REIMAGINING THE NEW YORK HARBOR SCHOOL

U.S. DEPARTMENT OF ENERGY Solar Decathlon

NYC Office of the Mayor | New York HARBOR SCHOOL

The Cooper Union
Solar Decathlon Team

THE COOPER UNION TEAM

Instructors: Melody Baglone, Pamela Cabrera,
Julian Palacio, Nader Tehrani, Cosmas Tzavelis, David Wootton

We are a multidisciplinary team of engineers and architects ranging from first-year students to seniors. We are dedicated to the design of efficient, sustainable and innovative buildings, and focus on high-performance buildings which requires building science, energy efficiency, structural and mechanical systems, resilience, and water conservation and other skills. We aim to contribute to climate solutions that can be used to decarbonize the building sector.

Architecture
Ji Yong Chung
Tate Liang
Shannagh H. Crowe

Civil Engineering
Lionel Gilliar-Schoenenberger
Sophia Zhao
Matviy Zhachek
Vito Di Gregorio
Mohamad H. Hassan
Benny Wu
Shirley Xingyu Yan
Larry Zeng

Mechanical/Electrical Engineering
Sarah Coraizaca
Samantha Wu
Mizanul Hoque
Amelia Roopnarine
Grace Ee
Yu Shan Luo

PROJECT GOALS

Population Growth:
520 students -> 900 students

New Academic Building Construction:
+60,000 sqft

Building 555 Renovation:
+32,000 sqft

Additional Needs:
- 19 Additional Classrooms
- Competition-sized Pool
- Gymnasium
- 4 Labs

