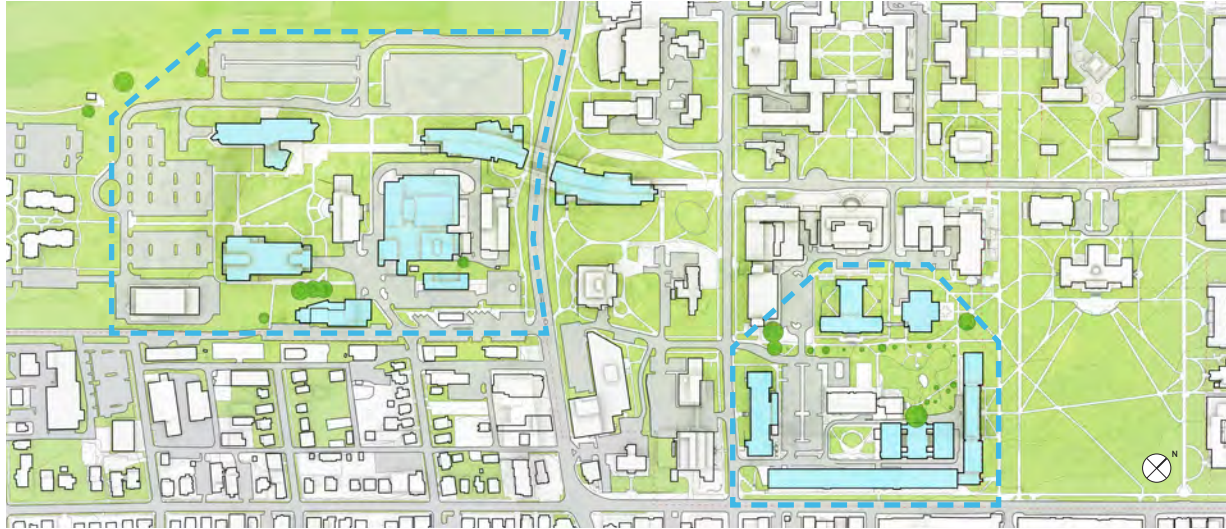


EXISTING CONDITIONS



Overall Site Plan Showing Master Plan Study Area

This chapter examines various aspects of the College's existing facilities, encompassing the campus context, infrastructure, zoning, buildings, and program. This analysis forms a foundation and guide for development of the Master Plan (presented in Chapter 4) and its underlying growth projections, which are presented in Chapter 3.

One College with 12 departments, 14 buildings and wide-ranging dispersion of programs beyond; the Master Plan needs to develop coherence where there is currently fragmentation.

2

CAMPUS

The Master Plan is focused on two precincts within the Penn State campus at University Park. The Core Campus is located west of Old Main and is bounded by College Avenue and Burrowes Road on its south and west sides, respectively, and is contained within the Farmers' High School Historic District. COE buildings within the Core Campus include Sackett, Hammond, the Engineering Units, Reber, Electrical Engineering West, and Electrical Engineering East. The Core Campus has a strong historical connection to the overall Penn State campus with three Charles Klauder designed buildings, the most prominent of which is Sackett, which face Pattee Mall and the Old Main Lawn. Klauder designed many prominent buildings on campus, including Old Main. He is "known for being the creator of background buildings, the warp and tapestry of great American college campuses."* At the center of the Core Campus is one of the oldest buildings on campus, University House, which was home to eleven of the University's presidents and is now part of the Hintz Alumni Center.

The West Campus is a much newer development, situated to the west of North Atherton Street and bounded by the golf course and playing fields to the north, the White Course Apartments to the west, and Railroad Avenue / Old Railroad Grade to the south.

COE Buildings within West Campus include Earth and Engineering Sciences, Leonhard, Engineering Services, Hallowell, Research West, and Westgate. The College also has some presence in the Applied Sciences Building, which is primarily occupied by the Advanced Research Laboratory (ARL). Westgate, which the College shares with the College of Information Sciences and Technology (IST), was completed in 2004 and serves as a pedestrian bridge over North Atherton, which is part of US Route 322 and a heavily traveled road. Westgate thus serves as a critical link between the West Campus and the rest of the Penn State campus, aligning with Pollock Road, a primary east-west thoroughfare.

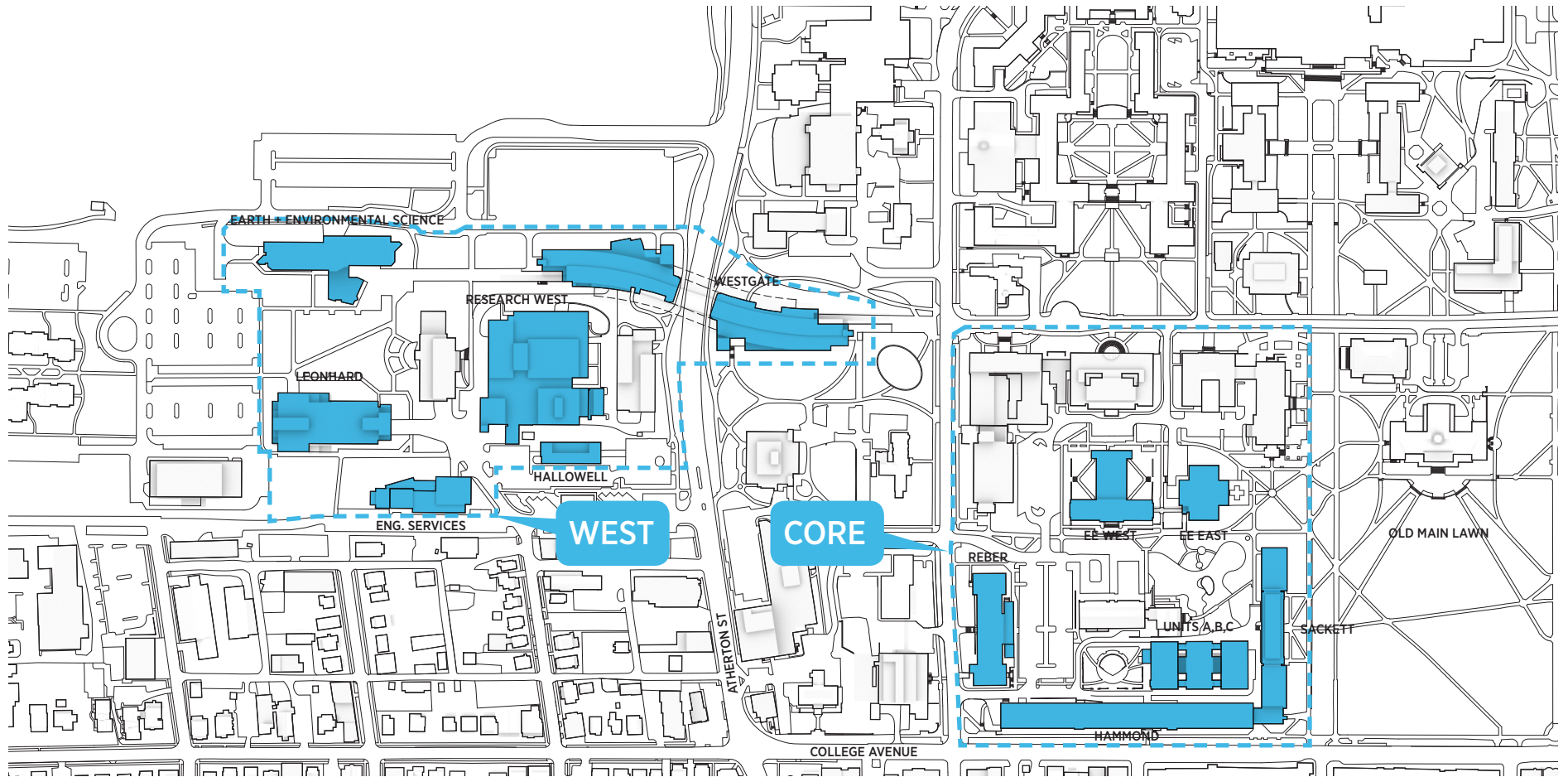


Core Campus



West Campus

* Reference 1, Refer to Chapter 6



West Campus and Core Campus, Showing COE Occupied Buildings



CONNECTIVITY

Like many university campuses, Penn State is organized as a grid of pedestrian precincts connected by access roads that tie into the surrounding street system of the Borough of State College. The bulk of Penn State's academic campus is within the area bounded by East Park Avenue to the north, University Drive to the east, College Avenue to the south, and North Atherton Street to the west. Within this superblock are several key roads—Pollock, Burrowes, Curtin, Shortlidge, Bigler, and a few others—that provide connectivity within and through the campus. Off these primary roads are numerous spur roads that provide access for service vehicles and some surface parking within the otherwise pedestrian precinct.

Within the pedestrian precincts, the campus facilitates pedestrian movement by means of quads and open spaces, which are crisscrossed with hardscaped walks that reflect common patterns of movement; major walks that pass through a precinct, such as Pattee Mall or Spearly's Walk, which passes east-west through the Core Campus to the south of Electrical Engineering East and West; and numerous gaps between buildings. While north-south pedestrian movement happens primarily via more formal walks that are part of the open space network, east-west movement is more informal and most often occurs through gaps between buildings. A notable exception to this is the wall formed by Sackett with its wings facing the Old Main Lawn.

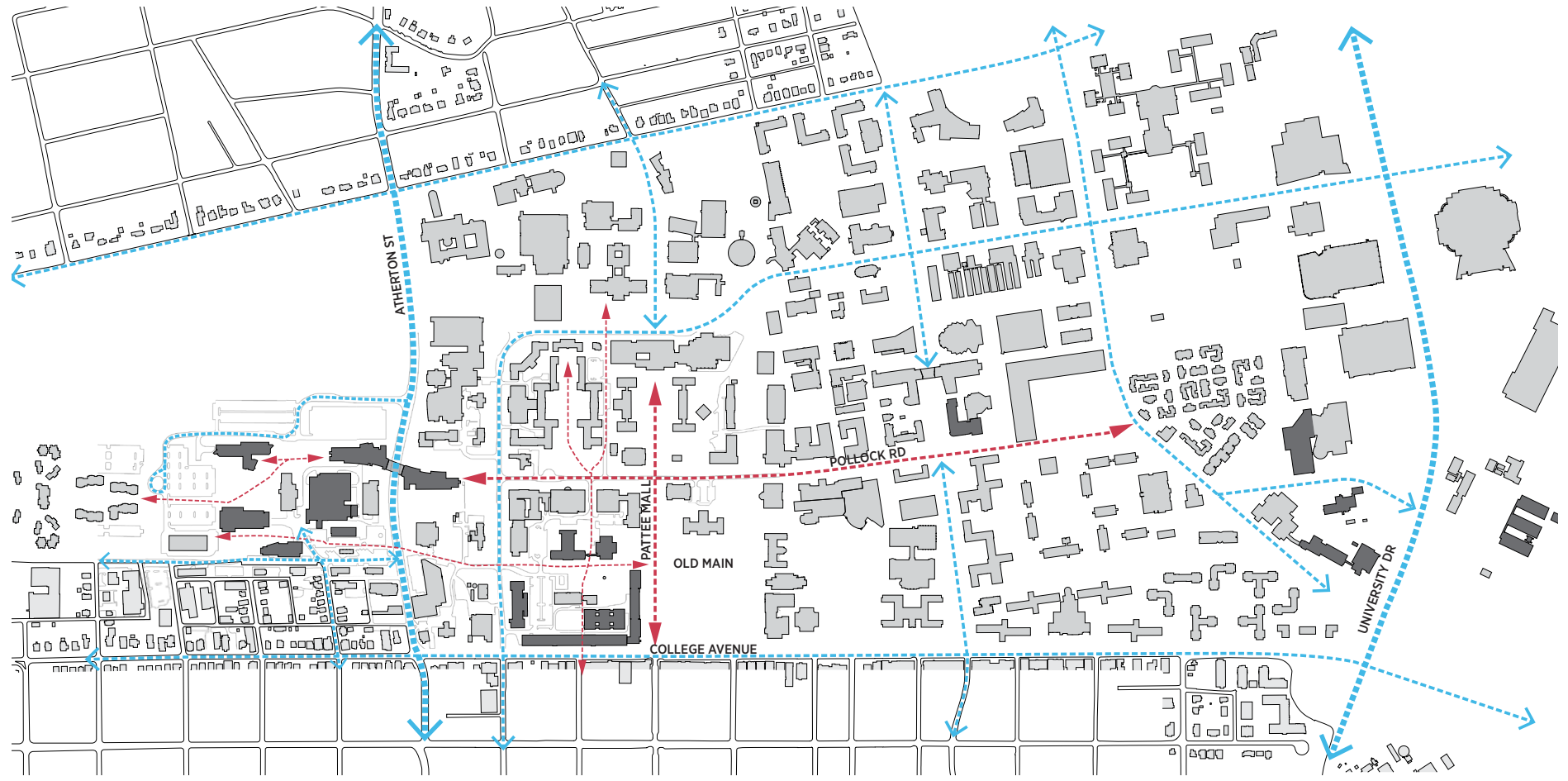
As noted above, Westgate provides an important connector to the West Campus for the University community at large. However, for COE students moving back and forth from buildings on the Core Campus, most of which are clustered near College Avenue, the natural desire line to the West Campus is to head west down Steam Drive, between ARL and Walker, and cross Atherton at the crosswalk that leads to the bus depot. COE students seem disinclined to walk up Burrowes Road in order to use the Westgate connector. While there is a traffic signal and crosswalk at the Atherton crossing, the University reports that members of the Penn State community frequently cross against the light which, combined with drivers' tendency to exceed the speed limit, presents a pedestrian safety issue. In May 2018, the Borough of State College approved an ordinance amendment that reduces the speed limit to 25 miles per hour along this stretch of Atherton.

Within the Core Campus, there are several north-south pedestrian routes that play a vital role in connecting the campus to the Borough of State College. While Pattee Mall is clearly the primary such connector, starting from the Allen Street Gates and extending all the way to Pattee Library, these other three routes provide convenient connections to commercial and retail amenities for the College and beyond.



Above: Outdoor Bridge of the Westgate Building, Spanning Atherton Street to Provide Pedestrian Connection to West Campus

Below: Fraser Street and Hammond Building, Showing Breezeway Connection to Core Campus

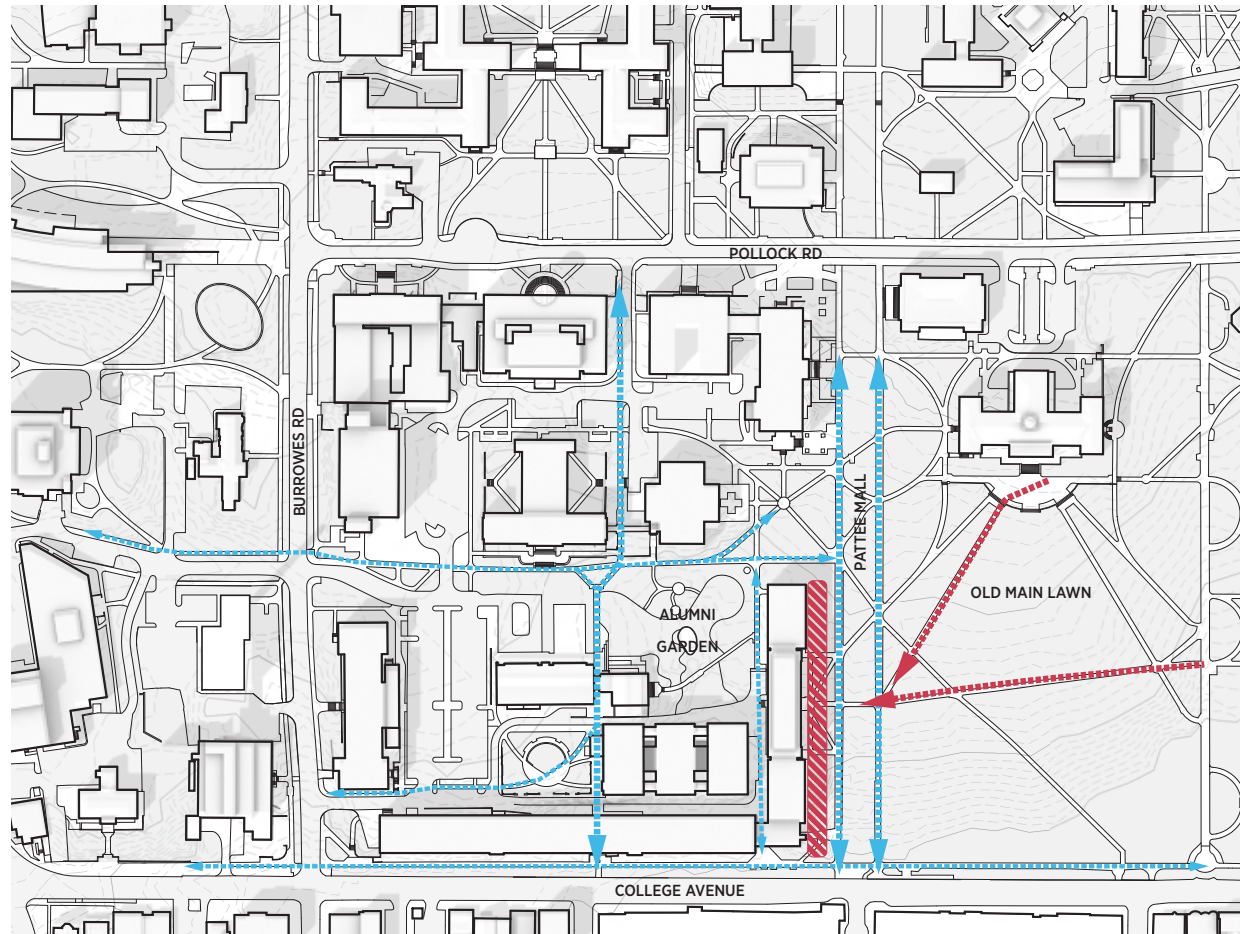


Vehicular and Pedestrian Circulation

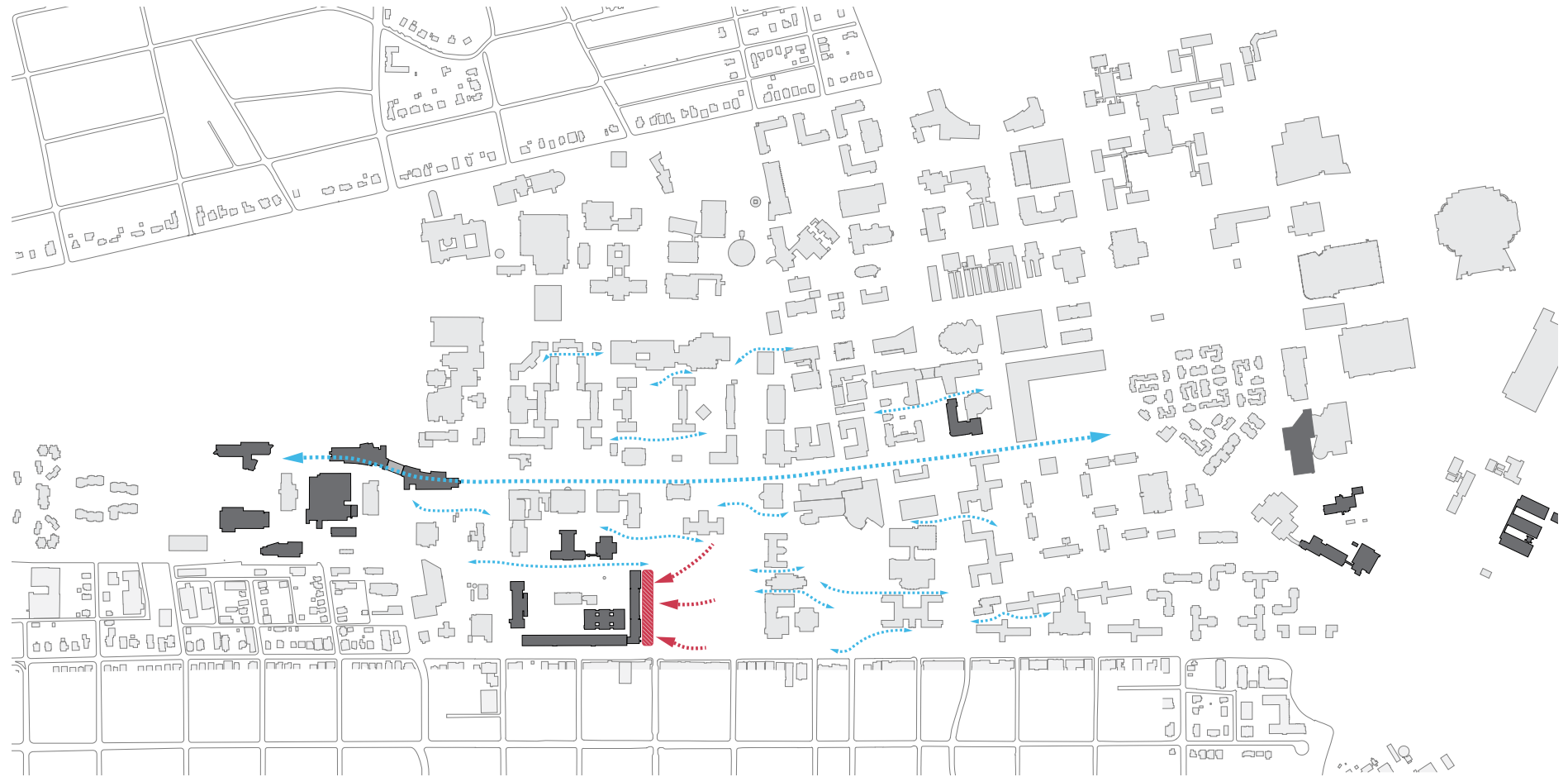


- VEHICULAR CIRCULATION
- PEDESTRIAN CIRCULATION

The most prominent of these starts with a network of informal walkways that filter through the campus to the north and come together between Steidle and Willard, passing between EE-West and EE-East, then shifting alignment slightly to pass alongside Alumni Garden, continuing through a breezeway at the west end of the Engineering Units, and finally passing under the center of Hammond to emerge on to College Avenue at Fraser Street. The second route collects pedestrians from walkways around the Obelisk, brings them south between Sackett and Alumni Garden, continues down a fairly steep service drive before discharging to College Avenue through a breezeway that passes below Kunkle. The third route picks up walkways alongside parking lots between Deike and EE-West and between Reber and Hintz, leading to the service drive between Reber and Hammond to exit on to Burrowes Road near the intersection with College Avenue.



Porosity and Circulation of Core Campus



East/West Site Porosity



LANDSCAPE AND MORPHOLOGY

A campus can be understood in terms of its open spaces—the landscape—and the patterns and arrangements of buildings—morphology—that define them. Depending on the cultural context and location of a campus, the landscape can either serve as a “field” in which buildings emerge as individual objects or form clusters that can be perceived as objects in the field. This paradigm describes most campuses in the US to varying degrees, with a notable exception of University of Chicago’s original Main Quad complex, where the open spaces emerge as figures within a nearly continuous fabric of interconnected buildings that tightly hold the edge of a block of the Chicago city grid in Hyde Park. This Collegiate Gothic campus echoes the much older University of Oxford campus in the UK, where campus and Medieval town merge almost seamlessly. Harvard University, descended from the Cambridge and Oxford models, shows a similar blurring of both the campus and town, but with

a looser arrangement of buildings in Harvard Yard, the landscape once again becomes the ground for the more figural buildings.

At Penn State, the campus morphology is defined by clusters of buildings within a precinct, in turn defined by roads or major campus open spaces such as Pattee Mall or Old Main Lawn. At times, buildings within a precinct are interconnected, but by and large, they are relatively closely spaced, providing a clear definition of smaller open spaces, both formal and informal, within the precinct. At the same time, the campus landscape forms a continuous field and network of open spaces and pathways that provides connectivity within and between precincts.

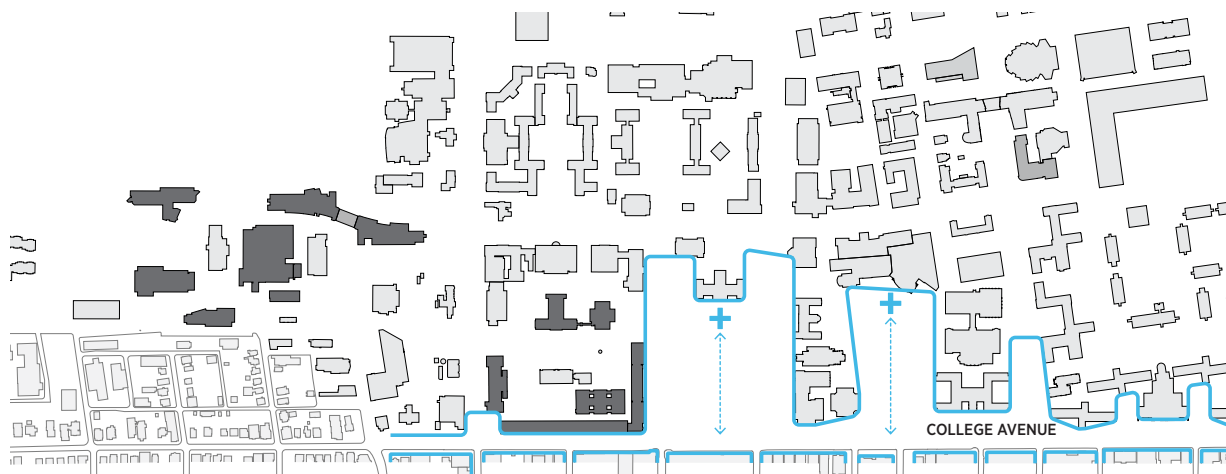
Morphology of the Core Campus:

The buildings of the Core Campus form strong edges to the precinct and capture open space within, such as Alumni Garden and Foundry Park. These strong edges

limit connection to College Avenue in contrast to other precincts (see diagram below). Open space typically finds its way into campus in other precincts, extending inwardly, and connecting fabrics, however the Core Campus proves to be an exception to that rule. The Core Campus is also characterized by its embrace of the berm to the north of College Avenue, directly engaging it, tight to the zoning setback, as opposed to most other buildings along College Avenue, which sit atop the berm.

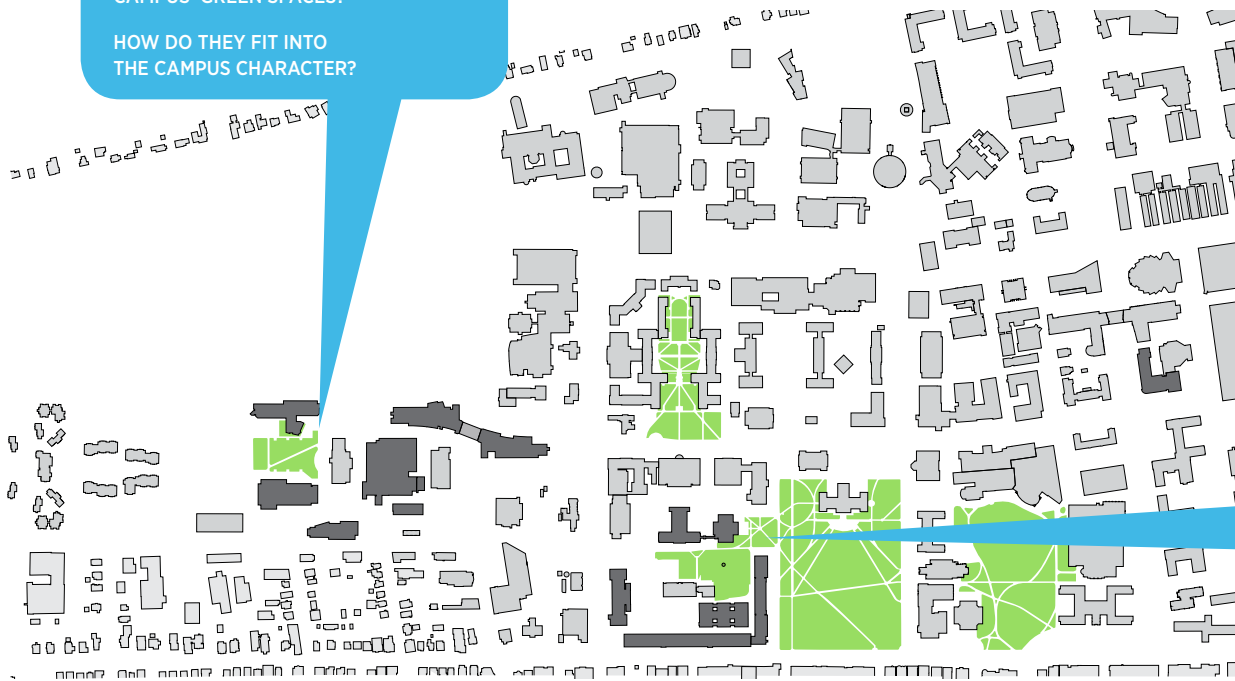
Morphology of the West Campus:

In comparison to the Core Campus and other precincts on campus, the West Campus features an array of younger buildings, loosely arranged on the expanse of a rolling landscape. The height and scale of the buildings in relation to the open space between them makes the space feel vast and empty. The West Quadrangle, the only formal space in the precinct, is unevenly defined physically by three of these buildings. However, these buildings fail to engage the quadrangle successfully, due to lack of transparency, openness and functional connectivity. Building entrances are hidden to the space, and they are not inviting. Moreover, the open space is not equipped to support outdoor programs, and its landscape falls short of its potential as a meaningful open space asset for the campus. Longer buildings tend to be oriented in the east-west direction. Research West makes poor use of its site, with a large footprint limiting the quality of the campus space around it and providing a long and opaque edge to the campus.



Street Wall and Campus Space

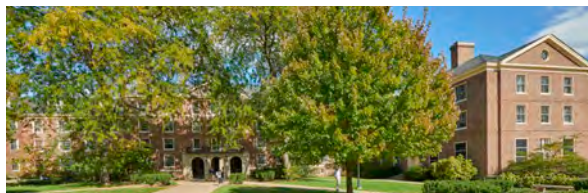
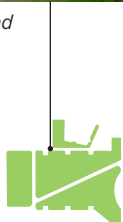
WHAT IS THE CHARACTER OF THE WEST CAMPUS' GREEN SPACES?
HOW DO THEY FIT INTO THE CAMPUS CHARACTER?



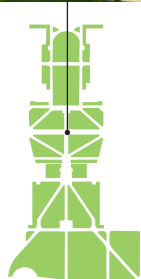
WHAT IS THE CHARACTER OF THE CORE CAMPUS' GREEN SPACES?
HOW ARE THEY ENHANCED AND ENGAGED WITH?
HOW DO THEY ENGAGE WITH COLLEGE AVENUE?



West Quad



West Residence Halls



Alumni Garden & Old Main



Student Hub Lawn



Campus Green Space within Context of Two Precincts

DENSITY STUDY

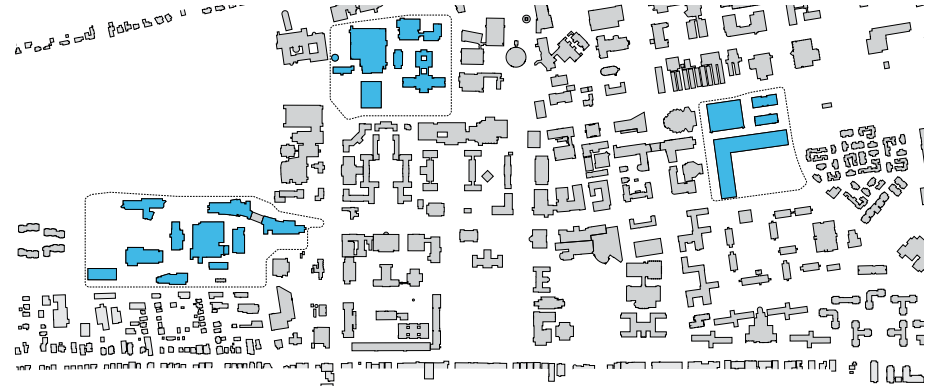
West Campus:

The West Campus' density is low, with vast open spaces, loosely defined boundaries and edges, and large, relatively uninviting buildings. The Master Plan aims to ameliorate the existing lack of defined campus spaces and to give identity and pedestrian scale to new ones.

West Campus



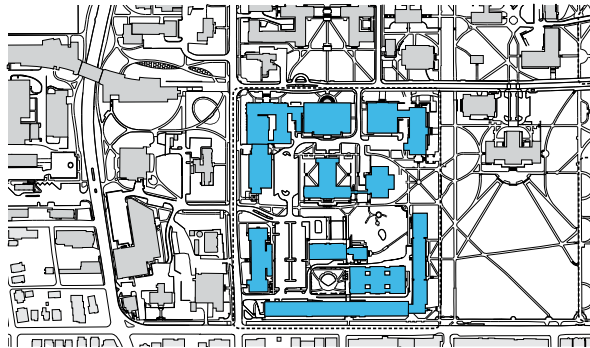
Low Density | West Campus Analogs



Core Campus:

The Core Campus' density is much higher, the spaces between the buildings, more granular, and it is defined by stronger edges. This is a quality that the Master Plan aims to uphold and enhance.

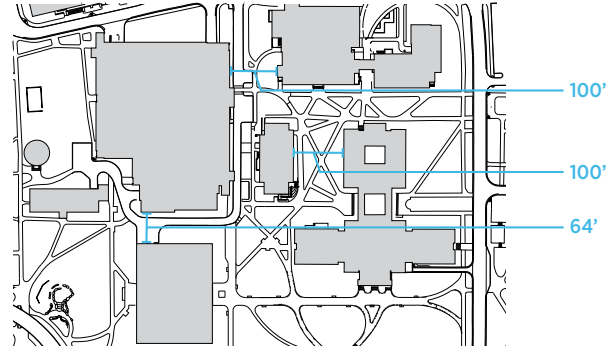
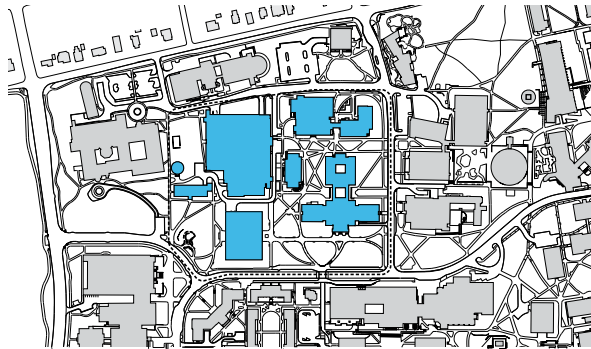
Core Campus



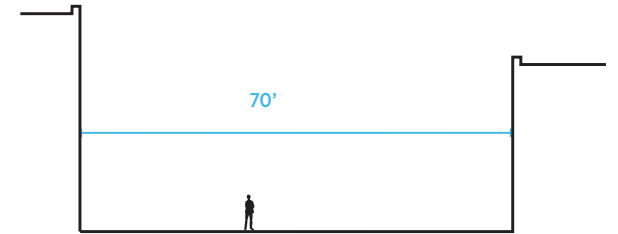
High Density | Core Campus Analogs



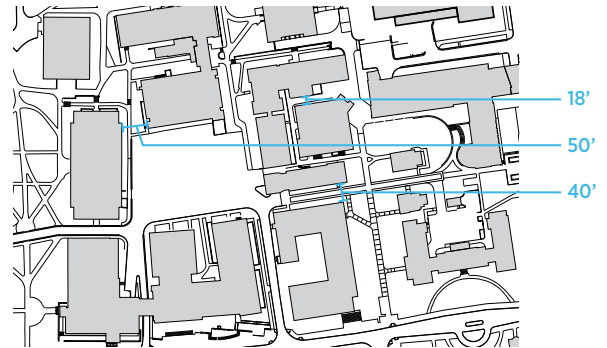
Sample Block: Chambers Building, Nittany Parking Deck, Moore, Kern



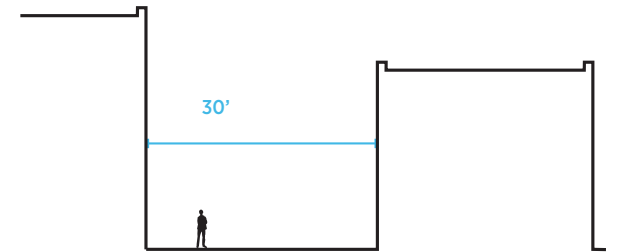
Low Density Section



Sample Block: Osmond Lab, Davey Lab, Whitmore Lab, Frear North & South, Boucke



High Density Section



HERITAGE TREES

Heritage trees and other designated trees contribute largely to the character of Penn State's campus landscape. These trees were mapped and located by Penn State, and the diagrams shown to the right are derived from GIS Data received by the University. Payette worked with Penn State's Office of the Physical Plant (OPP) to determine which trees should be respected during the planning process in order to avoid damaging the canopies or root structures by construction disturbance.

