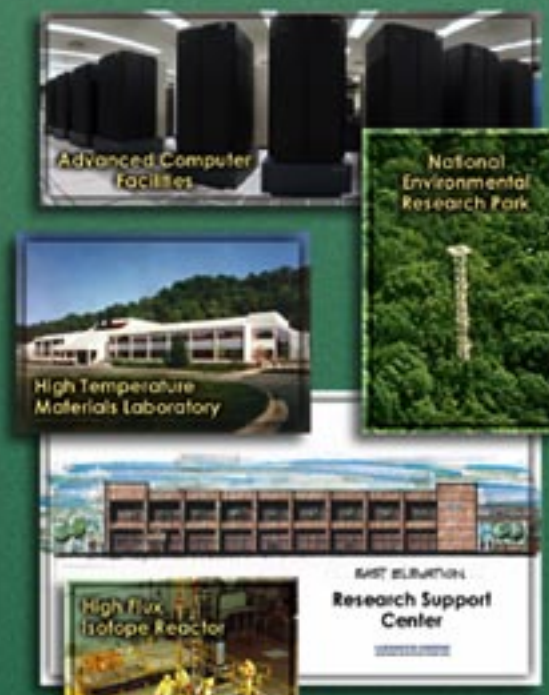
ORNL/TM-2000/238

Oak Ridge National Laboratory

Strategic Facilities Plan

for Making ORNL a 21st Century Laboratory



UT-BATTELLE

October 2000

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OAK RIDGE NATIONAL LABORATORY

STRATEGIC FACILITIES PLAN

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An electronic version of the
ORNL Strategic Facilities Plan
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ACRONYMS AND ABBREVIATIONS

ADS	activity data sheet
AMCL	Advanced Materials Characterization Laboratory
AMSE	American Museum of Science and Energy (Oak Ridge)
BES	Basic Energy Sciences
CBS	Center for Biological Sciences
CIND	Computing, Information, and Networking Division
CMSD	Computer Science and Mathematics Division
CPED	Computational Physics and Engineering Division
CROET	Community Reuse Organization of East Tennessee
CSiTE	Carbon Sequestration in Terrestrial Ecosystems
CSMB	Center for Structural Molecular Biology
CTD	Chemical Technology Division
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
E^2SF	Energy and Environmental Systems of the Future
EM	Environmental Management
ES&H	environmental, safety, and health
ESH&Q	environmental, safety, health, and quality
ETD	Engineering Technology Division
FDDI	Fiber Distributed Data Interface
FED	Fusion Energy Division
FIMS	Facility Information Management System
FRP	Facilities Revitalization Project
GJC	Grand Junction Colorado
GPP	general plant project
HFIR	High Flux Isotope Reactor
HTML	High Temperature Materials Laboratory
HVAC	heating, ventilating, and air-conditioning
JIBS	Joint Institute for Biological Sciences
JICS	Joint Institute for Computational Sciences
JINS	Joint Institute for Neutron Sciences
LCFG	Laboratory for Comparative and Functional Genomics
LDRD	Laboratory Directed Research and Development
LI	line item
LSD	Life Sciences Division
M&C	Metals and Ceramics
M&O	management and operating
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NTRC	National Transportation Research Center
O&M	operation and maintenance
ORCAS	Oak Ridge Center for Advanced Studies
ORELA	Oak Ridge Electron Linear Accelerator
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations Office (DOE)
ORR	Oak Ridge Reservation

P&E	Plant and Equipment
PD	Physics Division
R&D	research and development
REDC	Radiochemical Engineering Development Center
RPM	Risk-Based Priority Model
RPV	replacement property value
S&M	surveillance and maintenance
SAMS	Space Allocation Management System
SC	Office of Science
SNS	Spallation Neutron Source
SSD	Solid State Division
STP	Sewage Treatment Plant
UT	University of Tennessee

EXECUTIVE SUMMARY

Oak Ridge National Laboratory (ORNL) is the nation's largest and most diverse energy research and development (R&D) institution in the U.S. Department of Energy (DOE) laboratory complex. To accomplish its mission of scientific research, ORNL staff are dependent upon the availability of a wide variety of buildings and equipment, including specialized experimental laboratories, user facilities, hot cells and nuclear reactors, and a large complement of office space and associated utility systems. ORNL's physical facilities are, however, quite old, and many have reached the end of their safe operating life. The poor condition of facilities is a key environmental, safety and health (ES&H) concern and adds considerably to the overhead costs of research in terms of energy consumption, increased maintenance costs, and research inefficiencies. Revitalization of the ORNL campus is a key initiative of the new ORNL prime contractor, UT-Battelle LLC, and this *ORNL Strategic Facilities Plan* describes the details of UT-Battelle's approach to upgrading the scientific resources and supporting infrastructure of the Laboratory. The facilities upgrade needs at ORNL are not unique, however, within the DOE Office of Science (DOE-SC) multiprogram laboratory system. DOE-SC's goal is to accomplish full modernization of its laboratories by 2012, as part of its "Laboratories of the 21st Century" initiative. This ORNL plan meets the planning objectives put forth by the Office of Science for that initiative.

As detailed in the following sections, ORNL has developed a Master Plan for site development that (1) responds to the expected programmatic mission activities during the planning period; (2) establishes a safe, high-quality, energy-efficient working environment for research and support staff in a research-campus setting; and (3) addresses the long-term maintenance and ultimate disposition of retired facilities in an environmentally acceptable manner. As shown in Fig. 1, this plan results in consolidation of ORNL space from the current occupied levels of over 4.5 million square feet, to slightly over 3.2 million square feet (including almost 1 million square feet of newly constructed space) with the consolidated staff residing almost exclusively at ORNL's primary location at the main ORNL site. This consolidation would occur over a 5- to 7-year period, involving the movement of approximately 400 staff from off-site locations (Y-12 Plant and commercial leased space) and would result in the need for safe shutdown and demolition of 118 buildings. The Master Plan outlines a phased approach to the facilities revitalization effort, with the primary emphasis in the first 5 years being establishment of the East Campus infrastructure, construction and refurbishment of critical mission-oriented research facilities, and consolidation of research staff from the Y-12 Plant. The second phase of the facilities upgrade program would be completion of the East Campus core construction, consolidation of off-site staff to the main ORNL site, and primary development of the ORNL West Campus for environmental and life sciences research. A plan view of the resulting 21st Century Laboratory at ORNL is provided in Fig. 2, with construction phasing noted by color.

Accomplishing the facilities revitalization effort in the time frame proposed will require resources beyond those normally provided by DOE capital construction programs. Therefore, as part of the innovative UT-Battelle approach presented in this Strategic Plan, both private-sector and State of Tennessee funds have been incorporated into an integrated construction plan along with available DOE Line Item (LI) and General Plant Project (GPP) funds. A preliminary schedule outlining this integrated approach to facilities revitalization during the FY 2001 11 time frame is provided in Fig. 3. In addition to these capital construction needs, funds will also be required to support retired facilities shutdown, continued maintenance, and ultimate disposition either through DOE-SC or DOE Office of Environmental Management (DOE-EM) supported decommissioning programs. The total estimated cost of facilities consolidation, construction, and demolition for the FY 2001 11 planning period is summarized by funding type and site development phase in Table 1. The preliminary estimate of slightly more than $1,200 million represents a significant investment by the Office of Science organization but accomplishes the goal of modernizing ORNL into one of DOE's premier 21st Century Laboratories in a time frame consistent with the programmatic needs of the research community. Of that total, DOE construction represents approximately 45% of the investment, continued existing/new facilities operations 25%, facility consolidation/S&M 10%, and facilities D&D 10%. The State of Tennessee and private-sector facilities cost contributions come to just over 10% of the total. The revitalization resource needs are spread almost evenly between Phase I and Phase II of the project, with only the D&D portion of the project to be expended beyond the modernization 10-year planning horizon.

To place the total cost figure in perspective, however, it should be noted that a "business as usual" approach to continued operations and upgrade of existing facilities, plus the sunk cost of ultimate D&D of nonstrategic facilities totals almost $700 million during the same planning period. And if one considers that current maintenance levels [0.5% of replacement property value (RPV)] are significantly below industry standards (2.5% of RPV), bringing maintenance costs to needed levels would result in an additional $200 million cost during the 10-year period (see Fig. 1). **Hence, the "business as usual" case would result in almost the same level of investment as the SC modernization approach—with one huge difference. The modernization initiative provides world-class facilities for ORNL scientists on a schedule that is compatible with SC mission needs.**

Table 1. Preliminary cost estimate for ORNL site development ($ in millions)

Funding source	Phase I (FY 2001–06)	Phase II (FY 2007–11)	Phase III[a] (Beyond FY 2011)	Totals
DOE facilities				
Capital construction				
Line item	211	98	–	309
GPP/GPE	112	95	–	207
Facilities consolidation/S&M	73	40	–	113
Facilities operation	167	144	–	311
Facilities D&D	4	–	122	126
State of Tennessee facilities				
Facilities construction	26	–		26
Facilities operations	9	18		27
Private-sector facilities				
Facilities operations	29	58		87
Totals	631	453	122	1,206

[a]Only D&D costs were estimated beyond the end of the SC modernization planning period.

1. INTRODUCTION

Oak Ridge National Laboratory (ORNL) is the nation's largest and most diverse energy research and development (R&D) institution. It is a Department of Energy (DOE) multiprogram laboratory, supported primarily by DOE Office of Science (DOE-SC) research programs, but with other significant sponsors from the Department of Defense, the National Aeronautics and Space Administration, the Environmental Protection Agency, the National Science Foundation, and the Nuclear Regulatory Commission. To accomplish this mission of scientific research, ORNL staff are dependent upon the availability of a wide variety of buildings and equipment, including specialized experimental laboratories, user facilities, hot cells and nuclear reactors, and a large complement of office space and associated utility systems. ORNL's physical facilities are, however, quite old, and many have reached the end of their safe operating life. The poor condition of facilities is a key environmental, safety, and health (ES&H) concern; adds considerably to overhead costs in terms of energy consumption, increased maintenance costs, and research inefficiencies; and reduces our ability to attract and retain world-class scientific talent. Revitalization of the ORNL campus is a key initiative of the new ORNL prime contractor, UT-Battelle LLC, and this *ORNL Strategic Facilities Plan* describes the details of UT-Battelle's approach to upgrading the scientific resources and supporting infrastructure of the Laboratory.

The main ORNL site (also commonly referred to as the X-10 site) encompasses facilities in primarily two valleys (Bethel and Melton) concentrated in approximately 4250 acres of land. ORNL facilities are also located on other parts of the more than 21,000 acres for which ORNL is responsible, including some at the nearby Y-12 Plant and field research areas (Fig. 1.1). Within those areas, ORNL staff occupy approximately 4.5 million gross square feet of building space. The majority of these buildings were constructed during and immediately after World War II, with some 80% of the space exceeding 30 years of age, and nearly 54% being over 40 years old. Limited DOE budgets have allowed the physical condition and adequacy of that space to decline over the years, such that, at present, only 23% of the occupied space is deemed adequate under DOE criteria. The continued installation of sophisticated and expensive research equipment in such deteriorating physical facilities is compromising ORNL's standing as a world-class research institution. Similarly, the plant infrastructure serving the majority of ORNL's buildings also requires upgrading, as much of the piping, wiring, HVAC, fire safety, and connecting road systems were installed in the 1950s and have not been replaced or significantly upgraded. Much of this infrastructure does not meet current codes, or the evolving environment, safety, health, and quality (ESH&Q) requirements, and needs replacement as the rest of the ORNL campus revitalization is conducted.

The facilities upgrade needs at ORNL are not unique within the DOE-SC multiprogram laboratory system. Across the five primary SC multiprogram laboratories, similar facilities and infrastructure concerns exist and are the focus of a new initiative to upgrade the existing sites into "Laboratories of the 21st Century." SC's goal is to accomplish full modernization of its multiprogram laboratories by 2012, and each SC site is to develop a strategic facilities plan to outline its approach to meeting that goal, within the site-specific constraints of each laboratory and in concert with the institutional plans for new program growth at each site. The *ORNL Strategic Facilities Plan* is designed to meet this need, as well as to provide the basis for longer-term site-wide and reservation-wide planning efforts. The output from this *ORNL Strategic Facilities Plan* will be incorporated directly into the broader *ORNL Land and Facilities Plan* (ORNL/TM-2000/237), which is issued on an annual basis and deals not only with the main ORNL site facilities responsibilities, but also with ORNL's role in managing

large portions of the undeveloped ORR. It is through the *ORNL Land and Facilities Plan* that progress against the planned facilities revitalization schedule will be documented each year and changes in the scope or direction of that plan described.

The *ORNL Strategic Facilities Plan* provides the following: a brief overview of the Facilities Revitalization Project (FRP) team established to accomplish the revitalization mission (Sect. 2); a review of the current inventory and condition of existing ORNL facilities, as well as the programmatic mission drivers that are the basis for future facilities needs (Sect. 3); and an outline of the specific facilities consolidation, upgrade, and new construction needs (Sect. 4) that leads to the overall Master Plan for ORNL development (Sect. 5). The preliminary cost and schedule estimates for completing that Master Plan are then provided (Sect. 6), followed by a short discussion of the conclusions and recommendations of the strategic planning exercise (Sect. 7).

2. FACILITIES REVITALIZATION PROJECT SCOPE AND PLANNING PROCESS

To accomplish the goal of a fully modernized Laboratory of the 21st Century, ORNL has established a dedicated project team. The FRP has been authorized by the DOE Oak Ridge Operations Office (DOE-ORO) as one of the high-priority initiatives of the new UT-Battelle management and operating (M&O) contractor team for ORNL. The FRP mission is to provide world-class facilities for ORNL staff, consolidated at the main ORNL site, with the first phase of construction to be completed within 5 years. As will be detailed later in this plan, the project will utilize a combination of DOE, State of Tennessee, and private-sector funding to accomplish the revitalization goals in the near term. This unique approach requires integrated planning and new facilities construction and operations models to be employed; hence, the decision to implement the first phase as an identifiable project with a specific short-term mission and scope. The FRP team will define the process, implement it for the first round of construction, and provide the project execution framework for the remaining phases of the revitalization effort. However, those future projects will be managed as part of the routine ORNL Facilities and Operations organization mission.