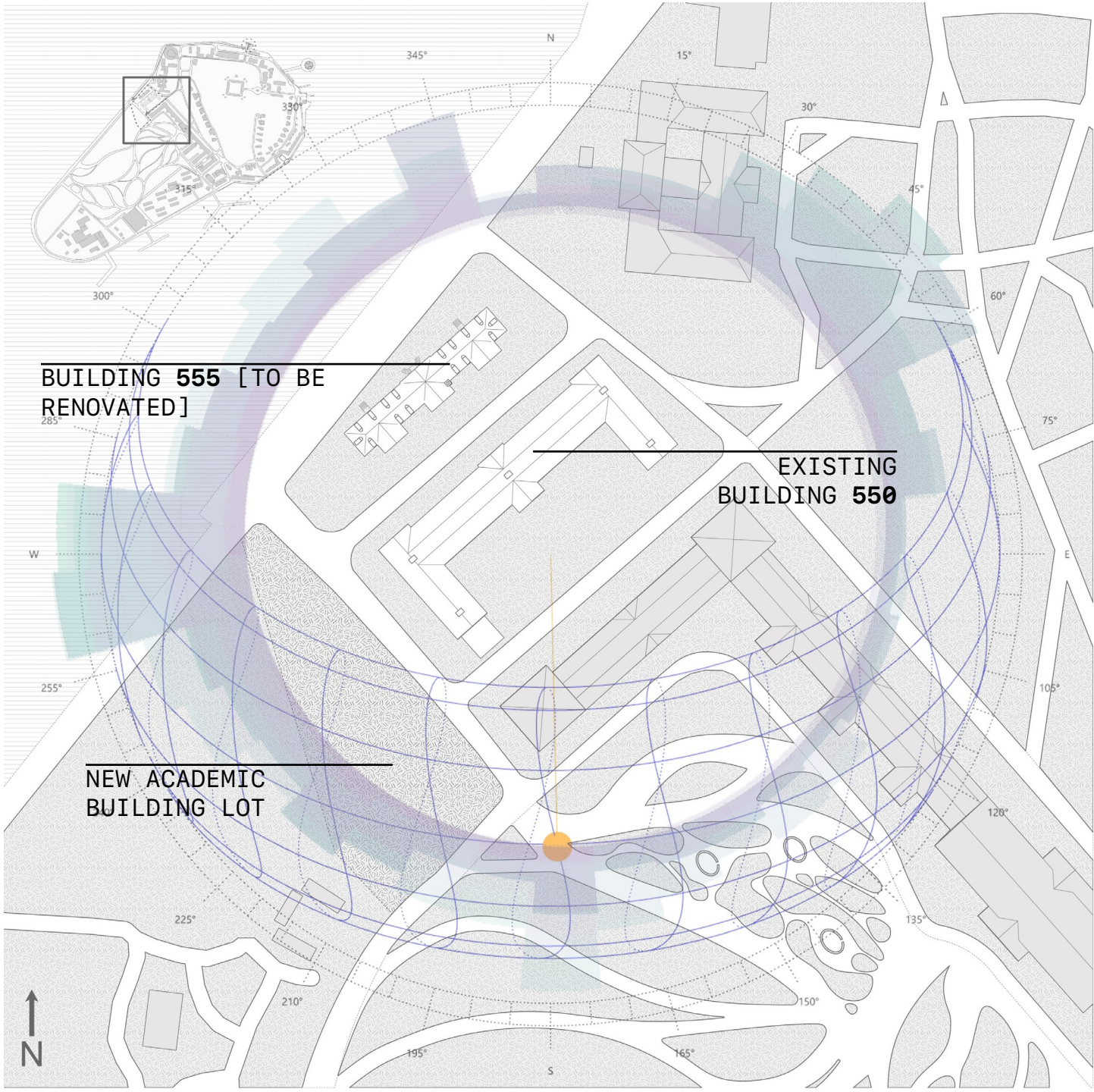
BOAT CONSTRUCTION

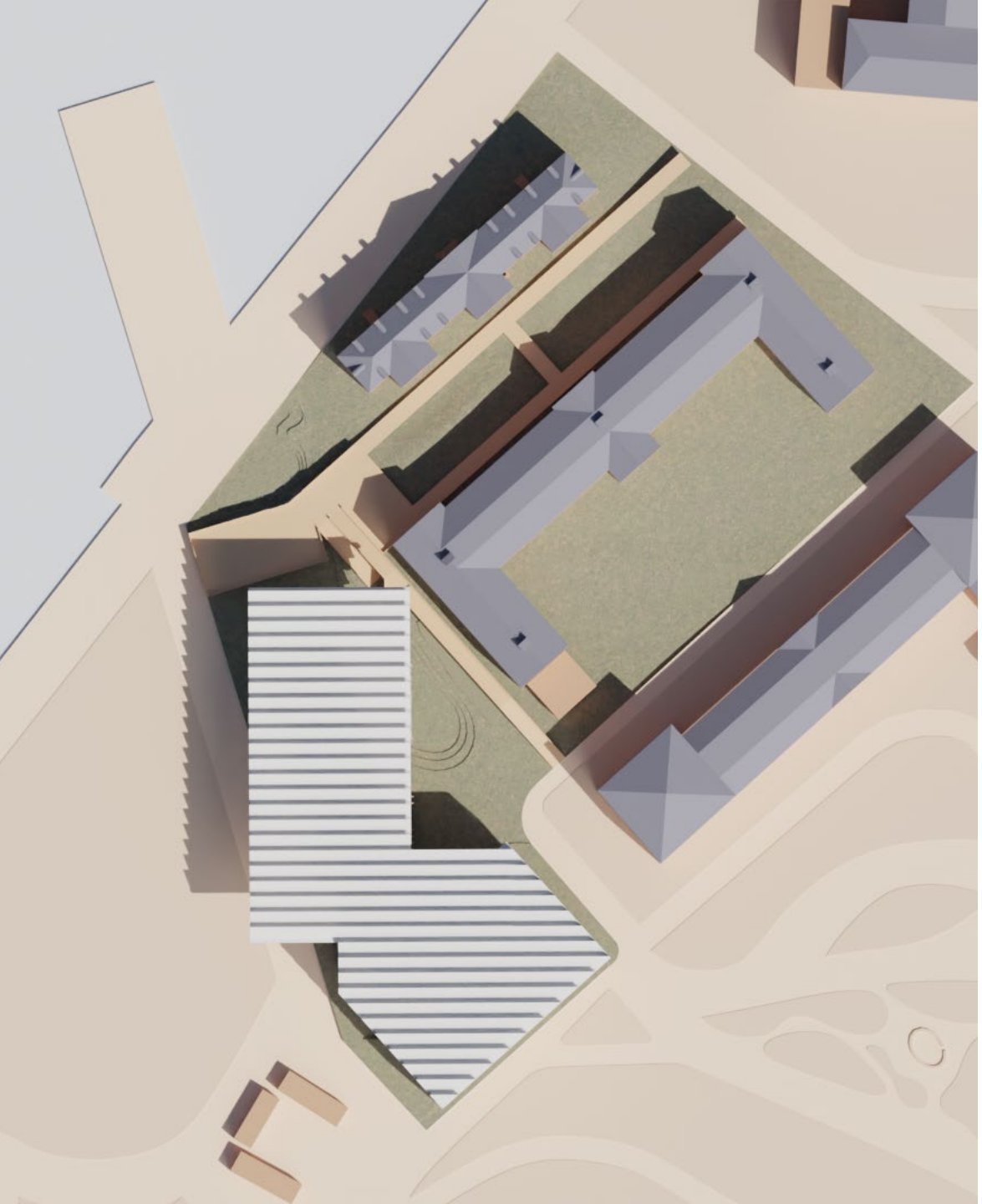
LEARNING FROM THE ENVIRONMENT

BILLION OYSTER PROJECT

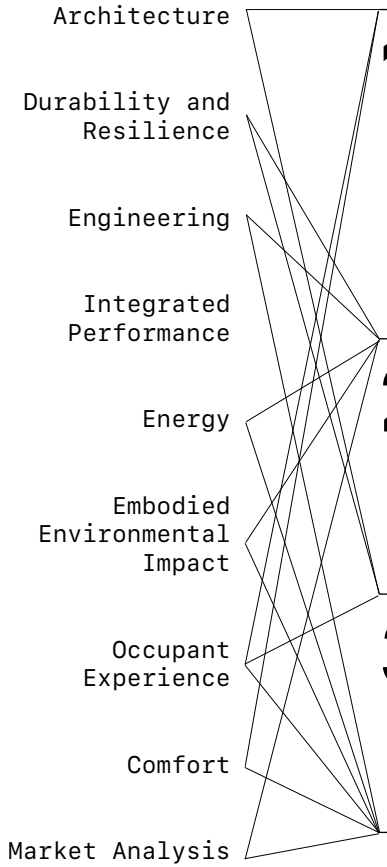
SITE ANALYSIS

- Architecture
- Durability and Resilience
- Engineering
- Integrated Performance
- Energy
- Embodied Environmental Impact
- Occupant Experience
- Comfort
- Market Analysis





DESIGN GUIDING CONCEPTS



1 Define & expand community space, promote circulation & access while considering historic context for practical and economic conservation & adaptation

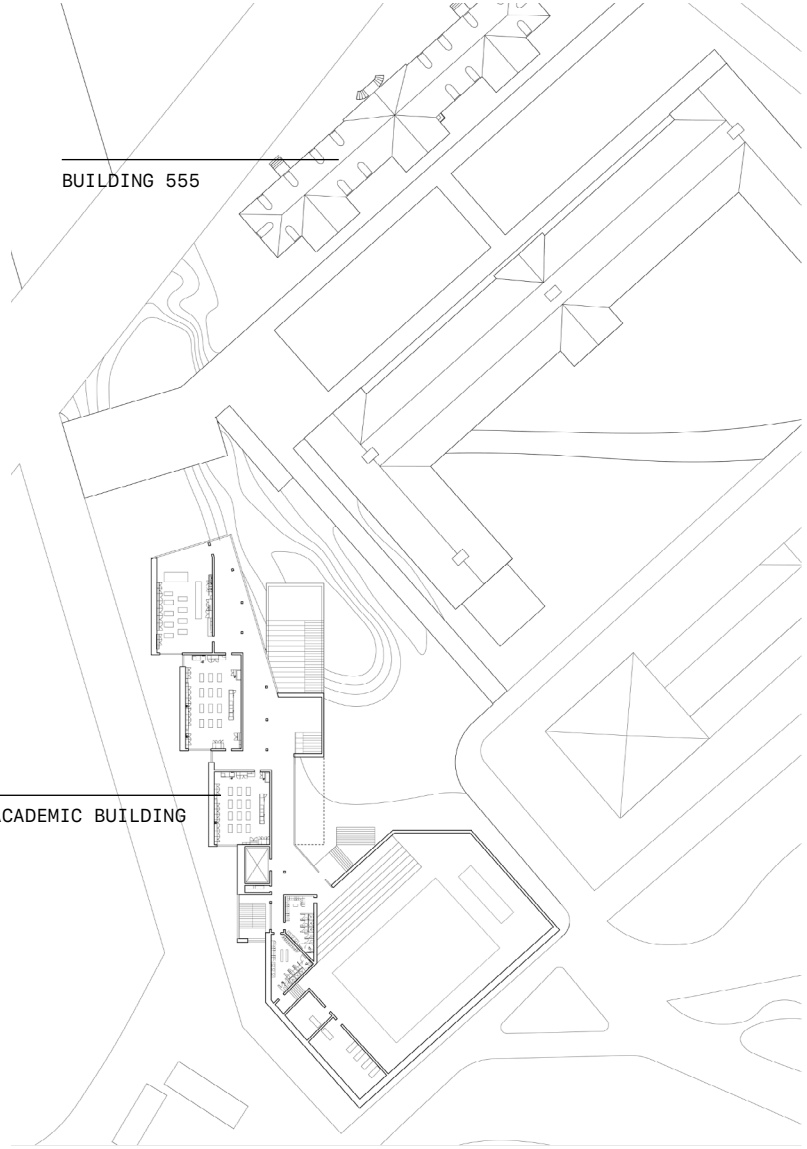
2 Minimizing carbon footprint to reach net zero with material reuse and renewable energy sources