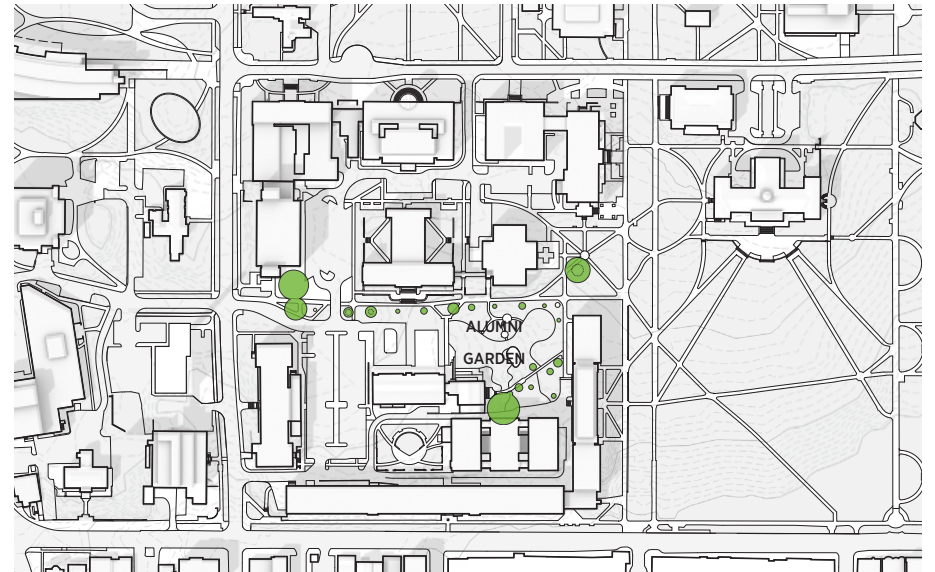
CAMPUS TRANSIT

CATA Bus Transit provides public transportation to both the Core and West Campus. The Core Campus is mainly served by the Blue, White, and Green Link, while the West Campus is served chiefly by the Red Loop. Since only one designated bike path and one designated shared pedestrian travel path serve to connect these two districts, it is imperative that cross-campus bike friendly paths are accommodated as the campus landscape is improved.

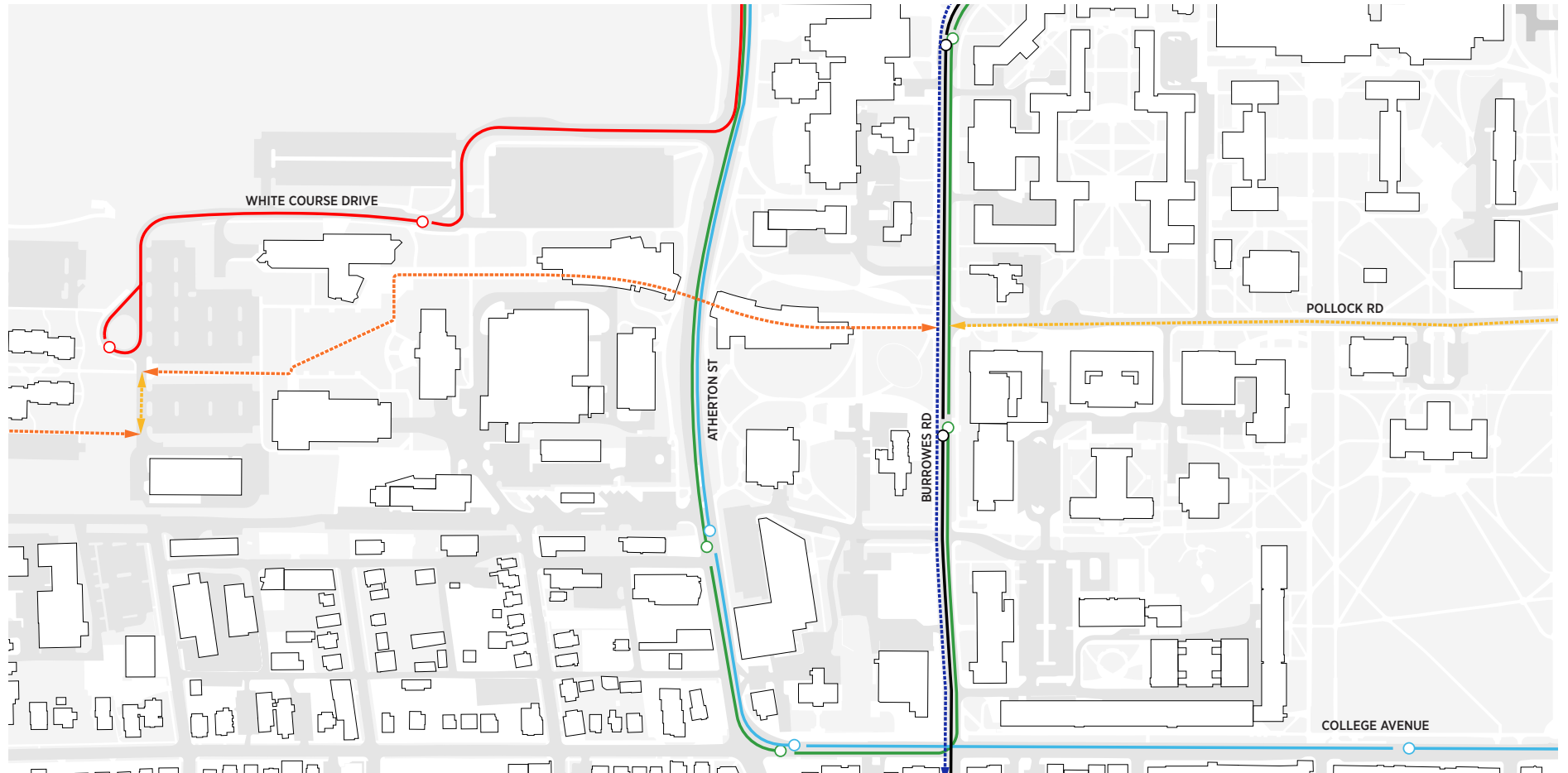
Please reference the diagram on page 2-13 (Opposite Page) for information regarding transit.



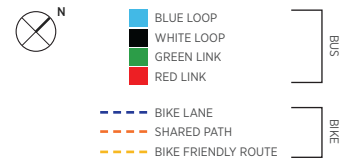
Protected Trees on West Campus' Area of Study



Protected Trees on Core Campus' Area of Study



Campus Bus and Bike Paths



ACCESS & SERVICE

Core Campus

Access: Many of the existing COE buildings on the Core Campus have challenges in terms of service and accessibility due to their age. The Hammond/Sackett complex has a single accessible entry at the far north of the complex requiring students and faculty who have mobility issues to traverse an exceedingly long and circuitous route likely using more than one elevator due to floor level changes within the complex. There are no accessible entries into the Hammond Building and all entries require the use of stairs. Access to the Alumni Garden and the Engineering Quadrangle require a pedestrian with limited mobility to circumnavigate the complex on sidewalks and through parking lots. Other buildings in the precinct have a single accessible entry, and in general this accessible entry is not located at the front door of the facility, but instead is located at a side entrance that has been modified to grant access. The accessible entries are noted on the diagram on the facing page.

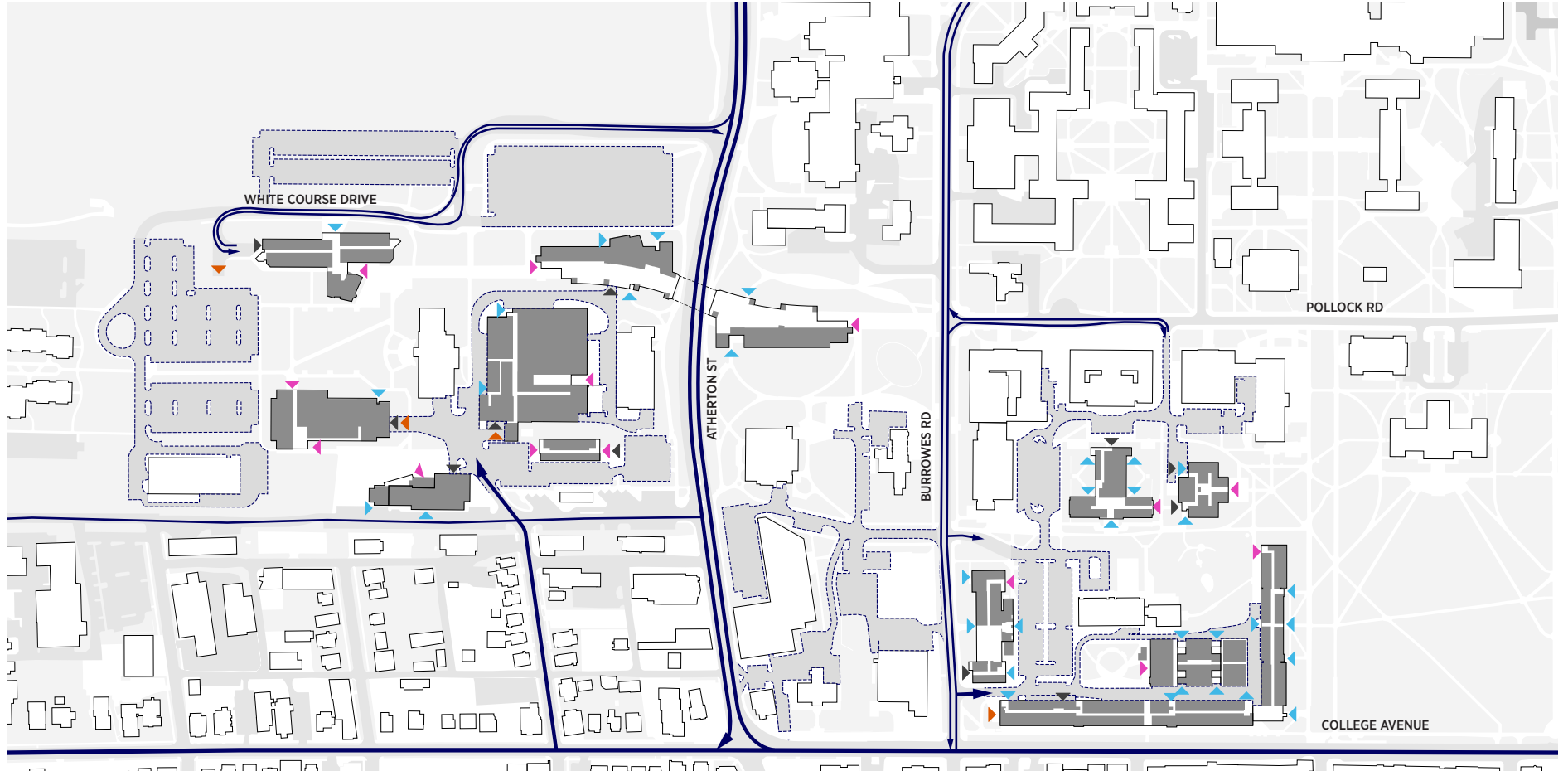
Service: Each building on the Core Campus has functional loading areas with the exception of the Reber Building which has a steep ramp internal to the building where a grapple hook is used to hoist materials between levels. The high-bay space in the basement of Sackett has a coiling door that opens directly to the service drive behind Hammond and Sackett and also provides a delivery point for research materials and large machinery.

Waste Collection: A shared waste collection point is located in the southwest corner of the Core Campus on the western-most end of Hammond.









West Campus

Access: All of the main entries on the West Campus buildings are accessible, and many of the buildings have multiple accessible entry points.

Service: All of the West Campus Buildings have functional loading areas. However, the service loading at the Hallowell Building is accomplished by a removable astragal in the main entry. The EES Building has rolling doors on all levels sized to receive large equipment which is lifted via a mobile crane.



Access and Service Diagram

-  N
-  ACCESSIBLE ENTRY
-  ACCESS OR EGRESS (NOT ACCESSIBLE)
-  LOADING DOCK
-  WASTE REMOVAL
-  VEHICULAR ACCESS
-  SURFACE PARKING
-  VEHICULAR SERVICE ROADS

ZONING

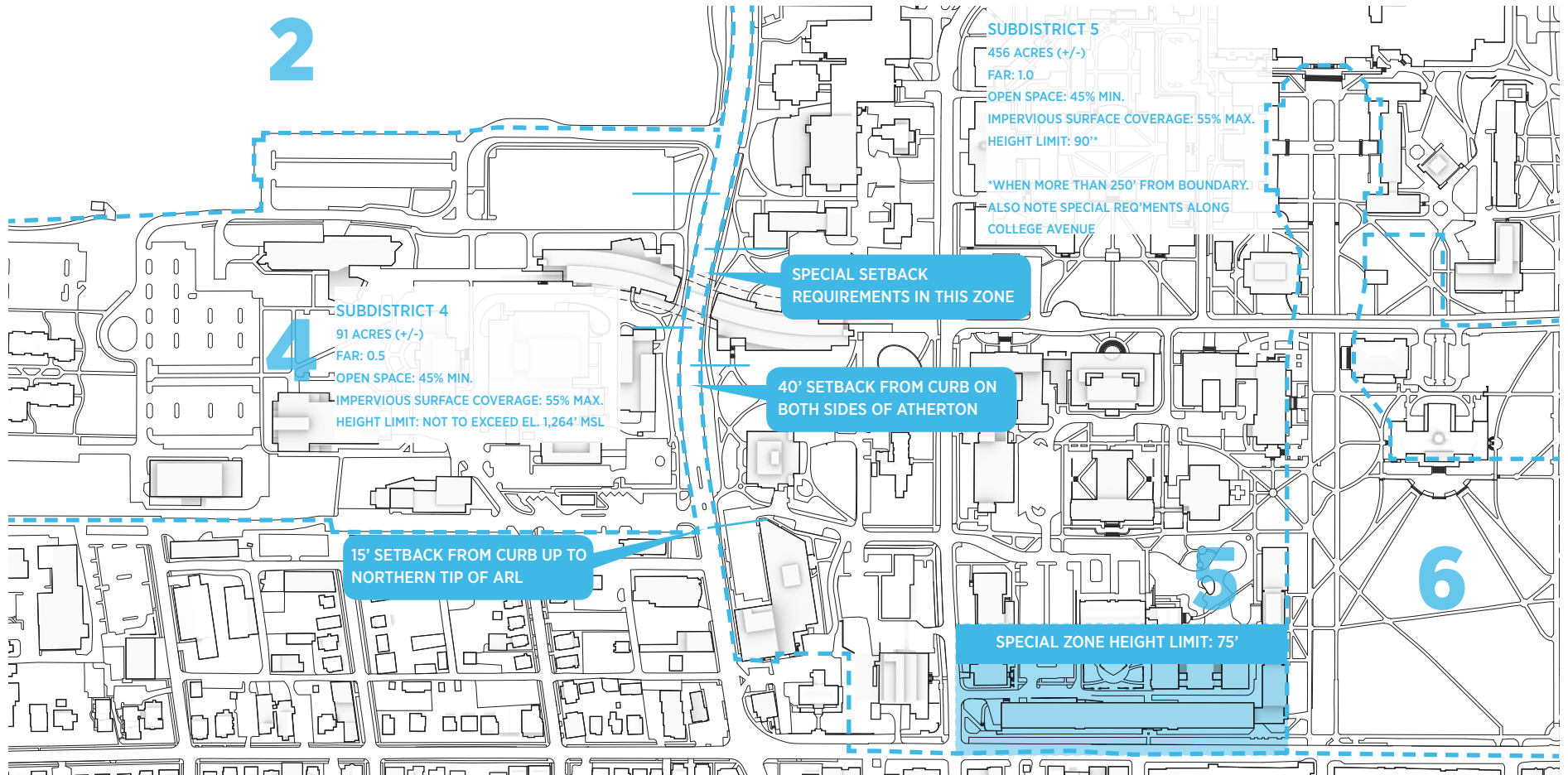


Illustration of Zoning Requirements

--- Subdistrict Boundary Line

The Penn State University Park Campus is governed by the University Planned District (UPD), a zoning ordinance “designed to promote the careful planning and orderly development of the University campus, consistent with the community development goals of the Centre Region and its member municipalities as described in the Centre Region Comprehensive Plan.” Centre Region is a subset of Centre County and includes the Penn State University Park campus, neighboring Borough of State College and Ferguson Township, and other surrounding communities.

The UPD subdivides the campus into various subdistricts and defines planning parameters and requirements for land development, including floor area ratio (FAR), minimum open space, setbacks, impervious surface coverage, and building heights, among others. Refer to Table 2.1 for a summary of maximum development density (FAR), impervious surface coverage, and minimum open space for Subdistricts 4 and 5, which encompass the study area for the Master Plan, as described in further detail below.*

* Reference 2,3, Refer to Chapter 6

SUMMARY OF ZONING PARAMETERS

SUBDISTRICT	4	5
Total Subdistrict Size (acres)	91.0	456.0
Total Subdistrict Size (SF)	3,965,091	19,863,400
Maximum Allowable FAR	0.5	1.0
Maximum Allowable FAR (SF)	1,982,546	19,863,400
Existing FAR	0.218	0.738
Existing FAR (SF)	862,944	14,668,449
Remaining FAR (SF)	1,119,602	5,194,901
IMPERVIOUS SURFACE		
Maximum Allowable Impervious Surface (%)	55.0%	55.0%
Maximum Allowable Impervious Surface (SF)	2,180,800	10,924,870
Existing Impervious Surface (%)	27.27%	47.91%
Existing Impervious Surface (SF)	1,081,261	9,516,407
Remaining Allowable Impervious Surface (SF)	1,099,539	1,408,463
OPEN SPACE		
Minimum Allowable Open Space (%)	45.0%	45.0%
Minimum Allowable Open Space (SF)	1,784,291	8,938,530
Existing Open Space (%)	72.74%	52.10%
Existing Open Space (SF)	2,884,164	10,348,831
Remaining Open Space to be Developed (SF)	1,099,873	1,410,301

Table 2.1

WEST CAMPUS

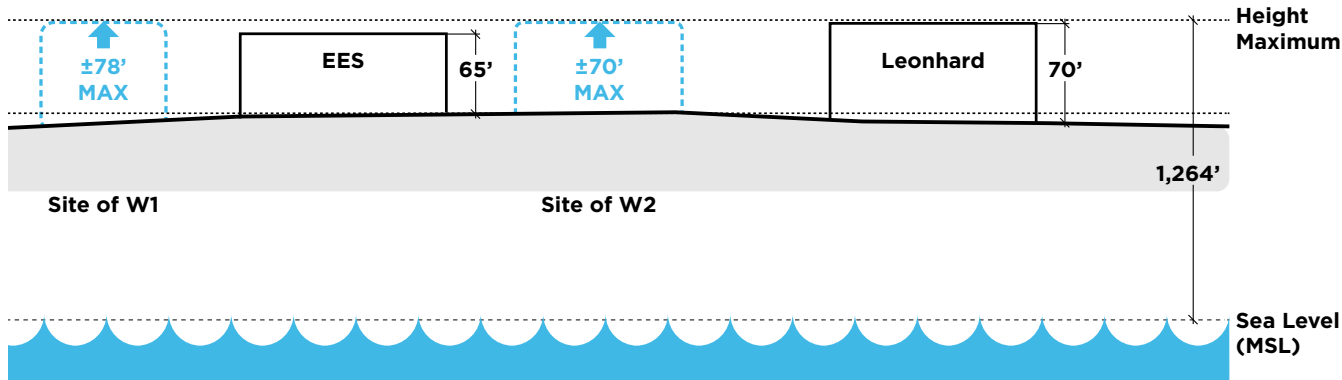
The West Campus is situated within Subdistrict 4, which encompasses 91 acres and lies within both the Borough of State College and Ferguson Township. However, West Campus lies entirely within the Borough of State College. Subdistrict 4 includes a Special Zone along Atherton Street, starting where an imaginary line representing the extension of the northern building face of the Thomas Water Tunnel building intersects the western curb of Atherton Street. The Special Zone extends north from this starting point 300 feet along the western curb of Atherton Street and is 40 feet wide measured from the curb in a westerly direction.

Setbacks are applied from the right-of-way line where buildings are along a public street frontage, or from a property line where no street exists, unless otherwise specifically noted:

- Along the northern boundary of the Subdistrict where it adjoins Subdistrict 2, no minimum setback is required.
- Along Atherton Street, across from Subdistrict 5, the minimum setback is 40 feet measured from the face of the curb on Atherton Street, except within the Special Zone described above.
- Along Atherton Street within the Special Zone, no minimum setback is required.

Maximum building height: for the portion of Subdistrict 4 located in the Borough of State College, the following maximum height limitations apply:

- For the portion of the subdistrict that lies east of an imaginary north-south line that corresponds to the northern extension of the centerline of Thorn Alley through the subdistrict, building height may not exceed elevation 1264 feet, mean sea level (MSL). This height limitation, effectively a “ceiling,” does not apply to chimneys, elevator towers, stair towers, mechanical rooms, or other necessary mechanical or electrical equipment mounted on or above the building’s roof, provided that such elements cumulatively do not occupy more than 10% of the linear length of the roof along its east-west axis.
- For the portion of the subdistrict that lies west of the imaginary line described above, building height is limited to elevation 1225 feet MSL. Exemptions apply; however, this portion of the subdistrict is not within the study area of the Master Plan.



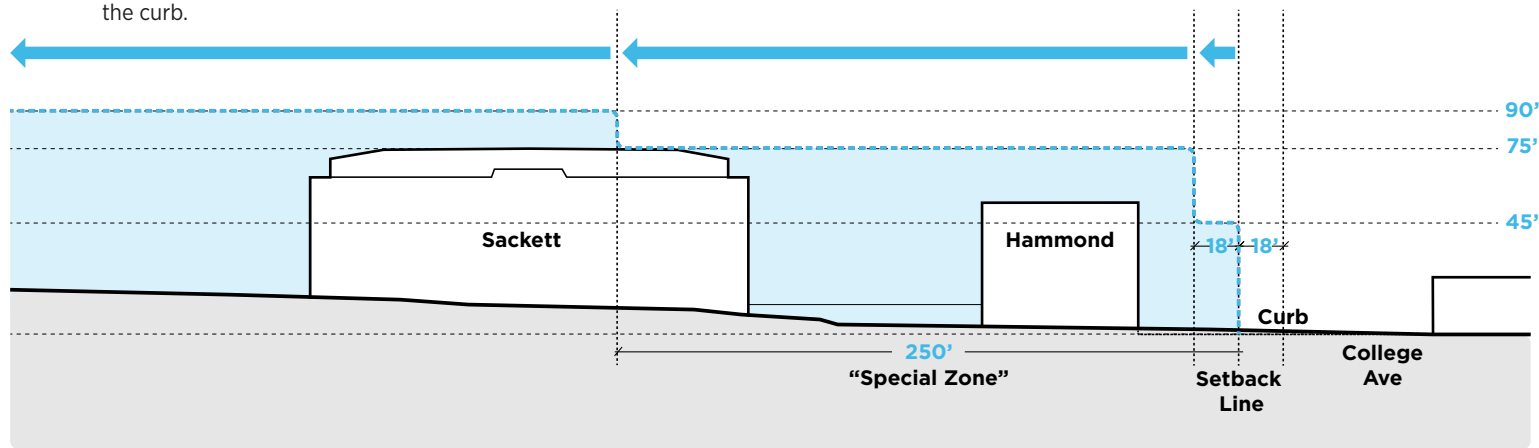
Above: Section at Subdistrict 4

CORE CAMPUS

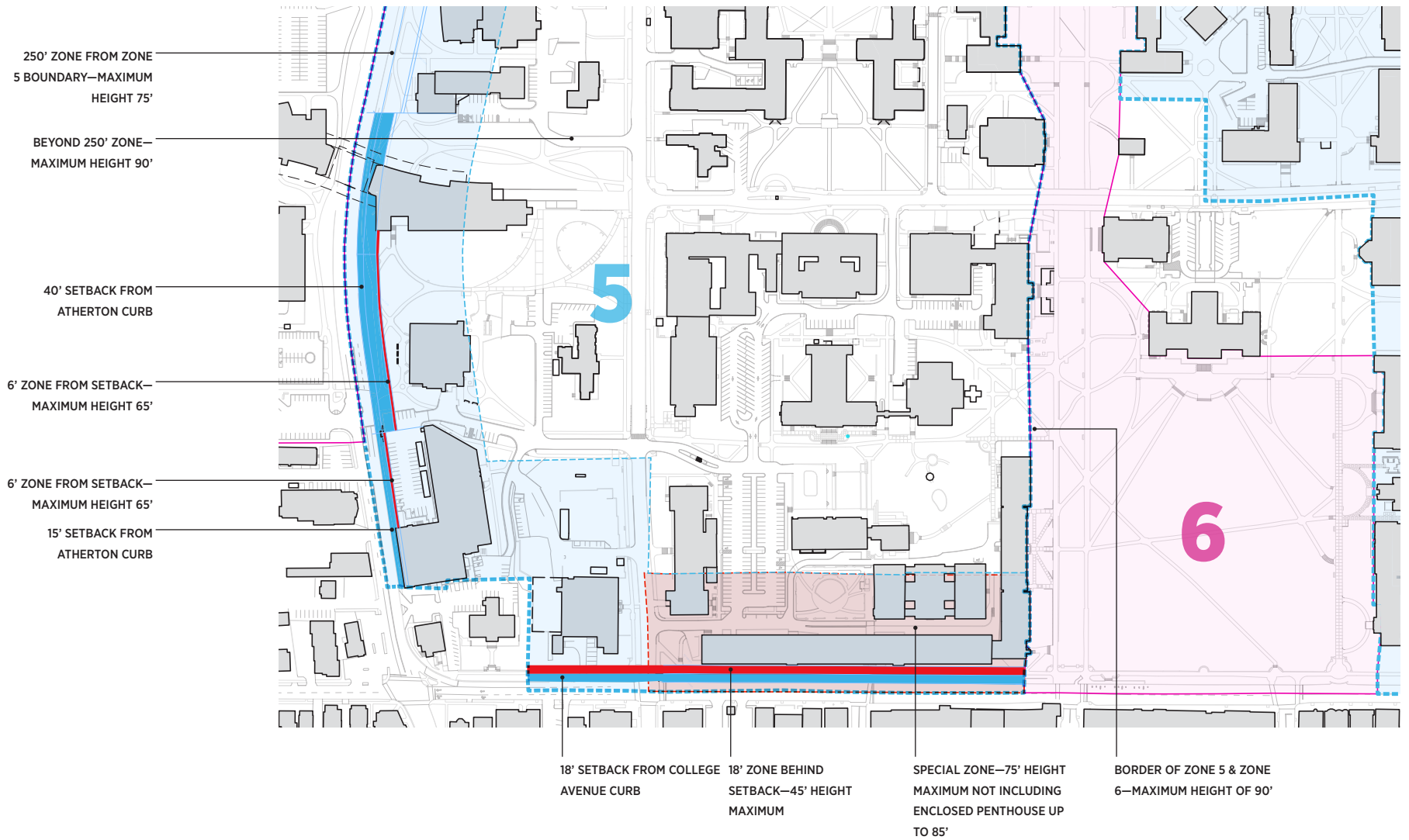
The Core Campus is situated within Subdistrict 5, which encompasses 456 acres and includes a Special Zone along College Avenue, between Burrowes Road and Subdistrict 6 (Old Main), with a depth of 250 feet from the UPD boundary. This Special Zone is the stretch of College Avenue that encompasses Reber, Hammond, the Engineering Units, and Sackett.

Setbacks are applied from the right-of-way line where buildings are along a public street frontage, or from a property line where no street exists, unless otherwise specifically noted:

- Where the Subdistrict adjoins non-University property in the Borough of State College, no minimum setback is required.
- Where the Subdistrict adjoins College Avenue across non-University property in the Borough of State College zoned "C" (General Commercial), the minimum setback is 18 feet measured from the curb.
- Where the Subdistrict adjoins Subdistrict 6 (Old Main), no minimum setback is required.
- Along Atherton Street, from College Avenue to the northern tip of the Applied Research Laboratory (ARL) building, the minimum setback is 15 feet measured from the curb or from any common property line with non-University property.
- Along Atherton Street from the northern tip of the ARL building to the southern edge of a special zone established for the Westgate building, the minimum setback is 40 feet measured from the face of the curb.
- Surface parking lots are not permitted in the setback area.



Above: Section at College Avenue, Subdistrict 5 & Special Zone



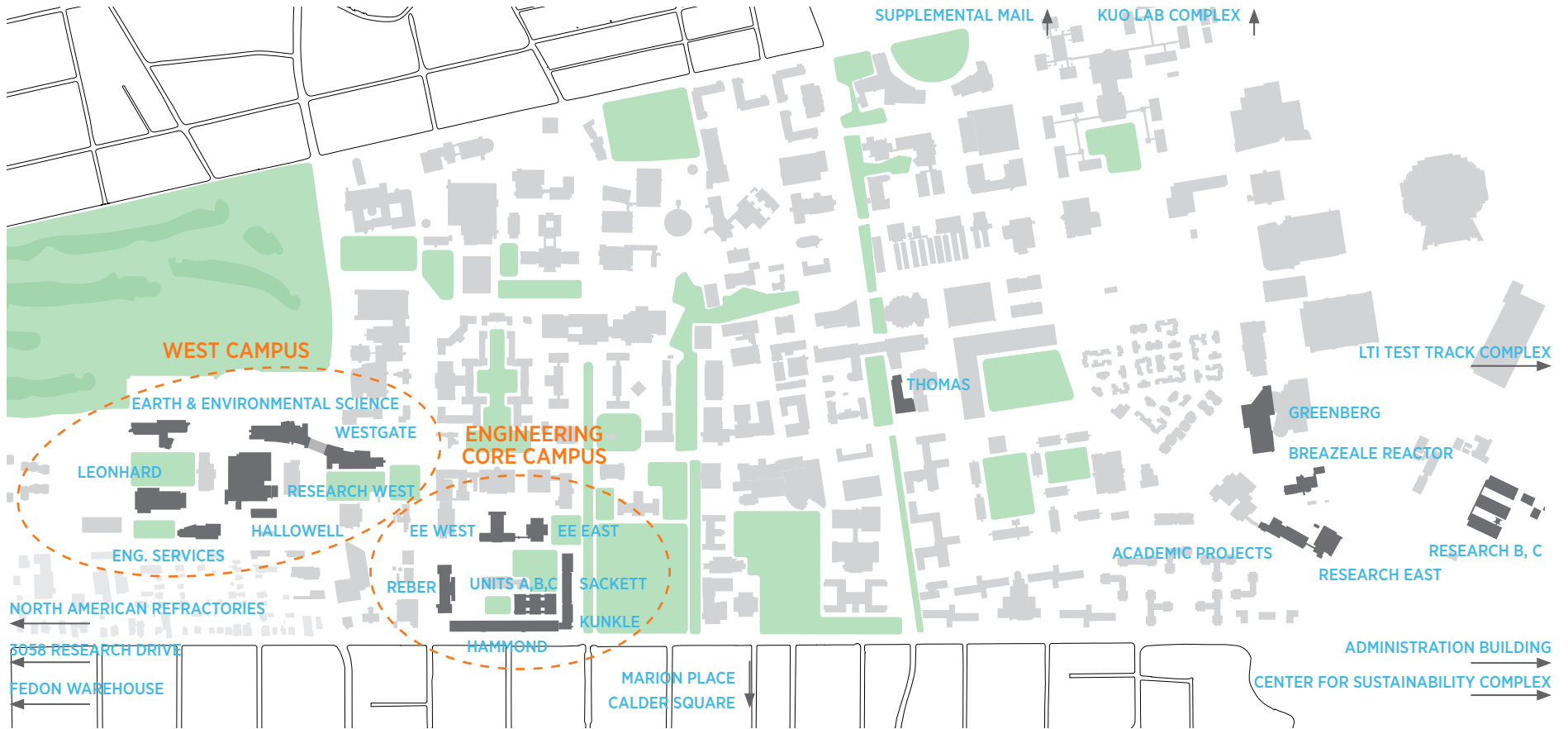
Core Campus Illustration of Zoning Requirements

* Reference 2,3, Refer to Chapter 6

Maximum building height:

- For buildings located more than 250 feet from a district boundary, the maximum height is 90 feet.
- Where the Subdistrict adjoins Subdistrict 6, the maximum height is 90 feet.
- Within the Special Zone described above, the maximum height is 75 feet.
- Along College Avenue, where the Subdistrict adjoins non-University property in State College Borough, the maximum height is 75 feet. Maximum height can increase to 85 feet for non-habitable sculpted roof areas designed to enclose mechanical equipment.
- Along College Avenue across from non-University property zoned “C” (General Commercial), the maximum height is 45 feet or 4 stories at the setback line, then 75 feet at a point 18 feet behind the setback line. Maximum height can increase to 85 feet for non-habitable sculpted roof areas designed to enclose mechanical equipment.
- Along Atherton Street, the maximum height is 75 feet at a point 6 feet behind the setback line. The maximum height can increase to 85 feet for non-habitable sculpted roof areas designed to enclose mechanical equipment.

