THE Ames Laboratory

Creating Materials & Energy Solutions

U.S. DEPARTMENT OF ENERGY

Lab Plan

Fiscal Year 2012

Prepared: April 27, 2012

The Ames Laboratory

Mission/Overview

The Ames Laboratory (AMES) was formally established in 1947 by the US Atomic Energy Commission as a result of AMES' successful development of the most efficient process to produce high-purity uranium metal in large quantities for the Manhattan Project. Situated on the campus of Iowa State University, the Laboratory's mission is to create materials, inspire minds to solve problems, and address global challenges. AMES is the premier DOE Laboratory for research on rare earths and other critical materials. Our scientific mission is aided by the Materials Preparation Center (MPC) which prepares, purifies, fabricates and characterizes materials in support of R&D programs throughout the world. AMES also performs research for the DOE's applied energy, fossil energy and nonproliferation programs. Through work for others activities, AMES provides research and materials to the National Institute of Justice, Department of Defense, various law enforcement agencies, and corporations. AMES researchers have won 18 R&D 100 Awards from R&D Magazine, and AMES leads the DOE Complex in converting its technology into products (2011 product sales of $750M). Educating future scientists is a key component of our work; since 1947, over 3000 Masters and Ph.D. degrees in science and engineering have been awarded to ISU students working on DOE funded projects.

Key areas of expertise are materials design, synthesis and processing, including rare earths; analytical instrumentation/device design/fabrication; materials characterization; catalysis; condensed matter theory (including photonic band gap and other novel materials); and separation science. These areas enable AMES to deliver its mission and customer focus, to perform a core role in the DOE laboratory system, and to pursue its vision for scientific excellence and preeminence in the areas of:

- Materials research directed towards energy technologies including alternatives for rare earths, optical, magnetic, intermetallic, and catalytic materials; studies of high temperature materials and materials in extreme conditions; and
- Analytical techniques and instrument development.

Lab-at-a-Glance

Location: Ames, IA

Type: Single-program Laboratory

Contractor: Iowa State University of Science and Technology

Responsible Site Office: Ames Site Office

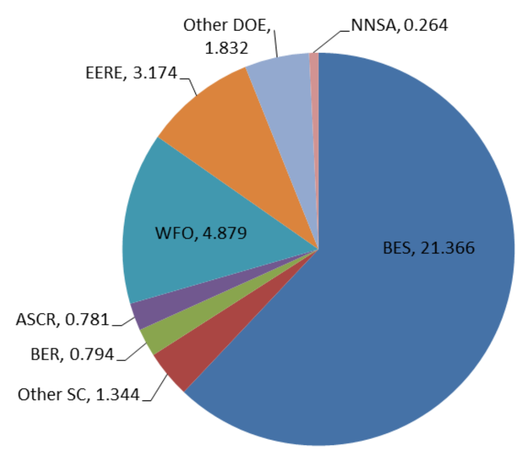
Website: www.ameslab.gov

Physical Assets:
- 8 acres (lease–long term, no cost) and 12 buildings
- 327,664 GSF in buildings
- Replacement Plant Value: $73.1M

- 0 GSF in 0 Excess Facilities
- 0 GSF in Leased Facilities

Human Capital:
- 315 Full Time Equivalent Employees (FTEs)
- 103 Joint faculty (if applicable)
- 53 Postdoctoral Researchers
- 57 Undergraduate Students
- 100 Graduate Students
- 0 Facility Users
- 0 Visiting Scientists

FY 2011 Funding by Source: *(Cost Data in $M):*



FY 2011 Total Lab Operating Costs (excluding Recovery Act*)*: $34.4

FY 2011 Total DOE/NNSA Costs: $29.5.

FY 2011 WFO (Non-DOE/Non-DHS) Costs: $4.9

FY 2011 WFO as % Total Lab Operating Costs: 14.2%

FY 2011 Total DHS Costs: $0.0

Recovery Act Obligated from DOE Sources in FY 2011: $0.0

Current Laboratory Core Capabilities

The Office of Science has identified 3 major core capabilities at the Ames Laboratory:

- Condensed Matter Physics and Materials Science
- Chemical and Molecular Science
- Applied Materials Science and Engineering

Condensed Matter Physics and Materials Science

The theory, design, synthesis, processing and characterization of innovative, energy-relevant materials comprise one of the Ames Laboratory's primary research foci. The Laboratory is recognized worldwide for its leading research on rare earth metals and alloys, photonic band gap materials, metamaterials, magnetic materials, high temperature superconductors, and biomaterials. AMES is also internationally recognized for its ability to grow high quality samples of unusual materials, which it distributes all over the world. To study these materials, the Lab's condensed matter physics and materials sciences teams develop and use cutting-edge techniques, including X-ray and neutron scattering, and solid-state nuclear magnetic resonance (SS NMR). Computational methods such as quantum Monte Carlo simulations, electronic structure calculations, and classical and quantum molecular dynamics simulations are continually being pushed to new limits for 'taming the complexity' of new chemistry and material problems. To advance the capabilities in "materials discovery" pioneering theoretical methods with innovative numerical algorithms are being created for novel materials, especially as a guide to experiment; additional, novel methods are being explored for data-discovery (distinctly different than data-mining) where data (in particular critical correlations) that are important is "discovered" rather than trying to mine information with some preconceived notion of expected correlations.

The continued interest in rare earth materials, including their properties, processing and reclamation, has put the Ames Laboratory in the international spotlight. AMES is the only National Laboratory with the background intellectual property, expertise, know-how and world-class researchers to develop new cost-effective processing techniques, improved properties and new materials to replace the rare earth metals that are becoming difficult to obtain. To create critical new alloys, we are investigating the fundamental origin for properties of rare earths governed especially by *4f electron* element behavior during alloy modifications; society would benefit greatly if we can control valence states of more abundant early lanthanides needed, e.g., for higher Curie temperatures and saturation magnetization in magnets.

Major sources of funding: The Office of Science's Basic Energy Sciences, the Office of Advanced Research Projects Agency-Energy, the Office of Energy Efficiency and Renewable Energy, and Work for Others.

Chemical and Molecular Science

The Ames Laboratory research teams develop and apply theoretical, computational and experimental methods to study biological processes, catalysts, chemical reactivity, energy conversion and surface dynamics. World-leading research is conducted at the interface between homogenous and heterogeneous catalysis enabling the design of new catalysts that combine the best characteristics of both. The Laboratory improves the understanding of molecular processes for energy and security decision-making, and molecular design using new simulation and modeling techniques. These methods are made available throughout the world, including GAMESS used by over 150,000 registered users.

The Ames Laboratory enables new discoveries through the development of new techniques to characterize a broad range of materials at time scales and lengths scales never before possible. The Ames Laboratory is internationally recognized for the advancement of new solid-state nuclear magnetic resonance (SS NMR), optical spectroscopy, mass spectrometry and microscopy. These techniques are used in applications ranging from bioenergy to bioremediation to national security. Fine spatial chemical analysis and optical imaging within plants and solid catalysts are a forte of the Ames Laboratory. Recent discoveries resulted in a revised model of plant cell walls and the first demonstration of enhancing chemical transformations by expelling the byproducts from porous catalytic materials.

Major sources of funding: The Office of Science's Basic Energy Sciences, Biological and Environmental Research, and Work for Others.