A Project Management Plan for the FRP has been issued (ORNL/TM-2000/174), which contains a definition of the project scope, the organizational roles and responsibilities, and the project approach (including the project Work Breakdown Structure). The FRP team reports to the Director for Facilities and Operations and has a Steering Committee led by the ORNL Deputy Directors for Operations and Science and Technology. DOE-ORO is providing direct support and leadership for the facilities revitalization effort through a similar Steering Committee headed by the ORNL Site Office Deputy Manager. DOE and the UT-Battelle team in Oak Ridge are committed to successfully implementing SC's vision of the Laboratory of the 21st Century, as detailed in the following Strategic Plan.

A comprehensive planning process has been employed by the FRP team in the development of this Strategic Plan. That process was initiated with a formal review of the *ORNL Institutional Plan* and hosting of a workshop with Laboratory senior managers to validate program directions and needs in each of the primary research mission areas, as well as to obtain input on the Laboratory priorities on support functions to be provided by the new campus. It was during that workshop that the guiding principles were also established for the architectural feel of the revised campus setting. Using this information and the existing ORNL facilities data as a baseline, a detailed review of all existing facilities and infrastructure conditions was conducted and an initial determination of strategic buildings made to guide consolidation planning. Those strategic facilities then formed the nucleus around which the resulting Master Plan was developed. For facilities considered nonstrategic (due to age, conditions, high maintenance costs), consolidation plans were then drawn up for all staff/equipment housed there, and by-building mapping of relocation needs produced. Those plans were reviewed with the management of each of the affected divisions, and modifications were made to accommodate specific needs. These consolidation plans then drove the siting and sizing of new facilities and infrastructure needs, and those new facilities were captured in the Master Plan layout.

Once the complete listing of facilities requirements was identified, decisions were made on expected funding type (DOE, State, or private-sector) for each identified project, and a formal prioritization process then implemented for the DOE projects to rank them within the overall ORNL capital assets program. This ranking information, along with reasonable expectations on availability of State, private-sector, and DOE expense funds through each of the project phases, was then used to sequence facilities construction plans and allow roll-up of funding estimates. Details of this process are contained within each of the following plan chapters.

3. CURRENT SITE AND PROGRAMS DESCRIPTION

Programs at ORNL require a variety of buildings and equipment, including specialized experimental laboratories, a large complement of office space, and major utility and waste disposal facilities. ORNL has one of the oldest physical plants in the DOE laboratory system, and continuing efforts will be required to renovate and rehabilitate general-purpose buildings and utility systems that have deteriorated, as well as provide for new mission-related facilities for expanded scientific endeavors. Following is a description of ORNL's research and support facilities, including their current use status and operational condition, as well as a brief review of the new program areas of emphasis, with their related facilities needs.

3.1 INVENTORY OF CURRENT FACILITIES, USES, AND INFRASTRUCTURE NEEDS

3.1.1 Current Facilities and Uses

ORNL's main site encompasses approximately 1100 acres in the Bethel (Fig. 3.1) and Melton (Fig. 3.2) valleys, approximately 10 miles southwest of the center of the city of Oak Ridge, Tennessee, with additional facilities located on the adjacent Copper Ridge (Fig. 3.3). ORNL also occupies space at the Oak Ridge Y-12 Plant (Fig. 3.4) and leases some space off-site.

As indicated in Table 3.1, buildings at the Melton Valley and Bethel Valley sites and Copper Ridge comprise approximately 3.4 million gross square feet of building space; at the Y-12 Plant, ORNL use accounts for approximately 1.4 million gross square feet of building space.

Facilities accepted into DOE's Environmental Management (EM) Program and those that are part of the waste management systems managed by Bechtel Jacobs under the M&I contract for environmental management have been transferred to Bechtel Jacobs to facilitate the accomplishment of contractual responsibilities. With the exception of these facilities, ORNL has full responsibility for its Bethel Valley and Melton Valley sites and surrounding areas. ORNL is also responsible for management of a 21,076-acre portion of the approximately 34,424-acre ORR, including ORNL facilities and most of the 20,000-acre Oak Ridge National Environmental Research Park. At the Y-12 Plant, ORNL has responsibility for building maintenance and ESH&Q functions as approved by Memoranda of Understanding (MOUs) between ORNL and Y-12.

The ORNL site has many functions and requirements similar to those of a small city. It is supported by a dedicated fire department, a medical center, a security force, and a steam plant. Amenities include 37 miles of paved roads, 180 miles of unpaved roads, 27,000 feet of steam lines, 100,000 feet of treated water piping, and 115 acres of mowed grounds.

Table 3.1. ORNL building summary

Location	Buildings	Building sq ft	Trailers	Trailer sq ft	Total sq ft
ORNL main site	**428**	**3,359,508**	**85**	**73,161**	**3,432,669**
UT-Battelle	296	2,912,870	52	46,243	2,959,113
Bechtel Jacobs	132	446,638	33	26,918	473,556
ORNL off-site	**2**	**55,400**	**4**	**9,960**	**65,360**
Museum (AMSE)	2	55,400			
Colorado (GJC)			4	9,960	
ORNL at Y-12	**21**	**1,372,910**			**1,372,910**
Leased off-site	**5**	**163,572**			**163,572**
Total	**456**	**4,951,390**	**89**	**83,121**	**5,034,511**

The overall condition of the space is shown in Figs. 3.5 and 3.6, and a summary of space use is shown in Fig. 3.7. Photographs of a few of the representative substandard buildings are provided in Figs. 3.8 3.11. A summary of building age is shown in Fig. 3.12. As is clear from these figures, the majority of current ORNL space is substandard and needs to be replaced or upgraded in order to support the long-term research mission of the Laboratory.

3.1.2 Infrastructure Conditions and Limitations

To support research activities, a wide variety of infrastructure systems are in place across the Laboratory and, similar to the research facilities themselves, are in various stages of deterioration due to age. These systems include utilities (electrical, gas, compressed air, potable/process water, chilled water, steam, industrial gases, HVAC, stormwater collection, and telecommunications), transportation infrastructure (roads and parking areas), security (fencing, portals, building access controls), fire protection, and waste management (conventional and hazardous). While a detailed description of the conditions and needs in each of these areas is beyond the scope of this plan, it is important to understand that these infrastructure systems are critical to the mission of the Laboratory and must receive equal attention in revitalization planning.

The systems having the greatest need for refurbishment or replacement as part of the 21st Century Laboratories initiative are those related to upgrade of the electrical distribution system, process/chilled water systems, ventilation and exhaust systems, transportation infrastructure, and security. Many of these upgrades are driven by health and safety requirements that can no longer be met by 35- to 50-year-old electrical or heating, ventilating, and air-conditioning (HVAC) equipment, or for which reliability concerns cannot be tolerated (e.g., the primary potable water systems). Roadway conditions are primarily a concern related to travel safety on the portion of Bethel Valley Road bordering ORNL to the north and on Melton Valley Road providing access to the High Flux Isotope Reactor (HFIR) area. Issues related to parking availability are less of a concern at present, but must be a major component of master planning for the new ORNL campus. Similarly, site security upgrades are being required due to changes in DOE's approach to research laboratory operations, as well as the desire by

UT-Battelle to have a more open campus environment as part of Laboratory revitalization efforts. The relationship of these needs to the overall facilities consolidation and upgrade plans are defined in more detail in Sect. 5.

3.2 ORNL'S PROGRAMMATIC DIRECTIONS AND NEEDS

To extend the nation's capabilities in key areas of science and technology, ORNL is pursuing major research initiatives in neutron sciences, complex biological systems, terascale computing and simulation science, carbon management, and advanced materials. The University Partnerships Initiative is aimed at increasing the value of ORNL's science and technology through active involvement of university faculty and students in Laboratory programs. These initiatives are captured in the Laboratory Agenda and described in detail in the *ORNL Institutional Plan*. A brief overview of these initiatives is presented below. Needs for new facilities to support them are summarized in Table 3.2 at the end of this section.

3.2.1 Neutron Sciences

ORNL is engaged in a Neutron Sciences Initiative to ensure that the Laboratory continues its stewardship of neutron science in support of DOE's science missions. This initiative has two major elements: (1) the design and construction of the Spallation Neutron Source (SNS), a next-generation spallation neutron source facility, in collaboration with five other DOE national laboratories and (2) upgrades and refurbishment of the HFIR, which will greatly enhance the neutron science capabilities of the world's highest-power research reactor and extend its life well into the 21st century. By investing a portion of its Laboratory Directed Research and Development (LDRD) funds in neutron science, ORNL is preparing to take advantage of these new scientific tools and to integrate neutron science into research programs across the Laboratory. ORNL's strengths in neutron sciences constitute an integrated capability that spans programs across the entire Laboratory. Two major in-house facilities at present are the HFIR and the Oak Ridge Electron Linear Accelerator (ORELA) pulsed neutron source. In addition to neutron sources, facilities supporting ORNL's broad neutron science programs include the Radiochemical Engineering Development Center (REDC), the Radioisotope Development Laboratory, the Transuranium Research Laboratory, and the Irradiated Fuels Examination Laboratory.

The SNS is an accelerator-based, next-generation neutron scattering facility that is under construction on the ORR. It will produce neutron beams that are 12 times as intense as any existing pulsed source, enabling researchers to "see" never-before-observed details of physical and biological materials, ranging from high-temperature superconductors to proteins. The SNS is the top-priority project of DOE's Office of Science (DOE-SC), which plays a key role in supporting DOE's goals and strategies in science.

The HFIR will remain the facility of choice for important classes of scattering experiments requiring steady-state beams and for radioisotope production, materials irradiation, and neutron activation analysis. To continue these missions, upgrades are needed at the HFIR to modernize some of its instruments and components, improve maintenance facilities, add new capabilities, and maintain or improve the availability of neutrons to researchers. The HFIR has been in operation for 30 years, and many of its control instruments and components are increasingly difficult to repair. Spare parts are scarce and sometimes impossible to find, and vendors no longer manufacture some components. In some cases, new technologies have led to more reliable, more accurate components that could reduce error margins and thereby enhance reactor safety and efficiency. Although many major components have been (or will soon be) replaced or refurbished, remaining instruments and components are based

on technology that is now more than 30 years old. Thus, replacing some of these instruments and components is both desirable and cost-effective.

Other planned improvements are to develop innovative research programs that take advantage of the unique capabilities afforded by the HFIR, SNS, and other neutron facilities (including a new HFIR user support facility); to build a world-class user program that provides access to these capabilities; and to construct a facility, funded by the State of Tennessee, for the Joint Institute for Neutron Sciences (JINS).

3.2.2 Complex Biological Systems

ORNL is developing a significant program in complex biological systems that builds on established programs and expertise in the life and environmental sciences. The Complex Biological Systems Initiative incorporates innovative applications of computational, physical, chemical, and engineering science, as well as special facilities and resources in analytical technologies, to advance the understanding of biological systems. This initiative engages organizations and disciplines across the Laboratory and draws on programs in comparative and functional genomics, structural biology, and computational biology and bioinformatics. It focuses ORNL's distinctive expertise and facilities in mammalian genetics, biochemistry, environmental microbiology, plant genetics, analytical technologies, computational science and applied mathematics, physical sciences, and engineering on the challenges of observing and understanding the functioning of complex biological systems. Five key areas will be pursued through the Complex Biological Systems Initiative: comparative and functional genomics, proteomics and structural biology, the microbial cell, biological systems analysis, and predictive toxicology.

A significant investment in a new Center for Biological Sciences (CBS) at ORNL during the period is being initiated. The CBS is planned as a modular complex of buildings, equipment, and infrastructure to house current and future research programs in functional genomics, structural biology, proteomics, and systems biology. It will provide the environment for the ORNL biological research program to make significant contributions to biology during the next decade and beyond, with a special focus on complex biological systems research. Development of the CBS will enhance the advantages inherent in the structure of the program, which embraces not only the biological sciences but also allied disciplines in information science and computing, analytical methodologies, and chemistry. The initial element of the CBS is the recently completed Environmental and Life Sciences Laboratory constructed with GPP funds. The next phase in the development of the CBS is the construction of a Laboratory for Comparative and Functional Genomics (LCFG) to house the Mouse Genetics Research Facility. The LCFG, which will replace an aging building at the Oak Ridge Y-12 Plant, will be constructed with DOE funding, beginning in FY 2001. In addition to the mouse colony, the LCFG will include laboratories with special phenotype screening and cryopreservation capabilities, thus supporting the ORNL Functional Genomics and Proteomics Program. The CBS will also encompass the Center for Structural Molecular Biology (CSMB) and the Joint Institute for Biological Sciences. The SNS beam line identified is the principal new capital resource needed to support the CSMB beyond 2003.

ORNL and the University of Tennessee (UT) have established the Joint Institute for Biological Sciences to promote and develop support for collaborative education and research in the biological sciences. UT organizations involved in this effort include the Medical Center, the College of Veterinary Medicine, and the Institute of Agriculture. The initial phase focuses on strengthening the partnership between ORNL and UT and developing or expanding collaborative efforts in functional genomics, structural biology, and computational biology and bioinformatics. This phase includes the integration of the ORNL-UT Graduate Program for Genome Science and Technology into the

Joint Institute. The second phase in the evolution of the Joint Institute will explore new areas such as biomedical engineering. The Joint Institute for Biological Sciences will be funded by the State of Tennessee.

3.2.3 High Performance Computing

As DOE's most programmatically diverse national laboratory, ORNL conducts a broad range of theoretical and experimental programs requiring a significant computational science resource. ORNL is also home to a comprehensive computational science effort that leverages extensive expertise in the application of computing to physical problems and excellent facilities for massively parallel high-performance computing to answer scientific questions and to advance the development of computational resources. DOE is exploring an initiative that points to new opportunities in and expectations for computational science. The Scientific Discovery through Advanced Computing Program is being developed to take the nation into a new era of information and communications technology. It will rapidly deploy computing and communications capability that is at least 10 times faster than today's fastest systems for government, academic, and industrial use. This capability will revolutionize current approaches to solving complex problems in energy, the environment, fundamental research, and technology development, and it will stimulate the national system of innovation.

