UNIVERSITY OF CALIFORNIA
UCRIVERSIDE

PLANT GROWTH ENVIRONMENTS

& SUPPORT FACILITIES RELOCATION STUDY

APRIL 25, 2016

PLANT GROWTH ENVIRONMENTS & SUPPORT FACILITIES

UC Riverside aspires to be a leader in crop and agricultural systems biology and its related fields over the next two to three decades. This study supports that goal by providing insight into the campus's current and future space needs. Capital Planning, on behalf of the College of Natural and Agricultural Sciences (CNAS) commissioned the study, which took place in conjunction with the Physical Master Plan Study.

GOALS OF THE STUDY

- Develop a broad understanding of the condition of available space in the research support facilities.
- Establish current and future need for such plant growth environments and support facilities necessary to deliver on the UCR 2020 vision and beyond.
- Develop an "order of magnitude" estimate of the quantity and types of plant growth environments and support facilities that need to be replaced, and those that can be renovated or re-purposed.
- Recommend the quantity and types of facilities preferable to locate on East Campus in close proximity to related existing and proposed lab-based research.
- Recommend the quantity and types of facilities preferable to locate on West Campus in close proximity to existing and proposed land-based research.
- Develop a concept plan of these recommendations.

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A.1 Study Methodology

In producing this report and its recommendations, the planning team undertook the following process. The findings of each of these steps will be elaborated in upcoming sections.

UNDERSTAND CONDITION OF EXISTING FACILITIES

This understanding was developed from several sources. These include:

- Site plans provided by the University showing the locations and names of all plant growth environments and support facilities.
- A 2010 report produced by UCR Facilities, evaluating the physical condition of a large portion of said facilities, to determine the usefulness of continued resource expenditure on their upkeep.
- An in-person tour of the facilities with representatives of CNAS and Capital Planning, which took place on August 4, 2015.
- Anecdotal evidence of the facilities' conditions gathered from the previously listed participants during four group workshops, which took place on August 4, September 2, September 25, and November 18 of 2015.

UNDERSTAND CURRENT AND FUTURE NEEDS OF RESEARCH COMMUNITY

Through workshops, stakeholders provided the planning team with information regarding the anticipated size of the future UCR research community, the appropriate glasshouse area per principal investigator, the types of anticipated research and ideal facility capabilities.

RESEARCH PRECEDENTS

The planning team conducted phone interviews with plant growth facility managers at a range of Universities, to establish standards against which UCR's current and proposed facilities could be evaluated. These precedent Universities varied widely in program size, location and climate. Both quantitative and anecdotal information was collected.

DEVELOP CONCEPT PROGRAM

Based on input received from the research community and data collected from peer institutions, the planning team made a comprehensive estimate of types and quantities of plant growth environments and support facilities.

TEST SITE PLANNING SCENARIOS

In cooperation with the Physical Master Plan Study team, "opportunity sites" were identified - optimal locations for placement of the proposed plant growth facilities program. A prototype greenhouse module was developed for the purpose of "test-fitting," and concept site plans were developed, including site elements like access drives and parking to serve the facilities.

INCORPORATE STAKEHOLDER FEEDBACK

Development of the concept program and site planning scenarios were presented at stakeholder workshops in the form of both plan graphics and physical models. In response to these, stakeholders provided feedback on which aspects of the proposal they felt were successful, and which required further development, which the planning team then reincorporated into this study. Comments generally provided further clarity on the uses of various existing facilities, and on the daily activities and needs of the research community that influence physical planning.

A.2 Glossary of Terms

The following are terms specific to physical planning and/or natural and agricultural science research, defined for the reader of this report.

Glasshouse (Greenhouse)
The space where plants are grown. A structure, generally of aluminum, possibly steel or wood, or even air supported, and enclosed with a clear material. Enclosure is typically either glass or a clear plastic such as polycarbonate.

Contained Research
Research requiring specialized facilities and procedures due to the potential consequences of unintended release into the surrounding environment. For the purpose of this study, this refers to research conducted under a bio-safety level rating of 3+, such as the HLB or "citrus greening" disease. See also *Bio Safety Level.*

Headhouse
An enclosed "workshop" space immediately adjacent to a glasshouse, where plants are prepared to be placed in the glasshouse. Typically has tables and/or counters, sinks, and storage space for pots and other accessories.

Lathhouse
A structure that provides shade via loosely spaced strips or pickets. Provides no temperature control or isolation.

Bench
Within a glasshouse, the tables that plants sit on. Can be made of metal or wood, and can either be stationary or rolling. While stationary benches are more stable, rolling benches allow for more efficient use of glass house floor space.

Bio Safety Level (BSL)
A set of biocontainment precautions (procedures and equipment) required to isolate biological agents in an enclosed laboratory facility, ranging from 1 to 4. In the united states, these levels are specified by the centers for disease control and prevention.

- BSL-1: This level is suitable for work involving well-characterized agents not known to consistently cause disease in healthy adult humans, and of minimal potential hazard to laboratory personnel and the environment.
- BSL-2: This level is similar to Biosafety Level 1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment. It includes various bacteria and viruses that cause only mild disease to humans, or those for which airborne transfer is difficult in a lab setting. Modern plant growth facilities are generally built to conform to this standard to allow research on transgenic organisms.
- BSL-3: This level is applicable to clinical, diagnostic, teaching, research, or production facilities in which work is done with indigenous or exotic agents which may cause serious or potentially lethal disease after inhalation. In the context of this study, a BSL-3 facility would allow research on the HLB, or "citrus greening" disease.
- BSL-4: Not relevant to this study.

Quarantine
Plant Protection and Quarantine (PPQ) is a program within the Animal and Plant Health Inspection Service, an agency of the United States Department of Agriculture. The PPQ program attempts to safeguard agriculture and natural resources in the United States against the entry, establishment, and spread of animal and plant pests and noxious weeds. PPQ also supports trade and exports of U.S. agricultural products.

Evaporative Cooling
Also called "swamp cooling" or "fan and pad" cooling, a system that cools air as it enters a glasshouse by drawing the air over moist pads, thus increasing humidity and lowering air temperature. Less expensive than mechanical refrigeration, but the achievable temperature differential is naturally limited.

Air Conditioning
Mechanical refrigeration. More expensive to install and operate than evaporative cooling, but with the capacity for more precise temperature control.

P.I.
Principal investigator. The head of a particular research project, and the unit by which future space needs are estimated for the purposes of this study.

Screen House
A tent-like structure covered in a fine mesh. Provides a degree of shade, but primary purpose is to control insects while growing outdoors.

Growth Chamber
An enclosed space, typically ranging from the size of a refrigerator to the size of a large closet, which allows for the precise control of all variables when growing plants: light, temperature, humidity, etc, to a higher degree than is possible in a glasshouse.

Transgenic
Refers to an organism, in this case plants, into which genetic material has been artificially introduced. Requires tightly controlled facilities, both because of the requirement that these organisms not be allowed to grow and reproduce in the outside environment, and because they can be targets for eco-terrorism. Work on this type of organism generally requires a facility with a BSL-2 rating.

Phasing
Breaking a large project into several separate portions, generally to lessen the disruption to other ongoing activities.

Economy of Scale
The theory that producing something becomes less expensive per unit as the total quantity of production is increased.

Capacity
The ability of a given area of land to accommodate an amount of built area, with respect not just to the size of the site, but also its slope and utility infrastructure.

Instructional Lab / Greenhouse
Lab and plant growth space dedicated to undergraduate student teaching.

Research Lab / Greenhouse
Lab and plant growth space used by researchers, faculty, and graduate students.

A.3
Condition of Existing Facilities

CNAS manages 116 seperate structures that support its plant growth research activities. These include glasshouses, headhouses, lath houses, screenhouses, growth chamber space and various other ancillary uses, collectively referred to a "plant growth environments and support facilities," and totaling approximately 236,000 gross square feet of floor area.

These structures are located in two major groups - one at the east edge of East Campus, centered at the intersection of East Campus Drive and Eucalyptus Drive, and the second in the southeast quadrant of West Campus, south of Martin Luther King Blvd.

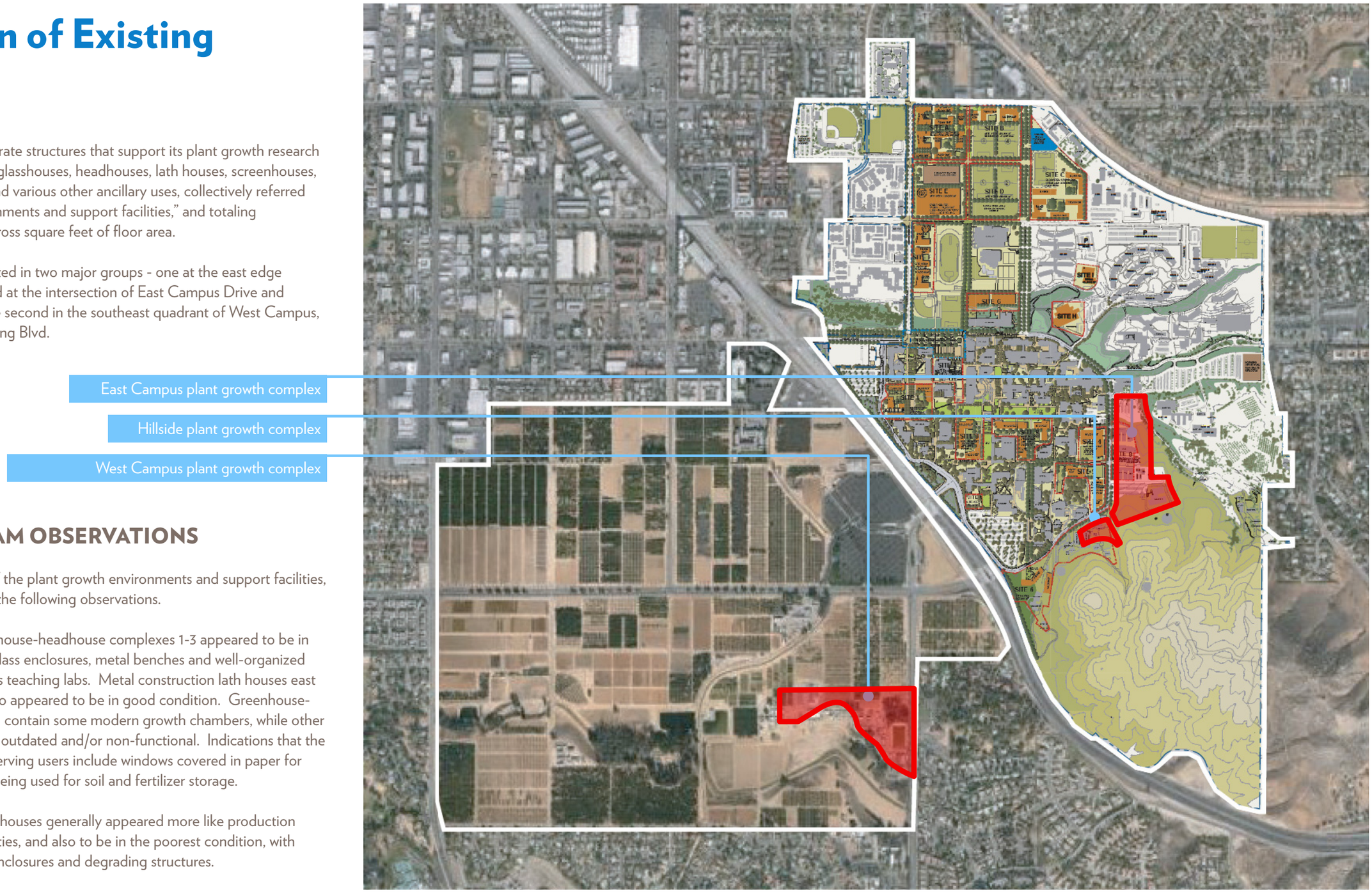


Figure A.1 VICINITY CONTEXT MAP

PLANNING TEAM OBSERVATIONS

On physical inspection of the plant growth environments and support facilities, the planning team made the following observations.

EAST CAMPUS: Greenhouse-headhouse complexes 1-3 appeared to be in the best condition, with glass enclosures, metal benches and well-organized headhouses being used as teaching labs. Metal construction lath houses east of East Campus Drive also appeared to be in good condition. Greenhouse-headhouse complex 18-21 contain some modern growth chambers, while other equipment appears to be outdated and/or non-functional. Indications that the space is not adequately serving users include windows covered in paper for light control and offices being used for soil and fertilizer storage.

WEST CAMPUS: Greenhouses generally appeared more like production rather than research facilities, and also to be in the poorest condition, with heavily yellowed plastic enclosures and degrading structures.

Figure A.2 East Campus. Metal lath house in good condition

Figure A.3 East Campus. GH 6

Figure A.4 West Campus. Degrading structure in GH 16-22

Figure A.5 East Campus. Ad-hoc uses in GH 18-21

Figure A.6 East Campus. Teaching lab in GH 1-3

Figure A.7 East Campus. Headhouse in GH 18-21

PHYSICAL PLANT STUDY

In 2010, UCR Physical Plant evaluated 80 structures used by CNAS and assigned each a rating from 1 (inoperable) to 5 (completely operable). Of these 80, 20 were deemed completely or mostly inoperable, thus not worthy of receiving ongoing routine maintenance. Another 17 were deemed "partially operable," leaving just over half with a rating of 4 (completely operable) or 5 (essentially operable). The study noted that in 2010, roughly half of the existing plant growth environments and support facilities were over 50 years old.

STAKEHOLDER OBSERVATIONS

The stakeholder group expressed the following as primary impediments to the performance of high quality research:

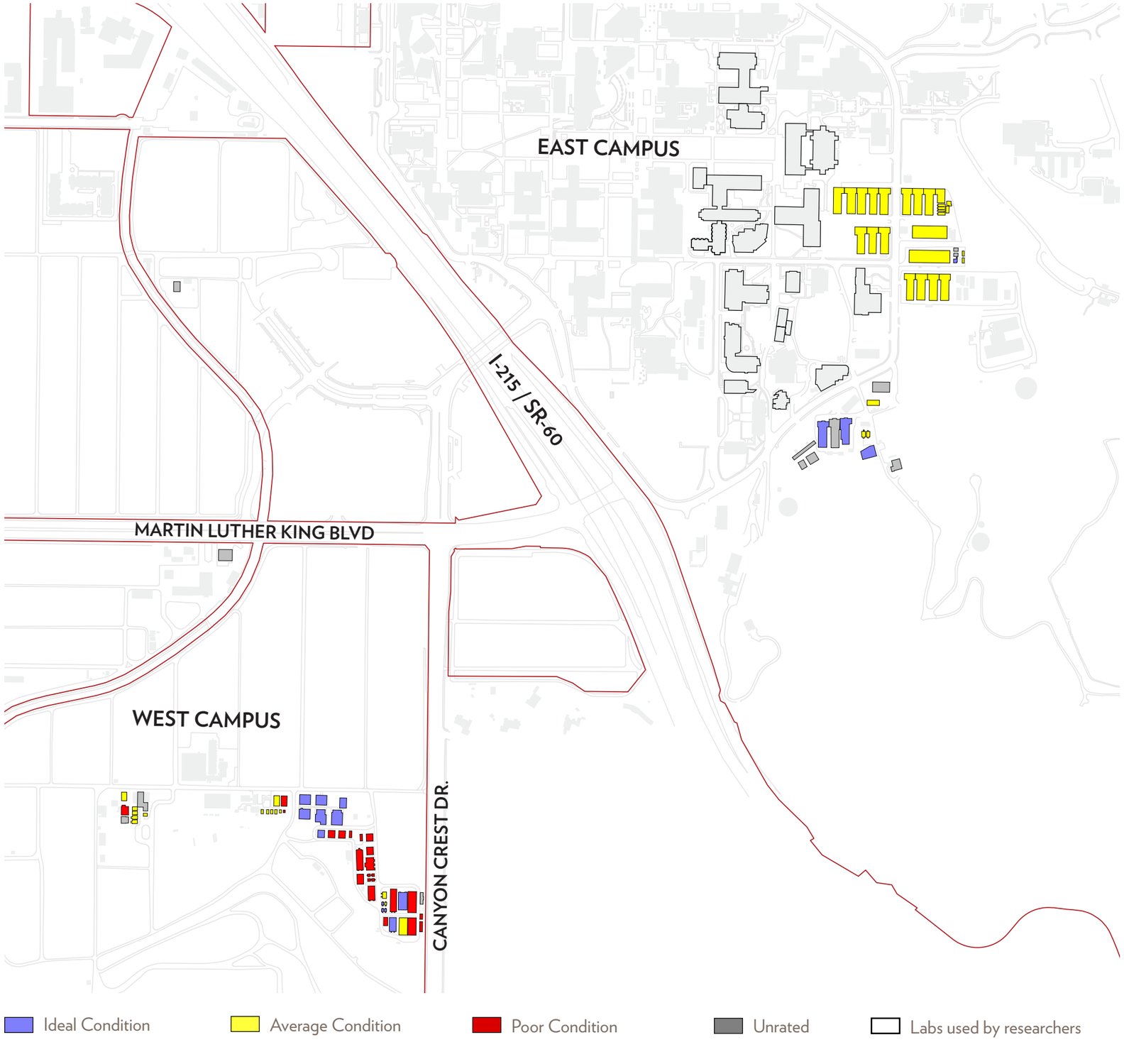
- Lack of a contained research facility precludes UC Riverside from working on the HLB or "citrus greening" disease, currently one of the most serious threats to citrus production in the United States.
- Insufficient quantity of glasshouse space capable of containing transgenic work.
- Failure of cooling and ventilation systems results in extreme temperatures and loss of research specimens.
- Lack of redundancy in critical systems, viz. emergency power and emergency ventilation, increases the likelihood of said extreme temperatures.
- Failure of cold storage equipment results in a loss of research.
- Wood benches are difficult to move, and wood promotes growth of fungi and harbors insects, impacting research.
- Gravel floors promote weed growth, impacting research.
- Unsealed greenhouses allow infiltration of insects and rodents, impacting research.
- Soil steaming (to kill weeds and diseases) is only available on East Campus. Transport to West Campus introduces the potential for recontamination.

The Nematology department reports losing 80% of research cultures in 2014.

FACILITY CONDITION

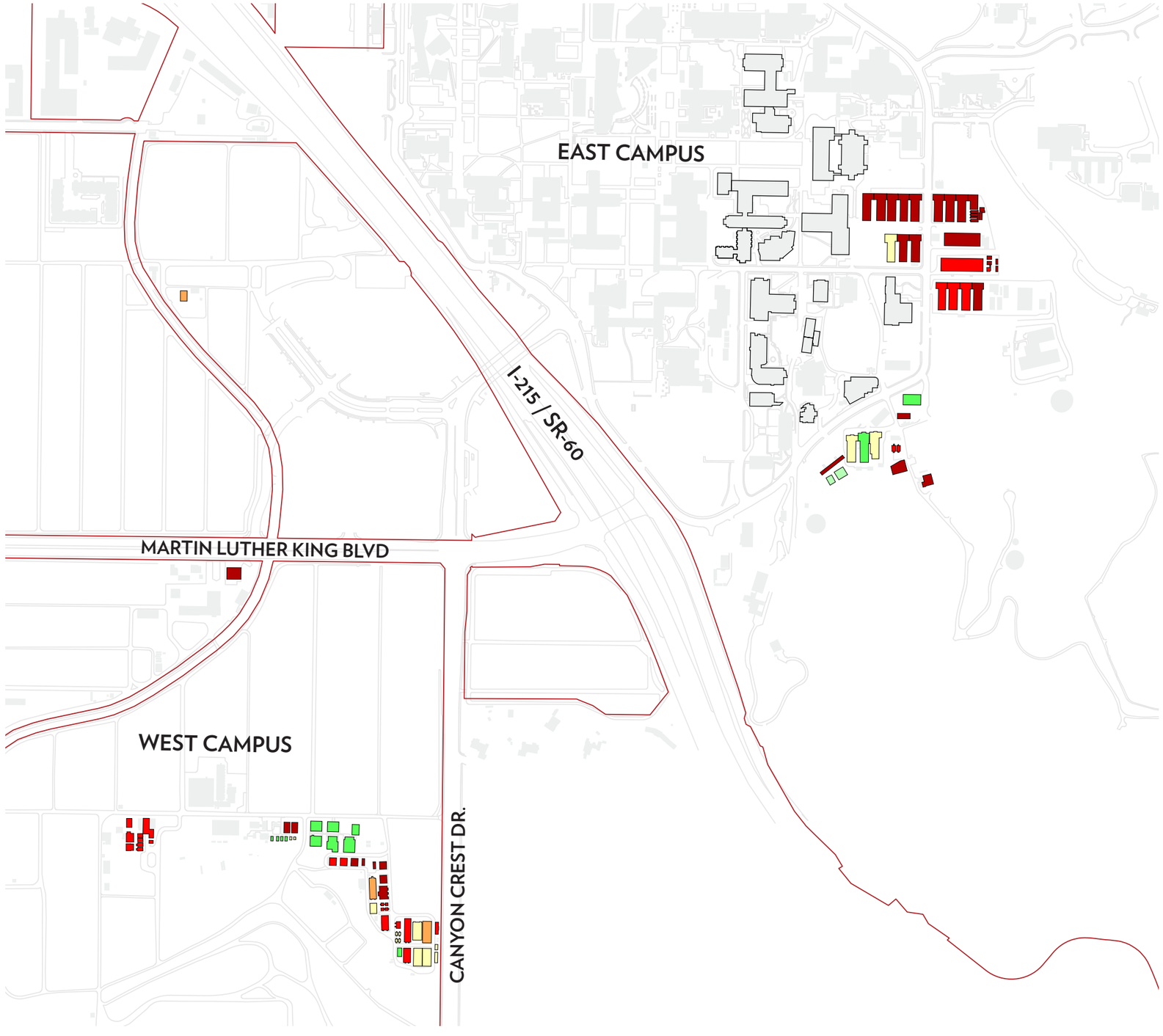
This map illustrates the condition of building enclosures.

