Chapter 6
Federal Research and Development in Colorado

- Approximately $1.4 billion of federal R&D funds are spent each year in Colorado.
- Colorado ranks 16th among the 50 states, District of Columbia, and Puerto Rico in terms of the amount of federal R&D dollars received annually.
- Approximately 13 percent of all federal funds spent in Colorado each year on matters other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance) is spent on R&D.
BACKGROUND

In recent years, the federal government has spent in the neighborhood of $1.4 billion annually in Colorado on research and development (R&D) activities. On average, federal R&D dollars account for approximately 13 percent of all federal funds spent in Colorado each year on matters other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance).

Most major federal agencies that currently support federal R&D efforts provide funding for R&D activities in Colorado. Foremost among these agencies is the Department of Defense (DOD), which accounts for 44 percent of all federal R&D dollars spent in the state. The Department of Health and Human Services (HHS), the Department of Energy (DOE), the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA) account for 12, 10, 10, and 8 percent, respectively. The remaining federal R&D dollars come collectively from the Departments of Commerce (DOC), Interior (DOI), Agriculture (USDA), and several other agencies.6

All federal R&D dollars spent in Colorado 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, contracts, or cooperative agreements to entities in the state. The following is an overview of what becomes of these federal R&D dollars once they arrive in Colorado.

FEDERAL R&D UNITS IN COLORADO

Akron, Colorado, is home to USDA’s Central Great Plains Research Station.

- The Central Great Plains Research Station is a unit of USDA’s Agricultural Research Service (ARS). It is on the Akron campus of Colorado State University. The unit develops integrated cropping systems and technologies for maximum utilization of soil and water resources. Specific research activities include

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6 For a complete agency-by-agency breakdown of these R&D dollars, see Appendix C.
developing techniques for the efficient use of plant nutrients, pesticides, and water and soil conservation and preservation. This federal R&D unit annually receives approximately $1.3 million of federal R&D funds and has about 24 FTEs.

Boulder, Colorado, is home to DOC’s Climate Monitoring and Diagnostics Laboratory, Climate Diagnostics Center, Space Environmental Laboratory, Forecast Systems Laboratory, Aeronomy Laboratory, and Environmental Technology Laboratory, and NSF’s National Center for Atmospheric Research.

- The Climate Monitoring and Diagnostics Laboratory is a unit of DOC’s National Oceanic and Atmospheric Administration (NOAA). It conducts research related to atmospheric constituents that are capable of forcing change in the climate of the earth through modification of the atmospheric radiative environment—for example greenhouse gases and aerosols—and those that may cause depletion of the global ozone layer. This federal unit annually receives approximately $6.3 million of federal R&D funds and has about 46 FTEs.

- The Climate Diagnostics Center is a unit of DOC’s NOAA. It conducts research to identify the causes and potential predictability of important climate phenomena. Specific areas of research activities include major droughts and floods, the El Niño–Southern Oscillation and its global impacts, and decadal to centennial climate variations. It also performs extensive intercomparisons of observational and climate model data, an activity essential to improving climate models and forecasts. This federal unit annually receives approximately $3.4 million of federal R&D funds and has about nine FTEs.

- The Space Environmental Laboratory is a unit of DOC’s NOAA. It conducts research on solar-terrestrial physics, develops techniques for forecasting solar and geophysical disturbances, and provides real-time monitoring and forecasting of solar and geophysical events. Its researchers study the sun’s electromagnetic, particle, and magnetic-field emissions and the
processes by which they affect earth’s space environment. It also takes a leading role in designing new data systems that will fly on government satellites. This federal unit annually receives approximately $5.2 million of federal R&D funds and has about 55 FTEs.

• The Forecast Systems Laboratory is a unit of DOC’s NOAA. It conducts research to improve data analyses and forecast systems, to improve methods for understanding atmospheric processes, and to validate systems utilizing real-time and archived data to test and evaluate new diagnostic and forecast techniques. This federal unit annually receives approximately $11.8 million of federal R&D funds and has about 68 FTEs.

