Facility & Infrastructure Strategic Investment Plan

FY 2018

Infrastructure Services Directorate
Project Management Office

FACILITY & INFRASTRUCTURE STRATEGIC INVESTMENT PLAN

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I. INTRODUCTION

PLAN MISSION

Argonne National Laboratory is a multi-discipline science and engineering research-focused U.S. Department of Energy Office of Science (DOE-SC) laboratory. It is one in the complex of ten national science laboratories and 17 total Department of Energy laboratories across the country. Argonne is managed and operated for the DOE by the University of Chicago under a performance-based contract.

Argonne's mission is to serve America as a science and energy laboratory distinguished by the breadth of its R&D capabilities in concert with a powerful suite of experimental and computational facilities.

Argonne serves DOE by advancing the frontiers of knowledge, creating and operating leading edge scientific user facilities and providing innovative and effective tools and solutions to the grand challenges of our time: for sustainable energy, a healthy environment and secure nation.

Argonne's facility and infrastructure vision is shaped by the research goals and service mission of the Laboratory, which guide the physical development of the campus.

This Facility and Infrastructure Strategic Investment Plan (Plan) is a structured, ten-year outlook for site modernization and outlines Argonne National Laboratory's strategy to both revitalize existing and construct new facilities and infrastructure that will meet current and emerging scientific needs.

Section II of this plan documents the existing conditions of Argonne's facility and infrastructure assets, establishing the baseline for which planned repairs, rehabilitations and modernizations are needed over the next 10-plus years. Proposed resources required in achieving the Plan's goals to support the vision of Argonne and DOE are outlined. Prioritized needs, with timing and sequencing of actions chosen to align with the mission and leverage resources available for execution are documented in Section III.

Few constraints exist to expanding Argonne's role in twenty-first century research. The physical site at Argonne is relatively unencumbered by serious environmental or contamination legacies and has available land and utilities to support mission adaptation and developmental change. Modernizations of existing facility infrastructure to meet the needs of emerging scientific missions and the mission support operations are key challenges for Argonne.

PLANNING PROCESS

The Facility and Infrastructure Strategic Investment Plan (Plan) utilizes several sources of data and information. Various condition assessment surveys, performed annually by IS building maintenance staff and system engineers, feed into the Environment, Safety, Health and Infrastructure (ESH&I) deficiencies list. The ESH&I list for the site is kept within the Strategic Planning Program Office under the PMO Division. The Plan incorporates these facility and utility condition assessments with the goals of the Site Sustainability Plan, system reliability and redundancy analysis and scientific program priorities analysis. These items are cross-referenced with the Laboratory's four campus strategies for modernization (page 08) to ensure consistency. Figure 1 provides a graphic representation of the planning process.

The first edition of the Facility and Infrastructure Strategic Investment Plan was issued in 2016. This plan builds on and consolidates the former Site Modernization and Ten Year Site Plans while complementing the Annual Laboratory Plan. Subsequent plan updates will be published to the Argonne website as they are made. The Plan is envisioned for an update cycle as necessary, to document changing facility conditions and emerging science priorities.

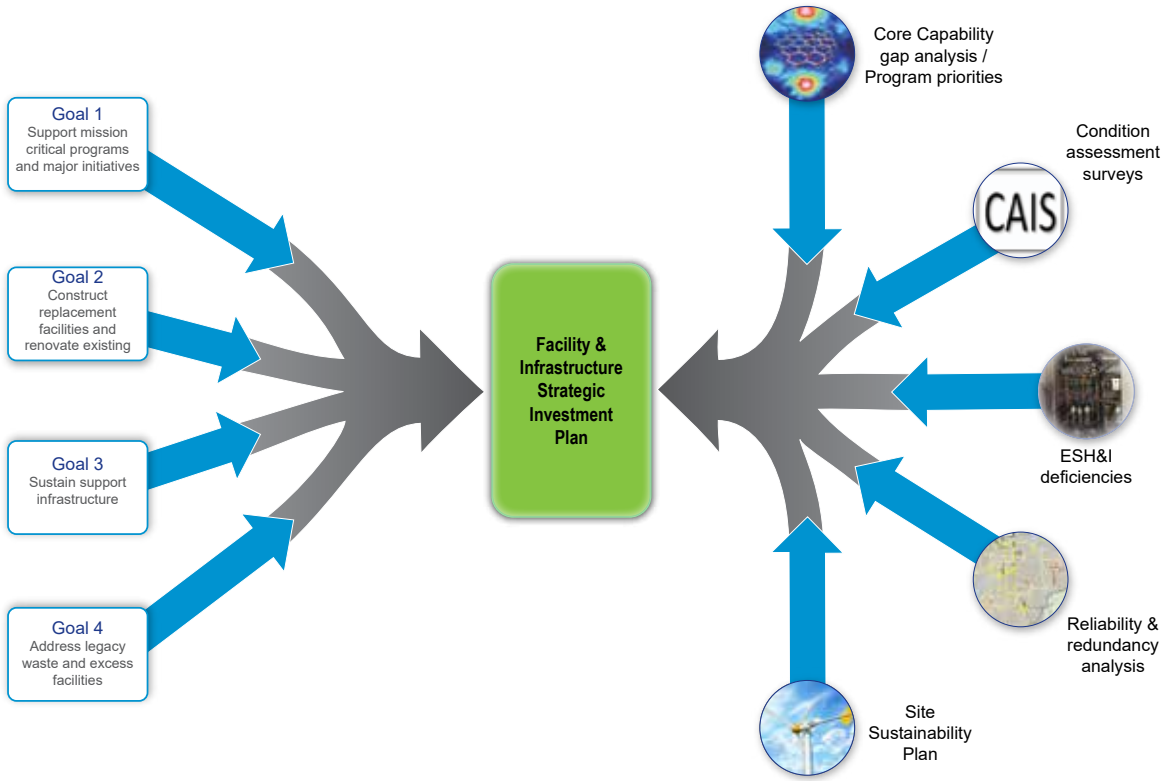


Figure 1. Planning Process

CAMPUS STRATEGY FOR MODERNIZATION

The vision for the Facility and Infrastructure Strategic Investment Plan is to provide a premier DOE laboratory that supports the DOE strategic plan and facilitates the advancement of Argonne mission goals. These goals include producing new fundamental knowledge about the physical and biological world; building on advances in computation and connectivity to meet national goals for sustainability and security; developing large-scale, forefront facilities and systems to support scientists and engineers across all disciplines; and increasing the impact of Argonne research by creating a world-class environment for discovery and innovation.

The emphasis on modernization reflects a comprehensive and executable approach for achieving and maintaining mission need. World-class research is enhanced by world-class work settings, in the workplace itself and in the natural surroundings of the Laboratory in a campus. State-of-the-art-facilities strengthen Argonne's ability to attract the best talent available, increasing its capacity for enhanced discovery and innovation. To achieve the Laboratory vision with respect to facilities and infrastructure, the following four objectives guide the overall investment strategy.

SUPPORT MISSION-CRITICAL PROGRAMS AND MAJOR INITIATIVES

Targeted investments to support mission-critical programs are a cornerstone of the plan strategy. Examples include utility modernizations to meet demand needs for chilled water cooling and/or electrical power required to support upgrades to the Argonne Leadership Computing Facility (ALCF) and the Argonne Tandem Linac Accelerator System (ATLAS). Other projects include providing support space through reutilization of the existing facilities, aligned with the shutdown schedule for the Advanced Photon Source (APS) upgrade project. New multi-user facilities, including the Argonne Clean Room and the Micro Assembly Facility, support multiple programmatic objectives and core capabilities, such as particle physics, condensed matter physics, and materials and applied materials science and engineering.

CONSTRUCT REPLACEMENT FACILITIES AND RENOVATE EXISTING FACILITIES

To support modern scientific research, Argonne is using a combination of building new facilities while targeting the renovation of existing facilities with favorable characteristics. This approach provides modern, flexible spaces to support today's research while providing the ability to adjust to changing needs as the science evolves. Examples include facilities identified for renovation and modernization in the 200 and 300 areas. These efforts apply overhead investment to enable re-use of facilities that, although obsolete due to age, retain positive structural and space characteristics that promote modern scientific research. In parallel, new facilities such as the Materials Design Laboratory (MDL), funded by the DOE Scientific Laboratories Infrastructure (SLI) Office, and the Energy Innovation Center, funded by the State of Illinois, will provide modern laboratory spaces and allow Argonne to vacate and ultimately demolish inadequate spaces.

SUSTAIN SUPPORT INFRASTRUCTURE

Argonne maintains a rigorous process for assessing building and site infrastructure conditions to prioritize and implement repairs and upgrades to meet reliability and redundancy goals. The Laboratory is committed to reducing the identified deferred maintenance backlog, with an ultimate target of achieving the DOE-established Asset Condition Index (ACI) goals for "mission critical" and "mission essential" facilities.

Specific investments include DOE General Plant Project (GPP) funding for electrical reliability upgrades to the 138-kV high voltage system in addition to water and sewer utility upgrades to improve substandard assets. Longer term plans support full electrical infrastructure redundancy and electrical capacity growth for the Argonne site through external power upgrades and construction of a secondary site power supply, both identified as future DOE-SLI line item projects.

ADDRESS LEGACY WASTE AND EXCESS FACILITIES

Removal of legacy waste and excess facilities is consistent with the DOE-SC goal of achieving an asset utilization index ratio of 1:1 for a utilization comparison of justified assets to current real property assets. The ratio also supports complex-wide DOE requirements for overall footprint reductions via space banking.

The Laboratory's approach to designating facilities as excess, and prioritizing excess facilities for removal, is based on an evaluation of whether a facility meets the following criteria:

- Has been, or over the next 10 years will be, replaced by new construction or vacated as a result of program consolidation
- Is an unlikely candidate for renovation due to contamination, infrastructure condition, or its general age/deterioration; and/or
- Has potential negative impacts to the environment, employee safety, or the surrounding community

The Laboratory is aggressively consolidating radiological facilities and reducing inventories of radiological materials, while preserving the capability to perform mission-important activities.

SUPPORT OF CORE CAPABILITIES

DOE-SC identifies 24 core capability categories that encompass the scientific and technological foundation of its national laboratories. Core capabilities are used to articulate the niche in which Argonne distinguishes itself from other national laboratories in the DOE complex. DOE-SC uses three criteria to define a laboratory's core capabilities: they must a) encompass a substantial combination of facilities and/or teams of people and/or equipment, b) have a unique and/or world-leading component, and c) be relevant to a discussion of DOE missions, as well as those of the Department of Homeland Security and National Nuclear Security Administration.

To maintain Argonne's role as a national leader in these areas of fundamental basic science, applied science and engineering, modern facilities and infrastructure are required. As of FY2018, DOE-SC has recognized Argonne for having 18 of the 24 possible core capabilities. These include:

- Accelerator Science and Technology
- Advanced Computer Science, Visualization, and Data
- Applied Mathematics
- Applied Materials Science and Engineering
- Biological and Bioprocess Engineering
- Chemical and Molecular Science
- Chemical Engineering
- Climate Change Sciences and Atmospheric Science
- Computational Science
- Condensed Matter Physics and Materials Science
- Cyber and Information Sciences
- Decision Science and Analysis
- Large Scale User Facilities and Advanced Instrumentation
- Nuclear Engineering
- Nuclear and Radio Chemistry
- Nuclear Physics
- Particle Physics
- Systems Engineering and Integration

As a multi-programmatic laboratory, a single building may be identified as supporting several core capabilities. As represented in the Sankey diagram (Figure 2) and bar chart (Figure 3), this overlap creates challenges as the individual research may have unique facility and/or infrastructure requirements; however, the synergies and potential for discovery created by integrating various research areas are invaluable. As a result, facility and infrastructure investments made now, and in the future, include robust, modular designs that can support changing requirements and facilitate modern science.

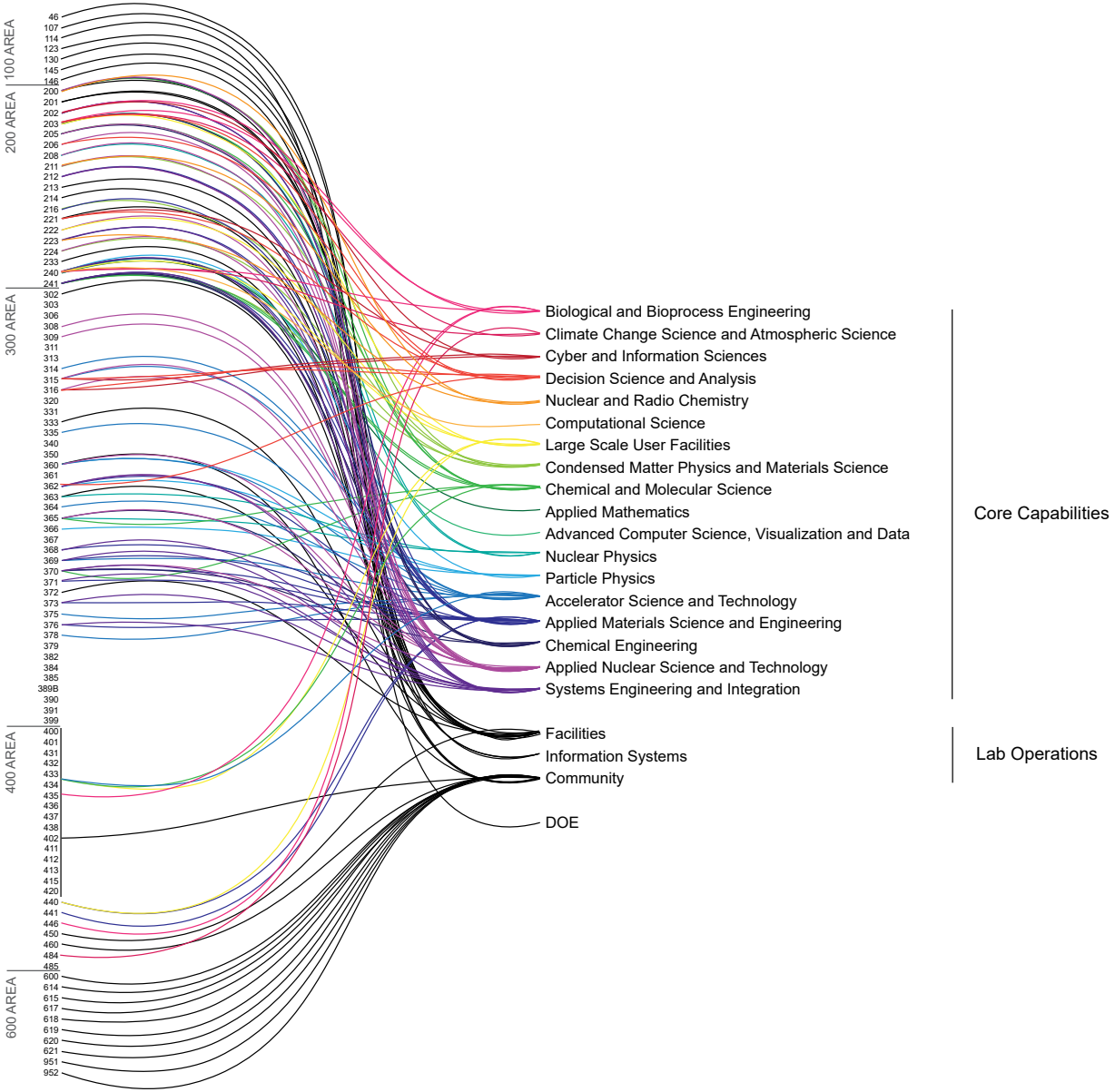


Figure 2. Core Capabilities by Building, FY16

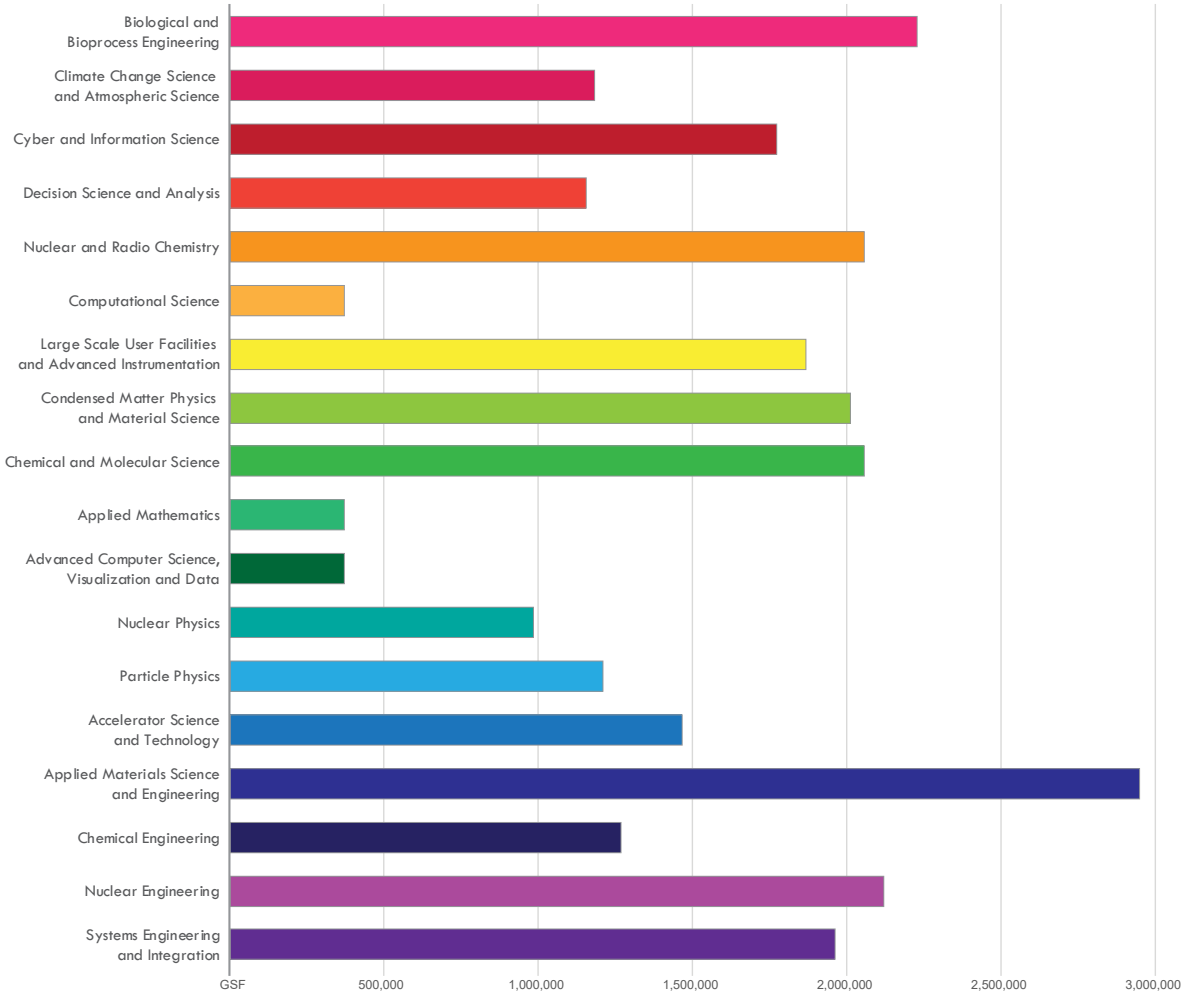


Figure 3. Core Capabilities by Building Space Allocation in Gross Square Foot, FY17

Argonne's 18 core capabilities support vast amounts of research across the basic and applied sciences, from climate research to x-ray imaging and clean energy technologies. Various types of facilities support science from early bench-scale research to prototyping and fabrication.

