronics, optoelectronics, and electrical industry sectors; and advertised calibration services. All of EEEL's R&D activities are conducted to advance the state of the art of electrical and electronic measurement. This federal R&D facility annually receives approximately $36 million of federal R&D funds and has about 269 FTEs. NIST's Information Technology Laboratory (ITL), formerly known as the Computer Science and Applied Mathematics Laboratory, conducts objective, neutral tests for information technology. Specifically, ITL works with industry and government organizations to develop and demonstrate tests, test methods, reference data, proof-of-concept implementations, and other infrastructural technologies. This federal R&D facility annually receives approximately $42 million of federal R&D funds and has about 327 FTEs. NIST's Manufacturing Engineering Laboratory (MEL) serves as a central research laboratory for manufacturing infrastructure technology, measurements, and standards. MEL research provides industry-needed manufacturing engineering tools, interface stan-

dards, manufacturing systems architectures, and traceability. This federal R&D facility annually receives approximately $18 million of federal R&D funds and has about 156 FTEs. NIST's Materials Science and Engineering Laboratory (MSEL) is focused on developing the measurement and standards infrastructure related to material critical to U.S. industry. Separate research initiatives of MSEL address ceramics, metals, polymers, composites, superconductors, and the theory and modeling of materials structure and performance. This federal R&D facility annually receives approximately $41 million of federal R&D funds and has about 362 FTEs. NIST's Physics Laboratory develops new measurement methods and instruments for overcoming measurement barriers to accuracy, reliability, and manufacturability. This research is a vital component of the nation's technology infrastructure, providing highly specialized services that support innovation and industrial progress. This federal R&D facility annually receives approximately $27 million of federal R&D funds and has about 191 FTEs. Altogether, NIST annually spends approximately $235 million of federal R&D funds on in-house R&D activities and has about 2,047 FTEs involved in R&D or R&D support activities.

Greenbelt, Maryland, is home to NASA's Goddard Space Flight Center.

- The Goddard Space Flight Center is a unit of NASA. It conducts research in Earth science, space science, and technology. The center's Earth Observing System is the centerpiece of NASA's Earth Science Enterprise. This system consists of science and data systems that support a coordinated series of polar-orbiting and low-inclination satellites for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans. The center's research in this area will advance understanding of the Earth as an environment system by determining how its components have developed, how they function, how they interact, and how they evolve on various time scales. The center is also committed to the development of cutting-edge technology by advancing next-generation space-

craft, sensor, and instrument technology. This federal facility annually receives a total of about $2.5 billion, at least $2 billion of which directly involves R&D efforts. The center has about 3,338 FTEs, only a portion of whom are involved in R&D activities. Approximately $120 million of these funds and about 256 of these employees are located at the Wallops Flight Facility in Wallops Island, Virginia. Another $9 million of these funds and about 150 of these employees are located at the Goddard Institute for Space Studies in New York, New York. A substantial portion of its funds is spent on the maintenance and operation of R&D equipment and facilities. In a recent year, the center awarded over $920 million of R&D contracts, about $330 million of which were made to entities based in Maryland.

Indian Head, Maryland, is home to the Naval Surface Warfare Center Indian Head Division.

- The Naval Surface Warfare Center Indian Head Division is a unit of DOD. It conducts R&D on explosive and propellant devices in the areas of chemistry, physics, and engineering using laboratory studies, computer simulations, and testing and mixing facilities. Specific R&D activities of this unit focus on such areas as energetic systems; material development, testing, and evaluation (including ordnance explosives, explosive leads, squibs, detonators, and propellants); detonation science; manufacturing technology; underwater warheads; explosives packaging, handling, storage, and transportation technology; chemical processing/nitration; nitramine gun and high-energy propellants; cartridge-actuated devices/propellant-actuated devices; explosive safety standards; and ordnance environmental protection. This federal unit annually receives approximately $49 million of federal R&D funds for in-house activities and has about 2,135 civilian personnel, only a portion of whom are involved in R&D activities.

Lexington Park, Maryland, is home to DOD's Naval Research Laboratory Flight Support Detachment.

- The Flight Support Detachment is a unit of DOD's Naval Research Laboratory. It maintains several modified turboprop airplanes at the Naval Air Station in Lexington Park for use as airborne research platforms. Among the R&D activities under way at the detachment are ones focusing on measuring and mapping the Earth's magnetic variations, as well as ones involving bathymetry, electronic countermeasures, gravity mapping, and radar. The funding and staffing for the detachment are modest and are included those for the main laboratory the District of Columbia.