CNAS maintains an inventory of available facilities, with a list of available features of each facility, and the relative physical condition of certain components. The planning team created this map to illustrate the "skin condition" parameter from that inventory.



FACILITY AGE

This map illustrates the age of plant growth environments and support facilities.



A.4 Precedent Research

A primary goal of improving UC Riverside's plant growth environments and support facilities is the recruitment and retention of top-quality researchers and faculty.

In assessing UC Riverside's competitiveness with regard to its plant growth environments and support facilities, the planning team conducted research on similar facilities at institutions around the United States. Information was collected primarily via interviews with managers of these facilities, supplemented by information made available on the institutions' websites.

One of the few recurring issues at each institution was the travel distance between the plant growth environments and the laboratories where researchers work.

CORNELL UNIVERSITY

Cornell University was selected for comparison for its similar program size. Greenhouses range from just a few years old, to those built in 1926. Cornell has the largest quantity of glasshouse space of any of the institutions studied. Of this, 80% is reported to be capable of supporting work on transgenic organisms, though only 5-10% of available space is actually used for that purpose. Air conditioned glasshouse is only used for work on cold-weather plants. Space assignments range from a low of 50 sf to over 2,000 sf for a single project. Cornell does not use lathhouses for research activities.

Some greenhouses have direct connections to laboratories, while others are within a few hundred feet. Some greenhouses are located up to one and a half miles from laboratories, which is not desirable for faculty.

UNIVERSITY OF CALIFORNIA, DAVIS COLLEGE OF AG & ENVIRONMENTAL SCIENCE

Agriculture and Environmental Science operates the majority of UC Davis's plant growth environments, including most of its newest facilities. It's worth noting that there are no air conditioned greenhouses in this complex. UC Davis reports that when researchers require precise temperature control for experiments, facilities managers recommend growth chambers be used instead. Some of these growth chambers, like at UC Riverside, are placed in the headhouses, but new growth chambers are placed in their own dedicated building.

No greenhouses at UC Davis have direct connections to laboratories, and some are driving distance. It was also noted that not all of UC Davis's available greenhouse space is used.

PRINCIPAL INVESTIGATORS	107	150
GLASS HOUSE ASSIGNABLE	146,000 S.F.	114,513 S.F.
A/C (INCLUDED ABOVE)	6,000 S.F.	0 S.F.
TEACHING GLASSHOUSE	-	4,000 S.F.
HEAD HOUSE	-	20,000 S.F.
GLASS HOUSE AVERAGE PER P.I.	1364 S.F.	763 S.F.
GROWTH CHAMBERS	150	300
GROWTH CHAMBERS PER P.I.	1.4	2.0

UNIVERSITY OF CALIFORNIA, DAVIS COLLEGE OF BIOLOGICAL SCIENCES

UC Davis is regarded as UC Riverside's most comparable peer in crop and agricultural systems biology, due to its similar size, location within California and reputation as a agricultural institution.

Biological sciences is one of two colleges at UC Davis that maintains and uses greenhouse space, and operates a minority portion of the total greenhouse space available on campus. In the 1990s, a planning study looked at possible locations for a new greenhouse complex. One option separated the greenhouse complex from the university labs with a freeway in between. The remoteness was deemed unacceptable.

UNIVERSITY OF CALIFORNIA, LOS ANGELES

UCLA was selected for comparison as another major public university within the greater Los Angeles area. Their plant growth facility is located directly adjacent to the life sciences building.

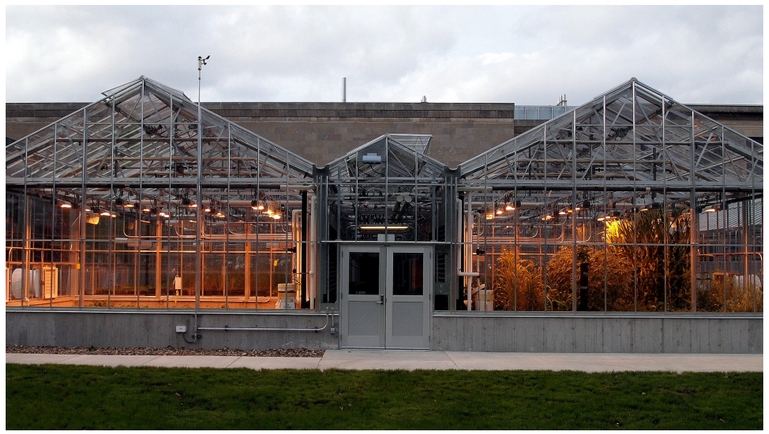
This structure is unique in its physical planning, in that it is split into two levels, making good use of its hillside site. The lower floor contains uses which dont require sunlight, namely a tissue culture lab, growth chambers, offices, storage and mechanical space serving the glasshouses above.

UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN

The University of Illinois, Urbana-Champaign was selected for comparison for its similar program size. U. of Illinois notes that its greenhouse complex is located very close to laboratories and classrooms, and that this proximity is highly desirable for faculty. Specific areas of research include plant breeding, plant pathology, entomology, corn and soybeans.

PRINCIPAL INVESTIGATORS	27	10	40-60
GLASS HOUSE ASSIGNABLE	14,500 S.F.	5,400 S.F.	58,000-73,000
A/C (INCLUDED ABOVE)	0 S.F.	5,400 S.F	2,000 S.F.
TEACHING GLASSHOUSE	-	-	7,500-9,000 S.F.
HEAD HOUSE	-	2,100 S.F.	-
GLASS HOUSE AVERAGE PER P.I.	537 S.F.	540 S.F.	1215-1450 S.F.
GROWTH CHAMBERS	-	12	-
GROWTH CHAMBERS PER P.I.	-	1.2	-

IOWA STATE UNIVERSITY



Iowa State University was selected for comparison for its reputation in agricultural research. The median allocation of glasshouse space at Iowa State is 500 sf per PI. One researcher uses 2,000 sf, which brings the average up. The facility has 1,000 sf of headhouse, yielding a ratio of 20%. The facilities manager reports this area is insufficient, and the result is that headhouse functions get pushed into the glasshouses. The facility is located directly adjacent to laboratory space.

UNIVERSITY OF NEVADA, RENO

The University of Nevada, Reno was studied at the request of project stakeholders, to gauge the necessity of air conditioning in a desert climate similar to Riverside's. This facility is entirely evaporatively cooled.

3000 sf was originally dedicated to teaching activities, but this was found to be too large and reduced by 50%. Most users drive to the facility from campus.

UNIVERSITY OF CALIFORNIA, RIVERSIDE

UC Riverside's current facilities are included in this study for purpose of direct comparison.

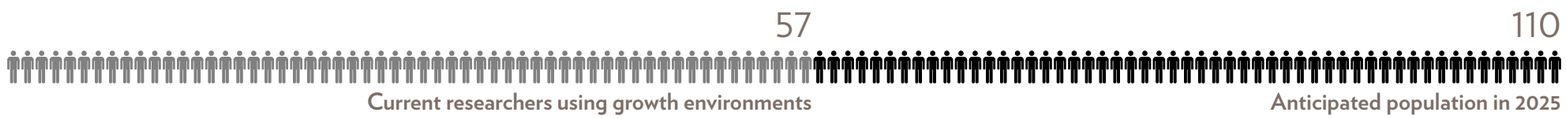
7	13	57
5,000 S.F.	16,500 S.F.	115,000 S.F.
0 S.F.	0 S.F.	2,000 S.F.
2,000 S.F.	1,500 S.F.	4,000 S.F.
1,000 S.F.	12,000 S.F.	31,000 S.F.
714 S.F.	1269 S.F.	2,018 S.F.
-	12	40-50
-	.9	0.7-0.9

A.5
Concept Program

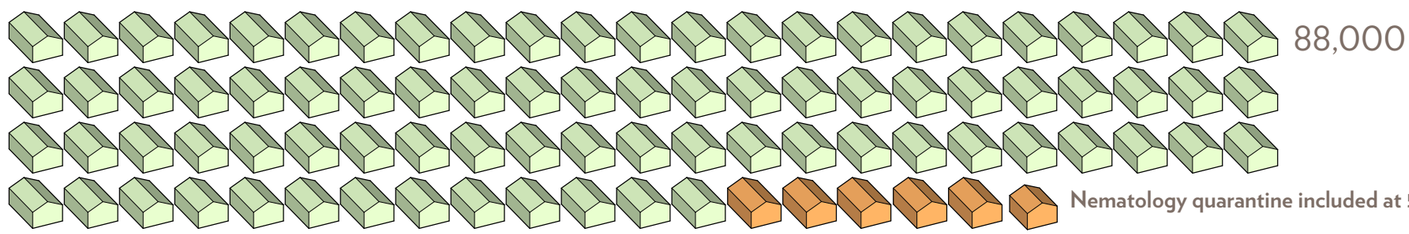
Based on departmental hiring projects provided by CNAS, the facilities available at peer institutions, and needs expressed by CNAS faculty, the following types and quantities of facilities are proposed as a basis for site planning.

MAJOR PROGRAM ELEMENTS

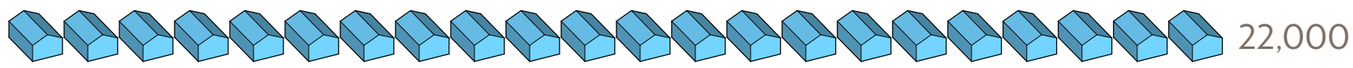
PIs: 110 The number of researchers requiring greenhouse space, this number forms the basis of the concept program. Currently 57 members of the research community use plant growth environments. Departmental hiring plans provided by CNAS project an increase of 40 within the near future, with estimates as high as 60 by 2025. For planning purposes, this study will assume a total population of 110.



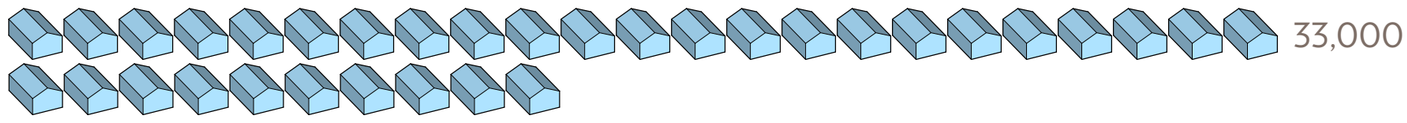
Glasshouse: 1,000 sf per PI The median allocation of glasshouse space per principal investigator in the precedents studied is 763 sf. In consideration that citrus research requires more space than smaller types of crops, this was increased by roughly one-third, yielding a planning module of 1,000 sf per principal investigator. Stakeholder confirmed the appropriateness of this assumption. 5,800 sf of this space should be specially equipped as a nematology quarantine facility, replicating the size of the existing facility, shown to the right in orange. This yields a total of 110,000 sf, including air conditioned space, listed below.



Air Conditioned Glasshouse: 20% of total Stakeholders expressed a desire for 20-50% of the total available glasshouse to be air conditioned for precise temperature control. Selecting the lower end of this range, we find 22,000 sf to be significantly higher than that available at any of the peer institutions studied. This would be a major asset in recruiting and retaining research talent, but due to the expense of building and maintaining this space, we recommend this area be revisited in a program validation phase.



Headhouse: 30% of glasshouse Headhouse-to-glasshouse ratios at peer institutions ranged from 17-39%. Based on anecdotal evidence, facilities towards the lower end of this range have congestion problems in their head-



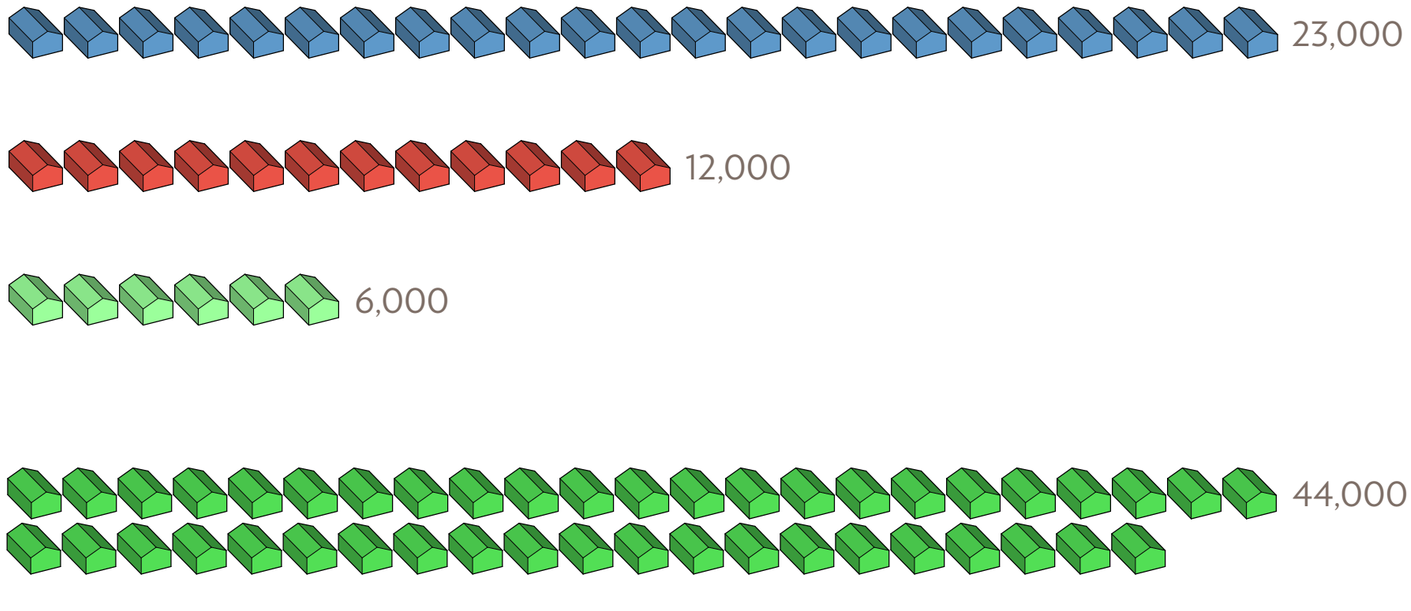
houses. For this study, 30% was selected as a target ratio.

Lathhouse: 23,000sf Analysis of UCR's current space allocation finds that approximately 20,000 of 31,000 total available sf of lathhouse is being utilized. 23,000 sf assumes the reuse of Lathhouses 3 (P5425) and B (P5535).

Contained Research Facility: 12,000sf A BSL-3 lab and growth environment, suitable for work on high-risk projects like the HLB "citrus greening" disease. The area for this facility replicates a similar facility at UC Davis.

Teaching Greenhouse: 6,000 sf The median allocation of greenhouse for undergraduate instruction at the precedent institutions is 4,000 sf, and also the current amount of allocated space at UCR. Stakeholders expressed a desire to accommodate classes of 30 students, where the current space serves 20. Thus this area was increased proportionally to 6,000 sf. ,

Growth Chambers: 2 per PI, or 220: A ratio of growth chambers-to-PIs of 2:1 matches the upper end of that found at peer institutions, viz. UC Davis. This total area assumes a clear floor space 10' x 20' to accommodate each chamber including space for circulation. Because the size of growth chambers varies, the planning team recommends this area be revisited in a future phase when actual growth chamber units are selected.



Support Facilities: These smaller auxiliary uses support the major program elements above. They are sized to match UCR's current facilities.

Total Concept Program: 235,000 sf

The total concept program's similarity to the total existing program is coincidental. The total researcher population is projected to approximately double, while the target average amount of glasshouse space per researcher is approximately half of its current number. Within the total, proportions of the different space types have shifted.

A.6
Prototype Facility Development

Before applying the concept program to a site plan, the planning team investigated different ways of organizing the program components. By creating a prototypical greenhouse module, the concept program is able to be test-fit on various potential sites more realistically.