PROGRAM



Buildings across the Penn State Campus with COE Occupied Spaces

CURRENT INVENTORY

The College of Engineering at Penn State's State College campus has approximately 714,800 assignable square feet (ASF) in 31 Penn State owned buildings and 3 leased properties.*

The majority of the College of Engineering's facilities are concentrated in two geographic areas of Penn State's State College Campus comprising 497,635 ASF:

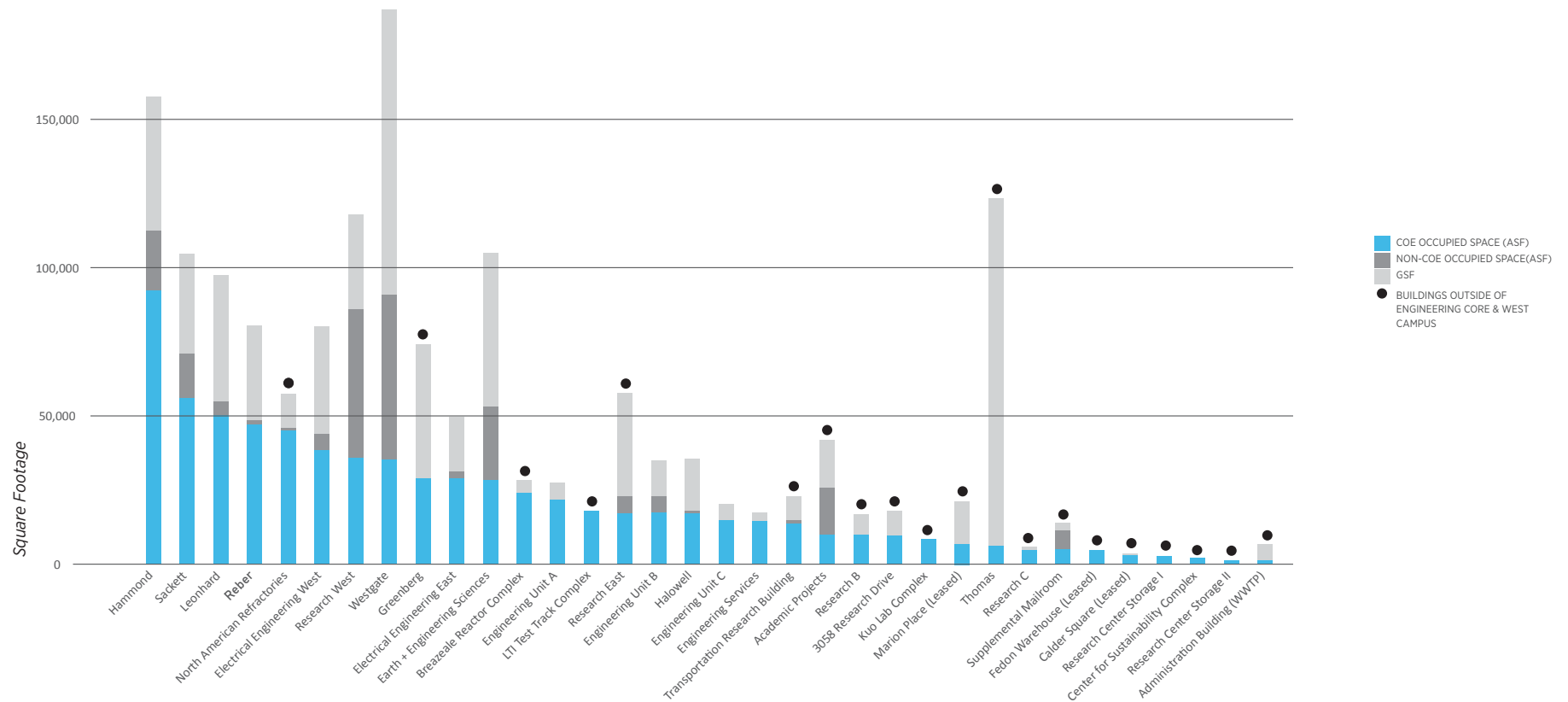
1. Engineering Core Campus (8 buildings)
2. West Campus (6 buildings)

Refer to page 2-23 (Opposite Page) for COE ASF

Additionally, a significant portion of COE facilities are distributed beyond these two campuses, in the areas of East Campus, North Campus and off campus in facilities that are not primarily occupied by the COE.

* All ASF values were provided by Penn State COE

BUILDINGS WITH COE ASSIGNABLE SPACE ACROSS THE PENN STATE CAMPUS



LOCATION AND DISTRIBUTION OF PROGRAM

The Engineering Core Campus is the historic center of the College of Engineering, with more recent engineering buildings developed on the West Campus.

As the COE expands, a guiding principal is to maintain a strong presence on the Engineering Core Campus, while leveraging the available building sites on the West Campus.

The COE would prefer much of the remote space (outside of specialized cores) to be consolidated back to the Engineering Core and West Campus and co-located with other COE programs.

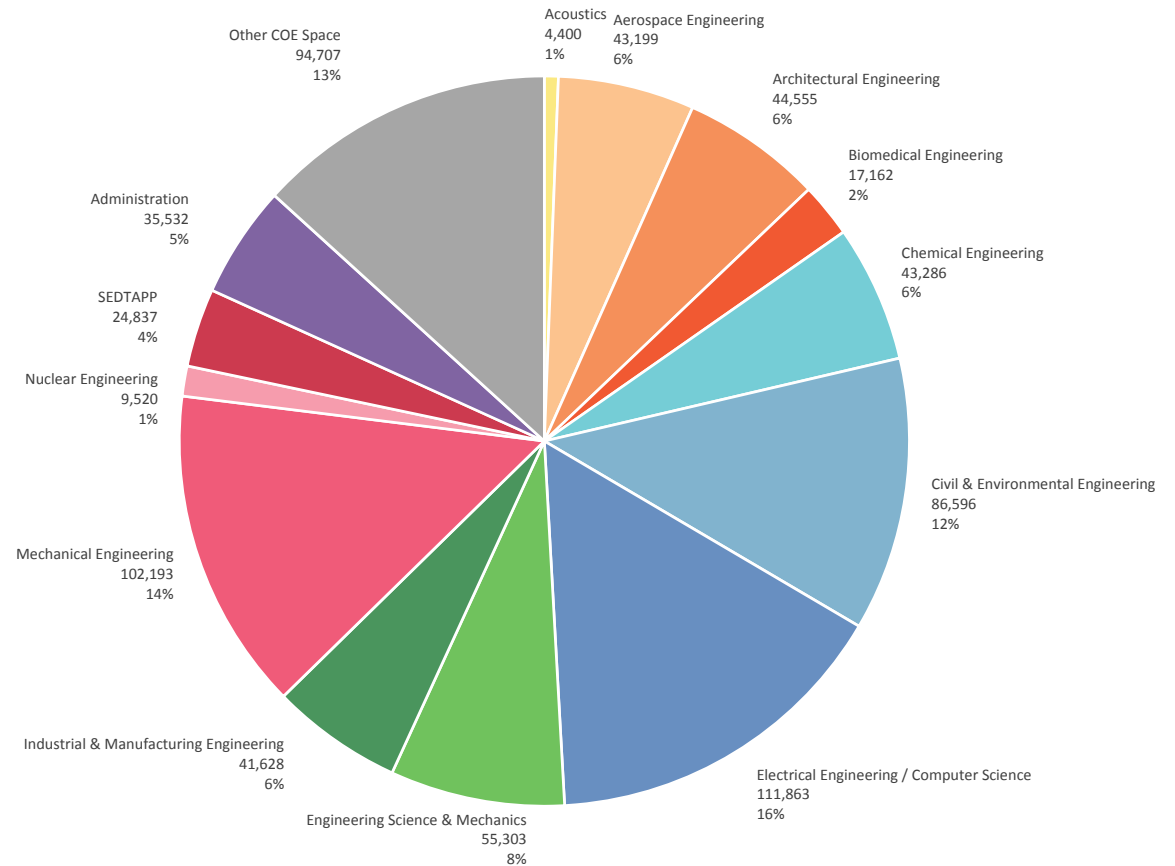
An additional guiding principal of the Master Plan is to reduce the deferred maintenance backlog for the COE -

refurbishing or demolishing buildings that do not serve the campus well.

The diagram above shows the buildings located outside of the core campus, and the associated COE ASF as a percentage of the total GSF (where known). Other occupants of the buildings are shown in dark gray.

COE OCCUPIED SPACES IN BUILDINGS ACROSS THE PENN STATE CAMPUS

Department	ASF
Acoustics	4,400
Aerospace Engineering	43,199
Architectural Engineering	44,555
Biomedical Engineering	17,162
Chemical Engineering	43,286
Civil & Environmental Engineering	86,596
Electrical Engineering / Computer Science	111,863
Engineering Science & Mechanics	55,303
Industrial & Manufacturing Engineering	41,628
Mechanical Engineering	102,193
Nuclear Engineering	9,520
SEDTAPP	24,837
	584,542
Administration	35,532
Other COE Space	
Engineering Shops	7,691
Office of Digital Learning	1,534
Facilities Engineering Institute	6,390
Learning Factory	7,257
Radiation Science & Engineering Center	25,889
Larson Transportation Institute	45,946
	94,707
TOTAL COE ASF	714,781 ASF



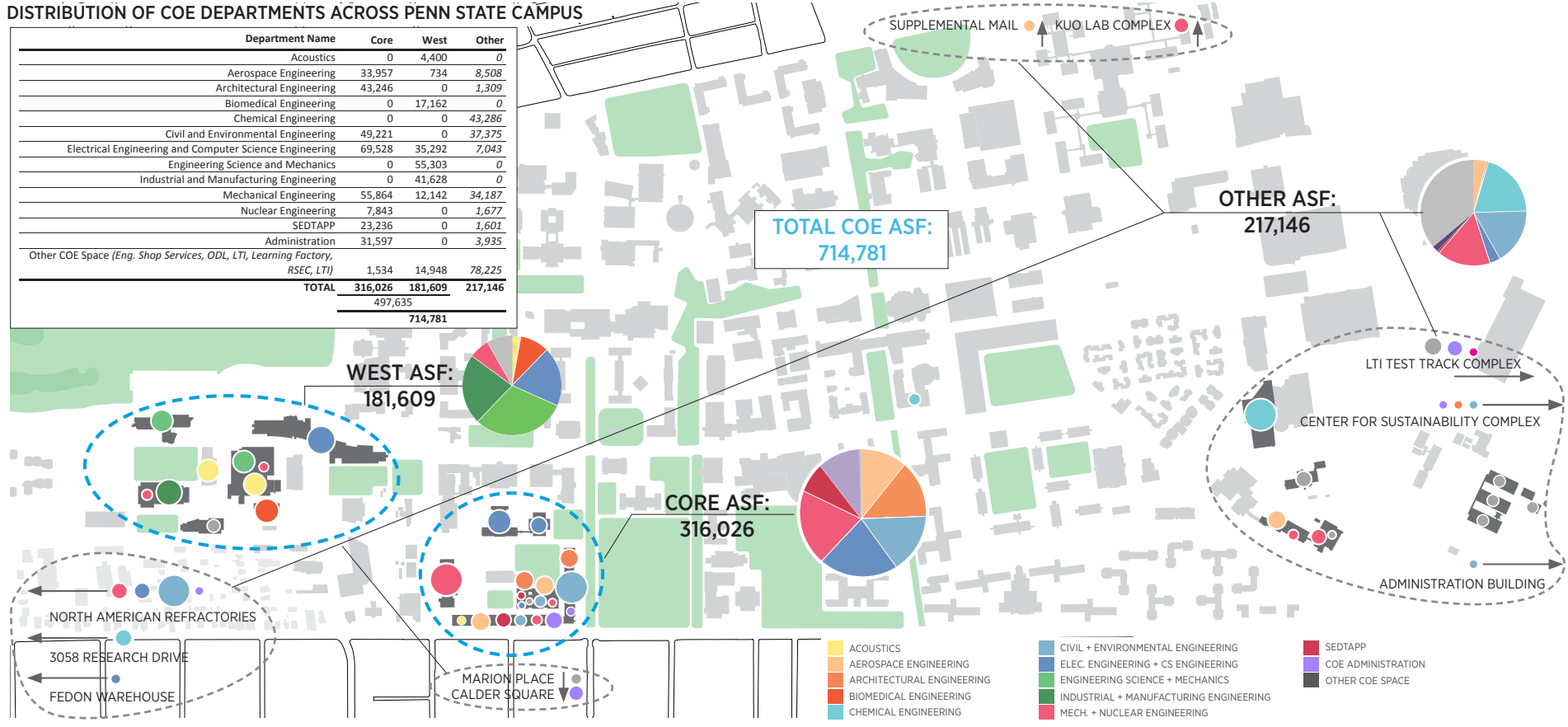
COE EXISTING ASF

The College of Engineering is comprised of the following departments, institutes, centers and groups as follows and as shown in the pie graph and table above:

- Acoustics
- Aerospace Engineering
- Architectural Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil & Environmental Engineering
- Electrical Engineering / Computer Science
- Engineering Science & Mechanics
- Industrial & Manufacturing Engineering
- Mechanical Engineering
- Nuclear Engineering
- SEDTAPP
- Administration
- Other COE Space*

DISTRIBUTION OF COE DEPARTMENTS ACROSS PENN STATE CAMPUS

Department Name	Core	West	Other
Acoustics	0	4,400	0
Aerospace Engineering	33,957	734	8,508
Architectural Engineering	43,246	0	1,309
Biomedical Engineering	0	17,162	0
Chemical Engineering	0	0	43,286
Civil and Environmental Engineering	49,221	0	37,375
Electrical Engineering and Computer Science Engineering	69,528	35,292	7,043
Engineering Science and Mechanics	0	55,303	0
Industrial and Manufacturing Engineering	0	41,628	0
Mechanical Engineering	55,864	12,142	34,187
Nuclear Engineering	7,843	0	1,677
SEDTAPP	23,236	0	1,601
Administration	31,597	0	3,935
Other COE Space (Eng. Shop Services, ODL, LTI, Learning Factory, RSEC, LTI)	1,534	14,948	78,225
TOTAL	316,026	181,609	217,146
	497,635		
	714,781		



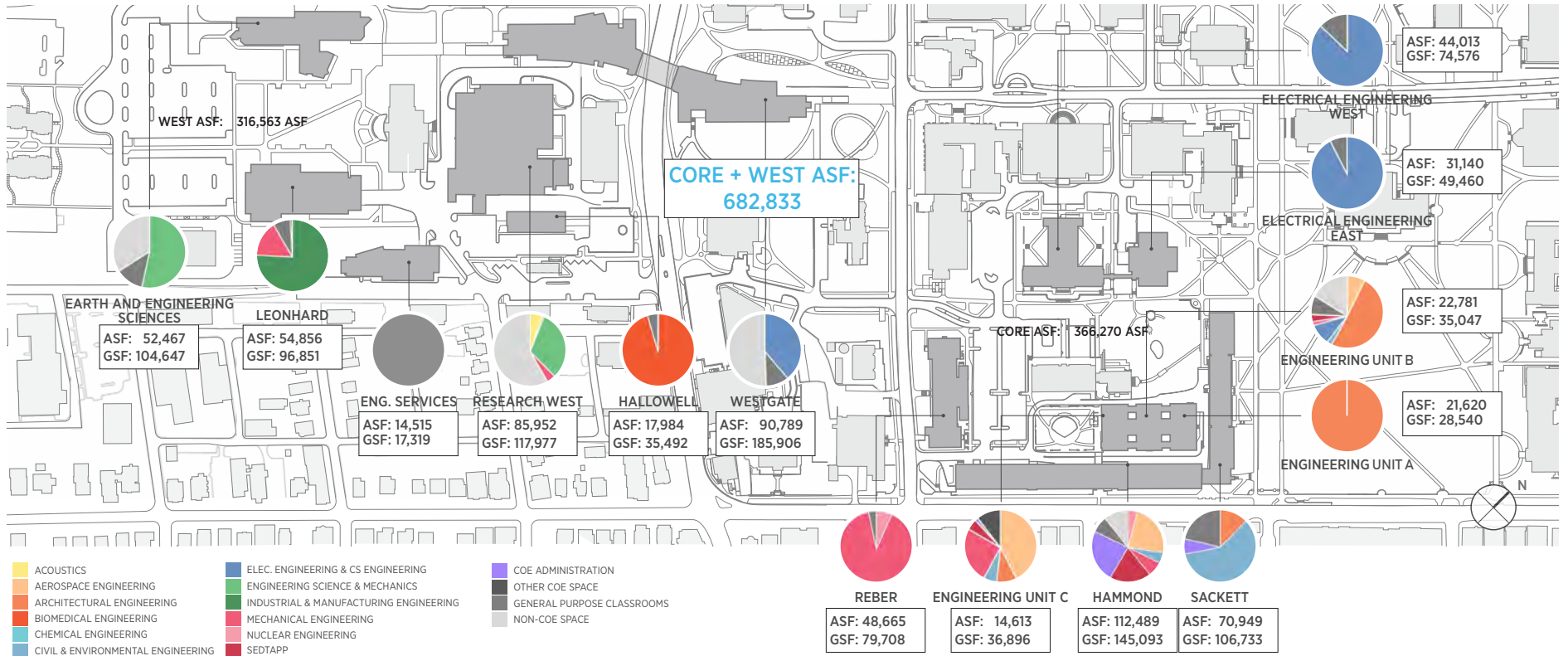
BEYOND THE CORE AND WEST CAMPUS

Other COE Space includes: Learning Factory, Engineering Shops Services, Office of Digital Learning (ODL), Facilities Engineering Institute (FEI), Radiation Science and Engineering Center (RSEC), and the Larson Transportation Institute (LTI). COE Existing ASF is understood as the Fall 2018 occupied ASF (not including the planned ASF in the new CBEB Building).

The COE departments occupy space across the Penn State Campus as shown in the map and table above. About 2/3 of the COE programs (~500,000 ASF) resides on the Core and West Campus. The remaining ~217,000 of the ASF for COE resides in areas beyond the Core and West Campus. This is comprised of spaces that are not considered for relocation: the LTI Test Track, and the Breazeale Reactor as

well as spaces that ideally would be consolidated back to Engineering Core and West Campus including significant Civil, Aerospace, and Mechanical research spaces that the COE would like to consolidate back with their departments. More detail is provided in the "Consolidation" section of the report in Chapter 3, "Growth Projections."

DISTRIBUTION OF COE DEPARTMENTS ON CORE AND WEST CAMPUS



PROGRAM	ASF
College of Engineering	497,635
General Purpose Classrooms (68)	55,615
College of IST	45,922
College of EMS	23,409
Engineering Library	9,699
Applied Research Lab	43,871
Others (Includes OPP Shop)	6,682
TOTAL	682,833

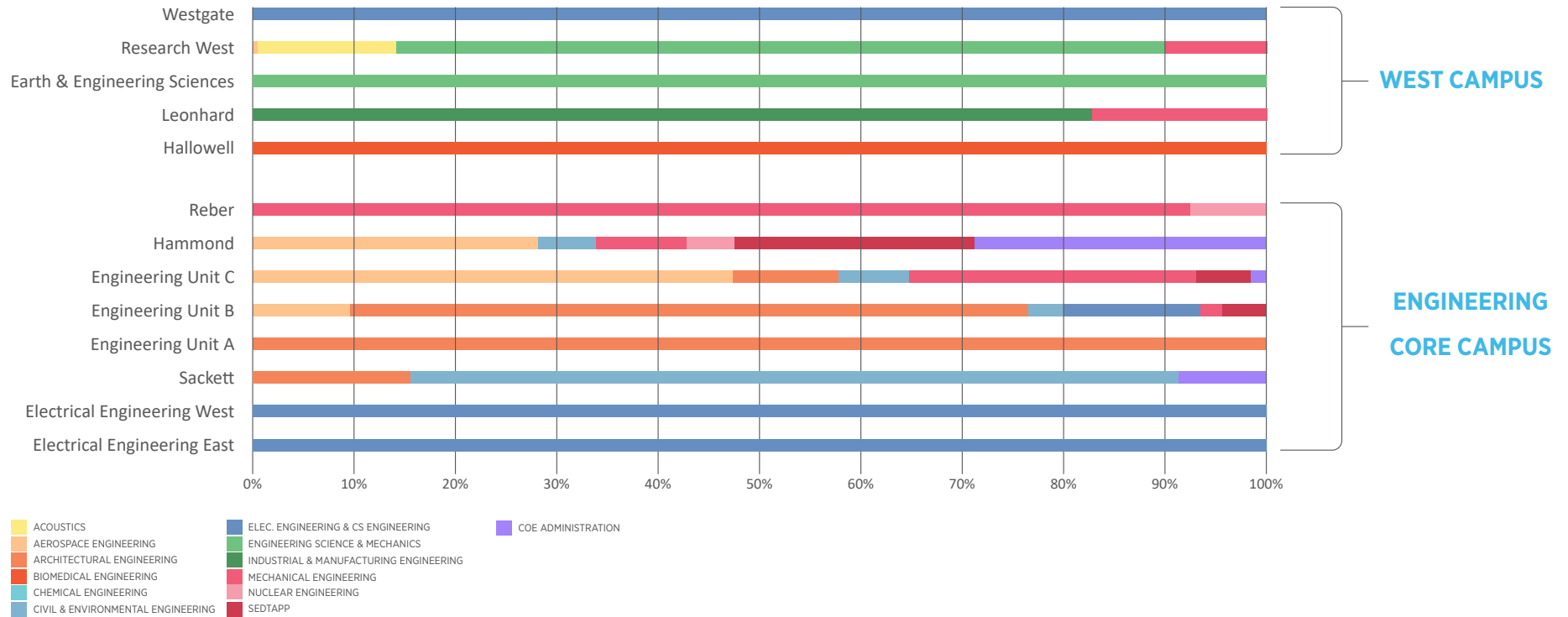
ENGINEERING CORE CAMPUS AND WEST CAMPUS

The focus of this study is fourteen (14) buildings on the Engineering Core Campus and the West Campus, comprising 682,833 ASF primarily occupied by the COE.

The buildings on the Core and West Campus are mixed use buildings and include a variety of space types including classrooms, studio space, student and library space, teaching laboratories, research laboratories, and office space.

These buildings contain not only COE space but also occupants that are outside of the COE including those listed in the table on the left of this page. Please reference table titled "Unit Assignable Space by Building and Sector" on page 2-31.

PERCENT OF COE DEPARTMENTAL SPACE IN CORE AND WEST CAMPUS BUILDINGS



COE DEPARTMENTAL SPACE ON CORE AND WEST

The distribution of COE Departmental ASF is shown in the graph above.

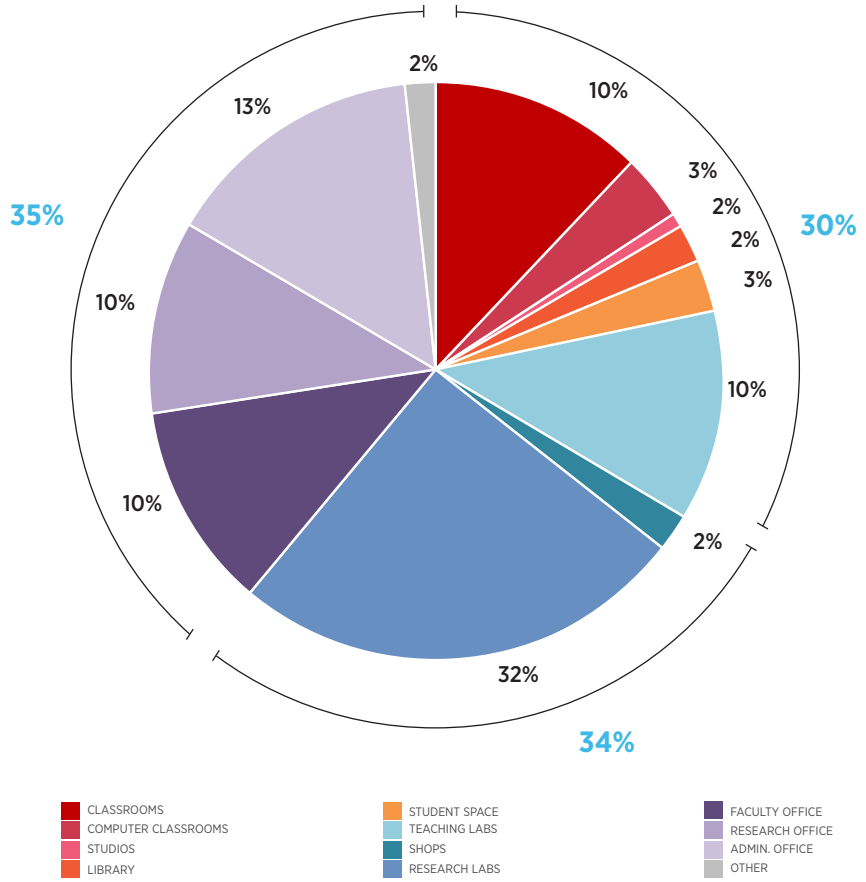
The Core Engineering Campus currently provides the departmental home to Mechanical Engineering and Nuclear Engineering, Aerospace Engineering, Architectural Engineering, Civil Engineering and SEDTAPP.

The West Campus currently provides a departmental home for Acoustics, Engineering Science and Mechanics, Industrial and Manufacturing Engineering, and Biomedical Engineering. Electrical and Computer Engineering has two homes, one on Core Campus and one on West Campus. The department of Chemical Engineering is currently located on the East Campus in swing spaces.

Most of the COE occupied buildings house one or two COE departments; however, Hammond and Engineering Units C and B currently have the most diverse portfolio of departments.

SPACE TYPES OF COE OCCUPIED BUILDINGS ON CORE CAMPUS AND WEST CAMPUS

SPACE TYPE	ASF	%	
Classrooms & Support	68,113	10%	30%
Computer Classrooms & Support	23,040	3%	
Studio Space	12,526	2%	
Library & Study Rooms	12,656	2%	
Student Space	17,183	3%	
Teaching Labs & Support	69,215	10%	34%
Shops	15,577	2%	
Research Labs & Support	219,643	32%	35%
Faculty Office	68,931	10%	
Research Offices	71,547	10%	
Administrative Office & Support	90,288	13%	
Other	13,562	2%	
TOTAL	682,833		

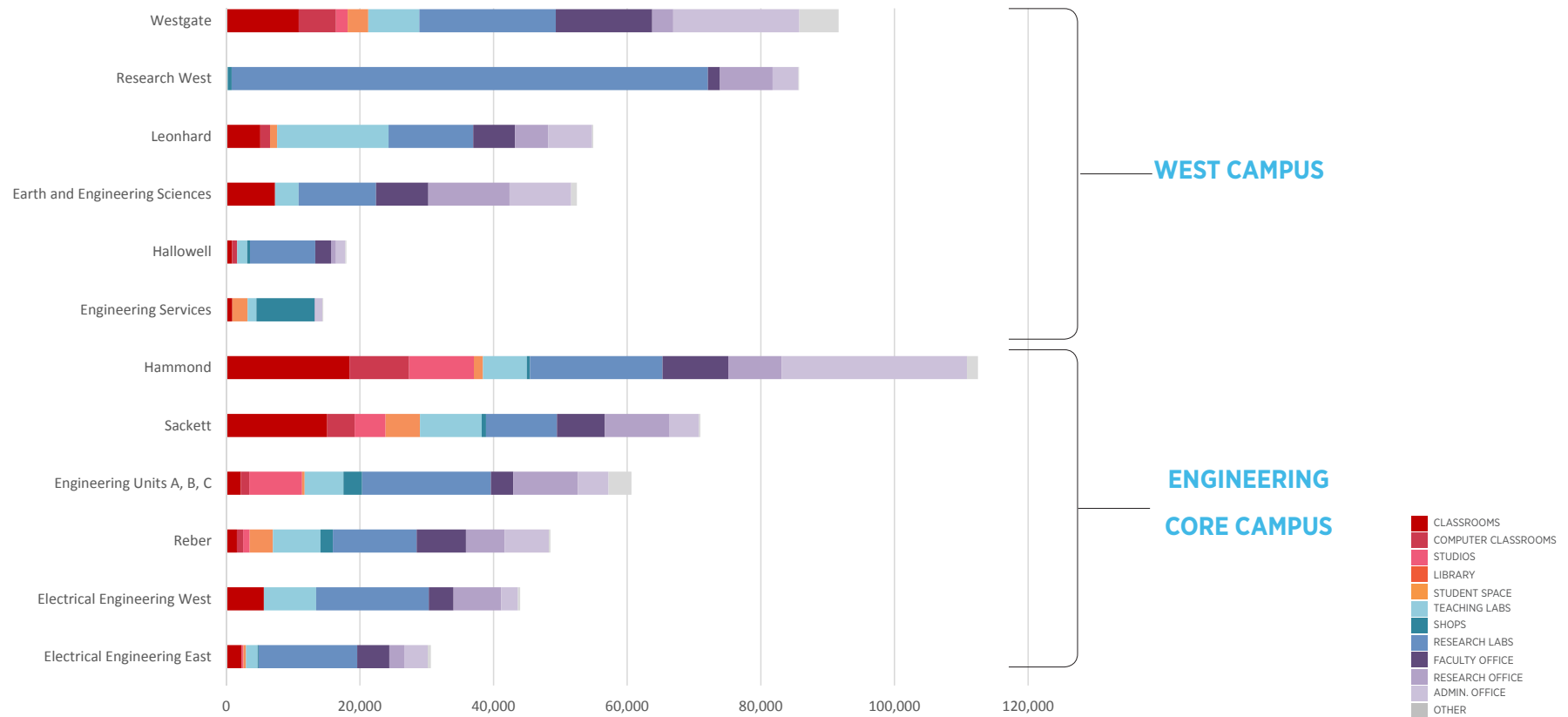


TYPE OF SPACE

The overall picture of the space types of the COE occupied buildings on the Core and West Campus is shown in the table and pie graph above.

Slightly more than a third of the space is office and administrative space, about a third is research and shop space, and the remaining space, slightly less than a third, is made up of undergraduate focused spaces including classrooms, computer classrooms, studios, teaching laboratories, student, and library spaces.

DISTRIBUTION OF COE DEPARTMENTS ON CORE AND WEST CAMPUS



Individually, the buildings have their own character, and the stacked bar graphs on the following page illustrate the space types that make up each of the buildings.

Research West is the only building that does not have any undergraduate focused space—all others have a blend of research, teaching and office spaces.

EXISTING INVENTORY

The COE provided an overview spreadsheet of their occupied space across the State College campus: “COE Space Matrix from May 2018” included on the facing page.

The COE data was further described by the Penn State OPP who provided current detailed space data for all of the COE occupied buildings including:

Core Campus

- Electrical Engineering East
- Electrical Engineering West
- Engineering Unit A
- Engineering Unit B
- Engineering Unit C
- Hammond
- Reber
- Sackett

West Campus

- Earth & Engineering Sciences
- Engineering Services
- Hallowell
- Leonhard
- Research West
- Westgate

East Campus

- Academic Projects
- Breazeale Reactor Complex
- Research East
- Research Center Stor. I
- Research Center Stor. II
- Research B
- Research C
- Transportation Research Building
- Center for Sustainability Complex
- Administration Bldg. (WWTP)

North Campus

- Kuo Lab Complex
- Supplemental Mailroom

Chemical Engineering Swing Space

- 3058 Research Drive
- Greenberg
- Thomas

Off-Campus

- North American Refractories
- LTI Test Track Complex
- Calder Square I LEASED
- Fedon Warehouse LEASED
- Marion Place LEASED

In some cases, the ASF numbers provided by the COE did not exactly match the numbers in the detailed space data provided by OPP, and in that case, the numbers provided by the COE were used as the baseline assumption for occupied space.

CBEB

Currently the new CBEB Building for Chemical and Biomedical Engineering is under construction on East Campus (194,500 GSF; 112,000 ASF). This building will provide significant wet lab teaching and research space for the COE. This planned growth is accounted for in the right-sizing and 2028 Growth figures for the COE in Chapter 3 and assumes that the CBEB Building accommodates needed growth for the Bio-E and Chem-E departments through 2028. After completion of the CBEB Building, Chem-E will move out of swing spaces, and BME will move out of its spaces in the Hallowell Building to occupy the new building.

The Chemical Engineering & Biomedical Engineering Building Project Update from September 2015 is included in the appendix for detailed information on the “Investment Option” for the addition, which was the basis of design.



Unit Assignable Space by Building and Sector
Updated May 2018

	Engineering Core							West Campus					East Campus										North Campus		Off Campus												
	Electrical Engineering East	Electrical Engineering West	Engineering Unit A	Engineering Unit B	Engineering Unit C	Hammond	Reber	Sackett	Earth & Engineering Sciences	Engineering Services	Hallowell	Leonhard	Research West	Westgate	Academic Projects	Brazzale Reactor Complex	Research East	Research Ctr Stor I	Research Ctr Stor II	Research B	Research C	Transportation Research Building	Center for Sustainability Complex	Administration Bldg (WWTP)	Kuo Lab Complex	Supplemental Mailroom	North American Refractories	LTI Test Track Complex	Calder Square I LEASED	Fedon Warehouse LEASED	Marion Place LEASED						
DEPARTMENTS																																					
Graduate Program in Acoustics													4,400																								
Aerospace Engineering				1,661	6,214	26,082							734	3,771													4,737										
Architectural Engineering			21,620	11,569	1,356		8,701																	1,309													
Biomedical Engineering										17,162																											
Chemical Engineering																																					
Civil & Environmental Engineering				582	913	5,408	42,318																580	817							35,978						
School of Electrical Engineering and Computer Science	28,819	38,390		2,319								35,292																									
Engineering Science and Mechanics								28,032				27,271																									
Industrial & Manufacturing Engineering											41,628																										
Mechanical Engineering				387	3,697	7,960	43,820				8,664	3,478			2,482	17,175								8,114						6,416							
Nuclear Engineering						4,588	3,255							1,052																							
School of Engineering Design, Technology & Prof. Programs				742	696	21,798																1,601															
CORE UNITS																																					
Administration				30	203	26,552	4,812															254										799	2,882				
Engineering Shop Services									7,691																												
Office of Digital Learning					1,534																																
Facilities Engineering Institute																																		6,390			
Learning Factory									6,824		433																										
Radiation Science & Engineering Center														2,321	23,568																						
Larson Transportation Institute																	2,400	1,100	9,471	4,750	11,377											16,848					
ENGINEERING TOTALS	714,781	28,819	38,390	21,620	17,290	14,613	92,388	47,075	55,831	28,032	14,515	17,162	50,725	35,883	35,292	9,626	23,568	17,175	2,400	1,100	9,471	4,750	13,232	1,889	817	8,114	4,737	45,762	17,473	2,882	4,474	6,390					
OTHER ASSIGNED SPACE																																					
General Purpose Classrooms																																					
Quantity	68	3	11		2		10	1	22	7		1	5		6																						
Total ASF	55,615	2,321	5,623		1,825		8,040	1,590	15,118	6,570		822	4,131		9,575																						
Non-COE Units																																					
College of IST													45,922																								
College of EMS												17,211		6,198	8,832		5,753				869																
Engineering Library						9,699																															
ARL												43,871																									
Others				3,666		2,362		654						6,853							5,235	1,145															

PSEAS DISCUSSIONS

Payette facilitated a conversation with the Penn State Engineering Alumni Society as part of the study. The Society works closely with deans, faculty, staff, and students to promote and improve engineering programs at Penn State. The recommendations from PSEAS for the COE were as follows:

- **Be in the top 10 engineering schools;** the “Harvard of the public universities”
- **Increase cross-disciplinary work** and collaborations outside of COE
- **Increase project based, hands-on learning** on real world problems
- **Teach communication skills** as well as technical skills
- **Be great at a few things**
- **Be bold!**

The areas in which the PSEAS group recommended focusing the research themes are:

- Sustainability & Environmental Engineering
- Energy
- Health
- Big Data/Data Analytics
- Cyber-Technology
- Robotics
- Artificial Intelligence
- Internet Of Things
- Autonomous Systems
- Transportation
- Industrialization
- Nano-Technologies
- Bio-Mimicry

DEPARTMENTAL DISCUSSIONS

During the study, a series of conversations was held with departmental groups. In March 2018, Payette met with IPAC (Industrial and Professional Advisory Council) groups for the departments, and the following month toured departmental space with representatives of the departments to understand typical spaces. Departments also delivered a briefing on spaces that worked well, worked poorly, and their vision for the future of their department and the COE.

The notes from these conversations are included in the Appendix, and following here are the themes that resonated across departments.