With computational power of 1.5 teraflops, ORNL has the nation's most powerful unclassified computing facility. In order to support the growing mission-critical computational needs of DOE, ORNL must continue to maintain state-of-the-art supercomputing and networking infrastructure. At the current rate of advance in computing capabilities, petascale computing will be required by 2010 to support programmatic needs. ORNL's current backbone fiber infrastructure was installed 10 years ago. It was designed and architected to provide data interface service only within the main ORNL campus; it offers no service to outlying facilities and is frequently hundreds of feet from buildings where service is needed. It is essential to upgrade this infrastructure to at least 10 times the current capacity and to provide a direct feed to every major ORNL building and facility. In conjunction with this upgrade, several ORNL buildings should also be rewired with modern copper, fiber, and hubs able to support local and and interlaboratory networks.

Attaining the proposed capability will demand significant advances in computational resources. Fully exploiting the power of massively parallel machines requires the creation of new programming paradigms, languages, scheduling and partitioning techniques, and algorithms, and all of these elements must be integrated into systems that are accessible and useful to a diverse user community. In support of this effort, a new Computational Science Building is being promoted as one of the highest-priority new facility needs for ORNL. In addition, the State of Tennessee has committed funding for a new facility to house the Joint Institute for Computational Sciences, which promotes collaborative relationships among ORNL, UT, and the UT-Battelle core universities and encourages and facilitates the effective use of high-performance computing resources in the southeastern United States.

3.2.4 Carbon Management Science and Technology

The Carbon Management Science and Technology Initiative marshals ORNL's capabilities for R&D on energy production, distribution, and use and for research on the environmental and societal effects of energy technologies and decisions to understand the effects of atmospheric carbon dioxide concentrations and develop acceptable options for carbon management. It provides the foundation for a comprehensive carbon management program to explore a range of science and technology opportunities (including policy options) to stabilize atmospheric carbon dioxide concentrations by

decreasing the carbon-production potential of the energy system and by reducing carbon dioxide emissions, including the capture and sequestration of atmospheric carbon dioxide and modification of the carbon biogeochemical cycle.

ORNL's vision is to become DOE's principal resource for carbon management science and technology. The goal is to advance the development of the U.S. carbon management agenda through an aggressive and responsive program that identifies and pursues new areas of R&D with significant potential for expanding the nation's carbon management options.

The Carbon Management Science and Technology Initiative will be focused on four tasks: (1) delivering the science and technology for understanding carbon sequestration, (2) strengthening research and analytical capabilities for evaluating carbon management options through new terrestrial ecosystem facilities and modeling studies, (3) expanding ORNL's leadership in energy efficiency R&D, and (4) expanding the Laboratory's clean power R&D.

DOE's new multilaboratory Center for Research on Enhancing Carbon Sequestration in Terrestrial Ecosystems (CSiTE) links ORNL, other national laboratories, and several universities and research institutions in a program designed to establish the scientific basis for enhancing carbon capture and long-term sequestration in terrestrial ecosystems. The Oak Ridge National Environmental Research Park will be used for field research to support this program. ORNL also plans to build on and expand its research and analytical capabilities for evaluating carbon management options through new terrestrial ecosystem facilities, drawing on the resources of the research park, and modeling studies that take advantage of the Laboratory's distinctive strengths in analysis and assessment and its resources for computing and simulation.

ORNL's resources in building technologies, distributed energy systems, and transportation will be enhanced and applied to improve the efficiency of power generation, transmission, distribution, and use. A new Building Science Research Facility and additional resources to support carbon composites research will support these efforts.

Clean power systems will be developed using fuels that emit less carbon or energy technologies that emit no carbon, building on strong ORNL programs in renewable energy, nuclear energy, and fusion energy. In addition, ORNL will continue its efforts to improve the efficiency of power generation, with an increasing emphasis on improvements in fuel cells, gas turbines, and reciprocating engines. Programs in hydrogen production and storage will also be expanded. In addition, the Laboratory is investing in two areas that offer significant potential as new sources of energy: methane hydrate and bioenergy.

The Carbon Management Science and Technology Initiative will draw on the resources developed to support other major initiatives. Enhancement of ORNL's neutron science capabilities will support investigations of new materials for energy systems and analysis of protein structure in support of new means of energy production and evaluations of energy impacts. The Complex Biological Systems Initiative will yield information about the biological and environmental impacts of energy choices and new resources for clean energy production. Advances in terascale computing and simulation science will support more accurate predictions of climate variation and provide insight into energy-related materials and processes. The Advanced Materials Initiative will improve the understanding of materials and materials-related phenomena that underpin energy technologies.

The goals of the initiative will also be supported by construction of the Engineering Technology Building, a planned private-sector-funded facility that will support multidisciplinary R&D on energy efficiency and use; mechanical, structural, and thermal sciences; and manufacturing sciences.

3.2.5 Advanced Materials Initiative

A new initiative in advanced materials is aimed at sustaining ORNL's position as a leader in advanced materials science and technology underpinning DOE's energy resources mission. This initiative includes the development of a recognized capability in nanoscale science, engineering, and technology; the construction of a new Advanced Materials Characterization Laboratory (AMCL); the development of extraordinary tools for materials characterization; the extension of ORNL's capabilities for synthesis, characterization, and processing of soft materials; the construction of a Center for Nanophase Materials Sciences; and the establishment of a Joint Institute for Advanced Materials.

Nanoscience is concerned with discovering, understanding, characterizing, and fabricating materials and systems with novel properties, phenomena, and processes that occur primarily because of their small size. An FY 2001 02 GPP is currently funded to modify existing space in Building 3500 for a dedicated facility for nanostructure characterization, inspection, and manipulation.

The Advanced Materials Characterization Laboratory is a proposed new 12,000-square-foot structure that will provide the high-quality environment required to optimize the performance of sophisticated characterization equipment essential for the next generation of advanced materials R&D and will provide for the centralization of advanced materials structural characterization equipment. As part of the initial complement of instruments, the AMCL will house the Aberration-Corrected Electron Microscope, a $3 million instrument that will be shipped to ORNL in FY 2003. This state-of-the-art microscope requires a specialized facility to house it, with extremely low stray electrical and magnetic field levels and similarly low vibration levels. It will be joined by two scanning transmission electron microscopes belonging to the Solid State Division (SSD), which are currently being upgraded and will also represent state-of-the-art capability. Additional electron microscopes from the Metals and Ceramics (M&C) Division, current and planned, will be housed in the AMCL. When completed, the AMCL will be a premier, perhaps the best, characterization facility on a world-wide basis. The building will include space and options for expansion to include other characterization equipment with similar requirements (e.g., scanning tunneling microscopes and/or atomic force microscopes) used in R&D in other ORNL divisions. The building will house instrumentation owned by several programs, including Basic Energy Sciences (BES) and the Office of Energy Efficiency and Renewable Energy, and will host guest users from both the HTML and the Shared Research Equipment User Programs.

The Center for Nanophase Materials Sciences is a proposed national facility for advancing the understanding of nanoscale phenomena in materials. The center will leverage the unprecedented opportunity for new research on the structure and dynamics of nanoscale materials systems that will be afforded by the SNS and the upgraded HFIR. The focus will be on interdisciplinary research areas that benefit from access to neutron scattering, including soft materials, interfaces, nanoscale magnetism, and other nanophase systems. Center research will provide the foundation for new nanotechnologies based on these materials systems and will optimize the use of the SNS and the upgraded HFIR for nanoscience-related research. Working through university and industry partnerships, the center will create an environment and provide facilities for rapid progress in interdisciplinary nanoscale science and engineering. The center will also provide training for graduate students and postdoctoral associates in interdisciplinary nanoscale science with particular emphasis on nanoscale materials synthesis and characterization, assembly of nanomaterials systems, and fundamental understanding of nanoscale phenomena. The center will consist of a new 60,000-square-foot laboratory/office complex anticipated to be constructed adjacent to the SNS and the Joint Institute for Neutron Sciences (JINS). This facility will include clean rooms and specialized equipment for nanoscience research that cannot be accommodated in existing space at ORNL. The center responds

to the recommendations of the BES Nanoscale Science, Engineering, and Technology Research Directions report and will provide a unique national resource in the nanosciences.

3.2.6 University Partnerships

In support of the University Partnerships Initiative, ORNL is undertaking the development of the Oak Ridge Center for Advanced Studies (ORCAS) in cooperation with Oak Ridge Associated Universities. ORCAS will serve as a center of intellectual inquiry to encourage interactions between ORNL researchers and university faculty and students. A building to be constructed with funding from the State of Tennessee will provide offices for visiting faculty, state-of-the-art distance education classrooms, and high-speed network connections to facilitate communication with the six UT-Battelle core universities and other partners.

Table 3.2. Future mission facility needs

Title and description	Proposed funding year(s)/type
Joint Institute for Neutron Sciences Center to provide a world-class user program that provides access to the capabilities of the SNS, HFIR, and other ORNL neutron sciences research programs 60,000-square-foot facility housing office, laboratory, process, and meeting space for collaborations	FY 2004 05 $8M State funded
HFIR Maintenance Building Building to provide facilities critical to the maintenance and support of reactor operations 22,000-square-foot facility to house maintenance shops and process space	FY 2002 03 $2.9M GPP
Laboratory for Comparative and Functional Genomics Building to provide facilities for the location of the mutant mouse colony 32,000-square-foot facility with accredited, environmentally controlled accommodation areas for housing animal research	FY 2001 03 $13.8M LI
ORNL Center for Biological Sciences Research programs for functional genomics, structural biology, proteomics, and systems biology Staged facilities to house the Center for Biological Sciences user facilities 50,000-square-foot facility with a modular complex of buildings, equipment, and supporting infrastructure to be located in the West Campus	FY 2005–07 $20M LI
Joint Institute for Biological Sciences Center for the promotion and development of collaborative education and research in the biological sciences of functional genomics, structural biology, and computational biology and bioinformatics 60,000-square-foot facility housing office, laboratory, process, and meeting space for collaborations	FY 2002–03 $8M State funded
Computational Science Building Center for computer science research to address effective use of distributed computers and massive parallel computer systems composed of symmetric multiprocessing clusters linked with high-speed network fibers 100,000-square-foot private-sector-funded facility to house supporting laboratories, process space, offices, and supporting infrastructure	FY 2001–02 $13M Private-sector funded

Table 3.2. Future mission facility needs (cont'd)

Title and description	Proposed funding year(s)/type
Joint Institute for Computational Sciences User- and visitor-oriented facility to provide access to high-performance computers, inspire collaborations and outreach between ORNL and partnering universities, facilitate enhanced high-speed networking systems, and facilitate auxiliary technologies 40,000-square-foot facility to house computing system laboratories, offices, and meeting space for collaborations	FY 2003–04 $6M State funded
Engineering Technology Building Multidisciplinary R&D facility relevant to energy conservation and utilization; mechanical, structural, and thermal sciences; and manufacturing sciences 100,000-square-foot private-sector-funded facility to house supporting laboratories, process space, offices, and supporting infrastructure	FY 2001–02 $13M Private-sector funded
Building Science Research Facility Building science initiatives for new materials research, systems integration and interaction, environmental factors research, and materials life cycle assessment 50,000-square-foot facility housing research staff, eight interior laboratories for material and component testing, outdoor space for model building testing to be located in the Central Campus Facility to house Building Science user facilities	FY 2004–06 $20M LI
Laboratory Expansion for Nanoscience Metrology and Instrumentation Scientific and engineering research initiatives for nanomaterials, nanostructures, and their applications 3,000-square-foot renovation of space in Building 3500 to house laboratory and process space with two new clean rooms	FY 2001-02 $1.2M GPP
Advanced Materials Characterization Laboratory Next generation of research for materials characterization Centralization of advanced materials structural characterization equipment to include the Aberration-Corrected Electron Microscope Facility to house the Advanced Materials Research user facilities 12,000-square-foot structure with microscope modules	FY 2002 03 $4.8M GPP
Oak Ridge Center for Advanced Studies Theoretical and applied R&D-oriented facility to explore grand queries, big thoughts, and major potentials for long-term program development for ORNL and core universities 30,000-square-foot facility to house state-of-the-art collaboration meeting room with teleconferencing and computing networking, offices, and information resource center	FY 2003 04 $4M State funded
Center for Nanophase Materials Sciences National center for nanoscience research on soft materials, interfaces, nanoscale magnetism, and other nanophase systems that benefit from access to neutron scattering Responds to BES panel recommendations for the creation of Nanoscale Science Research Centers Includes clean rooms and specialized equipment that cannot be accommodated in existing space 60,000-square-foot laboratory/office complex adjacent to the SNS and JINS	FY 2003 05 $20M LI

4. NEW FACILITIES AND INFRASTRUCTURE NEEDS

As outlined in Sect. 3, the current conditions of ORNL facilities and infrastructure and the future program needs of the ORNL research community point to requirements for significant upgrades and replacement of many of the existing Laboratory facilities. In response to this need, the FRP has been established by UT-Battelle to define and implement an integrated approach to exiting old facilities and constructing new facilities over the next 10 years. The FRP team has completed a condition assessment and future growth analysis and has developed a comprehensive facilities consolidation plan that identifies, by building and occupying ORNL division, the space requirements and timing of moves to accomplish the revitalization objectives. The following section outlines the details of that consolidation process, including an overview of the integrated strategy for new facilities development, the planning basis for the staff/facilities consolidation, a division-level summary of the resulting plans, and identification of support infrastructure improvements that must accompany the consolidation efforts.

