
**CO-LABS IMPACT STUDY
IMPACT OF FEDERAL RESEARCH LABORATORIES IN COLORADO
2009-2010**

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EXECUTIVE SUMMARY

Federal laboratories have long been coveted members of Colorado's economy owing to the numerous jobs and federal dollars infused in the local and state economies. However, given the nature of the research and development conducted at the various facilities, employment and expenditures represent only a fraction of the true benefits of federal research facilities in Colorado. These auxiliary benefits include the emergence and existence of high-tech firms that locate near the facilities, collaborations with Colorado universities on cutting-edge research, experience for higher-education students through internships and part-time jobs, world-renowned research conducted in the state, and the economic stability common to federal employment.

This study was prepared to quantify the economic impacts that federal research facilities and their university affiliates have on Boulder, Jefferson, and Larimer counties, and on the state of Colorado. This report details the economic benefits, public revenues, and public costs associated with these facilities. Additionally, American Recovery and Reinvestment Act funding was quantified for construction and operations at these facilities. Primary data were collected from the facilities using a survey with a response rate of 82.4%, and supplemented with interviews with facility administrators.

The net economic benefit of federal research facilities and their affiliates totaled \$1.2 billion in Colorado in FY 2009. Given moderate employment growth and expected construction projects, this impact grew to \$1.5 billion in FY 2010. Net economic benefits to Boulder, Jefferson, and Larimer counties totaled \$463.8 million, \$413.2 million, and \$99.5 million, respectively, in FY 2010. In total, these facilities account for 7,964 direct jobs in Colorado and an additional 8,521 indirect jobs in FY 2010.

The facilities occupy 4.7 million square feet of leased and owned real estate in Colorado. Construction at the study facilities topped \$84 million in FY 2009 and \$201 million in FY 2010.

PURPOSE OF THE STUDY

The Business Research Division (BRD) at the Leeds School of Business was asked by the CO-LABS organization to objectively measure the economic and fiscal impacts of CO-LABS research entities located in Colorado for fiscal years 2009 and 2010, as well as to measure the impact of American Recovery and Reinvestment Act (ARRA) funding on the organizations. This study is an update of an economic impact study conducted by the BRD for CO-LABS in 2008 titled, "CO-LABS Economic Impact Study: The Impact of Federally Funded Research Laboratories in Colorado."

STUDY OVERVIEW

CO-LABS is a consortium of federally funded scientific laboratories, universities, businesses, local governments, and community leaders organized to establish Colorado as a global leader in research, technology, and their commercialization (www.co-labs.org). This study reached out to the following entities as directed by the CO-LABS organization:

- Bureau of Reclamation Technical Services Center
- Centers for Disease Control and Prevention Division of Vector-Borne Infectious Disease
- Cooperative Institute for Research in the Atmosphere (CIRA)
- Cooperative Institute for Research in Environmental Sciences (CIRES)
- Federal Railway Administration Transportation Technology Center
- JILA
- Laboratory for Atmospheric and Space Physics (LASP)
- National Center for Atmospheric Research (NCAR)
 - Computational and Information Systems Laboratory
 - Earth Observing Laboratory
 - Earth and Sun Systems Laboratory
 - Research Applications Laboratory
- National Ecological Observatory Network (NEON)
- National Oceanic and Atmospheric Administration (NOAA)
 - Earth System Research Laboratory (ESRL)
 - Chemical Sciences Division
 - Global Monitoring Division
 - Physical Sciences Division
 - National Geophysical Data Center
 - Space Weather Prediction Center (SWPC)
 - National Weather Service
 - Weather Forecast Offices (WFO)
- National Institute of Standards and Technology (NIST)
- National Renewable Energy Laboratory (NREL)
- National Telecommunications and Information Administration (NTIA)
- Renewable and Sustainable Energy Institute (RASEI)
- University Corporation for Atmospheric Research (UCAR)
- U.S. Department of Agriculture – Rocky Mountain Research Station (RMRS)
- U.S. Department of Agriculture – Agricultural Research Service (ARS)
 - Rangeland Resources Unit

Soil Plant Nutrient Research Unit
Water Management Research Unit
Crops Research Lab, Sugarbeet Unit
Agricultural Systems Research Unit
Central Great Plains Resources Management Unit
Genetic Resources Preservation Research Unit
U.S. Department of Agriculture – National Wildlife Research Center (NWRC)
U.S. Geological Survey (USGS)
Colorado Water Science Center
Earth Surfaces Process Team
Energy Resources Team
Ft. Collins Biological Science Center
Geologic Hazards Team
Mineral Resources Science Center
Rocky Mountain Geographic Science Center
Water Quality Testing Laboratory
U.S. Air Force Academy Research Centers and Institutes

METHODOLOGY

This study was conducted in cooperation with the CO-LABS organization. A survey was created to solicit information on operating expenditures, labor costs, employment, construction, and one-time ARRA funding. Researchers from the BRD met with CO-LABS leaders to modify the survey instrument from the 2008 study. CO-LABS facilities were then informed of the survey by the CO-LABS Executive Director. Cover letters and surveys were subsequently sent via e-mail to facility representatives. A total of 17 surveys were sent to administrators with CO-LABS organizations. The BRD received responses from 14 of the 17 administrators. See Appendix 1 for an overview of the CO-LABS facilities.

This study applied the framework of the Insight Colorado Model to gather data, and utilized IMPLAN to quantify the economic and fiscal impacts of federal research facilities and their affiliates. The impacts are summarized in three areas: economic benefits, public revenues, and public costs.

Economic benefits refer to dollars generated and distributed throughout the economy due to the existence of an establishment. Public revenues indicate state, county, and local tax revenues generated due to the existence of an establishment via income taxes, sales taxes, property taxes, and special taxes. Public costs refer to the cost of providing government services to the facilities and their employees, both on-site and off-site. Public revenues are included in economic benefits, thus the net economic benefits are the economic benefits minus public costs.

The sources of impacts that sum to economic benefits, public costs, and public revenues include construction, operations, off-site employee effects, secondary effects, and visitor effects.

Construction comprises new construction, tenant improvements, and additions. Economic benefits arise from expenditures on materials, architectural and engineering services, and construction labor. The projects inherently generate tax revenues, including sales taxes on materials, impact fees, and property taxes. Public costs derive from providing government services to the property development and construction workers.

Operations include the purchases of materials and equipment, maintenance costs, utilities, and salaries and benefits. Direct public revenues are scarce in relation to federal facilities due to their tax-exempt status; however, public costs still exist when providing government services to the facilities (i.e., fire and police protection).

Off-site employee effects take into account the impact of employees incurred outside the workplace. Benefits encompass employee spending, including expenditures on housing (rent or own), retail purchases, transportation, entertainment, and other disposable income expenditures. Public revenues include sales taxes and property taxes, while public costs include services to respective households. The off-site impacts rest primarily in the county of employee residence rather than in the locale of the facility.

Secondary effects, or the multiplier effects, estimate the indirect employment and earnings generated in the study area due to the interindustry relationships between the facility and other industries. As an example, consider a manufacturing company operating in Boulder County. The firm employs management, engineers, and support staff for their direct manufacturing operations. In addition, the company spends on goods and services to support their manufacturing operations, leading to auxiliary jobs in the community in transportation, accounting, utilities, retail goods, and so on—the indirect impact. Furthermore, employees spend earnings on goods and services in the community, leading to jobs in retail, accounting, entertainment, and so on—the induced impact.