In general the departments agreed on the following needs:

- **Departmental consolidation**—Bringing departments together, and relocating far-flung research programs back to Core and West Campus
- **More and better departmental space**—Research labs, teaching labs, offices, student space, storage space
- **Project-based learning**—Faculty need teaching spaces that support curricular change
- **Research collaboration and student making** should define key shared resources
- **More large lecture halls** to teach large sections of engineering curriculum
- **Computing Spaces**
- **Student Learning Commons** for all departments as a shared resource

Additionally, department chairs responded to a questionnaire regarding shared spaces and collaboration

with other departments. Departments highlighted spaces that they would like to share, and around which they could imagine thematic collaborations. These were:

- Sound and Vibration Research Facility
- Biomedical Ultrasound Research Facility
- Multi-Modal Imaging Facilities

- UAV Design Facility
- Aircraft Fabrication Facility
- Indoor Flight Facility

- Structural Testing Facility
- Mechanical Testing Facility
- Automated Construction Facility
- Additive Manufacturing & Design Facility

- Chemical Analysis & Instrumentation Facility
- Quantum Engineering Facilities (Optics, Computing, Informatics)

- Collaboration space for multi-disciplinary research
- Digital Visualization Facility
- Global Virtual Teaming Facilities

- Learning Factory—Advanced Manufacturing
- Learning Factory—Robotics
- Learning Factory—Autonomous Vehicles (flight and terrestrial)
- Learning Factory—Wood Shop,
- Learning Factory—Electronics and Computing

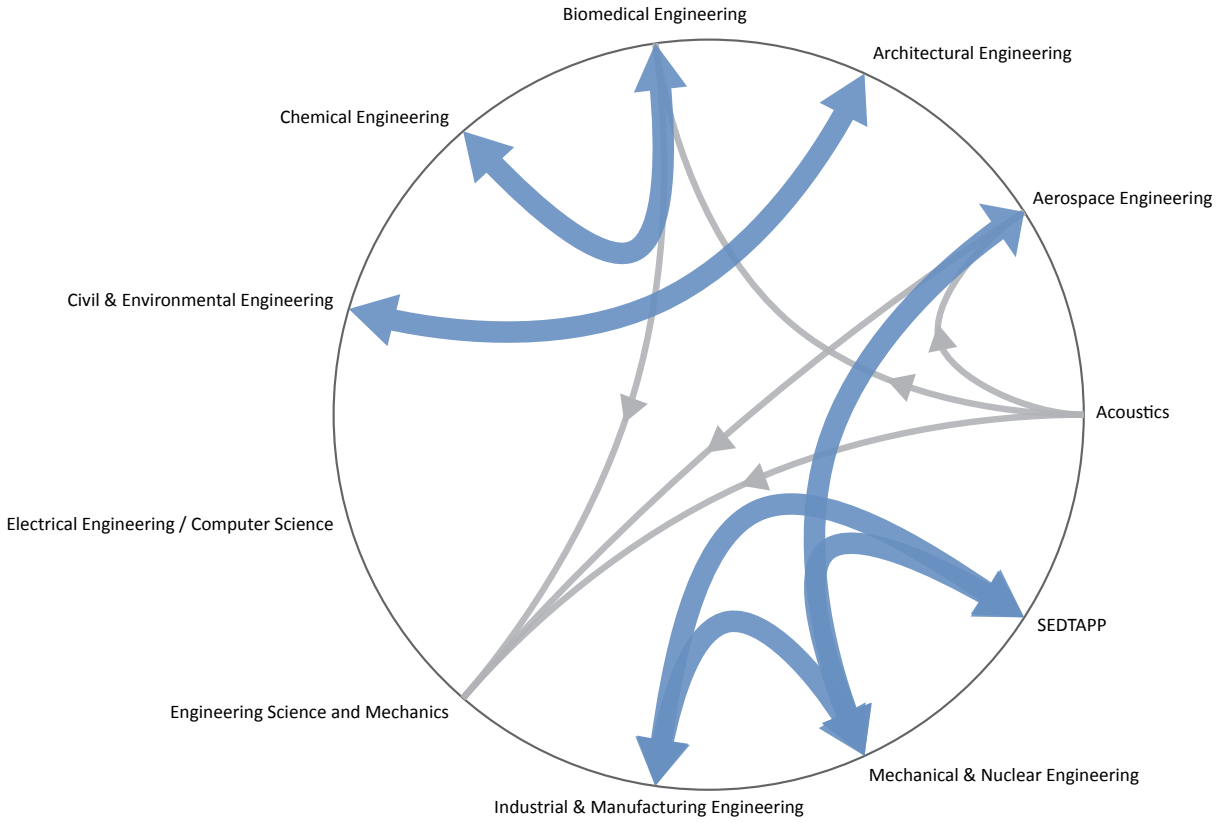
- Innovation & Incubator Facility for Student Projects
- Student Club Space
- Storage Space (student projects)

Departmental Affinities Diagram: One of the key questions of the survey was: “Which two departments would you like to be co-located within a new building?” The graphic at right illustrates the departmental responses indicating departmental affinities, with the strong blue lines representing instances in which both departments named each other as a preferred co-location partner, and the thinner lines represent instances in which one department named another as a partner for co-location, but the other department did not reciprocate. The arrow indicates the direction of the affinity. As can be seen from the diagram, not all departments named others as preferred co-locators, some departments named one other department, and a few named three preferred co-locators. A few additional items of note:

The School of Electrical Engineering and Computer Science did not respond to the question perhaps because EE and CSE have already joined to create a school. It is surprising that no other department named them as a co-location desire since Computer Science seems like it would be integral to almost all of the other departments as most have a computational aspect. EE and CSE are not currently co-located; EE is in EEW and EEE, and CSE is in Westgate.

ESM noted that most of the collaboration occurs not within the COE, but to departments like Chemistry, Biology and Physics residing outside of the COE. However, others within the COE saw ESM as a key collaborator.

Civil Engineering and Architectural Engineering named each other and no other departments as preferred co-locators.



Which two departments would you like to be co-located with in a new building?

BUILDINGS

The **Master Plan** included an assessment of the buildings shown in the site plan on the facing page. This assessment is based on firsthand observations from a site visit on April 30 and May 1, 2018, combined with review of existing conditions drawings and the University’s Facility Condition Assessment (FCA) reports prepared by ISES Corporation.

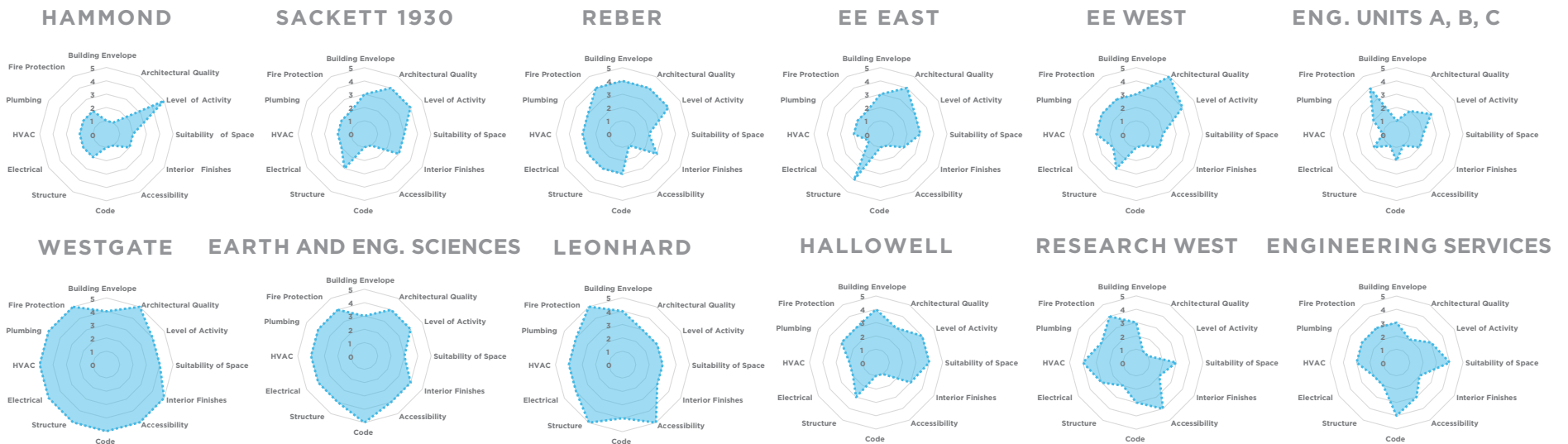
The buildings are rated on a scale from 1 to 5 across a range of attributes, with 1 being “poor,” 3 being “adequate,” and 5 being “excellent.” These ratings are elaborated upon in the narrative for each building and plotted in a “radar” diagram, which provides a visual indication of the building quality, where larger shaded areas represent higher-quality buildings and smaller areas represent lower-quality. These diagrams are also useful for visualizing situations where a building may have poor overall quality but happens to excel in a particular area.

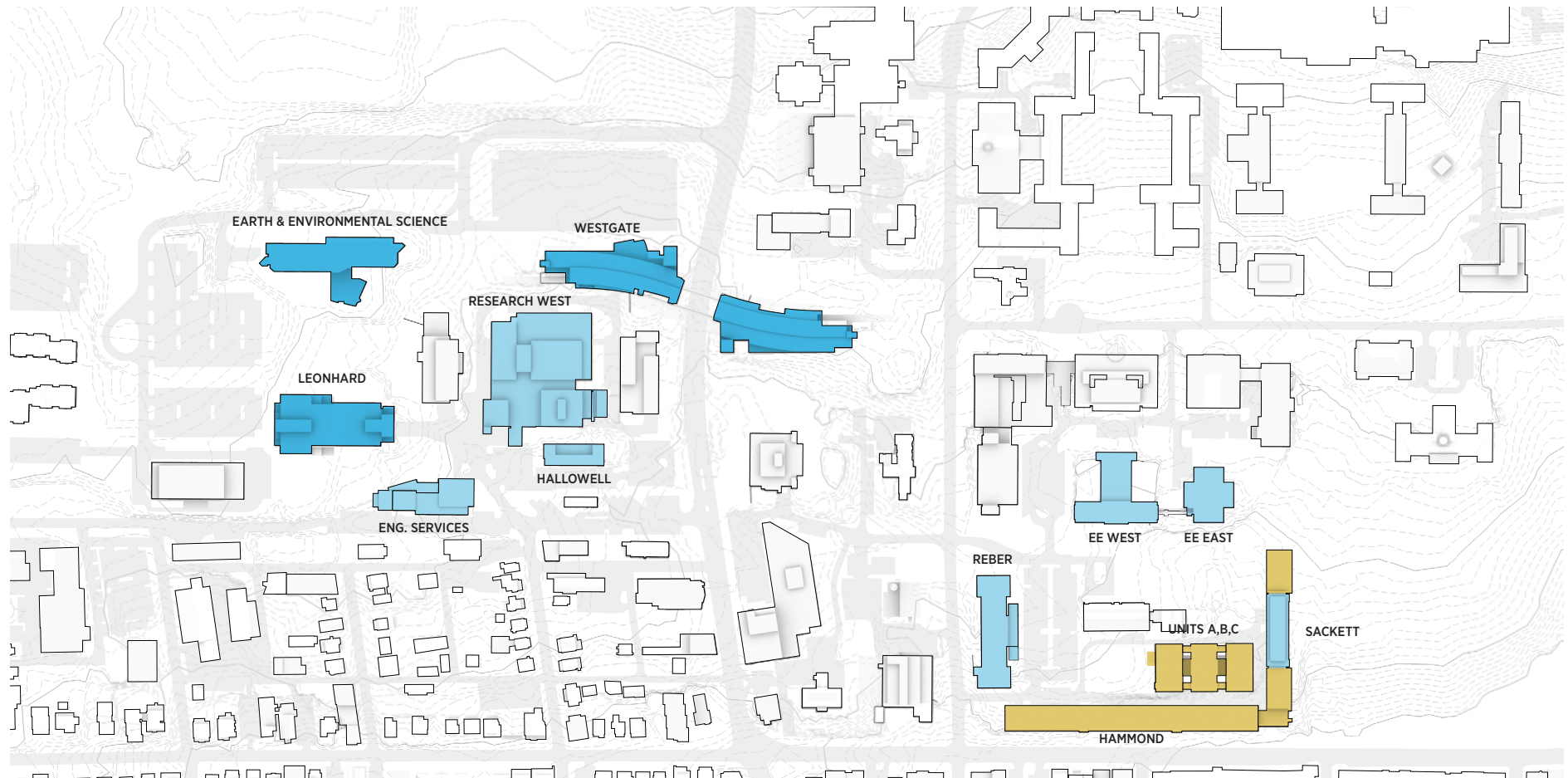
In addition, the assessment includes “summary sliders” that provide a high-level evaluation of each building in terms of its current condition, required investment, whether it maximizes its site’s potential, and how well it enhances the campus. “Estimated Current Value” and “10-Year Total Renewal Needs” are provided by the University and are shown in 2018 dollars. The 10-Year Renewal Needs represents the “backlog” costs for each building, made up of non-recurring maintenance costs, deferred maintenance costs, and projected renewal costs. Finally, each building assessment includes a highest-and-best use evaluation in terms of those program components that are best suited for the building, independent of whether the building is recommended for demolition and replacement.

Based on this assessment, the following buildings are recommended to be demolished and their sites re-developed at some point in the next 10-20 years:

- Hammond
- Sackett Wings and Kunkle
- Engineering Units (A, B, and C)
- Electrical Engineering East
- Hollowell
- Engineering Services
- Research West

The timing of demolition and re-development is discussed further in Chapter 5 of this report.





Buildings Assessed: Quality and Adequacy



Some building information was taken from the University's Facility Condition Assessment (FCA) reports prepared by ISES Corporation such as each building's year of construction, estimated value, and estimated renewal needs.

Other information, such as building gross square footage (GSF) and assignable square footage (ASF) was received from Penn State OPP. All other information regarding the buildings' existing conditions results from direct observation during walkthroughs by Payette and the consultant team.

HAMMOND

Year Built: 1958

GSF: 157,836

ASF: 112,489

Efficiency: 71%

Current Programs: Classrooms, Offices, Laboratories, Engineering Library

Floor-to-Floor Heights:

L3-Roof: 13'- 0"

L2-L3: 11'- 4"

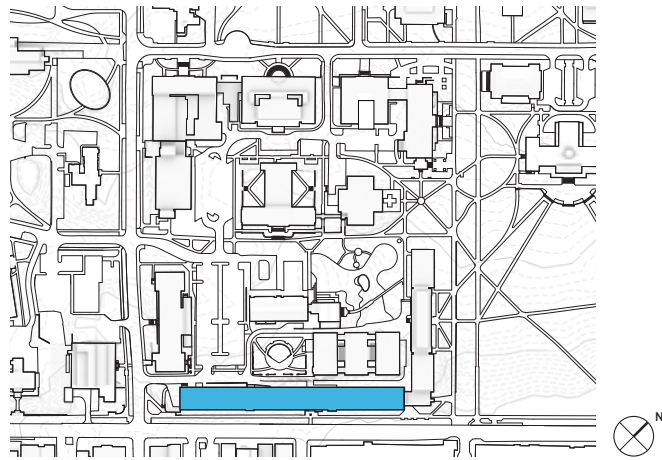
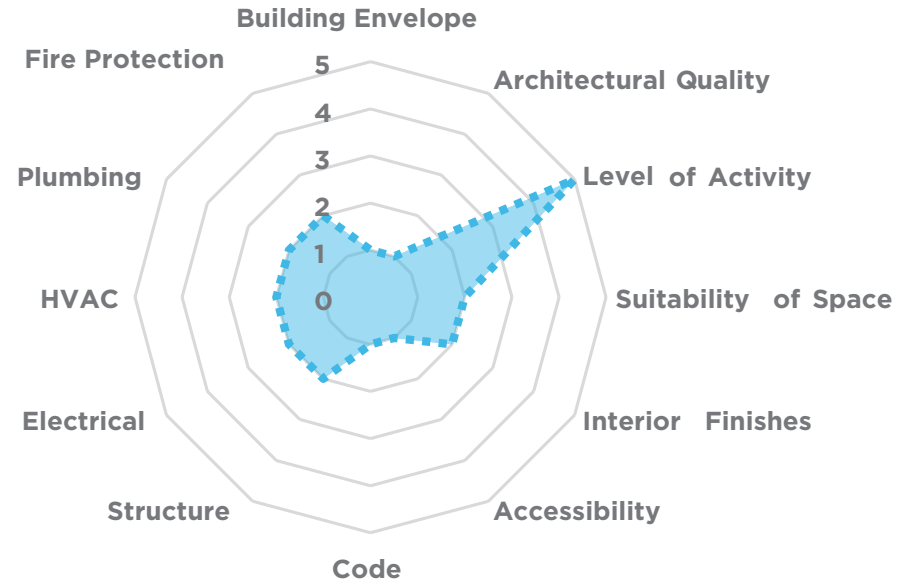
L1-L2: 11'- 4"

LL-L1: 17'- 4" (west end) and 20'- 0" (east end)

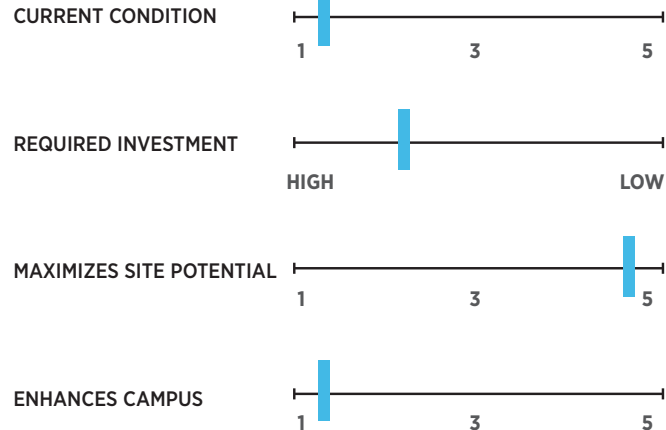
Estimated Current Value: \$57.9 million

10-Year Total Renewal Needs: \$30.9 million (53%)

Highest and Best Use: Classrooms, Offices, Studios



Location Plan



South Wall of Hammond at College Avenue

Building Envelope: The Hammond building utilizes a single-glazed, aluminum-frame curtainwall system with operable windows and fiberglass panels for the upper three floors, with a natural stone veneer base and end walls. The fiberglass panels are 1½” thick, suggesting a very low R-value. Glazing has a solar film that is compromised in many places, scratched and unsightly. The underside of the entry balconies is in poor condition, and the stone base needs re-pointing. The built-up roof is acceptable with no noted leaking.

Architectural Quality: Hammond does not have historical significance. The long façade creates a wall between the State College commercial district to the south and campus open spaces to the north. The architectural quality of this building does not live up to its prominent position on the campus.

Level of Activity: Hammond is very active with students, faculty, and administration. The corridors are teeming with students between class periods, and study spaces are highly utilized.

Suitability for Programs: Hammond is ill-suited to its programs. Its ventilation system is likely to be insufficient for wet labs. The narrow corridors (typically 6’– 5”) are overcrowded, and many office spaces are located within internal suites with no access to natural light and views to the outside. The Engineering Library and classrooms spaces are adequate, and the large classrooms and project rooms on Level 3 are well-suited for their uses. The long rectangular columns that run down the center of the building on the basement level and Levels 1 and 2 will impede retrofitting.

Interior Finishes: The general condition of finishes is poor. Painted surfaces are in adequate condition. Carpet

and ceilings are stained and worn. Lighting is adequate. Bathroom finishes are original and merit replacement. Sealed, polished concrete floors have been patched and repaired in places. Presence of asbestos is suspected in the 9-inch vinyl floor tiles and in the curtainwall spandrel panels.

Accessibility: All entries into Hammond except one require the use of stairs. The exception is the breezeway entrance at the east end. However, this leads to a non-accessible elevator. The only accessible entrance is through Sackett, making the accessible route into Hammond long and circuitous and requiring two elevator rides for access to some floors. Many doors throughout the building have hardware that does not meet accessibility standards. Water fountains are not accessible.

Code: The building does not have an automatic fire sprinkler system. The stair rise / run (7.25” × 11.25”) and the stair handrails and guardrails do not meet code. The plumbing fixture counts in the building may be inadequate.

Structure: The building’s structure consists of concrete framed superstructure with infill stack bond CME partition walls; concrete slab-on-grade at the basement; stone ballast on the roof. Level 3 omits the center columns and has a clear span utilizing steel bar joists. Lateral system likely relies on moment frame or infill masonry partition walls and shaft walls. Exterior concrete elements show some areas of extensive cracking, particularly at entry and exit areas, which likely have been exposed to chlorides and moisture. Interior corridor and basement level floor slabs also show cracking. Roof level is susceptible to vibration from typical walking level excitation due to longer slab spans.

Electrical: The building is served from (3) 5kV transformers, which were not accessible at the time of the site visit. Per

the FCA report, the building is fed from a 208/120V, 3200A switchboard (1152kVA capacity). Branch equipment is old and is located in a mix of mechanical rooms, shared chase rooms, and public spaces. Not all of the equipment meets current NEC requirements for working space. Emergency and normal equipment are co-located and sized for EM only.

HVAC: The building is served by the campus steam system. The shell-and-tube heat exchanger was replaced in 2016. The heating pumps and condensate return pump appear to be older. Chilled water is supplied to Hammond from a mechanical room on the south side of Reber. There is a new plate-and-frame heat exchanger, and pumps have just been installed. The ventilation systems vary in type and age due to many local renovations—they are a mix of VAV, FCU, and the original perimeter heating system. Central heating and cooling is in good condition, but the ventilation and distribution systems need replacement.

Plumbing: The domestic water system is copper and is old. The sanitary and storm systems are hub and spigot cast iron and are old. The plumbing water heater and pumps are all old and probably inefficient and should be replaced. The restrooms have been retrofitted with some new fixtures and in some cases have sensor flushometers. However, the fixtures did not appear to be low-flow or water saving.

Fire Protection: The building is not equipped with an automatic fire sprinkler system. There are fire hose stations at each elevator lobby along the main central corridor at each floor level. At each cabinet is a 2½” connection with a 1½” connection adapter and a handheld extinguisher, but no hose. Each standpipe (3 in total) appears to have a separate water feed from the street with no interconnection and no Fire Department connections on the face of the building.

SACKETT — ORIGINAL

Year Built: 1930

GSF: 47,853

ASF: 30,019

Efficiency: 63%

Current Programs: Classrooms, Offices, Laboratories, Design Studios

Floor-to-Floor Heights:

L4-Roof: 16' - 4"

L3-L4: 12' - 6"

L2-L3: 13' - 0"

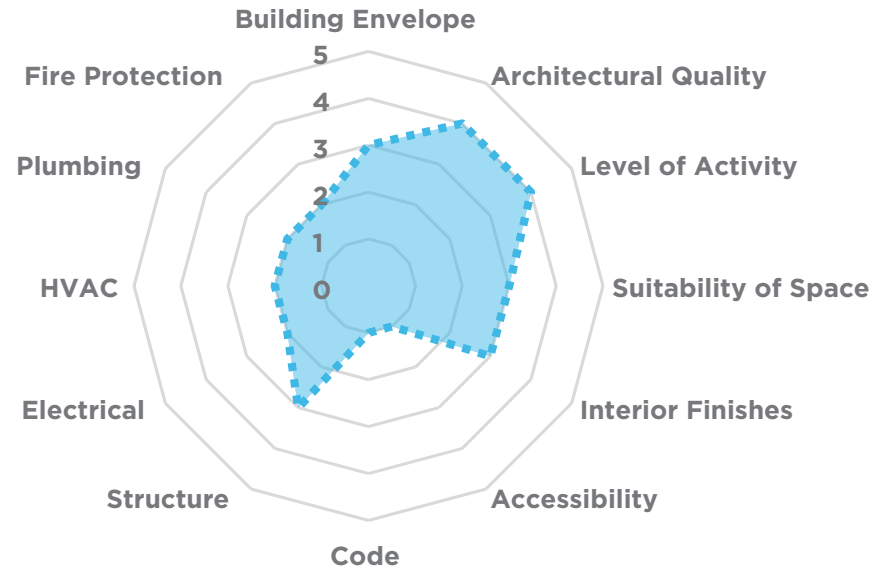
L1-L2: 13' - 6"

LL-L1: 16' - 0" and 20'-0"

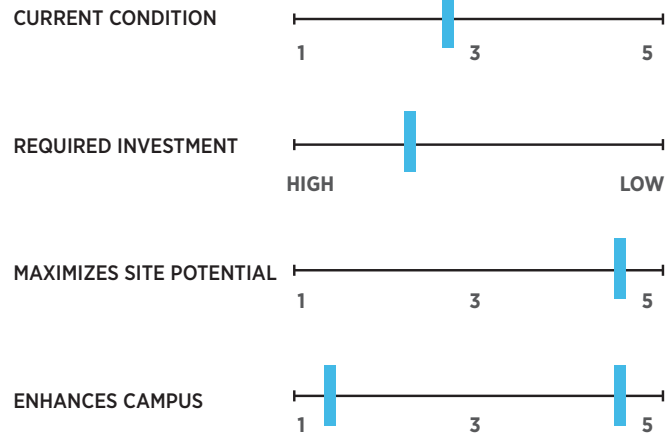
Estimated Current Value: \$35.2 million (includes additions)

10-Year Total Renewal Needs: \$17.3 million (49%, includes additions)

Highest and Best Use: Classrooms, Offices, Studios



Location Plan



Original Sackett Façade Facing Old Main

Building Envelope: Sackett is a five-level building with brick veneer and a limestone base, with aluminum single-glazed windows that are likely 50 years old and in need of replacement. Exterior doors also need replacement. The roof is in good condition with no reported leaks. Brick is in good condition with some areas of cracking and some need for re-pointing. Limestone is deteriorating in some areas, particularly at the areaway on the west side. The building's main entry stair needs attention to cracking and railing replacement. The original slate-clad hip roof was removed at some point in time and replaced with corrugated metal wall panels and operable windows, in effect raising the hip roof and reducing its slope to provide occupiable space on the top floor.

Architectural Quality: The original Sackett Building was designed by Charles Klauder and has historic significance for the Penn State campus. It exhibits a high architectural quality for its period, and given its prominent location on Pattee Mall, it should continue to remain as an asset to the campus.

Level of Activity: The building is very active with students, faculty, and administration.

Suitability for Programs: The building is well-suited for classrooms, offices, and studio spaces. The relatively high floor-to-floor heights would allow for dry electronics labs. The tall portion of the basement, originally a hydraulics lab, could support high bay lab use or serve as mechanical space, though the column layout may be suboptimal. The generous corridors (8'- 8" wide) are well-suited for classrooms.

Interior Finishes: Much of the original plaster detailing (e.g., at doorways from the corridor) is still in place, but introduction of HVAC systems have led to lay-in ceilings that compromise the original architectural integrity. Exposed electrical panels and conduit in the corridors similarly compromise the historic character of the interior. Some of the finishes and lighting have been updated, in particular within classroom spaces. Presence of asbestos is suspected in the 9-inch vinyl floor tiles.

Accessibility: There is an accessible entrance near the northwest corner of the building. Toilet rooms in general are inaccessible and often located beyond a level change in the corridor. Water fountains are not accessible.

Code: The building does not have an automatic fire sprinkler system. The stair rise / run (7.5" × 11") does not meet code. Handrail is 30" high with no guardrail, and the pickets are more than 4" apart.

Structure: The building's structure consists of unit masonry and stone masonry bearing wall on the perimeter with concrete slab and beam floors and concrete slab-on-grade at basement floor. Original drawings suggest deep foundations in the tall portion of the basement, which was designed for a hydraulics lab. Columns are located on both sides of the corridor, and terracotta masonry is used to infill between columns. Columns are likely concrete or steel sections wrapped in concrete. Lateral system probably relies on perimeter and infill CMU walls. Steel roof framing has been renovated with an enlarged envelope, exposing the original sloped steel framing. Exterior masonry shows minor weathering and wear.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer that feeds a 208/120V, 2000A switchboard (720kVA capacity), per the FCA report. Some of the branch electrical equipment has been recently replaced and appears to be in good condition. Approximately 50% of the electrical equipment is old and should be replaced as areas are upgraded. Emergency and normal equipment are co-located and sized for EM only.

HVAC: The building is served by the low-pressure steam system, which directly feeds terminal units such as steam radiators. Pressure is approximately 20-25 psig. Chilled water supply is provided from Reber via Hammond. Ventilation systems are via air-handling units and exhaust fans on the roof of the Sackett additions (see below). Dedicated fume hood exhausts are also roof-mounted on the Sackett additions. Additional cooling via direct-exchange window and roof-mounted units are provided for some spaces.

Plumbing: The building is equipped with several lab services: compressed air, natural gas, lab waste drainage. The vacuum pump and piped system is no longer operational. The piping is all old, and the equipment needs replacement, as it is old and inefficient. No lab waste treatment system was observed, neither local nor central. Plumbing fixtures are generally old and consume considerably more water than new fixtures would.

Fire Protection: The building is not equipped with an automatic fire sprinkler system. A standpipe system (not NFPA) is fed from the incoming 6" domestic main in the mechanical room and serves what appear to be 2" standpipes that rise in the central corridor to serve 1½" valved connections at each floor. This system does not serve the roof, and no Fire Department connections were observed on the exterior.

SACKETT — NORTH AND SOUTH WINGS AND KUNKLE LOUNGE

Year Built: 1958

GSF: 60,733

ASF: 40,930

Efficiency: 67%

Current Programs: Classrooms, Offices, Laboratories

Floor-to-Floor Heights:

L3-Roof: 12' - 8"

L2-L3: 11' - 4"

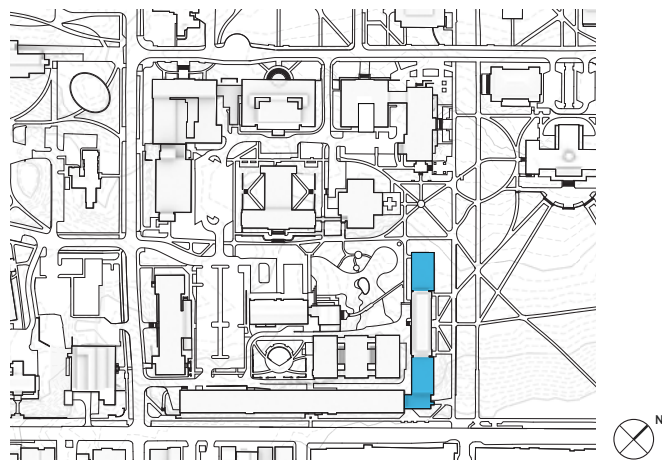
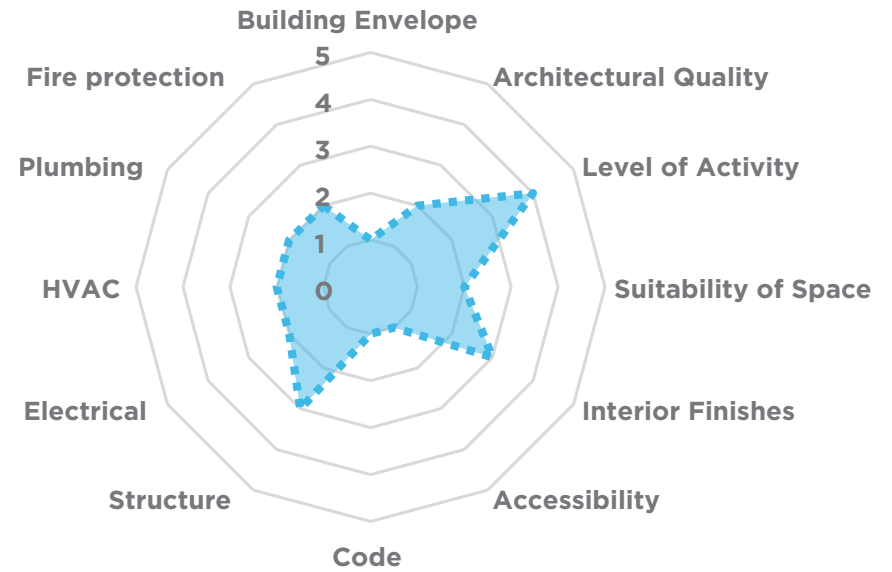
L1-L2: 13' - 4"

LL-L1: 16' - 0" (north wing) and 20' - 0" (south wing and kunkle lounge)

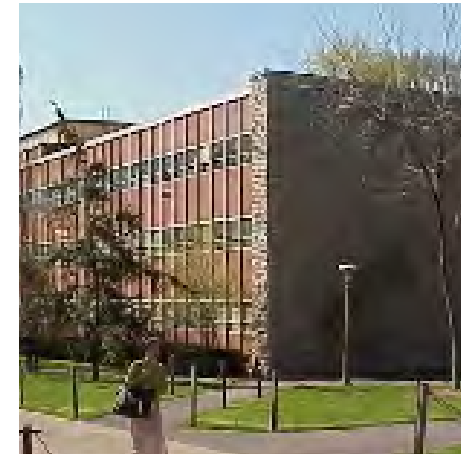
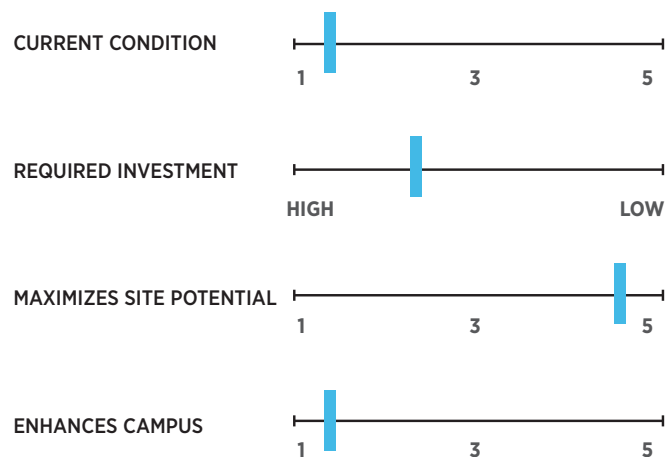
Estimated Current Value: see Sackett-Original

10-Year Total Renewal Needs: see Sackett-Original

Highest and Best Use: Dry Equipment Labs, Classrooms, Offices, Studios



Location Plan



North Addition to Sackett

Building Envelope: The 1958 additions to Sackett (North Wing, South Wing, and Kunkle Lounge) were implemented as part of the Hammond project and are in the same architectural design. These additions utilize a single-glazed, aluminum-frame curtainwall system with operable windows and fiberglass panels for the upper three floors, with a natural stone veneer base and end walls. The fiberglass panels are approximately 1½” thick, suggesting a very low R-value. Glazing has a solar film that is compromised in many places, scratched and unsightly. The built-up roof has had some reported leaking.

Architectural Quality: The Sackett additions do not have historical significance and are generally of lower quality than the original building. The architectural quality of the additions does not live up to its prominent position on the campus.

Level of Activity: The building is very active with students, faculty, and administration.

Suitability for Programs: The North and South Wings are ill-suited to their programs. While there are wet labs in the North Wing, the building was not originally designed with this use in mind, and the ventilation is likely insufficient. The narrow corridors (typically 5’- 9” and 5’- 11”) are overcrowded, especially during class changes. Classroom spaces are adequate. In several areas, the additions are not aligned with the floor levels of the original building, leading to stairs or steep ramps to connect the corridors.

Interior Finishes: The general condition of the finishes is in fair to poor condition. The paint in the building is adequate. Lighting needs replacement. Carpet and ceilings are stained and worn. Bathroom finishes are original and merit replacement. Sealed, polished concrete floors have been patched and repaired in places. Presence of asbestos is suspected in 9-inch vinyl floor tiles and curtainwall spandrel panels.

Accessibility: There is an accessible entrance near the northwest corner of the building. Toilet rooms in general are inaccessible and often located beyond a level change in the corridor. Water fountains are not accessible. Many doors throughout the building have hardware that does not meet accessibility standards.