4.1 FRP APPROACH TO FACILITIES/INFRASTRUCTURE IMPROVEMENTS

The UT-Battelle facilities revitalization approach is to provide new integrated facilities constructed in close proximity to the existing ORNL strategic research facilities, utilizing a combination of DOE, State of Tennessee, and private-sector financial resources. UT-Battelle would focus DOE capital funding on capabilities that are not likely to be financially or technically feasible by third parties, use State funds for the type of shared scientific facilities appropriate for collaborative research, and use private-sector construction for light laboratory and office support needs that accompany research efforts. These facility types would be constructed in an integrated campus layout that allows the free flow of scientific research between multidivision teams, with consistent architectural themes, regardless of construction funding source. The details of the resulting Master Plan development approach are provided in Sect. 5.

Because of the magnitude of needed facilities improvements and the historical limitations on federal funding availability, UT-Battelle has proposed an innovative use of federal, private, and State funds to accomplish the facilities revitalization. The key component of this approach is the transfer of land ownership from DOE to allow for (1) construction and lease of buildings by the private sector and (2) siting and construction of the State of Tennessee facilities. A mutually acceptable approach for land transfer has been developed between the DOE-OR Realty Office and UT-Battelle that involves the use of DOE's authority under Section 161(g) of the Atomic Energy Act and the establishment of a not-for-profit 501(c)(3) corporation by UT-Battelle that would be the responsible party for acceptance of the DOE land, with subsequent lease of that land to the private sector for construction and lease-back of the property to UT-Battelle (with DOE approval) for research activities. Under this arrangement, UT-Battelle would utilize the 501(c)(3) corporation to oversee land management, building construction, and lease (for private sector) or MOU implementation (for State of Tennessee) for the FRP, and DOE would transfer, through fee simple title via a Quitclaim Deed, specifically identified parcels of land to that development corporation. A block-flow diagram of this approach is provided in Fig. 4.1. The legal and contractual details associated with this concept are beyond the scope of this document but can be obtained through contact with the UT-Battelle or DOE project managers.

As currently envisioned, approximately 25 acres of land would be transferred from DOE to the 501(c)(3) corporation to accommodate the needed construction. This land would be transferred in specific parcels associated with programmatic needs and location requirements related to the mission areas to be supported by the completed buildings. Following construction and operation of facilities on that land, DOE would maintain the right for repurchase or retransfer of those parcels at some time in the future (expected to be 30 to 40 years), if desired.

The development of new facilities at ORNL will, of course, be accomplished in compliance with applicable environmental and other regulatory requirements associated with research operations. Because the campus revitalization is a federal activity (construction with federal funds and transfer of federal lands), its development will be addressed through the formal National Environmental Policy Act (NEPA) process, with appropriate NEPA documentation prepared to evaluate the impacts of the development approach. This NEPA review will only cover the activities defined for the 10-year modernization planning period since project scope beyond that time is not well understood. Similarly, with the transfer of federal property on the National Priorities List as part of the approach, a formal Comprehensive Environmental Response, Compensation, and Liability Act Section 120 (h) evaluation will have to be completed prior to the transfer to ensure that contamination liabilities (if any) are defined for all parties. For those older facilities for which plans are made for decommissioning and ultimate demolition, the historical value of the buildings (and the operations conducted in them) will be assessed and appropriate decisions made through the National Historical Preservation Act process to determine proper documentation of the sites and any desired preservation of equipment or facilities. Throughout all facilities construction and/or destruction activities, care will be taken to ensure control of releases to air and water resources, in full compliance with the Clean Water and Clean Air Acts. The safety of construction workers, surrounding ORNL staff members, and the general public will be of high priority as well, as the work is completed.

The FRP has incorporated energy efficiency, environmental sustainability, and brownfields reuse goals into the approach for new facilities development, and it is UT-Battelle's intention to make the new campus a showcase for environmental-friendly design. Several Energy Savings Performance Contractor and Federal Energy Management Program projects are already being undertaken on the ORNL site, and additional, much-broader-scoped projects are anticipated as part of the revitalization efforts. More details on the "green" nature of the new campus development are provided in the discussion of the Master Plan in Sect. 5.

4.2 FACILITIES CONSOLIDATION PROCESS

4.2.1 Basis for Consolidation Planning

Consistent with the latest version of the *ORNL Institutional Plan*, the FRP strategy is to consolidate laboratory research and support operations into a set of strategic facilities located at the main ORNL site and transfer excess facilities that are nonstrategic, uneconomical, and/or underutilized and no longer support ORNL's current and future programmatic missions to other parties. The transfer of excess facilities could mean transfer to another contractor for alternate use, transfer to the Community Reuse Organization of East Tennessee (CROET) for reindustrialization initiatives, or if the appropriate criteria are met, transfer of excess facilities to the DOE Environmental Management Program for ultimate disposition. Facilities determined excess that cannot be transferred for alternate use must be placed in a state of minimum cost, with minimum utilities maintenance and surveillance ("cheap-to-keep") until ultimate disposition can be scheduled as outlined in Sect. 4.2.2.

As the FRP initiated the consolidation planning process, the first step was to compile a current list of facilities for which ORNL has responsibility using existing databases such as the Facility Information Management System (FIMS), the Space Allocation Management System (SAMS), and the ORNL Facility Index. Criteria were then established against which ORNL facilities were evaluated to determine if individual facilities were to be considered strategic or nonstrategic. Strategic facilities were assumed to be those facilities located within the main ORNL site that are essential for ORNL to enable world-class scientists to deliver world-class research. These facilities typically are flexible in use, have unique capabilities that are difficult and/or too costly to duplicate, and are critical to the research mission. Nonstrategic facilities were identified in the consolidation planning process as those facilities that were generally greater than 30 to 40 years old, were of high maintenance and operation cost, had a high backlog of deferred maintenance, and posed a potential risk to the health and safety of staff and the environment. Location of staff in remote locations was also a factor when determining nonstrategic facilities such as those at 1060 Commerce Park, 111 Union Valley, and ORNL facilities at Y-12. Single- and double-wide trailers, though often used for short-term temporary needs, were also determined to be nonstrategic.

The list of nonstrategic facilities was then divided into two categories: (1) candidate for disposition that met EM criteria and (2) candidate for disposition that did not meet EM criteria and would be the responsibility of the Office of Science (see Tables A.1 and A.2 in Appendix A for listings of facilities). Approximately 82 facilities (a total of 645,000 square feet) were determined nonstrategic and will remain solely the responsibility of the Office of Science; 36 facilities (a total of 1,131,000 square feet) would meet the EM criteria. Figs. 4.2 (main ORNL site) and 4.3 (Y-12 site) are detailed maps showing facilities that meet EM criteria in red, non-EM facilities in blue, and those facilities that are currently Bechtel Jacob's (EM contractor for the ORR) responsibility in yellow. All other facilities were considered strategic for ORNL in the next 5 to 10 years and were not assigned a unique color. Facilities that are the responsibility of the M&O contractor at Y-12 were also not assigned a unique color.

Nonstrategic facilities were then reviewed to determine which research divisions occupied individual facilities and how the space in those facilities should be categorized. The four categories of space tracked in this plan are (1) Office Space (SP), (2) Laboratory Space (LB), (3) Process Rooms (PR), and (4) Shop Areas (SP). In the planning process, various consolidation scenarios were evaluated and reviewed. Input was gathered from each of the division directors most affected by the consolidation process.

Looking at a Laboratory-wide consolidation strategy for ORNL, several basic assumptions were used in the consolidation process. The Laboratory needs to focus on more efficient space utilization within strategic buildings; thus, existing space holdings must be reduced. This is currently being accomplished with a recent increase in the space charge rate. Space that is or could be made available was evaluated, and scenarios were created for potential new tenants from those facilities determined nonstrategic. Clearly, the goal in the entire consolidation process will be to minimize the amount of moves, renovations, and/or upgrades required. The FRP looked for opportunities to group individuals within divisions close together to maximize their effectiveness and operations, while also investigating the possibility of co-locating divisions that complement each other in order to create new synergies. The outcome of this assessment and the consolidation plan will be discussed in detail in Sect. 4.3.

4.2.2 The "Cheap-to-Keep" Process

ORNL faces an enormous challenge in the deactivation and disposition of its nonstrategic facilities. Many of the facilities identified in the consolidation process are large, complex, and contain multiple hazards. As ORNL facilities reach their end of expected life and are declared excess, they transfer from an operational mode into a transition phase that prepares them for ultimate disposition. The transition phase of a facility's life cycle typically includes deactivation, surveillance and maintenance (S&M), and decontamination/decommissioning (D&D).

The transition phase begins once a facility has been declared excess or is forecasted to be excess to the current and future needs of ORNL. Once all occupants and required equipment have been vacated from the facility, the deactivation process can begin. The deactivation of a facility includes placing the facility in a stable and known condition, identifying hazards, and eliminating or mitigating the hazards. Deactivation must be appropriately planned, conducted, and documented in a manner consistent with the guiding principals and core functions of ORNL's integrated safety management policies and Work Smart Standards. Deactivation will place a facility in a safe shutdown condition in a state of minimum cost and minimum utilities, under surveillance and maintenance for an extended period of time ("cheap-to-keep" mode), until the eventual decommissioning of the facility is accomplished. Deactivation of nonutilized excess facilities should occur as soon as is reasonable and for as many facilities as possible.

For each facility to be placed in "cheap-to-keep" mode, a specific facility deactivation plan will be generated on a graded approach. The general purpose of the deactivation plan will be to identify a structured process and sequencing of all activities in support of the deactivation of a specific facility. This plan will include everything from cleanout of wastes, materials, and equipment to typical "cheap-to-keep" facility system configurations. Such configurations include, but shall not be limited to, water and steam systems isolated, drains capped, electrical kept to a minimum or disconnected entirely, ventilation systems shut down, discharge stacks capped, and adequate freeze protection provided. When a facility is in "cheap-to-keep" mode, surveillance and maintenance can then be planned and scheduled as appropriate. The expectation is that all EM criteria for subsequent transfer of facilities would be met once a facility is in the "cheap-to-keep" mode.

S&M activities consist of two elements: surveillance and maintenance. Surveillance includes any activity that involves the scheduled periodic inspection of a facility, equipment, or structure as required by federal and State ES&H laws and regulations and DOE orders. The purpose of surveillance is to demonstrate compliance, identify problems requiring corrective action, and determine the facility's present environmental, radiological, and physical condition. More specifically, surveillance includes activities performed to determine the operability of critical equipment, monitor radiological conditions, check safety-related items, provide for facility-security controls, and assess a facility's structural integrity. Maintenance includes (1) any routine activity that is required to sustain property in a

condition suitable to be used for its designated purpose and (2) preventative, predictive, and corrective maintenance. It will be the goal of the FRP to minimize the S&M duration and plan for early funding to support D&D activities. It can be expected that S&M activities will be much longer for those facilities that would be transferred to the EM Program.

4.3 CONSOLIDATION PLAN

As outlined in the consolidation planning process of the previous section, the FRP strategy is to consolidate Laboratory research and support operations into a set of strategic facilities located at the main ORNL site. This plan results in the reduction of ORNL space from the current level of over 4.5 million square feet to slightly over 3 million square feet. This consolidation effort would occur over a 5- to 7-year period, involving the movement of slightly over 400 staff from off-site locations (e.g., Y-12, 1060 Commerce Park, and 111 Union Valley) to renovated and existing space at the main ORNL site or new private-sector, State, DOE line item, and GPP space and would result in the need for the deactivation and demolition of approximately 118 buildings.

As the master consolidation plan was developed for ORNL, it was recognized that the plan must be dynamic. The FRP consolidation plan is intended to provide a global strategy for Laboratory-wide consolidation and to capture a rough order of magnitude for the costs and timing associated with consolidation activities that support the *Strategic Facilities Plan*. This plan represents a snapshot in time. As some ORNL divisions will ultimately grow and shrink during the next 5 years, the consolidation plan will need to be adjusted, as necessary, to respond to new divisional space needs. Detailed space issues (e.g., who will occupy specific offices) are not part of the scope of this plan and will most likely be negotiated and finalized up to the day of each move. In order to understand the benefits and cost impacts, however, it is essential that this plan identify the buildings into which staff and laboratories will be consolidated, the year each move is planned and budgeted, and the year a facility will be deactivated.

As the overall consolidation scenario for ORNL is addressed, not all divisions will be individually discussed, nor will every move be identified. It is the intent of this section to address the divisions that are most affected by the consolidation planning in a global sense and provide an understanding of which facilities were determined nonstrategic, who occupies those facilities, and where the divisions will ultimately be moved. The consolidation summaries for the West, Central, and East Campuses, as well as the 7600 and 7900 Areas, are summarized in Table 4.1 and in Figs. 4.4 through 4.8 respectively. A master consolidation summary (Appendix B, Table B.1) and division-specific consolidation summaries (Appendix B, pages B-5 through B-16) include more detailed information, such as current and new space requirements. It should be noted, however, that construction activities and staff relocations at the SNS site are not included in this planning activity because of the separate and unique nature of that activity.