Conceptually, multipliers quantify the number of jobs. Multipliers are static and do not account for disruptive shifts in infrastructure without specifically addressing infrastructure changes. This model uses IMPLAN multipliers purchased from the Minnesota IMPLAN Group (MIG) and aggregated for the study area. Public revenues and public costs are not tabulated due to the unknown residence dispersion of secondary employees.

MODEL INPUT DATA AND ASSUMPTIONS

Construction

Total direct construction impacts at the research facilities are limited to those reported in the questionnaire. Facilities were surveyed as to the estimated expenditures on land, materials, soft costs, and labor, as well as the percentage of purchases in Colorado. The commercial and institutional buildings multiplier was applied to construction hard costs and labor. The professional, scientific, and technical services multiplier was applied to project soft costs. Facilities indicated the percentage of construction expenditures allocated to soft costs, hard costs, and labor. When facilities did not indicate the breakdown, 11.1% of construction expenditures were allocated to soft costs.¹

¹RS Means CostWorks 2010, General Requirements, R011110-10 Architectural Fees; RS Means CostWorks 2010, Engineering Fees, R011110- 30 Professional Consultants, Construction management Fees; Site preparation costs provided in Clayton Lane case, prepared November 8, 2006 by David B. Agnew, Esq., and Thomas G. Thibodeau, Ph.D., as an analysis tool of a major redevelopment in Cherry Creek, Colorado.

Operations

Primary data were obtained from 13 of 16 facility administrators. Parent entities responded for subsidiaries (e.g., NOAA responded for NOAA and NOAA subsidiaries ESRL, NGDC, SWPC, and the WFO). Most nonresponsive facilities for the 2010 survey also did not provide completed surveys in 2008. The Bureau of Reclamation and Federal Railway Administration were added to the list of entities after the completion of the 2008 study. The U.S. Air Force Academy Research Centers and Institutes was identified in the 2008 study, but did not complete survey. These entities were not included in this update of the economic impact analysis. The Centers for Disease Control did not complete a formal survey in the 2008 study, but provided responses via telephone. Attempts to reach the CDC in 2010 were unsuccessful, but the 2008 results were extrapolated forward and included in the 2010 study. The National Telecommunications and Information Administration (NTIA) completed a survey for the 2008 study, but did not do so for the 2010 survey. However, it indicated the past data were still relevant in 2010. The National Ecological Observatory Network and the Renewable and Sustainable Energy Institute did not participate in the study.

The “federal non-military” multiplier was applied to facility expenditures.

Facilities indicated facility maintenance expenditures. When maintenance expenditures were omitted, expenditures were assumed to be \$4.98 per square foot.²

Employment

The CO-LABS facilities reported a total of 5,870 full-time employees, 1,240 part-time employees, and 897 contract workers for a total FTE of 7,387³ in FY 2009 (see Table 1). Salary and benefits average \$91,649 across all facilities for the year. Benefits account for 24.9% of total compensation in 2009. Eight percent of the total compensation was assumed to be allocated to retirement, and therefore had no immediate economic benefit to the community.

Employment and wages increased at facilities in FY 2010. Facilities employed 6,280 full-time employees, 1,214 part-time employees, and 1,077 contract workers for a total FTE of 7,964⁴ in FY 2010 (see Table 1). Salary and benefits average \$93,379 across all facilities for the year. Benefits accounted for 25.1% of total compensation in 2010.

TABLE 1: CO-LABS TOTAL EMPLOYMENT BY COUNTY, FY 2009-FY 2010

County of Employment	FY 2009			FY 2010		
	Total FTE Workers ^a	Total Compensation (\$ millions) ^b	Average Compensation ^b	Total FTE Workers ^a	Total Compensation (\$ millions) ^b	Average Compensation ^b
Boulder	3,386	\$348.4	\$102,911	3,558	\$371.8	\$104,506
Jefferson	3,213	\$262.2	\$81,630	3,626	\$303.0	\$83,564
Larimer	765	\$64.9	\$84,915	754	\$67.2	\$89,173
Colorado	7,387	\$677.0	\$91,649	7,964	\$743.7	\$93,379

^aFTEs include full-time, one-half part-time employees, and contract workers.

^bCompensation includes salary and benefits.

²BOMA, Experience Exchange Report 2007, page 407.

³Part-time workers were counted as one-half FTE.

⁴Part-time workers were counted as one-half FTE.

Expenditures

Facility expenditures reported from the primary facilities totaled \$898.9 million in FY 2009 and \$990.7 million in FY 2010 (see Table 2 and Table 3). The primary facilities in each county reported on their Colorado operations, disaggregating lease payments, operating expenditures, employees, maintenance, and utilities by location.

TABLE 2: CO-LABS EXPENDITURES, IN MILLIONS, FY 2010

Primary County	Labor	Operating Expenditures, Maintenance, and Utilities	Lease Payments	Total Direct Colorado Operations
Boulder	\$348.4	\$40.1	\$9.8	\$398.3
Jefferson	262.2	68.9	28.6	359.8
Larimer	64.9	15.3	7.4	87.7
Colorado	\$677.0	\$175.9	\$46.0	\$898.9

TABLE 3: CO-LABS EXPENDITURES, IN MILLIONS, FY 2010

Primary County	Labor	Operating Expenditures, Maintenance, and Utilities	Lease Payments	Total Direct Colorado Operations
Boulder	\$371.8	\$39.9	\$10.1	\$421.9
Jefferson	303.0	78.3	30.2	411.5
Larimer	67.2	15.7	7.4	90.4
Colorado	\$743.7	\$199.4	\$47.7	\$990.7

Off-site employee effects

Facilities were asked to provide the total number of employees living in each ZIP code in Colorado in order to assign off-site economic benefits to their respective counties. Based on the survey data, 73.8% of workers live in the primary research counties of Boulder, Jefferson, and Larimer (see Table 4).

TABLE 4: COUNTY RESIDENCES OF CO-LABS EMPLOYEES, 2010

County of Residence	Total Individuals
Boulder	2,880
Jefferson	2,171
Larimer	803
Denver MSA	3,620
Colorado	7,725

^aFor this calculation, part-time employees are counted as 1.

^bDenver Metro includes Adams, Arapahoe, Broomfield, Denver, Douglas, and Jefferson counties.

Housing statistics were gathered from the U.S. Census Bureau's 2006-2009 American Community Survey⁵ for use in the impact model. Data include average household size, percentage of single family and multifamily units, median home prices, and median rents.

TABLE 5: HOUSING DATA, 2006-2009

County	Average Household Size (people)	Single Family ^a (% of units)	Multi-family (% of units)	Median Owner-Occupied Unit Value	Median Monthly Rent
Boulder	2.48	73.0%	27.0%	\$350,600	\$982
Jefferson	2.42	75.6	24.4	257,800	884
Larimer	2.42	78.6	21.4	243,300	821
Colorado	2.53	74.8	25.2	234,100	835

^aSingle family includes mobile homes.

Source: American Community Survey 2006-2009, retrieved December 12, 2010.

Pupils per household were gathered from the Colorado Department of Education for the purpose of assigning cost of government services. The number of pupils per household ranged from 0.37 in Larimer County to 0.48 in Boulder County (See Table 6). Per pupil expenditures ranged from \$7,461 in the Poudre R-1 school district to \$8,759 in the Park R-3 school district (See Table 7).