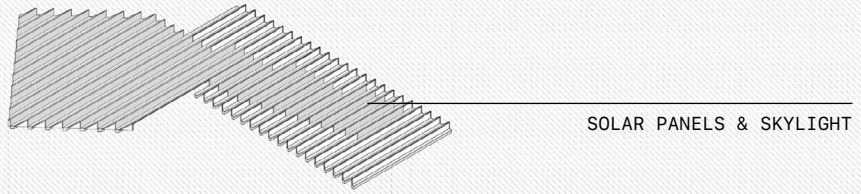
3 Respond sectionally to climate conditions to form a resilient campus

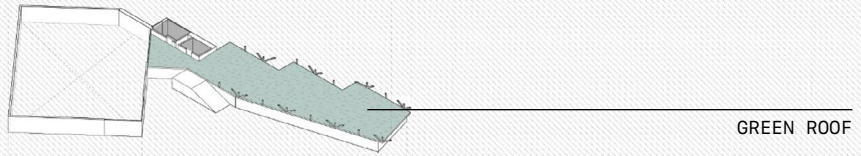
4 Integrate mechanical systems with architecture and structure for high performance

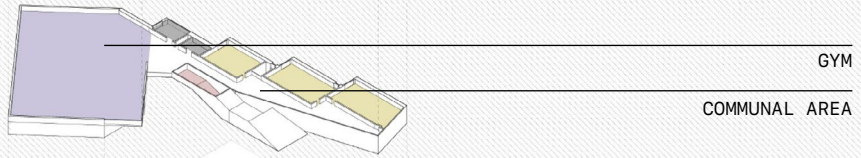
CAMPUS OVERVIEW

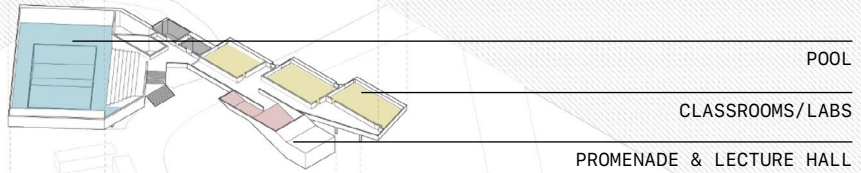
The New Academic Building includes sports facilities, larger classrooms, labs and flexible multipurpose areas, and the new boardwalk connecting the overall campus. We focus on the experience of students by introducing outdoor and indoor areas for events and communal activities.