4.3.1 ORNL Facilities at Y-12

The first priority of the FRP will be to relocate ORNL's research operations from the Y-12 Plant to the main ORNL site. Currently there are four major research divisions that occupy Y-12: (1) Life Sciences Division (LSD), (2) Chemical Technology Division (CTD), (3) Engineering Technology Division (ETD), and (4) Fusion Energy Division (FED). LSD has been in the process of consolidating its activities over the years and now is currently left with one very specialized facility, 9210. To support the LSD relocation to the main ORNL site, two new facilities will be constructed in the West Campus to replace the mouse genetic capabilities in 9210: (1) the Line Item for the Laboratory for Comparative and Functional Genomics (also referred to as the Mouse House) and (2) a GPP for the

Table 4.1. Master consolidation plan summary

Location[a]	Strategic facilities that support the consolidation effort	Facilities to be vacated[b]	
West Campus	1061 and 1062 Office Buildings	9210	
	Center for Biological Sciences	1060 COM	
	Environmental and Life Sciences Laboratory		
	Joint Institute for Biological Sciences		
	Laboratory for Comparative and Functional Genomics		
Central Campus	2018	2011	3504
	2033	2013	3508
	2518	2506	3525
	2525	3003	3543
	3500	3019A	
	4546	3080	
	Central Campus Research Building	3115	
East Campus	5500	1000	6026B
	6010	2000	6026C
	6025	2001	6026D
	4500N	2008	6026E
	4500S	2013	6026F
	Advanced Materials Characterization Laboratory	2019	6026G
	Computational Science Building	2024	6556E
	East Campus Research Office	2506	6556Q
	East Campus Service Building	2652A	6556S
	Engineering Technology Building	2652B	9102-1
	Joint Institute for Computational Sciences	2652C	9102-2
	National Transportation Research Center (NTRC)[c]	3017	9104-4
	Oak Ridge Center for Advanced Studies	3036	9201-2
	Research Office Building	3037	9201-3
	Research Support Center	3100	9204-1
		3503	9204-3
		3504	9224
		3550	9401-1
		5000	1060 COM
		6003	111 UNV
		6026A	
7600 Area	7601	9201-2	
	7602		
	7603		
	7605		
	7606A		
	7606B		
	7600 Area Office Building		
	7600 Area Highbay Building		
7900 Area	7900 Area Office Building I	7964A	7964F
	7900 Area Office Building II	7964B	7964G
	HFIR Highbay Storage	7964C	7965A
	HFIR Maintenance Building	7964D	7965B
	Manipulator Repair Facility	7964E	7965C

[a]See Figs. 4.2 and 4.3 for locations.

[b]Only facilities to be vacated in support of staff consolidation to main ORNL site. Appendix A contains a listing of all ORNL facilities to be considered excess as part of the 10-year modernization effort.

[C]Off-site location.

Environmental and Life Sciences Laboratory. LSD laboratories currently housed in 9224 will be

consolidated into existing space in 4500S. Deactivation efforts are currently underway, and will continue into FY 2001, to place four vacated LSD facilities, along with 9210, in "cheap-to-keep" mode.

The Chemical Technology Division currently has two programs being conducted in the 216,000-square-foot underutilized facility of 9204-3. The Stable Isotopes Program and the Isotope Distribution Office will be consolidated into existing CTD space in 4500N and/or in the 7900 Area.

The Engineering Technology Division has responsibility for approximately 11 major facilities, thus having the largest gross square footage responsibility at Y-12. With the completion of the National Transportation Research Center (NTRC) expected by the end of FY 2000, approximately 70 ETD staff will relocate to off-site leased space at NTRC, thus vacating two office buildings at Y-12. The balance of ETD's staff and laboratory infrastructure in the remaining facilities will be moved into one of three private-sector facilities to be constructed in the East Campus of the main ORNL site. This first private-sector facility (Engineering Technology Building) will provide a minimum of 170 offices and approximately 57,000 square feet of laboratory space to accommodate ETD's needs.

The Fusion Energy Division is primarily housed in the 258,000-square-foot facility of 9201-2. Approximately 90 staff and laboratory infrastructure will relocate to the 7600 Area, which is currently occupied by multiple divisions and is one of the only places at the main ORNL site with the capability to accommodate the extensive power requirements to support FED's equipment. Existing office space in the 7600 Area is currently fully utilized; therefore, the near-term strategy would be to move approximately 30 staff from the Computing, Information, and Networking Division (CIND) in the 7600 Area to Building 6012 located in the East Campus of the main ORNL site. The balance of the 60 FED staff would be housed in a new DOE-funded office building to be constructed in the 7600 Area by FY 2003. ORNL has requested that Bechtel Jacobs accelerate cleanout efforts in the 7602 Highbay to support the 7600 Area revitalization. As much laboratory infrastructure as possible will be moved into existing space, although it is recognized that more laboratory space will most likely be needed. A new DOE-funded highbay will be constructed by FY 2004 to house the balance of FED's laboratory capability.

4.3.2 ORNL Facilities at the Main ORNL Site

The Computational Physics and Engineering Division (CPED) and the Computer Science and Mathematics Division (CMSD) currently occupy various strategic and nonstrategic facilities located mostly in the 4000 and 6000 Areas. A significant portion of these two divisions will be relocated from the 6010, 6012, 6025, 6026 trailers and 4500N into the new Computational Science Building to be constructed with private-sector funds in the East Campus by the summer of FY 2002. This new facility will be ORNL's showcase for computer technologies, housing one of the world's most powerful terascale computers. The Physics Division (PD), which currently occupies space in the 6000 Area, will vacate 6003 and consolidate its operations into existing space in 6010 and 6025 as CMSD and CPED move out. PD is currently in the process of vacating 5500, which will allow for other consolidation. CIND, in addition to what has been discussed in the Y-12 scenario in the 7600 Area, also occupies space in the 5500A and 6026 trailers. These staff would be moved into 6012 in FY 2002. CIND staff displaced during construction activities in support of the 4500N Line Item renovation would also be relocated into 6012. The library and records storage area will remain in 4500N and Graphic Arts, Reproduction, and Photography, currently in 4500S, will be moved into the new DOE-funded East Campus Service Building to be located on the Building 5000 site by FY 2005.

The scope of the first phase of the 4500N Line item will be to upgrade the utility backbone in the headhouse and to renovate the first and second floors of Wing 4 into modern laboratory space. In order to allow for construction to begin, staff currently housed in those areas will need to be relocated. The Energy Division, which currently occupies the majority of the first floor of Wing 4, will be moved into the new Engineering Technology Building or into the existing 3546 Office Building. Other staff representing multiple divisions, including some DOE-ORO Site Office personnel, will be relocated into space such as 6010, 6025, the East Campus Service Building, the Research Support Center, and existing office space in strategic laboratory facilities.

ESH&Q organizations currently have staff and programmatic functions scattered about the main ORNL site. Over the next 2 to 5 years it will be the goal of ESH&Q to field-deploy their support staff in the areas where the day-to-day work is performed and consolidate their programmatic functions into Building 5500. For example, Quality will move Nondestructive Examination functions and inspection labs for respirator issue and repair into the Tandem space in 5500. Industrial Hygiene will move out of 3550 into 5500, and Health functions will be consolidated into 4500N. Much of the space in 5500 will need near-term DOE investments for renovation due to the relative age of the facility. To allow for ESH&Q to consolidate its operations into 5500, some R&D divisions will need to be moved into alternate space. LSD will move approximately eight laboratories and offices from 5500 into renovated space in 4500S. M&C Division currently occupies substandard space in the basement and first floor of 5500. These laboratories will be moved into the basement of 4500S vacated by Graphics, Duplication, and Photography, which will allow M&C to centralize their operations into a set of core buildings (4500S, 4508, and HTML). The AMCL is a proposed addition to the west end of the HTML, which will house six next-generation electron microscopes that M&C will use jointly with SSD. SSD currently occupies space in the 2000 Area, including Buildings 2000, 2019, and 2024. The goal will be to relocate SSD in FY 2001 from these facilities into existing space in 4500N, which will allow UT-Battelle to work with Bechtel Jacobs to accelerate efforts to D&D these very visible facilities. SSD also occupies space in 3003, 3080, and 3115 in the 3000 Block of the Central Campus. It is proposed that in FY 2006 a facility will be constructed with DOE funds to provide laboratory and office space in the Central Campus. In the Central Campus, Plant and Equipment (P&E) Division has multiple facilities located along Central Avenue. In this first phase of consolidation, the goal will be to vacate Buildings 2011, 2013, and 2506 into existing space in 2018, 2518, and 2525. P&E's Forestry Group currently occupies three trailers in the 6000 Area. These staff would be consolidated into existing P&E space in the 7000 Area. CTD and the Research Reactors Division currently house approximately 100 staff in single- and double-wide trailers in the 7900 Area. Two office buildings funded by DOE are planned to be constructed in the 7900 Area near the HFIR in order to remove the many trailers.

4.4 INFRASTRUCTURE NEEDS

4.4.1 Campus Improvements

Each of the campus improvement projects is discussed in Section 5.2 as part of the ORNL Master Plan for site development.

4.4.2 Utility Improvements

Major utilities, including electricity, natural gas, water, and telecommunications, are required at ORNL and are provided by outside entities . In addition, the Laboratory produces its own steam and compressed air and operates and maintains systems for the collection and treatment of sanitary, process, and industrial-type wastes. It is anticipated that the utilities infrastructure needed to support

the FRP will include much of that currently in use; however, refurbishment and upgrades to the existing systems and new systems will be necessary to support both continuing operations as well as planned facilities. Upgrades to the electrical, potable water, process waste, telecommunications, and fire alarm systems are scheduled over the next several years. The most pressing need is to provide utility systems with redundant capability, which will require additional electrical switchgear as well as additional water lines and water valves. The main thrust of this upgrade program is to ensure that a single point failure in a utility supply system at one Laboratory location will have a minimal impact on the other locations and facilities served by that utility. Utilities that serve potentially hazardous facilities should be provided with the redundancy necessary to ensure operation or the capability of performing a safe shutdown of its operations. This strategy coincides with DOE's desire to ensure that all facilities have the same level of reliability and protection as those which fall into the "best protected class" in general industry. Table 4.2 identifies all infrastructure-related projects in support of the FRP and other ORNL site upgrades.

Table 4.2. Landlord infrastructure projects supporting the FRP and other site upgrades over the 10-year planning period ($ in thousands)

Infrastructure Projects[a]	TEC
New campus facilities/renovation	
GPP and GPE	46,000
Programmatic GPP	7,500
Landlord line items	164,500
Programmatic Line Items	73,900
Utility improvements (GPP and GPE)	64,400
Other landlord GPP/GPE	88,600
Other landlord line items	70,400
Total	515,300

[a]Appendix C provides a summary table of projects phasing by year plus activity data sheet (ADS) identification for infrastructure projects by funding year.

Electrical. Plans for the ORNL Electrical Distribution System include the addition of alternate feeds, replacement of switchgear and transformers, rebuilding overhead feeders, and a general upgrading of many building service entrances in older facilities throughout the site. Other proposed projects will require additions and/or alterations to the electrical distribution grid and new substations to provide a safe and dependable power supply to new and renovated facilities.

Fire Protection. ORNL facilities are protected from fire by remotely monitored fire alarm and sensing systems coupled with automatic sprinkler devices. A Line Item and GPP have been funded that will upgrade many of the old, outdated fire alarm systems in Laboratory facilities and add new systems to facilities currently not covered. These improvements will enhance fire protection capability for the Laboratory and ensure compliance with the requirements in fire protection standards.

Natural Gas. The long-range plan developed by the ORNL Steam Plant proposes to move away from using coal as a primary fuel. Natural gas will be used to fuel the steam plant, which will use fuel oil as a secondary fuel resource. The addition of a new, efficient natural gas/fuel oil-fired boiler will provide the most economical source of steam while avoiding a number of future costs associated

with upgrading the existing coal firing, handling, and waste treatment systems. Evaluations of the existing 50-year-old natural gas distribution system are being conducted to determine upgrades for the most practical and efficient means of providing services for research and service support.

Sewer. Construction of the SNS, East Campus additions, and West Campus additions will require an addition to the ORNL Sewage Treatment Plant (STP). Increased wastewater load from these facilities will introduce new flows in excess of what the current plant is designed to treat. The addition of an aeration basin at the STP or the construction of a new oxidation ditch to replace the existing package plant would ensure adequate treatment capacity for the new facilities. Evaluations are currently being performed to selected optimal methods for expansion of the existing system.

Water. Water usage is expected to remain relatively constant until the SNS comes on line. A number of expansions and improvements to the water system are in construction and are being planned. Currently, a new 1.5-million-gallon reservoir on Chestnut Ridge, adjacent to the existing 3-million-gallon concrete reservoir, is being constructed. The existing 3-million-gallon reservoir is in need of major repair, and the new 1.5-million-gallon reservoir will allow down time to complete repair activities. Redundancy of systems will allow for improved operations following repair activities. Two Line Item projects have been submitted for funding that will address the potential for cross contamination in the potable water system due to water lines that run through areas of known subsurface contamination. Several isolation methods, to include trenchless technology, are being evaluated.

Telecommunications. Telephone systems will continue to be upgraded as technology and demand change. Computer networking improvements will include the gradual upgrading of office wiring to include “Category 5" grade copper scale and/or fiber to the desktop and the migration of the existing network topology from shared-media to switched-media using a combination of layer-2 and layer-3 switches. The ORNL network backbone will remain fiber-optic based but will evolve from its current Fiber Distributed Data Interface (FDDI) technology base to a set of parallel FDDI, Gigabit Ethernet, and ATM networks that provide the flexibility to accommodate almost any network-intensive computing project while holding the line on costs for less demanding applications.

Transportation and Grounds. GPPs have been submitted which will improve the transportation and grounds in both the East and West Campuses. Inside the ORNL boundaries, roads providing access to new facilities will be constructed and others realigned to improve traffic flow. Plans include widening and/or relocating Bethel Valley Road and upgrading Melton Valley Road to improve access and safety. Walkways will surround all new facilities and connect individual buildings with others in the same area and with parking areas.

Security. Future security planning will continue to place an emphasis on appropriate security measures to protect against events that may cause adverse impacts on national security, the environment, and the health and safety of employees, guests, and the public while continuing to maintain an environment conducive to ORNL’s research mission. Reconfiguration of ORNL’s security perimeter is planned to be completed before FY 2002. The objective of this reconfiguration is to ease access by creating a more open, less restrictive atmosphere. This will be accomplished by realigning security fences and portal accesses and placing access controls on facilities outside security fencing.

HVAC. The HVAC design in each building depends on the specific features of each building. Large computer installations and certain other instruments must be housed in an area with low temperature and relative humidity. Other needs are associated with staff indoor air quality and facilities housing animal experimentation. Buildings having exhaust hoods generally have a 100% outside air system which operates very inefficiently. Examples of needs include refurbishment of HVAC system heating

and cooling equipment, ductwork, filters, stacks, scrubbers, and alarm and backup systems. Several GPPs and LIs have been requested to refurbish existing systems and to install new systems. Evaluations are continually being made by P&E personnel and health and safety personnel to ensure that the air quality supplied by HVAC systems meets standards.