Figure A.8 GH 3: Glasshouse unit connecting to headhouse

Figure A.9 GH 18-21: Linear headhouse connects glasshouses

Figure A.10 EXISTING PROGRAM ORGANIZATION

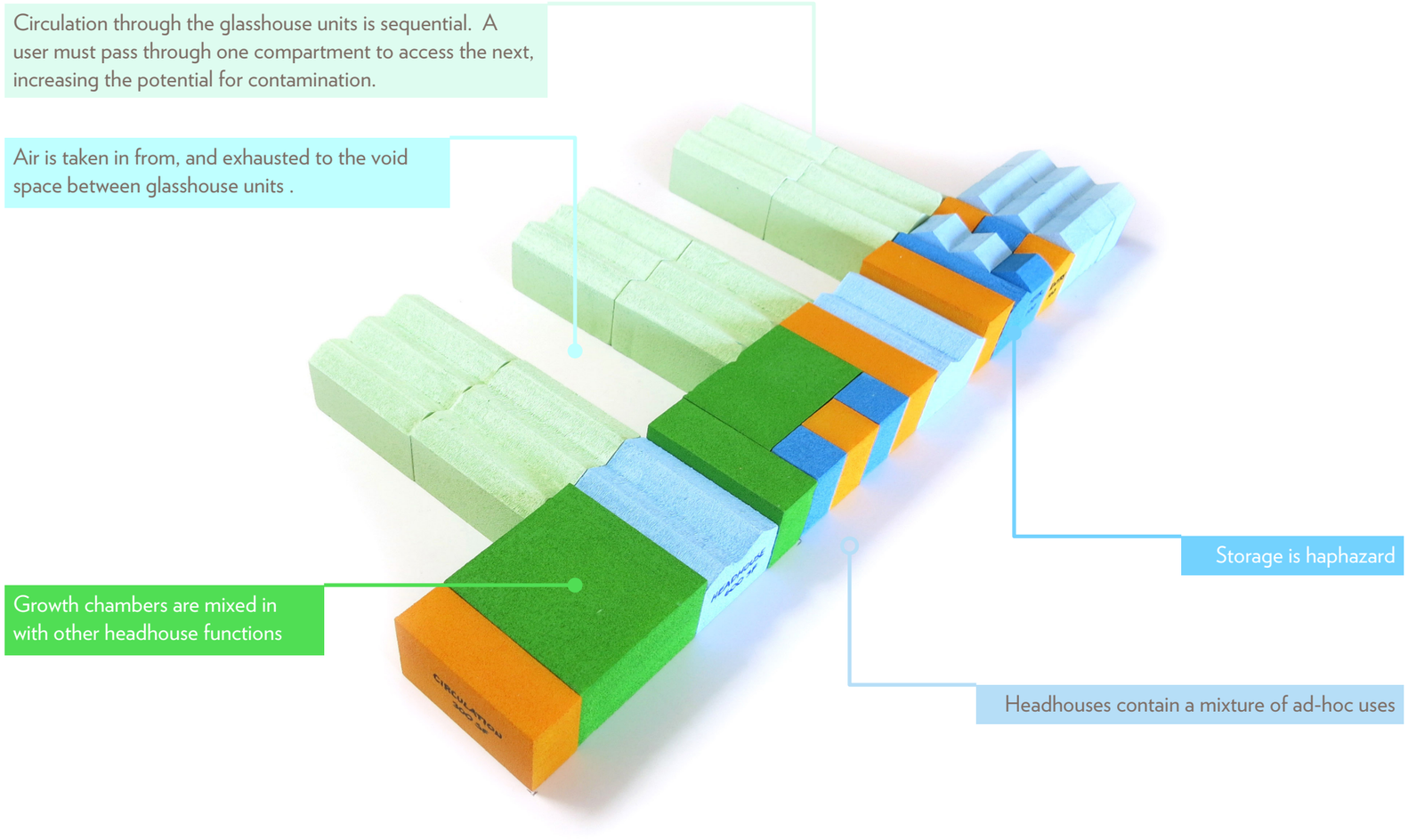
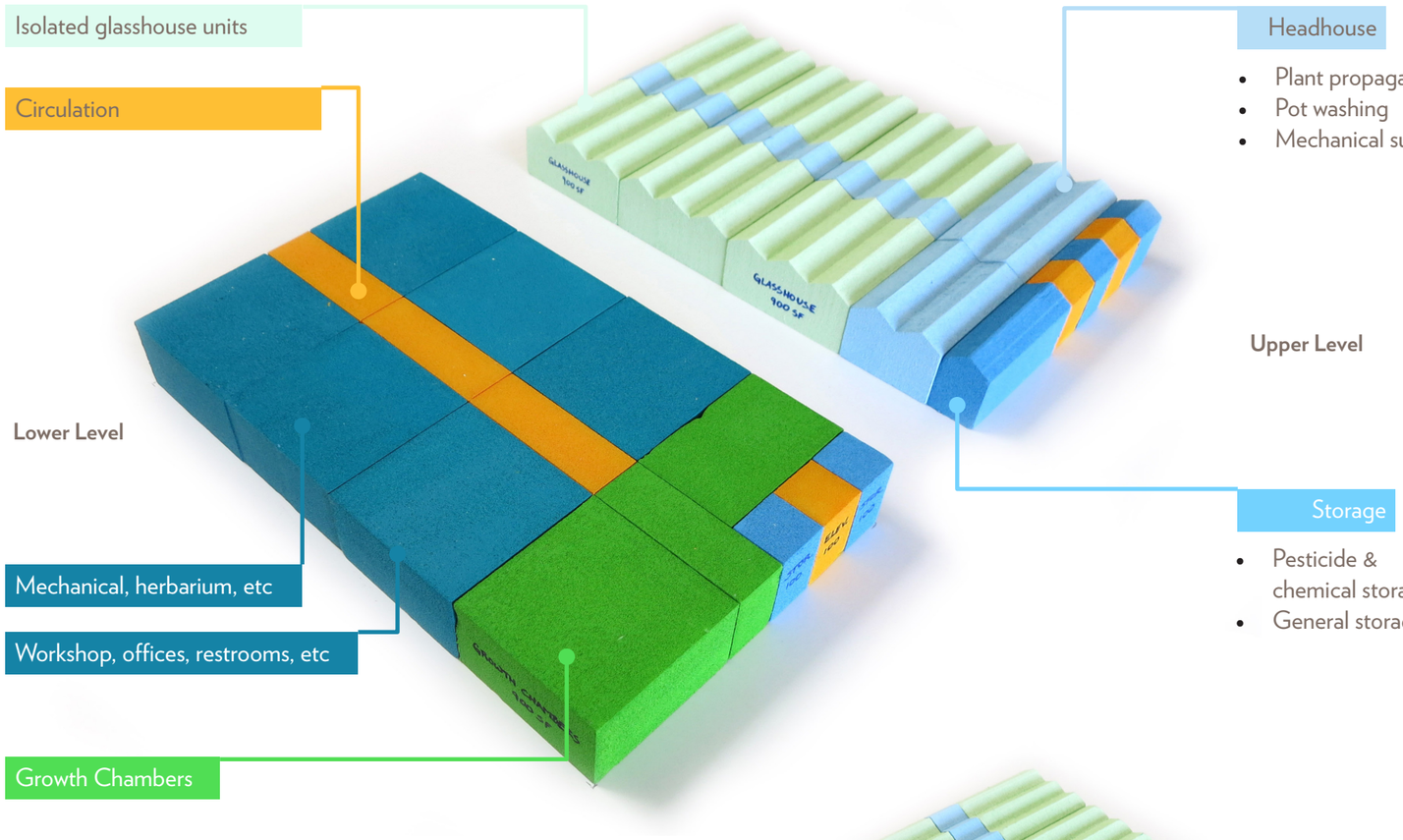


Figure A.11 PROPOSED PROGRAM ORGANIZATION



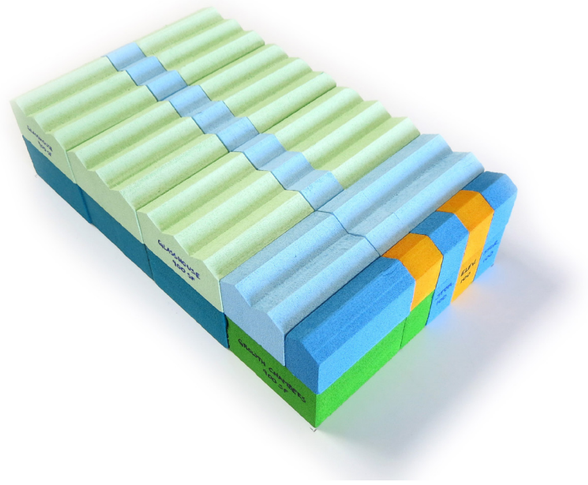


Figure A.12 Upper and lower levels stacked

EXISTING GREENHOUSE ORGANIZATION

On UC Riverside's East Campus, the prototypical greenhouse module comprises a linear headhouse connecting three to five glasshouse modules, each 40' x 100'. between each glasshouse is a 15' wide aisle to allow for the intake and exhaust of cooling air. Inside the glasshouse are fixed benches, and the headhouses contain a mixture of program, including circulation, growth chambers, bench lab, storage and potting. See fig A.10 opposite.

PROPOSED GREENHOUSE ORGANIZATION

The following strategies allow this unit to make more efficient use of land area:

- The space between glasshouse compartments is enclosed for headhouse use. Air is drawn in through vents in the roof and exhausted to the exterior around the perimeter.
- The module places function that don't require light (storage, mechanical space, growth chambers, offices, herbarium, etc.) on a lower floor. On a sloping site, this lower floor can be dug into the site to create a level pad for the glasshouse.
- Rolling benches allow more of the glasshouse floor area to be used for growing by eliminating circulation space.

Figure A.13 UCLA Plant Growth Center, Paul Murdoch Architects, uses the same space-saving strategies as outlined above.

PROTOTYPE PLAN FEATURES

The basic unit of the prototype greenhouse is the 1,000 sf glasshouse compartment.

This unit has separate access to both the headhouse and to the exterior, and has independent environmental controls. This compartment can be further subdivided as required, though the added circulation needed to maintain isolation reduces the usable floor area.

The modules are arranged in groups of four, and separated by a 10 ft corridor containing work benches for potting and other headhouse uses. The center of the facility is a 4,700 sf headhouse, inclusive of storage and other ancillary functions. A portion of this could be outdoor space. Where located on a sloping site, the lower level provides a level pad for the greenhouse, and creates additional program capacity. This space provides a high return on investment, as a large portion of the cost of building this space is in excavation and foundations, which are required to build on a sloping site, regardless. A wraparound balcony allows exterior access to each compartment.

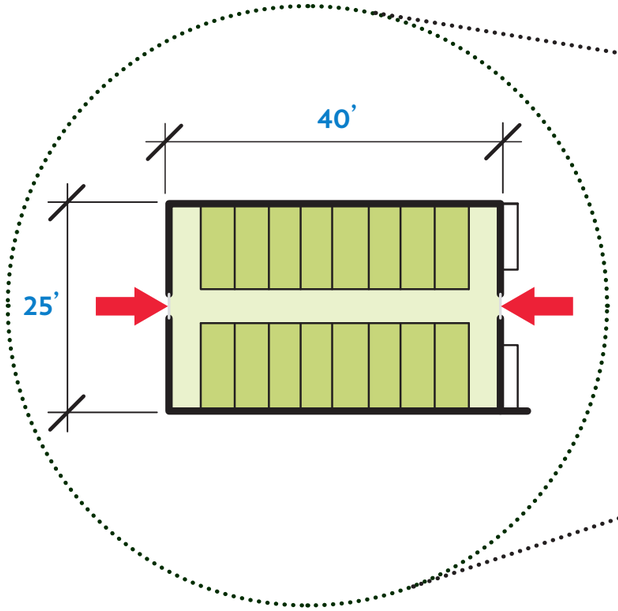


Figure A.14 Enlarged plan of a single 1,000 sf glasshouse compartment

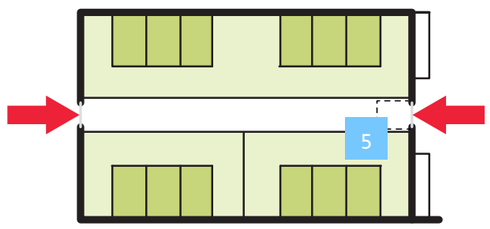
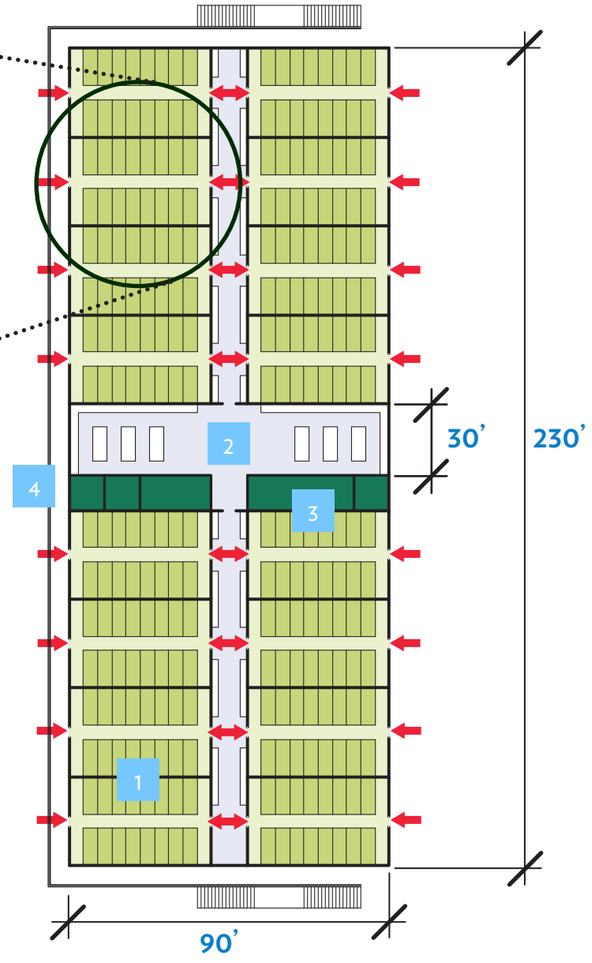


Figure A.15 Alternate plan of the same compartment showing subdivisions

Figure A.17 Complete prototypical greenhouse module.



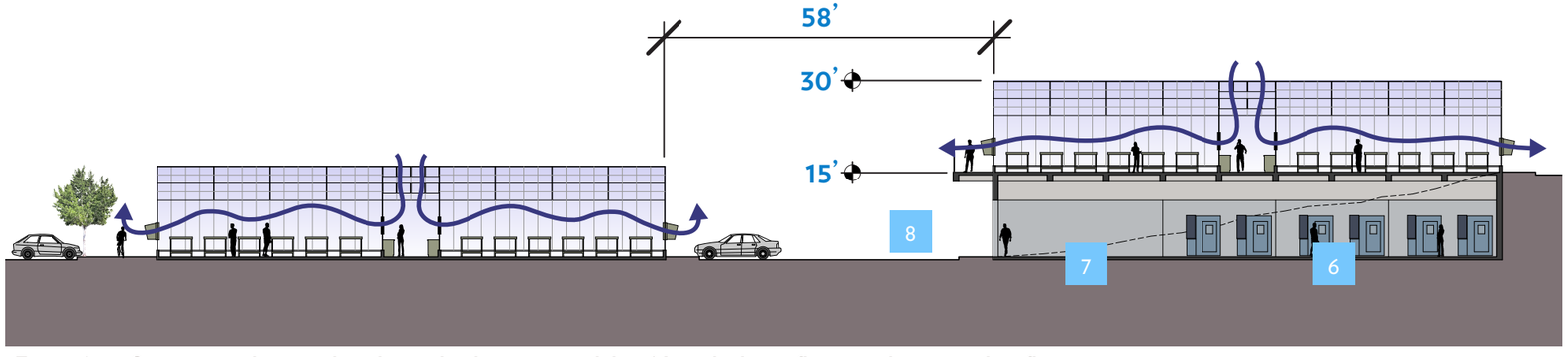


Figure A.16 Site section showing the relationship between modules. Note the lower floor may be omitted on flatter terrain

1 Glasshouse compartment
2 Headhouse
3 Storage
4 Walkway for exterior compartment access
5 Airlock Vestibule
6 Growth Chambers
7 Workshop, offices, or other ancillary uses
8 Lower floor serves adjacent greenhouse on same level

Figure A.18 Modern research glasshouse at Duke University

DESIRABLE FEATURES AND AMENITIES OF A MODERN RESEARCH GREENHOUSE

A research greenhouse is a laboratory in and of itself.

Scientific experimentation requires control of every variable affecting the growth and health of the research specimens. These include the intensity and daily duration of light exposure, watering patterns, fertilizer quantities and types, temperature and humidity, just to name a few. The more precisely a plant growth environment is able to control and isolate these variables, the higher the quality the result that can be obtained. Figure A.18 is representative of a modern research greenhouse.

Additionally, the following are desirable features:

- Humidity control
- Deionized water supply
- Irrigation system programmable from bench
- Direct fertilizer feed
- Airlock for exclusion of insects
- Cameras and scales for measuring and recording data
- Security system
- Redundancy of critical systems
- Electronic monitoring of systems
- Direct access to compartment from interior and exterior

A.7
Opportunity Sites

Opportunity sites are areas of campus identified as advantageous for the placement of plant growth environments and support facilities. In identifying these sites the planning team looked for areas which were underutilized.

East Campus Opportunity Site: On east campus, plant growth environments are located just outside of the Core Campus, defined by Campus Drive. The site currently occupied by plant growth environments has been expanded to include land now occupied by temporary facilities to the east, parking and open land to the north, and southward up to the base of the Box Springs Mountains. Potential jurisdictional wetlands and protected sage scrub at the north end of the site, adjacent to parking lot 10, will require further investigation. Portions of the site are steeply slopes, requiring significant earthwork.

West Campus Opportunity Site: While West Campus at first glance appears wide open for development, nearly all of the land is occupied by research fields. Some of these fields hold high value perennial crops, namely the University's citrus variety collections. A large portion of West Campus has also been designated a hazardous substance cleanup site by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, more commonly known as Superfund. A large area of land also sits within a FEMA flood zone, precluding development.

Figure A.19: Aerial view of campus

EAST CAMPUS OPPORTUNITY SITE

Site Attributes:

Positive:

- Proximate to the lab buildings used by researchers in the College of Natural and Agricultural Science.
- Easily accessed from Campus Drive and Eucalyptus Drive.
- Not impacted by the current flood zone delineation, LOMR (Letter of Map Revision) 2010.

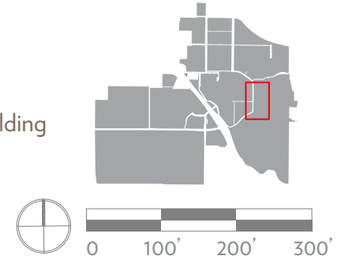
Negative:

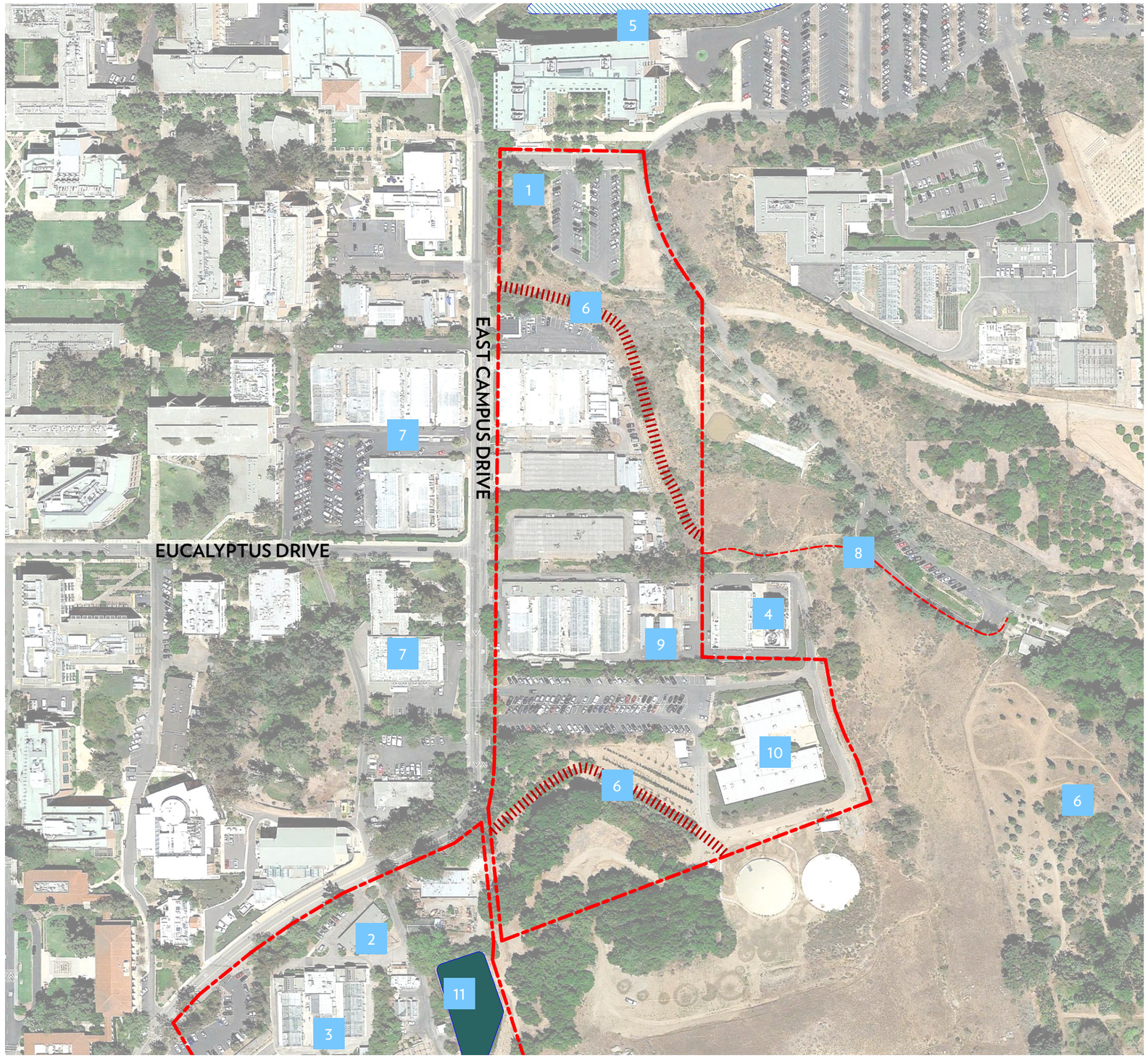
- The existing Computing and Communications Building, as well as several smaller trailers may need to be relocated.

Other:

- Downhill to the east are Botanic Gardens, accessible via an existing trail off the east end of Eucalyptus Drive.
- Topography requires significant earthwork, but also allows for stacked program, making better use of land area.

1. Possible environmental concerns have been raised adjacent to P10 lot. University should investigate before proceeding on this site.
2. Entomology workshop and herbarium to remain, pending new construction
3. Glasshouse/headhouse complex 1-3, adjacent lathhouses and genomics shed are lower priority for replacement.
4. Existing central chiller plant
5. LOMAR 2010 flood zone
6. Greatest slope
7. Future lab building site
8. Trail to Botanic Gardens
9. Temporary trailer facilities
10. Computing and Communications Building
11. Reservoir





WEST CAMPUS OPPORTUNITY SITE

Site Attributes:

Negative:

- Existing roadways are unpaved.
- Southern edge of site is bounded by a FEMA flood zone and Superfund cleanup site.
- Steep ridge at edge of site shows heavy erosion. New construction may require stabilization of hillside.
- Single family homes east of Canyon Crest Drive may be sensitive to construction effects.
- Possible concerns have been raised regarding a protected lizard habitat. The University should investigate this further before proceeding on this site.