• The Aeronomy Laboratory is a unit of DOC’s NOAA. It conducts fundamental research on the chemical and physical processes of the Earth’s atmosphere, concentrating on the two layers known as the troposphere and stratosphere. Through laboratory, modeling, and field research, it focuses on chemical and physical processes related to the ozone layer, the climate system, and air quality. This federal unit annually receives approximately $8.6 million of federal R&D funds and has about 43 FTEs.

• The Environmental Technology Laboratory is a unit of DOC’s NOAA. It conducts oceanic and atmospheric research and develops innovative remote sensing systems and techniques. It studies all aspects of the interaction of radio, light, and sound waves with the ocean and atmosphere to probe remote regions and meet the challenges posed by weather and climate. This federal unit annually receives approximately $4.9 million of federal R&D funds and has about 68 FTEs.

• The National Center for Atmospheric Research (NCAR) in Boulder, Colorado, is a federally funded research and development center (FFRDC) sponsored by NSF and managed by the University Corporation for Atmospheric Research. NCAR’s mission is to plan, organize, and conduct atmospheric and re-
lated research programs in collaboration with universities, to provide state-of-the-art research tools and facilities to the entire atmospheric sciences community, to support and enhance university atmospheric research education, and to facilitate the transfer of technology to both the public and private sectors. NCAR’s research includes atmospheric and environmental modeling, chemistry and biogeochemistry, climate, weather, solar research and solar-terrestrial interactions, atmospheric remote sensing, and airborne instrumentation. This federal R&D unit annually receives approximately $75 million of federal R&D funds and has about 750 employees.

Denver, Colorado, is home to DOI’s Center for Biological Informatics, Denver Field Office, Biological Resources Division, Rocky Mountain Mapping Center, and Geologic Central Regional Office; HHS’s Animal Drug Research Center; and a Department of Veterans Affairs (DVA) R&D unit.

- The Center for Biological Informatics is a unit of DOI’s U.S. Geological Survey (USGS). It conducts research on developing and providing standards and procedures for acquiring, managing, and sharing biological data and information. Specific research activities of the center include providing regional assessments of the conservation status of native vertebrate species and natural land cover types and facilitating the application of this information to land management activities. Other research activities focus on using remotely sensed data and dynamic spatial models to help scientists analyze current habitat conditions and the effects of the changing environment on the biological resources of the nation. This federal R&D unit annually receives approximately $1.4 million of federal R&D funds and has about 20 FTEs.

- The Denver Field Office is a unit of the Mid-Continent Ecological Science Center inside DOI’s USGS. It conducts research on regulated ecosystem research in cooperation with the DOI Bureau of Reclamation. Specific research activities of this unit include river systems management and in-stream and riparian
ecology. This federal R&D unit annually receives approximately $1.3 million of federal R&D funds and has about eight FTEs.

- The Biological Resources Division Central Regional Office inside DOI's USGS has direct line authority over the four science centers in its region. The office coordinates science and operational activities among the Central Region's centers and integrates with the Eastern and Western Regions. The office also provides research expertise to other Department of Interior bureaus and serves as coordinator and integrator of this activity within DOI as well. In addition, a cooperative unit coordinator/eastern supervisor is located in Denver. Altogether, this federal R&D unit annually receives approximately $1.4 million of federal R&D funds and has about 13 FTEs.

- The Rocky Mountain Mapping Center is a unit of DOI's USGS. It conducts mapping activities in the western U.S. These include the production of digital elevation and planimetric data, production of graphic maps, and development of new mapping techniques. Specific research activities of this center include research in environmental sciences, physical sciences, cartography, and geographic information systems. The unit also maintains the worldwide distribution facility for more than 100,000 different maps, open-file reports, and other products of federal agencies. This federal R&D unit annually receives approximately $1.9 million in federal R&D funds and has about 366 FTEs, 55 of whom are directly involved in R&D.

- The Geologic Central Regional Office is a unit inside DOI's USGS. It oversees the R&D activities of Montana, Wyoming, Colorado, New Mexico, Texas, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Minnesota, Iowa, Missouri, Arkansas, and Louisiana. These activities include research on geophysics, geochronology, earthquakes, landslide hazards, geochemistry, geologic mapping, climate change, oil and gas assessment, environmental monitoring and remediation, coal re-
source assessment, paleontology, and ecosystem analysis. Specific research activities in these regions focus on assessing the natural gas and petroleum potential for Montana, geologic mapping of the Omaha–Kansas City urban corridor, and studying the impacts of climate change and land use on the southwestern United States. One of the centers affiliated with this office is the national Earthquake information Center in Golden, Colorado. This federal R&D unit annually receives approximately $53.4 million of federal R&D funds, which are dispersed throughout all the states of the central region, as are its employees.