Applied Materials Science and Engineering

The Ames Laboratory applies the knowledge derived from fundamental computational, theoretical and experimental research to invent, design and synthesize new materials with specific energy- and environment-relevant functionalities. The Ames Laboratory develops, demonstrates, and deploys materials that accelerate technological advancements in a wide range of fields; from a lead-free solder that is used virtually in all electronics to a nanotube with the potential to deliver drugs or other materials to a specific site within a living cell. The Ames Laboratory is world-renowned for developing materials that improve energy efficiency and conversion, and reduce environmental impact. Our advanced titanium-powder processing capabilities lead the world, with unprecedented control over particle size and voiding, and will have substantial impact on key advanced manufacturing capabilities and reduction of materials waste during the manufacturing cycle (e.g., potential reduction of titanium feedstock-to-part ratio from 11:1 to 1.5:1). Key impacts of the Ames Laboratory's work in applied materials science and engineering include catalysts, ultra-hard materials, low friction materials, special magnetic alloys, high temperature superconductors, powder-processing for rapid and low-loss manufacturing, light-weight high-strength materials and engineering alloys that are responsive to energy and environmental concerns. Many of these are now available to industry.

Renewed interest in rare earths and rare earth replacements has brought several potential industrial partners to the Laboratory. In fact, we have several new projects underway funded by DOE or by US industrial partners. Discussions started last year, to set the direction for AMES continue as the interest in rare earths availability and alternatives remain a national issue. AMES, is working towards solutions in rare earths science to help assure new economically viable rare earth processing techniques, new non-rare earth materials for national defense and improved energy technologies such as traction motors and magnets, and new techniques to recover these metals from waste and scrap. We are working with key industrial partners to assure the availability of these metals or to find acceptable alternatives to critical materials such as neodymium-iron-boron magnets.

AMES Decision Sciences Program encompasses systems engineering that impact, for example, energy, wind and manufacturing development costs. In particular, virtual engineering, simulation and modeling – embodied in AMES' integrated engineering design environment called VE-Suite – links together models, detailed process simulations, data and real-time graphics to permit 3-D, real-time engineering design of complex systems, such as next-generation power plants, efficient cars, and new video games. For John Deere Company, the design time for a new tractor was reduced by a factor of two, with concomitant reduction in development costs. VE-Suite has received two R&D 100 Awards, and is used daily by the US Army.

Major sources of funding: The Office of Energy Efficiency and Renewable Energy, Vehicle Technologies and Advanced Manufacturing, the Office of Advanced Research Projects Agency-Energy, and Work for Others.

The Laboratory's effort within these core capabilities contributes to the DOE mission of "Scientific Discovery and Innovation, and Energy Security." Inherent in all research at the Ames Laboratory is the education and mentoring of future scientists and engineers. This is achieved through the coupling of DOE sponsored educational programs with the various programs and opportunities within the Laboratory's Contractor. Other research areas within the Laboratory contribute to or enhance the functionality of the DOE mission areas. The Laboratory's Work for Others also contributes to maintaining and advancing our core capabilities, and our proposed major initiatives will enable us to contribute to additional missions.

Contributions to Other DOE Mission Areas and Core Capabilities

AMES contributes to the DOE Mission in areas beyond its major core capabilities. Table 1 below maps our funded research to these other DOE Missions and Core Capabilities. Included within the table are other capabilities within the Ames Laboratory but not related to Office of Science Programs such as Energy Efficiency and Renewable Energy (EERE), Advanced Research Projects Agency-Energy (ARPA-E), Fossil Energy (FE), Workforce Development for Teachers and Scientists (WDTS) and Work for Others (WFO). Work for the Department of Homeland Security (DHS), is shown separately.

Table 1. *AMES funded research mapped to DOE Missions*

DOE MISSION AREA	DOE CORE CAPABILITY	FUNDING SOURCES AT THE AMES LABORATORY								
		BES	BER	ASCR	EERE	FE	WDTS	DHS	WFO	LABORATORY STRATEGIC INVESTMENTS
SCIENTIFIC DISCOVERY AND INNOVATION	1	❖	❖	❖						❖
	3			❖						
	6	❖	❖							
	7	❖	❖	❖						❖
	8	❖								❖
	9	❖	❖		❖				❖	
	11		❖							❖
	12				❖					❖
	14	❖	❖							
	15								❖	❖
	32	❖						❖	❖	
	33						❖			❖
	34						❖		❖	❖
	35						❖			❖
ENERGY SECURITY	4				❖					❖
	7					❖				
	8				❖				❖	
	10									❖
	13				❖				❖	❖
	15				❖				❖	❖
HOME-LAND SECUR-ITY	8							❖	❖	

Note: For a description of the numbered mission, the 1st column links to Appendix B. List of DOE/NNSA/DHS Missions.

Science Strategy for the Future/Major Initiatives

The Ames Laboratory's vision is to be our Nation's premier research institute in critical areas of condensed matter science, its related technologies, and the strategic applications of advanced materials. Dramatic energy efficiency improvements require new ways of harvesting and converting energy from one form to another, enabled by new materials with enhanced functionalities. Over the next 10 years AMES will focus its efforts on developing improved energy-conversion techniques, materials for energy efficiency, and new integrated methods to discover and process materials more efficiently with desired functionalities. AMES excels in the areas of materials processing methods, computational and theoretical materials science, rare earths, catalysts, magnetic and photonic materials, and analytical instrumentation development. AMES links basic and applied research across the scientific spectrum to achieve and maintain an impressive record of technology transfer success. We solve challenging problems by engaging multidisciplinary, multi-institutional teams of world-renowned experts.

Our proposed initiatives are designed to transform our Nation's energy future and fill critical technological gaps. These initiatives build upon our core capabilities and components of excellence: people, inspiration, innovation, collaboration, agility, and safety. Our research will continue to help lead the way for the US to reduce energy demand, innovate with new materials, control energetic processes, and use our Nation's biorenewable resources.

Our Science & Technology Cornerstones

The Ames Laboratory has a well-established and persistent set of Science & Technology Cornerstones, based upon which we develop an evolving array of initiatives. We have organized our cornerstone capabilities into four centers:

***C**enter for **R**ational and **I**nnovative **S**ynthesis and **Pr**ocessing (**CRISPr**)* reflects our novel materials synthesis and processing capabilities that impact all energy sciences and engineering. **CRISPr** capabilities and expertise includes:

- Synthesis and processing of rare earths, reactive materials, bio-inspired materials, catalysts and intermetallics
- Metamaterial design and development
- Computational materials discovery and design
- Biosynthesis
- Production of high-purity metals and compounds (including rare earths), often in single crystalline form, and supplying materials for both internal research programs and externally to research institutions worldwide through the *Materials Preparation Center (MPC)*

C**hemical and **A**dvanced **M**aterials **C**haracterization **C**enter* (CĀM-2C***) encompasses numerous advanced characterization capabilities and the design, development, fabrication, and application of new characterization methods (often adopted internationally) *for quantitative structure and property measurement and chemical analysis of materials, including biomaterials*. **CĀM-2C** in tandem with CRISPr has led to many of our notable accomplishments. AMES' strengths in the following directly benefit the DOE energy-sciences portfolio:

- Scattering Sciences: X-ray, electron, and neutrons
- Microscopies: chemical imaging, gene expression imaging, differential interference contrast, field ion,

scanning electron, scanning tunneling, atomic force and ultra-fast stimulated emission depletion microscopies

- Spectroscopies and Elemental Analysis: Auger, Raman, energy-dispersive X-ray spectroscopy, mass spectrometry, x-ray photoelectron microscopy, and solid-state NMR
- Property Measurements: magnetization; susceptibility; transport; thermodynamic quantities (e.g., heat capacities, enthalpies, magnetocalorics, thermopower, DTA, DSC, and TGA) measured across a wide range of temperatures and applied magnetic fields (up to 14 Tesla)

Su*rface- and* ***C****hemical-sciences* ***C****enter for* ***E****nergy* ***S****cience****S*** *(****SuCCESS****)* brings together our collective expertise in surface science, catalysis, and energy biosciences. **SuCCESS** has world-leading expertise in:

- Morphological control of surfaces
- Surface reaction phenomena
- Interfacial catalysts combining the best aspects of homogeneous and heterogeneous catalysts, design and synthesis of reactive intermetallics
- Applications of advanced solid state NMR to study catalytic reactions

SuCCESS in tandem with CĀM-2C also develops new techniques to characterize systems at time and length scales never before possible, e.g. single-cell analysis and tracking. **SuCCESS** draws upon other centers including the synthesis and processing of single crystals, complex alloys, catalysts and biomaterials of CRISPr; characterization and analysis efforts of CĀM-2C; and the computational capabilities for energy-relevant catalysis (iCOMPUTE).

I*ntegrated Center for* ***Co****mputational Chemistry,* ***M****aterials, and* ***P****hysics –* ***U****nifying* ***T****heory and* ***E****xperiment (i****COMPUTE****)* embodies our collective efforts in computational methods, scientific software development and applications (i.e., in materials science, chemistry, and physics) joined with *theory* and *experiment* to characterize and provide robust explanations for fundamental phenomena, and materials discovery and design, including:

- Material properties and surface predictions
- Scientific software and middleware, such as the GAMESS software suite

iCOMPUTE collectively engages and involves the Scalable Computing Laboratory, CRISPr, CĀM-2C, SuCCESS, and our initiatives, such as Materials Discovery. For materials discovery, new theoretical methods and advanced algorithms are being developed, and then implemented within computational frameworks and software tools for direct applications, as well as sharing these capabilities, especially within the DOE complex. AMES has a longstanding reputation in development of novel methods to enhance materials discovery and synergy with experimental materials efforts.

I*nstitute for* ***Mat****erials* ***T****echnology,* ***E****ngineering, Education, and* ***R****esearch (****i-MatTER****)* matches our centers with applied activities in EERE, FE, ARPA-E, technology transfer, and external relations (CRADAs and WFO), and our educational activities in WDTS reflecting important teaming and integrated activities.

I-MatTER integrates:

- The MPC, CRISPr, CĀM-2C, SuCCESS, and iCOMPUTE
- The Midwest Forensic Resource Center (MFRC)
- Technology Transfer
- Our Major Initiatives

This Institute's successes include:

- Proven track record in successfully marketing intellectual property and partnering
- Development of spin-off technologies and start-up companies
- Production of *3-D Virtual Simulation Software* (a Virtual Engineering Suite)
- Training of law enforcement personnel nation-wide in forensic analysis of materials and application of new technology to the infrastructure and management of crime laboratories.

Our Strategic Investments

AMES has a strategic investment pool. The overarching goal of the investment pool is to take new, innovative ideas and concepts that are highly risky scientifically, but have the potential for high payoff, to DOE. This pool is used for the following initiatives:

Seeding research projects. AMES holds internal calls for proposals in areas that align with our Strategic Plan, our major initiatives and DOE's current or anticipated research directions. The themes for each call are established by the CRO. Funded projects are generally small and are scoped to establish "proof of principle" to go forward with further research or a proposal. Renewal of support beyond one year is considered on a case-by-case basis. Seed projects over the last few years have turned into a CRADA, new intellectual property in the area of materials for transmission wires and advances in solid state NMR techniques. Our approach includes a specific effort to develop projects with other National Laboratories through coordinated investments.

Investing in our research future. We maintain a prioritized list of equipment needs used to guide equipment requests to BES. Additional needs and special opportunities to create unique equipment are addressed from our investment pool through consultation with our Division Directors, the CRO, and the Lab Director. Recent investments include support of a graduate student to run analyses on a beta-test NMR instrument provided under an MOU with the manufacturer, an induction generator, and fabrication of a ***ST****imulated* ***E****mission* ***D****epletion* (STED) microscope. A PI funded by this pool researched the benefits of including a quantified technology acceptance factor in alternative energy source implementation and will participate in the EERE workshop on the "Social Aspects of Bioenergy Sustainability".

Attracting potential ISU collaborators. Our relationship with ISU continues to provide us access to new talent for the Lab's programs. We invest strategically, in partnership with ISU, to recruit strong researchers through start-up packages. Current activities focus particularly on hiring researchers who can build upon our strengths in catalysis, and we are developing succession plans for some of our senior researchers.

Proposal development activities. The Director allocates funds for travel to formal and informal meetings to foster interactions that can lead to collaborative proposals. At this time, most of this activity is being focused on the rare earths.

Our strategy is to develop a broader variety of funding sources for our strategic investments. AMES currently utilizes overhead, and royalty income from privately funded technology transfer activities. Starting in FY2013, Laboratory Directed Research and Development (LDRD) will also be used. By utilizing all the tools available for growing new ideas, AMES will continue its long standing strengths in new materials creation and its tradition of innovation.

Infrastructure/Mission Readiness

Executive Summary

AMES strives to be a good steward of DOE facilities by maintaining them in excellent condition with a long term viewpoint in order to maximize our ability to support the mission of the Laboratory. While the facilities have been maintained in good condition, the research buildings are all 50-60 years old and there are limits to the ability to update them to support current research initiatives. AMES has embraced the mission readiness process as a way to identify the mission critical gaps in our facilities and infrastructure.

The basic strategy of this plan for meeting AMES' infrastructure needs is to design projects that address specific gaps identified during the Mission Readiness process. By addressing specific gaps our projects can be smaller and easier to fund. However, this can create a patchwork of facility improvements rather than an integrated facility improvement that meets multiple modernization needs. AMES will continue to pursue a multi-track approach for meeting our infrastructure needs including projects supported by overhead, GPP, SLI and Line-Item. This flexible approach will provide more options and greater flexibility as AMES continues the dialog with key DOE individuals concerning our infrastructure needs. Listed below are the key elements in our strategy and the decision points that will affect the successful execution of the plan:

Sensitive Instrument Facility. A GPP funded facility to provide six instrument bays for high resolution microscopes and other sensitive instruments. Funding is ~40% complete. Decision Point: Determine the timing of receipt of the remaining GPP funds.

Scientific Computing Facility. A GPP funded facility (~10,000 gsf) to provide data center and support space. Decision Point: Determine the Program support for this facility.

Scientific Computing-Optional Approach. A SLI or other line Item project for a larger facility (~40,000 gsf) that will provide a much more comprehensive, long-term, solution to computing infrastructure needs. Decision Point: Up for discussion is to ascertain if there is Program Support for a more comprehensive infrastructure initiative through line item funding.