TABLE 6: PUPILS PER HOUSEHOLD, FALL 2009

County	Pupils	Households	Pupils per Household
Boulder	55,735	115,180	0.48
Jefferson	86,250	215,592	0.40
Larimer	42,955	114,856	0.37
Colorado	832,368	1,869,276	0.45

Source: Colorado Department of Education, 2009 Fall Pupil Membership by District, www.cde.state.co.us/cdereval/rv2009pmlinks.htm, retrieved December 12, 2010.

TABLE 7: FY 2008-09 DISTRICT REVENUES AND EXPENDITURES PER PUPIL

County/School District	Total State Revenue	Total Local Revenue
Boulder County		
St. Vrain Valley RE 1J	\$4,520	\$5,343
Boulder Valley RE 2	2,573	8,246
Jefferson		
Jefferson County R-1	4,425	5,532
Larimer		
Poudre R-1	4,063	5,521
Thompson R-2J	4,598	4,708
Park (Estes Park) R-3	1,023	9,989
Colorado	\$4,732	\$5,249

Source: Colorado Department of Education, Fiscal Year 2008-09 District Revenues and Expenditures, Comparison of Revenues and Other Sources, www.cde.state.co.us/cdefinance/FY08-09RevExp.htm, retrieved December 12, 2010.

⁵www.Census.gov, retrieved December 12, 2010.

Consumer spending data were obtained from the Bureau of Labor Statistics' 2008-2009 Consumer Expenditure Survey for MSAs in western states.⁶ It is estimated that 25.4% of consumers' disposable income is spent on taxable retail goods and services in Colorado. This assumes the following taxable goods and services: food at home, food away from home, alcoholic beverages, housekeeping supplies, household furnishings and equipment, apparel and services, vehicle purchases, gasoline and motor oil, personal care products and services, reading, and tobacco products and smoking supplies.

Indirect Effects

Multipliers were selected based on the published North American Industrial Classification System (NAICS) codes. IMPLAN multipliers were obtained from MIG by matching the NAICS description to IMPLAN's corresponding unaggregated sectors. Employment, earnings, and output multipliers were based on NAICS sector Public Administration (92), and corresponded to "federal, non-military" in IMPLAN (Table 8). Other multipliers were selected based on the specified expenditures, including maintenance, construction, operations, and utilities (Table 8).

TABLE 8: FEDERAL NON-MILITARY MULTIPLIERS

Type	Boulder County	Jefferson County	Larimer County	Denver Metro	Colorado
Employment	1.97	1.90	1.94	1.98	2.07
Earnings	1.15	1.17	1.16	1.21	1.22

Source: Minnesota IMPLAN Group.

TABLE 9: OUTPUT MULTIPLIERS

Type	Boulder County	Jefferson County	Larimer County	Denver Metro	Colorado
Federal, Non-Military	1.50	1.56	1.57	1.69	1.75
Commercial and Institutional Buildings (Construction)	1.59	1.62	1.63	1.80	1.83
Professional, Scientific, and Technical Services	1.78	1.84	1.83	1.97	2.04
Facilities Support Services (Maintenance)	1.58	1.69	1.61	1.81	1.85
Utilities	1.37	1.52	1.27	1.66	1.70

Source: Minnesota IMPLAN Group.

Income Taxes

The Colorado income tax rate is 4.63% of taxable income. This study assumes that 70% of CO-LABS employee income is taxable, and that the marginal tax rate is 2.8%.

Property Taxes

Given the tax exempt status of federal properties, the property taxes captured in this study are derived from employees' home property taxes. The Colorado Department of Local Affairs, Division of Property Taxation's *2009 Annual Report*⁷ provides a summary of county, average municipal, average school, and average special property levies in *Section XI: Assessed Valuation, Revenue, and Average Levies by County*

⁶<http://www.bls.gov/cex/2009/msas/west.pdf>, retrieved December 12, 2010.

⁷http://dola.colorado.gov/dpt/publications/docs/2009_annual_report/AvgLevies.pdf, retrieved December 2, 2010.

(Table 10). Taking the weighted average of property tax by the stated residences of CO-LABS employees provided weighted average mill levies for the state.

TABLE 10: PROPERTY TAX LEVIES, 2009

County	Assessed Valuation 2009	Total Revenue	County Mill Levy	Average Municipal Levy ^a	Average School Levy	Average Special Levy ^b	Total Average County Levy ^c
Adams	\$4,654,686,410	\$488,641,955	26.824	7.22	55.563	3.441	104.978
Arapahoe	7,961,944,990	730,275,613	15.672	7.865	48.02	3.093	91.721
Boulder	5,837,190,300	469,382,713	23.667	11.143	41.675	1.6	80.412
Broomfield	1,083,709,940	112,197,947	17.511	11.457	48.815	6.367	103.531
Denver	12,012,342,720	826,377,436	25.308	0	39.262	1.933	68.794
Douglas	4,879,538,950	501,156,050	19.774	1.868	46.681	4.778	102.706
Jefferson	7,405,609,040	698,848,018	24.346	4.958	48.145	3.458	94.367
Larimer	4,264,024,277	361,791,133	22.435	9.509	44.329	2.359	84.847
Washington	128,623,184	7,671,966	30.254	54.998	23.31	0.866	59.647
Weld	5,770,793,860	386,779,350	16.804	13.114	27.27	2.708	67.024
CO-LABS Weighted Average ^d	-	-	23.306	8.470	43.979	2.550	85.619

^aMunicipal revenues are divided by the sum of municipal assessed valuation.

^bSpecial district revenues are divided by the sum of special district assessed valuation.

^cAverage will not add to the total average county levy because denominators (assessed valuation) are not common to all.

^dCO-LABS average weighted by stated residence of employees.

*These figures include tax increment valuation, and all tax revenues attributable to the increment are allocated to the increment financing authority.

Source: http://dola.colorado.gov/dpt/publications/docs/2009_annual_report/AvgLevies.pdf, retrieved December 2, 2010.

Sales Taxes

State, city, and county tax rates are published on the Colorado Department of Revenue website (www.taxview.state.co.us) (Table 11 and Table 12).

TABLE 11: COUNTY SALES TAX RATES

County	County Rate	RTD	Scientific and Cultural Facilities	Metropolitan Football Stadium	Total County
Adams	0.75%	1.00%	0.10%	0.10%	1.95%
Arapahoe	0.25	1.00	0.10	0.10	1.45
Boulder	0.65	1.00	0.10	0.10	1.85
Broomfield ^a	4.15	1.00	0.10	0.10	5.35
Denver ^a	3.62	1.00	0.10	0.10	4.82
Douglas	1.00	1.00	0.10	0.10	2.20
Jefferson	0.50	1.00	0.10	0.10	1.70
Larimer	0.80	0.00	0.00	0.00	0.80
Washington	1.50	0.00	0.00	0.00	0.00
Weld	0.00	0.00	0.00	0.00	0.00
CO-LABS Weighted ^b	0.93	0.84	0.08	0.08	1.93
Colorado	2.90	0.00	0.00	0.00	2.90

Note: Does not include local improvement districts in dispersed areas of the counties.

^aCounty and city tax rates are combined in Broomfield and Denver.

^bCO-LABS average weighted by stated residence of employees.

Source: www.taxview.state.co.us/QueryTaxrates.aspx?selected=1, retrieved December 2, 2010.