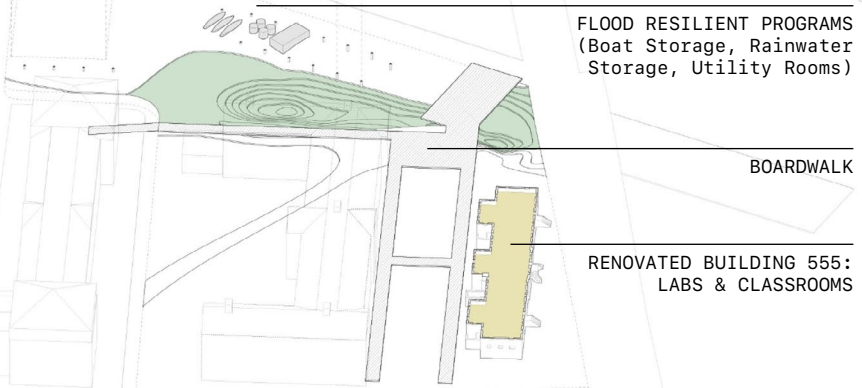












- Architecture
- Durability and Resilience
- Engineering
- Integrated Performance
- Energy
- Embodied Environmental Impact
- Occupant Experience
- Comfort
- Market Analysis

PROGRAM

NEW ACADEMIC BUILDING

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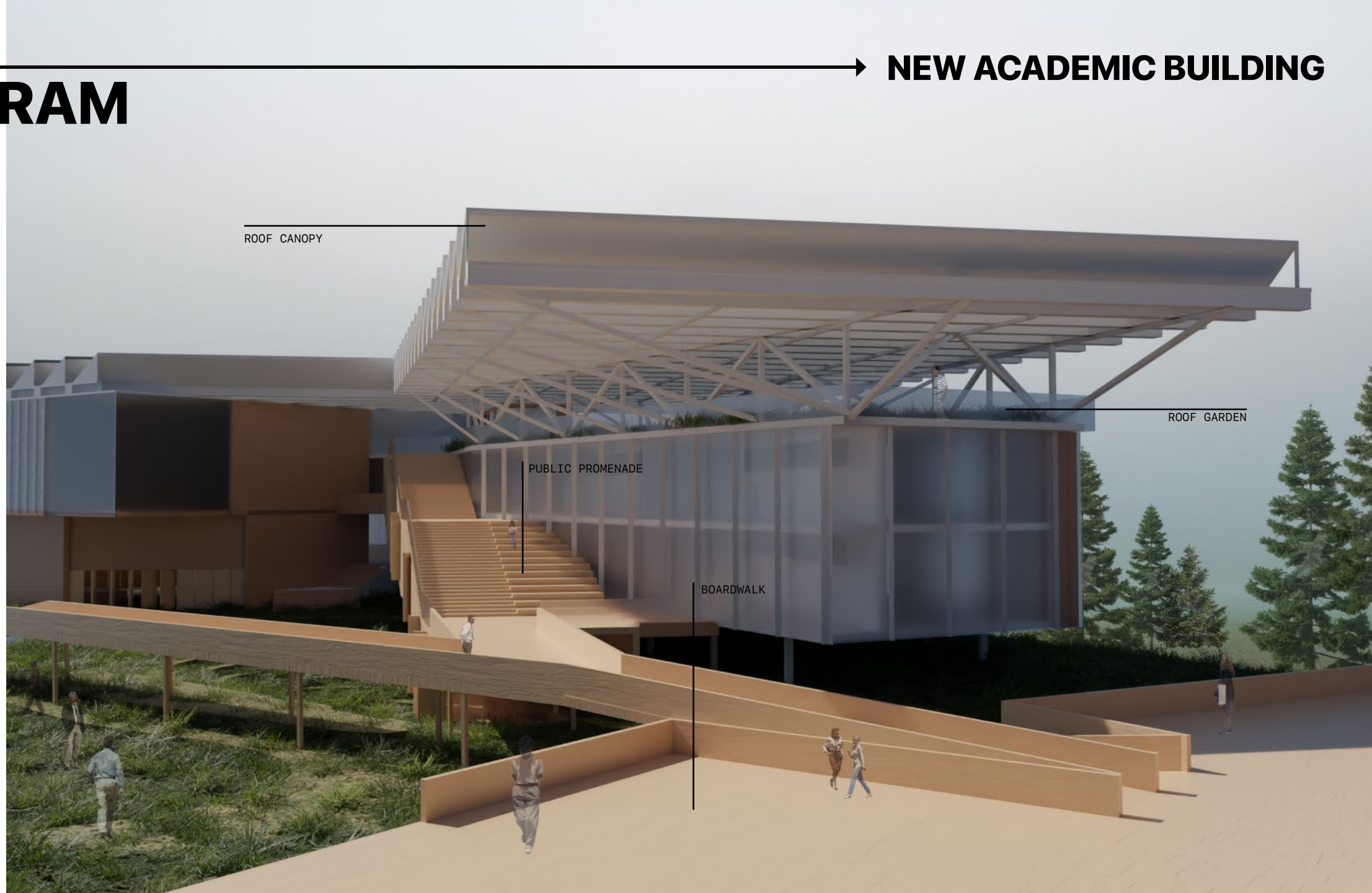
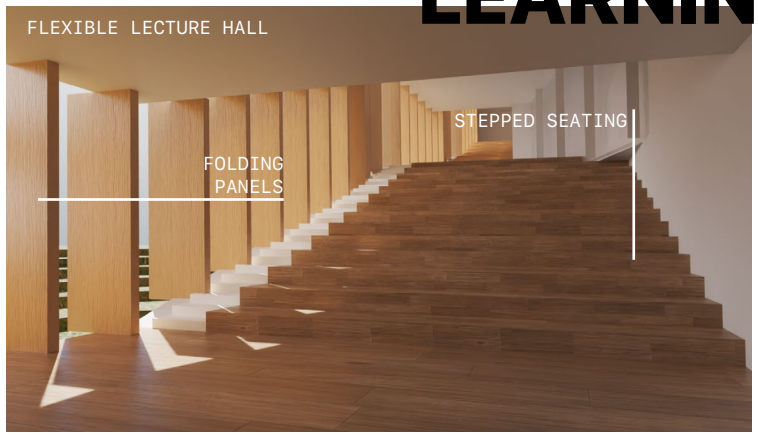
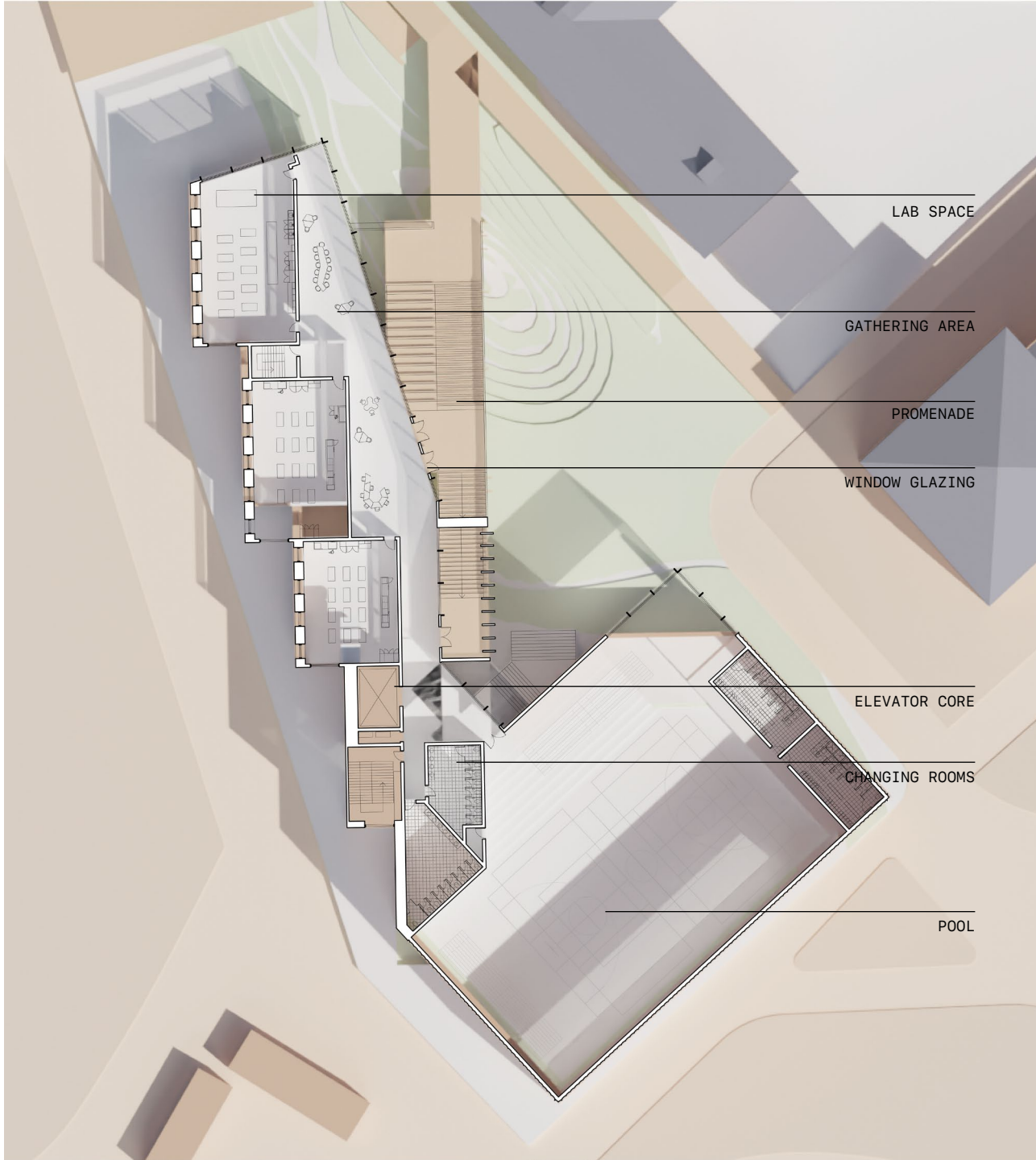
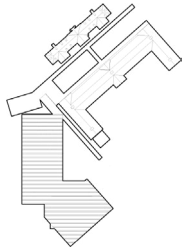