Code: The building does not have an automatic fire sprinkler system. The stair rise / run (7.25” and 11.25”) do not meet current code, and stair handrails and guardrails are non-compliant. The plumbing fixture counts are likely inadequate.

Structure: The building’s structure consists of steel and concrete frames, with a hung steel mezzanine at the Kunkle Lounge; and concrete slab-on-grade at the basement level. Lateral system likely relies on concrete or steel moment frames or shaft shear walls. Condition of interior superstructure is largely hidden by finishes and difficult to ascertain. Limited areas of exposed concrete structure at the mechanical room and along exterior overhang do not exhibit significant cracking.

Electrical: The buildings are each served from an exterior pad-mounted 12.47kV transformer, which feeds a 480/277V, 400A switchboard (332kVA capacity). Some of the branch electrical equipment has been recently replaced and appears to be in good condition. Approximately 50% of the electrical equipment is old and should be replaced as areas are upgraded. Emergency and normal equipment are co-located and used for EM only.

HVAC: The North Wing is served by steam converted to heating hot water via shell-and-tube heat exchanger. The South Wing is served from Hammond’s heating hot water system. The chilled water system in the additions are served the same way as the original building. The ventilation system is as described above for the original Sackett building.

Plumbing: Refer to notes above for the original Sackett Building—the same systems span the entire building complex.

Fire Protection: Refer to notes above for the original Sackett Building—the same systems span the entire building complex.

REBER

Year Built: 1921

GSF: 80,072

ASF: 48,665

Efficiency: 61%

Current Programs: Classrooms, Offices, Laboratories

Floor-to-Floor Heights:

L3-Roof: 11'- 3" to underside of slab

L2-L3: 12'- 6"

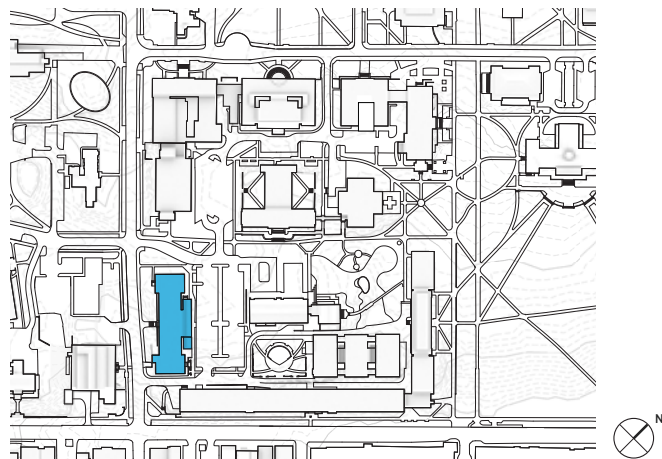
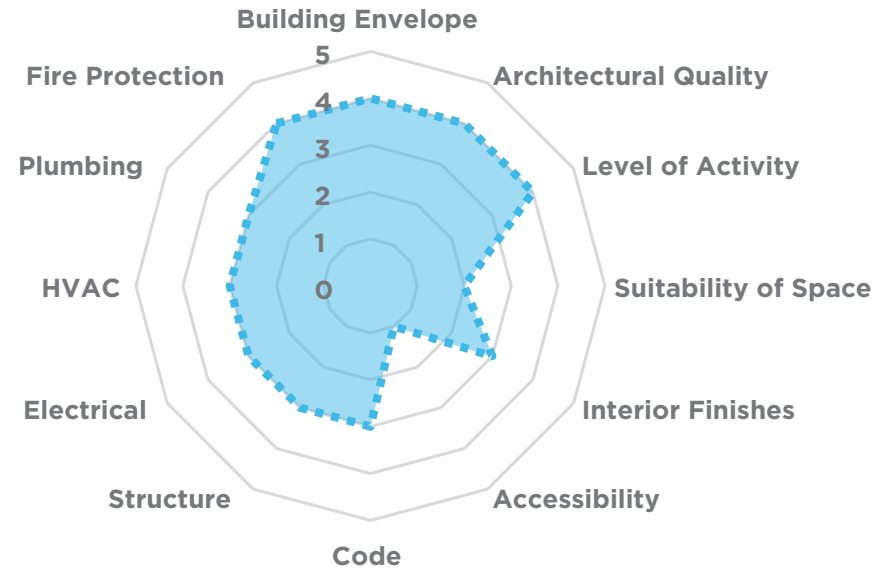
L1-L2: 13'- 0"

LL-L1: 10'- 9" and 16'-3"

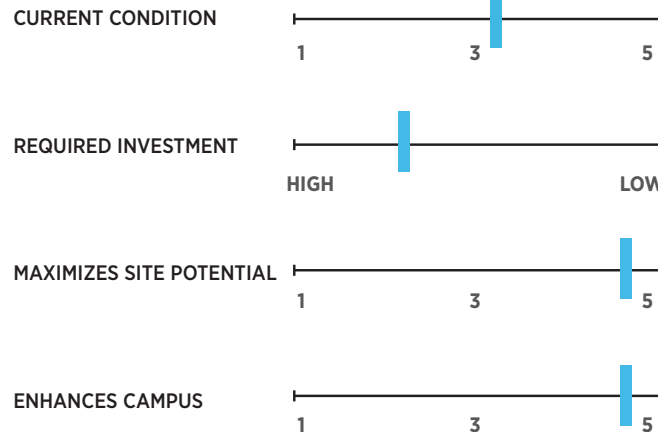
Estimated Current Value: \$24.7 million

10-Year Total Renewal Needs: \$5.3 million (21%)

Highest and Best Use: Dry Labs for Research and Teaching, Classrooms, Offices



Location Plan



Northeast Exterior Corner of Reber

Building Envelope: Reber is a 4-story masonry building that has had two major additions in 1949 and 1993. The brick and limestone masonry are in good condition, with some minor re-pointing, re-caulking, and repair needed. The windows are aluminum-framed, operable, and double-glazed, installed in 1993 and in good condition with the exception of rusting over many of the lintels. The roof is in adequate condition with evidence of ponding and deterioration.

Architectural Quality: Reber was designed by Charles Klauder and has historic significance for the Penn State campus. It exhibits a high architectural quality for its period, and given its prominent location on Burrowes Road, it should continue to remain as an asset to the campus.

Level of Activity: The building is very active with students, faculty, and administration. The renovated Knowledge Commons on the main level is very active with student activity (individual and group study), and when observed, nearly every seat was occupied.

Suitability for Programs: The building is well-suited for classrooms, offices, and studio spaces. The floor-to-floor heights are generally insufficient to support wet lab use but are acceptable for dry laboratories or small equipment labs. The generous corridors (8'-0" wide) are well-suited for classrooms. The building has loading access near the southwest corner, with a dock leveler in the corridor to make up the difference from basement level to grade. A gantry crane is provided to facilitate movement of equipment, especially where a steep (non-accessible) ramp connects the two basement levels.

Interior Finishes: Some of the finishes and lighting have been updated in the building, including classroom spaces and the Knowledge Commons. However, the corridors need

an upgrade, as do many of the labs and other spaces.

Accessibility: There is one accessible route and entry into the building at a side door at the northeast corner of the building. In general, the toilet rooms are not accessible, lacking accessible stalls and sinks. Water fountains are not at an accessible height.

Code: The building is equipped with an automatic fire sprinkler system. The stair rise / run (7" and 12") is code-compliant. However, stair handrails (28") and guardrails (38") are lower than current code standards, and at times the guardrails are missing. Elevators have a 4-foot wide opening.

Structure: There were multiple phases of construction. Building structure consists of perimeter masonry walls with steel beam and column interior frames with concrete slab floors and infill masonry partition walls. Roof structure consists of steel joists and metal decking. Lateral system likely relies on perimeter wall and infill CMU walls or possibly a steel lateral system. This is difficult to determine due to extensive cladding and finishes. Basement concrete slab changes in elevation, with several areas incorporating trenches.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer that feeds a 480/277V, 1200A switchboard (977kVA capacity). Distribution at 208/120V is fed from a 300kVA transformer. Distribution and branch equipment appear to be a mix of 1992 and 2017 vintages and appear to be in working condition. Emergency and normal equipment are co-located and are intended for emergency loads only.

HVAC: The building is connected to the campus low-pressure steam system and converts to heating hot water via shell-and-tube heat exchanger. Reber, Hintz Alumni Center, Electrical Engineering West, and Electrical Engineering East are served from the campus chilled water system via a plate-and-frame heat exchanger in Reber that was installed in 2008. Two VAV air-handling units provide ventilation. Dedicated fume hood exhausts are ducted to the roof.

Plumbing: A 6" incoming water line serves the plumbing and fire protection systems. An air compressor in the basement is reasonably new. The majority of other piping in the building and other equipment, including the steam domestic heat exchanger, is old and inefficient and needs replacement. The plumbing fixtures are old and consume a lot of water.

Fire Protection: The building is fully sprinkler protected with a Class I manual wet standpipe system installed in each egress stair. However, there is no fire pump. A double-detector check assembly is provided on the incoming main. The sprinkler and standpipe piping appear to be in good condition. All valves appear to be supervised back to a central fire alarm system. The sprinkler flow control assemblies could not be found—they are fed from a central riser.

ENGINEERING UNITS

Year Built: 1919

GSF: 85,111

ASF: 59,014

Efficiency: 69%

Current Programs: Classrooms, Offices, Dry Laboratories

Floor-to-Floor Heights:

L3-Roof: 10' - 11"

L2-L3: 14' - 0"

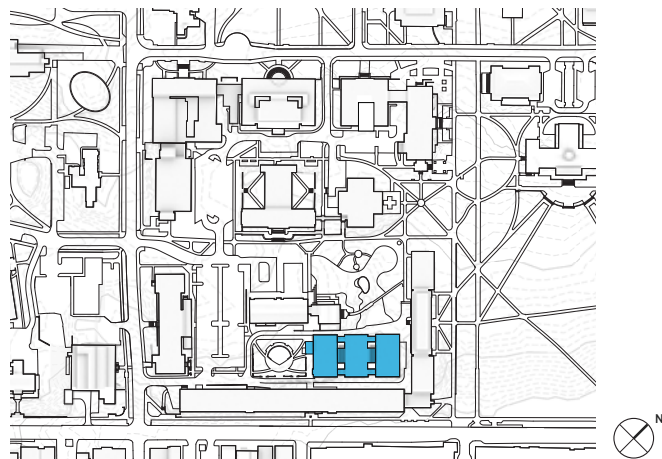
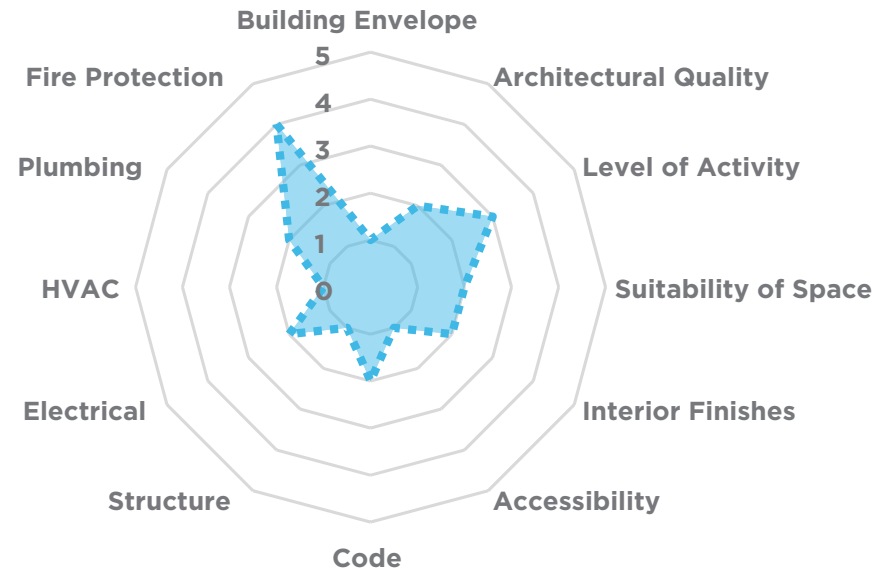
L1-L2: 14' - 8"

LL-L1: 10' - 9"

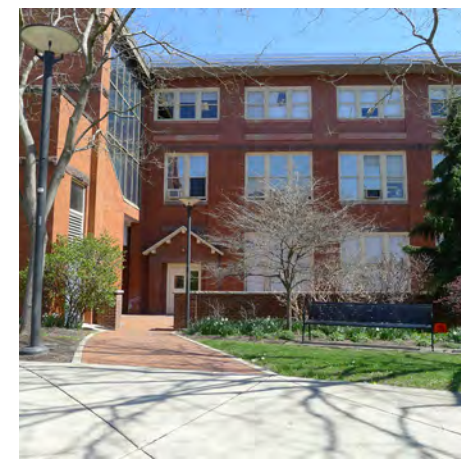
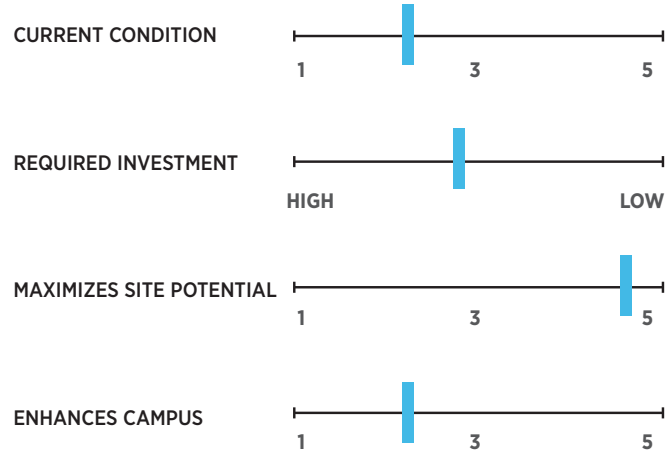
Estimated Current Value: \$34.0 million

10-Year Total Renewal Needs: \$15.6 million (46%)

Highest and Best Use: Classrooms, Offices, Studios



Location Plan



West Façade of the Units from Foundry Park

Building Envelope: The Engineering Units (A, B, and C) are an interconnected, 4-story masonry building in poor physical condition. Wood framed windows are single-glazed. Brick has deteriorated in many places and also needs repointing. There are visible cracks in the masonry at upper floors and some visible bulging. Exterior doors are a mix of replacement metal doors and original wood doors, which are in poor condition. There is a new roof on Unit C, and the other roofs are in adequate condition. The soffit and fascia at the cornice line appear to have been recently replaced.

Architectural Quality: In comparison with the Sackett North Wing and Hammond, the Engineering Units provide a reasonably attractive backdrop to the Alumni Garden. However, these buildings were originally designed to be temporary, are of poor quality, and have been poorly maintained. The buildings are also not well sited on the campus and would be best demolished.

Level of Activity: The buildings have a moderate level of activity with students and faculty active throughout.

Suitability for Programs: These buildings are suited to offices, classrooms, and studio space. However, due to the corridor layout, there are many windowless internal spaces, and the buildings would require major overhauls to modify them into suitable space for these programs.

Interior Finishes: The building has recently received some new finishes (carpet, paint, lighting). The ceilings are typically open, exposed construction. Most office areas have suspended grid tile ceilings, many of which have been upgraded. Presence of asbestos is suspected in 9-inch vinyl floor tiles. Many wood doors are original and need to be replaced.

Accessibility: This facility has some accessible features. An accessible entry is located at the west end, where a small addition with an elevator was built. A renovated accessible women's restroom is located on the first floor and an accessible men's restroom is located in the central adjoining hallway between Unit A and B. Water fountains are not at accessible heights. Much of the door hardware is not accessible.

Code: The stair rise / run (7" and 12") is code-compliant. The building is sprinklered. Handrails and guardrails are not compliant (30" high handrails) and open between supports.

Structure: Multiple phases of construction and materials. Original buildings are masonry perimeter bearing walls with steel beam and wood deck floor framing. Some ground level floors are on grade, others consist of a suspended floor. Concrete basement slab floor where present. Infill connectors are concrete column, beam, and slab framed structures. Lateral system likely relies on perimeter and infill CMU walls plus contribution from concrete moment frames or shafts at newer infill structures. It appears the uppermost level floor was added later, consisting of perimeter masonry bearing walls with steel beams and precast concrete roof planks. Perimeter masonry bearing walls, particularly at uppermost level, exhibit many areas of diagonal shear cracking and out of plane movement at the perimeter top layer where steel beam framing system bears. Cracks and deterioration are also present in masonry perimeter walls at ground level.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer which feeds a 208/120V, 2000A switchgear (720kVA capacity). Switchgear appears to be relatively new; however, branch equipment appears to be fairly old. Emergency and normal equipment are co-located in the main electrical and are intended for emergency loads only. There is an emergency power feed to Sackett from the main electrical room.

HVAC: The buildings are served from the low-pressure steam system, which feeds radiators, unit heaters and air-handling units distributed through the building. Cooling is provided locally via small chillers, direct-exchange units, and in Unit A from the chilled water loop in Hammond. Ventilation and exhaust are provided by operable windows and exhaust fans on the roof. Generally, the systems are in poor condition with minimal control of temperature.

Plumbing: Incoming water to Unit A has new meter and duplex RPZ backflow devices. First floor restrooms have been renovated. Domestic hot water supply was unclear—a small instantaneous steam heat exchanger was found in the basement of Unit B, installed in 2011 and believed to serve all units. New emergency fixtures are evident in Unit B basement with mixing valves.

Fire Protection: The buildings are fully sprinkler protected. Did not observe any standpipes. Incoming source of fire protection water could not be found. Stairs are partially sprinklered. No fire department connections on face of building. No flow control assembly by floor, but likely by building unit. Generally, sprinkler system appeared in good condition.

ELECTRICAL ENGINEERING WEST

Year Built: 1938

GSF: 80,017

ASF: 44,013

Efficiency: 55%

Current Programs: Laboratories, Clean Room, Classrooms, Offices

Floor-to-Floor Heights:

L3-Roof: 12' - 5"

L2-L3: 13' - 0"

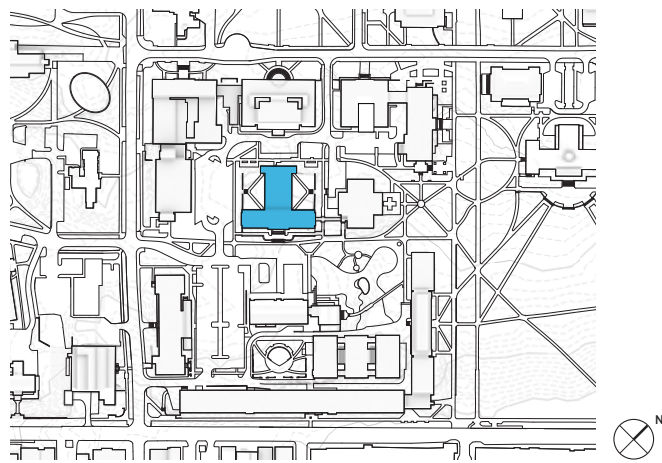
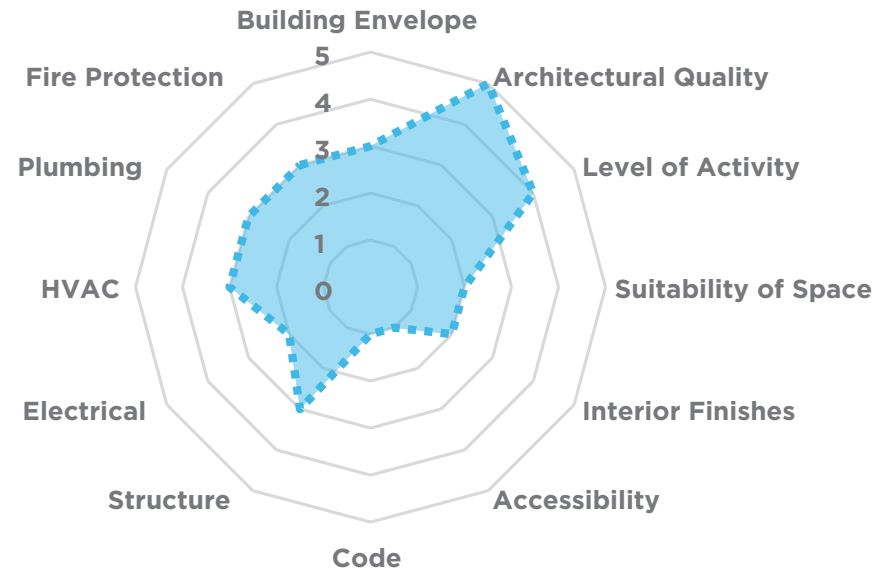
L1-L2: 15' - 0"

LL-L1: 14' - 0"

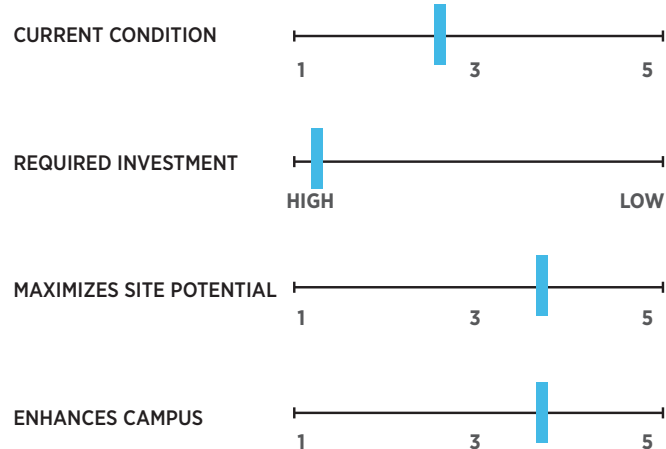
Estimated Current Value: \$35.9 million

10-Year Total Renewal Needs: \$19.0 million (53%)

Highest and Best Use: Research Labs, Teaching Labs, Offices, Classrooms



Location Plan



South Façade of Electrical Engineering West

Building Envelope: EE West is a 4-story masonry building with a full basement and partial 3rd floor. The building is red clay brick with a limestone and concrete base with classic ornamentation details. The brick is in good condition, with some need for repointing. The limestone base is stained in places. The windows are double-glazed with steel frames and internal blinds (installed 1980). The entrances have replacement doors, but in other areas the exterior doors need replacement. The roof is in poor condition with evidence of ponding and reports of leaking.

Architectural Quality: EE West was designed by Charles Klauder and has historic significance for the Penn State campus. The building is high quality and an asset to the campus.

Level of Activity: Observed a moderate to high level of activity in the building especially in the lobby spaces, which have tables set up for student work.

Suitability for Programs: EE West contains two perchlorate acid hoods and an RODI system in the basement. The building is adequately suited to wet labs; however, it is hard to imagine that the building design adequately supports the air changes required for a cleanroom. Corridors are 7'- 11" wide.

Interior Finishes: Flooring is in adequate condition, but the ceilings are in poor condition and need replacement. The facility would benefit from new paint, lighting, and carpet. The first-floor terrazzo floor is in good condition. Some original Art Deco details are still evident at the main stair and central lobby. Many of the interior doors appear original and should be replaced.

Accessibility: The building has one accessible entry at the southeast entrance, and accessible restrooms on 3 floors. Signage is not accessible. Door hardware on many doors is not accessible. Drinking fountains are not accessible.

Code: The stair rise / run (7" and 11") is code-compliant. The stair handrail and guardrail are not compliant: handrail height: 28"; guardrail: 35" (but often missing). The building has some sprinklers (clean room, main stair opening) but is not comprehensively sprinklered.

Structure: The structure consists of masonry bearing walls and concrete framed floors with interior masonry stair shaft walls. Concrete slab at basement floor. Lateral system likely relies on perimeter and infill CMU walls. Roof system not visible but likely to be metal decking.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer which feeds a 480/277V, 2000A switchboard (1662kVA capacity). 208/120V distribution is fed from a 750kVA transformer. Distribution equipment is generally from 1992 and appears to be in working condition. Branch equipment appears to be old and should be replaced. Emergency and normal equipment are co-located and are intended for EM loads only.

HVAC: The building is heated and cooled using the central low-pressure steam and chilled water systems, respectively (refer to Reber for more details). Shell-and-tube heat exchangers and pumps are located in the basement. Ventilation is provided by three air-handling units, two on the roof and the other internal to the building. The roof unit is rusted in many locations. Additional cooling is provided locally by air coolers and split units. Dedicated exhaust ducts and fans are provided for fume hoods, two of which have been installed recently.

Plumbing: A shared 6" fire and domestic water supply feeds a 3" domestic water system with duplex RPZs. An aged Patterson Kelly 4 steam heat exchanger serves the domestic hot water. A RODI pure water system in the penthouse, together with a vacuum pump and air compressor, are all in reasonable condition. The majority of other piping in the building and other equipment is old. The plumbing fixtures have been renovated.

Fire Protection: The building is provided with a Class I standpipe system with hose valves in each egress stair. Water supply to the system is shared with the domestic water main. A few cleanrooms in the basement are sprinklered, and in the southeast stair, flow control assemblies are visible serving floors. However, very few sprinklers were found and generally no sprinkler protection appears to be provided.

ELECTRICAL ENGINEERING EAST

Year Built: 1964

GSF: 49,660

ASF: 31,140

Efficiency: 63%

Current Programs: Dry Laboratories, Classrooms, Offices

Floor-to-Floor Heights:

L3-Roof: 11' - 4"

L2-L3: 11' - 0"

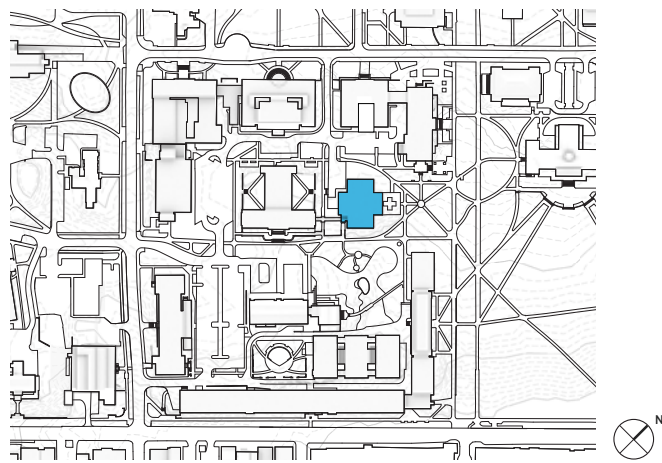
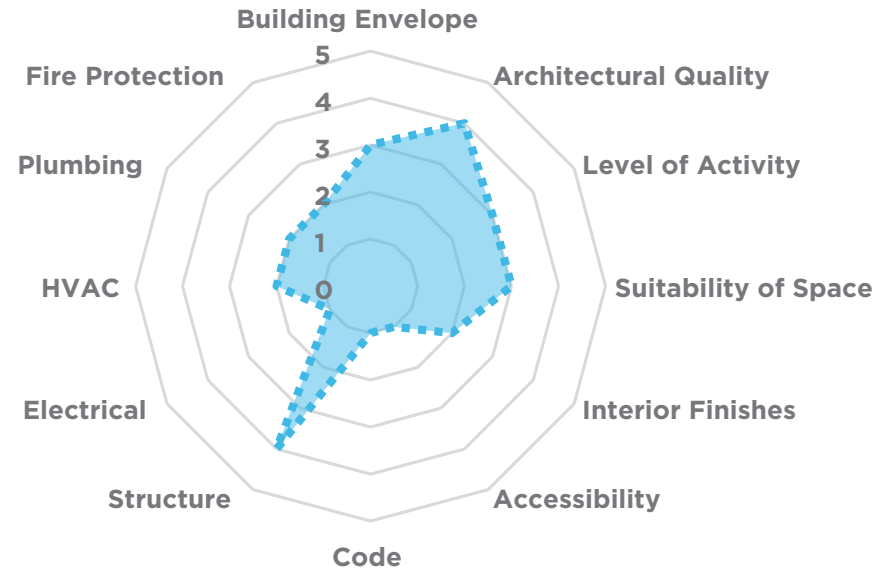
L1-L2: 11' - 0"

LL-L1: 11' - 7"

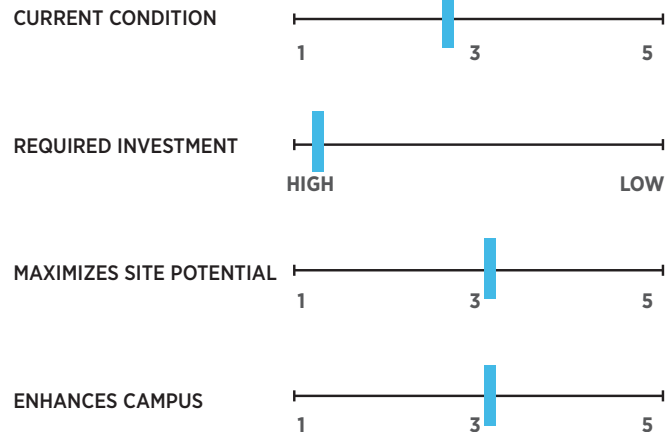
Estimated Current Value: \$16.4 million

10-Year Total Renewal Needs: \$8.0 million (49%)

Highest and Best Use: Offices, Classrooms



Location Plan



Entrance to EE East

Building Envelope: EE East is a 4-story concrete frame and brick infill building with aluminum curtainwall and windows. The concrete and masonry are in good condition, with some repointing needed. The curtainwall and windows are original and single glazed; the exterior doors need replacement. The roof is in good condition.

Architectural Quality: Though seen as a campus detractor, due in part to the prevalence of window air-conditioning units, the original building is of reasonably good quality, and could be renovated as an asset to the campus.

Level of Activity: The building was observed to have a moderate level of activity.

Suitability for Programs: This building is suited to classrooms, offices, and studio spaces. The building is not well suited to lab space as the floor-to-floor heights are too low. The dock has a small lift and it is not adequate for research purposes. The corridor layout is inefficient, but the space itself is pleasant.

Interior Finishes: The interior finishes are in moderate to good condition. The original terrazzo floor and glazed ceramic wall tile are in good condition, and the facility appears to have been recently repainted. The central stair is a classic 1960s design and is an attractive feature, though unfortunately enclosed in wire glass. Presence of asbestos is suspected in the 9-inch vinyl floor tiles. In general, the ceilings need replacement.

Accessibility: The building has some accessible features that include a wheelchair ramp to an accessible entrance with door operators and an elevator. However, the elevator appears to be too small to meet current accessibility standards. There are accessible restrooms on the first floor. Upper floor restrooms, water fountains, and door hardware are not accessible.

Code: The stair rise / run: (7" and 10.5") is not code-compliant. The stair handrail and guardrail are not compliant: handrail height: 32"; guardrail: 42" (but often missing). Openings in the railing system are not compliant. The building is not sprinklered.

Structure: The building structure consists of concrete frame with infill CMU partition walls. Concrete slab at basement floor. Exterior cladding consists of masonry and precast concrete. Lateral system likely relies on concrete moment frames and/or infill shear walls. Concrete structure appears in good condition with some minor cracking in basement slabs.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer which feeds a 480/277V, 1600A panel (1329kVA capacity). The main switchboard is a mix of very old and new components and should be replaced. Branch equipment appears to be old and should be replaced. Emergency and normal equipment are co-located and are intended for EM loads only.

HVAC: The building is heated and cooled using the central low-pressure steam and chilled water systems, respectively (refer to Reber for more details). Shell-and-tube heat exchangers and pumps are located in the basement. The distribution steam and chilled water piping is accessible via a partial height basement / crawlspace. Most of the central equipment is original to the building including ventilation systems. The chilled water connection was added recently but does not serve the whole building. A mix of local direct-exchange units, dry coolers, and individual room ventilators are distributed around the building.

Plumbing: A shared incoming water supply with the fire protection system branches off and is then metered with an RPZ backflow preventer. The steam heat exchanger appears to be in reasonable condition. The restrooms are old, and fixtures are not the water saving type. The piping within the building is likely old and replacement should be considered.

Fire Protection: A shared incoming water supply that also feeds the plumbing to the building is provided. A double detector check valve is provided, and the piping then serves a wet standpipe system throughout the building's stairwells. The building is not sprinkler protected. The piping is not new but appears to be in reasonable condition where visible.

HALLOWELL

Year Built: 1987

GSF: 35,491

ASF: 17,984

Efficiency: 51%

Current Programs: Wet Laboratories, Classrooms, Offices

Floor-to-Floor Heights:

L4-Roof: 12'- 10"

L3-L4: 11'- 10"

L2-L3: 12'- 0"

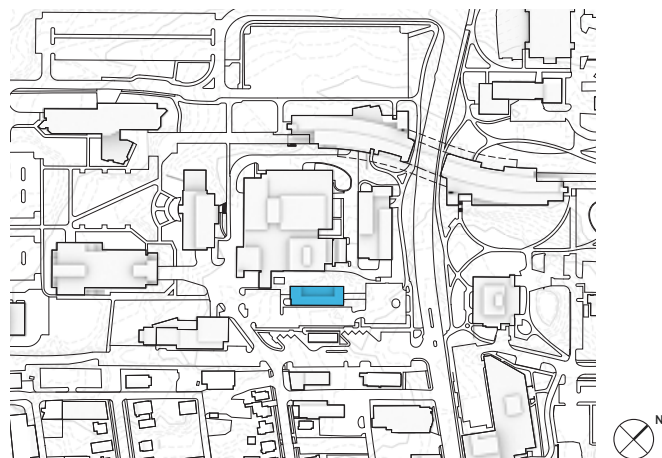
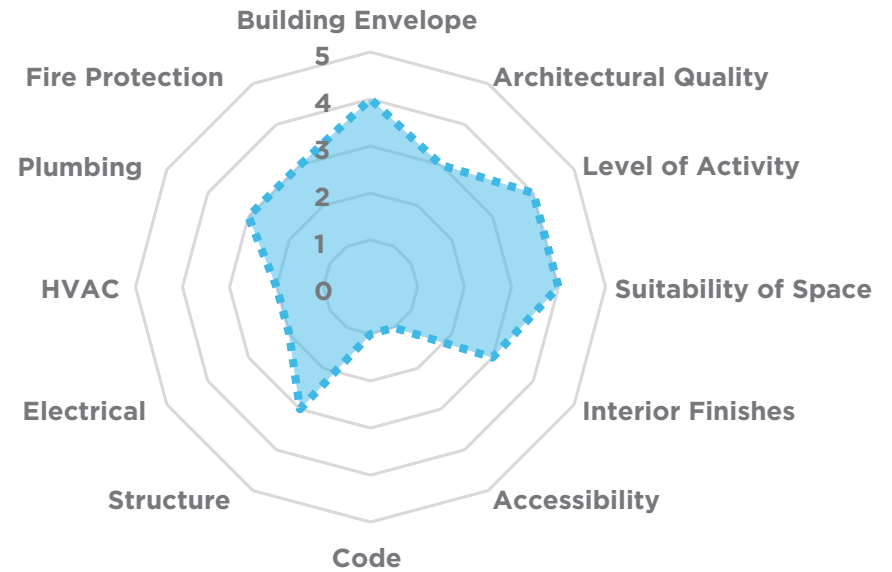
L1-L2: 14'- 9"

LL-L1: 13'- 0"

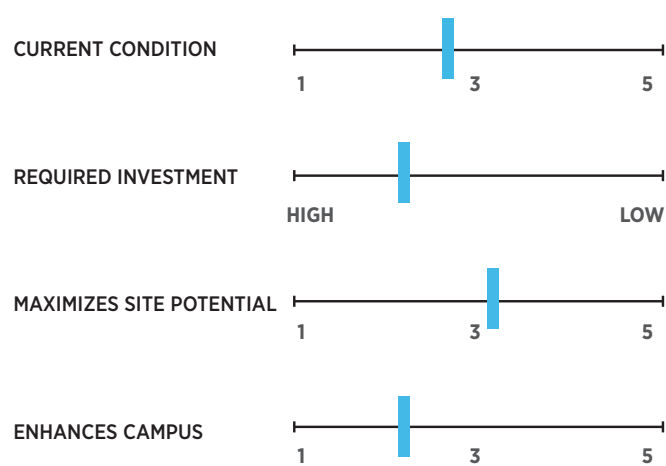
Estimated Current Value: \$18.0 million

10-Year Total Renewal Needs: \$12.2 million (68%)

Highest and Best Use: Research Labs, Teaching Labs



Location Plan



Southeast Corner of Hallowell

Building Envelope: Hallowell is a 5-story masonry building with some areas of curtainwall, but predominantly punched openings. The curtainwall and windows are double-glazed with an operable sash at the bottom. The brick veneer and mortar are in good condition. The high roof and low roof are in very good condition with no sign of ponding or leaking. There is evidence and reports of leaks on the north façade. The exterior doors are in good condition.