Biological and Bioprocess Engineering

Argonne is pioneering new approaches to biological and bioprocess engineering that combine synthetic biology and synthetic chemistry to create biomaterials with tuned, collaborative functionalities. Key facilities include the CNM, APS, and Advanced Protein Characterization Facility (APCF) in the 400 Area.

Climate Change Sciences and Atmospheric Science

Research advances have improved understanding of complex atmospheric and related soil processes, from the molecular to the global level. Key facilities supporting this capability include the APS and the Atmospheric Radiation Measurement (ARM) Southern Great Plains site.

Cyber and Information Sciences

Cyber security research advances the science in data analysis, energy resiliency, intelligent log analysis, authentication, infrastructure risk assessment, moving target defense, vehicle security, power grid cyber susceptibility, and technologies to increase resilience and improve national security. Key facilities include secure data centers and vehicle cyber security analysis centers in the 200 Area.

Decision Science and Analysis

Argonne is addressing pressing national challenges through innovative applications of agent-based modeling, complex adaptive system modeling, system dynamics, and complex network analysis. Facilities that support this capability

include an immersive decision visualization studio and the ALCF, both in the 200 Area.

Nuclear and Radio Chemistry

Efforts are focused in chemical separations, nuclear chemical engineering, and the materials science of actinides, radioisotopes and the nuclear fuel cycle. Key facilities include the APS, ATLAS, ALCF, and two radiological facilities in Building 211.

Large-Scale User Facilities / Advanced Instrumentation

State-of-the-art user facilities include the APS (Bldg 400-401), ATLAS (in Bldg 203), ALCF (in Bldg 240), and CNM (Bldg 440).

Condensed Matter Physics and Materials Science

This core capability advances the understanding of the foundational principles that link material complexity to function, tailors this functionality for applications, and designs and creates new materials. Key facilities include the Energy Sciences Building (ESB), APS, CNM, and ALCF.

Chemical and Molecular Science / Chemical Engineering

Argonne also possesses expertise in synthesis, characterization and control of molecules and chemical processes, with a focus on energy production and use. Key facilities include the APS, ALCF, the Cell Analysis, Modeling and Prototyping (CAMP) facility, Electrochemical Analysis and Diagnostics Laboratory (EADL), High Throughput Research (HTR) Laboratory and Midwest Transformative Energy Manufacturing (MTEM) Facility.

Applied Mathematics / Advanced Computer Science, Visualization and Data / Computational Science

Argonne possesses recognized expertise in mathematical modeling, analysis, and algorithm development, implemented in scalable software for execution on the world's largest computing systems, including leading efforts in exascale operating systems. Key facilities include ALCF, the Joint Laboratory for System Evaluation, and the Laboratory Computing Resource Center, all located in the 200 Area.

Nuclear Physics

Key efforts supporting theoretical and experimental nuclear physics research work are located at ATLAS, which provides stable and radioactive ion beams at energies up to about 20 megaelectron volts/nucleon.

Particle Physics

Particle physics research advances understanding of the properties and interactions of the particles making up the universe and the underlying symmetries of nature. Key facilities are located in the 300 Area of the Laboratory.

Accelerator Science and Technology

Expertise includes the modeling, design and operation of photon sources in addition to the creation, acceleration and manipulation of high intensity stable and rare isotope ion beams. Key facilities include APS, ATLAS, and the Argonne Wakefield Accelerator located in the 300 Area.

Applied Materials Science and Engineering

Applied materials development and synthesis drives advances in clean energy science and manufacturing processes. Key facilities supporting applied and basic science include APS, CNM, ALCF, ESB, Materials Engineering Research Facility (MERF) and MTEM in the 300 Area.

Nuclear Engineering

Argonne has pioneered nuclear energy systems and continues to advance systems to provide an abundant, sustainable, safe and secure energy source. Key facilities that support this capability include APS, ALCF, ATLAS, the Intermediate Voltage Electron Microscopy Tandem Facility (IVEM), and specialized test laboratories in the 300 Area.

Systems Engineering and Integration

This core capability focuses on the development of experimental facilities and analytical tools to advance understanding of transportation, infrastructure, urban, communications, and other large-scale systems. Key facilities include the APS, Advanced Powertrain Research Facility (300 Area), Engine Research Facility (300 Area), and the Electric Vehicle Smart Grid Interoperability Center (300 Area).

II. EXISTING CONDITIONS

SITE OVERVIEW

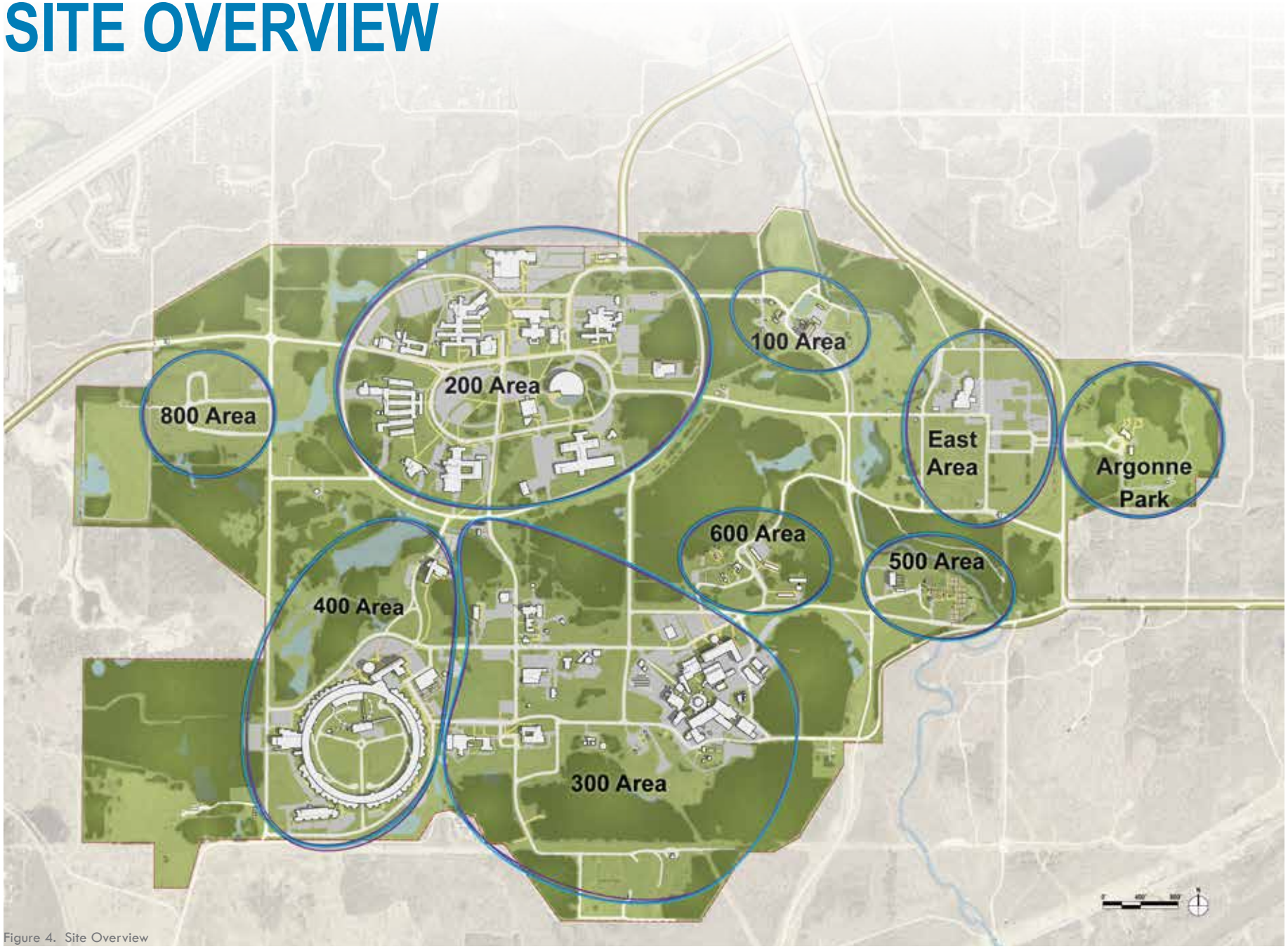


Figure 4. Site Overview

CAMPUS AREAS

The Argonne campus is located on 1,517 acres. The site includes 157 buildings, totaling 4,966,048 gross square feet (GSF). The Laboratory is completely surrounded by the 2,470-acre Waterfall Glen Forest Preserve of DuPage County. Much of the Waterfall Glen preserve land was once part of the original Argonne boundary, and was donated as excess property to the County in the 1970s. The areas adjacent to Argonne are developed, suburban residential communities.

The Argonne campus can be considered as several unique areas that complete the whole, each of which presents unique challenges for planning, design and infrastructure improvements. The site evolved over the last 70 years since its inception, adapting to changes in the scientific needs and programmatic strategy of the Laboratory. This has resulted in clustering of different research into different site areas (Figure 4).

The average age of Argonne-operated facilities and infrastructure is 48 years, with 61% of the assets being more than 50 years old.

Buildings are grouped generally by individual facility number, and campus areas are designated to reflect this numbering.

100 Area, East Area, 500 Area

Primarily consists of laboratory support services, including the site steam generation and sewage treatment plants. The East Area was once home to the original Quonset huts, used to house the Laboratory before permanent structures were built in the 200 and 300 areas of the site. The East Area now houses site services, vehicle fleet maintenance and shipping and receiving.

200 Area (Main Campus)

Predominantly office and laboratory space of one- and two-story red brick construction designed in the mid-century style, the 200 Area contains some of the earliest permanent facilities built. Recent construction at the “Energy Quad,” which includes the Energy Sciences Building (ESB/Bldg 241), and will include the MDL (Bldg 243), creates approximately 255,000 square feet (sq. ft.) of modern, flexible laboratory space. Two leased facilities, the Theory and Computing Sciences (TCS) Building (Bldg 240) and the Howard T. Ricketts Regional Biocontainment Laboratory (Bldg 204), which is operated by the University of Chicago, are located in the 200 Area.

300 Area

Several buildings in the 300 Area that were completed in 1950 serve specialized functions related to nuclear engineering research, in addition to legacy waste processing and storage. Argonne security and the fire department are also located in the 300 Area.

Buildings 360 through 399 were originally built around a high-energy accelerator the now decommissioned Intense Pulsed Neutron Source (IPNS). The area is more industrial in aesthetic and contains many office, laboratory, and high bay research facilities now dedicated to transportation and vehicle research and high energy physics.

400 Area

The APS and associated facilities, as well as the Center for Nanoscale Materials (CNM), Argonne Guest House, and a few 300-series buildings associated with the APS fill the 400 Area. The APS and CNM are Argonne’s two most frequented user facilities. The 400 Area was developed from the mid-1990s to 2010s and consists of modern architecture clad in white or light gray panels.

600 Area

Devoted to recreational and lodging facilities, this area contains the original and historic Erwin Freund Estate, 1960s era student housing and several recreational facilities, including tennis, basketball and Frisbee golf.

800 Area

A former contractor staging yard, now housing waste and storage containers.

Argonne Park (900 Area)

Park area outside the perimeter fencing, consisting of the Child Development Center, outdoor picnic structure, and athletic fields.

REGIONAL SETTING

Argonne is located in DuPage County, Illinois, twenty-five miles southwest of the downtown Chicago Loop. This location offers direct access to Interstate 55 and easy connections to the seven-county Chicago metropolitan area containing more than 8 million residents. Both the University of Chicago (U-Chicago) and Fermi National Accelerator Laboratory (Fermi) are within a 30-mile drive. Argonne is within 30 miles of two international airports, O'Hare and Midway, and is at the hub of the national interstate system (Figure 5).

Argonne leverages its valuable position within the Chicago region for enhanced collaboration with its industry and university partners to drive discoveries supporting the wide range of science performed at the Laboratory. Faculty collaborations with U-Chicago and Northwestern University, amidst other Chicago business partners, enrich the scientific programs, while strong connections with local and national industry partners support the transfer of new technology derived at Argonne to private sector innovation. These partnerships facilitate engagement, mentoring and other support for Argonne staff interested in entrepreneurship and companies interested in engaging with Argonne researchers and scientists.

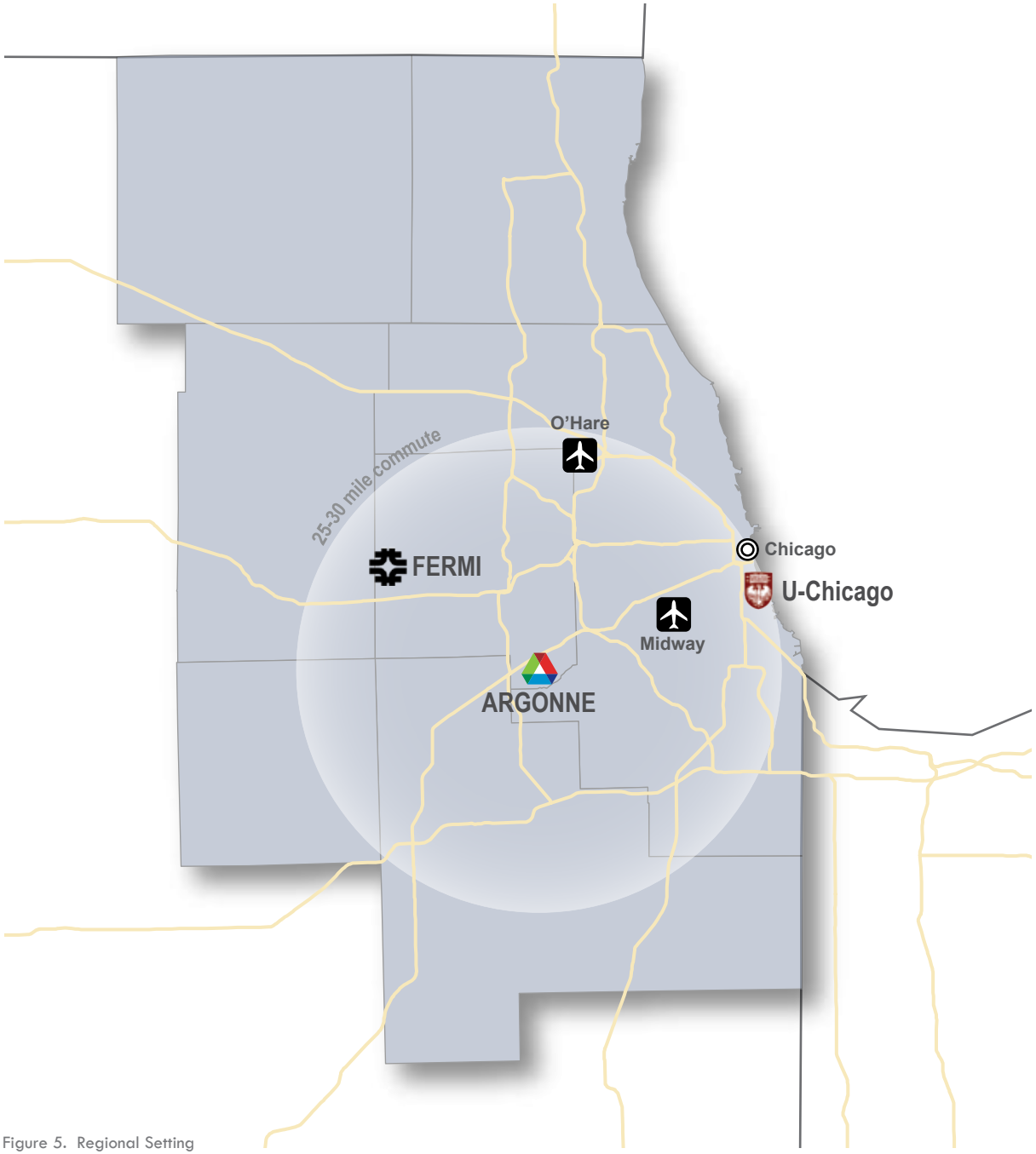


Figure 5. Regional Setting

SITE CONTEXT

Three secure site entrances provide access to individuals with approved entrance badges. The west site entrance experiences the highest traffic volumes into and out of the Laboratory. The Main Gate, accessed from the north on Northgate Road, is the second most traveled. All visitors use the Main Gate entrance to obtain a visitor access badge from the Argonne Information Center (Bldg 224). Only the Northgate Road guard post is staffed 24 hours/day, 7 days/week. On-site truck traffic was permanently redirected to use the east entrance in 2014 to alleviate traffic backups and site constraints at the main gate.

Argonne total area is 2.37 square miles and is situated between two main thoroughfares with highway access. Argonne's road network incorporates many of the rural roads which pre-date the Laboratory. Pedestrian circulation paths form a mostly complete network in the 200 Area and connect to the 400 Area.

Several site amenities are available, such as restaurants and coffee shops serving the main 200 Area and 400 Area of campus. Argonne offers indoor and outdoor fitness and recreation opportunities across the site.

The micro-climate at Argonne can be affected by the surrounding forest preserve and on-site wooded areas provide shade and respite. Buildings oriented in an east-west layout can take advantage of the solar orientation and natural winds for passive heating and cooling measures. Figure 6 summarizes the site analysis.