CREEM. A GPP project to renovate major sections of our existing facilities will support the needs of the CREEM initiative. Decision Point: Determine funding sources in addition to BES.

Existing Facilities. Maximize the mission readiness of existing facilities through the effective use of maintenance and GPP resources. Decision Point: Level of GPP funding and maintenance funding for facilities and infrastructure.

Overview of Site Facilities and Infrastructure

The Ames Laboratory is a Government-owned, contractor-operated facility located on the campus of and operated by Iowa State University (ISU) in Ames, Iowa. There is no federally owned land at the site (See the Ames Laboratory Land Use Plan, http://www.ameslab.gov/plans/land-use-plan). Instead, the Laboratory is situated on approximately 8 acres of state-owned land on the ISU campus under long-term, no cost lease. The lease line can be adjusted to accommodate new Laboratory facilities in the future (see Attachment C). The real property assets include 12 buildings that total 327,664 gross square feet. The three laboratory research buildings represent over 70% of the total area and have an average age of 58 years. The newest research building in the inventory was constructed over 50 years ago. The average age of the entire inventory (prorated by area) is 49 years. The buildings are highly utilized with an Asset Utilization Index (AUI) of 0.978. The buildings have been well maintained over their lifetimes and are currently in good condition as indicated by an Asset Condition Index (ACI) of 0.980. However, the research buildings were designed and built for the research needs and activities of the 1950's. As such, even though they are in good condition, they do not provide the effective and efficient infrastructure needed to support current and future research activities at the cutting edge of materials research. Staffing includes 315 full time staff (FTEs) and approximately 400 associates who access the Ames Laboratory facilities. There are also two other real property assets defined in the Facility Information Management System (FIMS), an electrical switch pit and parking lot.

Being located on the University campus, allows the Laboratory to take full advantage of the infrastructure services provided by ISU, such as steam, chilled water, water and sewage service, compressed air, grounds maintenance, telecommunication systems, and roads without the need for Federal investment to construct, maintain, or recapitalize. The availability of these services allows the Laboratory to focus on maintaining and operating its research and support buildings. The relationship with ISU also enables the Laboratory to use space in University–owned buildings through a space usage agreement without investing in permanent space or long-term leases.

No real estate actions are planned for FY2012 or FY2013, other than a possible modification to the land lease between DOE and ISU to accommodate the Sensitive Instrument Facility.

Table 3. *SC Infrastructure Data Summary*

FY11 Site Infrastructure Data Snapshot
Secretarial Office **SC**
Field Office **Chicago Office**
Site **Ames Lab**
Year **2011**

Total Bldg,Trailer,and OSF RPV($)(Less 3000		$73,144,776.00					
Total OSF 3000 Series RPV($)		$0.00					
Total RPV($)		$73,144,776.00					
Total Deferred Maintenance($)		$1,440,926					
Total Owned Acreage		0					
Total Leased Acreage		8					
Site-Wide ACI(B, S, T)		0.980					
			#Building Assets	**#Trailer Assets**	**#OSF Assets**	**GSF (Bldg)**	**GSF (Trailer)**
Asset Condition Index (B, S, T) [1]	**Mission Critical**	0.981	4	0	1	280,825	0
	Mission Dependent	0.972	8	0	1	46,839	0
	Not Mission Dependent	0	0	0	0	0	0
			#Building Assets	**#Trailer Assets**		**GSF (Bldg)**	**GSF (Trailer)**
Asset Utilization Index (B,T) [2,3]	**Office**	96	1	0		46,991	0
	Warehouse	100	5	0		25,798	0
	Laboratory	97.78	3	0		233,834	0
	Hospital	0	0	0		0	0
	Housing	0	0	0		0	0

Facilities and Infrastructure to Support Laboratory Missions

The Ames Laboratory is dedicated to providing facilities and infrastructure that will effectively support its mission now and into the future. AMES also strives to be an effective steward of the DOE assets entrusted to it by managing them with a long-term view which is quality driven, looks at the life cycle of the assets, utilizes best industry practice, and is commensurate with the value and mission impact of the asset. This management links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. Resources are directed to facilities and infrastructure in the context of the overall needs and operation of the Laboratory to carry out its mission.

The Mission Readiness tables (Attachment B) provide a summary of the condition of the facilities from a mission readiness point of view, now and into the future. These tables list the core capabilities and the investments required to make the facilities and infrastructure fully capable to meet the mission needs within the 10-year planning window. In accordance with the definitions from the Mission Readiness Model, Support Facilities and Infrastructure are all rated as capable. The completion of the Spedding Hall auditorium remodeling improved the Conference and Collaboration Space category from Partial to Capable. The Technical Facilities and Infrastructure i.e. the research buildings are currently considered "Partial." This means that deficiencies require minor resources (work-arounds) to ensure achievement of mission; investments to return to mission ready, if capital, are within the GPP limit. The facility capital improvements needed to achieve mission readiness are possible within the GPP limit of $10M per project. However, the historic level of annual GPP funding ($610K) is not sufficient to undertake those projects so that special GPP allocations are required.

This plan identifies three significant GPP projects that will require dedicated GPP allocation. These projects are targeted to meet specific mission-critical needs identified through the mission readiness process. These three projects are the Sensitive Instrument Facility, the Scientific Computing Facility, and Renovations for the Center for Rare Earth and Energy Critical Materials. These projects are described in greater detail in the next section. The strategy of utilizing GPP funded projects to address specific mission needs can be effective at the Ames Laboratory, particularly for very focused needs. However, the Laboratory must not be limited to this strategy because it will result in infrastructure solutions that do not fully address the needs and are not the most effective use of resources.

More general capital improvement projects are also incorporated into the Mission Readiness tables in Appendix B. These projects address more general needs in utility systems, security infrastructure (access control), safety, energy conservation and facility modernization. The general GPP program is described in greater detail in the next section also.

A peer review of the Mission Readiness Process was performed in July 2011 by a team representing SC Laboratories and industry. The Peer Review Objectives and Lines of Inquiry provided a thorough assessment of the planning process and its integration with the mission of the Lab. The review team presented a very favorable assessment of the Ames Laboratory Mission Readiness process. The executive summary stated, “The Ames Laboratory demonstrated a clear commitment to the Mission Readiness tenets; the processes and work products offered as part of this review demonstrated implementation. The dedication of the Ames Laboratory staff was evident from both the scientific and the support organizations of the Laboratory. It is apparent that all involved fully understand the importance of facilities and infrastructure to support the core missions.”

Strategic Site Investments

The Ames Laboratory embraced the Office of Science SLI Infrastructure Modernization Initiative that has the goal of the SC laboratories operating thoroughly modernized complexes by the end of the ten-year period (FY2010-FY2020). The Modernized facilities will encompass the following characteristics:

- Safe, Secure, and Environmentally Sound Infrastructure
- A Highly Productive Working Environment
- Efficient Operations and Maintenance

As part of this effort, the Ames Laboratory developed a modernization strategy. The primary component of the original plan was to replace the Metals Development Building with a new state of the art, LEED compliant building that would address the critical needs of the Laboratory. Based on input from prior year's Lab Planning Meetings, the Laboratory proposed ways to meet our highest priority needs with smaller projects. The 2011 Laboratory Plan proposed GPP-scale projects to address what the Laboratory sees as its highest priority needs for consideration by DOE's Office of Science. The following plan continues with that approach. The plan also presents an option for utilizing a modest SLI project or other line-item funding to leverage the investment required for the core scientific computing facility to provide additional support and scientific facilities. We request feedback on the relative merits of these requests.