Steam. The steam production system consists of four dual-fuel boilers and one package-type boiler. The total capacity of the five boilers is 305,000 lb/h of saturated steam at 250 psig. Steam is supplied to Bethel Valley facilities and Melton Valley facilities in the 7500 and 7900 areas. The steam plant also houses the necessary auxiliaries such as feedwater pumps, draft fans, water softeners, fuel pumping stations, reducing stations, and fuel handling systems. Major refurbishment of the steam and air distribution systems took place in 1998 with plans to complete activities with planned projects. Systems are being refurbished to convert systems to gas-fired with oil-fired backup. A new fuel oil tank has been installed to ensure continued service to connected equipment. Boiler upgrades have taken place, and new projects are being funded to upgrade system components for long-term gas operation.

Waste. ORNL has responsibility for conventional waste, including sanitary/industrial wastes, process wastewater, and stormwater. Solid conventional wastes are regulated by the Tennessee Solid Waste Management Act. Bechtel Jacobs Company is responsible for systems and operations for disposal of low-level radioactive, transuranic, hazardous, mixed, and toxic waste. Increased loads from facility and staff relocations to the Bethel Valley site will require refurbishment and expansion of existing systems.

Miscellaneous Systems. Miscellaneous systems include telecommunications, transportation and grounds, security systems, compressed air, distilled water, etc. Each of these systems is essential to the continued research mission at ORNL. Planning is included to ensure that, as facilities and infrastructure are built or refurbished, all miscellaneous systems will be included.

Future Changes in Infrastructure. Site development planning is a real-time activity, evolving as necessary to meet changing needs. Infrastructure improvements are planned as changes in facility types and needs are made.

4.5 OTHER GPP/GPE

Although not categorized as FRP or utilities, other general GPP and GPE ADSs identify essential needs for the continued operation of the Laboratory. These projects and equipment needs typically are in support of ongoing operations and maintenance activities and planning, oversight, and management activities funded through the Office of Science Basic Energy Sciences landlord funds.

4.5.1 Other General GPPs

General GPP ADSs address concerns for site reservation activities and ongoing facilities operations to include the following categories:

Facility additions and upgrades Building 2500 - Fire Protection Headquarters, Building 7900 - HFIR Entrance, Building 2007 - Internal and External Dosimetry, Building 6012 - Computer Sciences Research, Building 4512 - Technical Support Building, and the site heavy equipment shed.

Road improvements Bethel Valley and Melton Valley.

General facilities Elevators, hot cell systems, data network systems, and motor/generator replacements.

Appendix C contains tables identifying those other GPPs that generally support additions to existing facilities, safety and health supporting projects, roads and grounds, and special projects.

4.5.2 Other General GPEs

General GPE ADSs address the following equipment categories:

LDRD equipment.

ES&H, quality, and security systems.

Information and records management.

Multiprogram research instrumentation.

Appendix C contains tables identifying those GPEs identified as other general GPEs.

5. ORNL MASTER PLAN

The Master Plan for development of the ORNL Laboratory of the 21st Century has been formulated to meet the scientific needs of the research community utilizing the facilities; provide a safe, quality, and energy-efficient work environment for ORNL staff; and ensure adequate flexibility and growth potential for future expanded research missions. The following description of the Master Plan includes a review of the basic guiding principles used in developing the plan, an overall view of the long-term Master Plan, and separate descriptions of each of the phases of the Master Plan growth.

5.1 MASTER PLAN VISION/GOALS

The guiding principles for the ORNL Master Plan were developed early in the planning process and incorporated input from a variety of stakeholders, including ORNL research, operations, ESH&Q, land use, program development, and DOE staff. From formal brainstorming sessions, stakeholder surveys, management- and staff-level briefings, and written DOE guidance, an overall vision for the facilities revitalization effort was developed and adopted that states:

The vision of the FRP is to provide ORNL staff with world-class facilities, consolidated at the main ORNL site, that lay the foundation for ORNL's scientific excellence into the 21st century.

Accomplishing that vision as soon as possible then became the mission of the FRP team, with the highest-priority projects to be completed within a 5-year time frame. Specific Master Plan goals to be realized when modernization is complete were then defined in each of the following areas:

Scientific Mission: Support the multiprogram nature of the Laboratory and accommodate program growth and technology changes well into the 21st century. Integrate the program needs into a research campus environment that encourages interdisciplinary teaming.

Work Environment: Provide a quality work environment for employees and visitors that enhances their productivity and attracts the next generation of world-class scientists to ORNL. Facilities will contain the latest advances in information technology and research laboratory infrastructure and will be designed to provide maximum flexibility for program changes.

Environment, Safety, Health, and Security: Provide a safe, healthy, environmentally conscious, secure workplace for employees and visitors. The Master Plan should maximize the use of already disturbed (brownfield) areas for new development, emphasize energy efficiency and sustainability design features, and provide an open campus security environment wherever possible.

Operations and Maintenance: Facilities and infrastructure will be efficient to operate and maintain. New building designs will incorporate energy-efficient heating/cooling systems, utility services, insulation, and exterior surface materials that are state-of-the-art, yet durable and maintainable.

Architectural: The new ORNL campus will have a unifying architectural style that reflects the mulitprogram scientific nature of the Laboratory mission and celebrates the unique history of the main ORNL site and the natural beauty of East Tennessee. The new research facilities will be built around an identifiable campus center where staff, visitors, and the general public will be welcomed and allowed to meet and exchange ideas.

We believe the Master Plan, outlined as follows, achieves these goals in a most innovative and attractive manner.

5.2 THE MASTER PLAN FOR ORNL SITE DEVELOPMENT

A view of the Master Plan for long-term site development at ORNL is provided as Fig. 5.1, with the planned new facilities highlighted in color by phase of construction. This plan, incorporating the vision and goals described above, focuses on a multicampus layout (East, Central, and West Campuses) to accommodate the multiprogram nature of ORNL research activities. The East Campus was structured to continue the historical mission work in High Energy Physics, Computational Science, Chemical/Analytical Sciences and Engineering, and Materials Research, as well as provide expansion room for the Engineering Technology field of study and future collaborations with UT and the broader university community through new Joint Institutes. The West Campus Master Plan focuses on support of Environmental and Life Sciences research needs, making the Marilyn Lloyd Environmental and Life Sciences Complex historical vision a reality. The Central Campus plan for redevelopment was a bit more complicated, due to the presence of a large number of contaminated facilities that were critical to ORNL's early years and are now part of the EM Program for D&D. That portion of the ORNL site would continue to be a primary area for Solid State, Materials, Energy, Instrumentation, and Chemical Technology research, but with limited new facilities construction planned until D&D activities are completed in 10 to 15 years. Once the Central Campus area is returned to useable/buildable status, then additional research and support development would occur as part of the overall Master Plan.

The multicampus site layout provides identifiable campus centers to develop in the East, Central, and West portions of the site, around commons areas that promote researcher collaboration, and with reasonable walking distances maintained for all critical services to promote energy savings and improved worker health. The close-pack arrangement of new buildings, and their purposeful proximity to the existing strategic ORNL buildings, minimizes the area required for new development and allows reuse of already disturbed land (parking lots, remediated sites) in a brownfield-type approach. The natural areas on the hillsides overlooking the ORNL site to the north are maintained in their current state under this plan; a tree-lined avenue is established from east to west through the entire site; and an expansion of the historical Swan Pond is provided at the ORNL entrance to emphasize the natural beauty of Bethel Valley in which ORNL resides and to provide a water source to support energy-efficient operations of new facilities. This entrance area comes to a focal point at the Research Support Center (hereafter referred to as The Center), the centerpiece of the East Campus, where visitors to the Laboratory will be welcomed, conference facilities are provided, and ORNL staff are encouraged to congregate and collaborate in the main cafeteria facility and surrounding open areas.

Architectural consistency will be provided within each campus to ensure blending of new construction with the existing strategic structures, while allowing state-of-the-art improvements in building sustainability designs. Recognition of the history of the ORNL site will be a critical element of the design and siting of new buildings, with preference given, where possible, to protecting those important features of the Laboratory. The proposed site layout, use of between-building spaces, and dispersed parking concepts are predicated on a change in the physical security approach at the Laboratory. Such a change would involve, in its simplest form, elimination of the fence boundary to allow the East and West Campuses to become more open, and for access controls to be provided, instead, on a building-by-building basis through a badge-reader-type system at each building entrance.

The emphasis of the Master Plan is on the main ORNL site in Bethel Valley since the majority of the research staff and the old facilities are located there; however, the important missions at HFIR and the Robotics and Process Systems areas (the 7900 and 7600 Areas, respectively) are not overlooked in this plan. Facilities improvements and new construction investments will continue to be made in those areas throughout the planning horizon, as noted in the details of the Strategic Plan that follow. As well, the significant investment being made by DOE in constructing the SNS is factored into the ORNL Master Plan, with recognition of the entrance requirements for that facility and the availability of shared resources and facilities.

5.2.1 East Campus Design Features

The East Campus (see Fig. 5.2) is built around the new ORNL Center as the central point for interface with the public and for congregation of the Laboratory staff. That facility contains the visitor reception area, the main ORNL cafeteria, and the primary large auditorium for Laboratory seminars and briefings (with adjacent breakout conference rooms). These conference rooms would also become a critical resource to the Laboratory for support of normal research project teams, university/ commercial partnerships, and routine audit team space. Commons areas in front and behind The Center would provide a quality environment for staff/public interactions and congregating space for conference attendees and lunch-time crowds.

Support for the research mission is a primary emphasis in the East Campus design, with siting proposed for up to eight new research and related buildings within walking distance of The Center and the current research/administration hub of 4500N/S. These buildings would be phased, as required by program growth, and located in strategic proximity to collaborating organizations. Existing research laboratories and offices in the 4500N/S complex, as well as those in the Physics and Computational Sciences complex in the 6000 Area and the HTML area (4515), would be upgraded, as required, under this Master Plan to bring them up to 21st century technology and infrastructure capabilities to allow them to continue serving as the research backbone for this portion of the Laboratory.

A key component of the new research capabilities in the East Campus will be the expected addition of facilities to house the Joint Institute for Computational Sciences (JICS) and the Oak Ridge Center for Advanced Studies, two of the commitments made by the State of Tennessee as part of the UT-Battelle facilities revitalization proposal. These user-facility/scientific-collaboration-type buildings will be consistent with the open public nature of the East Campus setting and will be sited to best accommodate scientific/public needs. The location currently shown in Fig. 5.2 is representative only, with final siting to be determined through agreements with UT, the State of Tennessee, and UT-Battelle management staff.

Utilities and infrastructure improvements will be made as part of the development of the East Campus, with upgrades anticipated in potable water, electrical distribution, steam, HVAC, and wastewater collection/distribution systems. As the majority of new facility construction activities are sited on the current main ORNL parking lot, replacement of that critical piece of infrastructure also becomes important. Traffic flow and parking availability planning has been factored into the Master Plan, with particular emphasis on traffic calming along Bethel Valley Road, visitor parking associated with The Center, and use of previously disturbed areas for provision of staff parking near their place of work assignments.

5.2.2 West Campus Design Features

The emphasis on the West Campus development (Fig. 5.3) is to consolidate Environmental and Life Sciences research activities into an identifiable complex surrounding a natural commons area. The

existing strategic research facilities housing Environmental Sciences Division and LSD staff would be retained and upgraded as required to meet the state of science in the 21st century. Adjacent to those buildings, the new Laboratory for Comparative and Functional Genomics, the Joint Institute for Biological Sciences, and a proposed Center for Biological Sciences office/laboratory facility would be constructed around a commons area, all of which are tied visibly to the East Campus by the landscaped avenue that runs east to west through the main ORNL site. Accomplishing this vision for the West Campus will require the demolition of Building 1000, one of the prime examples of outdated, substandard office buildings that are the focus of the revitalization effort. Similar to the East Campus, upgrades will have to be made in the general infrastructure of the West Campus to accommodate planned growth and replace/reorient roadways and parking.

5.2.3 Central Campus Design Features

Few design features have been developed at this point for the long-range redevelopment of the Central Campus area (Fig. 5.4), since remediation of the majority of the structures there is still 10 to 15 years away. What is planned, however, is the continued use and upgrade of current strategic research facilities in the heart of the campus, the addition of a few key near-term facilities in proximity to existing concentrated program complexes (e.g., Energy Division and Solid State), and longer-term development of a central commons area to be bounded by future mission-related research laboratories/offices. In addition, the Master Plan includes an ultimate relocation of ORNL support services capabilities from the 7000 Area into the center of the ORNL site to complete the consolidation of ORNL operations within the compact, three-campus setting. While the existence of closed/remediated EM sites within the Central Campus area will certainly restrict the location and type of buildings sited, sufficient unrestricted development areas are expected to be made available for the needed ultimate consolidation. In fact, early planned reuse of the remediated surface impoundments area for parking is a good example of the type of brownfield redevelopment that will be the hallmark of the Central Campus revitalization.

5.3 MASTER PLAN PHASE I: FY 2001–06

Accomplishment of all of the ORNL Master Plan objectives will obviously take many years. Phasing of the project will be required to correspond to the availability of each of the various funding types, the programmatic needs of the research organizations, and the constraints of the existing/planned infrastructure to support construction and operations. The discussion that follows of each of the planned construction phases is intended to outline the general goals that we would hope to accomplish during those time frames, blending the reality of these constraints with the strong push from the Office of Science to modernize ORNL on an accelerated schedule. The FRP has been separated into three primary phases, representing plans for the periods FY 2001–06, FY 2007–11, and beyond FY 2011. Obviously, the details of specific projects and timing gets less clear after the first 5 years, and for the period beyond FY 2011, information deals only with general programmatic mission potential and the hopefully successful remediation of the Central Campus area by EM.

Phase I is the most critical stage for the revitalization effort, as it is here that the concept of private-sector involvement and State of Tennessee investment in the ORNL campus upgrade must happen. It is here, also, where the "new" look of 21st Century ORNL begins to take shape around The Center in the East Campus and the Laboratory for Comparative and Functional Genomics in the West Campus. This phase also includes completion of the relocation of all ORNL staff from off-site locations at Y-12 and most leased space to the main ORNL site. A view of the overall ORNL site plan

at the end of Phase I is provided in Fig. 5.5, with details of the activities in each campus area outlined as follows.