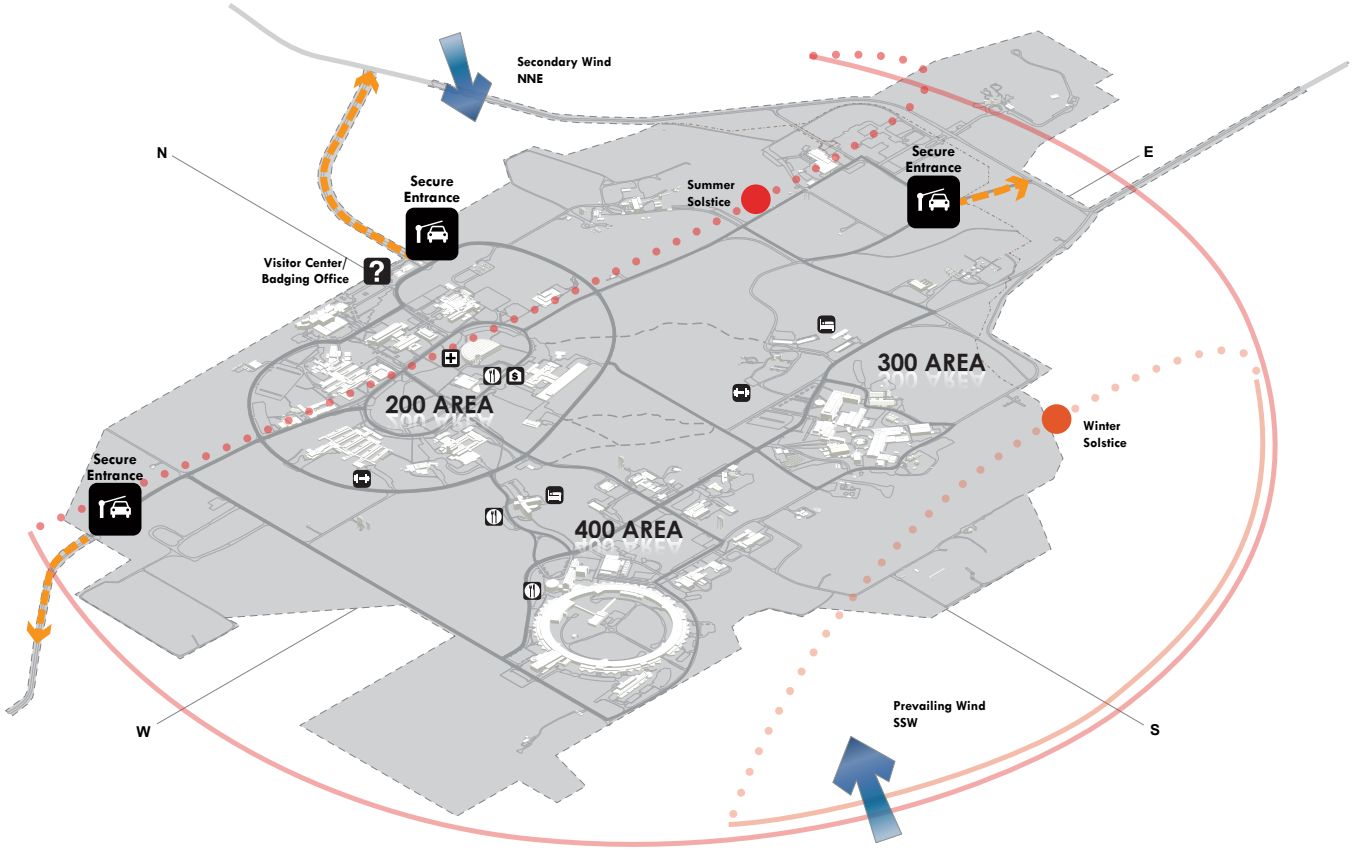


Figure 6. Site Analysis Including Security, Access, Circulation, Micro-climate and Amenities

LAND COVER

Land cover data is derived from aerial imagery and reveals characteristics about whether a site is developed with buildings or structures, represented in shades of pink, or is undeveloped and exhibits features such as forest areas, represented in shades of yellow and green (Figure 7).

Land cover provides a quick snapshot of the rough area of open space vs. developed space at Argonne.

Developed	*763.5 acres*	*51%*
Forest and Prairie	*725.5 acres*	*49%*

Land cover data can be incorporated into other planning applications and functions to inform studies such as stormwater runoff analysis.

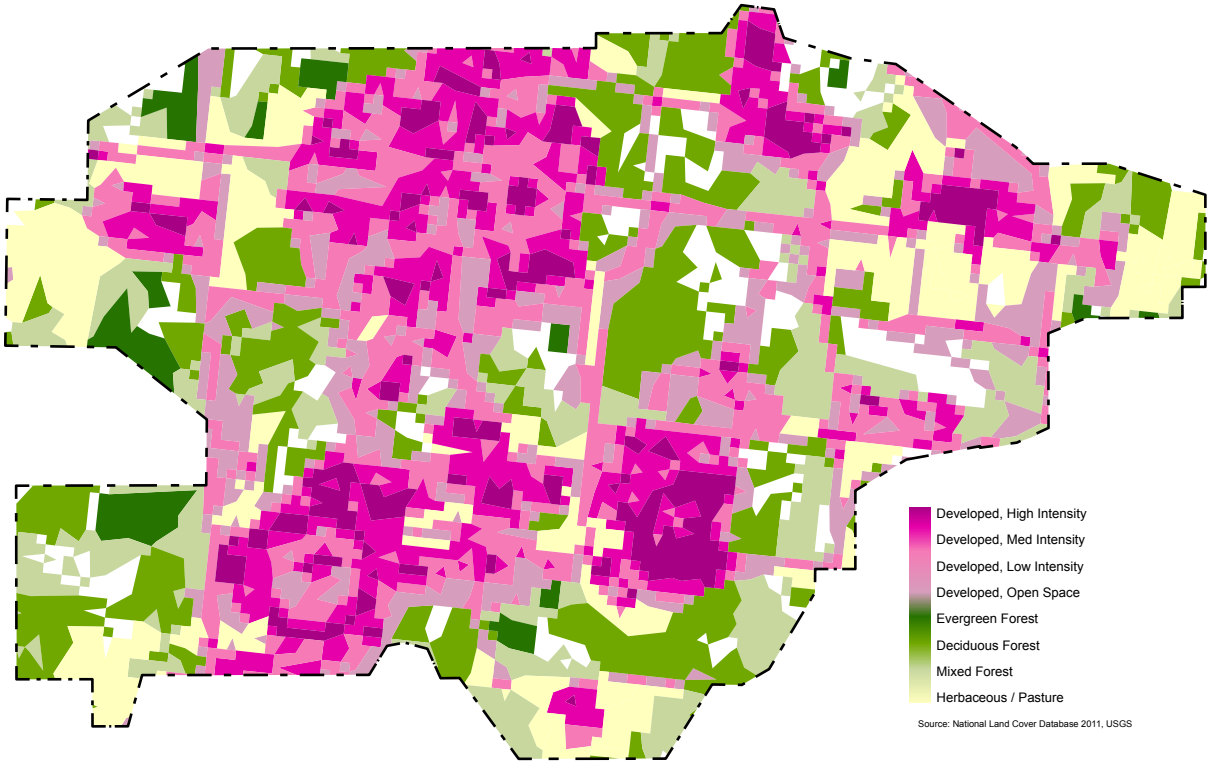


Figure 7. Land Cover

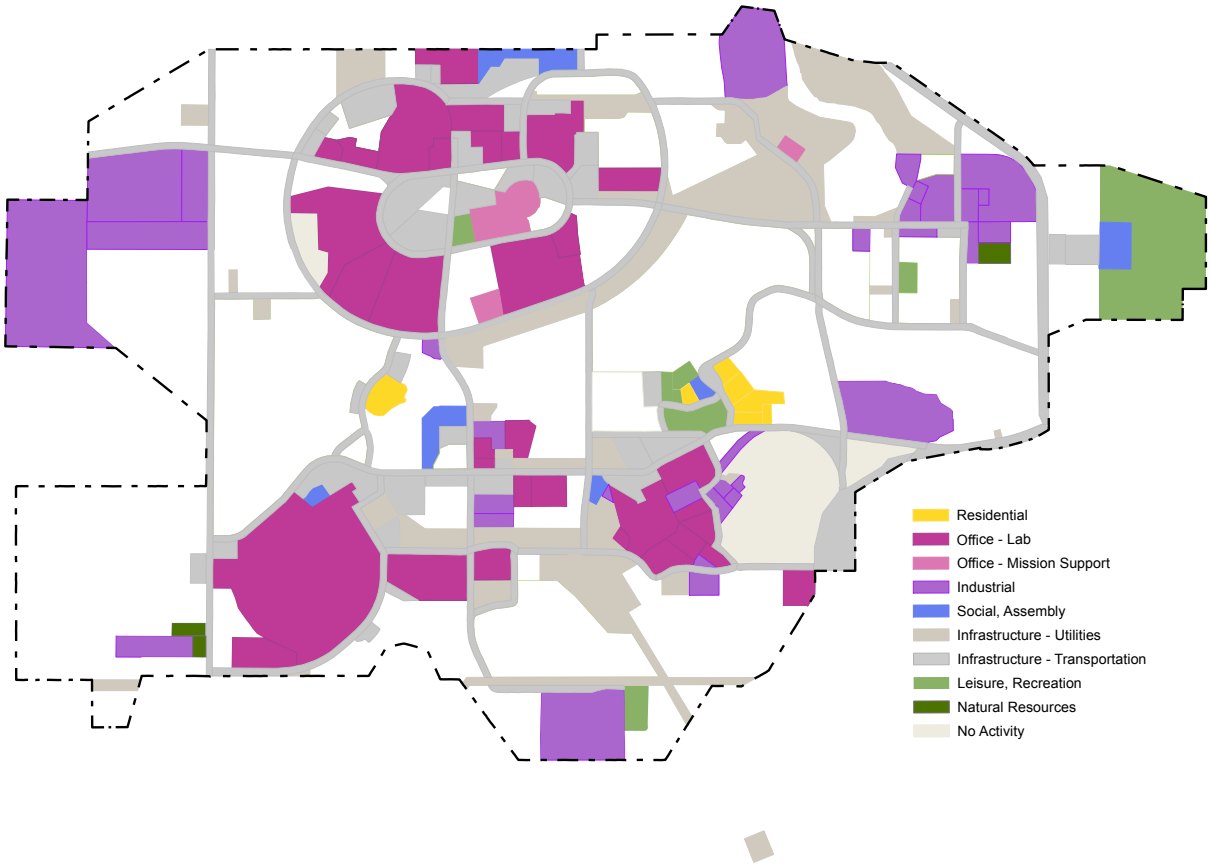


Figure 8. Site Land Use by Activity, FY16

LAND USE

Whereas *land cover* tracks land characteristics, *land use* classification tracks the physical activity that occurs on a piece of land at a given time. Land use is a better descriptor for classifying specific activities at Argonne, rather than using land cover data alone. Land use is classified across several dimensions including land activity, economic function, structure type, development character and ownership providing more granularity over the underlying data. Figure 8 shows the site by land use.

Argonne's land use activity on site correlates to the land cover data and shows that roughly 50% of the site has no physical activity occurring, land that is commonly referred to as "vacant space." These areas of no activity are addressed in the Natural Resources Management Plan. Table 1 lists land use activity classifications.

Table 1. Land Use Activity Classification, FY16

	Acre	%
Residential	9.0	0.6
Office - Lab	176.2	12.0
Office - Mission Support	9.5	0.6
Industrial	138.9	9.5
Social, Assembly	14.1	0.9
Infrastructure - Utilities	120.5	8.2
Infrastructure - Transportation	206.6	14.1
Leisure, Recreation	42.6	2.9
Natural Resources	3.4	0.2
No Activity	742.8	50.8

LANDSCAPE AND NATURAL AREAS

Land management activities at Argonne are driven primarily by two orders: Executive Order 13112, on Invasive Species, and the Migratory Bird Treaty Act of 1918. These policies provide the guidance to increase species diversity and decrease non-native or invasive species populations at Argonne. One-third of the site vegetation is surveyed annually to assess species diversity, habitat quality, and progress of management activities. The following goals and their associated actions, are assigned to sections of the site, depending on the result of the annual assessments.

Goal 1: Preserve existing native remnant plant communities

Goal 2: Identify and control new invasive species introductions/expansions

Goal 3: Re-establish natural plant communities

Activities in natural area management are targeted to address habitat quality levels. Activities to increase the habitat quality (Goals 2 and 3) focus on poorer quality areas while Goal 1 is aimed at preserving the quality of areas with existing, higher quality vegetation. Although the northwest area of the site is denoted as having a high quality habitat, the health of the area is declining. The pine plantations established when the Laboratory originated are not regenerating and conditions represent an opportunity for future activity in this area.

Increasingly, site natural areas are investigated for their use to advance the Laboratory's sustainability goals to reduce pollution and carbon emissions in support of climate change adaptation.

Habitat management efforts have resulted in increased habitat quality over the past three years. Increases can be tied to the recent habitat management efforts of controlled burns, targeted herbicide applications, and clearing where appropriate.

More information is available in the Habitat Management Plan. Figure 10 provides a habitat quality site map.

Topography

Argonne is located approximately 150 feet above the nearest large water body and, as a result, is not subject to major flooding. Generally, the site terrain slopes to the east and south, as the site approaches the Des Plaines River and Sanitary and Ship Canal to the south of the Waterfall Glen Forest Preserve. The 100- and 500-year floodplains are limited to low-lying areas of the site near Sawmill Creek, Freund Brook, Wards Creek, and other small streams, associated wetlands and low-lying areas. The floodplain delineations are included in Argonne's site development standards and are generally contained within areas not intended for development. No significant structures are located in these areas. See Figure 9 for site topography.

Figure 9. Site Topography

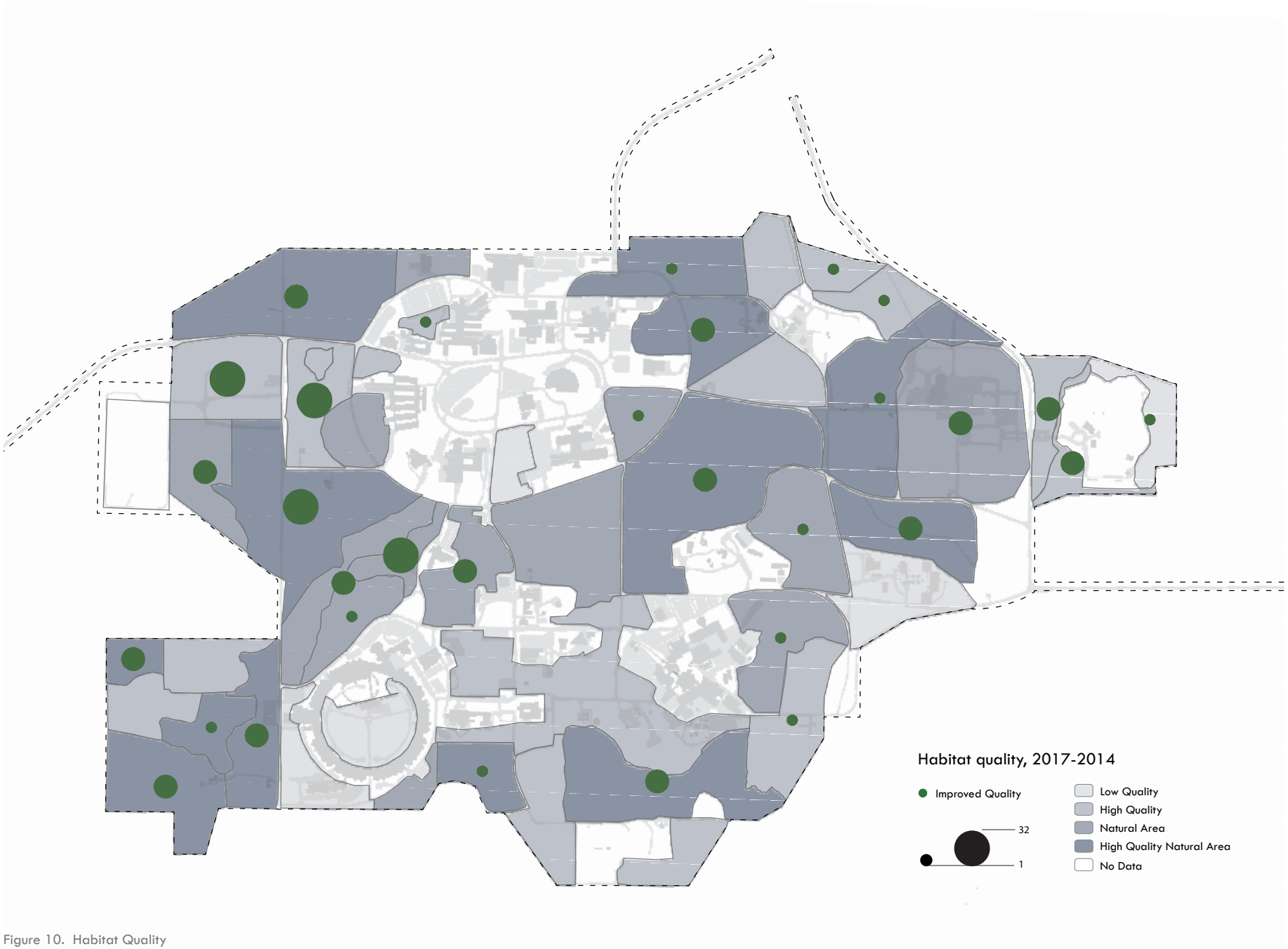


Figure 10. Habitat Quality

DEVELOPABLE AREA

The natural topography and features of the site influenced its development pattern over time, preserving significant tracts of oak groves and natural areas. Although 50% of the Argonne site area does not currently have a land use activity, several natural environmental constraints reduce future development potential. The main campus is circled by a substantial area of streams and wetlands and varying degrees of quality vegetation.

Argonne's development strategy is to reduce site impacts as best as possible when siting a new facility or expansion. Goals include concentrating development in existing facilities through renovation and rehabilitation, and siting new facilities in locations which leverage existing infrastructure and satisfy program and mission needs.

Considering these environmental features, as well as floodplain areas and contaminated and previously disturbed sites, Argonne's potential development spaces are revealed. Areas with opportunity for future development represent 254 acres of the site, or 17% of total acreage. Figure 11 shows future development sites.