Oxford, Maryland, is home to DOC's Center for Coastal Fisheries and Habitat Research.

- The Center for Coastal Fisheries and Habitat Research is a part of the Beaufort/Oxford Laboratory inside DOC's NOAA. While most of the laboratory's activities take place in North Carolina, a small center is located on Maryland's Eastern Shore. This latter center conducts research on oyster diseases, habitat restoration, and protection of marine mammals and sea turtles. The funding and staffing figures for this center are included in those for the Beaufort/Oxford Laboratory in Beaufort, North Carolina.

Patuxent River, Maryland, is home to a unit of DOD's Naval Air Warfare Center Aircraft Division.

- The Naval Air Warfare Center Aircraft Division is a unit of DOD. It is headquartered in Patuxent, with activities at an additional site in Lakehurst, New Jersey. It conducts R&D on aircraft systems; shipboard, fixed, and mobile communications; and information technology systems. This federal unit annually receives approximately $318 million of federal R&D funds and has about 2,300 civilian personnel, only a portion of whom are involved in R&D activities. A substantial portion of these

funds is spent on the maintenance and operation of R&D equipment and facilities.

Princess Anne, Maryland, is home to DOI's Maryland Cooperative Fish and Wildlife Unit and Patuxent Wildlife Research Center.

- The Maryland Cooperative Fish and Wildlife Unit is part of DOI's USGS. It is on the campus of the University of Maryland, Eastern Shore. It conducts research on the effects of current or potential environmental changes or perturbations on fish and wildlife resources. Specific research activities of this unit include studying aquaculture and fish physiology, fisheries and aquatic ecology, fish health and pathology, and wildlife and terrestrial ecology. This federal R&D unit annually receives approximately $322,000 of federal R&D funds and has about four FTEs.
- The Patuxent Wildlife Research Center is a unit of DOI's USGS. It conducts research on understanding and addressing national and regional natural resource problems—from establishing inventories, identifying resource issues, and testing hypotheses through monitoring and evaluation programs. Specific research activities of this center include developing and managing national inventory and monitoring programs and the North American Bird Banding Program. This federal R&D unit annually receives approximately $7.6 million of federal R&D funds and has about 137 FTEs.

Rockville, Maryland, is home to four centers of HHS's Food and Drug Administration.

- The Food and Drug Administration (FDA) is a unit of HHS that is headquartered in Rockville. The FDA is responsible for ensuring that foods, drugs, medical devices, biological products, cosmetics, and radiation-emitting electronic products are safe and effective. While the majority of FDA's activities focus on enforcing the federal Food, Drug, and Cosmetics Act and related public health laws, the FDA must conduct research to set the

basic standards required by these laws and to assess the safety and efficacy of the various products that it oversees. The FDA consists of six centers, four of them in Rockville, with ancillary units in Bethesda and Beltsville. The Centers for Biologics Evaluation and Research, Devices and Radiological Health, Drug Evaluation and Research, and Veterinary Medicine are located here. The Center for Food Safety and Applied Nutrition is in Washington, D.C., and the National Center for Toxicological Research is in Jefferson, Arkansas. FDA's Center for Biologics Evaluation and Research is responsible for ensuring the safety and effectiveness of biological and related products, including blood, vaccines, and biological therapeutics. This federally owned and operated facility has a total annual budget of approximately $123 million, about $22.4 million of which is federal R&D funds. The center has about 1,000 FTEs, approximately 200 of which are directly involved in research activities. FDA's Center for Devices and Radiological Health is responsible for ensuring the safety and effectiveness of medical devices and eliminating unnecessary human exposure to man-made radiation from medical, occupational, and consumer products. This federally owned and operated facility has a total annual budget of approximately $155 million, about $6.7 million of which is federal R&D funds. The center has about 1,550 FTEs, approximately 70 of whom are directly involved in R&D activities. FDA's Center for Drug Evaluation and Research ensures the availability of safe and effective drugs. This federally owned and operated facility has a total annual budget of approximately $262 million, about $8.4 million of which is federal R&D funds. The center has about 2,400 FTEs, approximately 100 of whom are directly involved in R&D activities. FDA's Center for Veterinary Medicine is responsible for ensuring that animal drugs and medicated feeds are safe and effective for their intended uses and that food from treated animals is safe for human consumption. This federally owned and operated facility has a total annual budget of approximately $41 million, about $7.1 million of which is federal R&D funds. The center

has about 390 FTEs, approximately 53 of whom are directly involved in R&D activities.