TABLE 12 CITY TAX RATES

City	City Rate
Akron	2.50%
Arvada	3.46
Aurora	3.75
Berthoud	3.00
Boulder ^a	3.41
Brighton	3.75
Broomfield	4.15
Denver ^a	3.62
Erie	3.50
Evergreen	NA
Fort Collins ^a	3.00
Golden	3.00
Lafayette	3.50
Lakewood	3.00
Littleton	3.00
Longmont	3.28
Louisville	3.50
Loveland	3.00
Lyons	3.00
Nederland	3.75
Westminster	3.85
CO-LABS Weighted	3.33

^aBoulder and Denver have an alternative tax on food and liquor for immediate consumption (3.56% and 4%); Fort Collins has an alternative tax on food for home consumption (2.25%).

Source: www.taxview.state.co.us, retrieved December 2, 2010.

Cost of Government

Colorado's federal research facilities undoubtedly provide economic benefits and public revenues to Colorado through operations and employees' off-site impacts. However, costs exist in providing state, county, and local government services to the facilities and their employees, including general government administration, public works (e.g., roads, utilities), public safety (e.g., fire protection, police protection), parks and recreation, and so forth. Comprehensive annual financial reports (CAFRs) were used as resources to identify these costs at state, county, and city levels. Costs were assigned to residents and businesses based on government function, and per capita expenses were derived using total business employment and residential population as denominators.

The cost of providing state government services was estimated at \$1,435 per resident and \$867 per employee (Table 13).

TABLE 13: COST OF GOVERNMENT, 2008

County	Per Resident	Per Employee
Boulder	\$303	\$239
Jefferson	279	225
Larimer	288	190
State	\$1,435	\$867

Sources: County Comprehensive Annual Financial Reports.

SUMMARY OF IMPACTS

Construction

The Colorado portion of construction at Colorado’s federal research facilities totaled approximately \$84.1 million in FY 2009 and \$201.0 million in FY 2010.

TABLE 14: COLORADO PORTION OF CONSTRUCTION FUNDING, BY FACILITY, FY 2009-FY 2010

Primary County	FY 2009				FY 2010			
	Hard Costs	Soft Costs	Labor	Total	Hard Costs	Soft Costs	Labor	Total
Boulder	8.0	7.3	12.5	27.7	39.5	25.4	24.7	89.6
Jefferson	20.7	5.0	23.9	49.5	42.1	14.8	51.4	108.3
Larimer	3.0	0.5	3.3	6.7	1.2	0.0	1.2	2.4
Colorado	31.6	12.7	39.7	84.1	83.2	40.2	77.6	201.0

Note: Assumes 28% of hard costs, 30% of soft costs, and 80% of labor are sourced within Colorado.

Employment

Employment at federal research facilities and their university affiliates totaled 7,387 FTE direct jobs and an additional 7,904 indirect jobs in FY 2009, increasing to 7,964 direct and 8,521 indirect in FY 2010 (Table 15).

TABLE 15: EMPLOYMENT, DIRECT AND INDIRECT, FY 2009-FY 2010

County of Employment	FY 2009			FY 2010		
	Direct Employment	Indirect	Total Direct and Indirect	Direct Employment	Indirect	Total Direct and Indirect
Boulder	3,386	3,284	6,669	3,558	3,451	7,009
Jefferson	3,213	2,891	6,104	3,626	3,263	6,889
Larimer	765	719	1,483	754	709	1,463
Colorado	7,387	7,904	15,291	7,964	8,521	16,485

Note: Based on IMPLAN, federal non-military multipliers for selected areas.

American Recovery and Reinvestment Act Funding

Facilities reported ARRA funding in two components: construction and operations. Total ARRA-related construction spending in FY 2009 was \$2.7 million and \$102.7 million in FY 2010. ARRA funding for operations totaled \$1.6 million and \$5.4 million in FY 2009 and FY 2010, respectively.

Economic Impact

Impact on Colorado

The net economic benefit of federal research facilities and their university affiliates on the state of Colorado totaled \$1.2 billion in FY 2009 and \$1.5 billion in FY 2010 (Table 16). In FY 2010, the operational impact of the lab facilities alone are expected to have an impact on the state of \$772.0 million from expenditures to keep the facilities functioning and the related spending along the supply chain.

Given the tax-exempt status of the federal facilities, public revenues are chiefly derived from employee income taxes and off-site sales taxes. Public revenues are estimated at \$20.0 million in FY 2009 and \$24.3 million in FY 2010 (Table 16).

While federal facilities are tax exempt, they do receive government services, including police and fire protection and the benefits of parks and roads. The costs of providing state government services to the facilities and employees, including K-12 school funding, totaled \$28.5 million and \$31.8 million in FY 2009 and FY 2010, respectively (see Table 16).

TABLE 16: CO-LABS, IMPACT ON COLORADO, IN THOUSANDS, FY 2009-FY 2010

Source	FY 2009	FY 2010
Economic benefits		
Construction	\$84,063	\$201,029
Operations	698,536	771,981
Employees (off-site)	128,901	141,215
Indirect	315,063	446,303
Visitors	10,110	10,211
Total	1,236,673	1,570,739
Public revenues		
Construction	2,069	4,663
Operations	14,236	15,596
Employees (off-site)	3,633	3,980
Visitors	74	75
Total	20,012	24,314
Public costs		
Construction	0	0
Operations	6,464	7,198
Employees (off-site)	22,057	24,563
Visitors	0	0
Total	28,520	31,761
Net economic benefits	\$1,208,153	\$1,538,978

Impact on Boulder County

The net economic benefit of federal research facilities and their affiliates on Boulder County totaled \$402.9 million in FY 2009 (Table 17). In FY 2010, the facilities are expected to have an impact on Boulder County of \$463.8 million. The majority of this impact is related to operations, followed by indirect impacts related to spending along the supply chain.

Given the tax-exempt status of the federal facilities, public revenues (city, county, school, and special) are largely derived from employee income taxes, off-site sales, and property taxes. Public revenues are estimated at \$8.3 million in FY 2009 and \$9.5 million in FY 2010 (Table 17).

While federal facilities are tax exempt, they do receive government services, including police and fire protection and the benefits of parks and roads. The costs of providing government services (city, county, school, and special) to the facilities and employees totaled \$7.4 million in FY 2009 and \$8.0 million in FY 2010 (see Table 17).

TABLE 17: CO-LABS, IMPACT ON BOULDER COUNTY, IN THOUSANDS, FY 2009-FY 2010

Source	FY 2009	FY 2010
Economic benefits		
Construction	\$11,091	\$35,846
Operations	267,742	282,220
Employees (off-site)	61,054	64,655
Indirect	70,285	88,965
Visitors	1,807	1,825
Total	411,979	473,511
Public revenues		
Construction	442	1,389
Operations	-	-
Employees (off-site)	7,878	8,063
Visitors	20	21
Total	8,340	9,474
Public costs		
Construction	-	-
Operations	1,751	1,900
Employees (off-site)	5,644	6,128
Visitors	-	-
Total	7,394	8,029
Net economic benefits	\$402,872	\$463,755

Impact on Jefferson County

The net economic benefit of federal research facilities and their affiliates on Jefferson County totaled \$334.9 million in FY 2009 (Table 18). In FY 2010, the facilities are expected to have an impact on Jefferson County of \$413.2 million. The majority of this impact is related to operations, followed by indirect impacts related to spending along the supply chain and substantial one-time construction projects.