The scale and amount of available land for development and/or redevelopment provide an advantage for Argonne's campus. Considerable tracts of land adjacent to Cass Avenue and the west site entrance off Lemont Road are suitable for large-scale development, where the interior of the site provides opportunity for smaller-scale infill development.

The large-scale development tracts on the east and west borders of the site are prime locations for establishing commercial partner engagement areas. Quick, direct access to the Interstate 55 highway interchange from both Cass Avenue and Lemont Road, with expansive development potential offer unlimited opportunity. These sites also offer a lower development impact, as they are predominantly gray-field sites, where past development occurred and much of the site infrastructure remains. These areas are prime targets for use in technology commercialization and development with Argonne's industry partners.

Remaining primary development sites are better suited for smaller scale, infill type development. Growth in existing programs or expansions to satisfy emerging scientific needs would expand into these areas, as best determined by program and space needs.

GROWTH POTENTIAL	
113.3 acres	Primary Development Laboratory/Office Research
140.9 acres	Primary Development Tech/Manufacturing

Figure 11. Future Development Sites. Graphics are for illustrative purposes only.

SITE DENSITY

Site population is concentrated in the 200 and 400 Areas of campus. An influx of student interns in the summer months and visiting scientists and facility users throughout the year influence the daily population. Various public lectures, events and education programs increase the lab population by nearly 14,000 persons per year. See Table 2 for a breakdown of the Argonne population.

Nearly 60% of the laboratory population works in the 200 Area, concentrated in Buildings 201 and 240. Buildings 400 and 401 house the majority of the second highest concentration on campus, the 400 Area. The 300 Area holds roughly 16% of the total Laboratory population. Remaining areas of the site (East, 100, 600, 500) represent a mere 3% of the lab population.

Site occupant concentrations roughly correspond to facility size in each area. In the 200 Area, 47% of the site's square footage is located across 23 facilities. The 400 Area, with the second highest occupancy, contains 27% of the site's space footprint. The 300 Area rounds out the total square footage of space with 23%.

Argonne's four on-site user facilities are all located in these heavily populated areas of the site (i.e., 200 and 400 Areas), which can contribute to parking issues in already stressed lots and increase use of site infrastructure and amenities. Figure 12 illustrates site population concentrations.

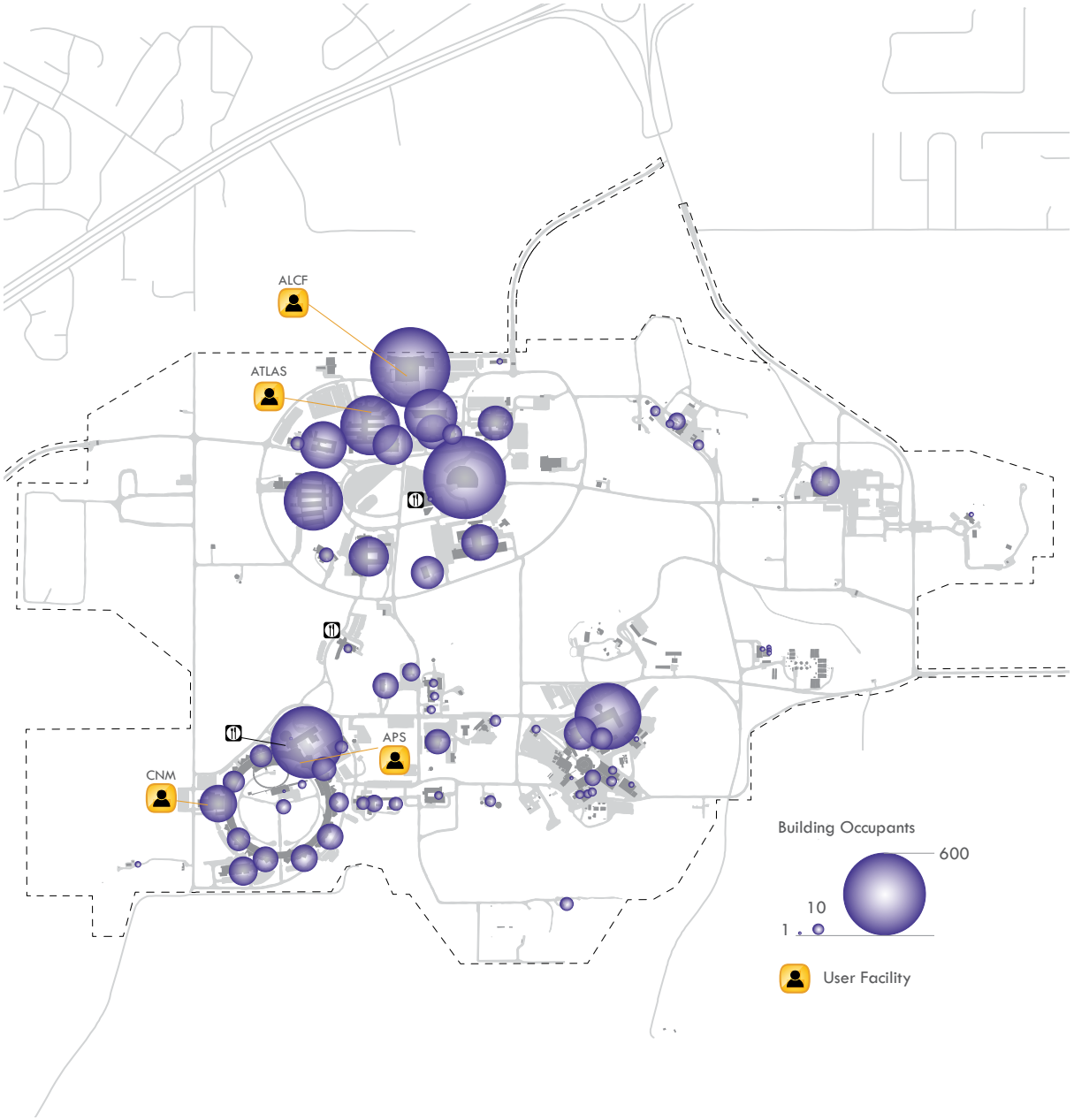


Figure 12. Building Occupants, User Facilities and Amenities Locations, FY17

Table 2. Argonne Site Occupants

HUMAN CAPITAL	
3,225	Full Time Employees
274	Joint Faculty
273	Post-Doctoral Researchers
409	Undergraduate Students
160	Graduate Students
8,305	Facility Users
1,107	Visiting Scientist

Source: FY18 Annual Laboratory Plan

Circulation Network

The Laboratory maintains a robust vehicle and pedestrian network to accommodate its population across a large campus. Major pedestrian circulation routes are provided and prioritized between the main campus and the 400 Area. The many paths provide a variety of experiences, from functional daily movements to passive or leisure-use.

The majority of employees arrive at the Laboratory via personal vehicle and park close to their office in designated parking lots. As a result, the necessary parking space to accommodate employee and visitor demand is high.

School buses for educational programs and large delivery trucks frequently enter the site, which requires adequate space for turning movements, loading and parking. Throughout the day, many site users will access different buildings across the site and will walk or travel by personal vehicle, government vehicle, or bicycle. The Laboratory provides a bicycle share program and users are encouraged to “share the road” with other modes of transit, occupying the paved road shoulders.

Plan Impact

Argonne provides free parking, but expends its operating and maintenance budget to maintain these facilities in adequate condition. The Laboratory, through the Sustainability Program, is investigating alternative transportation methods to accommodate site visitor and employee access to and within the site.

Site modernization planning has geographically focused site improvements of parking lot reconstruction, road repaving, wayfinding signage and access improvements in the 200 and 400 Areas due to their larger population concentrations. When possible, opportunities to reduce or eliminate redundant roads and parking lots and eliminate extra surface area to reduce maintenance are pursued under the site work repair program.

Other planning goals will concentrate people and programs into existing growth areas of the main campus and 400 Area in appropriately sized facilities for efficiency and collaboration purposes.

FACILITY INFRASTRUCTURE

FACILITY CONDITION

The Laboratory Operations Board Assessment of FY2016 confirmed that Argonne's proposed strategic investments are correct and on track to support the Laboratory's mission. Facilities identified as substandard or inadequate are aligned with proposed renovation, construction, or demolition projects.

Facility age generally aligns with building condition and reinforces the need to invest in the oldest facilities. Figure 13 shows the relationship of facility age to deferred maintenance. The largest concentration of substandard rated facilities is located in the oldest buildings on site in the 200 and 300 Areas.

The amount of substandard space presents a challenge and is addressed in a two-pronged approach. First, the facilities that are not suitable candidates for reuse are identified and placed on the planned demolition list. Second, those facilities which do possess positive attributes for reuse, and are suitable to the programmatic mission, are adapted with a renovation strategy to modernize for twenty first century science (see Figure 14).

Over the past decade, a combination of new construction (ESB, APCF, and CNM) and selective renovation (Buildings 200, 201, and 360) has resulted in substantial improvements to increase the quantity of adequate facilities across the Laboratory. Three radiological facilities were removed, which also reduced the total square footage of what would have otherwise been deemed as inadequate space.

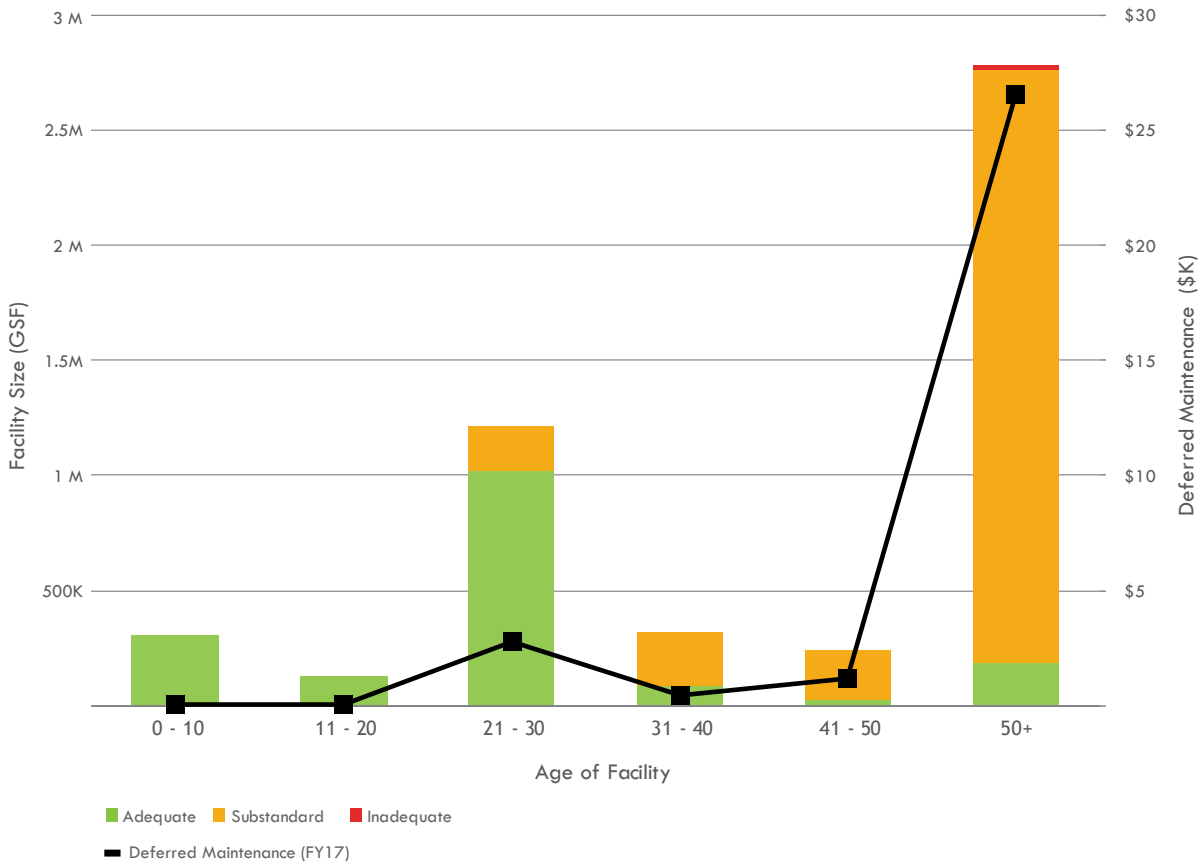


Figure 13. Deferred Maintenance by Age of Facility and Size, FY17

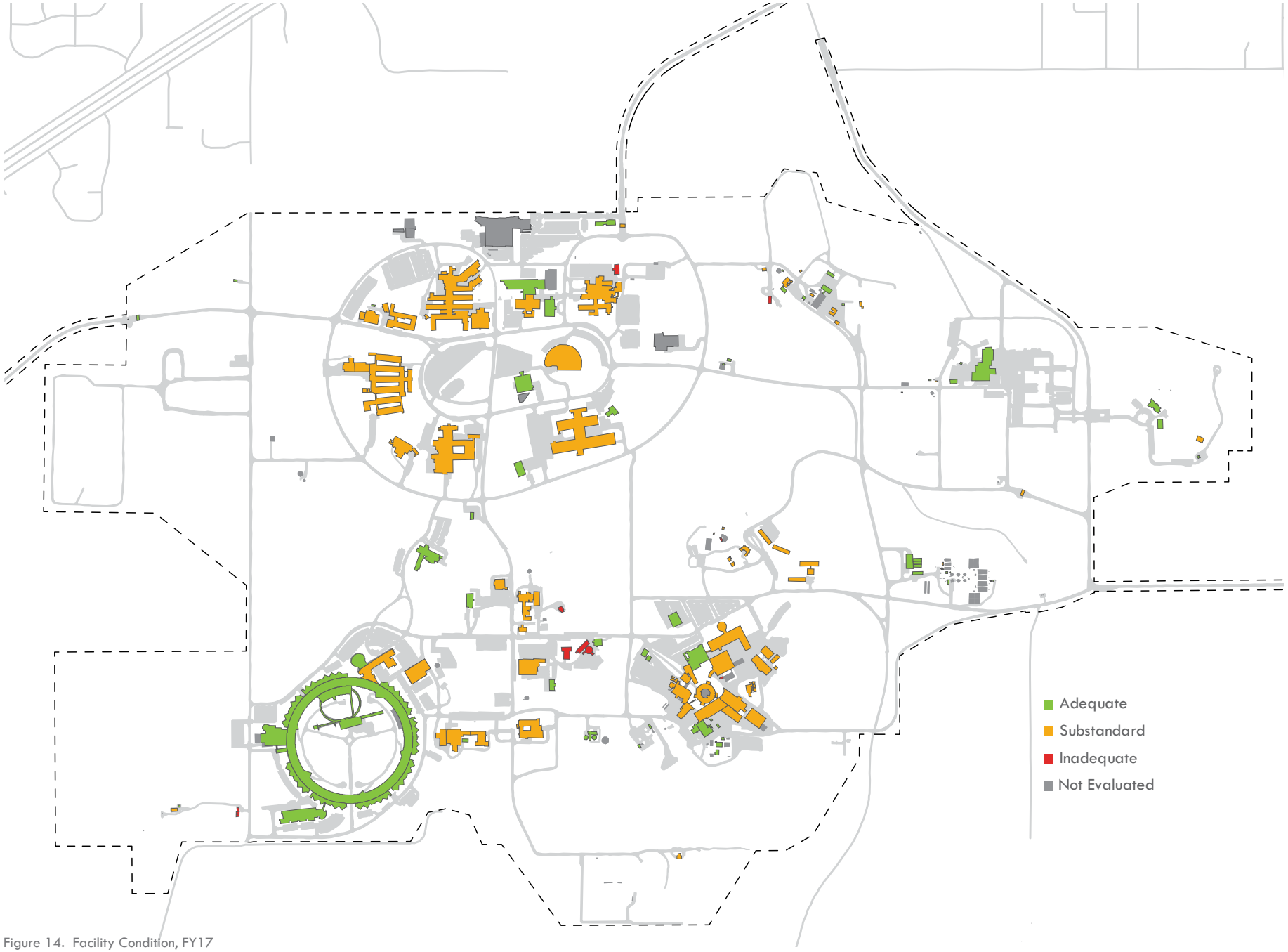


Figure 14. Facility Condition, FY17

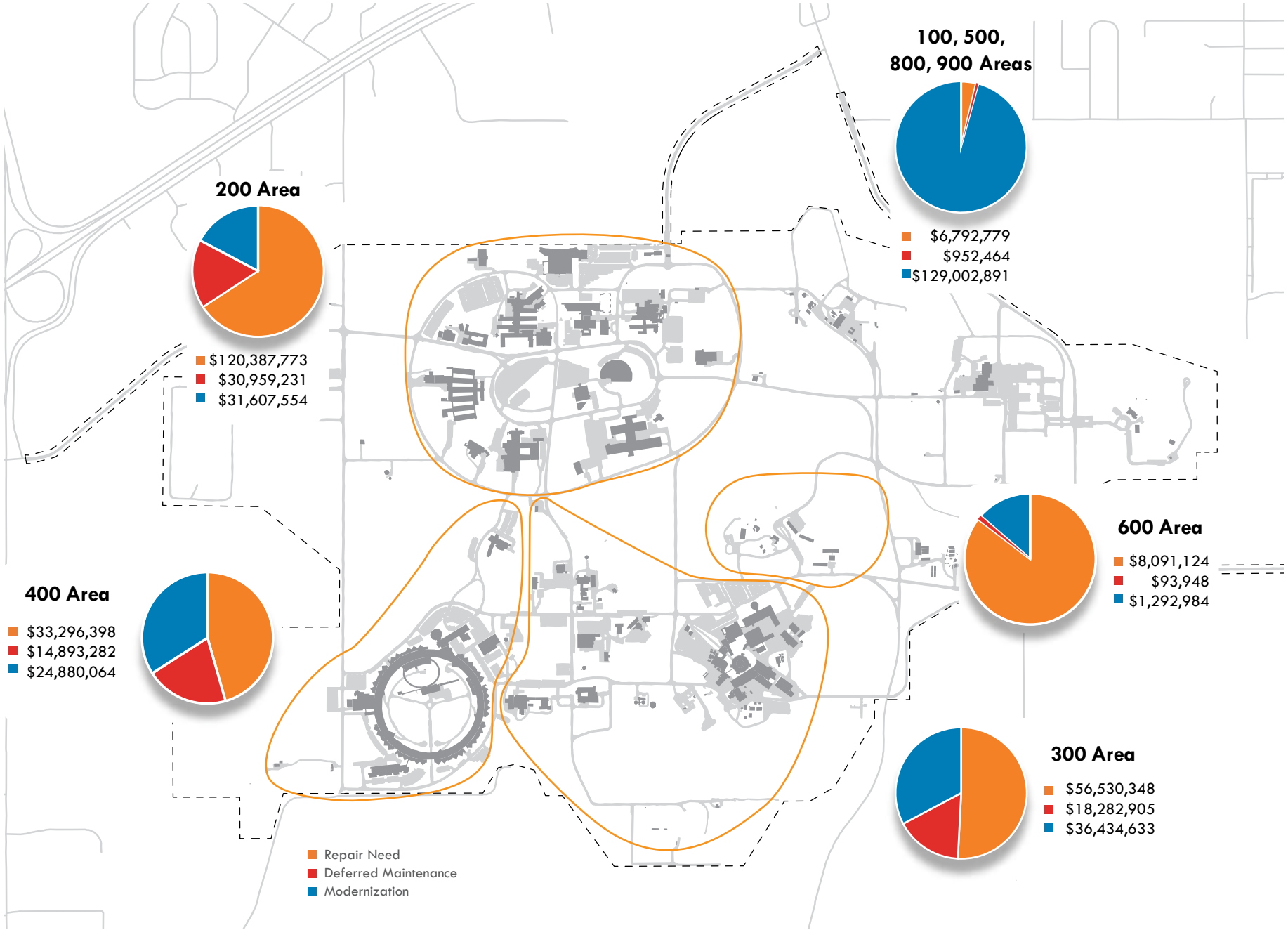


Figure 15. Investment Needs Grouped by Site Area, FY17

DEFERRED MAINTENANCE, REPAIR NEED AND MODERNIZATION

Facility repair deficiencies identified through condition assessments that are not performed at the appropriate time as determined by the system engineer/subject matter expert, are identified as "deferred maintenance." Deferred maintenance is often a result of limitations in repair budgets or restrictions related to performing repairs as they may impact mission critical programmatic operations. Deferred maintenance is examined in terms of risk related to functionality and performance of a building or support infrastructure (e.g., utility system).