Silver Spring, Maryland, is home to DOC's Hydrologic Research Laboratory, Advanced Development and Demonstration Laboratory, Integrated Systems Laboratory, Techniques Development Laboratory, Air Resources Laboratory, and Geosciences Research Division.

- The Hydrologic Research Laboratory is unit of DOC's NOAA. It conducts research on flood and water resource forecast systems in field operations to support weather prediction activities. It also provides support for the implementation of hydrology-related components of major weather-prediction systems, such as the Doppler weather surveillance radar and the Advanced Weather Interactive Processing System. This federal unit annually receives approximately $2.6 million of federal R&D funds and has about 18 FTEs.

- The Advanced Development and Demonstration Laboratory is a unit of DOC's NOAA. It defines, plans, and initiates development of advanced functional capabilities required to modernize and restructure the National Weather Service. Specifically, the laboratory plans for the timely introduction of new functional capabilities within the modernized systems architecture to respond to evolving requirements and emerging scientific opportunities and to avoid costly technological obsolescence. It is responsible for providing government-developed software to the Advance Weather Interactive Processing System. This federal unit annually receives approximately $1.7 million of federal R&D funds and has about 12 FTEs.

- The Integrated Systems Laboratory is a unit of DOC's NOAA. It develops, demonstrates, and integrates systems and system improvements required for weather warning and forecasting operations. As the repository for engineering, computer science, and the state-of-the-art technical expertise on embedded weather system planned and operational systems, the laboratory is responsible for in-house design and development efforts requiring

such expertise. This federal unit annually receives approximately $1.1 million of federal R&D funds and has about 11 FTEs.

- The Techniques Development Laboratory is a unit of DOC's NOAA. It conducts or sponsors applied R&D to improve diagnostic and prognostic weather information for use in making official weather forecasts. It carries out studies to improve the prediction methodology used by the National Weather Service. It gives special emphasis to developing improved methods for predicting tornadoes, severe local storms, and abnormal water levels caused by hurricanes. This federal unit annually receives approximately $4.0 million of federal R&D funds and has about 49 FTEs.

- The Air Resources Laboratory is a unit of DOC's NOAA. It studies climate and air quality, turbulence and diffusion in the atmosphere, global transport of pollutants, the meteorology of air pollution, air-surface exchange, and global climate change. This federal R&D unit annually receives approximately $3.7 million of federal R&D funds and has about 113 FTEs.

- The Geosciences Research Division, formerly known as the Geosciences Laboratory, is a unit of DOC's NOAA. It conducts research on the standards for conducting geodetic surveys and assists in the development of surveying instruments and procedures. This federal R&D unit annually receives approximately $3.3 million of federal R&D funds and has about 20 employees.

Suitland, Maryland, is home to the Smithsonian Institution's Center for Materials Research and Education.

- The Center for Materials Research and Education is a unit of the Smithsonian Institution. This specialized research facility is dedicated to the technical study and conservation of museum artifacts and their components. It also advises and assists the Smithsonian and other museums in the study, preservation, and conservation of artistic and historic objects. It conducts re-

search in the areas of material technology, chemistry, art and cultural history, and development of treatment procedures. The center conducts programs that include basic and advanced conservation training and provides various opportunities for the increase and diffusion of knowledge about conservation to museums and associated professionals throughout the United States and the world. This federal R&D unit annually receives approximately $3 million of federal R&D funds and employs about 36 FTEs, all of whom are involved in R&D activities.

White Oak, Maryland, is home to a unit of DOD's Arnold Engineering Development Center.

- The Arnold Engineering Development Center is a national aerospace ground test center headquartered at Arnold Air Force Base, Tennessee. It conducts R&D on propulsion, aerodynamic, reentry, transatmospheric, and space-flight systems. The center also conducts research to develop new test capabilities, facilities, and technologies for future simulated flight-testing. Its hypervelocity wind tunnel test facility is located in White Oak. This latter federal unit annually receives approximately $845,000 of federal R&D funds and employs about 23 civilians.

Federal R&D Grants to Maryland Entities

Every major institution of higher education in Maryland is the recipient of significant federal R&D dollars each year through grants made by federal agencies to faculty, graduate students, and research centers. The vast majority of the R&D grants are made by HHS, NSF, and DOD to individual faculty members and therefore ultimately inure to the benefit of such institutions as Johns Hopkins University, the University of Maryland, and Morgan State University. The table below shows the total number of R&D grants that were active in FY 1998, highlighting those made by HHS, NSF, and DOD to parties at the various institutions and estimates of the total dollars transferred to them in FY 1998 pursuant to the terms of these grants. The grants in the "Other Agencies" category going to Johns Hopkins come equally from

DOE, the EPA, and the Department of Education. The comparable grants going to U of Maryland include $8 million from DOE, $6 million each from USDA and DOC, and $3 million from EPA.