Architectural Quality: The building is unremarkable, but it is easy to navigate with its simple organization and clear visibility through the ends of the corridor. The building has good dimensions for labs, classrooms, or office space.

Level of Activity: The building had a moderate to high level of activity, with many people observed working in the laboratories and offices.

Suitability for Programs: The building is fairly well suited to its current program, except for the configuration of the HVAC system, where lab exhaust, other than through fume hoods, appears to be extracted through the corridor. There are a number of wet bench biology labs, though the very heavy concrete walls and structure in the basement would be better suited to laser work, magnetic work, or highly sensitive instruments. The corridor is 6'-0" wide and is narrow for high traffic zones outside of classrooms.

Interior Finishes: The flooring throughout the facility is in adequate to good condition. The ceilings are in poor condition and need replacement. The paint and lighting appear recent and are in good condition. Interior doors are older and merit replacement.

Accessibility: Both entries to the building are generally compliant with current accessibility guidelines, but it is recommended that powered door operators be provided. There is an accessible elevator. Door hardware is mostly

non-accessible. Signage is not accessible. Drinking fountains are not accessible. Restrooms are not accessible and alternate genders from floor to floor. At minimum, one accessible unisex restroom should be created on each floor.

Code: The stair rise / run (7" and 11") is code-compliant. There are no fire sprinklers. System appears to draw air from the labs through the corridor as a plenum return, which is not in compliance with current code and best practices.

Structure: Concrete basement foundation walls and columns. Concrete slab at basement floor. Ground floor over basement consists of deep concrete beams and concrete slab. Upper levels are steel beams and steel columns with composite concrete slab on metal deck at suspended floors plus roof. Lateral system likely relies on concrete / CMU shaft shear walls. Minor cracking at some basement level deep beams supporting ground floor. Roof includes steel framed perimeter structure supporting tall louvers. There is some loss of paint finish exposing the galvanized steel in this perimeter structure.

Electrical: The building is served from an exterior pad-mounted 4.2kV transformer which feeds a 208/120V, 500A switchboard (180kVA capacity). Switchboard appears to be relatively old and is located in a room shared with the elevator equipment; this arrangement does not meet code requirements. Branch equipment appears to be fairly old. Emergency and normal equipment are co-located and are intended for EM loads only.

HVAC: The heating for the building is provided by the campus low-pressure steam system via a shell-and-tube heat exchanger. The hot water serves local reheat terminal units and the air-handling units. Chilled water is generated by a local chiller, which is original to the building. The chiller

uses R-11 refrigerant. The cooling tower on the roof is in poor condition and showing signs of leakage and corrosion. The building is ventilated using a VAV system and was recently upgraded with DDC controls. Fume hoods in the building are provided with dedicated exhaust ducts and fans located on the roof. Most of these fans are showing signs of corrosion.

Plumbing: A metered incoming main with duplex RPZ's is installed. The storage steam water heater and air compressor in the penthouse are both old. An old vacuum pump was found in the basement. All are near the end of their life. No chemical lab waste piping or treatment could be found. Lab waste piping is PVC. There are several sanitary ejectors in the building which appear to be old. Restroom fixtures are adequate but not low-flow.

Fire Protection: The building shares an incoming main with domestic water. A double detector check valve is installed in the main, and the valves are supervised to a central fire alarm system. The piping appears to be new. There is no fire pump. The building has no sprinklers but has a wet manual Class I standpipe in each egress stair—the standpipes are interconnected. Fire Department connections are provided at each end of the building.

EARTH AND ENGINEERING SCIENCES

Year Built: 1998

GSF: 104,753

ASF: 52,467

Efficiency: 50%

Current Programs: Wet Laboratories, Classrooms, Offices

Floor-to-Floor Heights:

L4-Roof: 14'- 3" (to underside of deck)

L3-L4: 14'- 10"

L2-L3: 14'- 9"

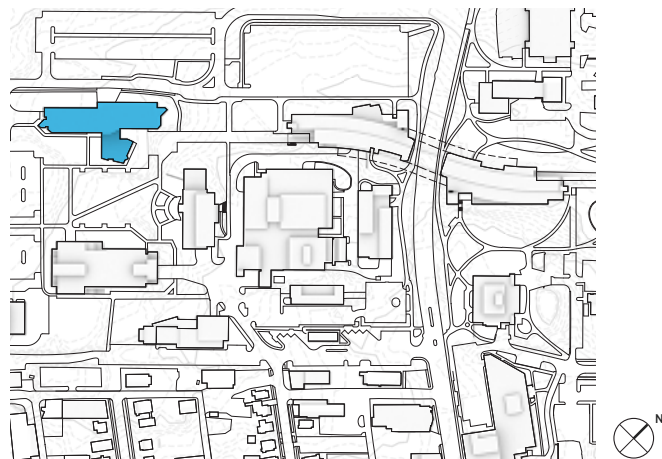
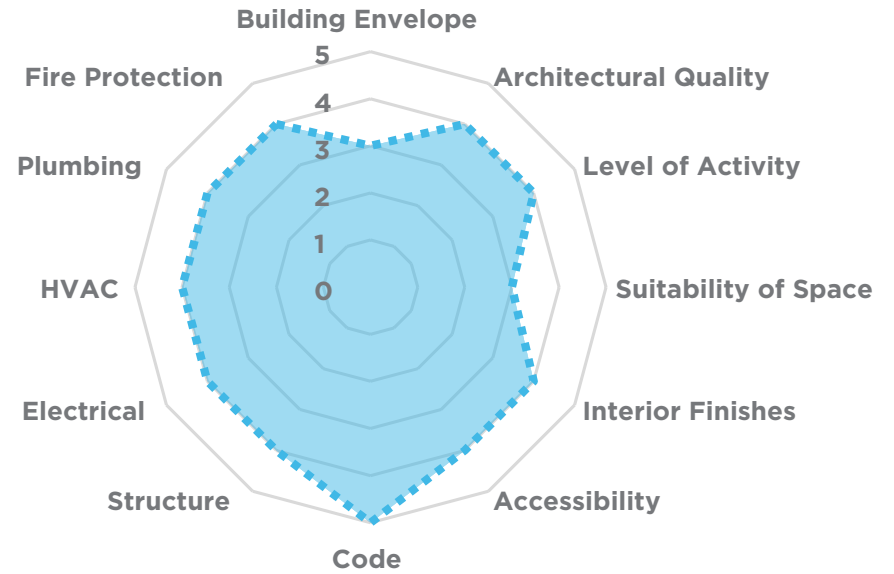
L1-L2: 17'- 3"

LL-L1: not observed

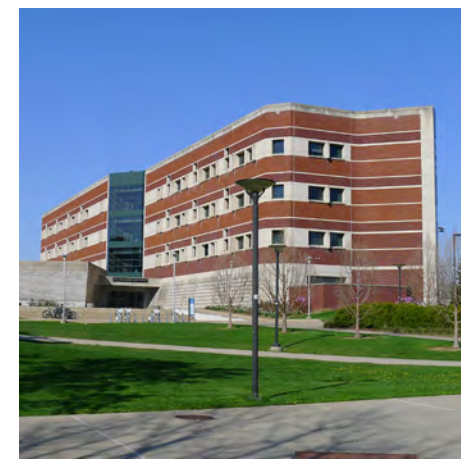
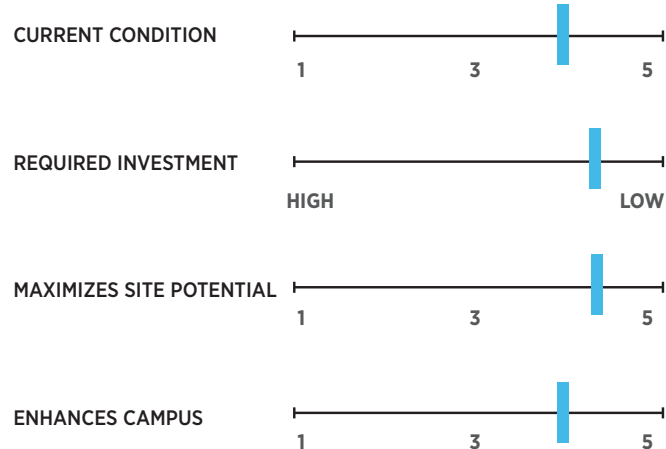
Estimated Current Value: \$51.7 million

10-Year Total Renewal Needs: \$5.4 million (10%)

Highest and Best Use: Research Labs, Teaching Labs



Location Plan



Southeast Corner of EES

Building Envelope: EES is a 4-story (plus basement) masonry building with predominantly punched openings with some areas of curtainwall. The building is veneer brick with precast concrete details and a granite base. There are sloped masonry walls at the base of the structure—in some cases these walls are solid, in other cases they are designed as a brise-soleil. The masonry is generally in good condition with some staining on the precast. Windows are double-glazed, and exterior doors are in good condition. There are coiling doors on every level to allow large equipment to be craned into the building, though the University reports that these are rarely, if ever, used. The roof is in adequate condition. Some locations of sealant on the granite base are failing.

Architectural Quality: The building is of generally good quality and is an asset to the campus. The primary detractor is the opaque “bunker” that houses the lecture halls. This element obscures the most public areas of the building that would otherwise have more visual and spatial connection with the campus quad.

Level of Activity: The building had a moderate to high level of activity with many people observed working in the laboratories and offices.

Suitability for Programs: The building is a good match to the existing programs, though with high floor-to-floor heights, it could house more laboratory space than it does currently. There are pleasant public corridors and lobby spaces throughout the building.

Interior Finishes: In general, the finishes are in good condition. The floors and ceiling are in good condition, the paint needs refreshing. The lighting is good condition. The rubber flooring on the fire stairs is degraded and should be replaced.

Accessibility: In general, the building is accessible. There is an accessible route through the front entrance and an elevator that serves all floors. The bathroom geometries are accessible, though some sinks and hardware need replacement to be accessible. Water fountains are accessible. Signage is in compliance.

Code: The stair rise / run (7” and 11”) is code-compliant. The building is fully sprinklered. No evident code issues were observed.

Structure: The building structure consists of concrete foundation wall and basement with steel column and beam superstructure. Composite slab on deck floors. Masonry infill walls at corridors and concrete bearing walls at elevator/stair shafts. Lateral system likely relies on steel braces/moment frames and possibly elevator/shaft shear walls. Precast concrete and masonry perimeter walls. Small areas of cracking detected at interior partitions.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer which feeds a 480/277V, 2500A switchboard (2077kVA capacity). Distribution and branch equipment appears to be from 1998 and appears to be in good working condition. Emergency and normal equipment are co-located and are intended for emergency loads only. There is an 86kW UPS in the main electrical room to serve the data center.

HVAC: The building is connected to the low-pressure steam system and converts to heating and process hot water via two shell-and-tube heat exchangers. The steam equipment appears to be original to the building. Chilled water is supplied from the campus loop. Five VAV air handling units provide the ventilation and cooling to the spaces. Computer rooms and data rooms have local CRAC units. Fume hood exhausts have been manifolded at the roof and are served by three lab exhaust fans. One separate hazardous exhaust has a dedicated fan. All are roof mounted and were recently installed.

Plumbing: Shared incoming 8” water main serves fire and plumbing. Meter and duplex RPZs are installed. Hot water (not steam) heat exchanger is provided. Central vacuum, 90 PSI compressed air, and RODI pure water system equipment are all in the basement. All appear to be in reasonable condition. All drainage appeared to be gravity-driven without pumps. Restrooms are adequate but no low-flow fixtures.

Fire Protection: A single double detector check valve is provided on the incoming 8” main. Separate automatic sprinkler system and wet manual standpipe systems are provided in the building. There is no fire pump. Flow control assemblies are provided to serve each floor and connected to a central fire alarm system. Fire Department connection is provided on the north side of the building with a hydrant adjacent on the street. Piping appears to be in good condition.

LEONHARD

Year Built: 2000

GSF: 96,781

ASF: 54,856

Efficiency: 57%

Current Programs: Research Laboratories, FAME Lab, Classrooms, Offices

Floor-to-Floor Heights:

L3-Roof: 15'- 0" (to underside of deck)

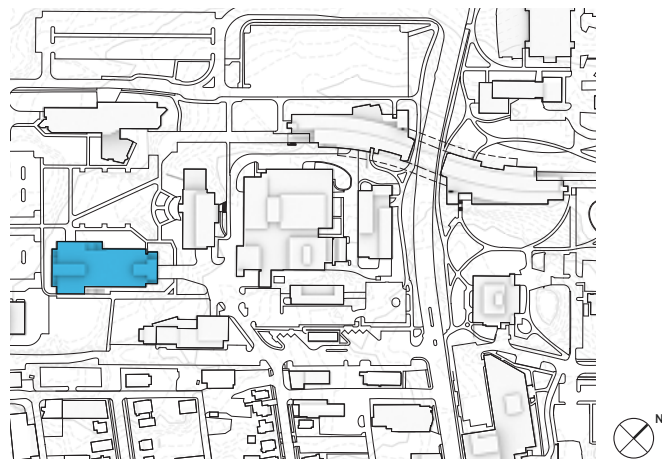
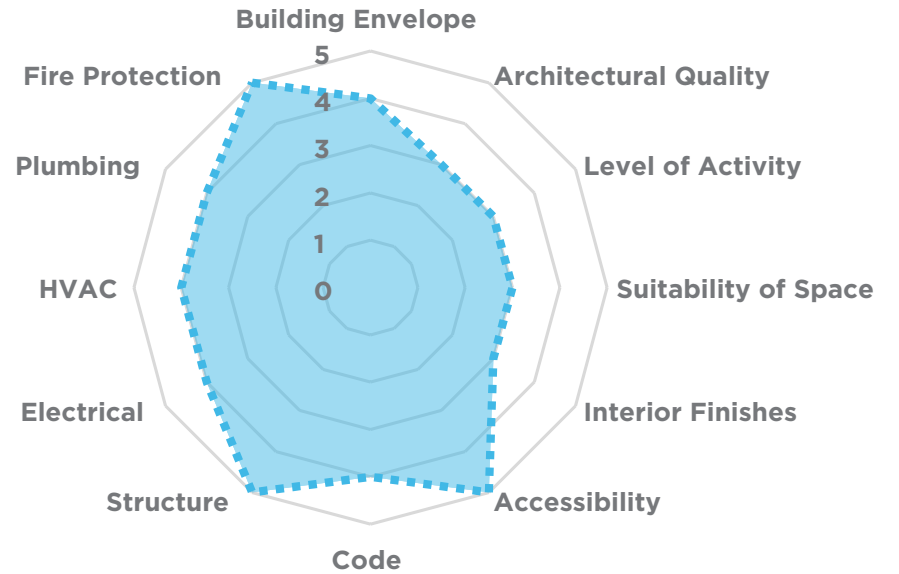
L2-L3: 16'- 4"

L1-L2: 9'-0"

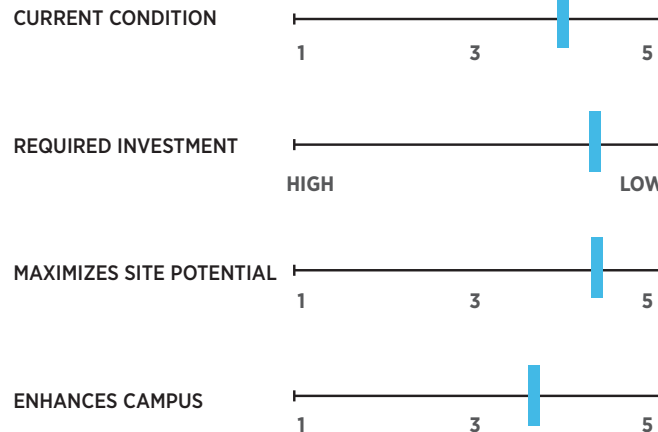
Estimated Current Value: \$45.4 million

10-Year Total Renewal Needs: \$6.6 million (15%)

Highest and Best Use: Research Labs, High Bay



Location Plan



Exterior of Leonhard

Building Envelope: The Leonhard Building is a 3-story brick and cast stone masonry veneer building with a large roof skylight over a 3-story high bay / atrium. The roof is in adequate condition with some signs of ponding and some visible deterioration of the membrane. The brick, precast, mortar, and sealant are in good condition. The aluminum framed windows are double-glazed and are in good condition. Some windows are operable. Exterior doors are a combination of aluminum storefront, flush metal, and coiling overhead doors. All appear to be in good to excellent condition. There is a zone of the building on the 2nd floor with a raised access floor that would need to be addressed if the space is converted to wet labs.

Architectural Quality: The building is of good quality and is an asset. However, a new color palette for the interiors and new furnishings in the corridors and lobbies would enhance the building.

Level of Activity: A moderate level of activity was observed. There are limited gathering and social spaces in the building.

Suitability for Programs: The building seems overdesigned for the current programs. The program is predominantly office and computer lab space with some electronics labs and minimal wet labs. However, high floor to floor design could easily support intensive wet lab uses.

Interior Finishes: The finishes are in good condition. Floors are vinyl tile, carpet, and sealed concrete. The carpet and vinyl tile show some wear, and the concrete has some stains and cracks. The walls are painted concrete masonry or drywall and are in good condition. The majority of the ceilings are lay-in acoustic ceiling panels and in good condition. Interior doors are mostly clear finished solid core wood and in good to excellent condition.

Accessibility: In general, the building is accessible. There is an accessible route through the front entrance and an elevator that serves all floors. The bathroom geometries are accessible, though some sinks and hardware need replacement to be fully accessible. Water fountains are accessible. Signage is in compliance.

Code: The building is fully sprinklered. The primary concern is a strong chemical smell in some public areas.

Structure: The building structure consists of steel columns and beams with composite slab on deck floors. Concrete slab ground level floor. Steel joists and metal decking at roof with stone ballast. Lateral system likely relies on steel braces/moment frames and possibly elevator/shaft shear walls. Interior CMU partitions. Masonry and curtainwall/window façade.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer which feeds a 480/277V, 2000A switchboard (1662kVA capacity). 208/120V distribution is fed from (2) unit substations (225kVA and 300kVA) and a 500kVA transformer for the shop. Equipment is original to the building and appears to be in working condition. Emergency and normal equipment are co-located and are intended for EM loads only.

HVAC: The building is connected to the low-pressure steam system and converts to heating hot water via two shell-and-tube heat exchangers. Chilled water is supplied from an adjacent building. The heating and chilled water pumps are showing signs of corrosion or leakage issues. One chilled water pump has failed, and the pump body had been removed for replacement at the time of the assessment. Six VAV air handling units provide ventilation and cooling to the spaces. Dedicated fume hood exhausts are served by roof-mounted fans. The perimeter heating is not currently provided with local control for temperature.

Plumbing: A 4" metered supply with duplex RPZs is provided. A duplex domestic water booster pump is provided with hydro-pneumatic tank. A steam heat exchanger and storage tank are provided. A circulating domestic hot water system is installed. No ejectors are present. Secondary roof drains are installed. An air compressor for the level 1 machine shop providing 100 PSI air appears to be old. All systems appear to be original to building and in reasonable condition.

Fire Protection: Shared incoming 8" water supply. Double detector check valve and separate sprinkler riser and standpipe risers and roof manifold. No fire pump provided. Fire Department connections are provided. Flow controls to the floors are in very inaccessible locations behind access panels in janitors' rooms and up ladders. System condition appears good.

RESEARCH WEST

Year Built: 1949 (renovated 1970)

GSF: 117,977

ASF: 85,952

Efficiency: 73%

Current Programs: Research Laboratories, Offices

Floor-to-Floor Heights:

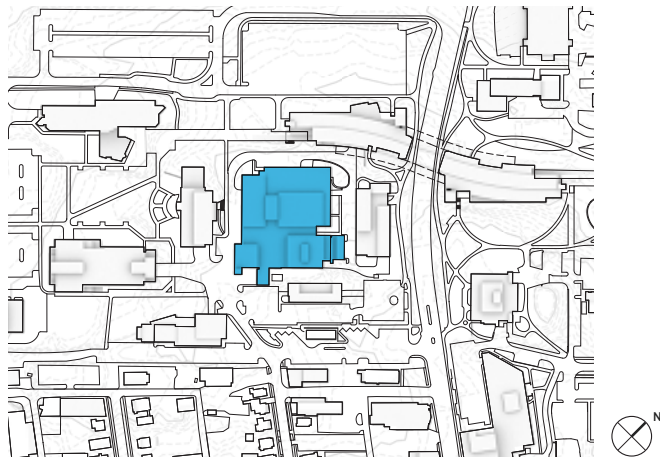
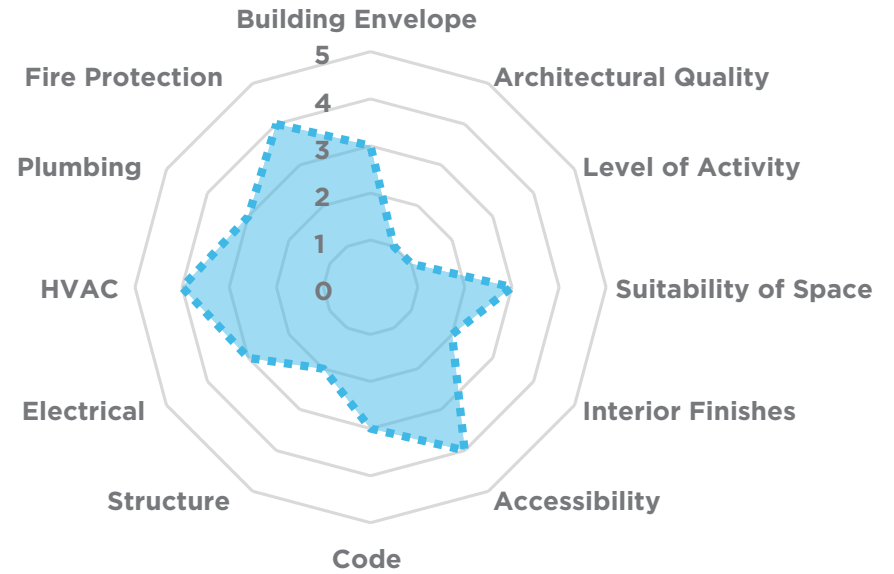
L1-Roof: 13'- 0"

LL-L1: 10'-5"

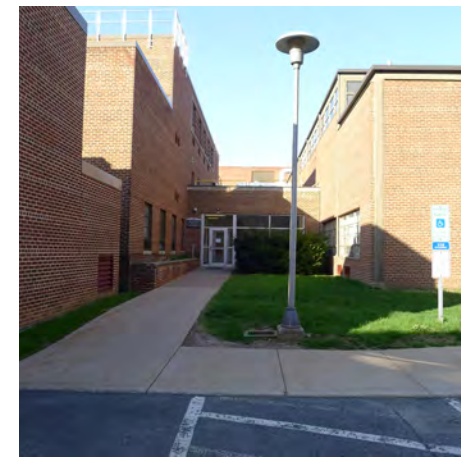
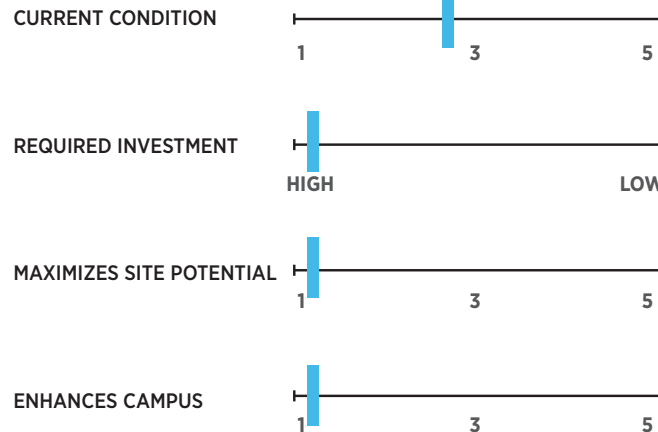
Estimated Current Value: \$61.8 million

10-Year Total Renewal Needs: \$24.8 million (40%)

Highest and Best Use: Research Labs



Location Plan



Entrance to Research West

Building Envelope: Originally designed as a food service facility (kitchen, bakery), Research West is a 3-story brick veneer masonry building with a mixture of steel-framed single- and double-glazed windows. The brick is in good condition with some cracks in the sealant and some mortar degradation on the base and sills. Some repointing is needed. There are new steel doors at the loading dock. The roof system is a mixture of flat built-up and single-ply membrane roofs. The roof is in adequate condition.

Architectural Quality: This building does not have historical significance. The low quality of this building does not reflect its prominent location on West Campus. The building does not establish spatial or visual relationships between interior programs and exterior activity and so fails to contribute to campus placemaking.

Level of Activity: Very few people were observed in the building during visits to the facility.

Suitability for Programs: The facility is well suited to the large equipment labs that require expansive floor areas. A significant investment was recently made to the HVAC system to support wet lab use.

Interior Finishes: The floor finishes are a pastiche of materials including vinyl tile, carpet, terrazzo, sealed concrete, and quarry tile. Presence of asbestos is suspected with the 9-inch vinyl tile. Doors vary in age and condition and many need replacement. Ceilings need replacement, and the building needs repainting.

Accessibility: The building entry is accessible. However, it is recommended that a power door operator be provided. There is an accessible elevator. Door hardware is mostly non-accessible. Signage is not accessible. Drinking fountains are accessible. Restrooms are partially in compliance – the accessible toilet stalls need to be enlarged in most cases to provide the required 5'- 0" circle.

Code: Stair rise / run (7.25" and 11") does not meet current code requirements. Building is sprinklered. Some labs return lab air to the corridor as a plenum, which is not in compliance with current code and best practices.

Structure: Several phases of construction and materials ranging from steel columns and beams with hollow metal plank roofing, to concrete beams and precast concrete planks. Masonry perimeter walls and infill masonry or CMU walls. Tall metal silo structure clad with hollow metal planking facade. Lateral system likely relies on mix of perimeter and interior infill walls with possible steel bracing (difficult to determine due to extensive cladding/finishes). Some deterioration from deicing salts visible at ground perimeter foundation walls at loading dock area and signs of water leakage and peeling paint at roof of double height lab space. Visible portions of superstructure do not show any severe deterioration but mixed nature construction includes systems that are generally of lower quality than typical classroom and lab buildings.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer which feeds a 480/277V, 2500 switchboard (2077kVA capacity). 208/120V distribution is fed from a 4000A switchboard (1440 kVA capacity). Main equipment was installed in 1991, with a significant addition in 2012. Many branch panels are older and should be replaced. Emergency equipment is separated and is intended for EM loads only.

HVAC: The building is supplied with low-pressure steam and chilled water from the campus systems. Plate-and-frame heat exchangers separate the campus and building chilled water systems, and shell-and-tube heat exchangers convert the steam to heating hot water. Process chilled water has a separate heat exchanger and distribution system. The heating is split between two sections of the building and fed from separate mechanical rooms at opposite ends of the building. Ventilation is provided by packaged roof air-handling units, fan coil units, and VAV with reheat. A recent renovation of the building also replaced the controls with a Siemens EMCS. The major renovation project also manifolded the lab exhaust system and installed a heat recovery run around system.

Plumbing: Two incoming water services were found. North: incoming 3" water meter and duplex RPZs are provided on the incoming main. A new steam heat exchanger and duplex circulation pumps are provided. South: incoming 2" meter and duplex RPZs are provided. An old steam heat exchanger is provided. Both mechanical rooms have sanitary ejector pumps. Restrooms are adequate but do not have low-flow fixtures.

Fire Protection: Domestic and fire water share a 6" incoming supply. A double detector check valve is provided on the incoming main. The building is fully sprinklered, and fire mains appear to be in good condition. There is no fire pump. Each floor appears to be its own supervised zone with flow switch fed from the lowest level north mechanical room. Some areas have galvanized piping with flow switches. It is unclear if there are pre-action systems. Fire Department connection is present.

WESTGATE

Year Built: 2004

GSF: 186,446

ASF: 90,789

Efficiency: 47%

Current Programs: Classrooms, Offices, Computer Labs, Server Room

Floor-to-Floor Heights:

L2-Roof: 12'- 0"

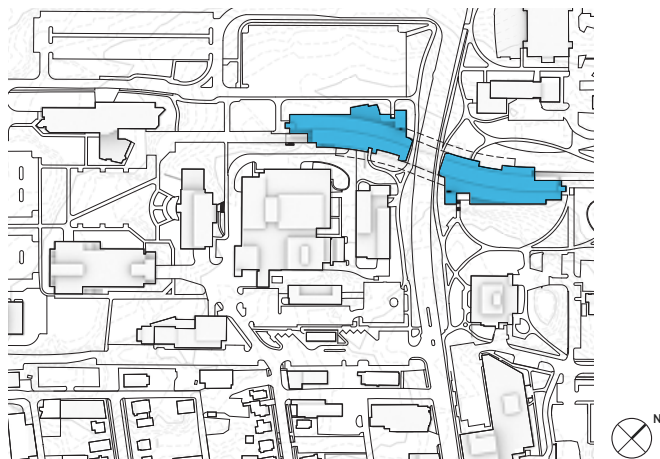
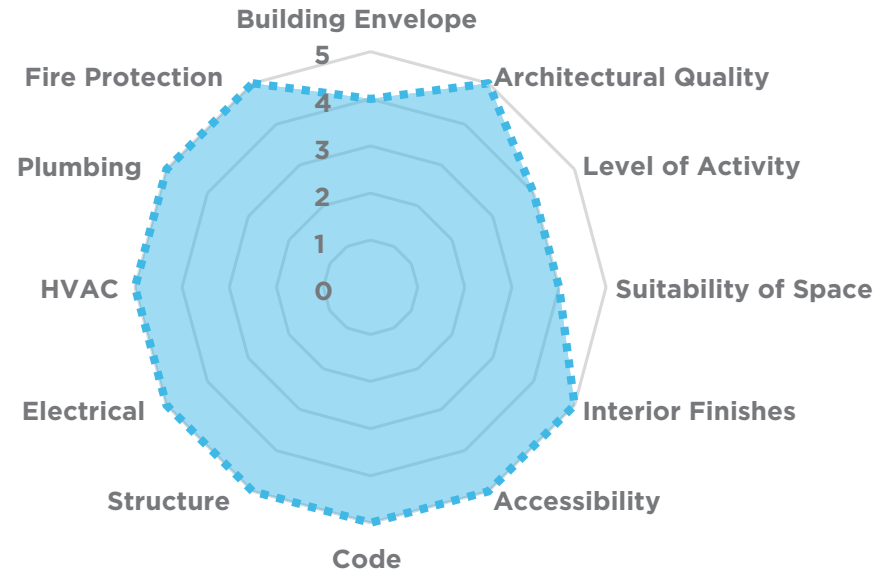
L1-L2: 28'-0"

LL-L1: 15'-0"

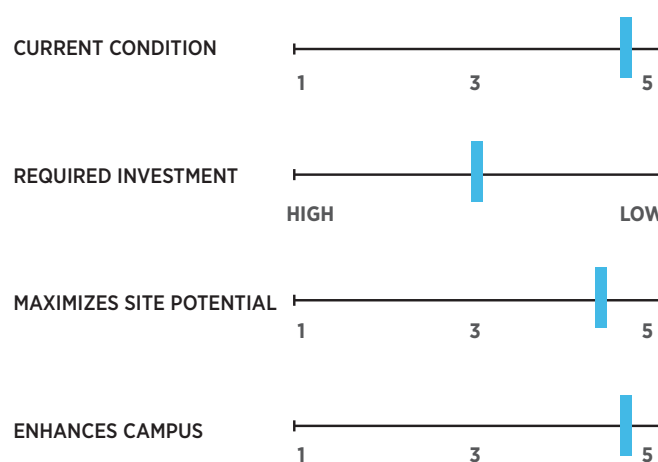
Estimated Current Value: \$58.3 million

10-Year Total Renewal Needs: \$7.0 million (12%)

Highest and Best Use: Computationally-Driven Research, Offices, Classrooms



Location Plan



Entrance to Westgate from the West Campus

Building Envelope: Westgate is a 3-story masonry building that serves as a pedestrian bridge across North Atherton Street. The brick veneer is in good condition, as is the metal panel, curtainwall, and skylights. The single-ply membrane roof is in good condition but shows some signs of ponding and deterioration. There is minor damage to some of the curtainwall fins at the entries. There are some filled cracks on the pedestrian bridge that show evidence of leaking and repairs. The building is double-glazed. The entry doors to the building are in good condition.

Architectural Quality: The building is of good quality, and is an asset to the campus. It plays a valuable role as a connector between the West Campus and the rest of the University and provides strong identity over North Atherton Street, which is a designated state road.

Level of Activity: The building has a high level of activity, with many people observed working in the offices and many students occupying informal spaces as well as offices and classrooms. The first-floor Au Bon Pain café is busy and popular.

Suitability for Programs: The building is well-suited to its current uses, though the high floor-to-floor heights, driven by the building's role as an overpass/pedestrian connector, is considerably more than what the programs require. While the high floor-to-floor heights could conceivably support wet lab use, the building lacks the proper MEP infrastructure.

Interior Finishes: The interior finishes of the building are in excellent condition. The terrazzo is in good condition, and the carpet has been recently replaced. The walls are painted, and the ceramic tile and metal panels are all in good condition. The acoustic panel ceilings and painted ceilings are in good condition. The interior doors are in good condition. The observed conditions of this building were better than any other observed building.

Accessibility: The building is fully accessible by current standards. The only concern is that because of the length of the building, some spaces are a long distance from the elevator.

Code: The stair rise / run (6.75" and 12") is code-compliant. The building is fully sprinklered. There are no apparent code issues.

Structure: The building structure consists of steel-framed superstructure over concrete foundation with masonry and curtainwall facades. Floors are likely composite slab on deck, and roofs are metal deck. Lateral system likely relies on steel braced or moment frames. Interior structure and supported finishes are in good condition as expected for a recently completed building. Exposed concrete topping of main bridge/walkway exposed to exterior shows cracking but this is deemed to be non-structural.

Electrical: The building is served from an exterior pad-mounted 12.47kV, 1500kVA transformer which feeds 480/277V to (2) 2000A switchboards, east and west (1662kVA capacity each). 208/120V distribution is fed from several transformers in each of the main electrical rooms. All equipment is original and appears to be in working condition. EM and optional standby feeds are also provided and co-located with normal equipment.

HVAC: The building is served by the campus steam and chilled water systems. A pressure-reducing valve station and shell-and-tube heat exchangers convert to heating hot water, and steam is also used for humidification. Chilled water is distributed through two secondary loops at different temperatures to serve the chilled beam system and air-handling units. Multiple air-handling units provide ventilation to zones of the building, and the building utilizes Siemens controls.