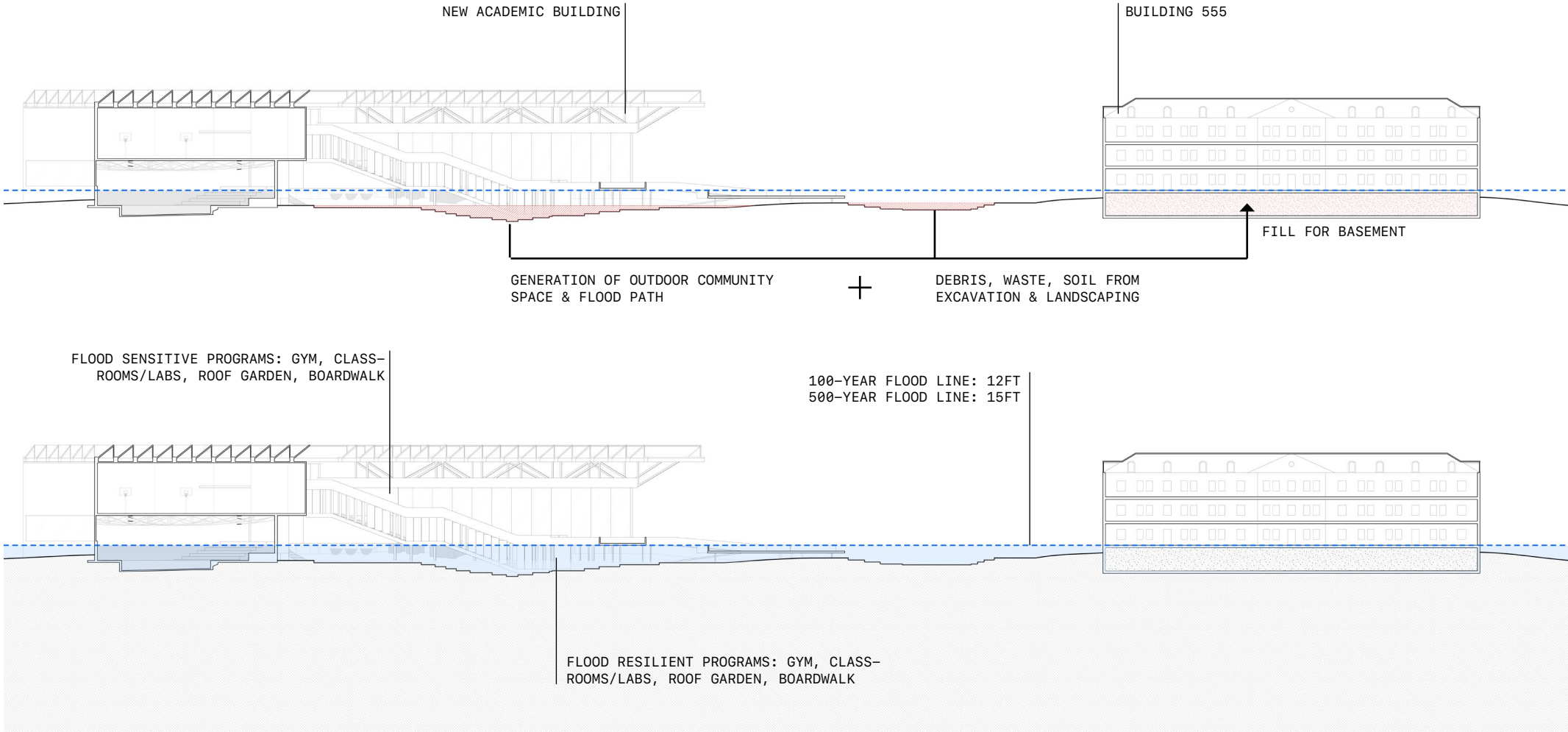
OCCUPANT EXPERIENCE & LEARNING SPACES



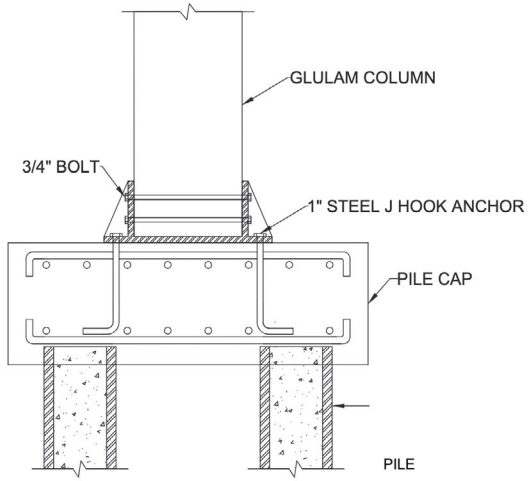


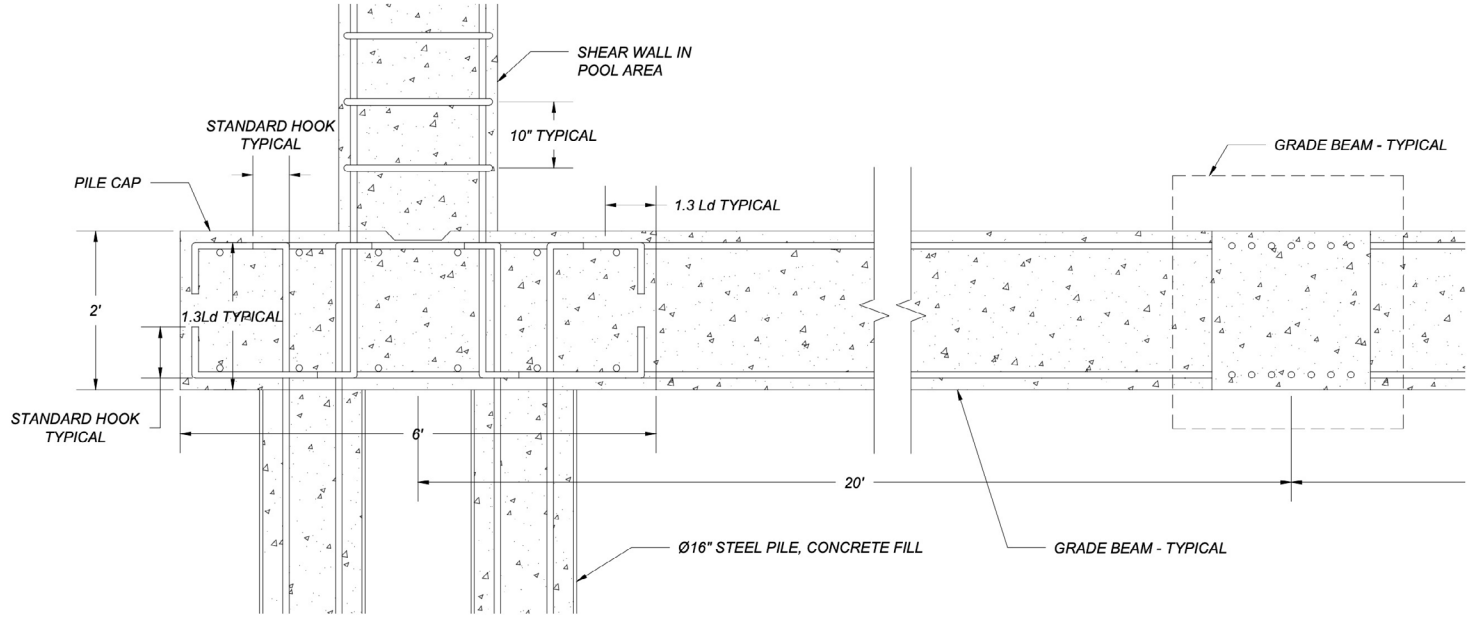
FLOOD RESILIENCE

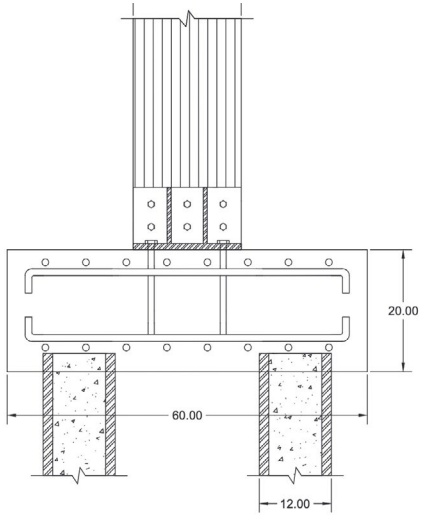


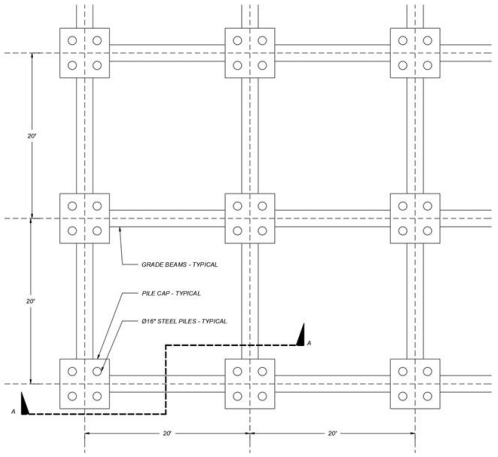


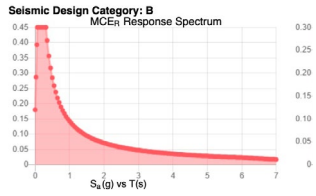
FLOOD RESILIENCE







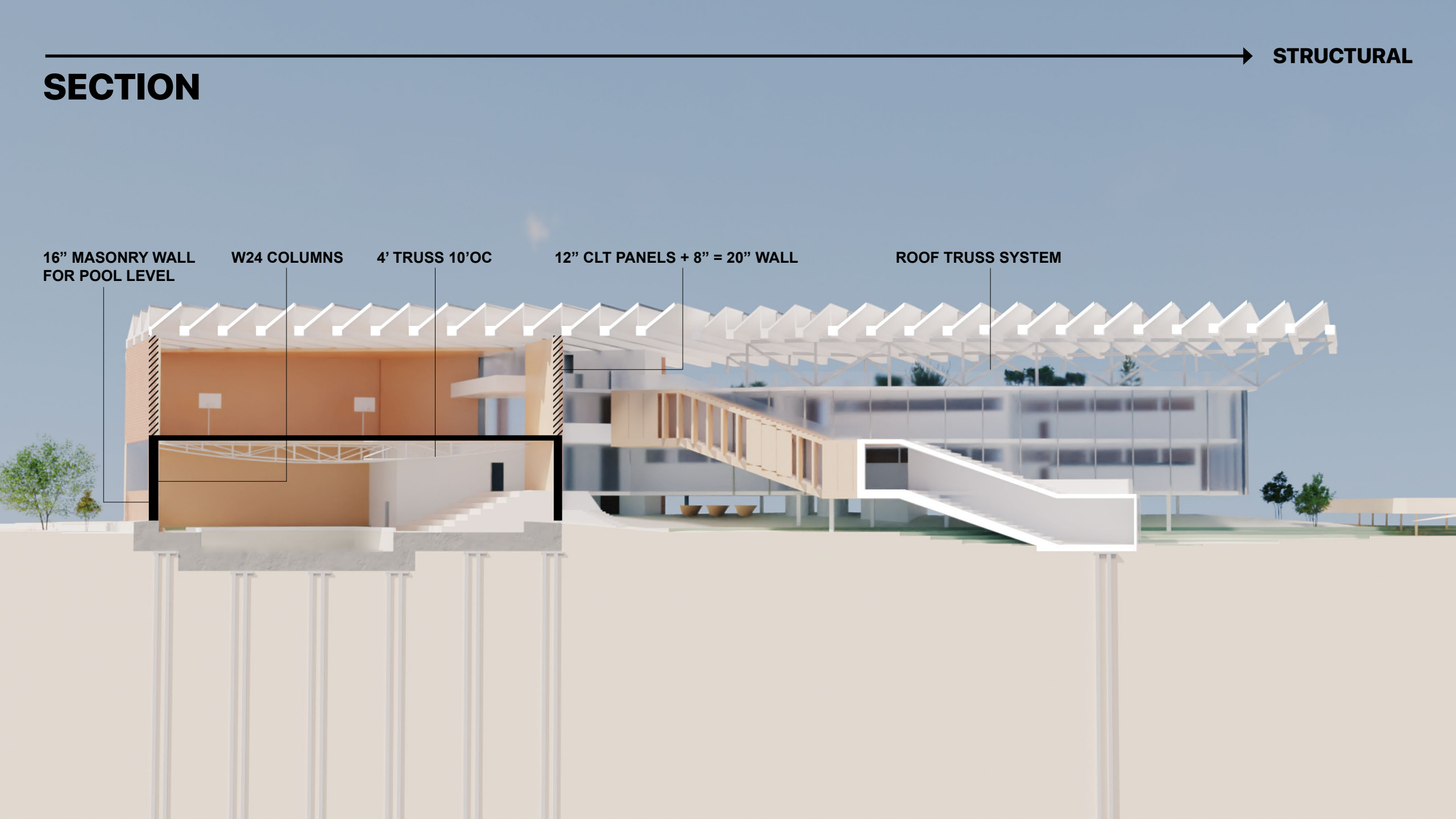




NATIVE PLANT RESILIENCE

The bathtub style foundation system incorporates resistance to extreme storm events in terms of strength and serviceability. Grade beams span between pile caps to provide lateral stability and support the pool slab in case of liquefaction or up-lift caused by an elevated water table. Monolithic pours are used to make integral connections seen in the typical plan and section A-A as well as reduce the number of expansion and construction joints. Waterproofing wrap, Drainage mats and hard board insulation are added to prevent stagnation of salt-water near foundation.