Higher deferred maintenance needs equate to a greater probability of equipment failures, resulting in negative impacts to facility operations. An Infrastructure Services Directorate goal is to focus on deferred maintenance items that pose the greatest risk to continued Laboratory operations and mission critical science, while maintaining a steady downward trend in the total amount of deferred maintenance carried for the Laboratory.

Argonne's FY2017 deferred maintenance totaled $73.567M. The vast majority of deferred maintenance, 64%, is located in the oldest facilities, aged over 50 years, which account for 61% of the site's total building square footage. Beginning in FY2016, a multi-lab initiative re-evaluated the deferred maintenance categorization, significantly impacting total deferred maintenance and repair need funding profiles. Deferred maintenance for the Laboratory reduced by $46M from FY2015 to FY2017 as a result. Figure 16 shows the projected reductions in deferred maintenance costs for the next ten years.

In contrast, repair needs are categorized by the estimated amount to bring a facility back to optimal operating condition. As a result of the re-categorization in FY2016, Laboratory repair needs increased to $276M. The 200 Area had the highest amount of repair needs in FY2017.

A modernization cost is considered a need that keeps existing facilities relevant and fresh, in a setting with ever-changing standards and emerging science needs. This includes activities that improve quality, increase capacity, extend an asset's useful life, or enhance an asset's value. Argonne's modernization needs were $223M in FY2017. These needs most significantly occur in the Laboratory support facilities of the 100 Area and are second highest in the 300 Area. Figure 15 shows investment needs by site area.

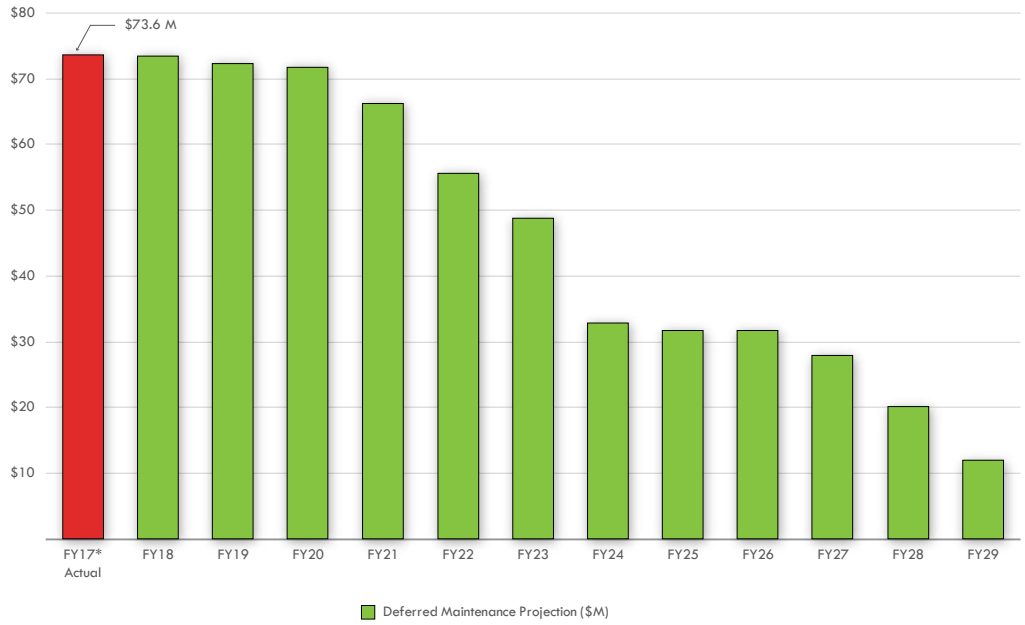


Figure 16. Projected Reduction in Site-wide Deferred Maintenance Costs, FY17

SPACE MANAGEMENT

Argonne maintains a robust space management program that aids in the identification and planning of office and laboratory facilities to support changing programmatic needs. These include growth or reduction, movement to support consolidation or efficiencies, and/or specialized space needs.

Gross building space at Argonne totals 4.9M sq. ft., in which roughly 90% of space is currently occupied. FY2016 vacancy rates were at 8%, compared to 10% in FY2017. Vacant space is primarily located in buildings planned for demolition through the excess facilities program or through relocation to newly constructed buildings, such as the MDL (Bldg 243).

Recently vacated spaces in the 200 Area are being evaluated for reuse by other programs and/or initiatives and are identified as opportunity areas in the long-term facility renovation plans of the Laboratory. Argonne's goal is to maintain a small amount of vacant space across the site in order to provide for program fluctuations and expansion needs. Figures and show usage by space type and vacancy rates for FY16.

Argonne supports various types of research through the different types of spaces on campus: laboratory, office, and high bay. Figures 17 and 20 show examples of each.

The 200 Area contains primarily office and laboratory uses that support basic science, such as dry or wet chemistry laboratories and other bench-scale research. Office space supports Laboratory operations staff and programmatic research staff.

Figure 17. Laboratory Space (left) and High Bay Space (right)

In the 360 Area, high bay space is used for large-scale experiments and applied engineering research primarily related to manufacturing, transportation and battery testing.

The 400 Area contains the APS and is the Laboratory's largest experimental facility. The APS experiment hall houses ultra-bright, high-energy x-ray beams that are generated in the storage ring and used for research in almost all scientific disciplines. The storage ring is categorized as high bay space.

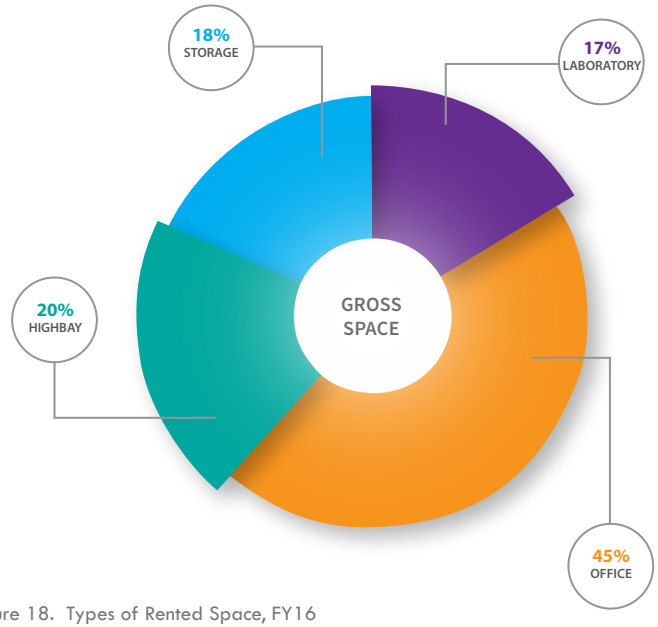


Figure 18. Types of Rented Space, FY16

Figure 19. Office Space

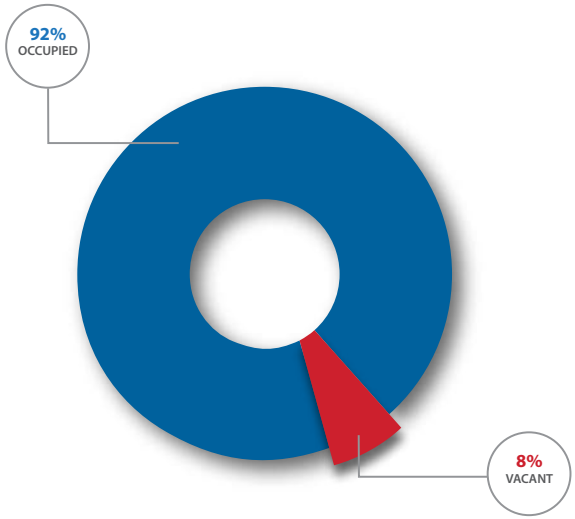


Figure 20. Vacancy by Rentable Area, FY16

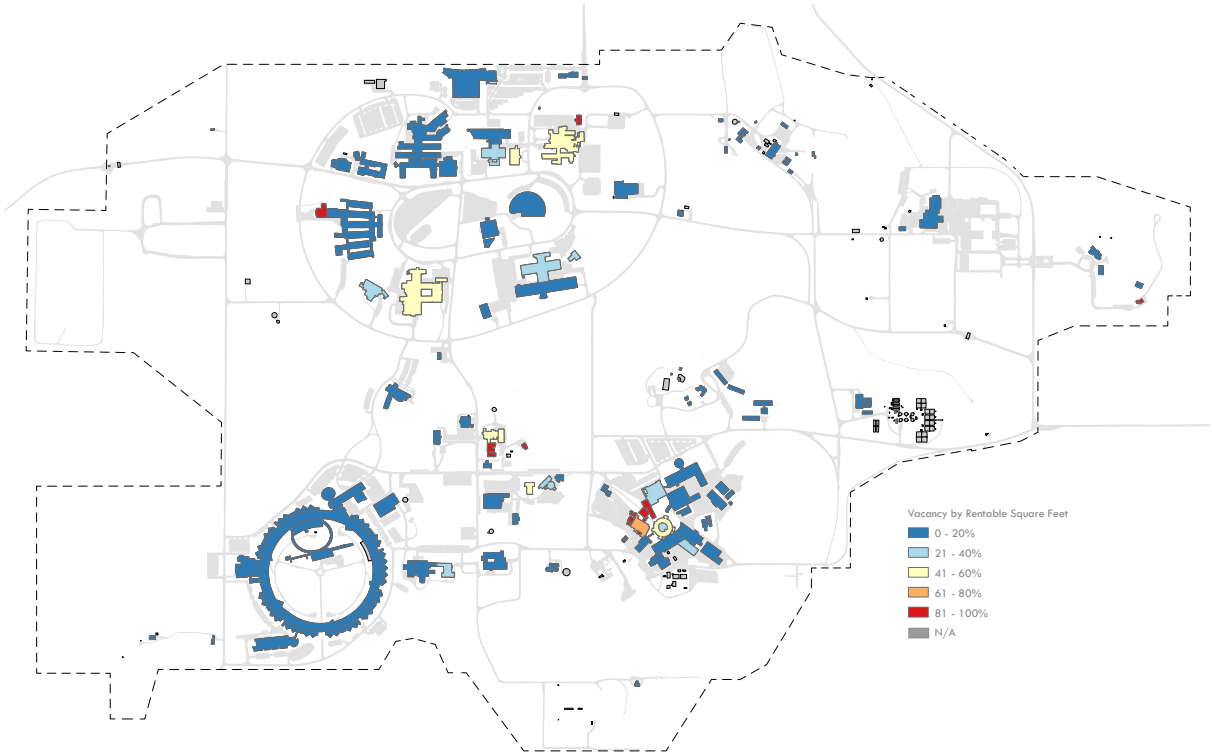


Figure 21. Vacancy by Rentable Square Foot per Building, FY16

UTILITY AND SITE INFRASTRUCTURE

Figure 22. Utility Condition of Domestic Water Lines as Compared to Density of Water Main Break Locations Across the Laboratory, FY17

UTILITY CONDITION

DOE Order 430.1C, Real Property and Asset Management, requires performing a condition assessment on all DOE assets at least once during a five-year period. Argonne system engineers and subject matter experts inspect 20% of all facility and infrastructure assets each year to identify the current condition and determine estimated time to failure, optimal period to perform maintenance actions, and estimated costs to correct identified deficiencies. Results from the condition assessment are used to develop near- and long-term repair and upgrade strategies to ensure proper prioritization of deficiencies that may impact mission critical activities and/or environmental, safety, and health issues.

Utility Master Plan

A planned initiative began in FY2017 to create a utility master plan for the campus. The plan will use condition data and site growth projections to identify a long-term maintenance, repair, or replacement strategy to guide future infrastructure investments.

The Utility Master Plan was a collaborative effort between Argonne system engineers and a consulting engineering firm to look at the current and future infrastructure requirements and provide a high-level utility road map for Argonne's future. Ten different campus utility systems were investigated to better understand asset condition, maintenance and repair needs and capacity for future site upgrades. See Figure 22 for condition of water utilities site-wide and Figure 23 for condition by utility system.

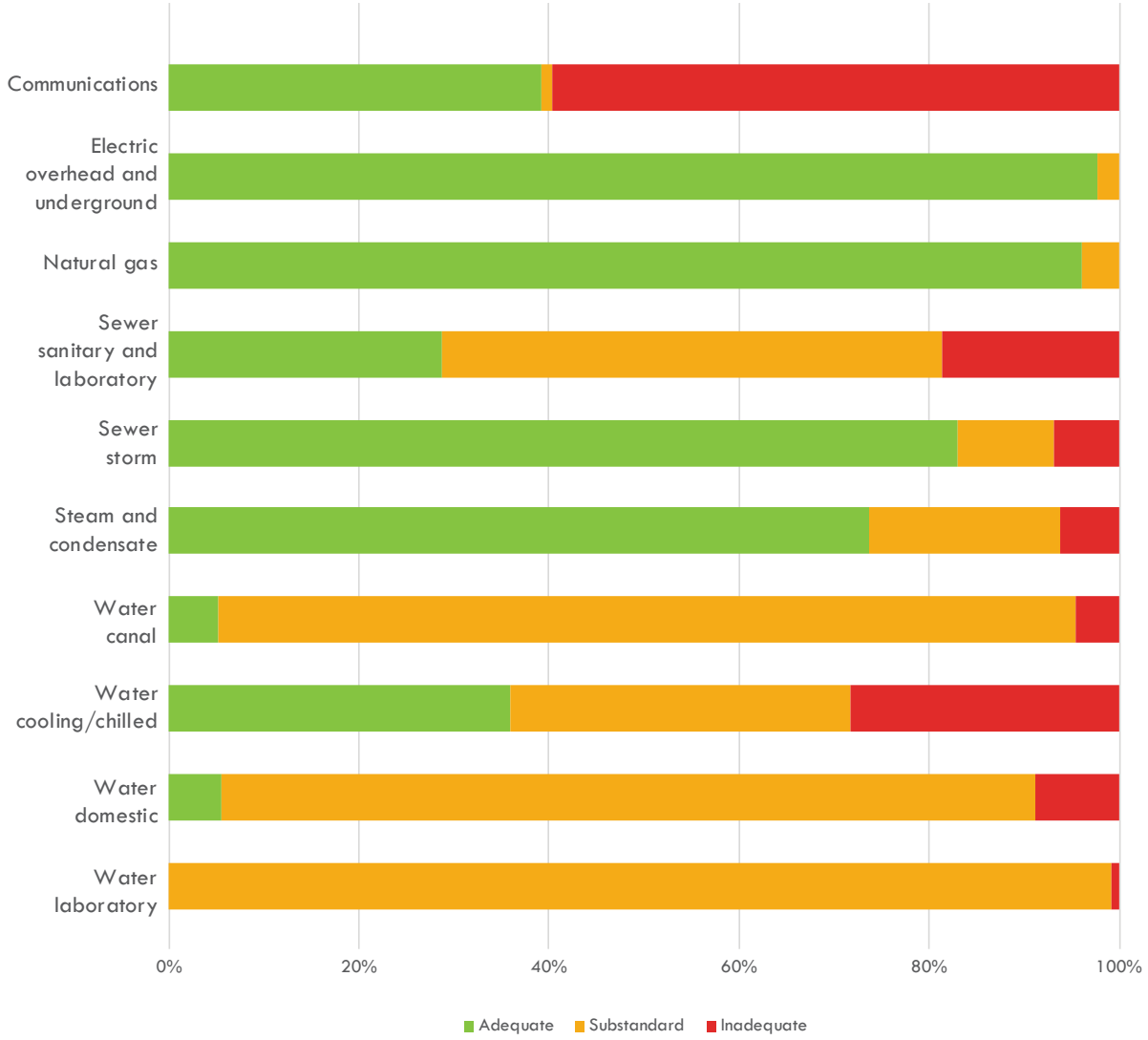


Figure 23. Utility Condition by System, FY17

From this data, 226 projects were identified, totaling over $460 million. Of these, 94 projects are currently tracked on the Condition Assessment Information System (CAIS) or ESH&I priority list. As a result of the plan, 132 new projects and studies were identified. Repair or maintenance needs were reviewed to ensure they were incorporated onto the site's CAIS and are now tracked under the site maintenance and/or modernization needs. Projects resulting from the utility master plan are scheduled for implementation over the next 25 years.

One key investment resulting from the initiative is a water and sewer utilities modernization project, funded at $8.7M. A large percent of the Laboratory's underground water and sewer distribution system are original to the site and are in substandard or inadequate condition. Direct funding from DOE is necessary to complete this large-scale project, which prioritizes critical locations for replacement piping and inadequate support infrastructure, such as water towers, in a multi-year program.