- The Animal Drug Research Center is a unit of HHS’s Food and Drug Administration. It conducts research on animal drugs and medicated feeds to ensure that they are safe and effective for their intended uses and that food from treated animals is safe for human consumption. The center is particularly concerned with animal drug residue testing. Co-located with the center is the FDA’s Denver District Laboratory. It conducts research on the safety and efficacy of human drugs and the safety and nutritional content of foods. Together these federal units annually receive approximately $812,000 of federal R&D funds and have about 12 FTEs directly involved in R&D activities.

- While the principal focus of the Denver 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 253 projects with total funding of approximately $5 million. These R&D activities focus on a wide range of topics, including drug therapy, chemotherapy, neoplasms, HIV, genetics, and schizophrenia.

Fort Collins, Colorado, is home to DOI’s Mid-Continent Ecological Science Center and Colorado Cooperative Fish and Wildlife Research Unit; USDA’s Natural Resources Research Center, Crops Research Laboratory, National Seed Storage Laboratory, Rocky Mountain Research Station, and National Wildlife Research Center; and HHS’s Division of Vector-Borne Infectious Diseases.
• The Mid-Continent Ecological Science Center is a unit of DOI’s USGS. It conducts research to develop, integrate, and provide ecological knowledge necessary to understand the causes and predict the consequences of change in order to improve the conservation and management of natural resources in interior western landscapes. The center also develops and implements inventory and monitoring programs for the accurate assessment of biological status and trends and provides information, technical services, and training related to the management of biological resources. Specific research activities of this center include ecological research on native western species, water resources ecology and management; ecosystem analysis in support of public land management; and social science analysis in support of natural resources decisions. This federal R&D unit annually receives approximately $7.4 million of federal R&D funds and has about 89 FTEs.

• The Colorado Cooperative Fish and Wildlife Research Unit is part of DOI’s USGS. It is on the campus of Colorado State University. It conducts research on the management of fishery and wildlife resources, educates fishery and wildlife biologists at the graduate level, and provides technical assistance to the conservation agencies and groups. Specific research activities of this unit include population biology, habitat management, and parasitic interactions. This federal R&D unit annually receives approximately $350,000 of federal R&D funds and has about three FTEs.

• The Natural Resources Research Center is a unit of USDA’s ARS. It is on the Fort Collins campus of Colorado State University with three other ARS research units. One of the center’s divisions conducts research on water conservation and water quality as impacted by management and on the development and application of a decision support system for farmers and ranchers in the Great Plains. Another division conducts research to develop irrigation, agricultural chemical, and other management practices that protect water quality. And yet an-
other division conducts research to develop and evaluate the new knowledge required to efficiently manage soil, fertilizer, and plant nutrients (especially nitrogen) to achieve optimum crop yields, maximize farm profitability, maintain environmental quality, and sustain long-term productivity. This federal R&D unit, in combination with the two units described immediately below, annually receives approximately $11.3 million in federal R&D funds and has about 135 FTEs.

• The Crops Research Laboratory is a unit of USDA's ARS. On the Fort Collins campus of Colorado State University with three other ARS research units, it conducts research to identify and produce sugar beet germplasm exhibiting superior disease and stress tolerance and agronomic qualities; improve production efficiency and biochemical processing characteristics of sugar beets; and adapt biotechnologies to modify host-pathogen relations that affect sugar beet disease resistance, pathogenesis, and epidemiology. Specific research activities of this unit include investigating the causes of sucrose losses and chemical quality decreases for sugar beets stored in outdoor piles for long periods before processing and looking into biological disease controls as a means of maximizing production efficiency and reducing environmental risks inherent in the use of pesticides. The federal R&D funds and staff information for this federal R&D unit are included above in those provided for the Natural Resources Research Center.