SECTION


16” MASONRY WALL FOR POOL LEVEL
W24 COLUMNS
4’ TRUSS 10’OC
12” CLT PANELS + 8” = 20” WALL
ROOF TRUSS SYSTEM

SECTION


HIGH VOLUME LOW SPEED FAN


ECODAN CRHV GHP


BATTERY STORAGE


DOAS SYSTEM


HEAT PUMP

PV PANELS

SKYLIGHTS

HYDRONIC SYSTEM IN SLAB

GREEN ROOF

CONDITIONED AIR DISTRIBUTION

ENERGY PILES

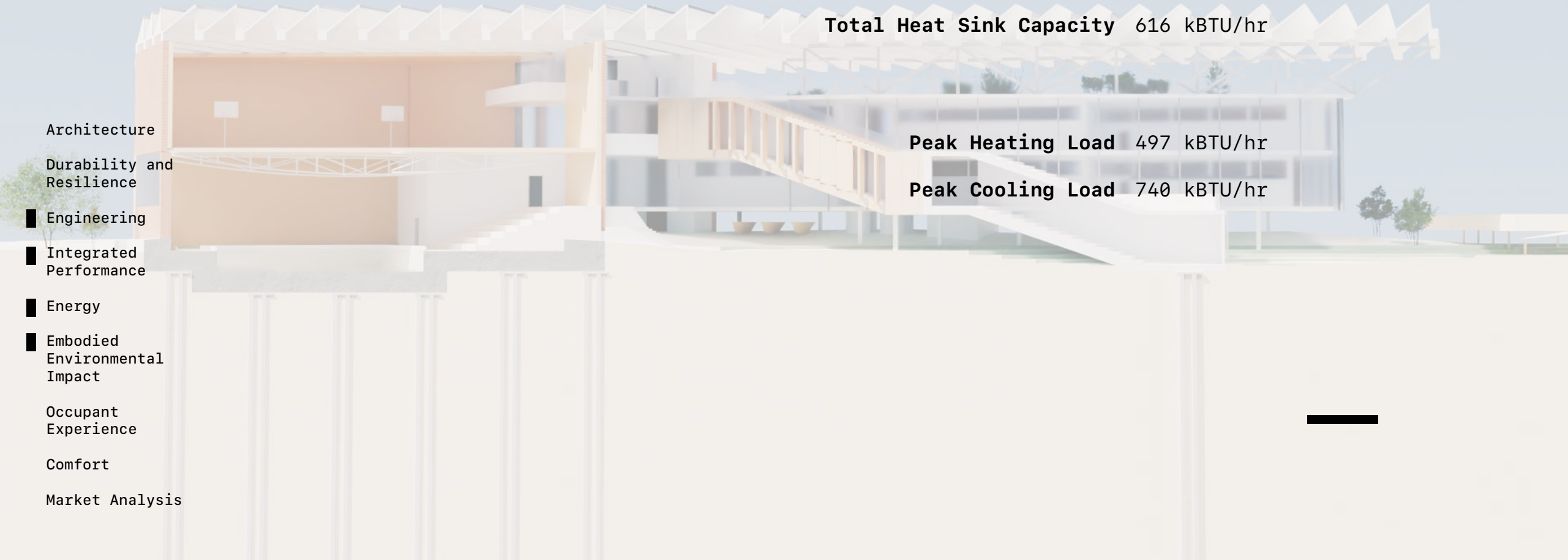
SHALLOW SLINKY COILS

BOAT STORAGE

RAINWATER STORAGE

RETURN AIR

ENERGY PILES & SLINKY



Energy Pile Capacity	0.042 kBTU/hr/ft
Slinky Capacity	0.026 kBTU/hr/ft^2
Total Energy Pile Capacity	269 kBTU/hr
Total Slinky Capacity	347 kBTU/hr
Total Heat Sink Capacity	616 kBTU/hr

Peak Heating Load	497 kBTU/hr
Peak Cooling Load	740 kBTU/hr

Architecture

Durability and Resilience

Engineering

Integrated Performance

Energy

Embodied Environmental Impact

Occupant Experience

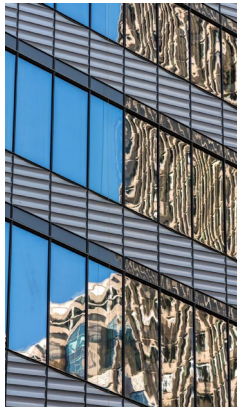
Comfort

Market Analysis

INTEGRATED ROOF SYSTEM

↳ RAINWATER COLLECTION & REUSE

RAIN-CATCHING FACADE



SAMPLE PRECEDENT

Architecture

Durability and Resilience

- Engineering

- Integrated Performance

Energy

- Embodied Environmental Impact

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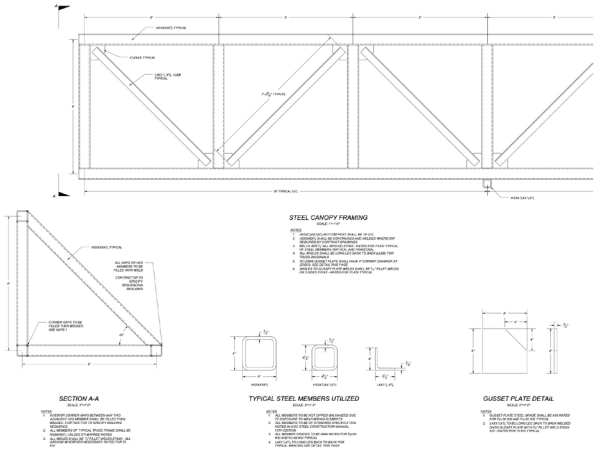
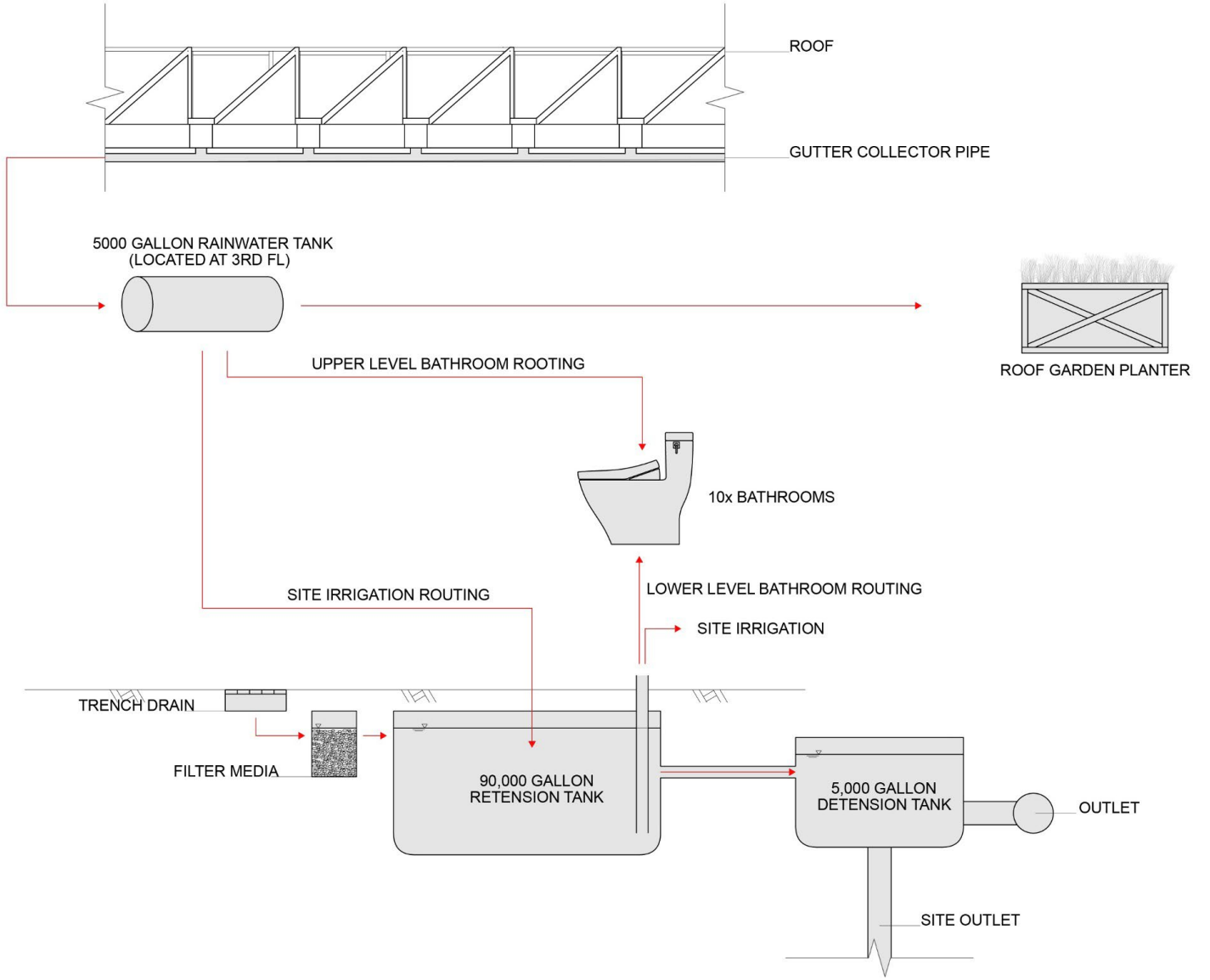
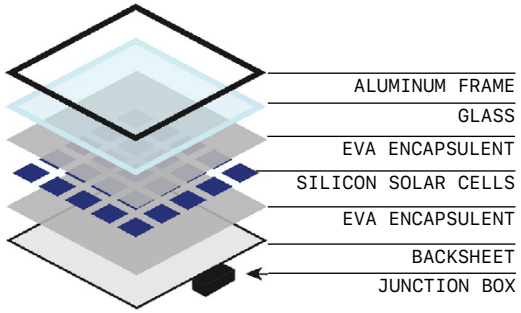