Given the tax-exempt status of the federal facilities, public revenues (city, county, school, and special) are largely derived from employee income taxes, off-site sales, and property taxes. Public revenues are estimated at \$6.0 million in FY 2009 and \$7.4 million in FY 2010 (see Table 18).

While federal facilities are tax exempt, they do receive government services, including police and fire protection and the benefits of parks and roads. The costs of providing government services (city, county, school, and special) to the facilities and employees totaled \$5.2 million and \$6.1 million in FY 2009 and FY 2010, respectively (see Table 18).

TABLE 18: CO-LABS, IMPACT ON JEFFERSON COUNTY, IN THOUSANDS, FY 2009-FY 2010

Source	FY 2009	FY 2010
Economic benefits		
Construction	\$19,809	\$43,326
Operations	186,850	211,719
Employees (off-site)	45,017	51,445
Indirect	84,214	108,552
Visitors	4,216	4,258
Total	340,106	419,300
Public revenues		
Construction	964	2,024
Operations	-	-
Employees (off-site)	4,999	5,329
Visitors	51	52
Total	6,014	7,405
Public costs		
Construction	-	-
Operations	1,661	1,937
Employees (off-site)	3,576	4,169
Visitors	-	-
Total	5,237	6,106
Net economic benefits	\$334,869	\$413,194

Impact on Larimer County

The net economic benefit of federal research facilities and their affiliates on Larimer County totaled \$100.1 million in FY 2009 (Table 19). In FY 2010, the facilities are expected to have an impact on Larimer County of \$99.5 million. Economic benefits are chiefly related to operations, followed by indirect impacts related to spending along the supply chain and substantial one-time construction projects.

Given the tax-exempt status of the federal facilities, public revenues (city, county, school, and special) are largely derived from employee income taxes, off-site sales, and property taxes. Public revenues are estimated at \$1.84 million in FY 2009 and \$1.78 million in FY 2010 (Table 19).

While federal facilities are tax exempt, they do receive government services, including police and fire protection and the benefits of parks and roads. The costs of providing government services (city, county, school, and special) to the facilities and employees totaled \$1.78 million in FY 2009 and \$1.75 million in FY 2010 (see Table 19).

TABLE 19: CO-LABS, IMPACT ON LARIMER COUNTY, FY 2009-FY 2010

Source	FY 2009	FY 2010
Economic benefits		
Construction	\$3,347	\$1,205
Operations	67,284	69,370
Employees (off-site)	11,627	11,960
Indirect	18,845	17,957
Visitors	730	737
Total	101,833	101,229
Public revenues		
Construction	118	45
Operations	-	-
Employees (off-site)	1,714	1,726
Visitors	6	7
Total	1,839	1,778
Public costs		
Construction	-	-
Operations	388	382
Employees (off-site)	1,389	1,370
Visitors	-	-
Total	1,777	1,752
Net economic benefits	\$100,056	\$99,477

CONCLUSION

Federal research facilities and their university affiliates have a strong economic benefit on the state of Colorado, with a net economic benefits estimated at \$1.2 billion in FY 2009 and \$1.5 billion in FY 2010. Boulder, Jefferson, and Larimer counties were the primary beneficiaries of the research facilities due to their physical location in these counties, as well as the residences of a majority of the facilities' employees. Net economic benefits to Boulder, Jefferson, and Larimer counties totaled \$463.8 million, \$413.2 million, and \$99.5 million, respectively, in FY 2010.

These facilities were major recipients of American Recovery and Reinvestment Act (ARRA) funding. Total ARRA-related construction spending in FY 2009 was \$2.7 million and \$102.7 million in FY 2010. ARRA funding for operations totaled \$1.6 million and \$5.4 million in FY 2009 and FY 2010, respectively.

In FY 2009, employment at these facilities accounted for 7,387 direct jobs in Colorado and an additional 7,904 indirect employees serving the supply chain. In FY 2010, direct employment increased to 7,964 and 8,521 indirect employees.

The facilities occupy more than 4.7 million square feet of leased and owned real estate in Colorado. The Colorado component of construction at the studied facilities topped \$84 million in FY 2009 and \$201 million in FY 2010.

APPENDICES

Appendix 1: Background of Federal Research Facilities and University Affiliates in the Region

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) claims very early roots as a science agency, from 1807 when President Thomas Jefferson ordered the Survey of the Coast. The coastal and geodetic survey and other Earth system science components were officially bundled together in 1970 to form the present-day agency. Other pieces to come under the NOAA umbrella include the Weather Bureau, founded in 1870, and the Bureau of Commercial Fisheries, 1871. From daily weather forecasts, severe storm warnings, and climate monitoring to fisheries management, coastal restoration, and marine commerce support, NOAA's products and services provide economic vitality and impact more than one-third of America's gross domestic product. Areas of focus are climate; oceans, great lakes, and coasts; and weather and air quality. Major NOAA divisions are the National Ocean Service; NOAA Fisheries Service; NOAA Research; National Weather Service; and NOAA Satellite and Information Service. NOAA has offices in Boulder, Denver, Fort Collins, Grand Junction, Longmont, and Pueblo.

Earth System Research Laboratory

The Earth System Research Laboratory (ESRL) was formed in 2005 by consolidating six NOAA research laboratories. ESRL's mission is to observe and understand the Earth system and to develop products that advance NOAA's environmental information and services on global-to-local scales. ESRL's scientists study the components and dynamics of the physical Earth and how these work together to produce weather and climate and influence ecosystems. ESRL is the largest of NOAA's research labs, and collaborates with partners that include the University of Colorado, Colorado State University, National Center for Atmospheric Research, and U.S. Department of Energy.

Headquartered in Boulder, ESRL research reaches around the globe. Flasks of air collected at 70 worldwide locations, including Niwot Ridge along the Front Range, are analyzed at ESRL to track trace gases, such as carbon dioxide and methane. ESRL's baseline observatories – from Hawaii to the South Pole – monitor the global atmosphere. ESRL researchers chart atmospheric rivers that bring extreme rain and snow storms onto the West Coast, and work with water managers who need sound scientific data for decision making. Remote sensing instruments like the wind profiler, now used worldwide, were developed by ESRL. The lab's scientists study atmospheric chemistry – helping communities identify solutions to pollution issues and tracking recovery of the Earth's stratospheric ozone layer. ESRL researchers design work stations to modernize the nation's Weather Service, develop and refine weather and climate models, and improve NOAA's computing capability. They contribute to international efforts to assess climate change and identify information needed for renewable energy development.

National Geophysical Data Center

NOAA's National Geophysical Data Center (NGDC) in Boulder provides long-term scientific data stewardship for the nation's geophysical data – ensuring quality, integrity, and accessibility. From showing where the lights are out after a hurricane hits the coast and revealing the explosive history of

solar flares, to mapping the outer continental shelf – NGDC collects, archives, and delivers data for research, commerce, and decision makers. Organized under the NOAA Satellite and Information Service, NGDC data describes the solid Earth, marine and solar-terrestrial environments, and Earth observations from space. NGDC works closely with contributors of scientific data to prepare documented, reliable data sets, encouraging data exchange and welcoming cooperative projects with other government agencies, nonprofit organizations, and universities. This data is utilized nationally and internationally by private industry, universities and other educational facilities, research organizations, governments, and the general public.