Plumbing: Incoming water supply is 3" meter with RPZ backflow preventer. A domestic water booster pump is provided and appears to be very corroded. Domestic water heating is achieved with localized electric storage heaters around the building due to long horizontal distances. All drainage is gravity with one exception in the west mechanical room, where a small ejector pumps floor drains only. Restrooms are fairly modern with some sensor flushometers.

Fire Protection: Shared incoming 6" fire main. A double detector check valve is provided, and with 80 PSI after the valving, no fire pump is provided. Separate automatic sprinkler system and wet manual Class I standpipe system are provided throughout the building. Pre-action system is assumed at basement server room. Floor zoning could not be determined. All piping appeared to be in good condition as would be expected for a building of this age.

ENGINEERING SERVICES

Year Built: 1985 (2007 Expansion)

GSF: 17,100

ASF: 14,515

Efficiency: 85%

Current Programs: Shops / Fabrication (including Learning Factory), Classrooms, Offices

Floor-to-Floor Heights:

L1-Roof: 15'- 8" (at shop)

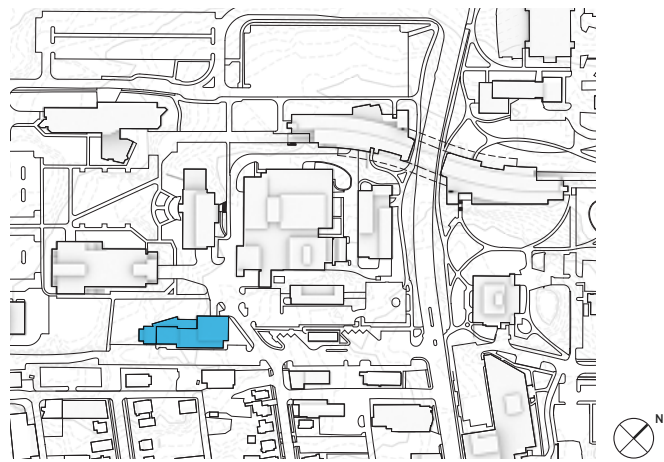
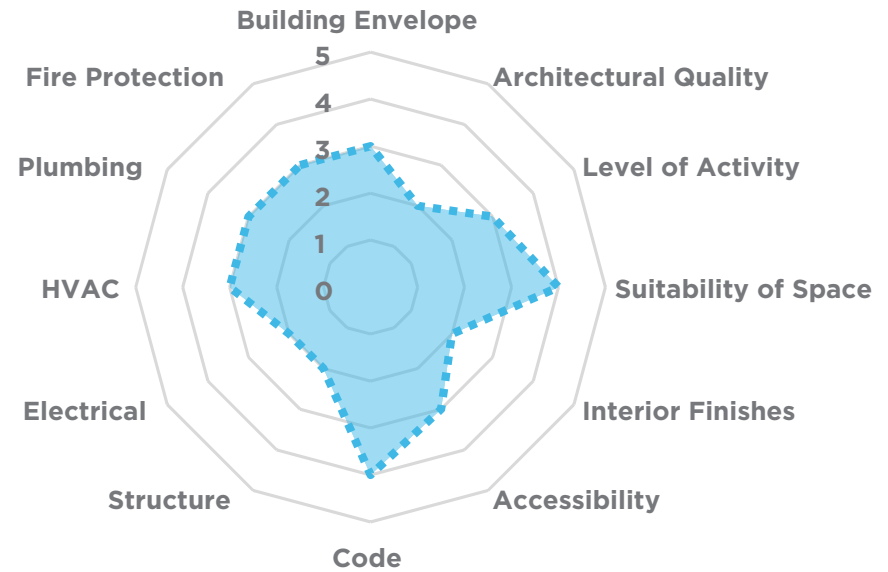
L1-Roof: 15'-1" (at Learning Factory)

L1-Roof: 11'-3" (at entry addition)

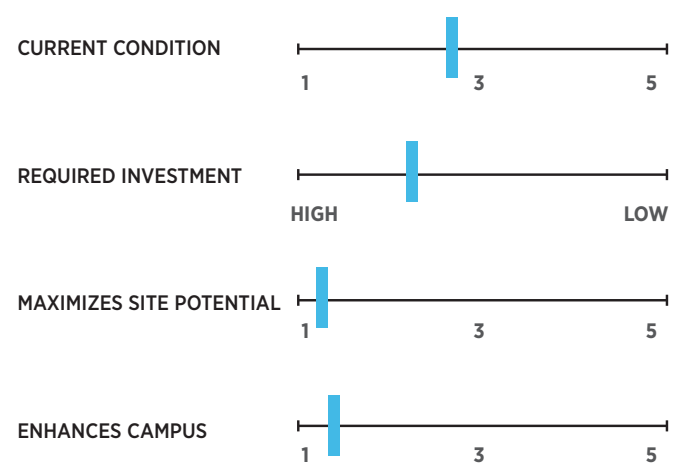
Estimated Current Value: \$5.6 million

10-Year Total Renewal Needs: \$2.0 million (36%)

Highest and Best Use: Shops / Fabrication



Location Plan



Entrance to Engineering Services

Building Envelope: Engineering Services is a one-story masonry building with brick veneer. The brick is in acceptable condition with some areas requiring repointing and re-caulking and many areas needing power washing. The roof is in good condition with no visible ponding. Some areas of moss were observed on the high ballasted roof.

Architectural Quality: Engineering Services is of low to moderate quality. It serves its purpose as a shop and maker space, but the site could support a much larger facility.

Level of Activity: The building varied in use—the student maker space seemed to have a high level of activity with active student projects arrayed around the space. The professional shop appeared to have a low level of activity.

Suitability for Programs: The building is suitable for the programs housed within it. However, it has been noted that the student shop should be much larger to accommodate the high level of use. Originally the space was designed for the Mechanical Engineering Department, but it has since been expanded to serve the needs of the College at large.

Interior Finishes: The interior finishes are in poor to adequate condition. The VCT flooring and acoustic panel ceilings are worn, as are the cabinetry and tables throughout. The building is in need of repainting.

Accessibility: This facility has some accessible features. There is an accessible entry (however, door operators are recommended). There is an accessible women's restroom and an accessible men's restroom located on the student side of the building. The restrooms on the professional shop side are not accessible. Water fountains are not at accessible heights. Much of the door hardware is not accessible.

Code: The building is sprinklered and appears to meet current code requirements.

Structure: Multiple phases of construction using similar materials. Steel column and beam structure with steel roof joists and metal deck roof. Concrete slab at ground level floor. Perimeter walls are infill masonry. Lateral system likely relies upon the perimeter infill masonry. Stone ballast present on roof. Ground level concrete slab exhibits some cracking. Superstructure does not show any severe deterioration but this type of building system is generally of lower quality than classroom/lab buildings.

Electrical: The building is served from an exterior pad-mounted 12.47kV transformer which feeds 208/120V, 1000A switchboard (360kVA capacity). Some of the branch electrical equipment has been recently replaced, however the majority appears to be old and has surpassed its expected useful life. Emergency lighting is provided by wall mounted battery units.

HVAC: The machine shop is connected to the steam system which serves unit heaters. Three condensate return pump sets are distributed around the building. Roof mounted package units provide cooling and ventilation to the building which is exhausted via roof or wall mounted exhaust fans.

Plumbing: The incoming water was a shared connection with sprinklers. A water meter, disused pressure reducing valve, and RPZ backflow preventer were present. Domestic hot water is provided by an electric water heater in the janitor's closet. Campus air at 58-60 PSI is distributed in the building. Plumbing fixtures are in reasonable condition but are not the water saving type.

Fire Protection: The building is fully sprinkler protected. A shared incoming water supply, enters through an Ames double check valve in the mechanical room. Flow and tamper switches are supervised to a central fire alarm system. The building is a monitored as a single wet sprinkler zone. A fire dept. connection is provided on the outside wall of the mechanical room.

INFRASTRUCTURE

OVERVIEW

Penn State serves the University Park campus with district steam plants, chilled water plants, and electrical substations that serve the extensive network of campus buildings. The current plants are well maintained and supply the needed utilities to the campus. This section of the report will outline existing campus-wide utilities and then discuss the utilities on the Core and West Campus in more detail by utility.

Utilities discussed are:

- Steam
- Chilled Water
- Power
- Tel/Com
- Compressed Air
- Natural Gas
- Water
- Storm System
- Sanitary System

Utility Network: The University owns and maintains the infrastructure that provide services to campus buildings. The network of utility tunnels and piping, connecting to the central utility plants, has evolved haphazardly over long periods of time, and new building projects often require demolition of existing utility lines and construction of new ones. When master planning is occurring on Campus, OPP Engineering Services attempts to consolidate utilities in common utility tunnels and trenches under paved pathways to provide future maintenance access and reduce the need to relocate infrastructure to accommodate future development.

This Master Plan provides an opportunity to consolidate utilities in clearly delineated corridors—tunnels, trenches, or under paved pathways—to facilitate maintenance access and minimize the need to relocate existing infrastructure to accommodate future development.

Many of the existing utilities are direct-buried to save costs in the short term instead of being collected in walkable utility tunnels. Direct-buried utilities must be spread out horizontally so that they can be dug up without impacting other utilities. This approach has several impacts including:

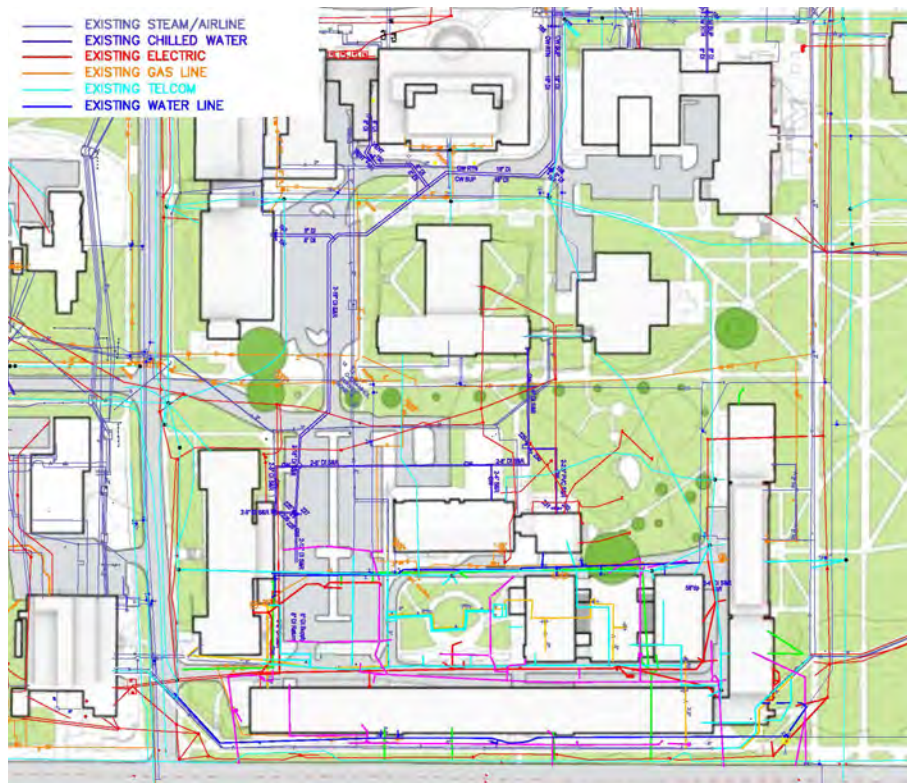
- Large areas of land required.
- Limits location of future buildings and trees.
- Maintenance or modifications to direct-buried utilities are costly and involve digging and campus disruption.

Gravity Lines: Penn State mandates that gravity lines (stormwater and sanitary sewer) should not pass below buildings and should avoid pumping / lift stations unless absolutely necessary. This requirement results in a need to relocate gravity and sewer lines when new buildings are added to the campus. Future planning should strive to outline and respect future building site locations, thus minimizing the need to relocate utilities as the campus expands in the future.

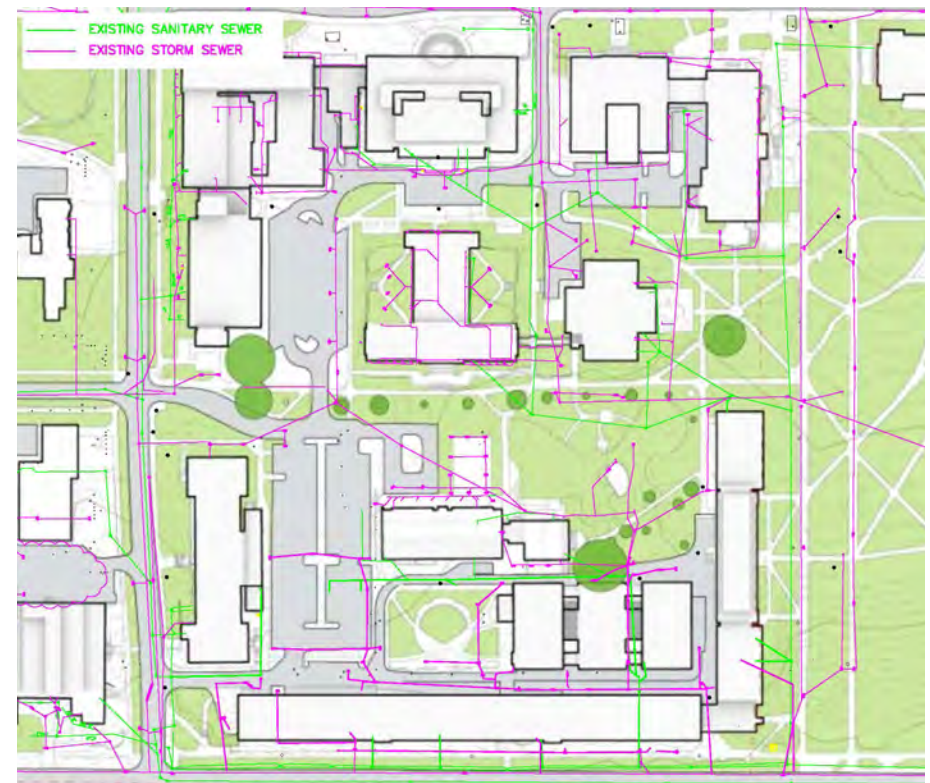
Historic Trees: The locations of heritage trees, heritage grove trees, and trees of significance must be considered when looking at locations for new or relocated utilities to avoid disruption of their root systems.

Coordination and Design: Design of all campus utility work must be closely coordinated with the OPP, Engineering Services, prior to the start of construction documents.

* Reference 1, Refer to Chapter 6



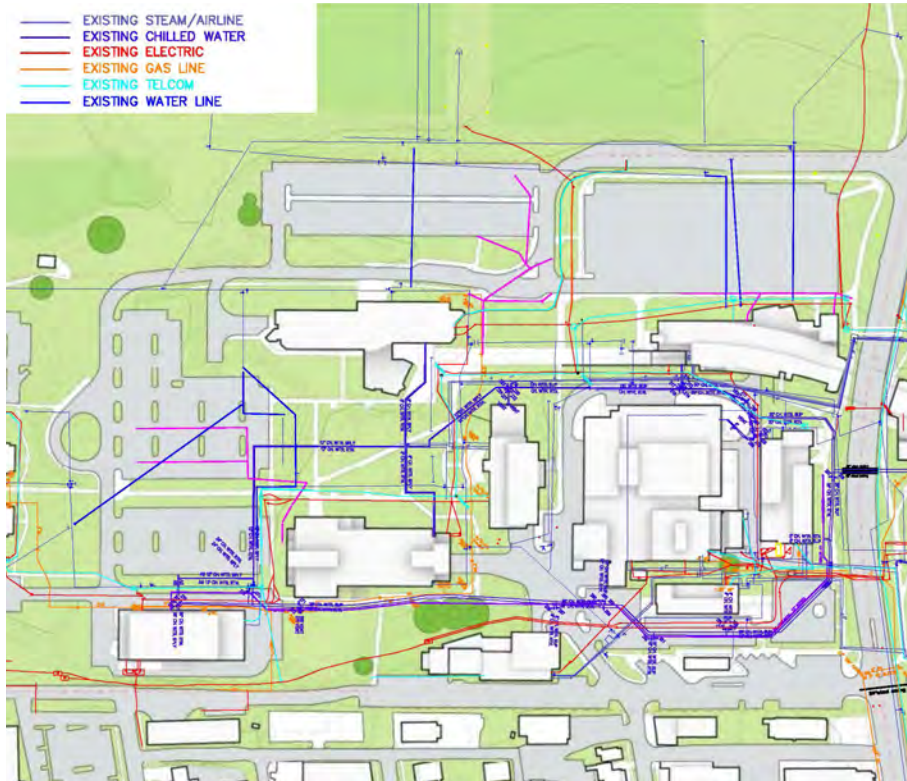
Core Campus Utilities (Steam, Chilled Water, Electric, Natural Gas, Water, Tel/Com)



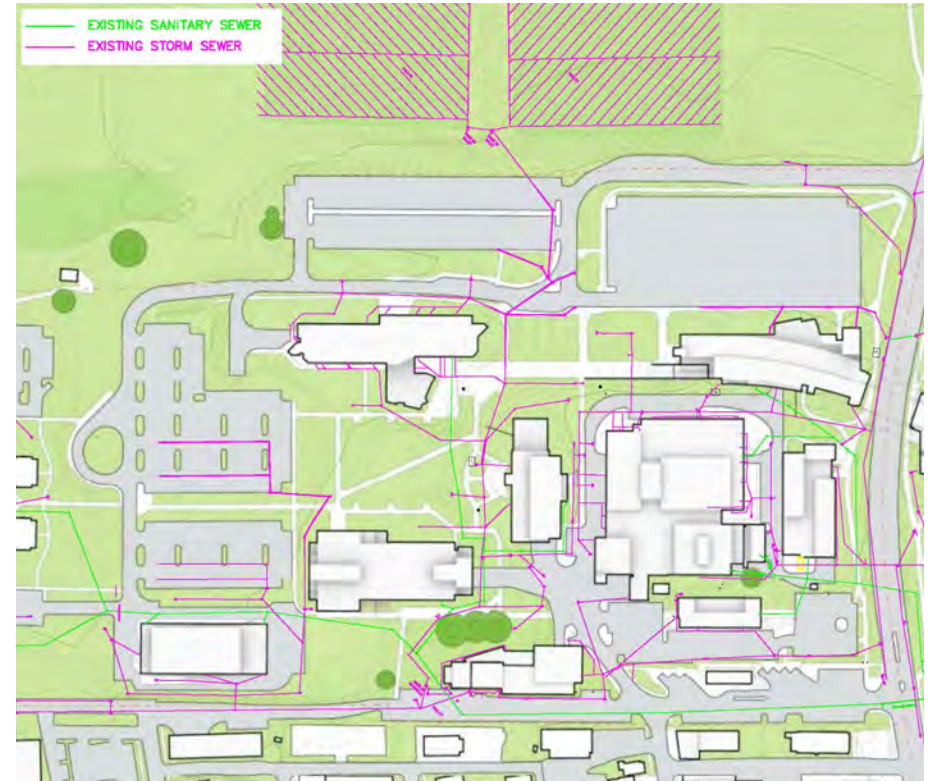
Core Campus Utilities (Storm, Sanitary)

Core Campus Overview

Generally speaking, development in the Core Campus has not had a unified, planned approach with identified utility corridors, with the exception of the steam tunnel under the sidewalk between College Avenue and Hammond. Existing infrastructure, both active and some abandoned, snake around the existing buildings of the Core Campus. The figures above show the locations of utilities on the Core Campus.



West Campus Utilities (Steam, Chilled Water, Electric, Natural Gas, Water, TelCom)



West Campus Utilities (Storm, Sanitary)

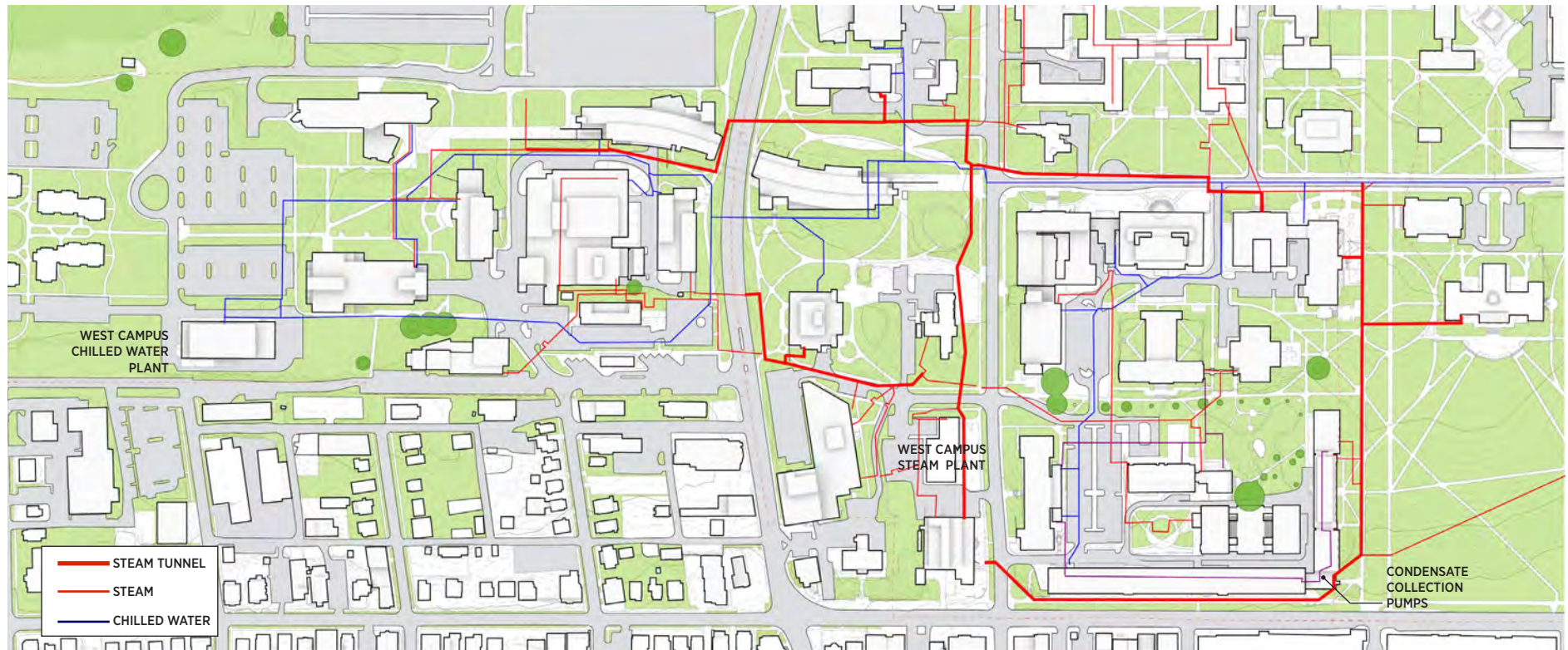
West Campus Overview

Development in the West Campus is generally more recent and is less dense than it is in the Core Campus. Utility locations are more regular, and there are some well defined utility corridors

STEAM

Overview: There are two main co-generative steam and electricity plants, one on the West Campus and one on the East Campus, which supply heat and power to more than 200 buildings on the University Park Campus. In 2016, the campus switched from coal-fired plants to natural gas. Annually, Penn State's District Energy System produces 100% of campus steam and about 20% of campus electrical needs.

West Campus Steam Plant: Two new 150,000 lbs/hr gas fired boilers and one smaller 40,000lbs/hr gas-fired boiler produce superheated, high pressure (250 PSIG) steam for turbines that operate pumps, fans and electric generators. Low pressure (13 PSIG) turbine exhaust steam is delivered to campus for heat and process. Pressure reducing stations take HP steam to medium pressure (150 PSIG) for delivery to buildings further away from the West Campus steam plant.



Steam and Chilled Water Locations

- Steam Capacity: 340,000 pounds per hour
- Electric Capacity: 5 mW
- Plant Efficiency: 50% - 70%

East Campus Steam Plant: Two 1970s vintage dual-fuel 100,000 lbs/hr boilers produce saturated, high pressure (250 PSIG) steam. In addition, a combustion turbine connected to a heat recovery steam generator installed in 2010 has a capacity of 117,000 lbs/hr and produces 7000kW of electricity.

- Steam Capacity: 317,000 pounds per hour
- Electric Capacity: 7 mW
- Plant Efficiency: 80%

Distribution: The 170-PSI system is used for process and heating loads throughout the campus. Process loads include lab use, sterilizers, distilled water, laundry, dining hall use, etc. For heating purposes, this steam is reduced to low pressure at the individual buildings. The 13-PSI system is used for space heating, domestic hot water and absorption chillers throughout the campus. Due to system use and losses, the 13-PSI system only delivers about 5 to 8 PSI to the buildings during heavy load conditions in the winter months.

Steam Condensate System: The steam condensate is gathered at the individual building level by a gravity return system to a building condensate pump. The building pump pushes the condensate into the campus return system. The Central Campus area condensate flows by gravity to the Kunkle Lounge to the east of the Hammond Building, where it is pumped to the West Campus steam plant. The West Campus condensate is returned to the West Campus steam plant via a vacuum assisted pump. A small proportion (approximately 25%) of the campus condensate is returned to the East Campus steam plant by gravity. The average return rate for steam condensate is 75%.

Core and West Campus Steam

The COE-occupied buildings on the Core and West Campus are served from the West Campus Steam Plant, shown in the “Steam and Chilled Water Locations” figure, located between the ARL and Reber Buildings.

Steam Tunnels: A network of steam tunnels and pipes feeds the buildings on the Core and West Campus as shown in the “Steam and Chilled Water Locations” figure. Most of the steam service between the Hammond Building and the Hinz Alumni Center is abandoned and not a factor in the potential siting of future buildings.

Steam Tunnel (A): Runs parallel to Burrows road and contains both low pressure steam (LPS) and high pressure steam (HPS) lines, 18” and 10” respectively. Separate condensate return (CR) lines are also located in the tunnel, a 6” CR for the LPS and a 2” for HPS.

The HPS line extends to just past the Pollock Road intersection where the tunnel turns 90° where it converts down to LPS and heads towards Westgate IST. HPS also extends along Pollock Road as far as the Willard Building.

Steam Tunnel (B): Continues over to the West Campus with a 12” LPS line and 6” CR line crossing under North Atherton Street under the Westgate Building, and between Westgate and Research West, located in a shallow tunnel. This line currently serves Westgate, Earth and Engineering Sciences, Applied Science and Leonhard on West Campus. It is a direct-buried tunnel and the system is too small to serve additional buildings at low pressure.

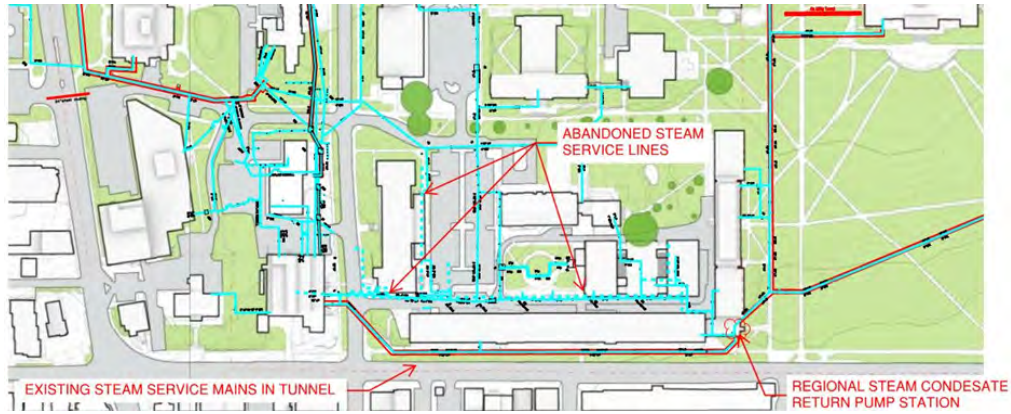
At this time, all of the buildings on the West Campus connected to the campus steam system use low pressure steam, but the services and utility piping were designed for future use with high pressure steam. The steam lines in the tunnel were designed and constructed to allow conversion to HPS in future.

The buildings fed by this line that currently receive LPS would require conversion to HPS, by installation of pressure reducing stations (PRV). A PRV bypass would be required during summer operation when the steam service reduces to LPS.

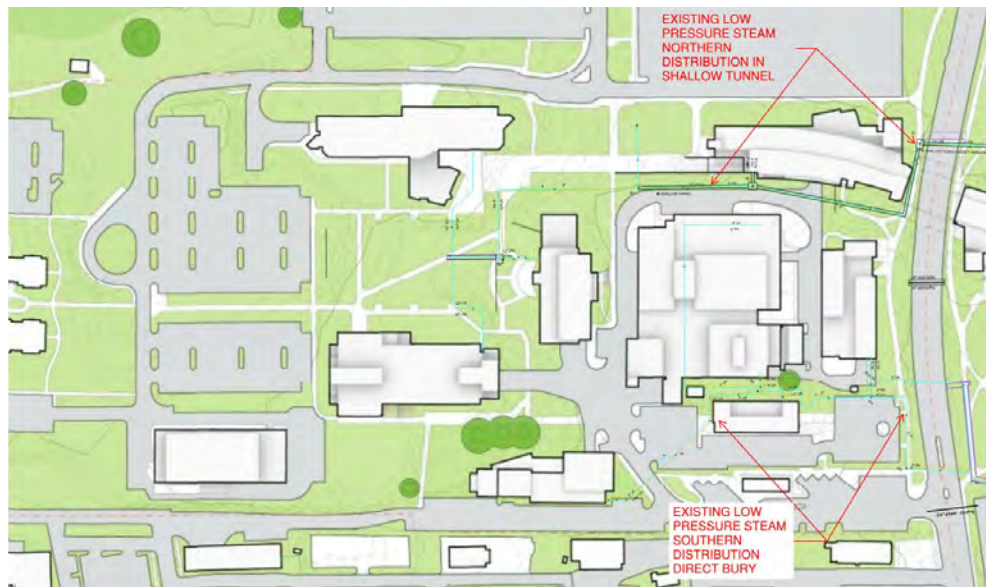
The remaining buildings on West Campus are served by a second line that connects to the Steam Plant via a 10” LPS line with 3” CR, that runs between the ARL and Walker. These buildings are Garfield Thomas Water Tunnel building, Research West, Hallowell and Engineering Services.

Steam Tunnel (C): Runs from the steam plant along West College Avenue south of Hammond, containing two 14” LPS lines, one 10” HPS line and a 6” CR line. This tunnel opens into the basement of the Kunkle where it runs exposed in the mechanical room before continuing in another tunnel in front of Sackett towards Old Main.

The direct feed of steam from the West Steam Plant on Bigler Road serves central campus from a tunnel that runs parallel and south of Hammond passing under Kunkle to Sackett. Within the Kunkle basement is a regional condensate-return pump station that serves a large portion of the campus condensate collection system. Most of the steam service between Hammond and Hinz Alumni Center is abandoned and not a factor in the potential siting of future buildings.



Low Pressure Steam Tunnel Locations on the Core Campus



Low Pressure Steam Tunnel Locations on the West Campus

CHILLED WATER

Penn State has three chilled water plants on campus: West Campus, North Campus, and the Chemistry Building on Shortlidge Mall with a total capacity of 25,300 tons. The chilled water is conveyed through an underground chilled water pipe system to provide space cooling and process cooling capacity to campus buildings. The North Campus chiller plant and Chemistry chiller plant provide 14,200 tons and 3,900 tons respectively.

Chilled water piping has been installed under the campus main road network including: Pollock Road, Shortlidge Road, Curtin Road, Bigler Road and McKean Road. Piping has also been installed from the West Campus chiller plant across Atherton Street. As of August 2017, the Campus Chilled Water System (CHW) serves a total of 9.3 million square feet in 111 buildings; an estimated peak cooling load of approximately 18,100 tons.

Core and West Campus:

As shown in figure “Water Mains on West Campus,” a 7,200 ton chiller plant is located on the West Campus feeding both the West and Core Campus buildings. This plant was visited during the existing conditions surveys and was found to be well maintained with room for expansion to feed future demand on the West Campus.

The West Campus chiller plant has capacity to provide an additional 13,000 tons. There are plans to further expand the West Campus CHW plant to service the proposed Buildings on the West Campus.

Core Campus Chilled Water Distribution

Existing 18” and 12” campus chilled water mains are located behind Reber below the surface parking lot between Reber and Hintz. There are no dedicated chilled water supply and return service laterals for Sackett Building; the chilled water piping for Sackett runs through the basement of Hammond Building and the Kunkle Lounge. This line also feeds the Engineering Units. New building service should be extended to the proposed building sites from the existing campus chilled water mains through the site rather than passing through buildings.

Pollock Road Chilled Water Main: There is a 24” line that crosses North Atherton Street and runs along Pollock Road; this is the largest pipe size that can be accommodated along Pollock Street as the quantity of buried services and tunnels under Pollock limits further increases in size of the CHW lines. Several 18” branch lines feed off the 24” main. One such branch line runs between Steidle and Willard, passes around the west side of Electrical Engineering West and connects to the heat exchangers in Reber.

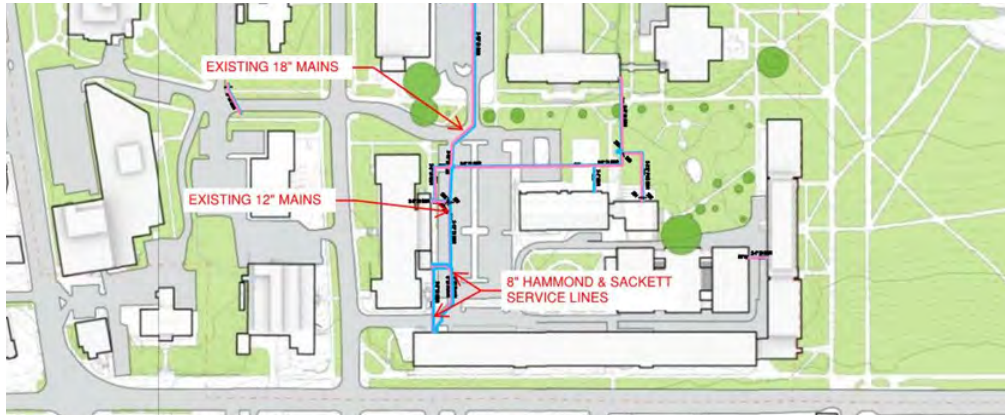
Reber Heat Exchangers: The two heat exchanger plants in Reber provide a hydronic break separating the campus CHW system from the building CHW system. This is a common arrangement for buildings on campus connected to the campus chilled water utility. In Reber the heat exchangers are sized to serve multiple buildings in the vicinity.