East Campus. The research campus nature of the Laboratory will appear during Phase I, with the planned construction of The Center, three private-sector research buildings, two State of Tennessee Joint Institutes, a general purpose support office building, and the infrastructure that integrates the new facilities with the existing Laboratory and provides a new face to the public and visiting scientists. In addition to the new construction, renovations will begin to take place on existing research and support buildings to accommodate staff consolidation and new science initiatives, the most notable of those being the upgrades to 4500N/S, to the HTML, and to Building 5500 (for ESH&Q consolidation). Research wings of the 4500N/S complex will be prioritized for upgrade, and staff will be temporarily relocated in a phased approach to allow the existing 1950s laboratories to be updated to current technology. At the HTML, a new special-foundation-designed wing would be added to the current laboratory to allow consolidation of the primary ORNL electron microscopes into a single, unique, and highly stable facility to support long-term use of these supersensitive instruments.

While specifications are not complete for each of the primary new buildings in the Phase I East Campus, some basic footprint and program content planning has been completed. As described earlier, The Center would contain the most public parts of the campus, housing the visitor reception area, main Laboratory conference center, and cafeteria. This roughly 50,000-square-foot facility would be built with DOE Line Item funds and would become the "statement" building for ORNL, with design features that would emphasize the importance of ORNL as one of the country's premier research institutions and incorporate energy efficiency and sustainability in building materials of construction and operation (Fig. 5.6). Its glass facade would front the expanded pond area to the east and a courtyard to the west, providing ORNL staff and visitors an opportunity to embrace the beauty of the East Tennessee setting of the Laboratory during their normal conduct of business. Similarly, each of the private-sector buildings would have a view to the north of the existing pond and hillside landscape, through glass-enclosed fronts that form the southern boundary of the new campus quadrangle. These roughly 100,000-square-foot laboratory/office buildings would be built in complementary style to The Center but would be focused on very specific research mission functions. One would be dedicated to the work performed by ETD, which will be moved from its location at Y-12 into a facility designed to house its special mechanical, thermal, and materials research needs. The second will be designed for movement of the ORNL supercomputer capabilities into 21st Century Laboratory space and establishment of a Computational Science Building at ORNL.

The third private-sector building is expected to house energy and materials research staff, as well as support organizations critical to the research mission.

The other new buildings in the East Campus area consist of a DOE GPP-funded office building adjacent to the existing Building 5002, and the two State-funded joint institutes. The Joint Institute for Computational Sciences (JICS) and the Oak Ridge Center for Advanced Studies (ORCAS) would be sited in the East Campus, in close proximity to The Center and the ORNL Computational Science Building to ensure close ties to those complementary functions. While the program content of these collaborative facilities is still being finalized and the specific siting of those buildings is still to be determined, the basic functions, interrelationships, and footprint are understood and have been accommodated in the Phase I plan. The East Campus Service Building has been proposed to provide a new, more space-efficient and centrally located home for the ORNL Graphics and Reproduction Center, along with office space to be used for temporary overflow space for staff being displaced during the 4500N/S complex upgrades. This facility is expected to utilize the standard office design

concept for GPP offices that has worked so effectively in minimizing the cost of construction of standard office facilities at ORNL. The 4500N upgrade program would be initiated in Phase I and would focus on Wing 4 and the headhouse portions of that complex as the first Line Item project, with subsequent projects (over a 10-year period) sequenced as appropriate to address the laboratory upgrade needs in the rest of 4500N, 4500S, and the adjacent attached buildings, such 4501, 4505, and 4508.

The primary infrastructure improvements in the East Campus during Phase I will be associated with providing necessary utilities support to the new facilities construction, construction of the roads, ponds, and commons areas between buildings, and the replacement of parking that is eliminated by new campus construction. Another key infrastructure change during Phase I is the assumed reorientation of the security perimeter on the east end of the main ORNL site to allow building-controlled access in the East Campus and implementation of a revised traffic/parking plan.

West Campus. Phase I activities in the West Campus will be centered around the new Laboratory for Comparative and Functional Genomics, a DOE Line Item now in the design stage that will house the ORNL mouse colony critical to ORNL's future genomics research. This 35,000-square-foot facility will allow the mouse colony to be moved from its historical (but now deteriorated) home at Y-12 and open the availability of that important DOE resource to a broader research community.

That enhanced research community will be better able to utilize this resource through the Joint Institute for Biological Sciences (JIBS), a State of Tennessee funded research laboratory and office facility to be co-located in the West Campus during Phase I. Only the necessary infrastructure to support the construction and operation of these facilities will be provided in the West Campus during Phase I, with commons areas, restructured parking, and roads to await Phase II funding.

7600 and 7900 Areas Development. While not within the main ORNL campus boundaries, critical activities are occurring in the HFIR/REDC complex (7900 Area) and the Robotics and Process Systems Complex (7600 Area) in the Phase I time period that are important to the overall ORNL revitalization initiative. The improvements to HFIR operations and research capabilities occurring during their ongoing upgrade program will make the reactor and adjacent facilities more user-friendly and available. To support that increase in mission, several DOE GPP-level projects will be undertaken in Phase I that eliminate multiple trailers housing research and support staff, provide much-needed highbay operations and storage areas, and improve the user-facility status of the complex. The 7600 Area has been selected to be the location for consolidation of FED staff and facilities that have been historically located at Y-12. To allow that consolidation to occur, staff from several divisions in existing 7600 space will have to be moved to the East Campus, upgrades provided for the vacated space, and several new DOE GPP facilities constructed (for offices and for highbay process space needs). Locations of the planned new facilities in the 7600 and 7900 Areas are shown in Figs. 5.7 and 5.8.

5.4 MASTER PLAN PHASE II: FY 2007–11

Phase II of the Master Plan focuses on continuation of the upgrade to the 4500N/S complex in the East Campus area, on additional development of the West Campus quadrangle, and on refinements of the infrastructure (roads, parking, and utilities) across the ORNL site (Fig. 5.9). While the site construction efforts are smaller in Phase II of the plan, significant investments instead are being made in the placement of vacated buildings into "cheap-to-keep" mode and implementation of facility decommissioning for the highest-priority projects. During this phase, cost savings from the Phase I

exit from inefficient buildings will peak and will help fund many of the ongoing maintenance improvements needed for the remaining inventory of ORNL facilities.

East Campus. The primary construction activities in the East Campus during this phase will be continuation of the 4500N/S complex laboratory upgrade projects, with completion of that work expected early in Phase III. Infrastructure improvements would also continue throughout Phase II, focusing on final road and parking lot upgrades to support the private-sector buildings, traffic calming improvements along Bethel Valley Road, and the more routine utilities and facilities needs for the existing main plant area.

West Campus. In the West Campus, Phase II brings form to the commons quadrangle at that end of the ORNL site. The existing Building 1000 will be demolished to eliminate that substandard space and provide room for a new Center for Biological Sciences Line Item facility as well as the common space between it and the Genomics Laboratory/Joint Institute for Biological Sciences complex further to the west. The Biological Sciences facility will provide space to complete the consolidation of all LSD staff from off-site and other on-site locations, finally bringing to fruition the concept of the Environmental and Life Sciences Complex. Additional parking will be constructed to the north of the complex to serve the entire area, and a modified entrance from Bethel Valley Road will be provided to improve traffic flow and public interaction at this end of the ORNL site.

5.5 MASTER PLAN PHASE III: Beyond 2011

While programmatic and site infrastructure needs are not well defined for the period beyond FY 2011, the Master Plan has incorporated the necessary flexibility and expansion room to accommodate any level of growth that would conceivably occur. This phase of expansion could involve construction of office/laboratory space in the East Campus north of 4500N, additional office/laboratory space to the east of the 6000 Area, new Environmental and Life Sciences expansion in the West Campus, and/or redevelopment of a Central Campus area on sites that are remediated by the EM Program by that time frame (Fig. 5.10). The specific location and program content of those facilities would be determined in the outyears, but the Master Plan approach provides growth potential in areas adjacent to all major science centers within the ORNL main research campus. At this point in time, it may be appropriate to relocate the service functions currently being performed in the 7000 Area into the Central Campus redevelopment in order to make that support more efficient in serving the Laboratory research mission and allow appropriate disposition of those aging facilities.

Infrastructure needs to support the long-range site development would be addressed as decisions are made on the ultimate growth locations. Utilities upgrades and distribution, as well as road access and parking improvements, would be provided as required. During this phase, consideration will also be given to creating a bypass for the portion of Bethel Valley Road that forms the northern boundary of the ORNL site along the main entrance area. The bypass would route through traffic behind the low hills to the north of the ORNL main entrance and allow the existing road to become part of the ORNL campus, with appropriate boulevard landscaping and traffic calming to be incorporated.

6. PRELIMINARY COST AND SCHEDULE

Based on the facilities consolidation planning and Master Plan approach presented in previous sections, an analysis of the cost and schedule associated with implementation of the *ORNL Strategic Facilities Plan* has been completed. Currently, such cost and schedule information is necessarily very preliminary, since detailed construction project estimating has not yet been completed for most of the proposed facilities and the safe shutdown and decommissioning requirements of to-be-surplus facilities are just beginning to be understood. However, an attempt has been made to capture the order of magnitude of all significant cost elements and to provide a realistic time line for accomplishing the major site development activities.

6.1 COST ESTIMATING METHODOLOGY

The cost estimates provided are based on the use of site- or region-specific cost factors for each of the primary facility revitalization work activities expected to be accomplished during the planning period. These factors include (1) current operating costs of facilities at the Y-12 and main ORNL sites, as well as current lease costs for organizations that are at off-site locations; (2) transition costs for placing facilities in a "cheap-to-keep" mode; (3) routine annual S&M costs for facilities that are in the "cheap-to-keep" mode; (4) gross D&D costs for permanent disposition of surplus facilities; (5) construction costs for facilities to be built by DOE, the State of Tennessee, and the private sector; and finally (6) relocation costs for moving staff and associated equipment/furniture into new/refurbished facilities. For each of these factors, ranges were developed to bound the expected costs, and differences were noted for such factors as location (Y-12 vs the main ORNL site) and type of space (office vs light laboratory or nuclear facility). Generally, costs were captured on a dollar-per-square-foot basis to allow ease in application of the estimating methodology across the wide range of activities to be completed as part of the revitalization effort. However, for some costs (e.g., staff relocation), a dollar-per-person range was utilized as appropriate. A summary of the primary cost factors used for this FRP budget estimating exercise is provided in Table 6.1 Most costs were estimated in current year (FY 2001) dollars, with escalation provided where appropriate for outyear activities.

Based on these cost factor ranges, estimates by individual building and ORNL division staff move were made, utilizing existing site knowledge and recent performance history to determine which end of the cost ranges to employ. For projects already in detailed design, or for which earlier cost documentation exists, those data were used specifically. Obviously, once detailed planning is available for each of the remaining planned activities, real bottoms-up engineering estimates can be made. No overall contingency factors have been added to the estimates at this point in time; however, contingencies are certainly included in the ranges noted for each cost factor.

6.2 RESOURCE PLANNING, PRIORITIZATION, AND ALLOCATION

For both capital construction and operating funds distribution at the ORNL site, a formal review and allocation process is conducted, and FRP needs will be addressed through that process. Such facilities planning is required by DOE Order 430.1A, "Life Cycle Asset Management," which specifies that

ORNL shall plan, acquire, operate, maintain, and dispose of physical assets as valuable national resources. Implementation of this order by the ORNL Facilities and Operations Strategic Planning

Table 6.1. Cost factors for FRP budget estimating

Current Operating Costs	
Main ORNL site	15 $/sq ft
Y-12 Plant	12 $/sq ft
Off-site leased space	20 $ /sq ft
Transition costs (“cheap-to-keep”)	
Office building	3–20 $/sq ft
Light laboratory	15–22 $/sq ft
Haz/nuclear facility	28–40 $/sq ft
Routine surveillance/maintenance	2–5 $/sq ft
D&D costs	
Office building	12 $/sq ft
Light laboratory	45 $/sq ft
Haz/nuclear facility	225 $/sq ft
Construction costs	
DOE office building	150–250 $/sq ft
DOE light laboratory	200–400 $/sq ft
Lease/operating costs	
State of Tennessee (light lab)	15 $/sq ft
Private sector (light lab)	25 $/sq ft
Staff relocation costs	$4–8K/move

Office is through a graded approach based upon best industry practice as agreed upon by the DOE SC and the local DOE oversight offices. The ORNL site planning methodology is outlined in Fig. 6.1.

The process generally consists of the following steps:

Needs assessment identification Needs assessments are performed by ORNL organizations and line management to identify the activities, systems, and programs needed to ensure the effective management of operations, ES&H, and infrastructure risks and to create a culture within ORNL that effectively integrates employee protection into work planning and the execution of work activities.

Activity data sheet (ADS) preparation ADSs contain the essential scope, schedule, cost estimate, and management information necessary for ORNL organizations to support planning and provide input to the budgeting process. ADSs are prepared for all landlord programs and activities needed to operate ORNL in a manner that protects the employees, the public, and the environment; meet those requirements set forth in the ORNL Work Smart Standards and by DOE; and ensure adequate infrastructure resources to meet the mission of the Laboratory.

Risk-based prioritization of activities The ORNL Risk Ranking Board uses a Risk-Based Priority Model (RPM) to perform risk evaluations of all landlord operations, ES&H, infrastructure, and other identified ADSs. Using the RPM, a risk-reduction benefit score is derived for each ADS, and ADS scores are used to establish preliminary priority lists that are reviewed by senior management. Priority adjustments are made as necessary in consideration of additional planning factors.

Allocation of resources Resource planning and allocation are done on the basis of programs essential for compliance, fulfillment of ORNL missions, and assurance of the safety and well-being of ORNL personnel, the public, and the environment. Resource allocation is determined by supporting the highest-ranking activities within the target funding levels. The ORNL Leadership Team and the DOE Site Office review and approve proposed GPP, GPE, and overhead programs.