Neutral:

- Surrounded by research fields on 3 sides.

1 Existing structures have been yellow-tagged (identified as significantly degraded)

2 Citrus variety collection

3 USDA Germplasm (P5994) to remain

4 Irrigation main beneath existing roadway

5 Soils receiving to remain at west campus

6 Turf lab to remain or be relocated nearby

7 Nematology microplots

8 Reservoir

9 Entomology (P5305) to remain

10 Picnic pavilion and tree grove to remain

11 Area of steepest slope

12 Superfund cleanup site

13 FEMA 2008 flood zone AE

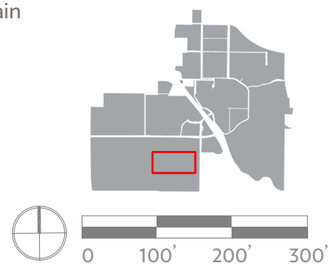


Figure A.20 West campus opportunity site

INDEX OF RELEVANT STRUCTURES

East Campus (Main Site)

P5506	Cold BX Roof
P5279	Greenhouse 11
P5280	Greenhouse 12
P5281	Greenhouse 13
P5481	Greenhouse 14
P5427	Soil Building
P5425	Lathhouse 3
P5387	Vivarium Trailer
P5535	Lathhouse B
P5479	Greenhouse AP FL3
P5478	Greenhouse AP FL2
P5402	Arabidopsis 1
P5423	Greenhouse 4
P5422	Greenhouse 5
P5513	Greenhouse 18
P5514	Greenhouse 19
P5515	Greenhouse 20
P5282	Greenhouse 21
P5509	AP Trailer 7
P5476	Anthropology Trailer
P5563	Trailer 9 A
P5560	Unknown
P5376	CNAS Trailer
P5367	Chiller Plant
P5382	Carport
P5381	Computing & Communications

East Campus (Parking Lot 11)

P5275	Greenhouse 6
P5276	Greenhouse 7
P5277	Greenhouse 8
P5200	Greenhouse 9
P5278	Greenhouse 10
P5210	Greenhouse 15 (Nematology Quarantine)
P5284	Greenhouse 16
P5483	Greenhouse 17

East Campus (Hillside)

P5466	Bio Control Building
P5449	Genomics Shed
P5363	Plant Drying Building
P5374	Greenhouse 1 (Teaching)
P5259	Greenhouse 2 (Teaching)
P5378	Greenhouse 3 (Teaching)
P5426	HH Storage
P5350	Growth Chamber Building
P5550	Greenhouse 20-51
P5553	Greenhouse 20-52
P5318	Lathhouse 4
P5319	Herbarium
P5355	Botany Screenhouse
P5356	Storage 6
P5424	Lathhouse 8

West Campus

P5461	Field Lab
P5463	Gar SS
P5464	Storage 2
P5255	Botany Fieldhouse 15A
P5521	Storage Dock
P5704	Greenhouse 15-35
P5315	Greenhouse 15-36
P5312	Lathhouse 32
P5355	Insect 19
P5321	Storage 37
P5361	Insect 44
P5516	Greenhouse 15-40
P5519	Greenhouse 15-41
P5522	Greenhouse 15-42
P5524	Greenhouse 15-43
P5529	Greenhouse 15-48
P5304	Insect Comp
P5288	Nematology Micro Storage
P5287	Plant Pathology Storage
P5189	Com Wrk Fd 16
P5291	Turf Plot Storage
P5188	Mite C Fld 16
P5531	Greenhouse 16-53
P5527	Greenhouse 16-52
P5526	Greenhouse 16-51
P5525	Greenhouse 16-49
P5375	Greenhouse 16-48
P5371	Greenhouse 16-47
P5260	Greenhouse 16-46
P5258	Greenhouse 16-45
P5408	Greenhouse 16-54
P5412	Greenhouse 16-55
P5434	Greenhouse 16-50
P5420	Greenhouse 16-58
P5419	Greenhouse 16-57
P5413	Greenhouse 16-56
P5548	Ag Ops Shed 9
P5547	Greenhouse 16-08
P5546	Greenhouse 16-07
P5545	Greenhouse 16-06
P5544	Greenhouse 16-05
P5540	Greenhouse 16-04
P5543	Greenhouse 16-01
P5296	Greenhouse 16-09
P5541	Greenhouse 16-02
P5542	Greenhouse 16-03
P5299	Greenhouse 16-10
P5564	Greenhouse 16-14
P5565	Greenhouse 16-13
P5587	Greenhouse 16-15
P5588	Greenhouse 16-12
P5583	Greenhouse 16-16
P5567	Greenhouse 16-20
P5536	Greenhouse 16-24A
P5537	Greenhouse 16-24B
P5538	Greenhouse 16-24C
P5539	Greenhouse 16-24D
P5499	Greenhouse 16-21
P5273	Greenhouse 16-22
P5297	Greenhouse 16-23
P5552	Greenhouse 16-29
P5187	Greenhouse 16-32
P5293	Greenhouse 16-25
P5267	Greenhouse 16-26
P5269	Greenhouse 16-27
P5344	Greenhouse 16-28

A.8
Scenario 1: East Campus

OVERVIEW

Scenario 1 locates the entirety of the concept program on the East Campus opportunity site.

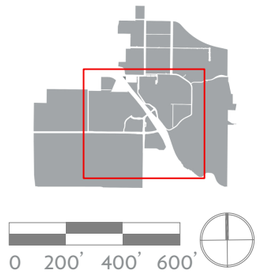
These planning scenarios demonstrate possible configurations of the concept program on the opportunity sites. While this scenario does not require any work on the West Campus, the planning team recommends removing the existing facilities that have been identified by Campus Physical Plant as being in poor or inoperable condition. The vacated land should be used for programs that support land-based research. Agricultural Operations will remain on the West Campus.

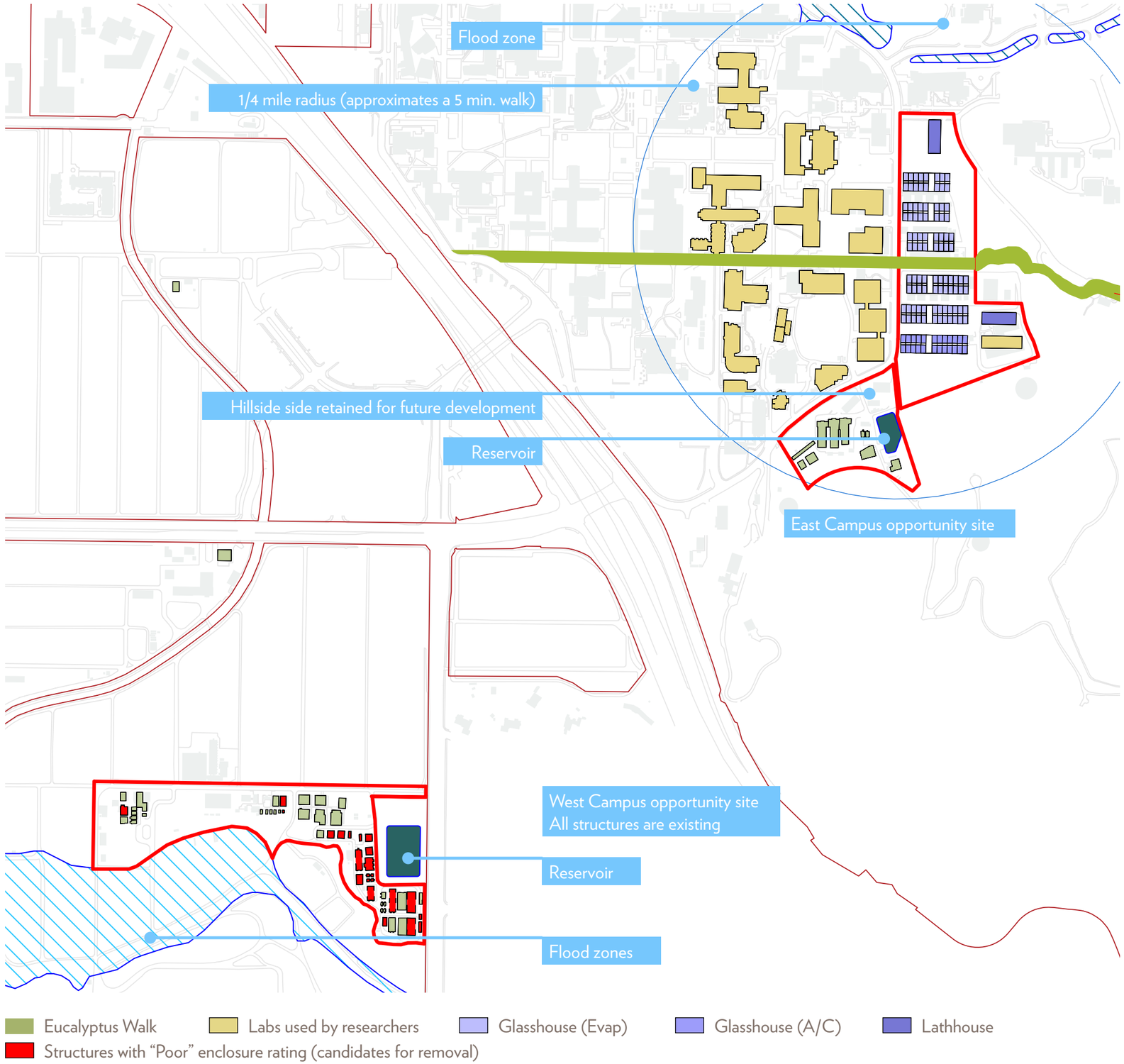
PROS

- All new and proposed laboratories used by CNAS researchers are within a 5 minute walk from the site. East campus amenities are within a 10 minute walk.
- Scenario defines a compact greenhouse and research lab district.
- Site has excess capacity for future growth beyond the concept program.
- Enhances the axis of Eucalyptus Drive by the siting of the new greenhouses and creates a vista point to the Botanic Gardens to the east.

CONS

- Steep topography requires significant earthwork for construction.
- P10 and P11 parking would need to be replaced elsewhere.
- Temporary space including the Computing and Communications Building would need to be replaced elsewhere.
- Precludes future development of other higher-density uses.





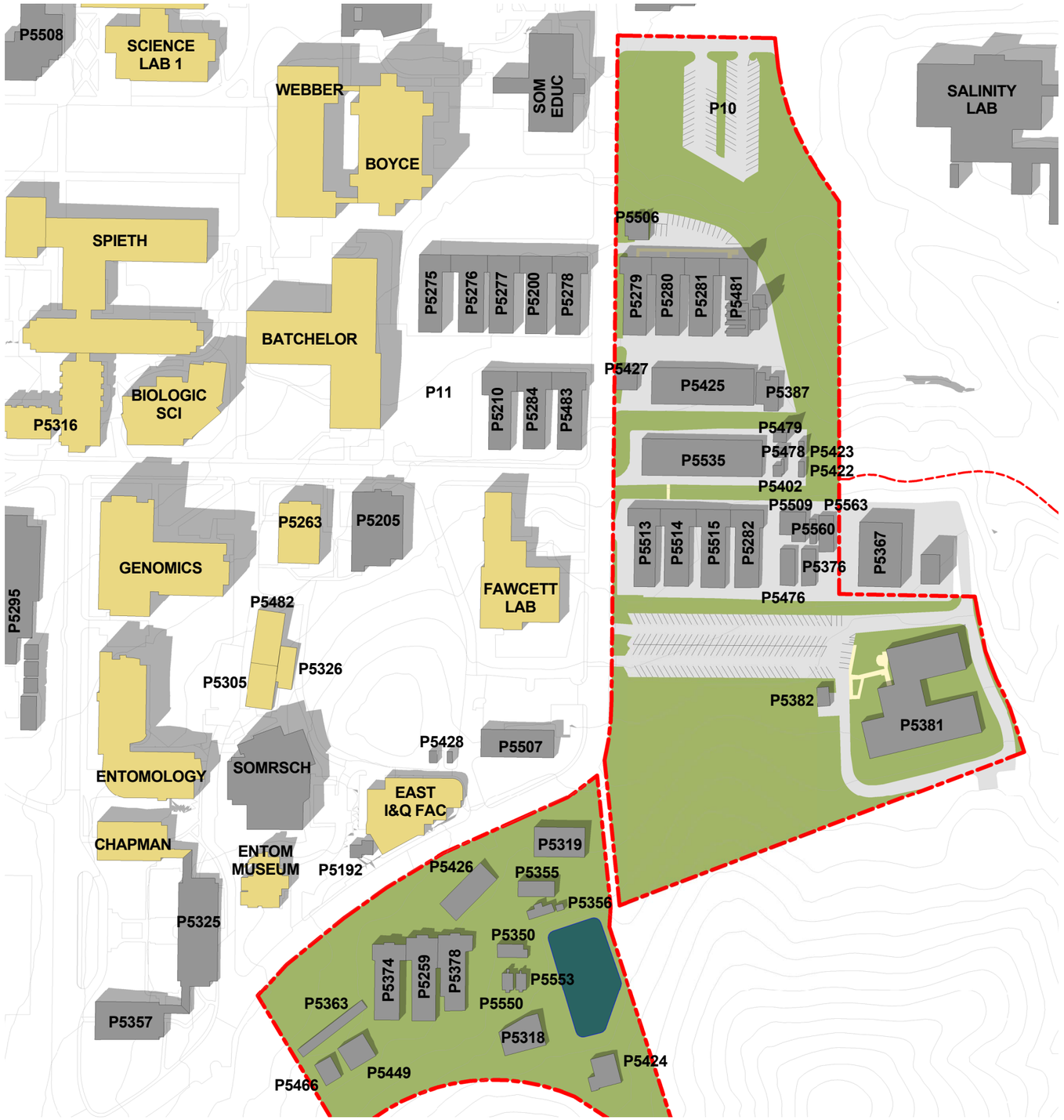
EXISTING SITE PLAN

This image shows the East Campus opportunity site in its current state. Buildings in yellow have been identified as containing labs or offices of CNAS research faculty.

PHASING

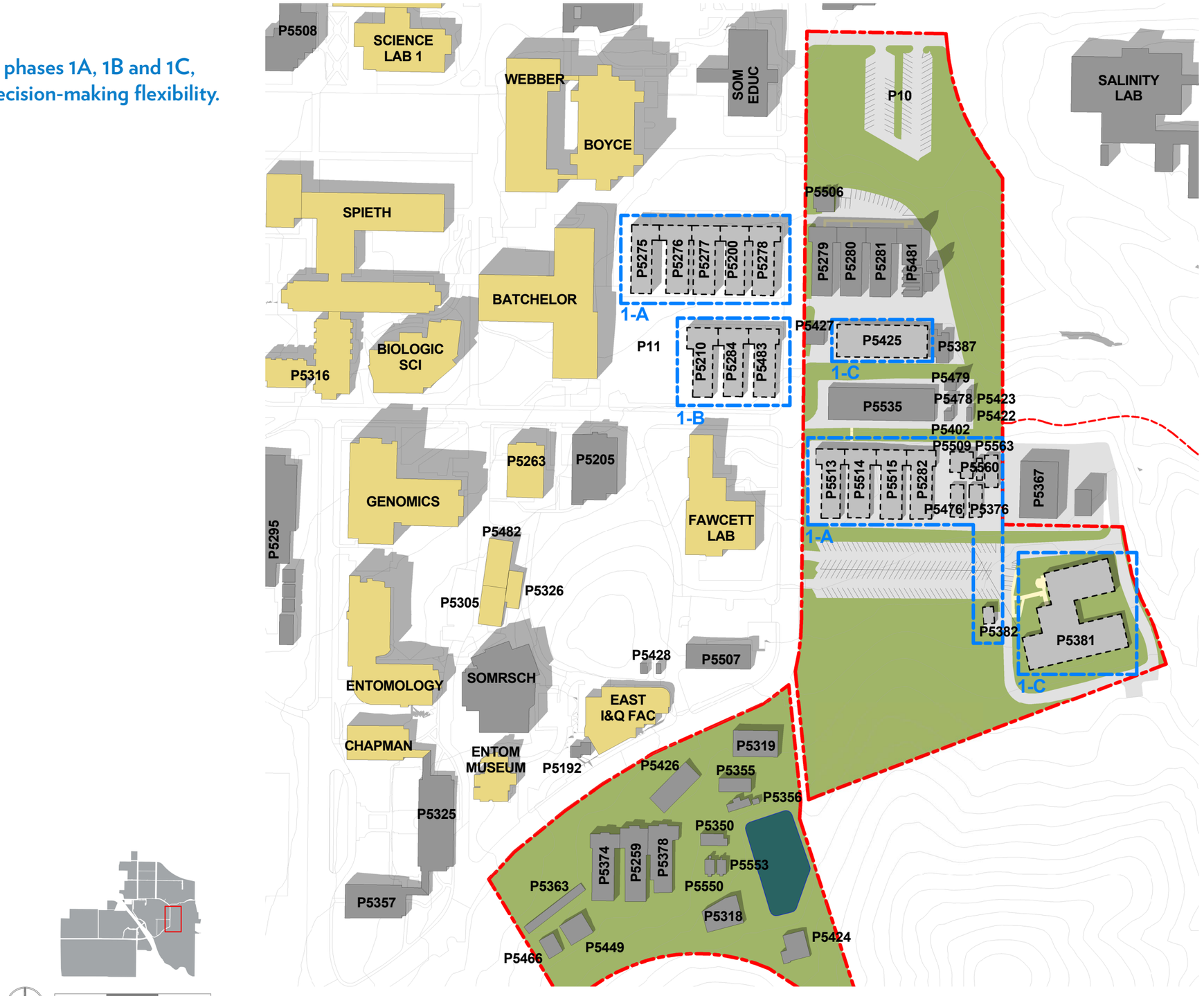
Building new plant growth environments and support facilities in stages allows for use of a portion of the facilities to continue throughout construction. These analyses are not meant to be prescriptive, but are some of the many possible ways new construction could be phased to reduce interruption to research activities.

Building in phases often increases the overall cost of construction, but this is often outweighed by the benefits of continued use through the construction process.



PHASE 1 DEMOLITION

Phase 1 has been sub-divided into phases 1A, 1B and 1C, giving the University additional decision-making flexibility.



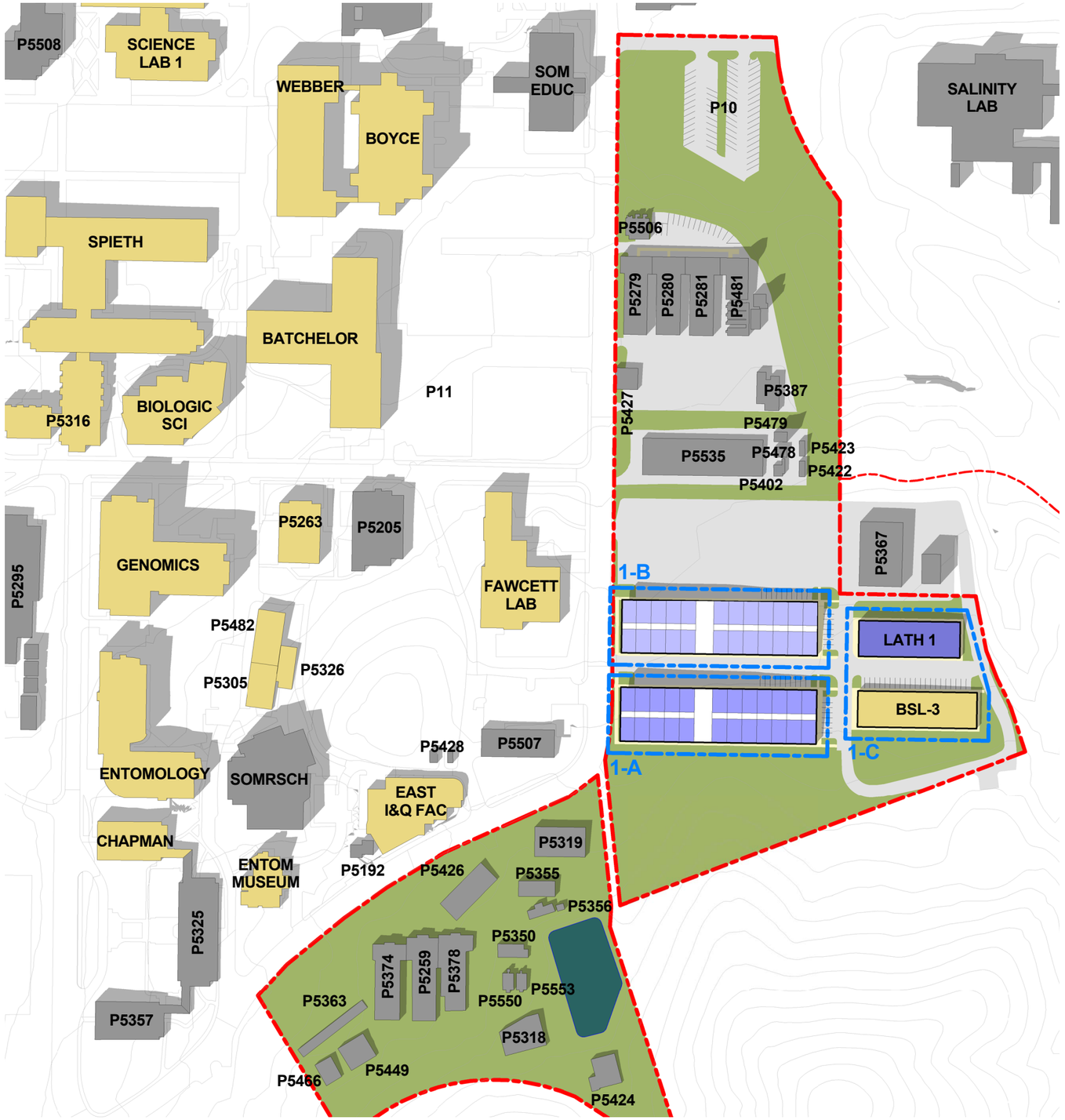
PHASE 1

Phase 1 provides a minimum supply of high-quality space to fill immediate needs and to prepare for subsequent construction phases.