Sensitive Instrument Facility

The Sensitive Instrument Facility was proposed as a stand-alone GPP project in the 2011 Plan. This Facility will provide specialized space for current and anticipated state-of-the-art instrumentation such as high resolution transmission electron microscopes and scanning probe microscopes. Current space within the Ames Laboratory is marginally adequate for instruments presently in use and is unacceptable for today's state-of-the-art instruments. The project will address this critical gap as identified in our mission readiness process.

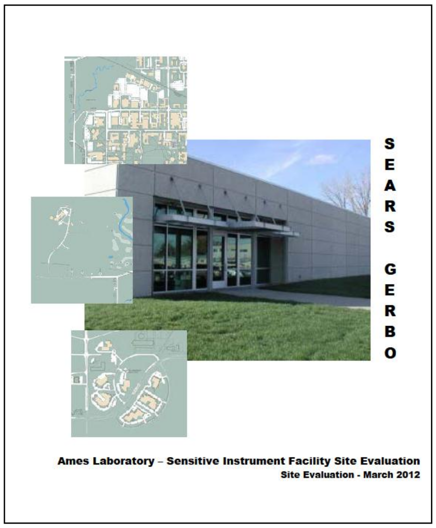


Figure 1. *SIF Site Evaluation Report Cover.*

This project will build a facility with six instrument bays, sample prep lab, control rooms, and staff support space. The electron microscope bays will provide vibration isolation, acoustic separation and control, EMI control, strict control of air flow and strict ambient temperature and humidity control. The facility design has been organized to optimize the site and program elements. In a compact, space efficient envelope, the building is planned to be approximately 11,000 gross square feet and will provide 7,000 net square feet of usable space (i.e., 64% is usable space). Total cost is estimated at $9.3M.

Progress to date:

- Initial GPP funds of $4M have been received to begin the project.
- A Site Evaluation has been performed by a consulting firm assessing five potential sites with respect to architectural considerations, vibration and electromagnetic interference.
- Procurement of the Architect/Engineer services for the design of the facility is currently in progress. Design will start as soon as the procurement process is completed.
- The project management plan describes how the project will be managed so that construction contract documents will be structured and executed to stay within available funding and that the overall project will stay under the $10M GPP project limit.

Scientific Computing Facility

This project will build a dedicated scientific computing facility that will provide for the current and future computing facility needs of the Laboratory. We propose to build a dedicated stand-alone facility to house AMES' computers, to address our expanding computer needs, reduce energy consumption, improve heat management, consolidate cluster management, and free up usable lab space not designed for housing computers. The current computational facilities, developed due to critical need without having critical infrastructure, are filled to capacity and scattered throughout our facilities in space originally designed for bench science and lack the full complement of features that are part of modern computing centers, such as raised floors, redundant systems, or energy efficient components. Expansion requires remodeling additional bays to house new machines; including additional requirements for HVAC and electricity.

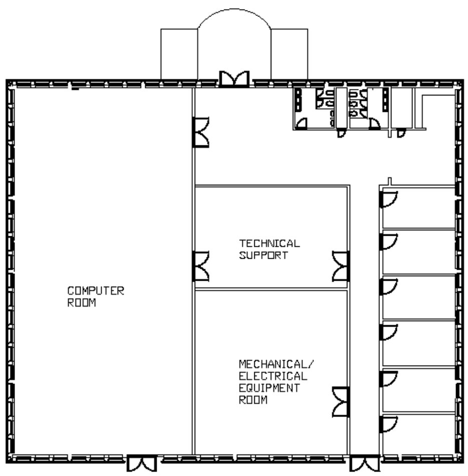


Figure 2. *Draft Floor Plan for the SCF.*

The new facility would be designed to utilize the latest techniques for energy efficiency that are not possible when modifying existing space. The facility would be approximately 10,000 gross square feet and provide approximately 5,000 square feet for computers and 2,000 square feet of ancillary space including offices for the cluster support staff. The estimated cost is $9.9M. AMES proposes that GPP funds be used for the facility.

Expanded Scientific Computing Facility—Line Item Project

As an alternative to the GPP-funded Scientific Computing Facility, a line item investment in a computing facility could provide a much greater benefit to the facilities and infrastructure capabilities of the Laboratory for a modest increase in funding. The data center would include additional support space, office space, and instrument space and will offer the advantage of co-locating the Laboratory's Information Systems department and their network servers and peripheral systems with the scientific computers and computational staff. It would not require the utility distribution or fume hood systems required by chemistry laboratories. The additional space could house both support personnel and research personnel who utilize the data center. A line item project of $20M -$22M could fund a multistory building of approximately 40,000 gsf.

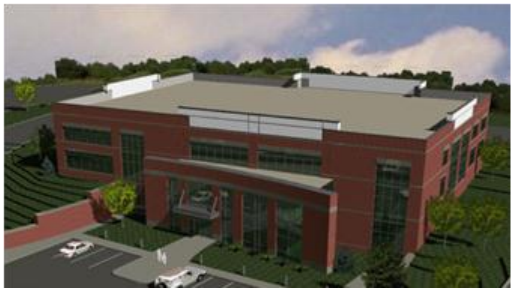


Figure 3. *Artist rendering of a potential expanded SCF.*

There are several advantages of this proposal. The larger footprint would provide an opportunity to program space into the facility for future expansion of the data center. Space could be identified that could be refitted with the network, electrical service, cooling and security needed for additional computer installations when the need arises.

Housing support for staff and research personnel in the facility would have multiple benefits. It would allow the Laboratory to reduce the amount of ISU space that is used under the space utilization agreement. It would vacate laboratory space that has the full utility distribution and fume hood systems needed for experimental research. It would reduce overcrowding in the Information Systems area of TASF and provide space for expanding administrative functions. Co-locating Information Systems personnel and the research personnel in the facility will facilitate coordination of data processing resources and management. The additional space will also provide us with greater flexibility for temporary surge space to facilitate modernizing, remodeling and restructuring existing laboratory space.

The existing core capabilities and the science strategy for the future initiatives continue to demand greater and greater computational resources. The Expanded Scientific Computing Facility would provide facility and infrastructure to support the computational needs of new initiatives as well as housing personnel who work directly with the computational resources. In particular, the project would have direct impact on Materials Discovery and Design, CRISPr and iCOMPUTE.

Incorporating the data center in a larger facility will have energy conservation/sustainability benefits. The design target would be LEED Gold. The larger facility will have greater opportunity for utilizing waste heat from the data center. A multistory facility provides a more energy efficient building shell.

As ISU continues to develop the campus, there is greater and greater pressure on suitable building sites for the growth of the Laboratory. The larger, multistory building meets the ISU standards for higher density construction that would allow it to be sited adjacent to existing AMES research and administration facilities.