• The National Seed Storage Laboratory is a unit of USDA's ARS. On the Fort Collins campus of Colorado State University with three other ARS research units, it is composed of two research divisions focusing on plant germplasm and seed viability and storage. The laboratory preserves the base collection of plant germplasm for the National Plant Germplasm System; determines the initial quality of germplasm and periodically monitors the viability of the plant germplasm in storage; and maintains the National Seed Storage Laboratory database and the Germplasm Resources Information Network. Specific research
activities of the lab include developing methods to preserve plant propagules of species and accessions not currently in the base collection and to evaluate conventional and cryogenic storage protocols and develop strategies to improve cost efficiency. The federal R&D funds and staff information for this federal R&D unit are included above in those provided for the Natural Resources Research Center.

- The Rocky Mountain Research Station, headquartered in Fort Collins, is a unit inside USDA's Forest Service. It conducts research on fisheries and watersheds, climate change and air resources, recreation benefits, biological diversity, and ecological processes and ecosystem health. Specific research activities of this unit include studying aquatic and riparian ecosystems, investigating alpine and forest ecosystems under atmospheric and terrestrial disturbances, and identifying and evaluating wild-land resource benefits. This federal R&D unit annually receives approximately $4.9 million of federal R&D funds and has about 52 employees.

- The National Wildlife Research Center is a unit of the Animal and Plant Health Inspection Service inside USDA. It conducts research to resolve problems caused by the interaction of wild animals and society. Specific research activities of this center include developing strategies to control blackbird damage in the United States, studying the use of biotechnology and immun-contraceptive vaccines to solve wildlife problems, identifying new techniques to reduce rodent damage to crops and range-land, and developing ways to reduce the threat of wildlife to avi-ation. This federal R&D unit annually receives approximately $8.9 million of federal R&D funds and has about 121 employ-ees.

- The Division of Vector-Borne Infectious Diseases (DVBID) is a unit of the National Center for Infectious Diseases inside HHS's Centers for Disease Control and Prevention (CDC), headquar-tered in Atlanta, Georgia. DVBID is composed of the Arbovirus Diseases Branch, the Bacterial Zoonoses Branch, and the
Dengue Branch. The Dengue Branch is separately located in San Juan, Puerto Rico. DVBID conducts laboratory and epidemiologic research to improve diagnosis, surveillance, prevention, and control of diseases of major public health importance, such as Lyme disease, dengue/dengue hemorrhagic fever, yellow fever, arboviral encephalitis, and plague. Additional expertise is maintained for other vector-borne infectious diseases that occur only sporadically or in periodic epidemics. DVBID serves as a national and international reference center for vector-borne viral and bacterial diseases. Specific research activities of the division include developing surveillance for vector-borne viral and bacterial agents and their arthropod vectors; conducting field and laboratory research and epidemic aid investigations; and providing diagnostic reference and epidemiologic consultation to state and local health departments, other components of CDC, other federal agencies, and national and international health organizations. This federal unit annually receives approximately $8.4 million of federal R&D funds and has about 72 FTEs.

Golden, Colorado, is home to DOE’s National Renewable Energy Laboratory.

- The National Renewable Energy Laboratory is an FFRDC sponsored by DOE and operated by Midwest Research Institute, Battelle Memorial Institute, and Bechtel National, Inc. It conducts R&D on renewable energy and energy efficiency. Specifically, it develops renewable energy technologies, improves energy efficiency, advances related science and engineering, and facilitates commercialization. Current research activities include photovoltaics, wind energy, biomass-derived fuels and chemicals, energy-efficient buildings, advanced vehicles, solar manufacturing, industrial processes, solar thermal systems, hydrogen fuel cells, superconductivity, and geothermal and waste-to-energy technologies. This federally owned and contractor-operated laboratory annually receives approximately $165 million of core funding, all of which is spent on specific R&D projects, and has about 900 employees. A portion of the labo-
ratory’s funds is spent on the maintenance and operation of R&D equipment and facilities.

Lakewood, Colorado, is home to DOI’s Colorado District Office of Water Resources.

- The Colorado District Office of Water Resources is a unit of DOI’s 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 $11.7 million in federal R&D funds.