Cooperative Institute for Research in Environmental Sciences

The Cooperative Institute for Research in Environmental Sciences (CIRES) of the University of Colorado, which collaborates in research with NOAA and other federal agencies, was founded in 1967. The Institute conducts research in Earth system science, which includes environmental chemistry and biology, atmospheric and climate dynamics, cryospheric and polar processes, and dynamics of the Earth's crust. Research topics range from glacial melting and rising sea levels to hurricane forecasting. CIRES has five research centers: (1) the Center for Limnology, which studies inland aquatic ecosystems, such as lakes, streams, and wetlands; (2) the Center for Science and Technology Policy Research, which analyzes the relationship between scientific and technological advances and formation of public policy; (3) the Earth Science and Observation Center which dedicated to the understanding of the Earth System through the use of satellite and airborne remote sensing techniques; (4) the Climate Diagnostics Center, which improves climate analysis and understanding; and (5) the National Snow and Ice Data Center, which manages and collects data that support analysis of the Earth system. As a research unit of University of Colorado, CIRES brings together government and university researchers and students from eight university departments and several NOAA laboratories in an array of scientific collaborations and interdisciplinary research.

Cooperative Institute for Research in the Atmosphere

The Cooperative Institute for Research in the Atmosphere (CIRA) is a cooperative institute between NOAA and Colorado State University, similar in structure to that between CIRES and the University of Colorado. CIRA conducts research concentrated in areas involving global and regional climate; local and mesoscale area weather forecasting and evaluation; applied cloud physics; applications of satellite observations; air quality and visibility; societal and economic impacts; numerical modeling; and education, training, and outreach. The vision of CIRA is to improve research in the atmospheric sciences by developing skills beyond standard meteorology, by exploiting cutting-edge advances in engineering and computer science, and by facilitating expansive continued research for future application. In addition to the relationship with NOAA, the National Park Service works with CIRA on air quality and visibility research, and NASA and the Department of Defense are also active sponsors. The Institute provides an interdisciplinary forum for research collaboration among university scientists, post-docs, staff, students and several NOAA laboratories.

Space Weather Prediction Center

The Space Weather Prediction Center (SWPC) is one of the nine National Centers for Environmental Prediction within the NOAA National Weather Service (NWS) and is the Nation's official source for space

weather alerts, watches and warnings. SWPC operates 24x7 in Boulder. As one of only four National Critical Systems in the NWS, it partners with the Air Force Weather Agency at Offutt AFB, NE, which is responsible for supplying space weather guidance to the defense and intelligence community.

The SWPC monitors and forecasts solar storms that can affect people and equipment working in the space environment, such as satellite systems that can be completely destroyed if caught unprepared for adverse space weather conditions. It safeguards national security by issuing notifications of extreme cases where storms can disable and compromise communication systems, the electric power grid and navigation equipment on the Earth's surface. SWPC collects most of its data from operational and research class satellites that monitor solar wind, x-rays, and other emissions from the Sun. Through the infusion of research and advances in science and technology, SWPC strives to provide the most accurate solar activity information possible, as well as improve techniques for forecasting solar storms and their impact. SWPC is focused on the coming solar cycle peak in 2013: the latest in a continuing 11-12-year cycle of the Sun's magnetic variability and sunspots that can have varying impacts on the Earth. The Center works with many worldwide organizations, to develop actionable information to mitigate the Sun's impact on advanced technologies which underlie our economic prosperity and national security.

Weather Forecast Offices

Is this thunderstorm expected to spawn a tornado? How much snow will fall overnight? Will the river reach flood stage tomorrow? Do we expect a hot and dry summer? NOAA's National Weather Service provides weather and seasonal climate forecasts, plus broad hydrology information for our nation. The Weather Service operates three Weather Forecast Offices in Colorado – in Boulder, Grand Junction, and Pueblo – and 122 across the country. Each location provides the most up-to-date weather and flood warnings, daily forecasts, and longer-term weather and water information. Data collected from each station is collected to produce national and regional forecasts. A related Weather Service unit located in the Denver Air Route Traffic Control Center (ARTCC) in Longmont, provides data used in directing aviation traffic.

University Corporation for Atmospheric Research

Founded in 1960 and headquartered in Boulder, the University Corporation for Atmospheric Research (UCAR) is a nonprofit consortium of North American member universities, each of which grants doctoral degrees in the atmospheric and related sciences. Affiliate members include a number of international universities offering comparable degrees and non-Ph.D. granting North American universities. UCAR promotes partnership in a collaborative community dedicated to carrying out long-term scientific programs to facilitate understanding the atmosphere and the interconnected processes that make up the Earth system science, from the ocean floor to the Sun's core. UCAR also manages the National Center for Atmospheric Research (NCAR) and the UCAR Office of Programs, which provide research, observing, and computing facilities and a variety of services for the atmospheric and Earth sciences community.

National Institute of Standards and Technology

The National Institute of Standards and Technology (NIST) has had several names since its founding as the National Bureau of Standards in 1901. It became the Bureau of Standards in 1903, went back to the National Bureau of Standards in 1934, and finally was renamed the National Institute of Standards and Technology in 1988. Established in Boulder in 1950, NIST has two national labs, one in Boulder and the headquarters in Gaithersburg, Maryland. NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST carries out its mission in four cooperative programs: (1) NIST Laboratories; (2) the Baldrige National Quality Program (operated from Gaithersburg, Maryland); (3) the Hollings Manufacturing Extension Partnership (based in Gaithersburg, Maryland); and (4) the newly created Technology Innovation Program.

With a staff of about 350 scientists, engineers, technicians, and support personnel, plus approximately 100 visiting researchers annually, the NIST Boulder Laboratories conduct research in a wide range of areas, including chemical, physical, materials, and information sciences and engineering.

National Renewable Energy Laboratory

Established as the Solar Energy Research Institute in 1977, the organization became a national laboratory of the Department of Energy (DOE) in 1991 and changed its name at that time to the National Renewable Energy Laboratory (NREL). The facility is the nation's primary laboratory for renewable energy and energy efficiency research and development. The organization's mission and strategy are focused on advancing the DOE's goals and our nation's energy goals. Scientists and researchers support critical market objectives to accelerate research from scientific innovations to market-viable alternative energy solutions. NREL's Technology Transfer Office works with private- and public-sector organizations to successfully transfer technologies into commercially viable products and businesses fit for the marketplace.

National Telecommunications and Information Administration

Created in 1978, the National Telecommunications and Information Administration (NTIA) is the President's principal adviser on telecommunications and information policy issues. Additionally, NTIA also manages the federal use of spectrum; performs telecommunications research and engineering, including resolving technical telecommunications issues for the federal government and private sector; and administers infrastructure and public telecommunications facilities grants.

NTIA categorizes a majority of its work and research into five line offices: (1) the Office of Spectrum Management monitors and maintains spectrum communication devices nationally; (2) the Office of Policy Analysis and Development generates, articulates, and advocates creative and influential policies and programs in the telecommunications and information sectors that promote innovation, competition, consumer welfare, and economic and social opportunities for all; (3) the Office of International Affairs researches and develops international policies that allow the U.S. private sector to compete globally; (4) the Institute for Telecommunication Sciences conducts the research and

engineering that will be implemented into government policies; and (5) the Office of Telecommunications and Information Application assists public and nonprofit entities in effectively using telecommunications and information technologies to better provide public services and advance other national goals.