The GPP funded Scientific Computing Facility will address an immediate need but it will not do a good job of addressing ongoing computing infrastructure needs. A line item project to provide an Expanded Scientific Computing Facility would provide infrastructure solutions that will provide long term benefits for computing infrastructure needs. AMES proposes that a SLI or other line item funding for this option is the preferred solution and we welcome input on the merits of this option.

Center for Rare Earth and Energy Critical Materials

As discussed in the Major New Initiatives section, an on-going initiative is being proposed for a Center for Rare Earth and Energy Critical Materials (CREEM). The Center will require office space for administrative and scientific staff, general laboratory space and some high bay space. Significant space consolidation, reassignment and remodeling will be required to accommodate those needs within the existing footprint. Space in this Center will be a combination of assigned space, space vacated as a result of the proposed new facilities and from consolidation of existing space enabled by adoption of modern technologies. Existing space will have to be remodeled to accept these people, their equipment and research operations. The vacated space will then need to be prepared for the new center. As part of the mission readiness process, it became clear that there is a need for a more strategic way to deal with existing space. As is currently the case, a program may have space in several different buildings. The creation of a dedicated CREEM provides an opportunity to enable programs to consolidate their operations into a more efficient footprint and to consolidate space for the new center. Providing a consolidated area for the new center will require that people be relocated out of targeted space. The facility renovation cost for the new center is estimated to be $6.5M.

Progress to Date:

- Initiatives are already under way to identify and remove unused equipment to free up space in existing labs. Removing under-utilized equipment will allow the metal fabrication functions of both the Materials Preparation Center and the Engineering Services Group to be consolidated into one area.
- Further define the facility needs of the CREEM initiative.

A summary of these projects with their estimated cost and proposed square feet is below.

	Est. Cost ($M)	Est. Gross Sq. Ft.	Est. Net Sq. Ft.
Sensitive Instrument Facility	$9.3	11,000	7,000
Scientific Computing Facility			
GPP Project (minimal solution)	$9.9	10,000	7,000
or,			
Line Item Project	$20.0-$22.0	40,000	26,000
CREEM (space remodel)	$6.5	NA	29,000

Figure 4. *Summary of Proposed Facilities (Estimated Costs and Sq. Ft.).*

Manufacturing Demonstration Facility

The Manufacturing Demonstration Facility (MDF) is an opportunity that will enable new and improved energy-sector technologies to be developed for commercial application. It will provide a dedicated facility, equipped with state-of-the art equipment and staffed with scientists and engineers in order to help change the US manufacturing "landscape." A conceptual design approach has been developed by research personnel and facility personnel that make use of an existing facility. The existing facility will be modified to provide the required utilities and mechanical/electrical systems and a small addition to the facility will provide a needed high bay capability. An initial budget estimate to provide the facilities needed for the initiative have been developed and will be incorporated into the overall budget of the proposal.

Energy Savings Performance Contract

AMES was unable to utilize funding for energy savings projects through an Energy Savings Performance Contract (ESPC) due to beryllium contamination discovered in Spedding Hall and Wilhelm Hall. The ESPC partner had identified projects that would generate savings of 15% in energy consumption and 16% of water consumption. The project included stack lining, lighting upgrades and low-flow water fixtures. Though the ESPC was discontinued, AMES is using overhead and GPP funds to complete the conservation projects.

Current GPP Program

Historically, our GPP funding level has been relatively constant in the range of $0.5 to $0.61M per year, which is less than 1% of our replacement plant value. FY2012 GPP was initially funded at $610K but was cut back to $200K during the second quarter of the year. ARRA funding of $1.7M was received in FY2009 for Phase 1 of an improvement project that was completed in FY2010. The limited GPP funding often necessitates doing projects in phases over several years. This is further complicated when funds are cut back during the year. A heating, ventilating, & air conditioning (HVAC) upgrade project in Spedding Hall is currently in progress with existing GPP funding. This project will upgrade the existing systems of heating, ventilating and air conditioning (HVAC) and makeup air controls in Spedding Hall to improve the safety, reliability, energy efficiency and flexibility of the systems. The existing system has been in service for nearly 50 years and cannot provide the level of control, air balance, reliability and safety monitoring that is beneficial for laboratory activities. The total cost of the project is approximately $3.2M which is well under the statutory limit for GPP projects. But because the size of the project is much greater than the annual GPP funding level, it had to be defined in phases over several years using GPP funds into FY2013. Once the HVAC upgrade project is completed, GPP funding will be directed to other projects as defined by our planning process. Projects will include Energy Conservation Projects; Access Control; Upgrade Windows; Upgrade Electrical Distribution System in Spedding Hall; and Upgrade of Handicapped Access. Additional GPP projects for capital improvement projects in Metals Development Building will need to be incorporated into GPP plans. The space modernization project will systematically take out-of-date research space out of service and completely refurbish it to modern standards. This will provide the resources to restructure and reorganize space utilization to improve the work environment for research operations. Unused and underutilized space will be reclaimed and modernized. This will allow research programs to be housed for more efficient operations. It will also create the space needed to house new planned initiatives. The complete list of the GPP funding plan will be included in the Integrated Facilities and Infrastructure (IFI) Budget Crosscut.

Maintenance

The maintenance program consists of maintenance and repair activities necessary to keep the existing inventory of facilities in good working order and extend their service lives. It includes regularly scheduled maintenance, corrective repairs, and periodic replacement of components over the service life of the facility as well as the facility management, engineering, documentation, and oversight required to carry out these functions. Historically, the facilities have been well maintained so that the service lives of the buildings have been extended. The historical data shows that the Laboratory has been able to control and slightly reduce deferred maintenance levels with modest levels of indirect funded maintenance, allowing AMES to operate with a 1.8% target Maintenance Investment Index. Historical experience shows that the current levels of expenditures have been adequate to maintain the facilities. Therefore, future maintenance funding levels are projected by escalating the base maintenance budget to continue this level of effort

Excess Facilities

There are currently no excess facilities at the Ames Laboratory and none are planned.

Trends and Metrics

Performance measures are utilized to link facility and infrastructure performance to outputs and outcomes. Broad-based measures are used so that a small sample of key results can provide a high level, integrated grasp of the stewardship of DOE assets at the Ames Laboratory. The DOE corporate wide measures defined in the Real Property Asset Management Order are the Asset Condition Index and the Asset Utilization Index. These values are reported directly in the DOE Facility Information Management System (FIMS) as well as being incorporated in the Laboratory Performance Evaluation and Measurement Plan (PEMP). AMES continues to perform well in the measures with high values for Asset Utilization and Asset Condition that continue to improve, though it's important to note that even when old buildings are maintained in good condition, it does not guarantee that they can provide infrastructure that meets the mission needs of cutting-edge research. This observation certainly is reflected in an ACI of 0.980 but mission readiness ratings of "Partial" for Core Capabilities. In the 2011 EOY PEMP, Section 7, there was a single notable outcome that applied to both of the Objectives in the section. The performance regarding the notable outcome and the objectives exceeded expectations resulting in an overall grade of A-.