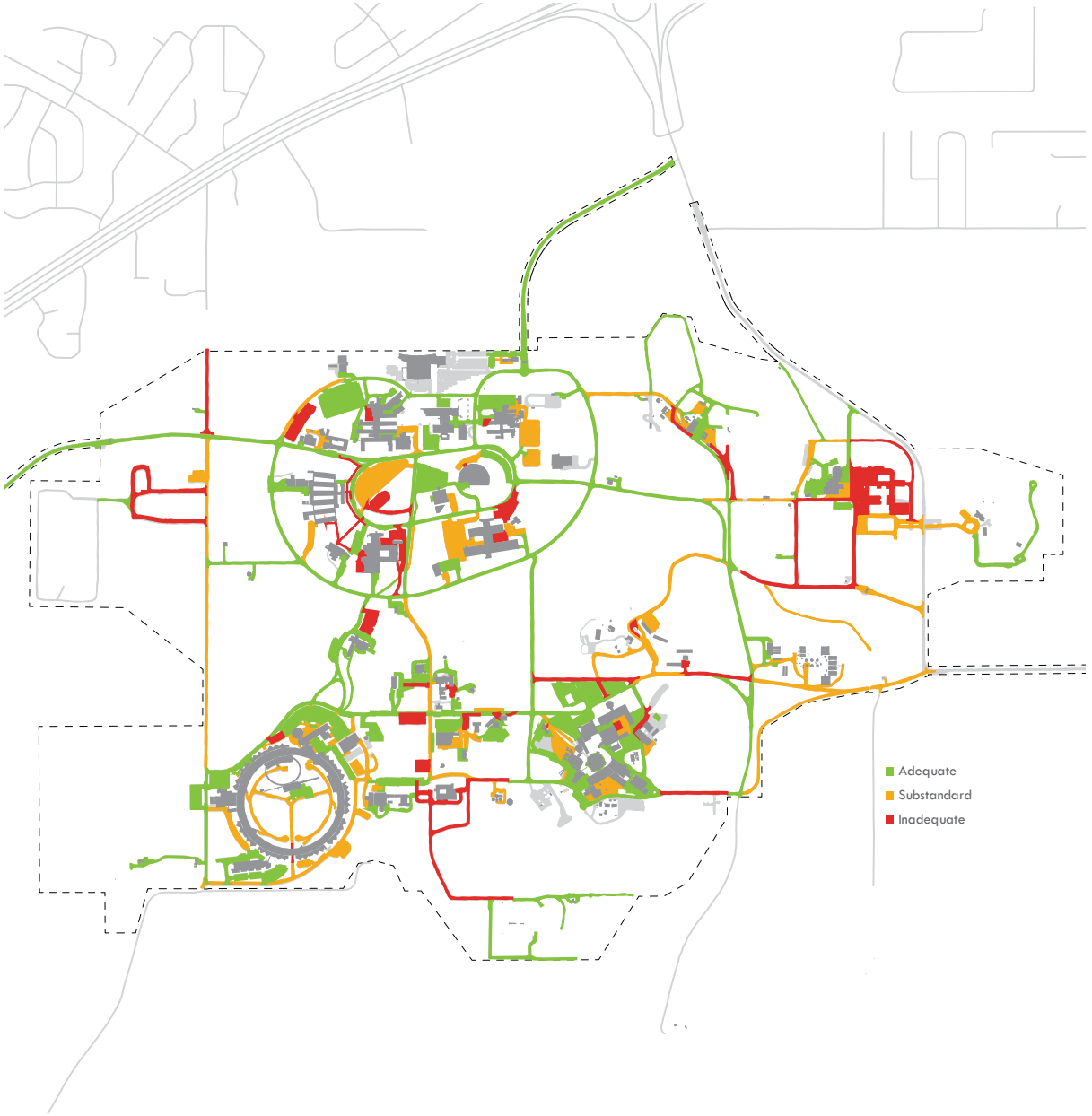


Figure 24. Condition Assessment of Site Transportation Infrastructure, FY16 and FY17 updates

SITE INFRASTRUCTURE CONDITION

Throughout the entire year, Argonne employees walk, run and cycle around campus for leisure and transportation purposes. Although paved sidewalks are not continuous throughout the entire site, many pedestrian paths were recently created or made continuous in the 200 and 400 Areas. The Infrastructure Services Directorate began paving the existing gravel road shoulders in the last 10 years to add room for pedestrian and bicycle use.

Parking analyses completed for the 200 and 400 Areas of site revealed that each area suffers from both parking oversupply and under-supply. In the 200 Area, ample parking exists for the current number of employees, although it may not be located closest to the need. When the MDL building is completed in 2021, the population concentration and associated parking demand will shift farther to the northern half of the main campus. The MDL project will install surface parking, which helps to alleviate parking pressures in the Energy Quad.

In the 400 Area, the parking supply locations do not correspond to the population and many lots are undersized for the amount of associated occupants. Many of the Lab-Office Module (LOM) facilities around the APS ring do not have adequate parking supply for visiting scientists and sponsors.

Increasing the availability of alternative commute methods and promoting alternate work schedules helps to alleviate the burden on some parking lots. The Site Sustainability Program is analyzing various mobility solutions, such as a Bike Share, for getting around the site without having to use personal vehicles.

The Annual Site Work Improvement Program, funded out of the Major Repair Program, funds infrastructure improvements such as road paving, parking lot reconstruction and sidewalk repairs. IS maintains a list of priority projects, which are evaluated and updated yearly with input from occupants, building managers, and subject matter experts who identify needs or safety concerns.

Access Analysis

Argonne follows the Architectural Barriers Act (ABA) of 1968 (42 U.S.C. §§4151 et seq.), which "requires access to facilities designed, built, altered, or leased with Federal funds."

In an effort to create a comprehensive database of accessible pedestrian features across the site, a self-evaluation and compliance inventory was initiated in FY2015. Site data was collected in order to determine compliance with the ABA and, identify physical barriers that can limit accessibility to programs, services, and activities. This evaluation began in the 200 Area, which is identified as a site priority area with high pedestrian traffic. Future phases will address the remaining portions of the site.

In terms of ABA compliance levels for parking lots in the 200 Area, curb ramps are considered non-compliant in 26% of locations, primarily because they do not exist where required. Surface conditions on sidewalks are 91% compliant, with 100% compliance for the dimensions of walkway width. Compliance is considered for each required element of parking lots, sidewalks, curbs, etc.

Identified deficiencies are addressed through the Site Work Improvement Program in conjunction with other location-specific repair projects.

III. PLAN IMPLEMENTATION STRATEGY

SUPPORT OF MISSION READINESS

ALIGNMENT OF CORE CAPABILITIES

The Argonne National Laboratory FY2018 Annual Laboratory Plan lays out a path to encourage and focus bold and visionary efforts from basic science to deployed technology. To expedite these strategies and ensure a successful outcome, key facility and infrastructure investments are required. Figure 25 shows investment trends for FY14-FY18. Infrastructure Services aims to provide adequate and modern facilities and infrastructure to support science needs and the Laboratory's Core Capabilities (pages 10 - 13).

Critical path investments for the site include expansion to the critical campus utility systems of chilled water and high voltage electrical power, along with focused building renovations and program relocations or moves, which allow for the consolidation of distributed organizations or new teaming structures. See the Site Modernization Plan, Figure 26.

One example of the interdependencies of construction, moves, and renovations is modeled in the sequencing of activities for the MDL. The planned strategic moves and space rehabilitations planned for post MDL construction will allow demolition of the Building 200 M wing and MA/MB wings, reducing deferred maintenance, risk, and operating costs.

More information can be found in the FY18 Annual Laboratory Plan, Table 6.3.

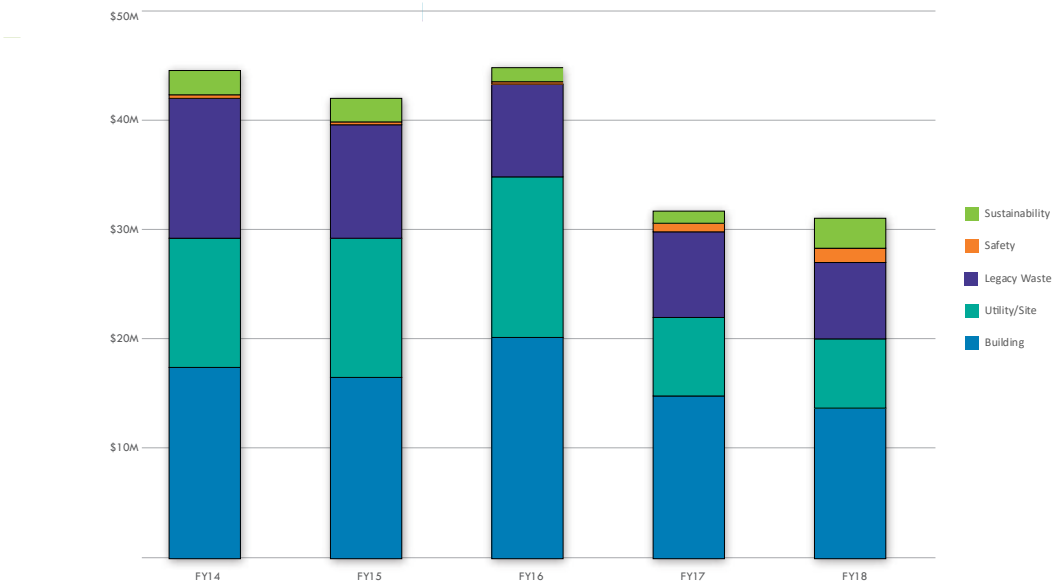


Figure 25. Internal Investment Trend, FY2014 through FY2018

SITE-WIDE INFRASTRUCTURE ENHANCEMENT PROJECTS

- Electrical Capacity and Distribution Capability (ECDC) project
- Fiber optic cabling plant upgrade
- Facility communications upgrade
- Enterprise data center (network)
- Site cooling water distribution upgrades
- Water and sewer utility modernization
- Site helium recovery system
- 100 Area physical plant modernization
- Consolidated space initiative

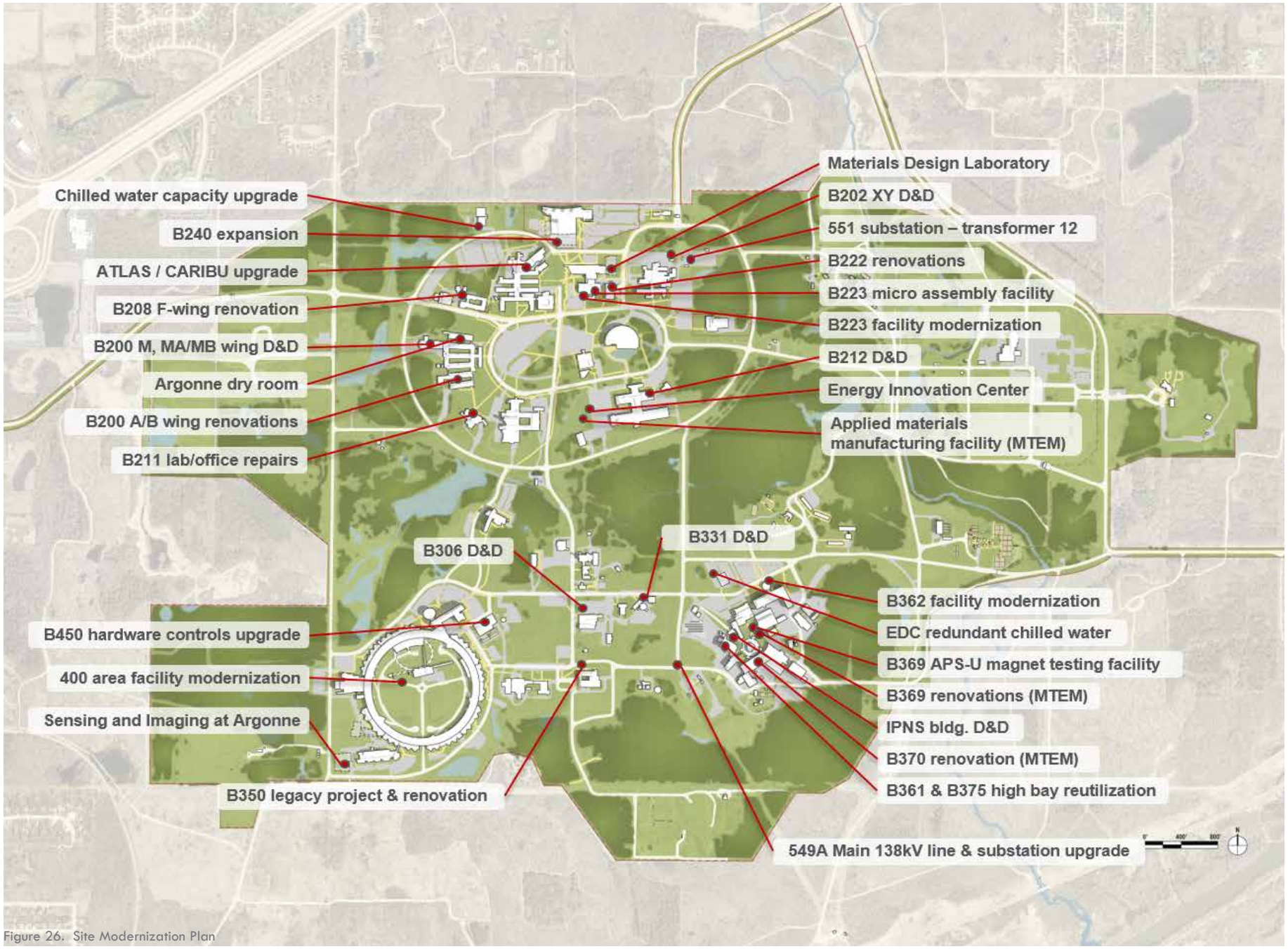


Figure 26. Site Modernization Plan

TEN YEAR PLAN

200 AREA

Major investments to support Argonne's near-term scientific strategy are identified in the FY2018 Annual Laboratory Plan. While preparing the laboratory for longer-term success, these investments support Argonne's major scientific initiatives through new construction, renovations and upgrades to critical infrastructure.

A major building project, the Materials Design Laboratory (MDL), funded by the DOE Science Laboratories Infrastructure (DOE-SLI) Program, will be complete by the end of 2021 (Figure 27). The MDL will accommodate roughly 100 employees in 115,000 GSF of new state of the art laboratory and office space, including new low-level radiological facilities. The space will support scientific theory and simulation, materials discovery, characterization and the application of new energy-related materials and processes.

When complete, the MDL will enclose the 200-Area and complete the vision for the modern "Energy Quad" at Argonne. MDL, following on the construction of ESB, consolidates research space that supports three core capabilities into the Energy Quad. See Figure 28 for a site layout of 200 Area investments.

Additional new laboratory and office construction will also include the Energy Innovation Center, a State of Illinois-funded building associated with the science performed by the Joint Center for Energy Storage Research (JCESR), estimated for completion in 2025. In preparation for the

Figure 27. Perspective rendering of the Material Design Laboratory (MDL), currently under construction. Source: Flad Architects

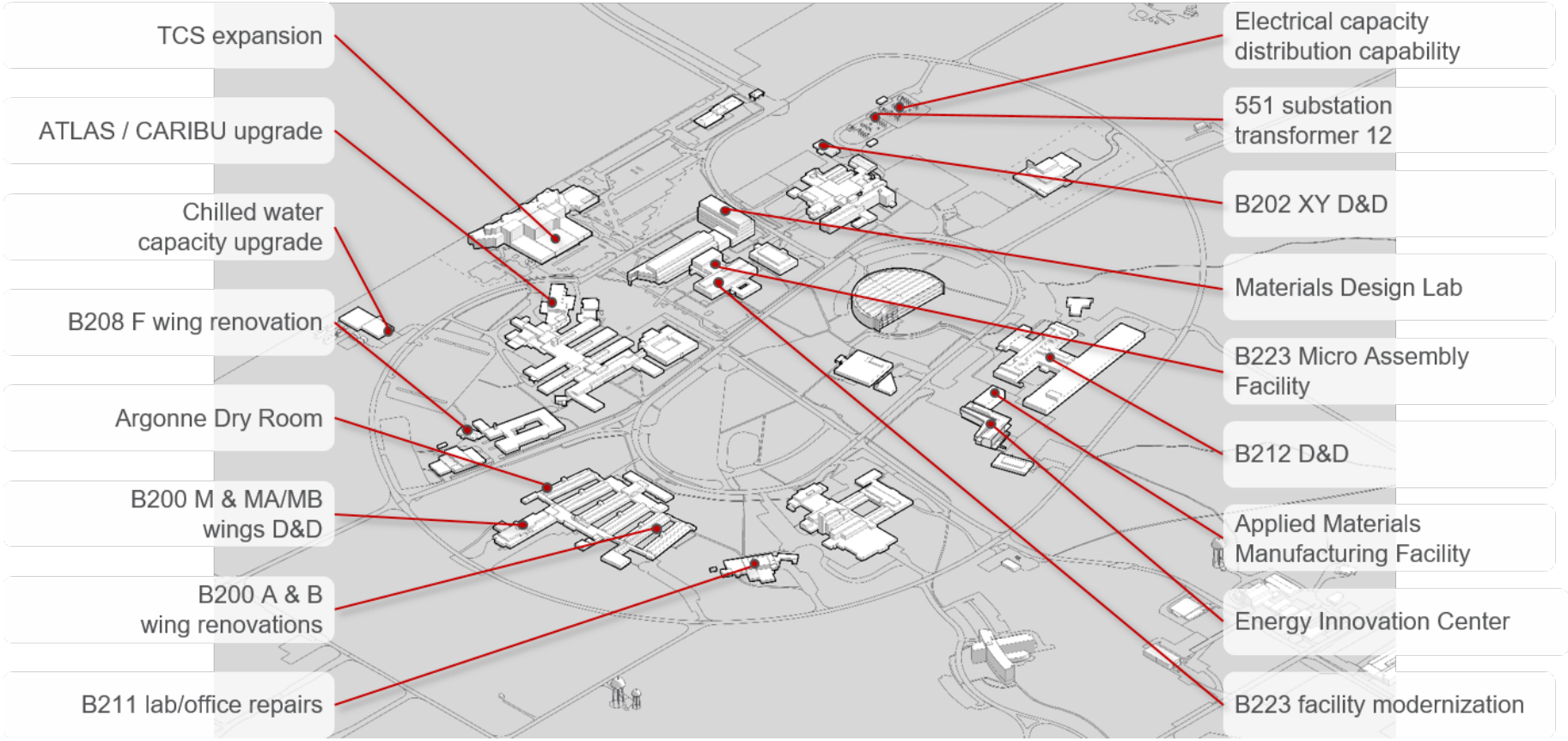


Figure 28. 200 Area Planned Investment Locations

Aurora 21 Exascale high performance computer, the TCS Building 240, is expanding its data center and utility support space.