Table 21.1 – Sources of Federal R&D Grants to Higher Education in Maryland

	HHS		NSF		DOD		NASA		Other Agencies		Total	
Institution	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#
Johns Hopkins	$304M	1,141	$13M	212	$7M	60	$6M	119	$6M	46	$336M	1,578
U of Maryland	$92M	462	$26M	440	$12M	74	$14M	251	$23M	261	$167M	1,488
Morgan State	$2M	5	<$1M	1	$1M	3	$1M	10	$1M	3	$5M	22
Other	$2M	9	$1M	18	0	0	<$1M	10	$1M	7	$3M	44
Total	$400M	1,617	$40M	671	$19M	137	$22M	390	$30M	317	$511M	3,132

These activities are particularly significant because they fund much of the "basic research" so critical to expanding our knowledge and understanding of fundamental scientific phenomena. In addition, these funds account for a substantial portion of the dollars available each year to various academic departments within these institutions, such as the Johns Hopkins School of Medicine.

Several other nonacademic institutions in Maryland also receive a significant amount of federal R&D grants each year. Foremost among the institutions that received R&D grants in FY 1998 are Social and Scientific Systems, Inc., in Bethesda ($26 million), the Henry M. Jackson Foundation for the Advancement of Military Medicine in Rockville ($15 million), Advanced Bioscience Laboratories in Rockville ($14 million), and the Institute for Genomic Research in Rockville ($9 million).

Scattered among these grants, as well as among the contracts discussed in the section below, are small business innovative research (SBIR) awards. These are special awards made by the SBIR programs supported by the 10 federal agencies with annual budgets for extramural R&D of more than $100 million. In a recent year, small businesses in Maryland received 202 SBIR awards totaling $53 million.

Examples include a $1 million award from DOD (Ballistic Missile Defense Organization) to Genex Technologies, Inc., in Rockville for development of an omnidirectional 3-D camera for battlefield modeling and a $400,000 award from NSF to Blazie Engineering, Inc., in Forest Hill to design a new and improved print-reading machine for the blind.

Also included among these grants are formula grants from federal agencies. Formula grants differ from the much more common project grants in that the money transmitted through formula grants is allocated to a state or one of its subdivisions in accordance with a distribution formula prescribed by law or regulation. Among the formula grants benefiting Maryland are ones valued at more than $3.3 million from USDA's Cooperative State Research, Education, and Extension Service (CSREES) to State Agricultural Experiment Stations, forestry schools, and veterinary colleges for the support of research in agriculture, forestry, and animal health and disease. Similarly, a modest formula grant goes from DOI's USGS to the Water Resources Research Institute in Maryland every year to foster research in water and water-related problems.

Other Federal R&D Activities in Maryland

Several entities in Maryland also receive notable sums of federal R&D dollars in the form of contracts or cooperative agreements from federal agencies for specific R&D efforts. By far the largest recipient of R&D contracts in FY 1998 was Johns Hopkins for work at its Applied Physics Laboratory. It received more than $400 million collectively from federal agencies, with the largest contributor by far being DOD. In addition, a large portion of federal R&D contract funds went to Lockheed Martin Corporation ($225 million), primarily for the Joint Strike Fighter Concept Demonstration Program. In addition, Westat Inc. ($172 million), the Association of Universities for Research ($116 million), Raytheon Company ($95 million), and Northrop Grumman ($94 million) received large R&D contracts from federal agencies in FY 1998. The contract to the Association of Universities for Research noted above is for the operation of NASA's Hubble Space Telescope.

The University of Maryland ($28 million) also received contracts from various federal agencies to conduct R&D for the federal government. Although these amounts are notable, generally they do not come close to eclipsing the funds that these institutions receive from federal R&D grants.

A total of $60 million of federal R&D dollars in the form of cooperative agreements was also received in FY 1998 by entities located in Maryland. By far the largest of these cooperative agreements ($33 million) came from DOD to the Henry M. Jackson Foundation for the Advancement of Military Medicine in Rockville for its HIV Research program. Other federal agencies awarding cooperative agreements to Maryland-based entities include DOE, DOC, and NSF. Among these latter cooperative agreements are awards are two of NSF's Materials Research Science and Engineering Centers—the Center for Oxide Thin Films, Probes, and Surfaces at the University of Maryland, College Park, and the Center for Nanostructured Materials at Johns Hopkins University.