U.S. Geological Survey

The U.S. Geological Survey (USGS) provides reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. It is the nation's largest water, earth, biological science, and civilian mapping agency, and specializes in being an independent fact-finding agency that provides unbiased and impartial information that is valuable on a planet where natural resources are in increasing demand. Researchers collect, monitor, analyze, and provide scientific understanding about natural resource conditions and issues. A Department of the Interior bureau, the USGS was founded in 1879. It is headquartered in Reston, Virginia, with regional offices in Denver and Menlo Park, California. Some divisions of USGS are the Colorado Water Science Center, the Earth Surfaces Process Team, the Energy Resources Team, the Ft. Collins Biological Science Center, the Geologic Hazards Team, the Mineral Resources Science Center, the Rocky Mountain Geographic Science Center, and the Water Quality Testing Laboratory.

Centers for Disease Control and Prevention, Division of Vector-Borne Infectious Diseases

First established in the 1950s as the Disease Ecology Section of Centers for Disease Control and Prevention, the unit moved to Greeley, Colorado, in 1963 and four years later to its present location in Fort Collins. In 1974, the name was changed to the Division of Vector-Borne Viral Diseases, and then to the Division of Vector-Borne Infectious Diseases in 1989, when the unit was given the responsibility of developing a national Lyme disease program and was renamed to reflect its responsibilities for Lyme disease, plague, and other zoonotic bacterial infections. The division is a national and international reference center for diseases caused by mosquitoes, ticks, and fleas. Its mission is to: (1) develop and maintain effective surveillance for vector-borne viral and bacterial agents and their arthropod vectors; (2) conduct field and laboratory research and epidemic aid investigations; (3) define disease etiology, ecology, and pathogenesis in order to develop improved methods and strategies for disease diagnosis, surveillance, prevention, and control; (4) provide diagnostic reference and epidemiologic consultation to state and local health departments, other components of the CDC, other federal agencies, and national and international health organizations; and (5) provide intramural and extramural technical expertise and assistance in professional training activities.

Rocky Mountain Research Station

The Rocky Mountain Research Station is one of seven research stations/institutes of the U.S. Forest Service Research and Development organization. Headquartered in Fort Collins CO, the Rocky Mountain Research Station maintains a forest and rangeland research and development program among 14 states of the Interior West. Research laboratories and experimental areas are maintained in eight states (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, South Dakota, and Utah). RMRS develops

and delivers scientific and technological information and knowledge to improve the health and use of forest and rangelands. The organization has a long history of forest and rangeland research sites, dating back to 1903 on the Santa Rita Range Reserve in Tucson, Arizona and the Fort Valley Experimental Forest in 1908.

The station has seven science programs, one institute (Aldo Leopold Wilderness Research Institute), and several Research, Development, and Application Programs. The core science programs include research in (1) Air, Water, and Aquatics Environments; (2) Fire, Fuel, and Smoke; (3) Forest and Woodland Ecosystems; (4) Grassland, Shrubland, and Desert Ecosystems; (5) Inventory and Monitoring, (6) Human Dimensions, and (7) Wildlife and Terrestrial Ecosystems. The science programs are focused on long- and short-term research, science innovation and discovery, tool development, and delivery and program integration.

U.S. Department of Agriculture Agricultural Research Service

The Agricultural Research Service (ARS) is the chief intramural research agency of the U.S. Department of Agriculture. It develops solutions for current problems facing agriculture in America, as well as develops and transfers new methods and technology to help increase productivity, safety, and efficiency of food and fiber production. ARS works to ensure high-quality and safe food, assess the nutritional needs of Americans, sustain a competitive agricultural economy, and enhance the natural resource base. In 2010, the agency's budget was approximately \$1.2 billion, and it employed a total of 8,100 people, including 2,100 research scientists conducting 1,200 research projects within 22 national programs. Research is conducted in 100 facilities nationwide and in a few global locations. Within Colorado, ARS supports seven research units. Each unit is led by a research leader (RL) and is staffed by 2-10 scientists and associated support staff. In addition, Fort Collins hosts the Northern Plains Area office, led by Dr. Will Blackburn, that provides support to 13 locations within an 8 state area. The seven research units in Colorado are:

- Central Great Plains Resources Management Unit, Akron (RL – Dr. Merle Vigil)
- Agricultural Systems Research Unit, Natural Resources Research Center (NRRC), Fort Collins (RL – Dr. Laj Ahuja)
- Water Management Unit, NRRC, Fort Collins (RL – Tom Trout)
- Soil Plant Nutrient Research Unit, NRRC, Fort Collins (RL – Dr. Ron Follett)
- Sugar Beet Research Unit, Crops Research Laboratory, Fort Collins (RL – Dr. Lee Panella)
- Rangeland Resources Research Unit, Crops Research Laboratory, Fort Collins, Nunn, and Cheyenne, WY (RL – Dr. Justin Derner)
- Plant and Animal Genetic Resources Preservation Research Unit, National Center for Genetic Resources Preservation. (RL – Dr. David Dierig)

National Wildlife Research Center

The roots of the National Wildlife Research Center (NWRC), a facility within the U.S. Department of Agriculture (USDA), date back to 1886 when the Division of Economic Ornithology and Mammalogy was created within the USDA. A separate facility, the Control Methods Research Laboratory in Albuquerque,

New Mexico, conducted field and laboratory experiments in the early 1900s, and in 1920, the laboratory moved to Denver. In 1931, the USDA Food Habits Laboratory was established in Denver. Throughout the next several decades, various other bureaus are established and eventually combined in 1990 to form the National Wildlife Research Center. The center was relocated to Colorado State University campus in Fort Collins that year.

The NWRC is within the Animal and Plant Health Inspection Service's Wildlife Services program. The main objective of the center is to minimize the effects of interaction between wildlife and humans, so that both can continue to live harmoniously.

Sample of Other Federally Funded Research Facilities in the Region

Extreme Ultraviolet Science and Technology

Created by the National Science Foundation in 2003 among four core partner institutions—Colorado State University, the University of Colorado at Boulder, the University of California at Berkeley, and the Lawrence Berkeley National Laboratory—the Extreme Ultraviolet Science and Technology (EUV Center) is an Engineering Research Center that explores the development of compact coherent extreme ultraviolet (EUV) sources and their applications in challenging scientific and technological problems. The center's goal is to make extreme ultraviolet light available routinely throughout the country in a wide range of laboratory settings. EUV light is currently limited to a handful of large national facilities, but has potential to be useful in many research applications such as high resolution imaging, spectroscopy, elemental- and bio-microscopy, and nano-fabrication. Major research efforts are being pursued in three areas: Engineered EUV Sources; Imaging, Patterning and Metrology; and Novel Linear and Non-Linear Spectroscopies. The EUV Center is located on the main campus of Colorado State University in Fort Collins.

Center for Astrophysics and Space Astronomy

An astronomy and astrophysics center founded in 1985, the Center for Astrophysics and Space Astronomy (CASA) is an affiliated unit within the Astrophysical and Planetary Sciences Department at CU, along with JILA and LASP. CASA is housed in three different locations at CU, with the main location in the Duane Physics Building on the CU campus. Faculty, research professors, research associates, and graduate and undergraduate students conduct research in the areas of stars, solar physics, interstellar and intergalactic matter, extragalactic astronomy, high-energy astrophysics, origins, and X-ray/UV/IR/sub-mm instrumentation. Research projects are often funded by NASA and NSF.