Investment in the Building 200 laboratory and office facility continues with both planned demolition of M and MA/MB wings and renovation to A and B wings. The Argonne Dry Room construction in F wing has begun and will continue into FY19.

A Micro Assembly Facility is planned for Building 223, which will focus on the assembly and testing of micro-scale devices for large area detectors. The facility provides approximately 4,200 sq. ft. of clean assembly space and test bays, with the flexibility to adapt to changing and future project needs (see Figure 29). The assembly space is intended to meet the needs of future experiments, including silicon sensors for the APS Upgrade, the Cosmic Microwave Background Stage 4, (CMB-S4), Electron Ion Collider (EIC) and ATLAS. Multiple scientific divisions will benefit from the space.

The Building 528 chilled water plant and Building 551 electrical substation, both located in the 200 Area, will complete planned capacity expansions to support campus-wide power and cooling needs. Utility infrastructure upgrades are necessary to support projected load increases associated with scientific program growth. The Electrical Capacity and Distribution Capability (ECDC) project also will provide a fully redundant power source to the site, limiting potential single-point failures. Table 3 summarizes the 200 Area investments.

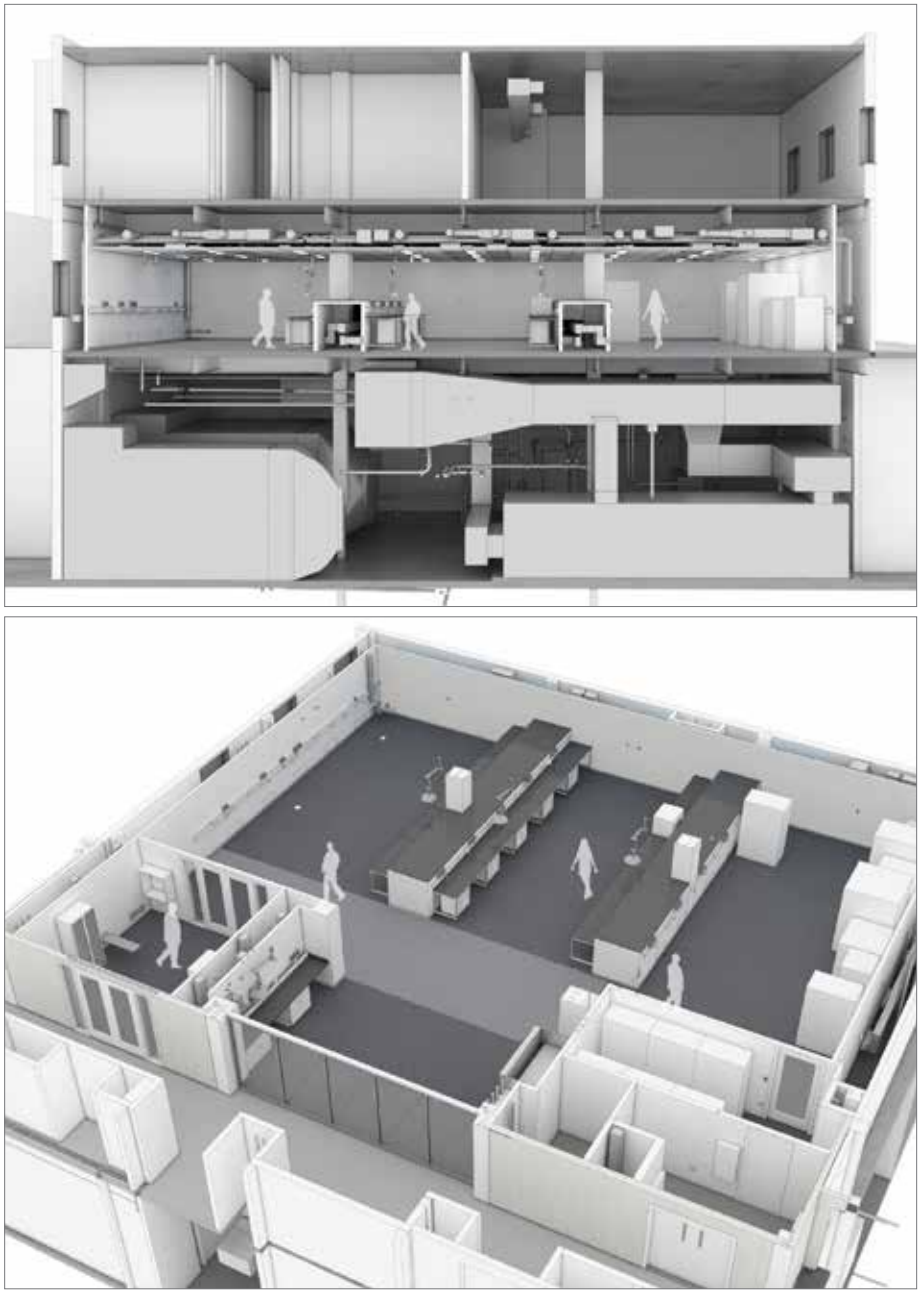
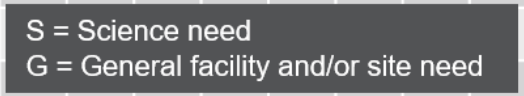


Figure 29. Conceptual renderings of a section cut through Building 223 (top) and bird's eye view (bottom) showing proposed renovations to support the Micro Assembly Facility. Source: Cannon Design

Table 3. 200 Area Investments

	Project	Type	$M	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
S	Materials Design Laboratory	SLI	$95.0												
S	Argonne Dry Room	IGPP	$1.2												
S	Theory & Computing Sciences Bldg. expansion	Other	n/a												
S	B223 micro assembly facility	IGPP	$2.5												
S	B208 F-wing renovation	IGPP	$2.1												
S/G	Electrical capacity distribution capability	SLI	$60.0												
S/G	551 substation - transformer T12	IGPP	$2.3												
S	B223 facility modernization	SLI	$18.0												
S	B211 lab/office repairs	OH	$0.6												
S/G	Chilled water capacity upgrades	IGPP	$5.5												
S	ATLAS / CARIBU upgrade	GPP	$4.2												
S	Energy innovation center	State	$35.0												
S	B200 A/B wing renovations	IGPP	$6.1												
S	Applied materials manufacturing facility (MTEM)	SLI	$60.0												



BES Basic Energy Sciences (DOE-SC)
EM Environmental Management (DOE-EM)
GPP General Plant Project (DOE)
IGPP Institutional General Plant Project (DOE)
OH Laboratory Overhead
SLI Science Laboratories Infrastructure (DOE-SC)
State State of Illinois

300 AREA

The Argonne Enterprise Data Center (EDC) was completed in 2017 and provides a central location for operation of critical IT and business systems equipment. The EDC is currently being enhanced with a project to supply redundant chilled water and network upgrades to achieve required reliability and availability levels.

In anticipation of the APS Upgrade starting in 2022, space in the 300 Area will be used for preparatory activities prior to the beamline shutdown. High bay space in Buildings 361 and 375 will be cleaned out through decontamination and demolition (D&D), then reused to create 21,000 sq. ft. of preparation space to support APS Upgrade operations.

Space at Building 370 will be renovated for the Midwest Transformative Energy Manufacturing Facility (MTEM), which is envisioned as a unique research environment to accelerate the progression of future energy technologies from discovery to applied research and scalable manufacturing. MTEM will support approximately 75 scientist and research associates (Figure 30).

Argonne took over operational responsibilities of Building 350 from the DOE in FY17. To make the facility usable for future research activities, Argonne initiated an SLI-funded project to de-inventory nuclear reference materials, clean out hazardous materials and characterize the residual contamination. Renovations are either proposed or planned to allow for reuse by programmatic divisions starting in FY2020.

Table 4 and Figure 31 summarize the 300 Area investments.

Table 4. 300 Area Investments

	Project	Type	$M	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
G	EDC redundant chilled water	IGPP	$1.5												
G	EDC network	IGPP	$2.3												
S	B369 APS-U magnet testing facility	BES	$0.6												
S	B370 renovations (MTEM)	IGPP	$9.5												
S	B375 high bay reutilization (D&D monolith)	OH	$6.3												
S	B350 legacy project	SLI	$42.9												
S	B369 renovations	IGPP	$8.0												
S/G	549A main 138kV line & substation upgrade	IGPP	$5.0												
S	B350 renovations	GPP	$9.7												
S	B362 facility modernization	SLI	$22.0												
G	B361 IPNS LINAC D&D	EM	$6.9												

S = Science need
G = General facility and/or site need

Figure 30. Conceptual Rendering of MTEM Facility at Building 370. Source: Cannon Design

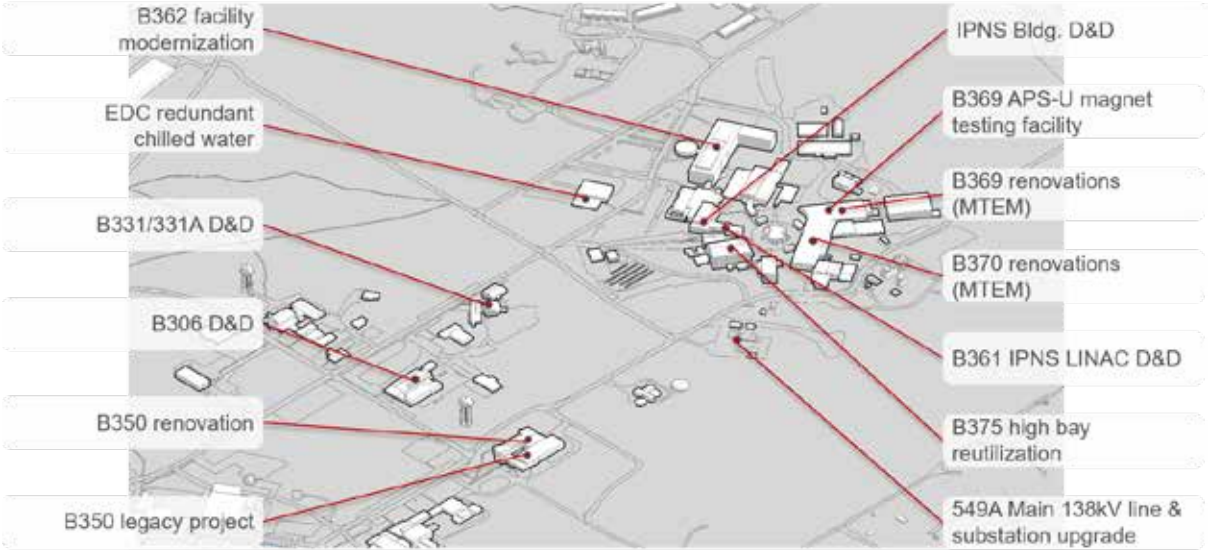


Figure 31. 300 Area Investment Locations

Legend (Table 4)

BES	Basic Energy Sciences (DOE-SC)
EM	Environmental Management (DOE-EM)
GPP	General Plant Project (DOE)
IGPP	Institutional General Plant Project (DOE)
OH	Laboratory Overhead
SLI	Science Laboratories Infrastructure (DOE-SC)
State	State of Illinois

400 AREA

The largest facility in the 400 Area is the Advanced Photon Source (APS), which was completed in 1996. The main facilities and systems have now reached their expected end of life and are deteriorating. Major investments for this area are planned to coincide with the APS-Upgrade project. Figure 33 shows locations of 400 Area investments.

The APS Upgrade project will increase the brightness of the APS' high-energy (hard) X-ray beams. Shutdown of the beamline to upgrade the facility is planned for 2022 - 2023. The planned upgrade includes the construction of long beamline end stations, which will be located north of Building 446.

APS Infrastructure Master Plan

Building on the valuable information collected in the Utility Master Plan effort, Argonne initiated an APS Infrastructure Master Plan in FY17. The purpose of the study, which is being prepared by a consulting engineer, is to identify future needs and repair investments in the 400 Area that must be addressed to support the upgrade project. Identification of needs and programming repairs will ensure continued operations at not only the APS but at CNM and APCF facilities, also.

A majority of the APS support facilities and utility distribution infrastructure are original to the APS construction, dating to 1992. Much of the equipment has reached end of life and emergency repairs are increasing in frequency. Underground cooling and electric piping were not constructed

Figure 32. Perspective rendering of proposed repairs to the Building 401/402 entrance. Source: Bailey Edward

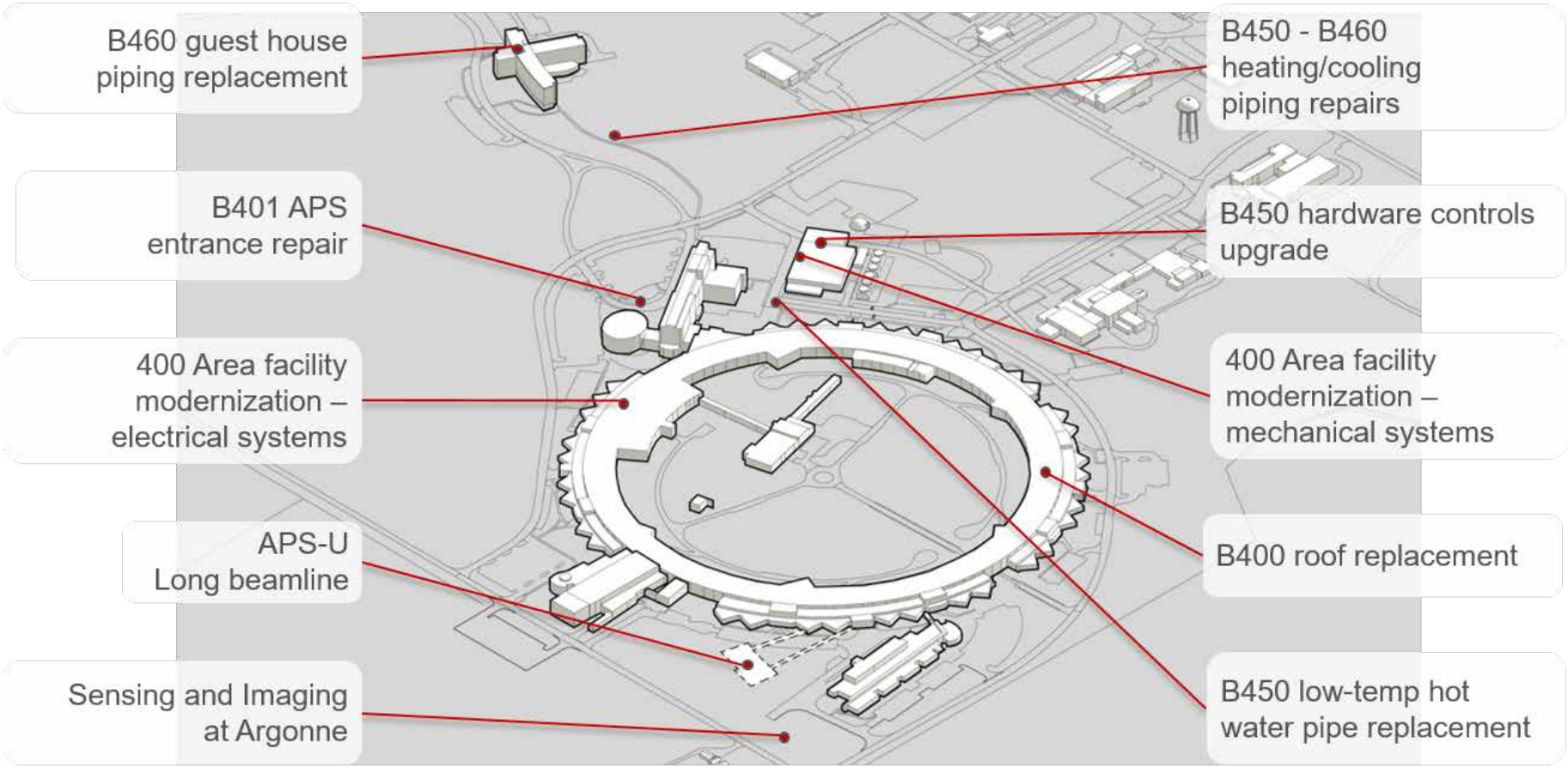


Figure 33. 400 Area Investment Locations

Table 5. 400 Area Investments

	Project	Type	$M	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
S	B450 low-temp hot water line replacement	OH	$1.4												
G	B460 guest house piping replacement	OH	$0.9												
S	B401 APS entrance repair	OH	$0.8												
G	B450 - B460 heating/cooling piping repairs	OH	$0.4												
G	B450 hardware controls upgrade	IGPP	$1.9												
S	400 Area facility modernization	GPP	$15.5												
S	*- Mechanical Systems*	*GPP*	*$7.1*												
S	*- Electrical Systems*	*GPP*	*$8.4*												
S	Sensing and Imaging at Argonne	SLI	$52.0												
G	B400 roof replacement	OH	$6.0												

S = Science need
G = General facility and/or site need

BES Basic Energy Sciences (DOE-SC)
EM Environmental Management (DOE-EM)
GPP General Plant Project (DOE)
IGPP Institutional General Plant Project (DOE)
OH Laboratory Overhead
SLI Science Laboratories Infrastructure (DOE-SC)
State State of Illinois

in duct banks, but are direct-buried, causing accelerated deterioration. Direct funding from DOE is required to replace these systems and construct utility tunnels to avoid future failures. Argonne internal repair funds would be used to replace roofs in coordination with the APS Upgrade shutdown time frame. Table 5 summarizes the 400 Area investments.

Sensing and Imaging at Argonne

A proposed 40,000 - 60,000 GSF experimental and computational imaging facility would be constructed in the 400 Area by the end of FY2022. The Sensing and Imaging at Argonne (SIA) facility would aim to solve pressing scientific challenges across a wide range of DOE applications. The estimated cost is $52 M of DOE-SLI funding, with DOE Critical Decision (CD-0) estimated in September 2018.