For the FRP capital and operating cost requirements outlined in this plan, the individual projects will be evaluated through this formal process prior to funds allocation and project execution.

6.3 MASTER PLAN SCHEDULE

An upper-level schedule has been developed that outlines the major construction activities to be conducted during each phase of the Master Plan implementation. This schedule (Fig. 6.2) provides an identification of the funding type; a project descriptive title; and a construction time line for all new building construction, major existing facility modifications, and primary infrastructure improvements required to support the facilities revitalization mission objectives. As can be seen from this schedule, multiple DOE capital projects are proposed to be underway simultaneously during each phase of the development plan, with the major early projects including completion of the Laboratory for Comparative and Functional Genomics (FY 2003), the 7600 Area Fusion Support Buildings (FY 2003), The Research Support Center (FY 2004), the East Campus Infrastructure Improvements (FY 2005), and the completion of the initial stage of the science laboratory upgrades in the 4500 North/South complex (FY 2005). In parallel to the ORNL improvements underway at that time, the SNS project will be completed (FY 2006) to complement the 21st Century Laboratory capabilities in Oak Ridge. Phase I investments by the private sector and State of Tennessee will also be critical to the new campus development, with all four of the State joint institutes expected to be operational by FY 2006 and the Engineering Technology and Computational Science laboratories to be the first private-sector facilities completed (FY 2002), followed by additional research office facilities/light laboratories to be constructed in the East and West Campus areas as required to support program growth and staff consolidation. By utilizing all three funding sources, it appears that most of the needed new facilities construction can be completed within the FY 2012 planning horizon, to be followed by more standard DOE construction schedules for specific programmatic needs in the years following.

A key to the accomplishment of DOE-SC's modernization vision is the consolidation of research and support staff from existing aging and substandard facilities into new or refurbished facilities. Once the staff and operations are removed from the older buildings, those facilities must be placed in a "cheap-to-keep" mode and put under a routine S&M program appropriate for each building.

Ultimately, those facilities must be decontaminated and decommissioned, either as part of an SC-funded program and/or as part of the EM remediation program. Based on our current understanding of the scope and complexity of this process for each of the buildings identified as surplus to ORNL needs, as well as a reasonable allocation of funds to address this part of the revitalization effort, a preliminary schedule for the staff relocation and facilities safe standby activities for the most critical ORNL facilities has been developed and is presented in Fig. 6.3. Only a few building decommissioning projects (Buildings 1000, 2000/01, and 5000) have been scheduled in the 10-year planning horizon, with the remaining work all to be conducted in FY 2012 and beyond. This schedule will have to be refined as funding profiles, project scope, and method of accomplishment are defined by DOE.

While knowledge of the phasing of construction projects and an understanding of consolidation schedules are important to the implementation of the FRP, the real measure of the success of the revitalization effort will be the identification and completion of the more global goals associated with the program. These goals include upgrading critical scientific facilities (i.e., securing the next teraflop computer, providing vibration-stabilized electron microscope laboratories, housing the ORNL mouse colony in accredited facilities); consolidating staff into more cost-effective quarters (i.e., ORNL at Y-12 staff relocated to the main ORNL site); providing significantly improved quality of work life facilities to keep existing staff and attract the next generation of world-class scientists (i.e., completion of The ORNL Center, reconfiguration of the security perimeter); and dispositioning excess contaminated facilities that have reached the end of their useful life and remain health and environmental hazards (i.e., Building 2000/2001 demolition). Fig. 6.4 identifies these types of program goals as major milestones along the Phase I and II time lines for the ORNL East and West Campuses, giving a real focus to the true mission of the revitalization effort.

6.4 MASTER PLAN COST

Based on the costing methodology outlined in Sect. 6.1 and the overall project schedules defined in Figs. 6.2 and 6.3, a preliminary cost estimate for the ORNL facilities revitalization effort has been developed and is presented in Table 6.2. This estimate provides project totals by phase of construction; funding source (DOE, State of Tennessee, and private-sector); and primary cost element. More thorough, project-specific details by year and funding type (LI, GPP, State, or private) are included in Table 6.3. As noted by these estimates, significant investments from all funding sources will be required over the next 15+ years to accomplish the goals of the DOE-SC laboratory modernization initiative. The emphasis in the first phases of the program will be in construction of new facilities and transition of staff into those facilities, with the primary outlay in the later years in the decommissioning of the resulting surplus facilities. These decommissioning cost estimates are very preliminary, providing only an order-of-magnitude look at the relative size of the SC and potential EM commitments in this area.

The preliminary estimate of slightly higher than $1,200 million represents a significant investment by the Office of Science organization but accomplishes the goal of modernizing ORNL into one of DOE's premier 21st Century Laboratories in a time frame consistent with the programmatic needs of the research community. Of that total, DOE construction represents approximately 45% of the investment, continued existing/new facilities operations 25%, facility consolidation/S&M 10%, and facilities D&D 10%. The State of Tennessee and private-sector facilities cost contributions come to just over 10% of the total. The revitalization resource needs are spread almost evenly between Phase I and Phase II of the project, with only the D&D portion of the project to be expended beyond the modernization 10-year planning horizon.

To place the total cost figure in perspective, however, it should be noted that a "business as usual" approach to continued operations and upgrade of existing facilities, plus the sunk cost of ultimate D&D of nonstrategic facilities totals almost $700 million during the same planning period. And if one considers that current maintenance levels [0.5% of replacement property value (RPV)] are significantly below industry standards (2.5% of RPV), bringing maintenance costs to needed levels would result in an additional $200 million cost during the 10-year period. **Hence, the "business as usual" case would result in almost the same level of investment as the SC modernization approach—with one huge difference. The modernization initiative provides world-class facilities for ORNL scientists on a schedule that is compatible with the SC mission needs.**

The early investments (Phase I) will include a larger percentage of funds from the State and private sector (25% of the total construction investment in that phase) as the emphasis is on developing quality, cost-effective scientific space for new endeavors as rapidly as possible. The later phases depend less on those external funding sources, as DOE capital and programmatic investments are used to complete the laboratory and infrastructure revitalization as well as take care of the legacy of excess facilities. The overall new facilities construction or upgrade investment by all funding sources ($600 million) represents a reasonable percentage of the total ORNL facilities replacement value (approximately 70% of the $900 million replacement value of the basic science infrastructure, excluding HFIR and Y-12 facilities) reversing the historical trend of inadequate repair/replacement investment in the DOE laboratory complex.

Table 6.2. Preliminary cost estimate for ORNL site development ($ in millions)

Funding source	Phase I (FY 2001–06)	Phase II (FY 2007–11)	Phase III[a] (Beyond FY 2011)	Totals
DOE facilities				
Capital construction				
Line item	211	98	–	309
GPP/GPE	112	95	–	207
Facilities consolidation/S&M	73	40	–	113
Facilities operation	167	144	–	311
Facilities D&D	4	–	122	126
State of Tennessee facilities				
Facilities construction	26	–		26
Facilities operations	9	18		27
Private-sector facilities				
Facilities operations	29	58		87
Totals	631	453	122	1,206

[a]Only D&D costs were estimated beyond the end of the SC modernization planning period.

Table 6.3. Resource needs for achieving SC Vision for the 21st Century Laboratory at ORNL
Estimated costs ($1000s)

Activity	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY 11	Beyond FY 11
CAPITAL FUNDING												
New Campus Facilities/Renovation												
Research Support Center (LI)		10,000	6,000									
Functional Genomics Lab (PLI)	2,500	10,000	1,400									
Advanced Materials Char. Lab (GPP)		400	4,400									
East Campus Service Building (GPP)			400	4,000								
Center for Nanophase Materials Science (PLI)			2,000	14,000	4,000							
Central Campus Research Building (GPP)				400	4,100							
Center for Biological Sciences (PLI)					2,000	14,000	4,000					
4500N/S Area (LI)		1,900	13,600	16,100	19,100	17,400	20,600	18,200	21,100	16,500	4,000	
7600 Area (GPP)	500	3,700	4,500	2,500								
Cold Guide Hall Extension (PGPP)	2,200	800										
HFIR User Support Facility (PGPP)			500	4,000								
7900 Area (GPP)		300	2,600	300	3,000	300	2,500					
5500 Building (GPP)			1,500	3,000								
East Campus Infrastructure (GPP)	700	2,400	2,000									
West Campus Infrastructure (GPP)						200	2,300					
Building Science Research Facility (PLI)				2,000	14,000	4,000						
Utility Upgrades (GPP/GPE)	4,100	2,600	2,000	4,800	4,800	10,700	9,000	8,500	6,500	5,700	5,700	
Other GPP/GPE	2,700	6,600	2,600	5,000	8,100	8,800	6,200	11,500	13,500	14,300	9,300	
Other LI	6,600	6,600	7,100	11,100	16,500	9,000	7,500	6,000				
Total DOE Capital Funding												
Line Item (PLI/LI)	9,100	28,500	30,100	43,200	55,600	44,400	32,100	24,200	21,100	16,500	4,000	
GPP/GPE (Landlord)	8,000	16,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	15,000	
GPP (Programmatic)	2,200	800	500	4,000								
STATE/PRIVATE SECTOR FUNDING												
State of Tennessee												
Joint Institute for Biological Sciences		2,000	6,000									
Joint Institute for Computational Sciences			1,500	4,500								
OR Center for Advanced Studies			800	3,200								
Joint Institute for Neutron Sciences				2,000	6,000							
Private Sector												
Computational Science Building	4,200	10,800										
Engineering Technology Building	4,200	10,800										
Research Office Building			5,000	10,000								
OPERATING COST												
DOE-Strategic Facilities												
Real Property Main. and Repair	11,000	12,100	13,300	14,500	14,700	15,000	15,200	15,400	15,600	15,900	16,100	
DOE-Nonstrategic Facilities	16,600	16,200	12,100	8,000	5,400	1,900						
State of Tennessee				3,000	3,100	3,200	3,300	3,400	3,500	3,600	3,700	
Private Sector			5,000	5,100	7,800	10,700	11,000	11,300	11,700	12,000	12,400	
New DOE Facilities	100	200	500	2,100	10,900	12,100	12,500	12,800	13,200	13,600	14,000	
DEACTIVATION/DECOMMISSIONING COSTS												
Y-12												
Staff/Equipment Transfers		400	4,300	3,000	700	2,900	800					
Cheap to Keep	1,500	3,200	5,000	6,000	5,300	3,900						
Surveillance and Maintenance	1,000	1,200	2,000	3,200	4,200	4,600	5,000	5,100	5,300	5,400	5,600	
Deactivation/Decommissioning												82,000
ORNL												
Staff/Equipment Transfers	500	200	3,000	2,000	3,000	2,600	300					
Cheap to Keep	800	500	300	900	700	2,800	1,400					
Surveillance and Maintenance	100	300	400	500	800	1,400	2,000	2,100	2,200	2,200	2,300	
Deactivation/Decommissioning		3,000				1,000						40,000

	Gross Sq Ft	TEC ($1000)	$/GSF
Research Support Center	50,000	16,000	320
Functional Genomics	32,000	13,900	430
Enviro/Life Sciences	9,275	3,000	320
4500N	102,000	15,800	155

DOE Total	
308,800	
199,000	
7,500	
State Total	
26,000	
Private Sector	
45,000	

79,600	Facilities consolidation/S&M Total	
82,000	Y-12 D&D Total	
33,300	Facilities consolidation/S&M Total	
44,000	ORNL D&D Total	

GPP = General Plant Projects
PGPP = Programmatic General Plant Project
PLI = Programmatic Line Item
LI = Line Item

7. CONCLUSIONS AND RECOMMENDATIONS

As outlined in the preceding chapters, it is clear that revitalization of ORNL facilities is critical to the future mission of the Laboratory and that UT-Battelle has a comprehensive and innovative approach to accomplish that goal. As presented in Fig. 7.1, the facilities consolidation strategy results in a 25% reduction in the operating footprint and cost of research and support facilities and decreases the average age of key ORNL scientific resources by 20 years. A unified, integrated ORNL research campus results from the UT-Battelle revitalization strategy, with all staff relocated to the main ORNL site within the 10-year planning horizon. The Master Plan for the new campus layout incorporates state-of-the-art energy efficiency and sustainability criteria into the new research building designs and focuses on new development in brownfield and previously disturbed areas rather than greenfield sites.

Completing the 21st Century Laboratory vision for ORNL will require significant investment of resources, both operating and capital funds. UT-Battelle's recommended approach of utilizing DOE, State of Tennessee, and private-sector funds to accomplish the new campus development is the most cost-effective option for accelerated improvements at the site. Preliminary analysis of DOE cost savings (operating and cost of capital) from early use of private-sector funds for construction of research facilities shows over $50 million in cost avoidance over a 15-year period compared to the standard dependence upon DOE funding alone. Similarly, the State of Tennessee contribution of some $26 million in support for establishing joint institutes is expected to substantially increase collaborative research with the university community.

This *ORNL Strategic Facilities Plan* fully meets the objectives of the DOE Office of Science Laboratories of the 21st Century modernization initiative, resulting in a workable plan for revitalizing the world-class ORNL research institution. However, implementing this plan will require a concerted effort from the DOE-SC, State of Tennessee, and UT-Battelle team in a number of areas:

DOE Must:
1. Institute a policy framework that permits private-sector investments.
2. Support modernization initiative with new administration and congress.
3. Accelerate transfers of surplus facilities to DOE-EM.
4. Increase flexibility on use of overhead funds for infrastructure needs.

UT-Battelle Must:
1. Provide guarantees for private-sector investments.
2. Improve operational efficiencies and reduce overhead burdens.
3. Define and cost-effectively implement the FRP tasks.

State of Tennessee Must:
1. Appropriate and build Joint Institutes on the ORNL campus.
2. Establish MOUs with UT-Battelle and DOE on building operations and long-term ownership.

All of these actions are critical to the success of the revitalization effort, and all must be addressed early in FY 2001 to achieve the modernization objectives.