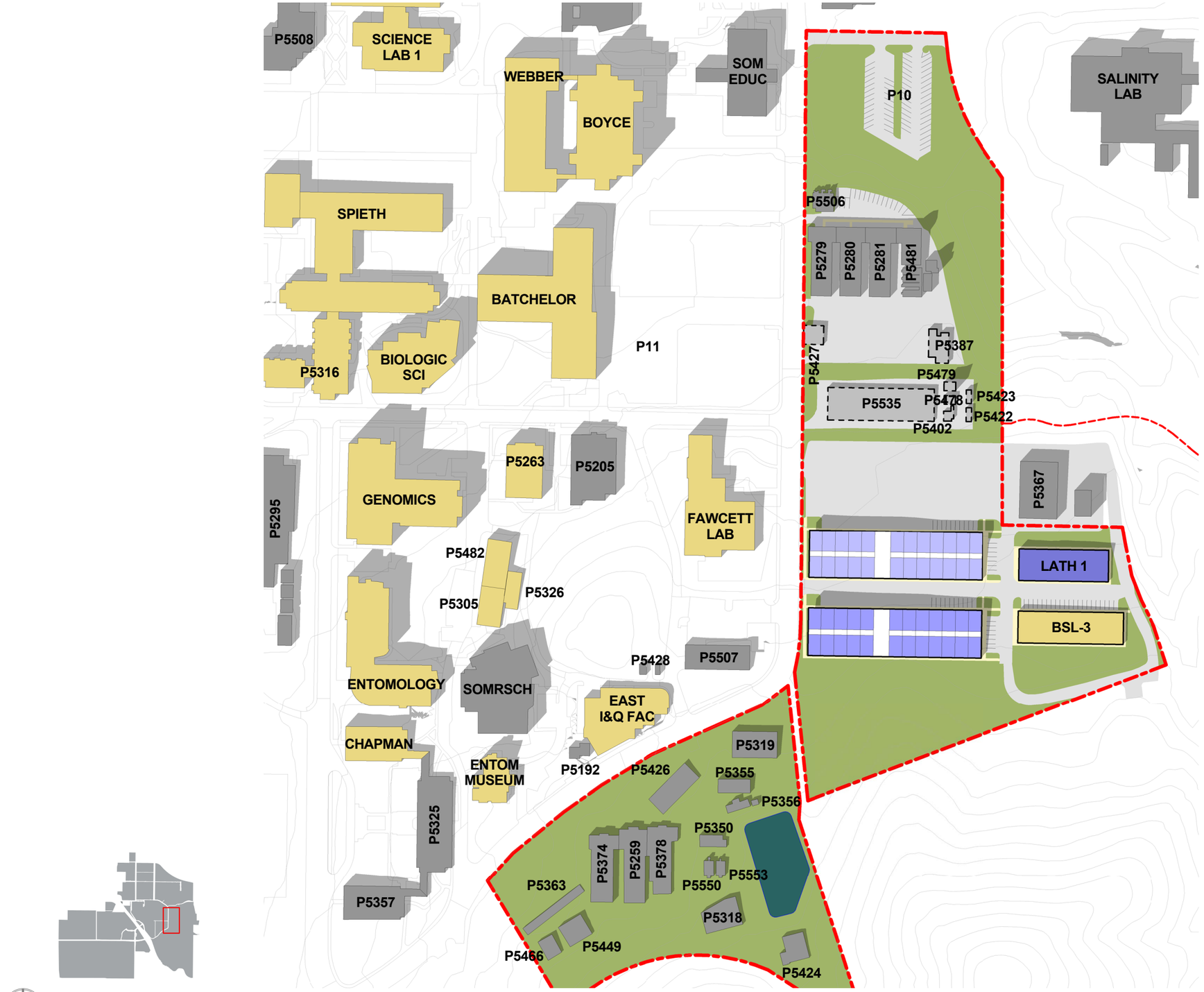
This phase removes the temporary Computing and Communications Building and its carport. It provides a BSL-3 laboratory, and replaces the glasshouse, headhouse, and lathhouse space to be demolished in Phase 2. It is anticipated that the newly constructed glasshouse space will accommodate all uses currently in Greenhouses 6 through 10, and 18 through 21, a total of 36,000 sf of glasshouse and 16,200 sf of headhouse.

Phase 1 Provides (sf)

Glasshouse (Evap Cooled)	24,000
Glasshouse (Air Conditioned)	24,000
Headhouse	11,400
Growth Chambers & Support	59,400
Lathhouse (Relocated)	10,560
Contained Research	12,000



PHASE 2 DEMOLITION

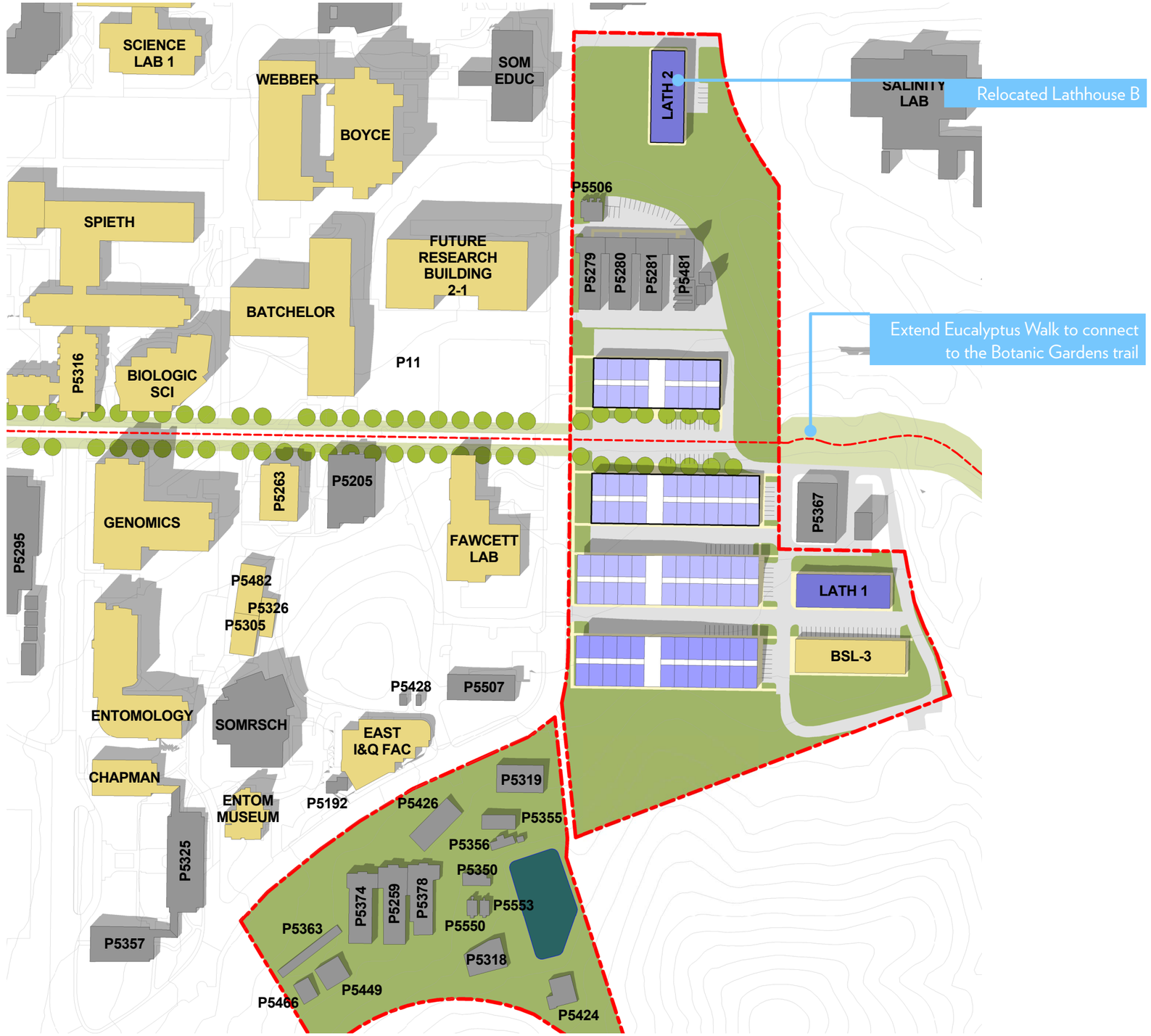


PHASE 2

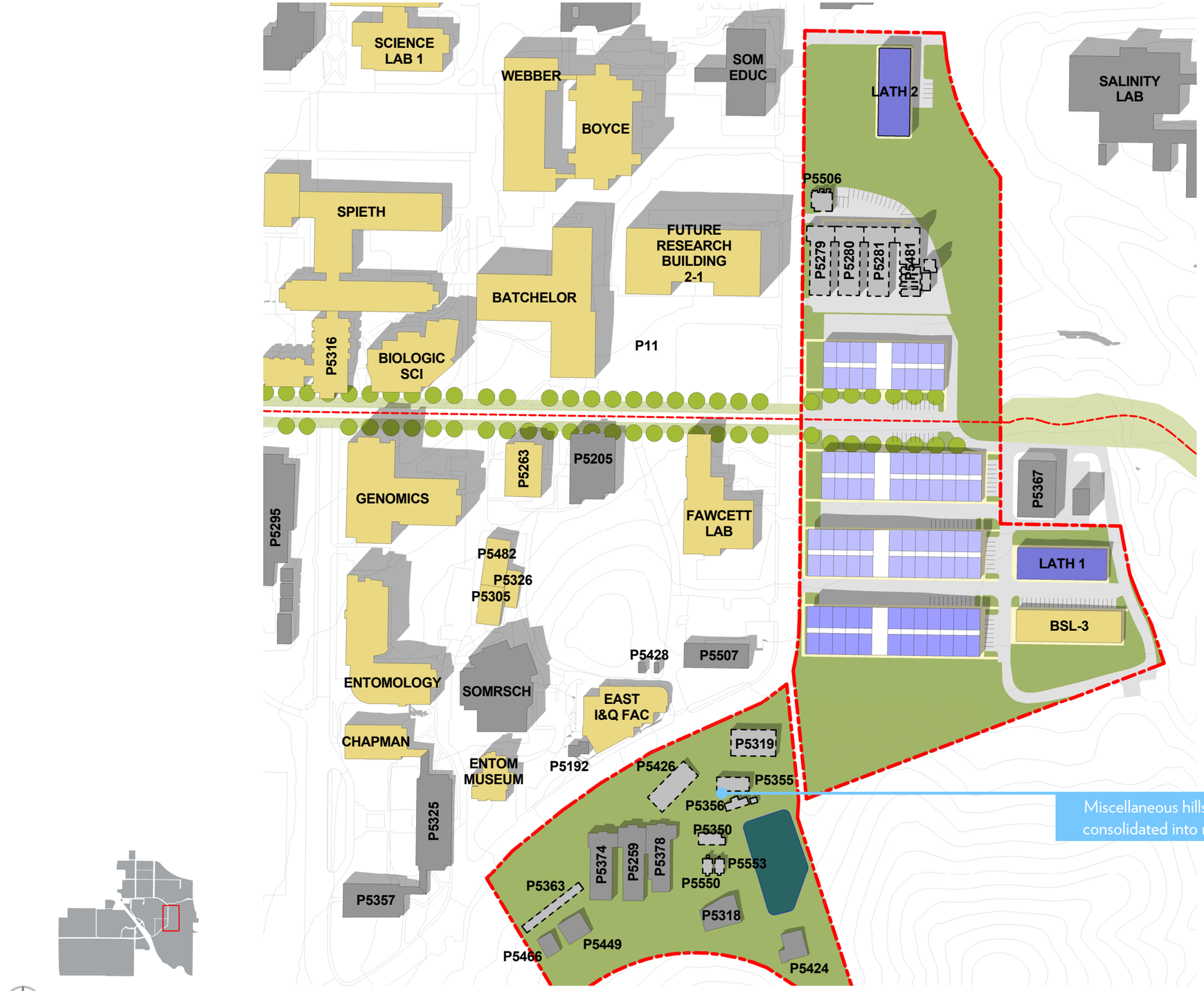
Phase 2 makes way for the proposed Future Research Building 2, and reinforces the axis of Eucalyptus Drive

Two additional glasshouses form a gateway to the newly formed "greenhouse district" of campus, and the existing Lathhouse B is moved north onto the P10 parking lot, making room for the third and final phase of glasshouse construction. At the completion of this phase, work currently housed in greenhouses 15-17 (including the nematology quarantine facility) and greenhouses 11-14 can move into new space.

Phase 2 Provides (sf)		Total New
Glasshouse (Evap Cooled)	38,000	62,000
Glasshouse (Air Conditioned)	0	24,000
Headhouse	10,150	21,550
Growth Chambers & Support	0	59,400
Lathhouse (Relocated)	12,360	22,920
Contained Research	0	12,000



PHASE 3 DEMOLITION



PHASE 3

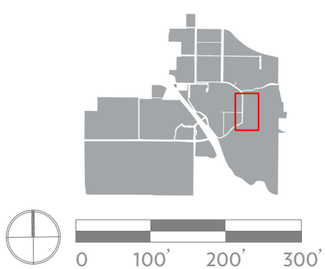
Phase 3 completes the concept program, and makes way for the south wing of MRB2.

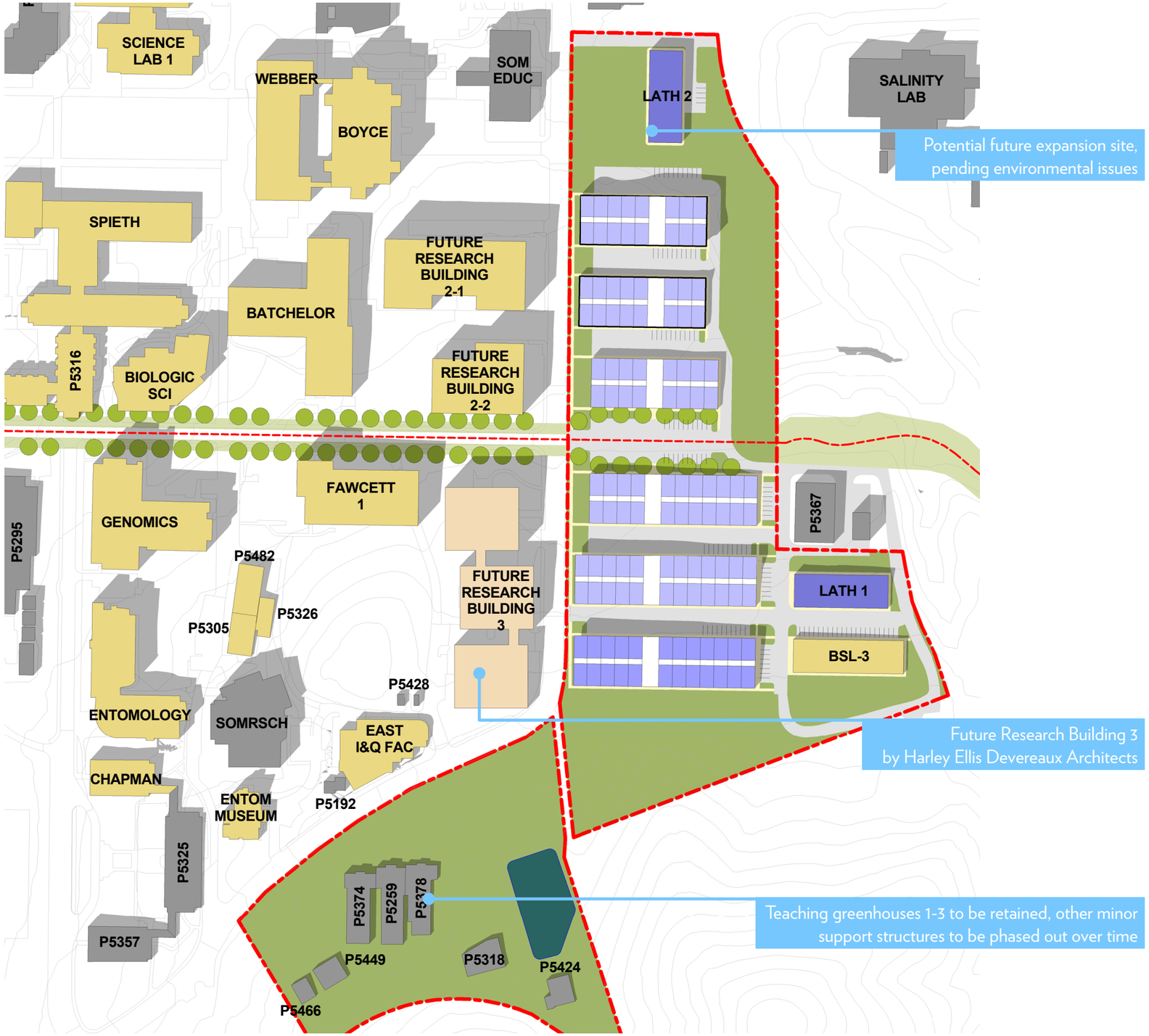
The third and final phase of construction replaces space lost in the removal of greenhouses 15-17 and 11-14. The second phase of Future Research Building 2 does not necessarily occur in this phase, nor does the construction of the proposed Future Research Building 3 by Harley Ellis Devereaux Architects, however they've been illustrated here to show this portion of campus with all proposed future improvements complete.

Undergraduate teaching activities can stay in greenhouses 1-3, as these are slated to remain, being some of the facilities in better condition. If desirable for CNAS, teaching could also be accommodated in newly built glasshouse space.

Several support structures on the hillside site, including plant drying, the herbarium, the entomology workshop, storage, and the growth chamber building can be removed, and their uses relocated to new space in the lower level of one of the new glasshouses.