West Campus Chilled Water Distribution

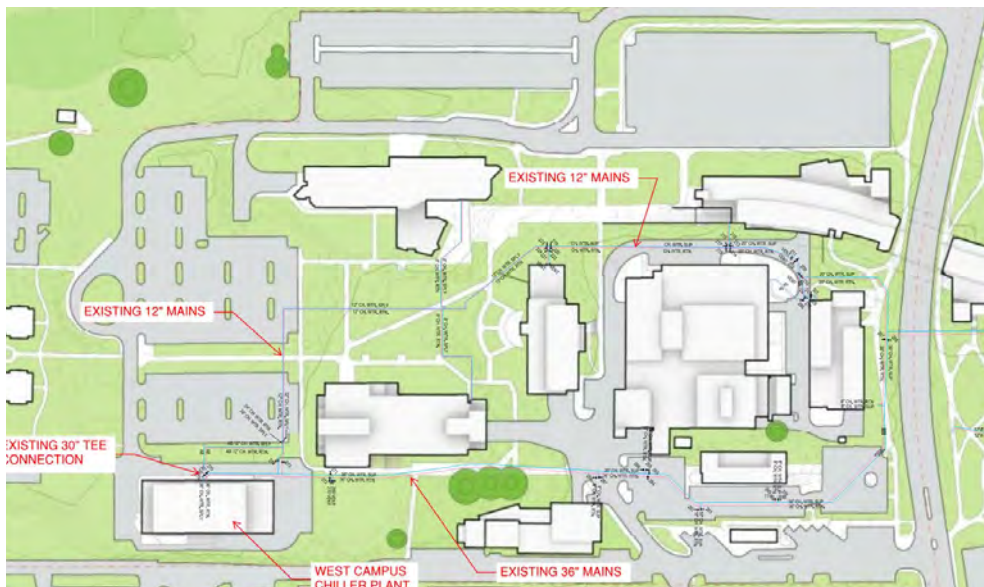
The 36” chilled water supply and return lines run from the West Campus Chiller Plant between Leonhard and Engineering Services past Hallowell then turns towards Westgate. An existing 30” tee connection is available at the plant.

The lines split in front of the Water Tunnel Building to 24” lines that cross North Atherton Street to serve the core campus and 20” lines that loop around between Westgate and Research West.

The CHW lines form a loop around the West Campus. A second set of lines branches off the 36” line running north from the Chiller Plant towards the Earth and Engineering Sciences Building and running down the center of the mall between EES and Leonhard to the Applied Sciences Building. These lines have a 24” connection but the current lines are 12”. The 12” lines connect to the 20” lines at the branch to the Applied Science Building.



Water Mains on the Core Campus



Water Mains on the West Campus

Load Estimates for Steam and Chilled Water in Existing Buildings

For the existing buildings under discussion for this study, Rough-Order-of-Magnitude (ROM) estimates were prepared to understand approximate loads and are not based on detailed calculations or metered data.

Flow rate (gallons per minute of chilled water) information was available for most of the buildings; those in italics and marked with an asterisk (*) did not have information available, and in those cases the tonnage is calculated using 12°F as the supply and return temperature difference.

On the heating side, the load was calculated using 0.1MBH/SF as a benchmark. This was checked against the existing pipe size. If the pipe size did not match the calculated heat load, the max available for that pipe size was used, and the figure then were written in italics and marked with an asterisk. The assumptions were: 10 PSIG steam, and max 12,000 FPM.

	GSF	ASF	Cooling (Ton)	Heating (MBH)	CHW GPM	Pipe size
Core Campus						
Hammond	145093	112489	800	14,400	1,600	8"
Reber	79708	48665	680	7,910	1,360	8"
Sackett	106733	70949	See Hammond	10,600		
Engineering units	100483	57277	See Hammond	9,970		
Elec Engineer West	74576	44013	See Reber	<i>5,770</i> *		
Elec Engineer East	49460	31140	See Reber	<i>3,670</i> *		
West Campus						
Hallowell	35942	17984	Local chiller	3,570	0	
EES	104647	52476	450	<i>22,780</i> *	900	8"
Leonhard	96851	54856	375	<i>22,780</i> *	750	8"
Research West	118547	85952	847	11,770	<i>1690</i> *	12"
Westgate IST	185906	90789	650	11,150	1300	8"
Engineering services	17319	14515	Local DX	1,720	0	

ROM Load Estimates for Steam and Chilled Water in Existing Buildings

POWER

Campus Electrical System—Normal Power: Electricity for the campus is supplied and distributed from four medium voltage West Penn Power substations at 12,470 volts. 23.5 MW of installed transformation reduces the 12,470 volts to 4,160 volts for an older part of the campus and certain chilled water production. All new facilities, as well as newly renovated facilities, are served from the 12,470 volt distribution system. Substations are interconnected to allow for redundancy of sources.

Primary electric service runs through the Core Campus connecting to the existing buildings. Portions of the existing duct banks between the Hammond Building and College Avenue are older terracotta. Along the Old Main Lawn, east of the Sackett Building, conduits are old wood-log conduits. Portions of the existing duct banks running along both the Sackett and Hammond Buildings are located under trees of significance for the campus.

Primary electric service is available adjacent to the proposed building sites on the West Campus. Based on the proposed work, some loads may need to be re-balanced via the existing switches from one substation to another in order to maintain load balance. It is anticipated that new medium voltage (MV) switches will need to be installed to allow new buildings to interconnect with existing MV distribution. It appears that the existing main radial feeds (typically 350MCM 15kW rated) will have sufficient capacity for the new loads, however the sub-feeds from the MV switches installed throughout the site may be beyond capacity if new loads are added.

Anticipated power interruption to integrate new switchgear: Interconnection of new MV site switchgear will require detailed phasing and shutdowns coordinated with campus activities. In many cases, multi-phased cutovers may be required to reduce the duration of planned outages to allow buildings to remain active via the use of the existing backfeeds, or temporary feeds.

A detailed phasing plan will be required in future work phases.

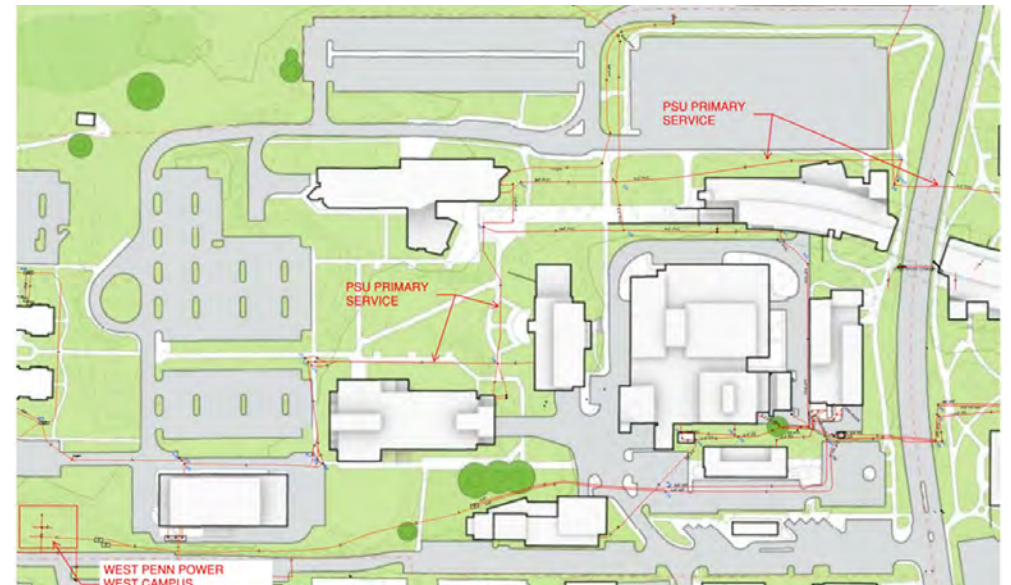
Emergency Power: The emergency power is distributed at 4,160 volts to a significant number of campus facilities from an emergency source in the power plant. Automatic transfer switches at each building sense the loss of normal power and transfer the building's life-safety load to the emergency system. Emergency power is provided by the two back pressure steam turbines in operation at the West Campus Steam Plant and by the Combustion Turbine at the East Campus Steam Plant and also two 2,000kW diesel generators. This emergency and standby power allows Penn State to maintain critical research and allow students to shelter in place during a regional power disruption. These systems are essential to the University's resiliency and sustainability strategy.

No load information has been provided regarding the spare capacity on the generators; however it is likely that upgrades will be required to support the proposed load of the new buildings. No detailed information was provided for the existing emergency power distribution throughout campus, so the capacity of these feeders should also be evaluated to determine any upgrades that will be required to accommodate the proposed program.

Optional Stand-by Power: A stand-by circuit provides power to serve critical research and legally required non-life safety backup power. This circuit will need to be extended to any buildings which require optional standby power.



Core Campus Power Distribution



West Campus Power Distribution

TEL/COM

There is a telecommunications line that runs from the Reber Building to the Sackett Building in a 3-inch wood log conduit. This conduit runs just south of the Alumni Garden and a heritage tree. This service line feeds the Units, Hammond, and Sackett, and continues north and east to service other buildings. Maintaining tel/com service to other buildings must be considered during the construction interim period.

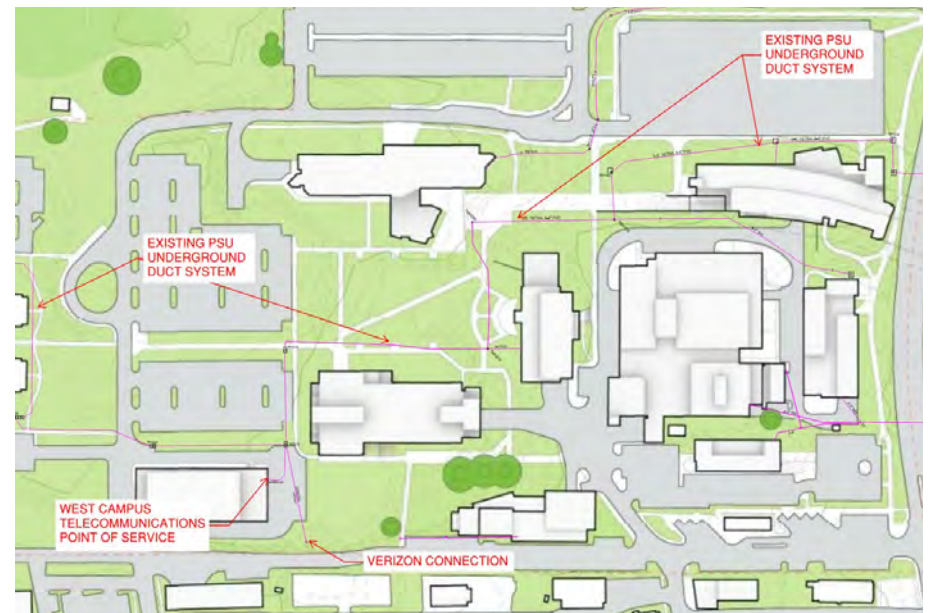
Fiber and copper telecommunications feed the West Campus buildings through a duct bank from the Telecommunications Building hub site via the West Campus chiller. The campus telecom duct bank system will need to be extended from a nearby telecommunications manhole.

COMPRESSED AIR

Control air to main campus (lab quality): 3,000 SCFM @ 70 PSI with a duty, standby and emergency compressor located at each steam boiler plant (East Campus plant and West Campus plant). While Penn State does have a compressed air system, the long-term goal is to decommission this system and use individual building compressors where needed.



Core Campus Tel/Com Distribution



West Campus Tel/Com Distribution

NATURAL GAS SYSTEM

Natural gas is distributed around the campus by an underground system of direct-buried, coated steel pipes. Columbia Gas owns some of the piping and all of the billing meters, while the University owns some of the piping and some sub-meters for billing within the University. The majority of the University-owned lines are at 5 psi, with the exception of some high-pressure gas lines on West Campus and near Physical Plant on the northern part of campus. All of the Columbia Gas-owned lines are at 25 PSI or higher.

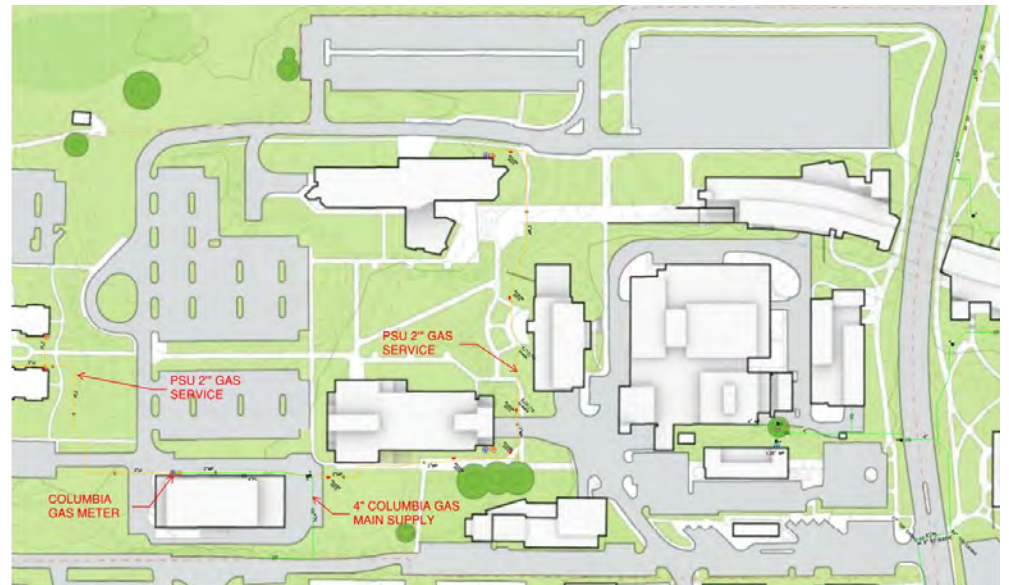
Natural gas is currently serving the Sackett Building and the Engineering Units from a 2" service line located between Hintz Family Alumni Center and the Engineering Units A, B, and C. This line runs just south of the Alumni Gardens and a significant Heritage Tree.

There is a 4" Columbia Gas main supply line in the vicinity of the West Campus Chiller Plant. Two-inch service lines are extended further west to the White Course Apartments and north to the Earth and Engineering Sciences Building. The University is no longer connecting buildings to natural gas services unless the programming for the building requires it.

It is a goal of the University to decommission this system and move towards individual building compressors where needed. New buildings shall take account for the life cycle cost analysis(LCCA) local verse the central systems when considering which approach to adopt. The campus system does not provide clean compressed air therefore may not be suited to some applications.



Core Campus Natural Gas Distribution



West Campus Natural Gas Distribution

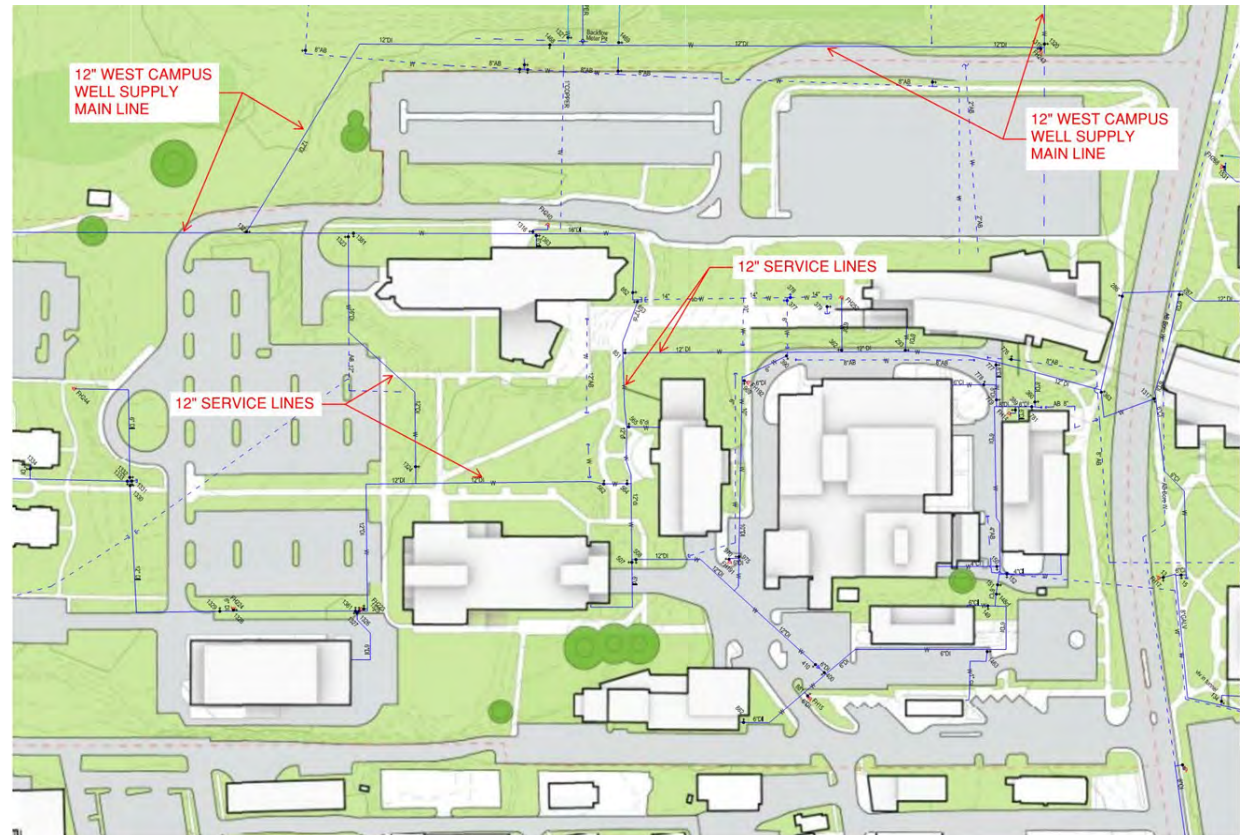
WATER SYSTEM

The **potable water system** on the University Park Campus is owned and operated by the University. There are nine production wells currently in service in two well fields, and each well field has additional production capacity above the daily water demands. The University uses, on average, approximately 2.0 million gallons of water per day. Three above ground water storage tanks have a storage capacity of 3,250,000 gallons, which is over a day's supply. Treatment and monitoring is provided for all wells at a central water treatment plant to ensure that water delivered to customers meets all regulatory requirements.

Water Quality: Both the Big Hollow and Houserville Well Fields' water is hard; Big Hollows water's hardness ranges from 150 to 250 mg/l as CaCO₃, and Houserville water's hardness ranges from 300 to 375 mg/l as CaCO₃. The water is high in alkalinity and total dissolved solids from the dissolved mineral content. While the water from the well fields is hard, the water treatment plant removes a significant amount of that hardness through nanofiltration of the Houserville water.

DOMESTIC WATER AND FIRE SERVICE

A 12-inch well supply main line runs through the northern portion of the West Campus. Service through this main must be considered during construction to maintain water supply to other parts of campus. Twelve-inch service water lines run through the West Campus to provide building service.



West Campus Water Service Distribution

STORM SYSTEM

The University Park Campus storm drain conveyance system is currently a 100% gravity flow system consisting of approximately 73 linear miles of storm drain pipes varying from 6 inches to 72 inches in diameter, over 830 manholes, and over 3,000 inlets. The University has varying levels of documentation for the entire system, and over half of the storm system is precisely surveyed.

Management: Land development and the construction of new impervious areas will trigger the need to install stormwater management controls to address peak rate, volume, and water quality regulations according to the Spring Creek Act 167 Plan, State College Borough Stormwater Ordinance, Ferguson Township Stormwater Ordinance, and PA Code Title 25, Chapter 102. Projects on Campus must also address policies in the University's document: *Penn State, University Park Campus, Stormwater Guidance, Policies, and Master Plan, December 2016* (Penn State Stormwater Master Plan).

Infiltration Regulations: The University Park Campus is located in the Ridge and Valley Physiographic Region and is underlain by highly fractured limestone bedrock. Sinkhole formation is common in the karst topography of the Nittany Valley. It is University policy to not use infiltration to meet volume control regulations in the vicinity of buildings and infrastructure. Vegetated Best Management Practices, such as rain gardens, can be used to address peak rate and water quality, but they must be lined and used for infiltration.



West Campus Drainage Divide Diagram (DA= Drainage Area)

Reclaimed Water: The University has developed a master plan* for a future reclaimed water system for the University Park Campus. It is estimated that this reclaimed water system could reduce groundwater withdrawals by 300,000 to 500,000 gallons per day. Sewage facilities planning and permitting has been completed for the system, and installation of portions of the reclaimed water distribution system has begun as opportunities present themselves.

Targeted uses for the future reclaimed water system include toilet flushing, irrigation, vehicle washing, non-potable washdown water, and laundry. When viable, interior plumbing systems of new or renovated buildings are being installed for future reclaimed water to facilitate the connection to the reclaimed water system when it becomes operational.

The use of reclaimed water as makeup water in cooling towers has been deemed inefficient as the high dissolved solids will require significantly more blowdown.

* Reference 5, Refer to Chapter 6

Core Campus

Core Campus is part of the Main Campus drainage area and is tributary to Thompson Run, which is defined as a Special Projection (High Quality) stream by the PA Department of Environmental Protection (DEP). The Penn State Stormwater Master Plan requires that projects in the Main Campus drainage area reduce the post-development peak run-off rate for all events up to the 100-year storm to the pre-development peak run-off rate while considering all existing impervious areas as meadow in good condition. PA DEP requires that 20% of the existing impervious area be considered as meadows in good condition in run-off calculations.

The main stormwater collection pipe along College Avenue, which drains the Main Campus, is undersized and causes flooding. To help mitigate this flooding, Penn State's policy for the Main Campus drainage area is that 100% of existing impervious area be considered as meadows in good condition in run-off calculations.

Additionally, gravity lines on the Core Campus must pass under the existing steam tunnel to tie into the municipal storm and sanitary sewers which run under College Avenue.

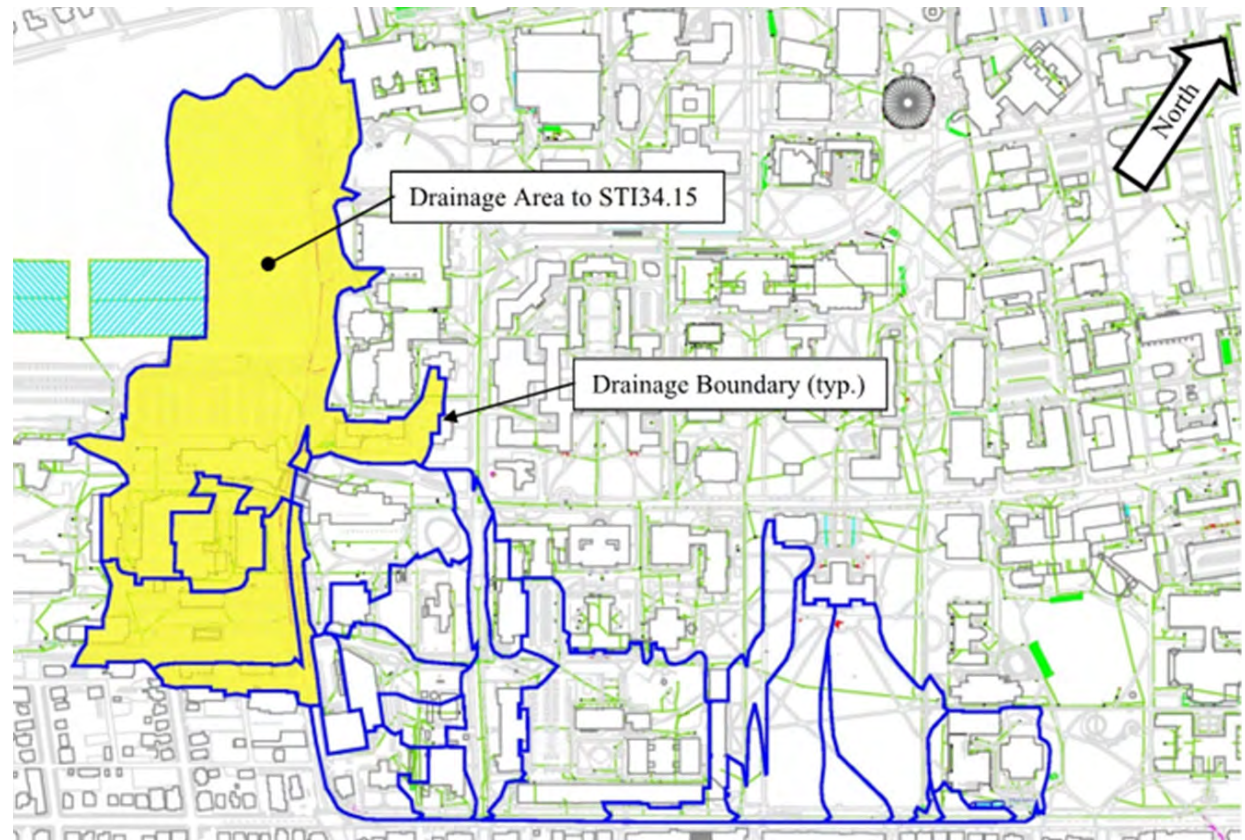
West Campus

West Campus is split between two drainage areas (see diagram to right). The eastern portion of the West Campus is part of the Main Campus drainage area. The western portion of West Campus drains to a stormwater management basin that is referred to as the West Pond and is tributary to the Big Hollow watershed. The Big Hollow is Cold Water Fisheries stream, which is not considered a Special Protection stream according to the Chapter 93 designations. Designation as a Cold Water Fishery is a watershed jurisdictional determination for purposes of regulating impacts. However, the Big Hollow watershed is an under-drained carbonate valley and does not have baseflow anywhere along its length and there are no large springs. In reality the Big Hollow streambed loses water to the ground.

There are significant existing stormwater runoff problems causing flooding on a regular basis in West Campus and Atherton Street. The University has a policy that no new impervious area can be built on the eastern portion of West Campus until these stormwater and flooding problems are addressed.

The West Campus Drainage Areas diagram shows the eastern portion of West Campus with very stringent stormwater requirements. The University has estimated that 2 underground storage facilities (approximately 2.5 acre-ft and 1.0 acre-ft) will be needed to reduce flooding.

Runoff from western edge of the Main Campus drainage area crosses under Atherton Street passing through a PennDOT-owned pipe that is undersized and causing flooding along Atherton. This undersized pipe is referred to as Trunk I. The OPP Water Recourses Publication Main Campus Trunk Line I (OPP-WRP-SR-TLI:2017) addresses



Drainage area to Atherton Street Inlet STI34.15 on the Trunk I line is highlighted in yellow. This yellow area is the eastern portion of West Campus that is part of the Main Campus Drainage Area. (Source: OPP-WRP-SR-TLI:2017)

policies specific to the eastern portion of West Campus. The diagram at right from OPP-WRP-SR-TLI:2017 shows the portion of West Campus that drains to the east through Trunk I. The diagram on the facing page shows the location of Inlet STI34.15, the “bottleneck” in getting flow across Atherton Street, where Trunk I crosses Atherton Street just south of the Water Tunnel.

In order to reduce the peak run-off rates to Inlet STI34.15, two subsurface detention systems will likely be required with one each in sub-areas PAS and PAN (diagram at right shows the names of the sub drainage areas). The volumes of these two detention structures are approximately 2.5 ac-ft for the PAN area and 1.0 ac-ft for the PAS areas.

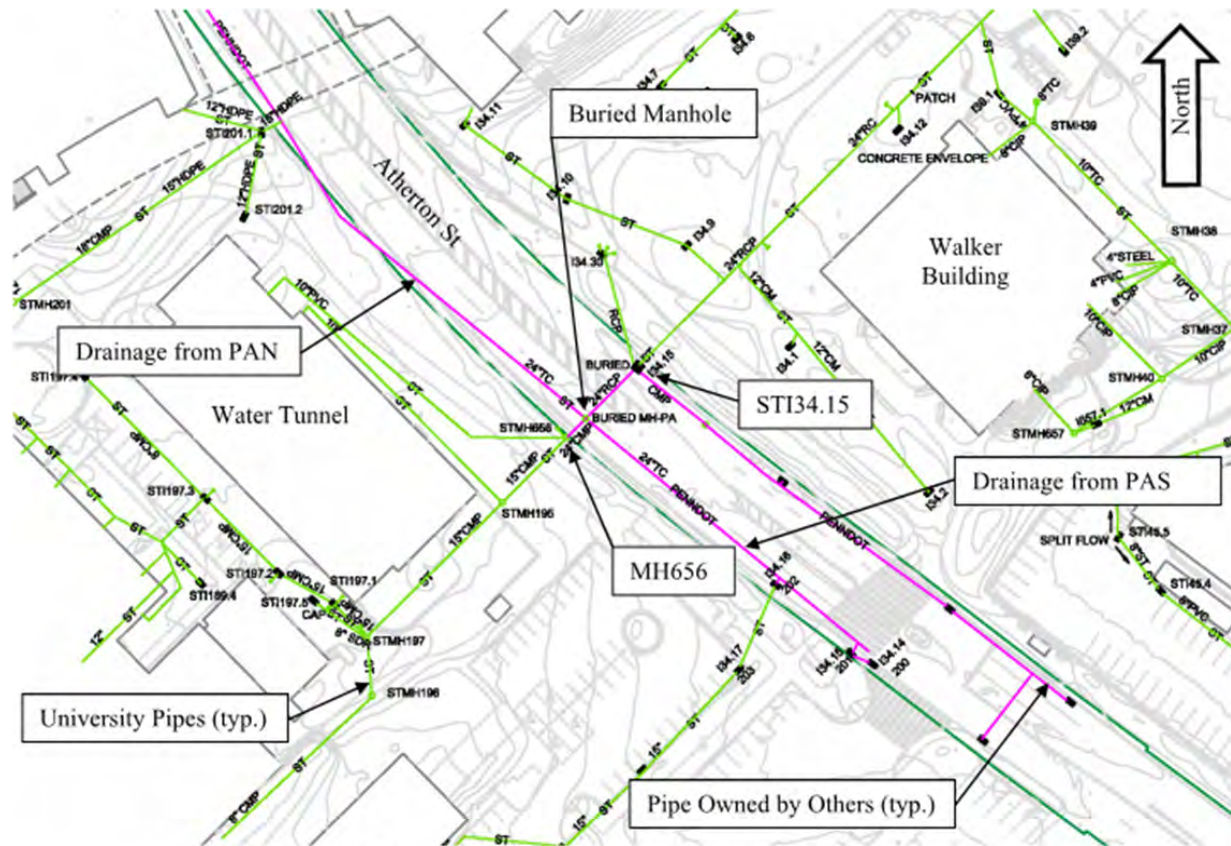
Rather than setting relative peak rate reductions as is typical for rate control, to address the capacity of the existing infrastructure downslope, the University set target allowable peak discharges for subareas and total drainage to inlet STI34.15 as shown in Table 1. The Trunk I document also provides some of the base data that a designer must use in calculating stormwater run-off to inlet STI34.15.

Table 1. Allowable peak rate discharges for subdrainage areas in West Campus. (Source: OPP-WRP-SR-TLI:2017).

West Campus portion to West Basin

Return Period (yrs)	Total PAN (cfs)	Total PAS (cfs)	Estimated 656 (cfs)	Estimated 34.15 (cfs)	Total Goal (cfs)
1	5.7	2.2	2.5	5.0	15.4
2	7.6	3.3	3.1	6.1	20.1
5	10.0	4.5	3.9	7.6	26
10	12.5	6.0	4.7	8.8	32
25	16.0	5.0	5.7	10.7	37.4

The western portion of the West Campus drains to the West Campus Pond, which is undersized for the current development in drainage area. According to Penn State policy, no new development can occur in this drainage area without expansion of the West Pond (Water Resources Publication, West Campus Pond (OPP-WRP-SW-WC:(3)-2016)). There are no University-specific requirements for this drainage area in addition to the municipal and state regulations.



Location of STI34.15 and where runoff from West Campus crosses Atherton St. (Source: OPP-WRP-SR-TLI:2017)

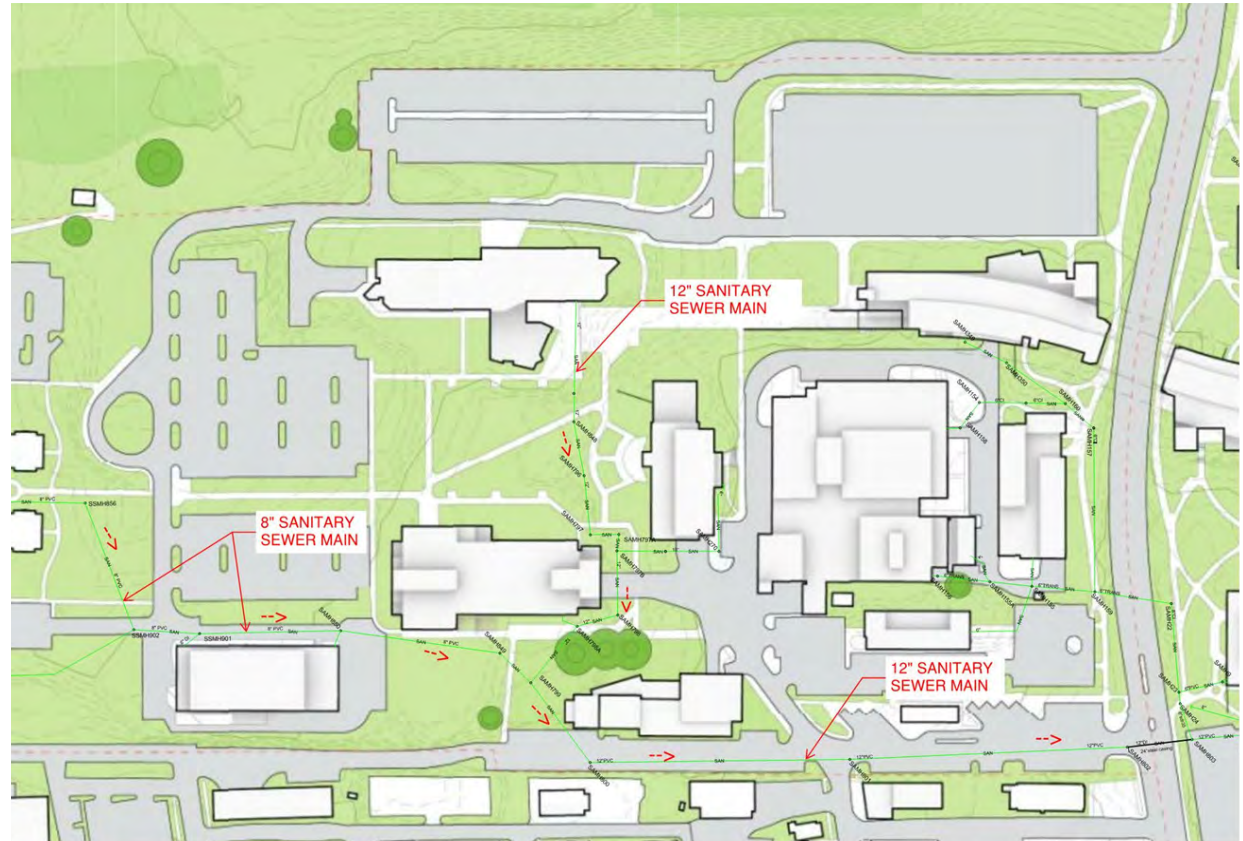
SANITARY SYSTEM

The University owns, operates and maintains a sanitary sewer system, which provides sanitary sewer service to a majority of the University Park Campus as well as a small portion of State College Borough in the College Heights neighborhood. The sanitary system consists of a sewer collection system, wastewater treatment plant and effluent disposal system.

The sanitary sewer collection generally consists of approximately 18 miles of gravity collection lines, over 900 manholes and five pumping stations. All pumping stations are currently operating well below their design capacity.

Core Campus: Gravity lines must pass under existing steam tunnels to tie into municipal storm and sanitary sewers under College Avenue. Most sanitary lines coming downhill from Steidl and other points north generally shift east and run down to College Avenue below Pattee Mall. The main existing sanitary line that the Master Plan will need to account for comes out of Hintz Alumni Center.

West Campus: An existing 12-inch campus sanitary sewer main runs through the West Campus and serves the existing buildings.



West Campus Sanitary Sewer Distribution