The SIA construction facilitates the consolidation of microscopy research on site and supports the shut down and demolition strategy for Building 212. Advanced electron microscopy research requires extreme vibration, humidity and temperature restrictions that would be accommodated in the new facility. This allows Argonne to consolidate the imaging research currently being conducted in aging facilities and support next generation equipment requirements. See Figure 34 for a conceptual view of the facility.

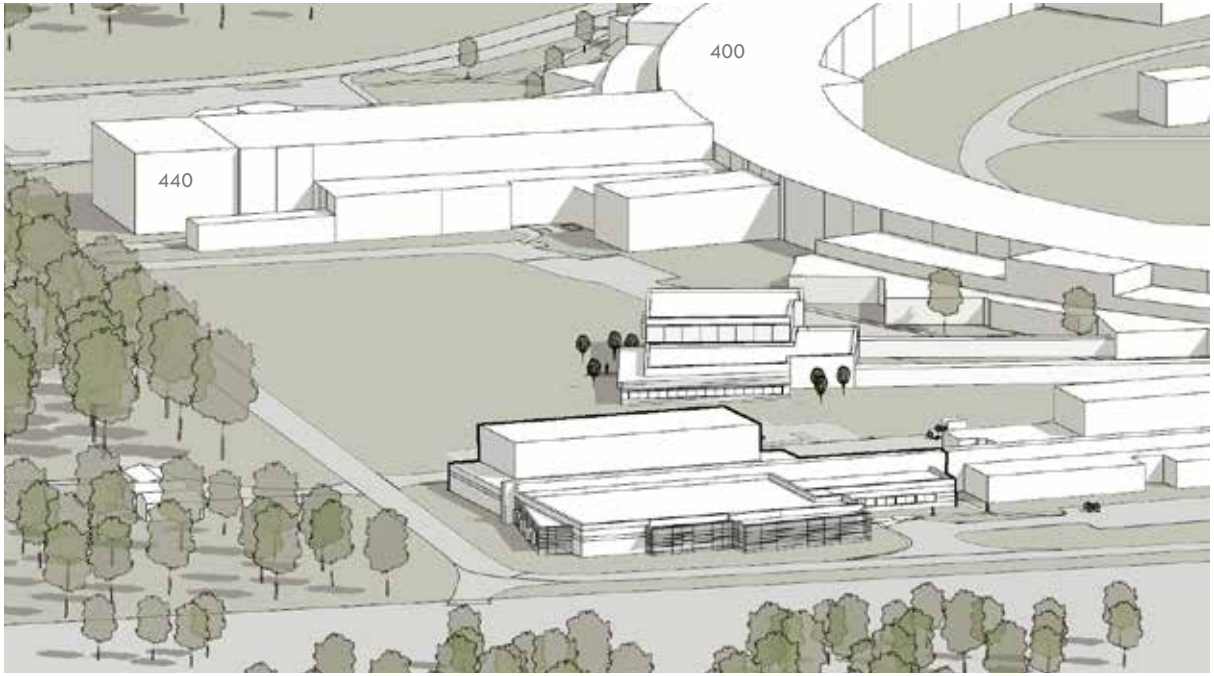


Figure 34. Conceptual View of 400 Area Improvements, Sensing and Imaging at Argonne Facility and APS Long Beamline Building in Background

EXCESS FACILITIES PLAN

Argonne maintains a multi-faceted approach to its excess facilities. The near-term approach focuses on the removal of legacy waste and relocation of staff to permit removal of excess facilities. The relocated staff are placed in renovated space or new facilities designed to accommodate the programmatic research need.

Removing programs from obsolete buildings and consolidating them into modern facilities allows the space to be prepared for removal. This drives consolidation of programmatic divisions across the Laboratory.

Removing excess equipment, tools and chemical and hazardous wastes from vacant spaces allows Argonne to transfer substandard and inadequate facilities to DOE-Environmental Management (DOE-EM) for demolition. DOE-EM has committed to funding the removal of several Argonne excess facilities.

Removing the obsolete space from the site contains high initial costs for the Laboratory to prepare spaces for removal, and the actual removal cost, but ultimately saves the Laboratory in yearly operations and maintenance costs.

Argonne's excess facilities are classified on the basis of being obsolete due to new construction, being an unlikely candidate for renovation, or having negative environmental impacts. Figure 35 shows the excess facilities site plan.

Based on the excess facilities plan, those buildings and structures proposed for demolition, but currently occupied, require a confirmation of the phased relocation and renovation programs needed to support their elimination. The expectation is to assess existing facilities that can be feasibly renovated to support program needs.

Legacy Waste

The complete removal of contact and remote-handled transuranic waste, CH- and RH-TRU waste, from Argonne's legacy nuclear research is projected to be complete by 2025.

Strategy

The removal of excess facilities will begin with Building 200 M and MA/MB wings, which will be vacated by programs destined for MDL (estimated 2020). The resulting clean-up fully retires the Alpha Gamma Hot Cell Facility in Building 212. A phased clean-out and demolition of Building 212 is planned over several years, with complete removal projected by 2027. Relocation of existing programs in Building 212 is currently under evaluation. Following the elimination of legacy waste, Buildings 331 and 306, which have facilities dedicated to the packaging, storage, and transport of waste, can be demolished. Several vacant IPNS buildings in the 300 Area are planned for removal by 2023

Facilities to replace Building 306 for the Waste Management Division are also under evaluation.

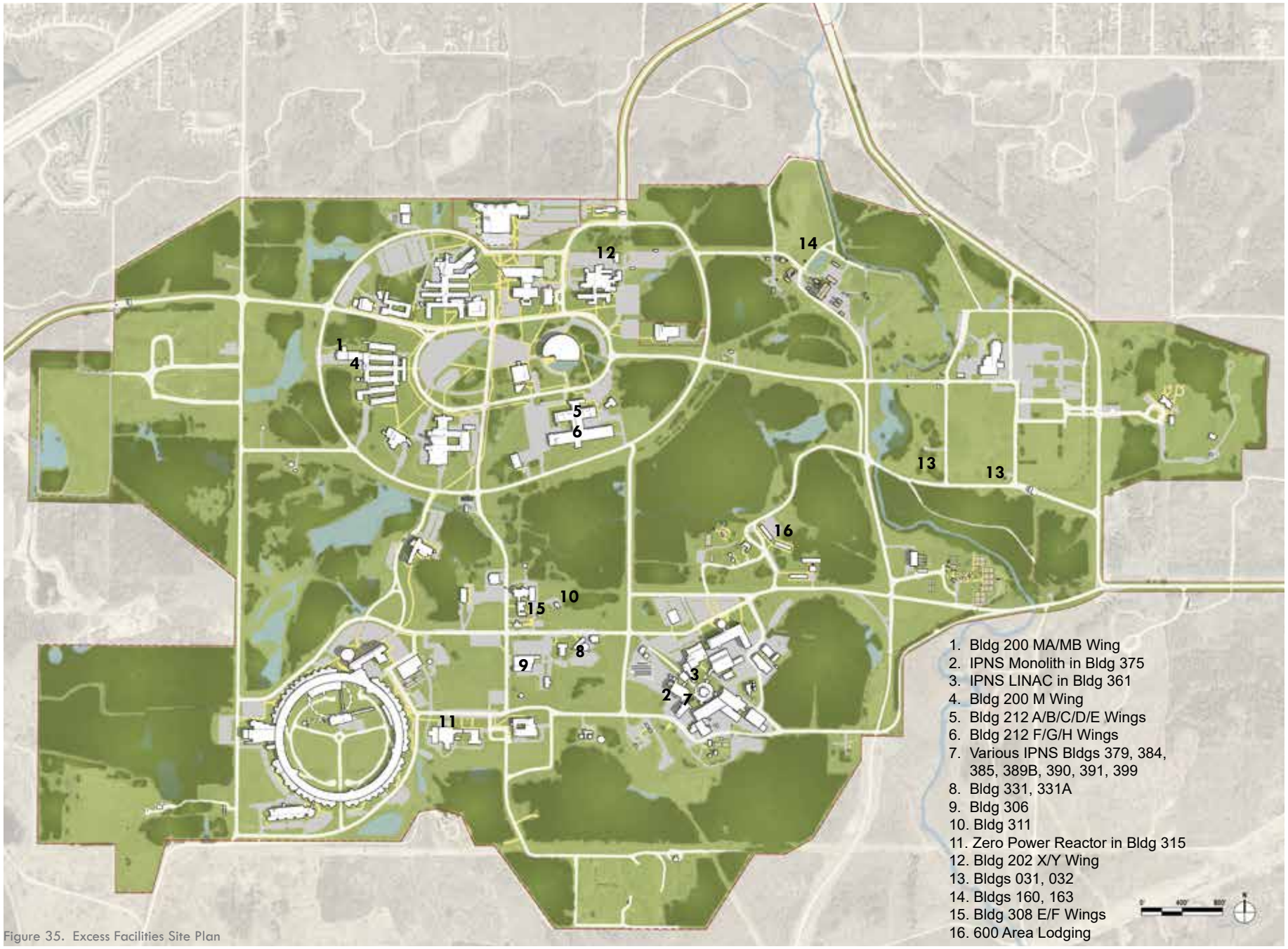


Figure 35. Excess Facilities Site Plan

Argonne's plan to demolish its excess facilities would remove 470,569 GSF of substandard and inadequate space. Removing this space represents a reduction in deferred maintenance and reduction of $14.8 M in annual operating cost for maintenance and surveillance. See Figure 36.

Planned deactivation and decommissioning (D&D), along with other associated clean-up activity estimates, are $305 million and are expected to be funded through the DOE-EM program over the next ten years. Without the necessary DOE-EM funding, Argonne projects to carry approximately $95M in total deferred maintenance costs by FY2029. Table 6 shows D&D investments.

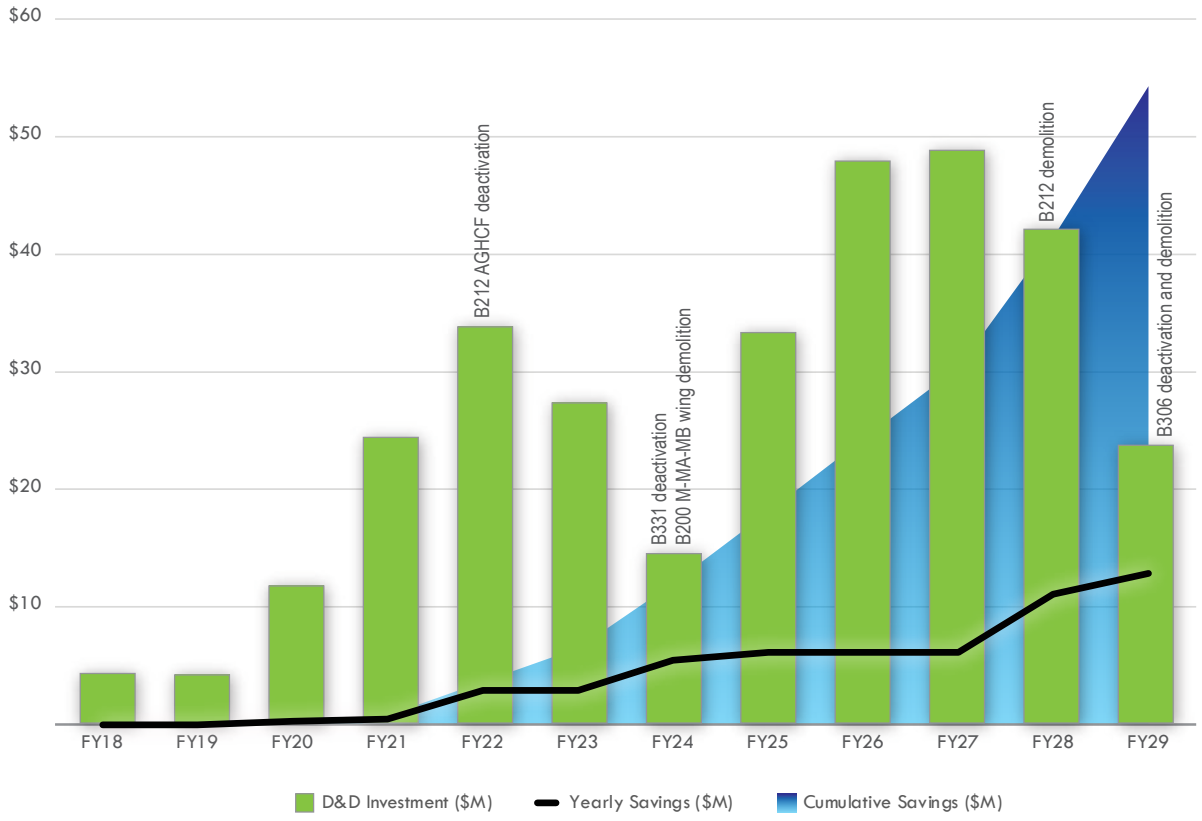


Figure 36. Investment Impact of D&D on Operations, Maintenance and Utilities and Surveillance, FY17

Table 6. D&D Investments

Project	Type	$K	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
CH TRU Waste Removal (331, 306, 205)	IF-EFD	$4,873												
RH TRU Waste Removal (AGHCF, 331, 306)	IF-EFD	$7,652												
Consolidated Space Initiative	IF-EFD	$7,862												
B202 XY Wing Cleanout and D&D	IF-EFD	$750												
RH-TRU Disposition (B212, 205 K-Wing)	DF-EFD	$7,373												
RH-TRU Disposition (B306/331 Shell)	DF-EFD	$8,849												
CH-TRU Disposition (B200, 205, 306, 331)	DF-EFD	$13,170												
B200 M-Wing Deactivation	DF-EFD	$3,809												
B200 MA/MB Wing Demolition	DF-EFD	$24,451												
D&D IPNS (Bldgs 379, 384, 385, 389B, 390, 391, 399)	DF-EFD	$13,956												
B200 M Wing D&D	DF-EFD	$23,446												
B331 Characterization	DF-EFD	$2,308												
B212 F/G/H Wings Characterization	DF-EFD	$5,858												
B212 A/B/C/D/E Wings Characterization	DF-EFD	$6,272												
B331 D&D Shell	DF-EFD	$37,300												
B212 A/B/C/D/E Wings Cleanout and D&D	DF-EFD	$51,800												
B212 FGH Wings Cleanout and D&D	DF-EFD	$66,400												
B306 Cleanout and D&D	DF-EFD	$41,600												

DF-EFD Direct Funded - Excess Facilities Demolition
IF-EFD Internally Funded - Excess Facilities Demolition

SITE RESILIENCY

Argonne's Sustainability Program supports world-class science and engineering research through infrastructure modernization and site occupant engagement. The program's goal is to deliver cost savings by addressing deferred maintenance and improving operations, while reducing Argonne's environmental impact.

Gains in energy savings and performance inherent to a modern facility can be realized by coordinating maintenance programs with sustainability actions. Laboratory-wide integration of DOE and Argonne sustainability program goals, with ongoing projects to address deferred maintenance and modernization of aging facilities, results in a greater benefit to the Laboratory. By integrating the Sustainability goals into existing operations and maintenance activities, projects are able to meet multiple Laboratory goals.

Argonne's Strategic Planning Program is leading organizational resilience efforts. The collaboration between the Strategic Planning and Sustainability programs integrates adaptation strategies into ongoing work to ensure overall mission readiness through Laboratory-wide facility and infrastructure strategic planning.

Climate Assessment

To determine potential risks associated with climate-related impacts on its mission, scientific programs, site operations and personnel, Argonne began a study on Climate Change Vulnerability Assessment in FY17.

Based on hazards identified in the climate change vulnerability assessment (e.g., extreme precipitation, severe hot or cold cycles), future facility and infrastructure designs incorporate the associated projected load increases to the systems. Specifically, the Electrical Capacity and Distribution Capability (ECDC) project, incorporates needed reliability and redundancy to the site to address power grid vulnerabilities. Providing resiliency to critical infrastructure at the Laboratory ensures mission-critical scientific programs remain operational.

In FY2018, Argonne will finalize the Climate Change Vulnerability Assessment and begin adaptation planning and the next steps identified in the assessment. Adaptation planning will include identifying climate resilience-related measures to implement at Argonne and developing an implementation approach with milestones and time lines to track progress.

Argonne will analyze flood risks identified as part of extreme weather events and incorporate them into the site's modernization plan for stormwater distribution, flood retention, and flood mitigation (e.g. bioswales, natural resource management) investments on site to reduce runoff and flooding.

To protect its employees, Argonne continues to implement and update safety procedures and protocols for working in extreme weather conditions, including extreme heat events. Argonne will also leverage existing activities and expertise of the Security, Travel, and Emergency Services Division during adaptation planning activities to further support ongoing efforts to maintain operational resilience at the Laboratory.

Efficient Operations

Executive Order 13834, Efficient Federal Operations, issued in May 2018, established streamlined goals for Federal agencies to increase efficiency, optimize performance and eliminate unnecessary use of resources and protect the environment. The EO sets goals specific to renewable energy and water consumption, sustainable building design, waste prevention and federal acquisitions.

The Sustainability Program collaborates with Laboratory operations groups to update processes to incorporate sustainability for improved efficiency and cost savings. Sustainability Program goals have been incorporated into the Facilities Design Guide, general construction specifications, procurement actions and the business case template.

Planned Investments

Argonne's portfolio of projects implemented since 2012 under the In-House Energy and Water Reinvestment Program implemented 22 energy and water savings projects, adding $77,437 annual savings.

Future programs include high voltage electric and water system capacity and redundancy investments, identified in the Ten-Year Plan (page 42). Repair, replacements, or upgrades needed to support projected scientific growth would consider climate impacts associated with rising temperatures, increased precipitation or drought conditions that were identified in the Climate Change Vulnerability Assessment.

Argonne will investigate the potential use of the Facilities Investment, Renovation, and Modernization (FIRM) Program, sponsored by the DOE-Sustainability Performance Office. The program focuses on strategies to leverage alternative financing measures such as energy savings performance contracts (ESPCs) or utility energy service contracts (UECs). These funding outlets would allow Argonne to implement deep energy retrofits to achieve a 40% or more reduction in energy use.

One current program in which the Laboratory is investing is a comprehensive asset commissioning initiative. Argonne developed a multi-year Campus Retrocommissioning (RCx) Plan and completed RCx activities at Building 200 in FY18, resulting in $125,000 in annual savings with a 5-year simple payback.

More information is available in the Site Sustainability Plan, located at www.anl.gov.

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