Phase 3 Provides (sf)		Total New
Glasshouse (Evap Cooled)	32,000	94,000
Glasshouse (Air Conditioned)	0	24,000
Headhouse	9,400	30,950
Growth Chambers / Support	20,700	80,100
Lathhouse (Relocated)	0	22,920
Contained Research	0	12,000

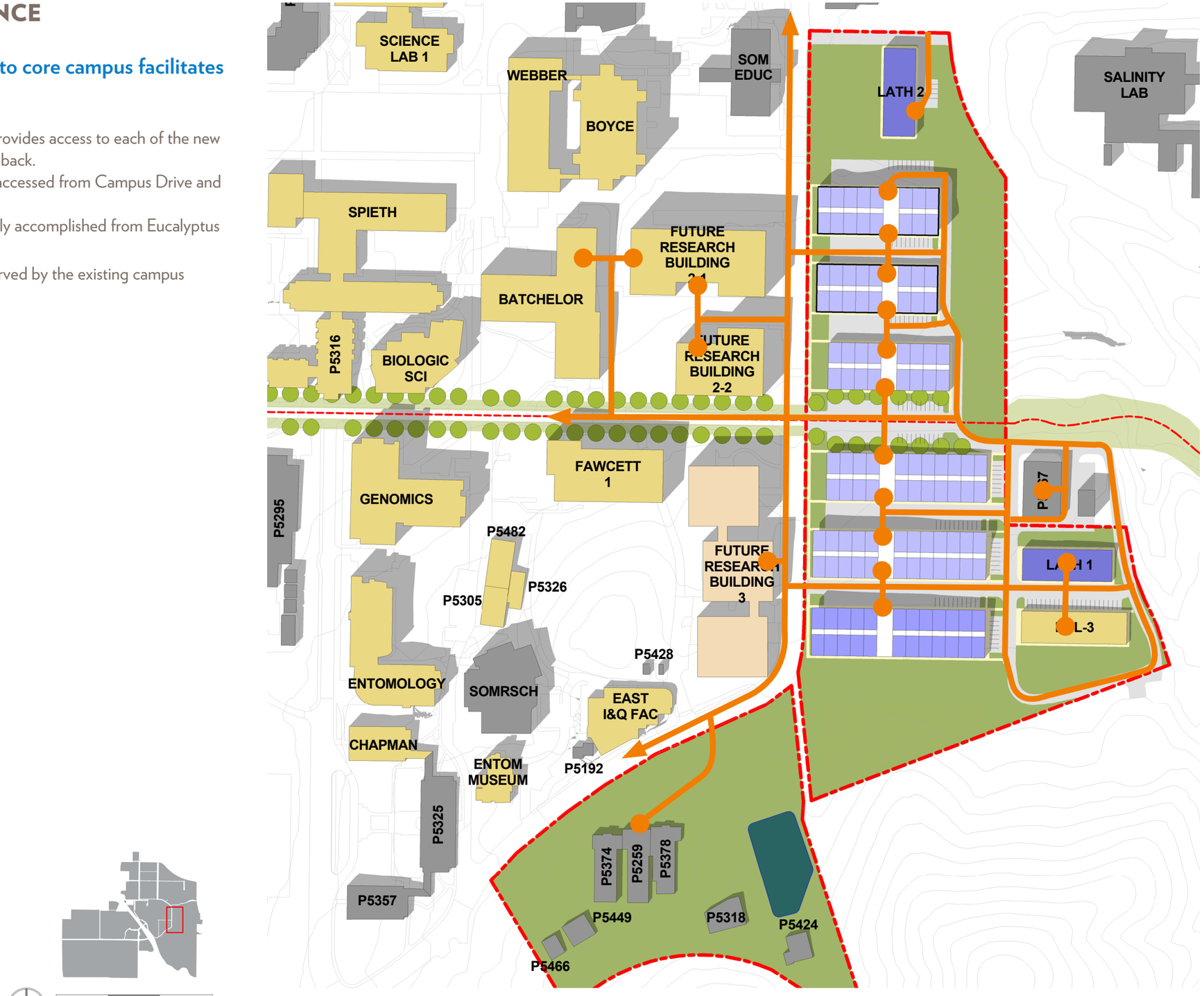




SERVICE AND MAINTENANCE

Compact planning and proximity to core campus facilitates service and maintenance.

- A continuous network of service roads provides access to each of the new facilities, in most cases to both front and back.
- The new "Greenhouse District" is easily accessed from Campus Drive and Eucalyptus Drive.
- Mail and package delivery on foot is easily accomplished from Eucalyptus Drive.
- Gateway to this new district is already served by the existing campus shuttle system.



RELATION TO "ESSENTIAL ELEMENTS"

Each scenario was analyzed for its addition to (or detraction from) the overall vision of the Physical Master Plan Study. Scenario 1 relates to the major principles of master plan in the following ways:

Identity: Enhance Sense of Place

- The proposed plant growth environments and support facilities east of Campus Drive, along with the existing and proposed laboratories (MRB 1 & 2, Fawcett Replacement) west of Campus Drive will create a clearly defined "Research District" on campus.

Community: Facilitate Engagement

- Co-location of plant growth environments with existing laboratories strengthens UC Riverside's living and learning community.
- A gateway to the greenhouse district at the end of Eucalyptus Drive will improve connectivity to labs and the greater campus.
- The extension of Eucalyptus Walk via the trail to the Botanic Gardens will encourage serendipitous interactions.

Stewardship: Exercise Environmental Stewardship

- Locating plant growth environments near the main campus creates value by leveraging existing campus infrastructure.
- West Campus research fields are preserved as a campus resource and revenue generator.

Density: Demonstrate Leadership and Innovation

- Stacking plant growth environment program takes advantage of East Campus topography to increase density.

Figure A.27: View East along Eucalyptus Walk from west of East Campus Drive

Figure A.28: View South along Eucalyptus Walk axis from existing greenhouses at left to the Botanic Gardens below at right

PHYSICAL MODEL

This model provides a three-dimensional view of the East Campus opportunity site. The site has been regraded to lessen the steepest slopes. The greenhouses terrace down from south to north, following the slope of East Campus Drive. Picnic Hill is visible in the lower right corner of the larger image. Off the East Side of the side, a small access road follows an arroyo to the Botanic Gardens.

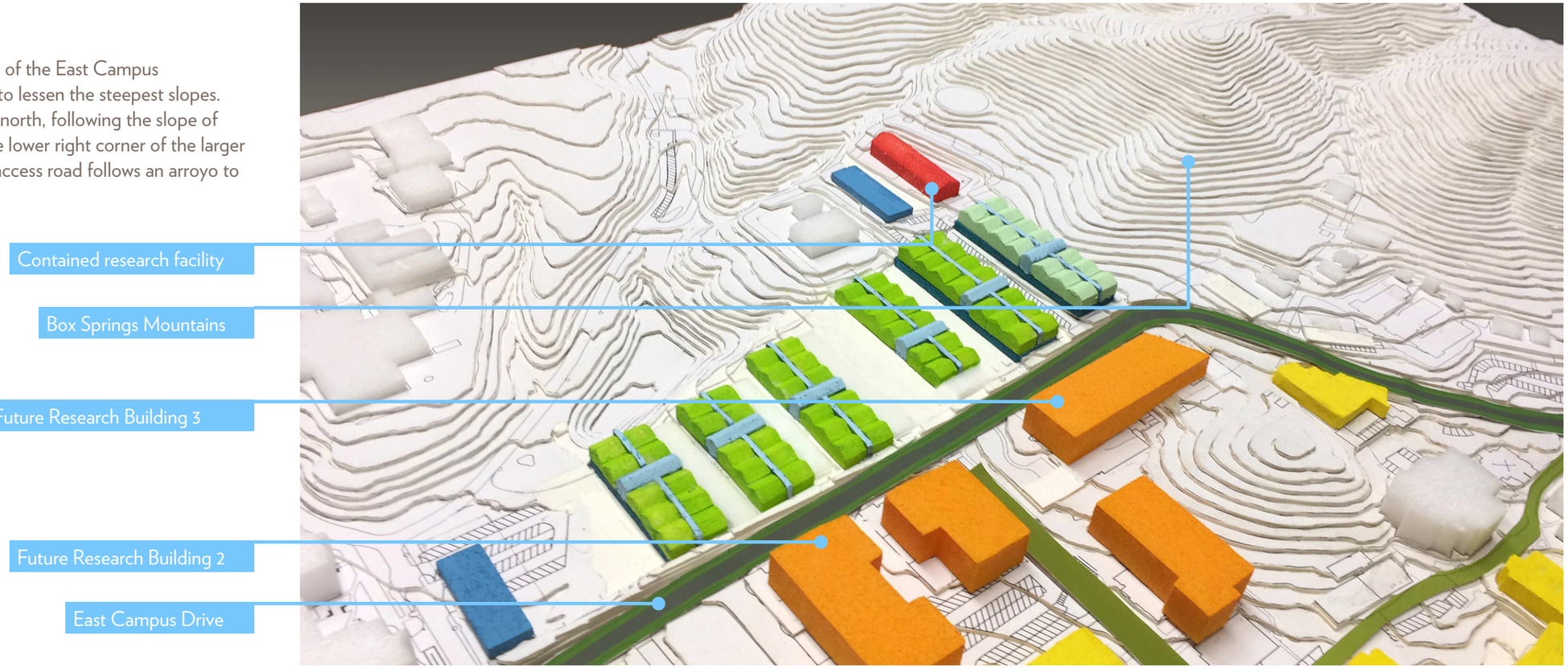


Figure A.29: Aerial view of physical model from northwest

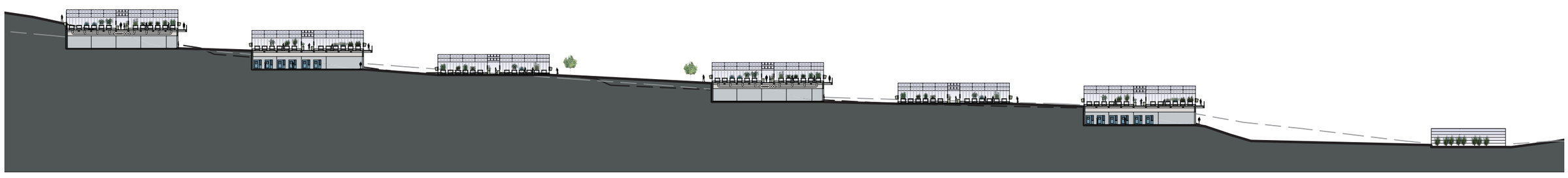


Figure A.30: Site section through East Campus opportunity site

PERSPECTIVE VIEWS

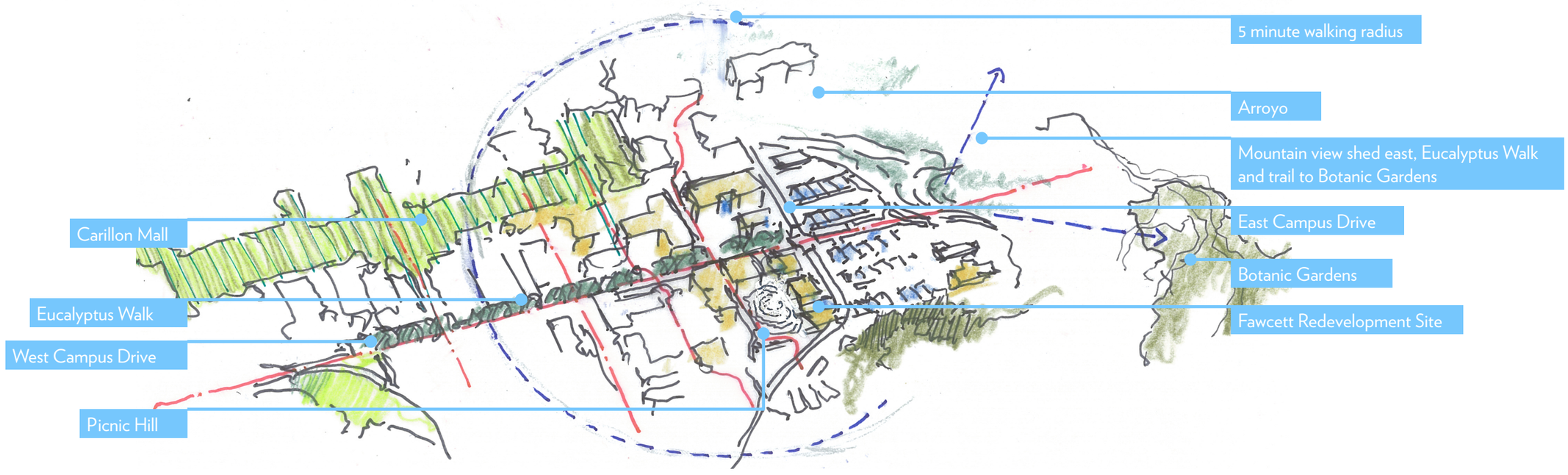


Figure A.29: Aerial view showing "neighborhood" concept

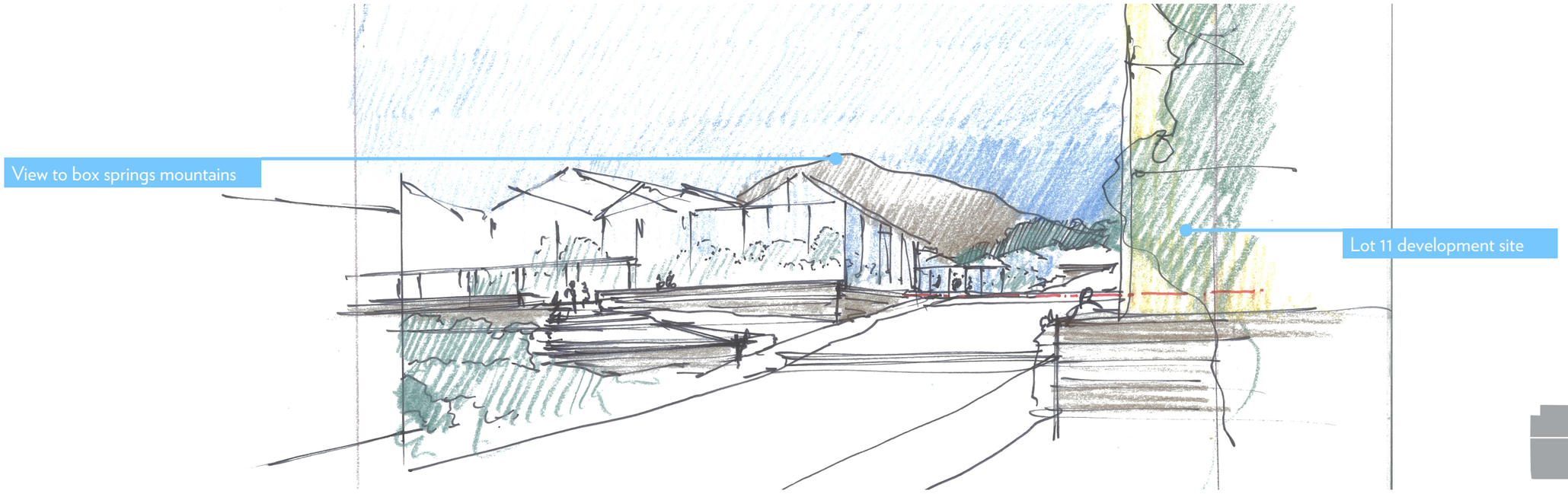
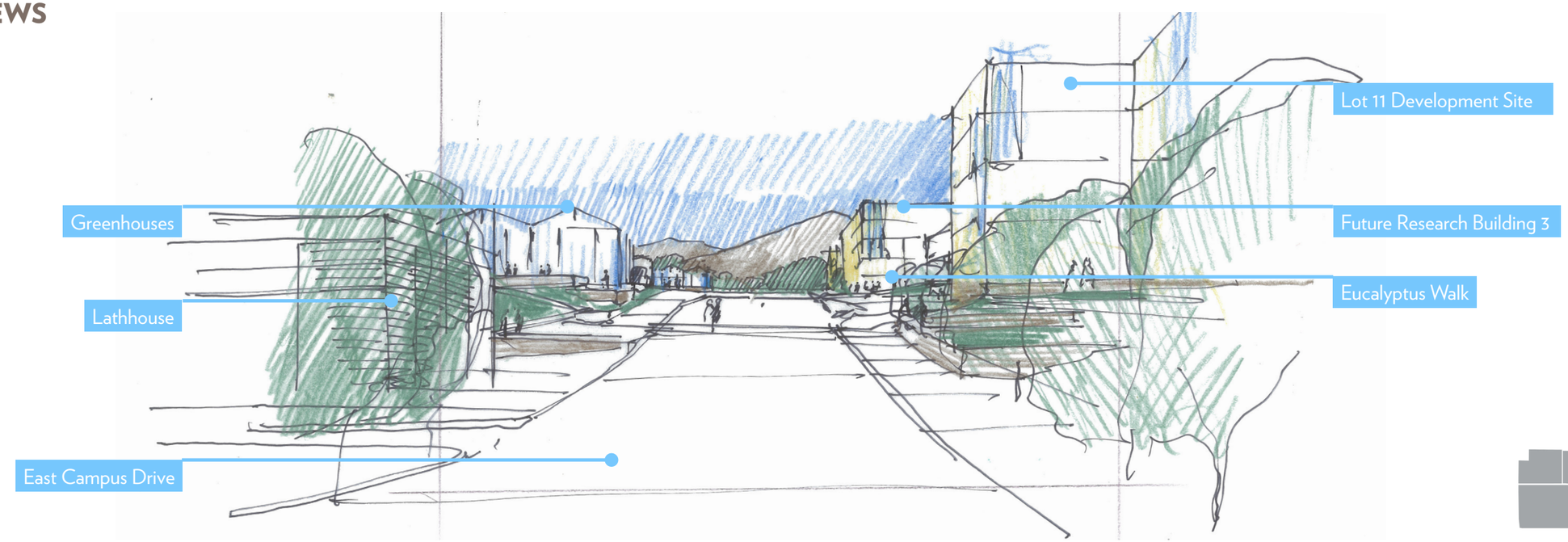


Figure A.30: View south along East Campus Drive from future site of MRB 2

PERSPECTIVE VIEWS



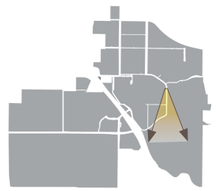
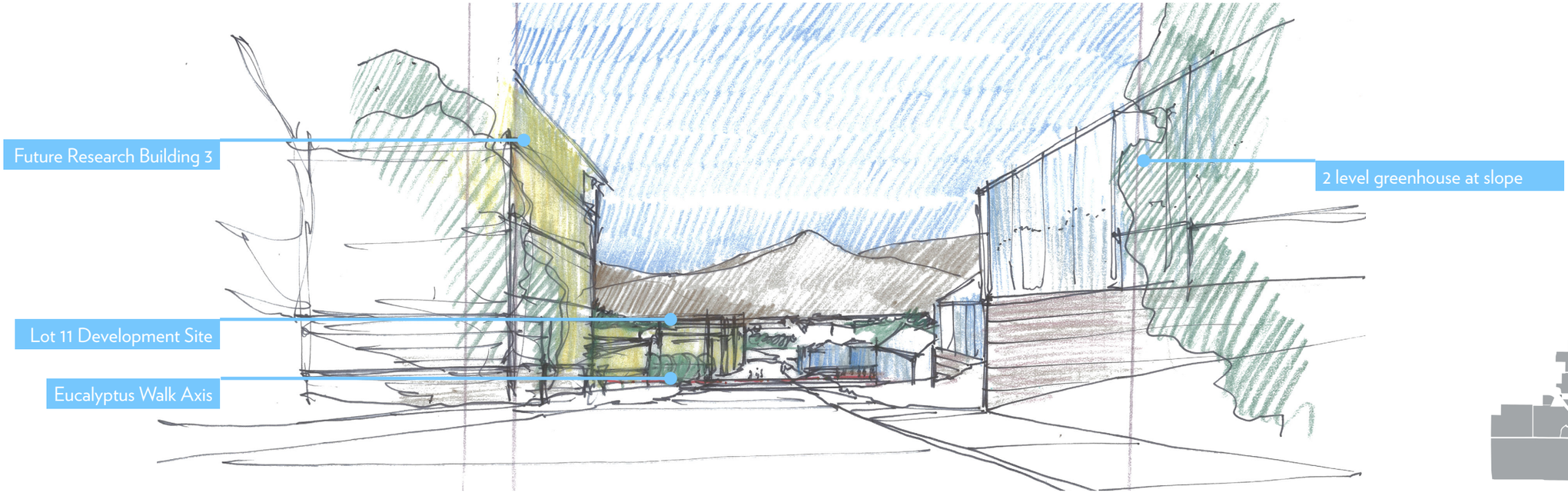


Figure A.31: Perspective view south along East Campus Drive



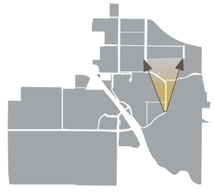


Figure A.32: Perspective view north along East Campus Drive

A.9
Scenario 2: West Campus

OVERVIEW

Scenario 2 creates a research community on West Campus, with minimal program retained on East Campus.

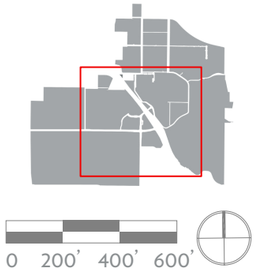
The contained research facility is anticipated to house sensitive material. Keeping this facility close to the activity of the Core Campus, where it can be easily surveilled and patrolled, will help to mitigate security concerns. Greenhouses used for undergraduate teaching also must be kept within easy walking distance of the Core Campus.