The Ames Laboratory continues to improve and document our Mission Readiness process. A peer review was performed in July 2011. The Peer Review Objectives and Lines of Inquiry provided a thorough assessment of the planning process and its integration with the mission of the Lab. The review team presented a very favorable assessment and found that the Lab was meeting the four Objectives of the Mission Readiness process. This year's mission readiness interviews with Laboratory Management, Program Directors, key researchers and Functional Managers were led by the Assistant Director for Scientific Planning, the Chief Operations Officer and the Facilities Services Manager. The input and insight obtained from these interviews was incorporated into the Laboratory infrastructure plans. The process helps

Laboratory management and facilities personnel to have an excellent understanding of the facility condition and needs.

Table 4. *Facilities and Infrastructure Investments (BA in $M) –Impact to Asset Condition Index*

	2011 Actual	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Maintenance ($M)	1.2	1.3	1.3	1.3	1.5	1.7	1.7	1.8	1.8	1.9	1.9	2.0
Deferred Maintenance Reduction[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Excess Facility Disposition	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IGPP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GPP	2.1	2.7	12.5	10.4	2.7	1.6	1.2	1.1	1.1	1.1	1.1	1.1
Line Items	0	0	0	0	0	0	0	0	0	0	0	0
Total Investment	3.3	4.0	13.8	11.7	4.2	3.3	2.9	2.9	2.9	3.0	3.0	3.1
Estimated RPV		76.8	78.2	88.9	100.4	102.2	104.0	105.9	107.8	109.7	111.7	113.7
Estimated DM		1.44	1.45	1.30	1.31	1.32	1.34	1.35	1.36	1.37	1.38	1.40
Site-Wide ACI		0.981	0.981	0.985	0.987	0.987	0.987	0.987	0.987	0.987	0.988	0.988

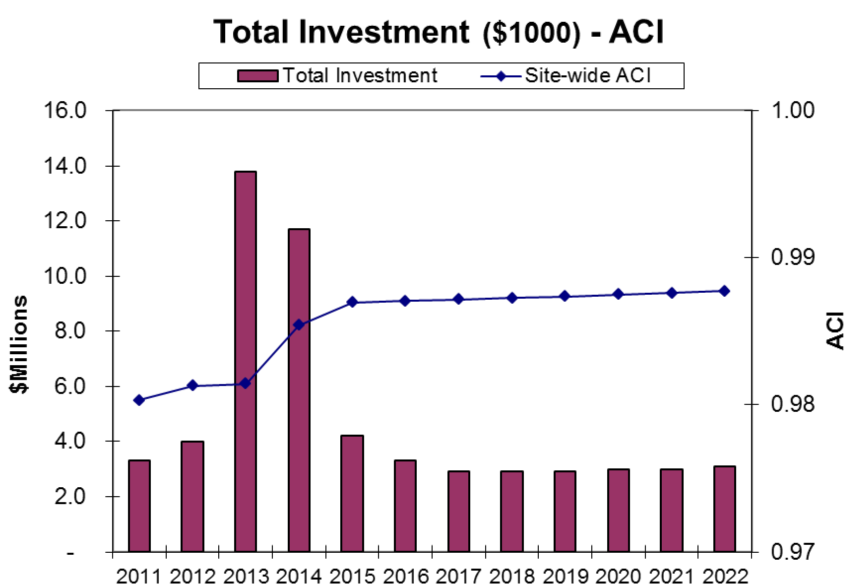
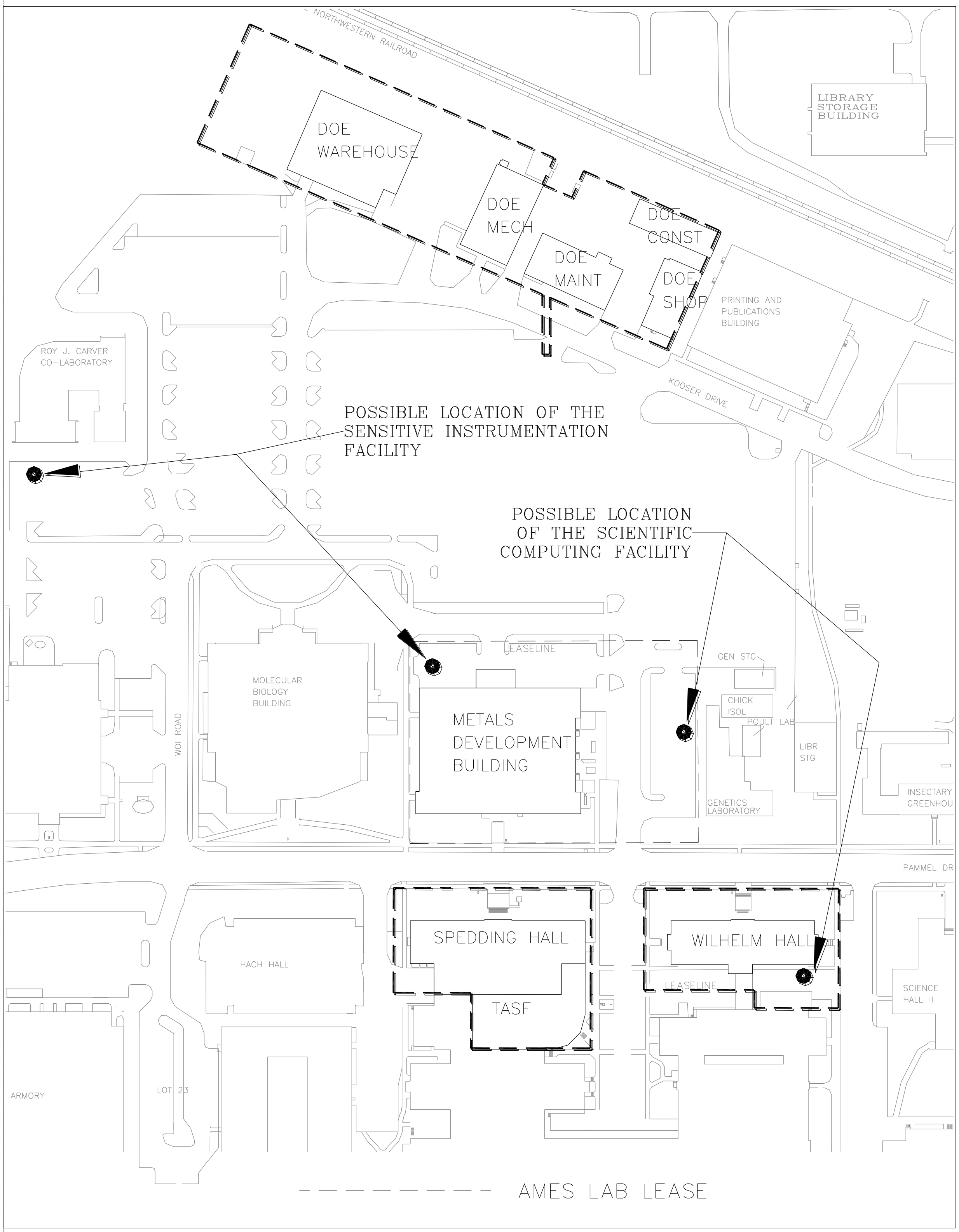


Figure 5*. Facilities and Infrastructure Investments.*

Appendix A. The Ames Laboratory Site Map



NOTE: Two off-site locations are also under consideration.

Appendix A. The Ames Laboratory Site Map

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Scientific Discovery and Innovation (SC)

ASCR

1. To develop mathematical descriptions, models, methods, and algorithms to accurately describe and understand the behavior of complex systems involving processes that span vastly different time and/or length scales.