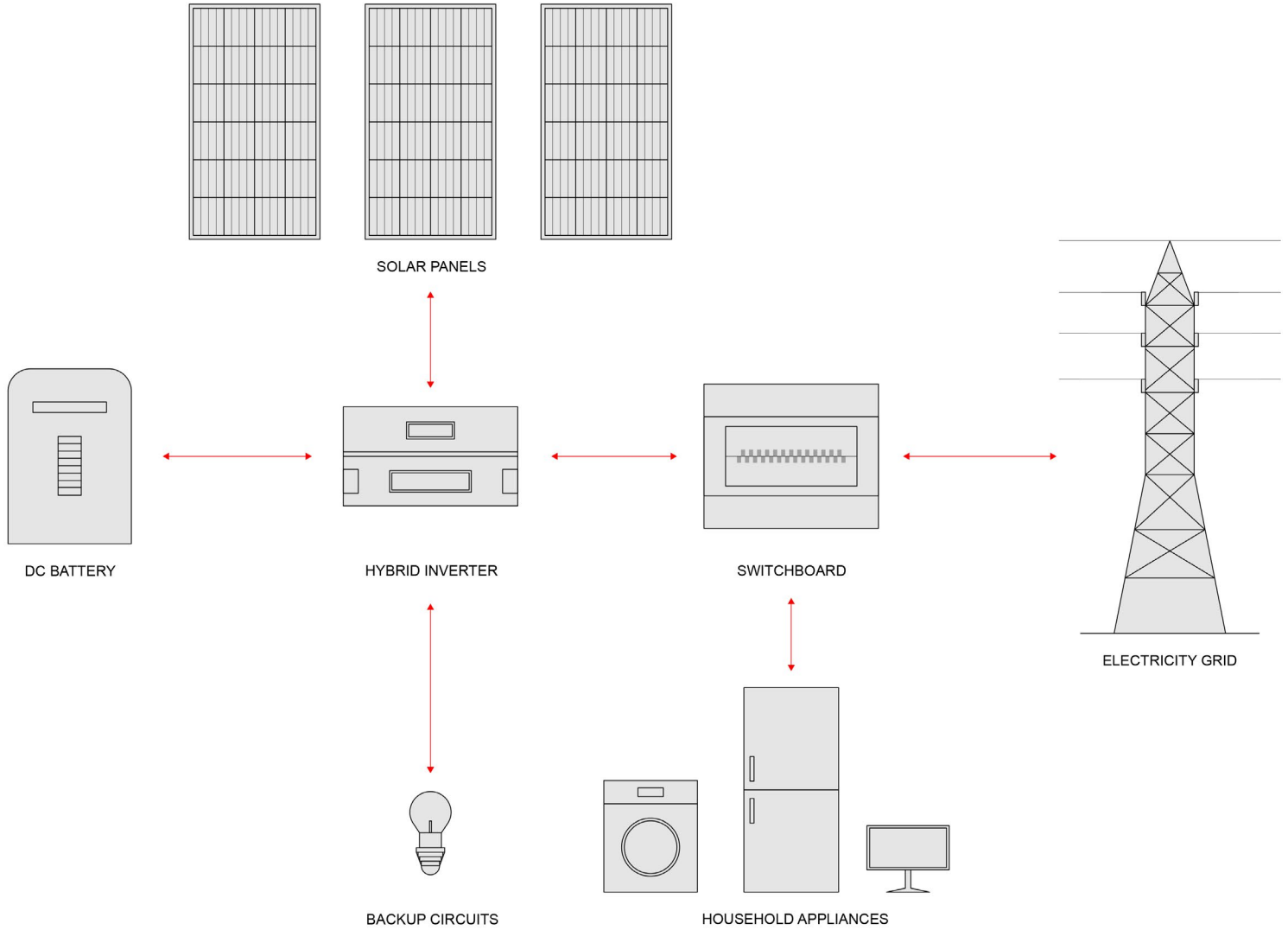


INTEGRATED ROOF SYSTEM

↳ BATTERY STORAGE



Under normal conditions, the solar panels collect power that goes through an inverter with a 99% efficiency and distributes it to the building then the lithium ion batteries. The automatic transfer switch is engaged, connecting the building to the PV panels and the battery. The batteries are located in an ABB eStorage Flex 40 Fully integrated Energy Storage System on the green roof and the second-floor MEP room. This system is equipped with fire suppression and allows us to integrate the components that we see fit to optimize performance.



Architecture

Durability and Resilience

Engineering

Integrated Performance

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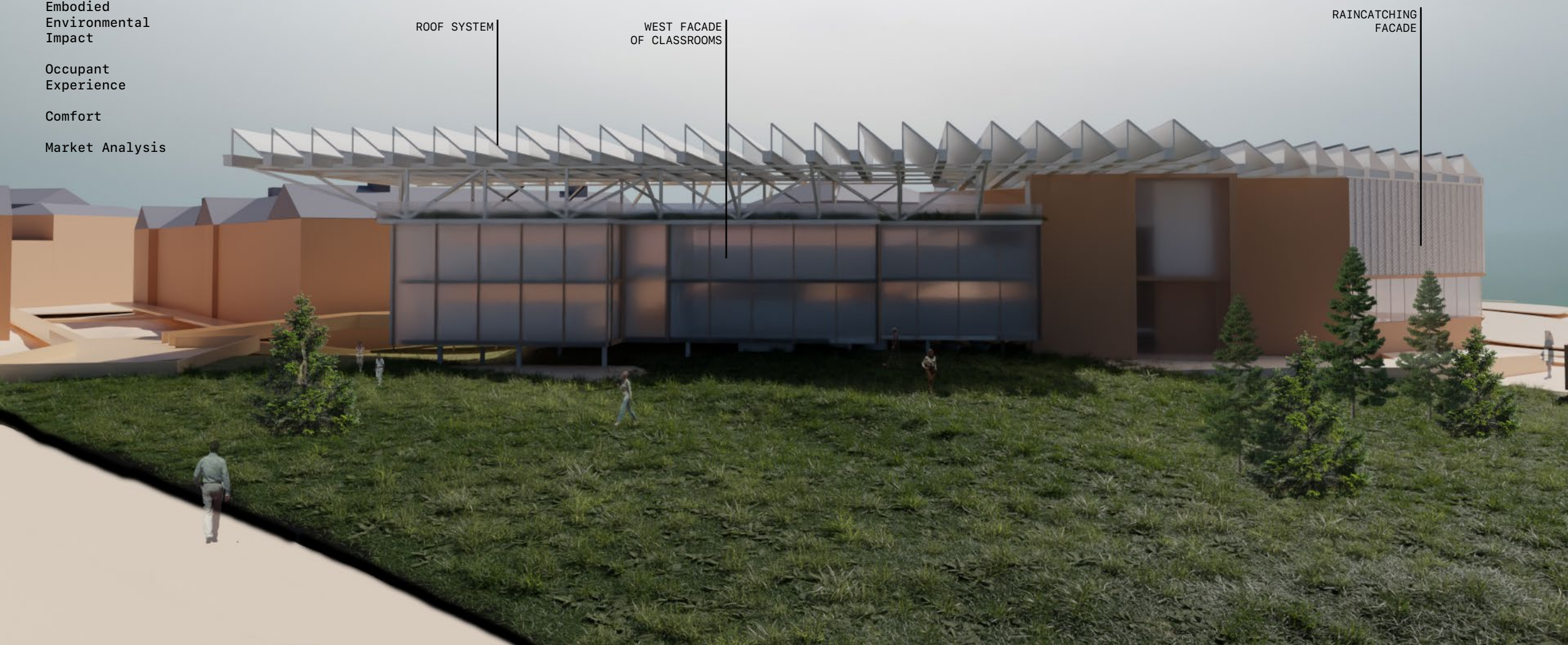
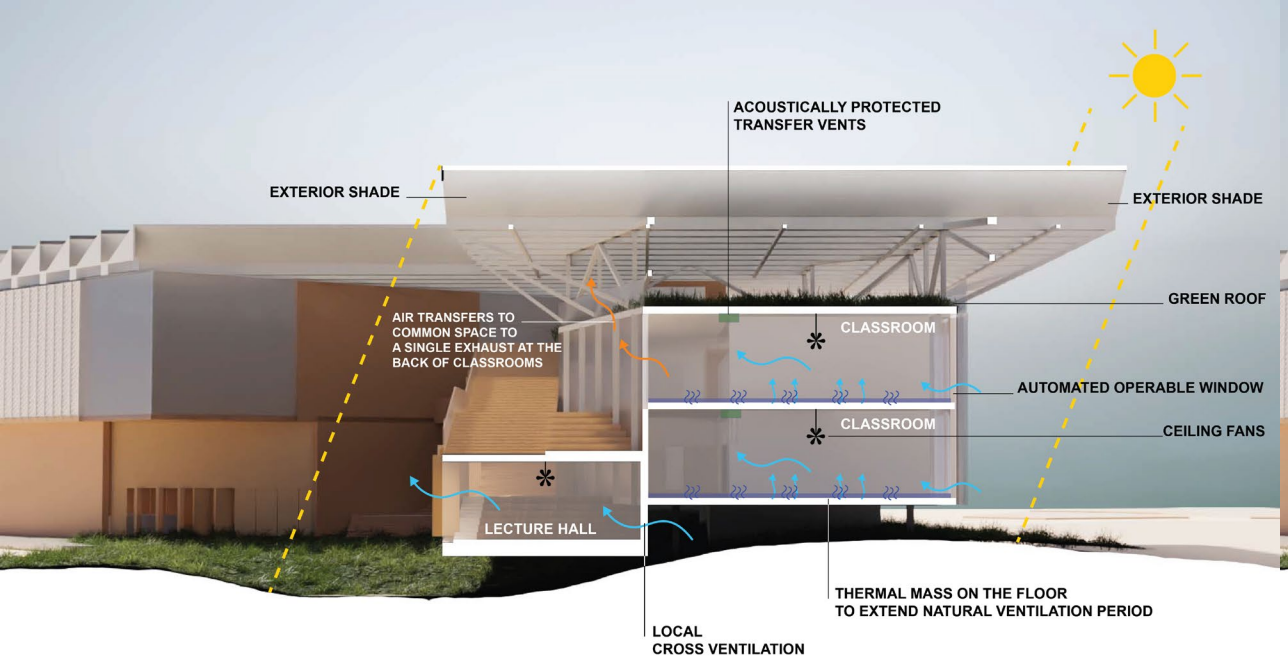
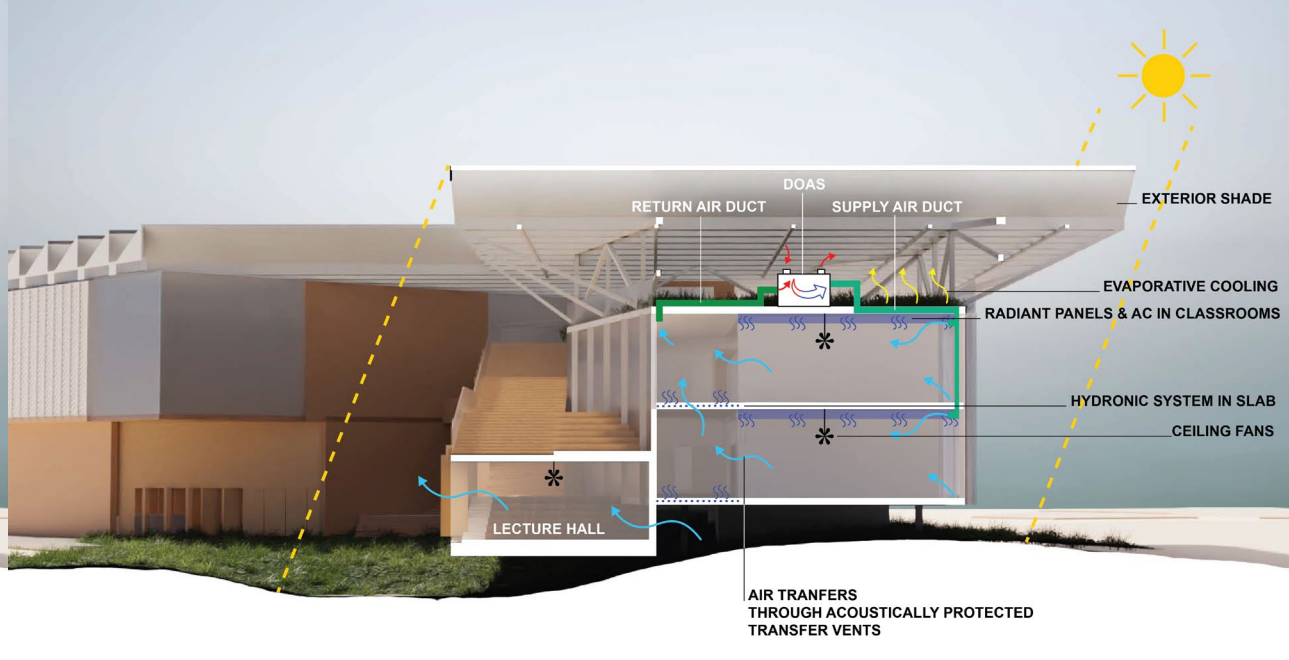
CLASSROOMS