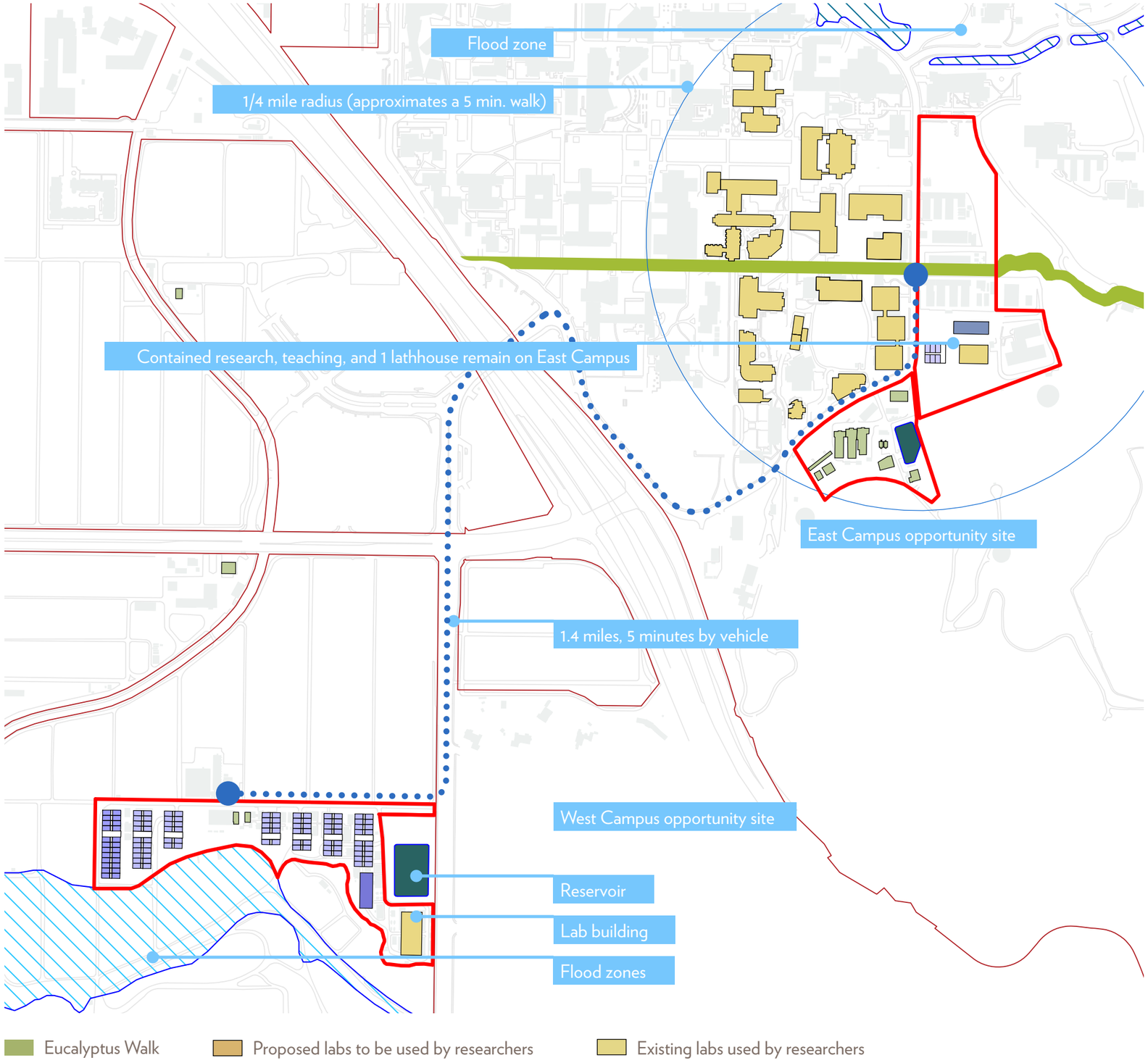
PROS

- Plant growth environments are close to existing land-based research.
- Buildable area on West Campus is relatively flat.
- Lab building on West Campus serves as a West Campus marker, visible from the freeway.
- Leaves the East Campus opportunity site open for future campus development.

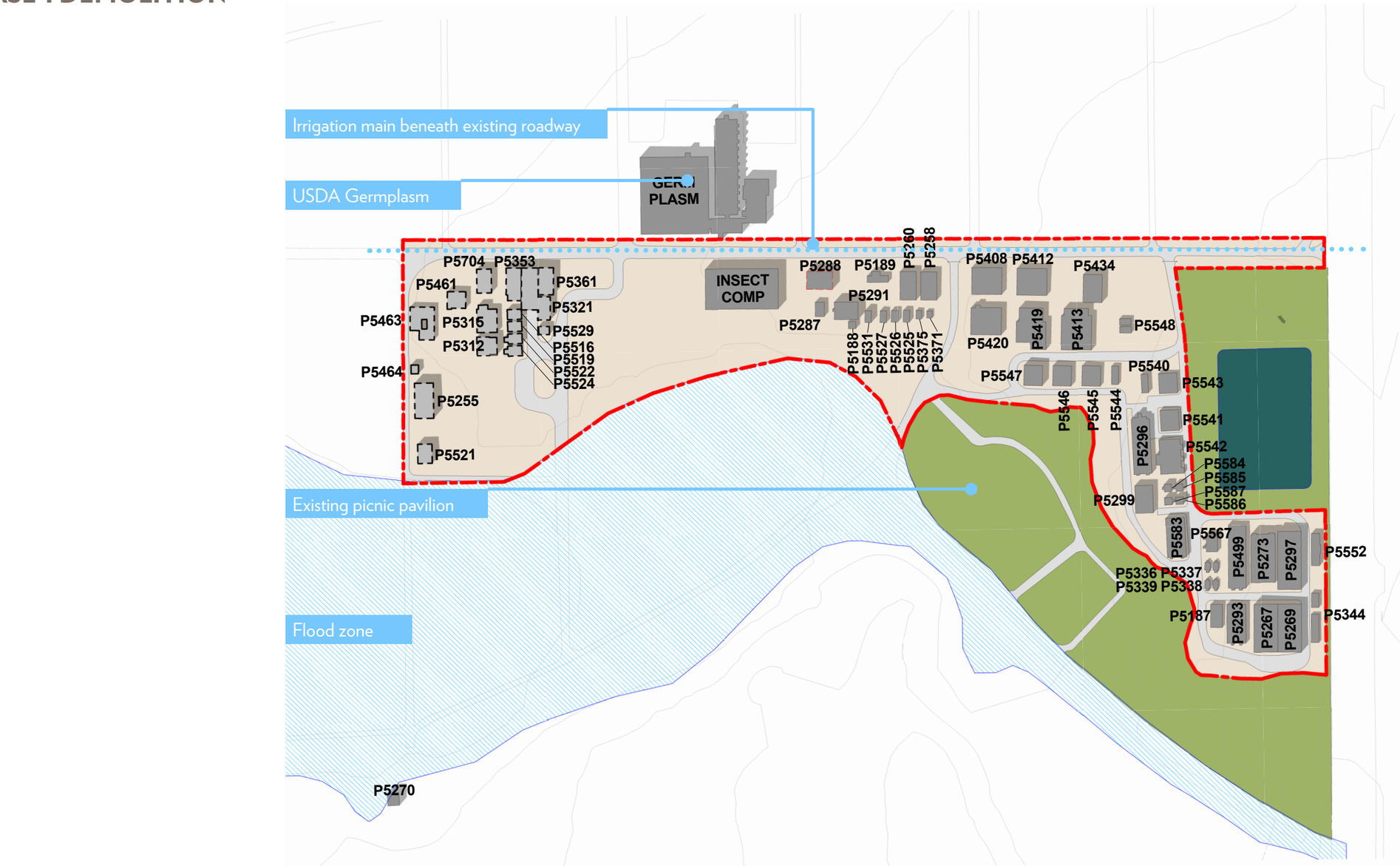
CONS

- Remote location isolates West Campus research community from East Campus and its researchers, laboratories, and amenities.
- Vehicles needed to travel to West Campus.
- Developable site is limited by environmental issues.
- Site is not large enough to accommodate full lathhouse program, or future expansion beyond the concept program without expanding into research fields.
- High site utility development costs due to limited existing infrastructure.
- Widened paved roadway needed to service new buildings. Relocation of irrigation main (see fig. A.20) likely required.
- Remoteness of lab building on West Campus creates security concerns, likely addressed with fences and electronic monitoring.





EXISTING SITE PLAN / PHASE 1 DEMOLITION



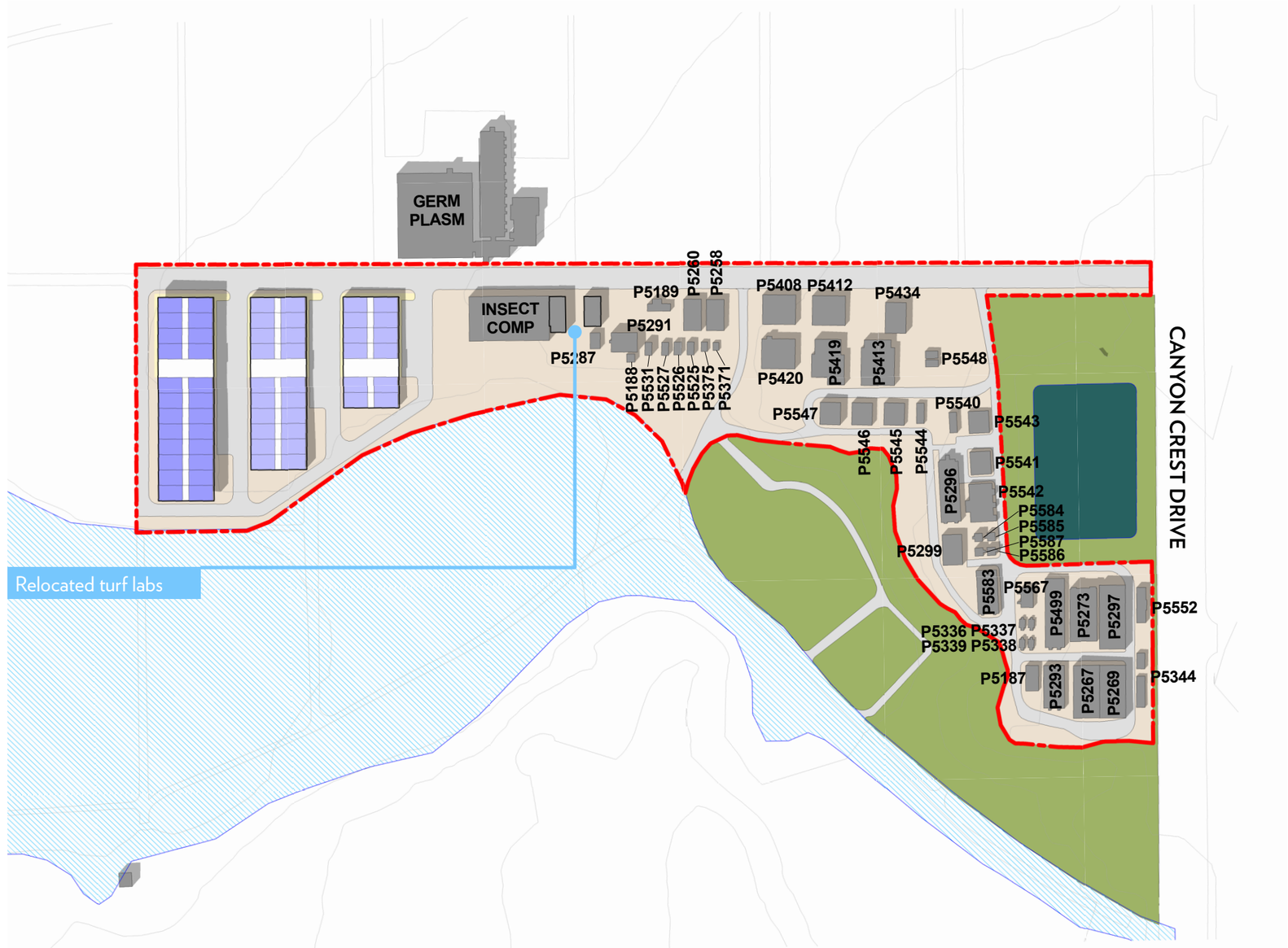
PHASE 1

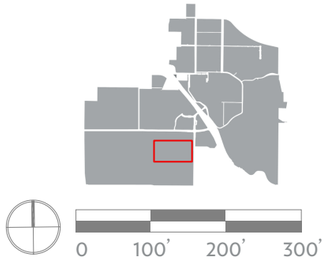
Phase 1 creates the beginnings of a West Campus research community.

The space built in phase 1 replaces glasshouse space to be lost on East Campus in the development of Future Research Building 2. It also creates space to allow work to continue when structures on the east half of West Campus are demolished in preparation for phase 2.

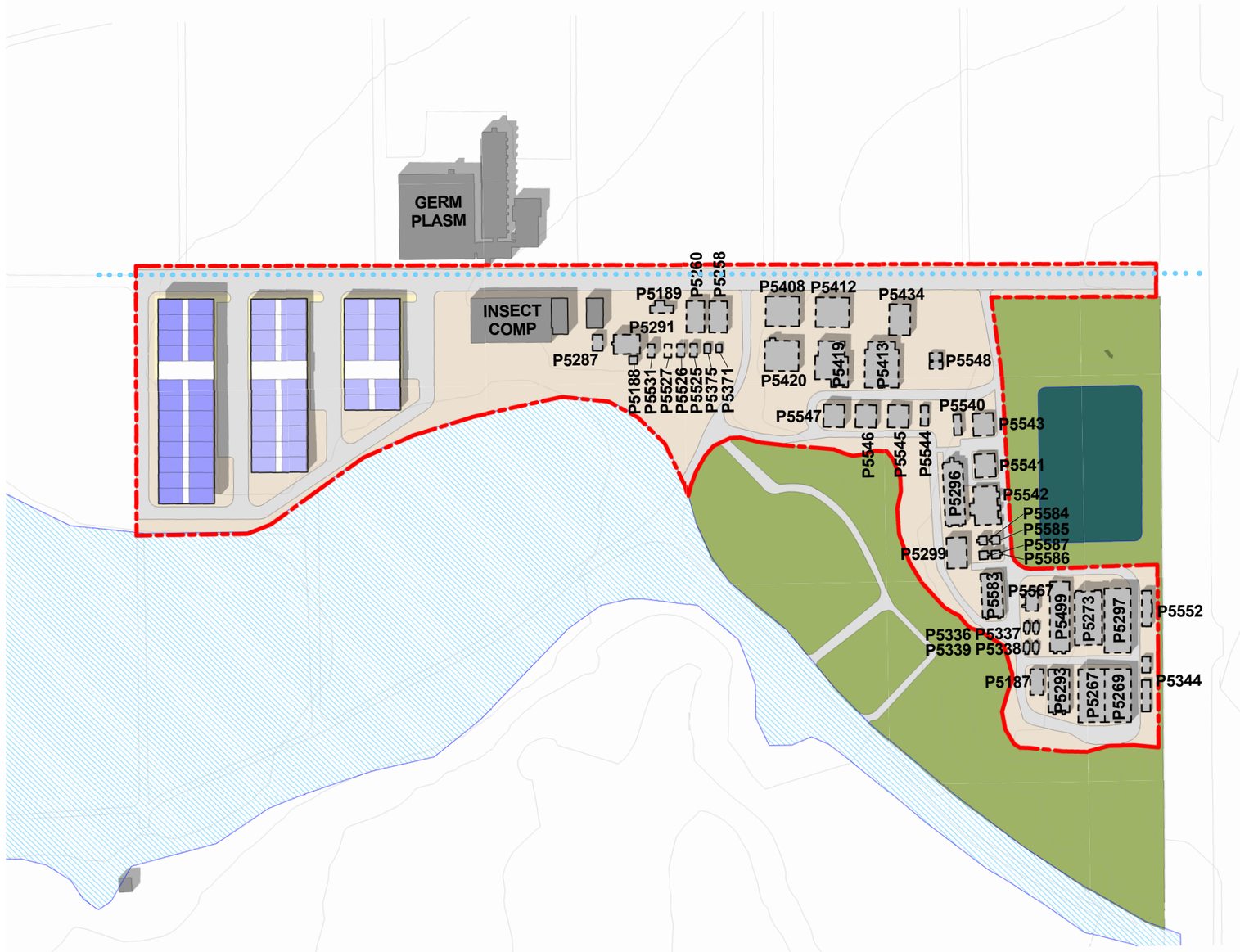
Phase 1 Provides (sf)

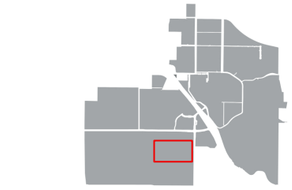
Glasshouse (Evap Cooled)	32,000
Glasshouse (Air Conditioned)	24,000
Headhouse	15,100
Growth Chambers / Support	20,700
Lathhouse (Relocated)	0
Contained Research	0





PHASE 2 DEMOLITION





0 100' 200' 300'

Demolition

PHASE 2

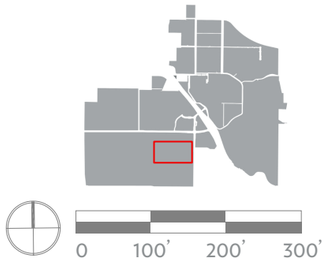
Phase 2 completes the West Campus research community.

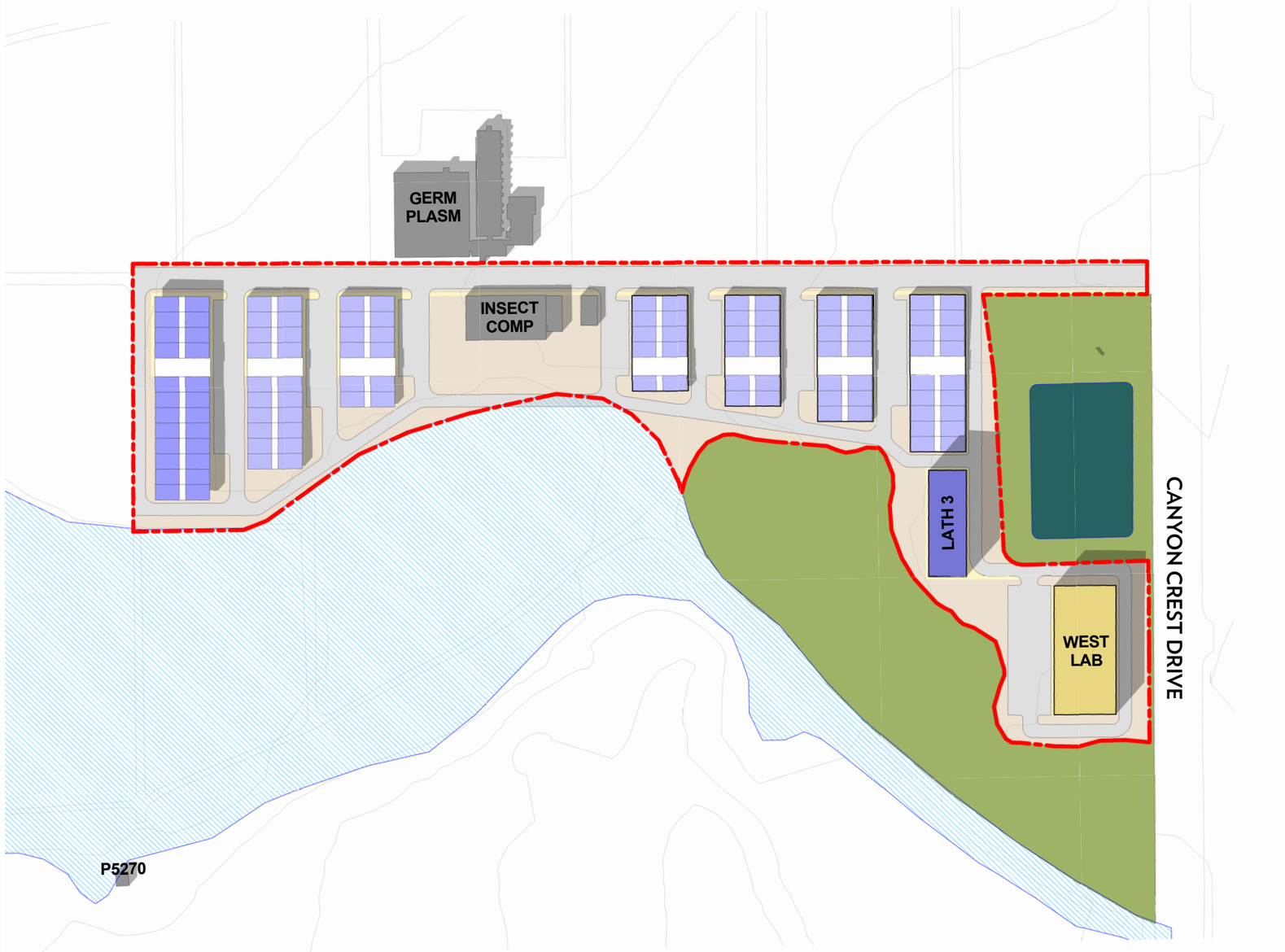
In phase 2, the remainder of the existing structures on the West Campus opportunity site are replaced, with the few exceptions shown in plan. Lathhouse 3 is relocated from East Campus, and a new laboratory building contains space for 30 primary investigators, including space for growth chambers and other support facilities in a basement level.