2. To develop the underlying understanding and software to make effective use of computers at extreme scales.

3. To transform extreme scale data from experiments and simulations into scientific insight.

4. To advance key areas of computational science and discovery that further advance the missions of the Office of Science through mutually beneficial partnerships.

5. To deliver the forefront computational and networking capabilities to extend the frontiers of science.

6. To develop networking and collaboration tools and facilities that enable scientists worldwide to work together.

BES

7. Discover and design new materials and molecular assemblies with novel structures, functions, and properties, and to create a new paradigm for the deterministic design of materials through achievement of atom-by-atom and molecule-by-molecule control

8. Conceptualize, calculate, and predict processes underlying physical and chemical transformations, tackling challenging real-world systems – for example, materials with many atomic constituents, with complex architectures, or that contain defects; systems that exhibit correlated emergent behavior; systems that are far from equilibrium; and chemistry in complex heterogeneous environments such as those occurring in combustion or the subsurface

9. Probe, understand, and control the interactions of phonons, photons, electrons, and ions with matter to direct and control energy flow in materials and chemical systems

10. Conceive, plan, design, construct, and operate scientific user facilities to probe the most fundamental electronic and atomic properties of materials at extreme limits of time, space, and energy resolution through x-ray, neutron, and electron beam scattering and through coherent x-ray scattering. Properties of anticipated new x-ray sources include the ability to reach to the frontier of ultrafast timescales of electron motion around an atom, the spatial scale of the atomic bond, and the energy scale of the bond that holds electrons in correlated motion with near neighbors

11. Foster integration of the basic research conducted in the program with research in NNSA and the DOE technology programs, the latter particularly in areas addressed by Basic Research Needs workshops supported by BES in the areas of the hydrogen economy, solar energy utilization, superconductivity, solid-state lighting, advanced nuclear energy systems, combustion of 21st century transportation fuels, electrical-energy storage, geosciences as it relates to the storage of energy wastes (the long-term storage of both nuclear waste and carbon dioxide), materials under extreme environments, and catalysis for energy applications.

BER

12. Obtain new molecular-level insight into the functioning and regulation of plants, microbes, and biological communities to provide the science base for cost-effective production of next generation biofuels as a major secure national energy resource
13. Understand the relationships between climate change and Earth's ecosystems, develop and assess options for carbon sequestration, and provide science to underpin a fully predictive understanding of the complex Earth system and the potential impacts of climate change on ecosystems
14. Understand the molecular behavior of contaminants in subsurface environments, enabling prediction of their fate and transport in support of long term environmental stewardship and development of new, science-based remediation strategies Understanding the role that biogeochemical processes play in controlling the cycling and mobility of

materials in the subsurface and across key surface-subsurface interfaces in the environment enabling the prediction of their fate and transport.

15. Make fundamental discoveries at the interface of biology and physics by developing and using new, enabling technologies and resources for DOE's needs in climate, bioenergy, and subsurface science
16. Operate scientific user facilities that provide high-throughput genomic sequencing and analysis; provide experimental and computational resources for the environmental molecular sciences; and resolve critical uncertainties about the role of clouds and aerosols in the prediction of climatic process

FES

17. Advance the fundamental science of magnetically confined plasmas to develop the predictive capability needed for a sustainable fusion energy source
18. Support the development of the scientific understanding required to design and deploy the materials needed to support a burning plasma environment
19. Pursue scientific opportunities and grand challenges in high energy density plasma science to explore the feasibility of the inertial confinement approach as a fusion energy source, to better understand our universe, and to enhance national security and economic competitiveness
20. Increase the fundamental understanding of basic plasma science, including both burning plasma and low temperature plasma science and engineering, to enhance economic competitiveness, and to create opportunities for a broader range of science-based applications

HEP

21. Understand the properties and interactions of the elementary particles and fundamental forces of nature from studies at the highest energies available with particle accelerators
22. Understand the fundamental symmetries that govern the interactions of elementary particles from studies of rare or very subtle processes, requiring high intensity particle beams, and/or high precision, ultra-sensitive detectors.
23. Obtain new insight and new information about elementary particles and fundamental forces from observations of naturally occurring processes -- those which do not require particle accelerators
24. Conceive, plan, design, construct, and operate forefront scientific user facilities to advance the mission of the program and deliver significant results.
25. Steward a national accelerator science program with a strategy that is drawn from an inclusive perspective of the field; involves stakeholders in industry, medicine and other branches of science; aims to maintain core competencies and a trained workforce in this field; and meets the science needs of the SC community
26. Foster integration of the research with the work of other organizations in DOE, in other agencies and in other nations to optimize the use of the resources available in achieving scientific goals

NP

27. To search for yet undiscovered forms of nuclear matter and to understand the existence and properties of nuclear matter under extreme conditions, including that which existed at the beginning of the universe
28. Understand how protons and neutrons combine to form atomic nuclei and how these nuclei have emerged during the 13.7 billion years since the origin of the cosmos.
29. Understand the fundamental properties of the neutron and the neutrino, and how these illuminate the matter-antimatter asymmetry of the universe and physics beyond the Standard Model.

30. Conceive, plan, design, construct, and operate forefront national scientific user facilities for scientific and technical advances which advance the understanding of nuclear matter and result in new competencies and innovation. To develop new detector and accelerator technologies that will advance NP mission priorities
31. Provide stewardship of isotope production and technologies to advance important applications, research and tools for the nation.
32. Foster integration of the research with the work of other organizations in DOE, such as in next generation nuclear reactors and nuclear forensics, and in other agencies and nations to optimize the use of the resources available in achieving scientific goals.

WDTS

33. Increase the pipeline of talent pursuing research important to the Office of Science

34. Leveraging the unique opportunities at DOE national laboratories to provide mentored research experiences to undergraduate students and faculty)
35. Increase participation of under-represented students and faculty in STEM programs
36. Improve methods of evaluation of effectiveness of programs and impact on STEM workforce

Energy Security (ES)

1. Supply - Solar
2. Supply - Nuclear
3. Supply - Hydro
4. Supply - Wind
5. Supply - Geothermal
6. Supply - Natural gas
7. Supply - Coal
8. Supply - Bioenergy/Biofuels
9. Supply - Carbon capture and storage
10. Distribution - Electric Grid
11. Distribution - Hydrogen and Gas Infrastructure
12. Distribution - Liquid Fuels
13. Use - Industrial Technologies (including efficiency and conservation)
14. Use - Advanced Building Systems (including efficiency and conservation)
15. Use - Vehicle Technologies (including efficiency and conservation)
16. Energy Systems Assessment/Optimization

Environmental Management (EM)

1. Facility D&D
2. Groundwater and Soil Remediation
3. Waste Processing

National Security (NNSA)

1. Stockpile Stewardship and Nuclear Weapons Infrastructure
2. Nonproliferation
3. Nuclear Propulsion

Homeland Security (HS)

1. Border Security
2. Cargo Security
3. Chemical/Biological Defense
4. Cyber Security
5. Transportation Security
6. Counter-IED
7. Incident Management
8. Information Sharing
9. Infrastructure Protection
10. Interoperability
11. Maritime Security
12. Human Factors