Federal R&D Grants to Colorado Entities

Every major institution of higher education in Colorado 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, NASA, and DOD to individual faculty members and therefore ultimately inure to the benefit of such institutions as the University of Colorado, Colorado State University (CSU), the University of Denver, and the Colorado School of Mines (CSM). The table below shows the number of R&D grants active in FY 1998, highlighting those made by
HHS, NSF, NASA, 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. Among the grants in the “Other Agencies” category going to the University of Colorado are ones from DOE ($5 million), DOC ($1 million), and the Department of Education ($1 million). The comparable grants going to CSU include $4 million from USDA, $3 million from DOE, and $2 million from the Environmental Protection Agency (EPA).

Table 6.1 – Sources of Federal R&D Grants to Higher Education in Colorado

<table>
<thead>
<tr>
<th>Institution</th>
<th>HHS</th>
<th>NSF</th>
<th>NASA</th>
<th>DOD</th>
<th>Other Agencies</th>
<th>Total</th>
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<td>$67M</td>
<td>$30M</td>
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<td>$293</td>
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<td>CSU</td>
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<td>$136</td>
<td>$10M</td>
<td>164</td>
<td>$2M</td>
<td>36</td>
</tr>
<tr>
<td>U of Denver</td>
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<td>30</td>
<td>$1M</td>
<td>28</td>
<td>$1M</td>
<td>9</td>
</tr>
<tr>
<td>CSM</td>
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<td>1</td>
<td>$2M</td>
<td>46</td>
<td>&lt;$1M</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
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<td>&lt;$1M</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>$147M</td>
<td>741</td>
<td>$43M</td>
<td>655</td>
<td>$14M</td>
<td>344</td>
</tr>
</tbody>
</table>

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 Health Sciences Center at the University of Colorado.

Several other nonacademic institutions in Colorado 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 the National Jewish Medical and Research Center in Denver ($23 million), the AMC Cancer Research Center and Hospital in Lakewood ($7 million), and the American Water Works Association in Denver ($5 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 Colorado received 199 SBIR awards totaling $48 million. Examples include a $1.9 million award from DOD (Ballistic Missile Defense Organization) to Macro-Vision Communications in Boulder for work on high-density, reconfigurable optical routing interconnects and a $750,000 award from DOE to Ada Technologies, Inc., in Englewood to develop energy-saving intelligent controls for commercial/industrial refrigeration.

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 Colorado are ones valued at more than $2.8 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 Colorado every year to foster research in water and water-related problems.

**Other Federal R&D Activities in Colorado**

Several entities in Colorado also receive notable sums in the form of contracts or cooperative agreements from federal agencies for specific R&D efforts. By far the majority of these funds go from DOD to Lockheed Martin in Littleton, which in FY 1998 received close to $1.1 billion in R&D contracts, primarily to fund its Air Force-sponsored work on Titan and Atlas launch vehicle assembly and flight operations. In addition, Antarctic Support Associates ($124 million), Ball Aerospace and Technologies ($43 million), Kaman Sciences Corp. ($40 million), Johnson Engineering Corp. ($23 million), and ITT Systems and Sciences Corp. ($15 million) received very large R&D con-
tracts from federal agencies in FY 1998. Note that these amounts are in addition to the federal R&D grants also received by these companies. The University of Colorado ($38 million) and CSU ($3 million) also received contracts from various federal agencies to conduct R&D for the federal government. Although these amounts are notable, they do not come close to eclipsing the funds that these institutions receive from federal R&D grants.

A total of $171 million of federal R&D dollars was also received in FY 1998 by entities located in Colorado in the form of cooperative agreements. One notable cooperative agreement came from DOC to Colorado State University at Boulder to operate the Cooperative Institute for Research in Environmental Sciences (CIRES) ($25 million in FY 1998). Another came from DOC to the University of Colorado to operate the Cooperative Institute for Research in the Atmosphere (CIRA) ($8.4 million in FY 1998). Other federal agencies awarding cooperative agreements to Colorado-based entities include DOC, DOE, and NSF. Among these latter cooperative agreements is an award supporting one of NSF’s Materials Research Science and Engineering Centers—the Ferroelectric Liquid Crystal Research Center at the University of Colorado at Boulder.