A new dedicated lab building is unique to Scenario 2, as distance to the East Campus labs makes commuting impractical.

With all research glasshouse accommodated on West Campus, the East Campus opportunity site can be cleared for future higher-density uses.

Phase 2 Provides (sf)		Total New
Glasshouse (Evap Cooled)	54,000	86,000
Glasshouse (Air Conditioned)	0	24,000
Headhouse	17,550	32,650
Growth Chambers / Support	20,900	41,600
Lathhouse (Relocated)	10,560	10,560
Contained Research	0	0
Laboratory	83,600	83,600





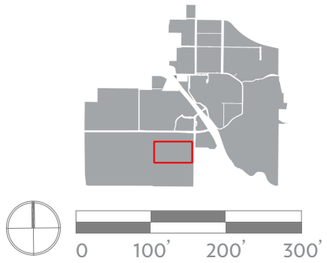
PHASE 2: EAST CAMPUS

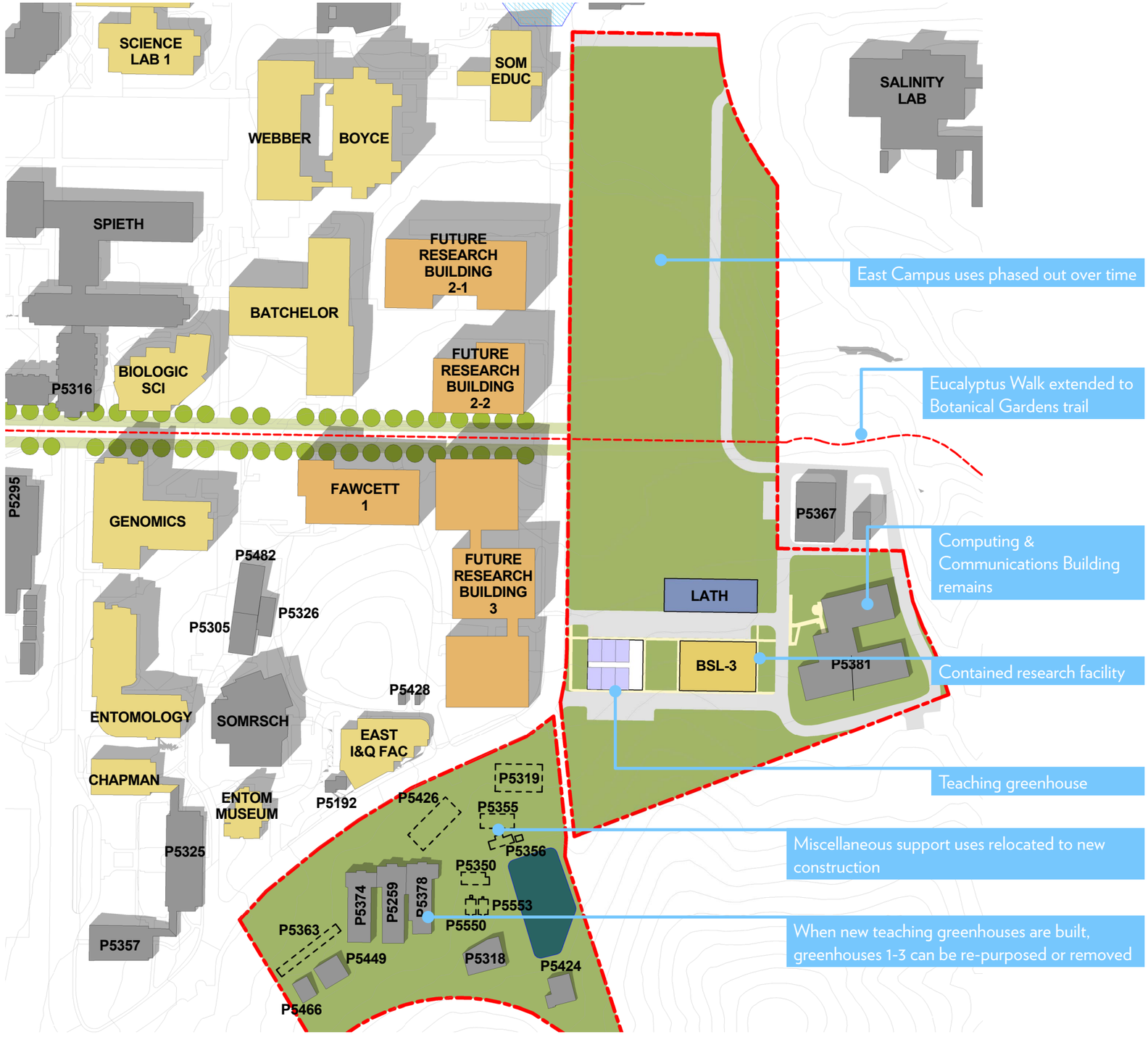
A minimum number of required facilities remain on East Campus.

Due to security concerns regarding the Contained Research Facility, its location on East Campus is preferable. Future facilites requiring heightened security should likewise be located close to the Core Campus. Teaching facilities are required to be within easy walking distance of the undergraduate student population. The West Campus site has insufficient space to locate Lathhouse B, so it too remains on the East Campus.

As with Scenario 1, Future Research Building 2 and 3 are not necessarily tied to a specific phase of this study, but are shown here to illustrate the future of the East Campus.

Phase 2 East Provides (sf)		Total New
Glasshouse (Evap Cooled)	0	86,000
Glasshouse (Air Conditioned)	0	24,000
Glasshouse (Teaching)	6,000	6,000
Headhouse	1,800	34,450
Growth Chambers / Support	0	41,600
Lathhouse (Relocated)	12,360	22,920
Contained Research	12,000	12,000
Laboratory	0	83,600

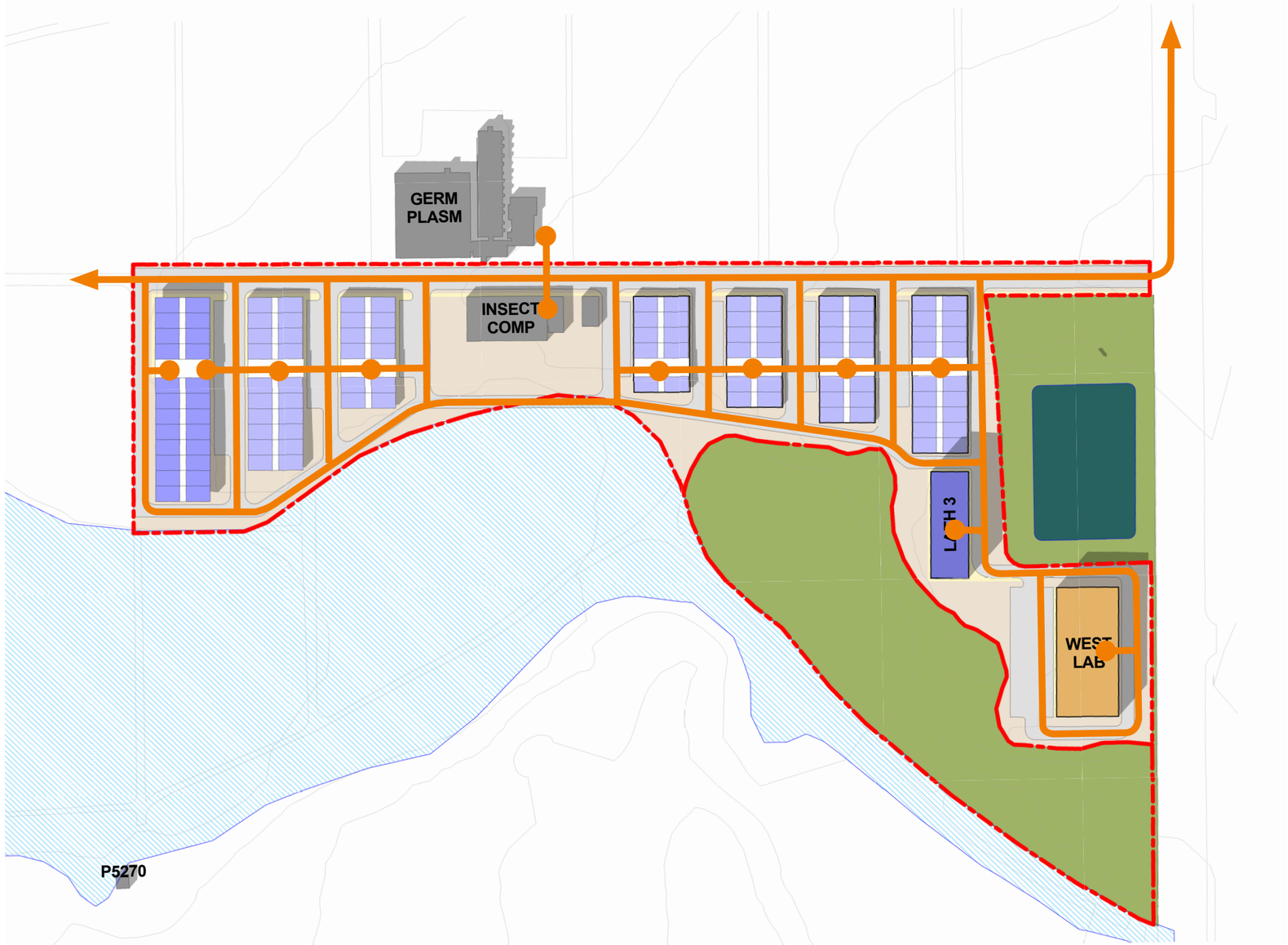


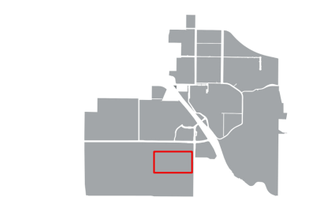


SERVICE AND MAINTENANCE

Distance from East Campus makes service more cumbersome.

- Complex needs new paved access roads for service from Canyon Crest Drive.
- Sensitive research on West Campus, namely work with transgenic organisms in greenhouses and the new laboratory building may need to be placed inside fences. This would also mean the addition of security gates and service protocols.
- UCR Facilities Custodial Services would need to provide housekeeping services, trash and recycling, equipment and supplies and package delivery services to include West Campus.
- Campus shuttle system may need to be implemented to service high volume of researchers and staff traveling between East and West Campus.





RELATION TO "ESSENTIAL ELEMENTS"

Each scenario was analyzed for its addition to (or detraction from) the overall vision of the Physical Master Plan Study. Scenario 2 relates to the major principles of master plan in the following ways:

Identity: Enhance Sense of Place

- Scenario 2 creates the beginning of a satellite research community on West Campus. In the future, with the addition of more lab space and amenities, this community could be self-sufficient.
- At the same time, scenario 2 arguably degrades the University's sense of place by dividing faculty on either side of the freeway.

Community: Facilitate Engagement

- Scenario 2 isolates West Campus research community from the East Campus faculty, precluding spontaneous interaction.
- Security concerns would likely increase West Campus isolation.
- Location of 30 PIs within a single West Campus lab will facilitate engagement within that smaller community.

Stewardship: Exercise Environmental Stewardship

- Research in adjacent fields would likely be impacted by construction activities including road widening.
- Scenario 2 requires the installation of new infrastructure to West Campus to support a satellite research community, including a lab building, rather than leveraging the existing infrastructure available on East Campus.
- Faculty and staff would need to drive, rather than walk to the West Campus research district.

Density: Demonstrate Leadership and Innovation

- With respect to East Campus, scenario 2 opens the East Campus opportunity site for future high-density uses like student housing.
- In a larger sense, scenario 2 decreases overall density by spreading program out rather than consolidating.

Figure A.38: View north to West Campus plant growth environments

Figure A.39: View east along access road of West Campus opportunity site towards gate at Canyon Crest Drive

PHYSICAL MODEL

This model provides a three dimensional view of the West Campus opportunity site. While the West Campus site may appear flat in comparison the East Campus site, there is a low-lying area clearly visible to the south of the proposed greenhouses. This area is a flood plain, and cannot be developed. The largest structure on the site is a new lab building, to reduce the need for researchers to travel back and forth to East Campus.

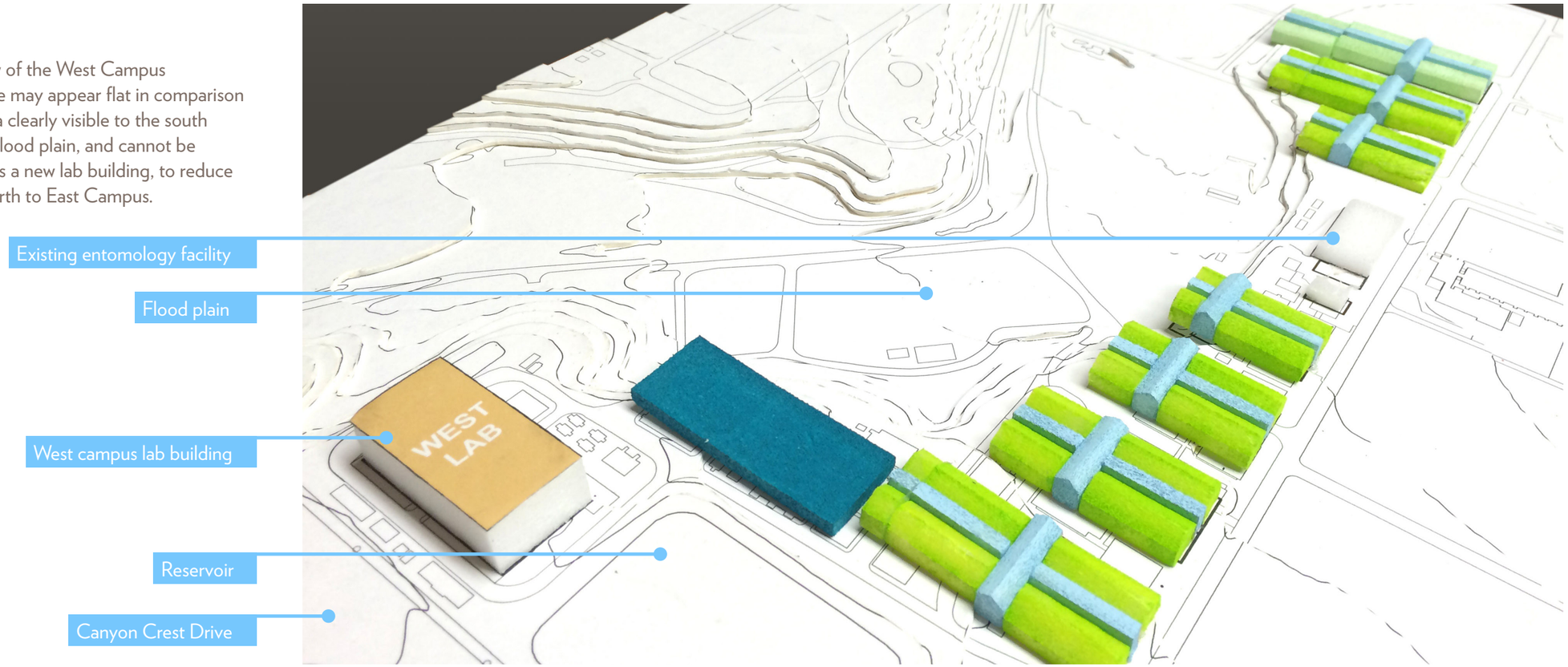
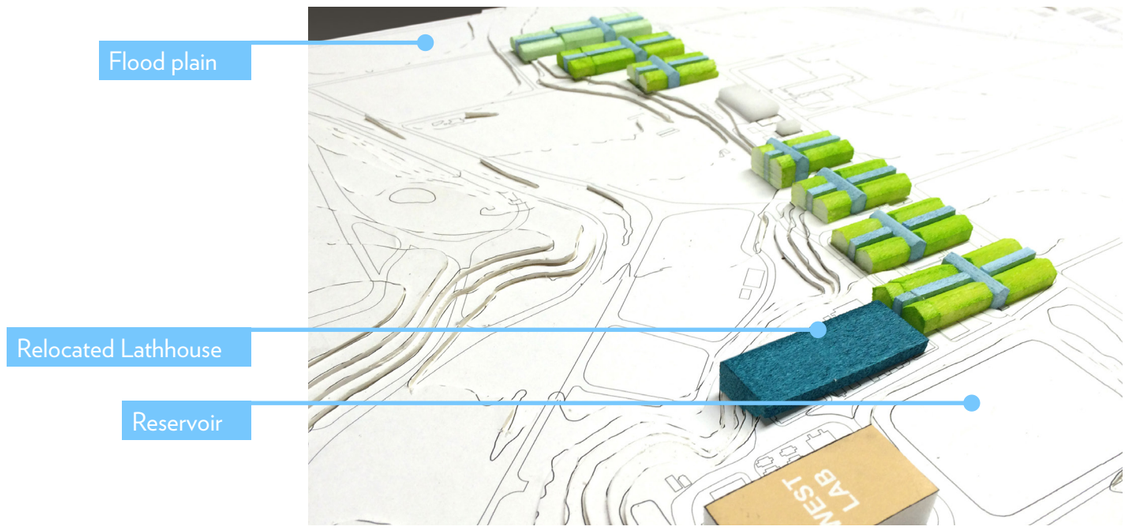
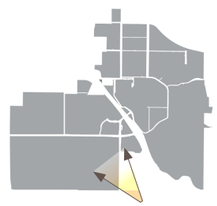


Figure A.40: Aerial view of physical model from northeast





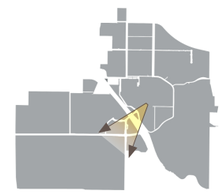


Figure A.41: Aerial view of physical model from southeast

Headhouse Lathhouse Glasshouse (Evap) Glasshouse (A/C)

A.10
Summary

Through the information presented, this study supports the following points:

1. The need for modern, functional plant growth environments and support facilities is two-fold: both to support current research and to recruit and retain high quality faculty within the College of Natural and Agricultural Science.

2. Both East and West Campus opportunity sites can accommodate the concept program, with teaching, contained research, and one lathhouse remaining on the East Campus in scenario 2.

3. Both scenarios allow for construction phasing to minimize disruption to ongoing CNAS research activities.

4. The extension of utilities and the construction of a lab building on West Campus add significant cost* to scenario 2 over scenario 1.

5. Scenario 1 better reinforces the principles of the Physical Master Plan Study.

6. In scenario 2, isolating a portion of the research community from the East Campus makes interdisciplinary interaction more difficult, such as the proposed use of greenhouse space by the colleges of engineering and medicine.

7. Distance between plant growth environments, support facilities and the East Campus is an important issue for project stakeholders. An effective means of transport between east and west would mitigate problems of remoteness.

9. Scenario 1 leaves room for modest expansion beyond the 2025 concept program, whereas future expansion in scenario 2 would mean development in the research fields.

The central decision point between scenarios 1 and 2 is the increased cost* and decreased convenience of development on West Campus versus the future value of East Campus land for higher-density development.

*A concept cost model for scenarios 1 and 2 was developed by The Capital Projects Group, and is available as a separate document.

A.11
Stakeholders and Participants

Stakeholders for this study include the College of Natural and Agricultural Sciences, the Office of the Vice Chancellor for Research, the Office of the Provost, and the Office of the Chancellor. The following were active participants in the study (in alphabetical order):

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Peter Atkinson, Divisional Dean, Life Sciences
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Katherine Borkovich, Department Chair, Plant Pathology and Microbiology
Tim Close, Professor of Genetics and Geneticist, Botany and Plant Sciences
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Mikael Roose, Department Chair, Botany and Plant Sciences
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