Colorado Renewable Energy Collaboratory

The Colorado Renewable Energy Collaboratory consists of four Colorado-based research institutions and a network of industry partnerships. The collaboratory's goal is to create renewable energy technologies and to rapidly transfer those technologies to the market. The collaboratory was formed in February 2007, when the National Renewable Energy Laboratory, the University of Colorado at Boulder, Colorado State University, and the Colorado School of Mines agreed to jointly conduct renewable energy research under a single administrative structure, creating a powerful renewable energy research organization. The proximity and complementary research strengths of these four facilities facilitate cooperation on

research, innovation, and information sharing. The research expertise of the four institutions is combined in a number of research centers, each focused on a single category of renewable energy technologies. This combined research talent is then made available to private partners through a single administrative structure for both shared and proprietary research.

The collaboratory's existing research centers include the Colorado Center for Biorefining and Biofuels (C2B2) and the Center for Revolutionary Solar Photoconversion (CRSP). The current roster of private partners in the C2B2 Center includes: Archer Daniels Midland Company, Chevron, ConocoPhillips, Dow Chemical, DuPont, General Motors, Shell Global Solutions, Suncor Energy, Weyerhaeuser, and W.R. Grace, as well as more than a dozen Colorado renewable energy companies (Tab1). Private partners in CRSP are: Applied Materials, Ascent Solar Technologies, DuPont, Evident Technologies, Konarka, Lockheed Martin, Motech Industries, QuantumSphere, Sharp, Solasta, Sub-One Technology, and SunEdison.

TABLE 20: C2B2 SPONSORING MEMBERS, DECEMBER 2010

Catchlight Energy	Genesis Biofuel	Solix Biofuels
Ceres	Gevo	Sundrop Fuels
Chevron	GICON	Valero
Cobalt Biofuels	Korth O-Neil Engineering	
ConocoPhillips	Live Fuels Inc.	
Ecopetrol - ICP	Mascoma	
Flad Architects	OPX Biotechnologies	
Genencor	Rentech	
General Motors	Shell Global Solutions	

Source: <http://www.c2b2web.org/2SponsorMem.php>, retrieved December 10, 2010.

JILA

JILA was founded in 1962 as a joint institute of the University of Colorado and NIST. Originally, the name stood for the Joint Institute for Laboratory Astrophysics; however, in 1994 members voted to keep the name but discontinue use of the meaning as it did not adequately describe the scope of science conducted at the institute. JILA serves as a research platform for some of the top physicists and scientific researchers in the world, including several Nobel Laureates. Located on the CU campus, the institute includes graduate and postgraduate students, faculty, and alumni who work in some of the most challenging and fundamental areas recognized by science. Research at the facility falls into seven categories: astrophysics, atomic and molecular physics, biophysics, chemical physics, nanoscience, optical physics, and precision measurement.

JILA faculty includes three Nobel laureates and two John D. and Catherine T. MacArthur Fellows. JILA scientists publish annually more than 200 original research papers in national and international scientific journals and conference proceedings. Creative research projects conducted by the JILA Fellows, CU professors, and NIST staff members help generate the pioneering research JILA is known for.

Laboratory for Atmospheric and Space Physics

The Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado was established in 1948 as the Upper Atmosphere Lab (UAL) to help initiate the era of space exploration, along with a handful of other American universities, the military, and industry. In 1965 UAL became LASP. Its goal: to “make discoveries through the research and technology efforts of our atmospheric, space physics, solar, planetary, engineering, and mission ops divisions.” Past accomplishments include LASP participation in planetary missions to each of the planets in the solar system, and highly successful student spacecraft programs. Among current projects is a LASP designed, built, and controlled satellite that will help determine how and why variations in the sun affect Earth’s atmosphere and climate.

Bureau of Reclamation Technical Services Center

Created in 1994, the Technical Services Center (TSC) is an engineering, science, research, and support center for projects related to water resources. The TSC provides specialized expertise to the Bureau of Reclamation, regions, other Federal agencies, and international customers. The TSC maintains a broad range of water resource management capabilities, from designing dams and power plants to studying aquatic plants. The sharing of scientific and technical expertise in the development and conservation of water resources has long been a fundamental practice of the Bureau of Reclamation. Currently, the TSC has four service divisions: Civil Engineering, Water and Environmental Resources, Geotechnical Services, and Infrastructure Services. The Technical Service Center is located in Lakewood, Colorado.

Federal Railway Administration Transportation Technology Center

On January 1, 1998, the Transportation Technology Center, Inc. (TTCI) was formed as a wholly owned, subsidiary of the Association of American Railroads (AAR). Headquartered at the U.S. Federal Railroad Administration’s (FRA) Transportation Technology Center (TTC), a testing site near Pueblo, Colorado, its mission is “accelerating the use of clean, safe and efficient technologies by railways worldwide.” TTCI supports the AAR and its members through cooperative research in improved suspension systems, top-of-rail lubrication, improved wheel and rail profiles, performance-based track geometry systems, center plate lubrication, effects of heavy axle loads, track-integrity monitoring systems, and improved ride quality. TTCI develops and maintains industry standards for freight cars and locomotives, under the direction of AAR. TTCI's Technical Standards group provides technical expertise, coordinates the development of new standards, manages the industry's certification and quality assurance programs, and publishes AAR's Interchange Rules and *Manual of Standards and Recommended Practices*.

National Ecological Observatory Network

NEON, Inc. is an independent corporation created to manage large-scale ecological observing systems and experiments on behalf of the scientific community. National Ecological Observatory Network (NEON) is a large facility project managed by NEON, Inc. and funded by the National Science Foundation. NEON’s goal is to contribute to global understanding and decisions in a changing environment using scientific information about continental-scale ecology obtained through integrated observations and experiments. NEON will enable understanding and forecasting of the impacts of climate change, land-use change and invasive species on continental-scale ecology—by providing infrastructure and consistent methodologies to support research and education in these areas. NEON is currently in the

planning and development stages, and expects to enter the construction phase in late 2010, when sites will be built and data will begin to come in. Constructing the entire NEON network will take approximately five years, so NEON expects to be in full operation by 2016. NEON, Inc. is headquartered in Boulder, Colorado.

Renewable and Sustainable Energy Institute

The Renewable and Sustainable Energy Institute (RASEI) began as a campus initiative of the University of Colorado at Boulder in early 2006. In June 2009, the final objective of the initiative was achieved when the University of Colorado Regents formally approved the creation of the Renewable and Sustainable Energy Institute, and an agreement was signed with the National Renewable Energy Laboratory (NREL) to make RASEI a joint institute. The goal of RASEI is to become an international force in solving the energy challenge through research, education, and technology commercialization. The RASEI is highly interdisciplinary, integrating the University's extensive research in renewable and sustainable energy with its strengths in climate and environmental science, behavioral studies, policy analysis, and entrepreneurship. This integration is reflected in the three-pronged approach of the RASEI that emphasizes discovery, transformation, and entrepreneurship.

U.S. Air Force Academy Research Institutes

The Air Force Academy research institutes include the Institute for Information Technology Applications (IITA) and the Institute for National Security Studies (INSS). The IITA conducts information technology application research for the Department of Defense, the Air Force and the U.S. Air Force Academy. It is closely partnered with the military and civilian research communities to deliver high-impact IT applications, ensuring information superiority for current and future generations. The INSS promotes national security research within the military academic community for the Department of Defense and supports the Air Force national security education program. It sponsors research into areas including arms control, national security affairs, Air Force policy, regional studies, information operations, and environmental security. The Air Force Academy is located near Colorado Springs, Colorado.

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