NEW ACADEMIC BUILDING
INTEGRATED PERFORMANCE







Architecture

Durability and Resilience

Engineering

Integrated Performance

Energy

Embodied Environmental Impact

Occupant Experience

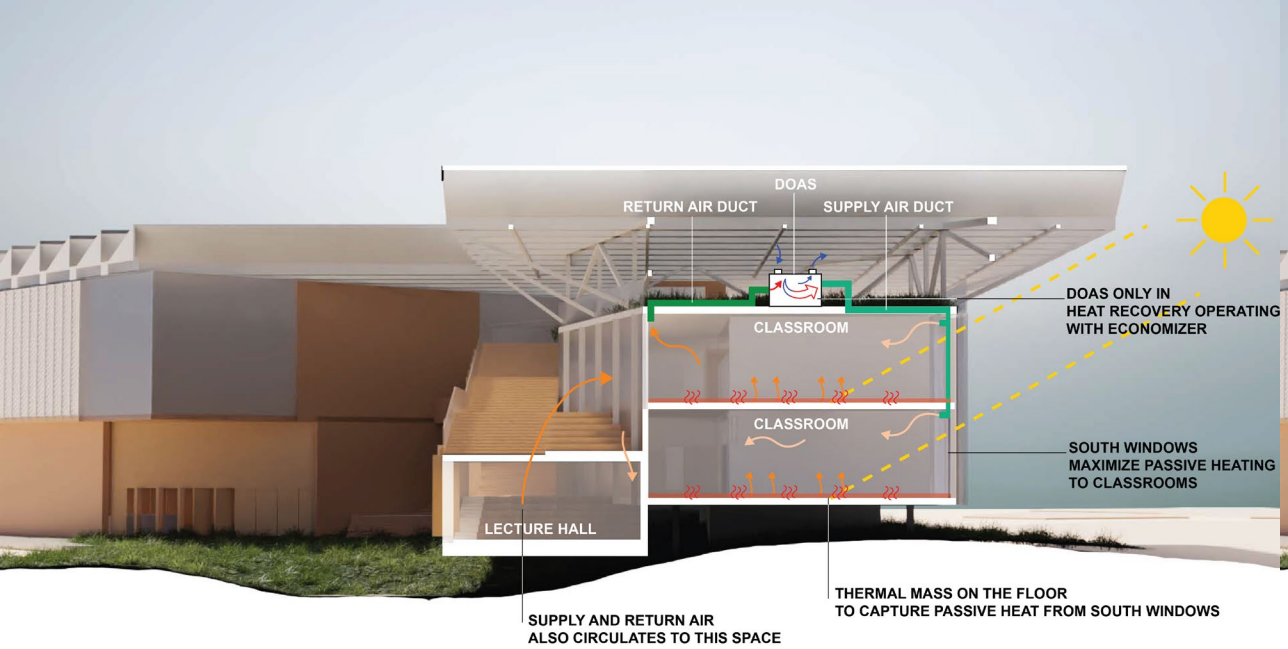
Comfort

Market Analysis

SUMMER

ACTIVE & PASSIVE MODES FOR THE NEW ACADEMIC BUILDING CLASSROOMS

In the active mode, the radiant panels are engaged and conditioned cool air is moved from the DOAS to the ducts located in the classroom and hallway. In the passive model, warm air travels from the glazed windows and heats the classrooms and eventually the hallway from radiation. Warm air also makes its way to the unconditioned promenade and is warmed through radiation.



Architecture

Durability and Resilience

Engineering

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Embodied Environmental Impact

Occupant Experience

Comfort

Market Analysis

In the active mode, the radiant panels heat the classroom and the hallway, where air is moved through the DOAS and is redistributed. In the passive mode the sun is positioned at a lower angle, allowing a longer period of time for the classrooms, hallway and the promenade to warm up from radiation.

WINTER

ACTIVE & PASSIVE MODES FOR THE NEW ACADEMIC BUILDING CLASSROOMS

POOL & GYM

NEW ACADEMIC BUILDING
INTEGRATED PERFORMANCE

Architecture

Durability and Resilience

Engineering

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Energy

Embodied Environmental Impact

Occupant Experience

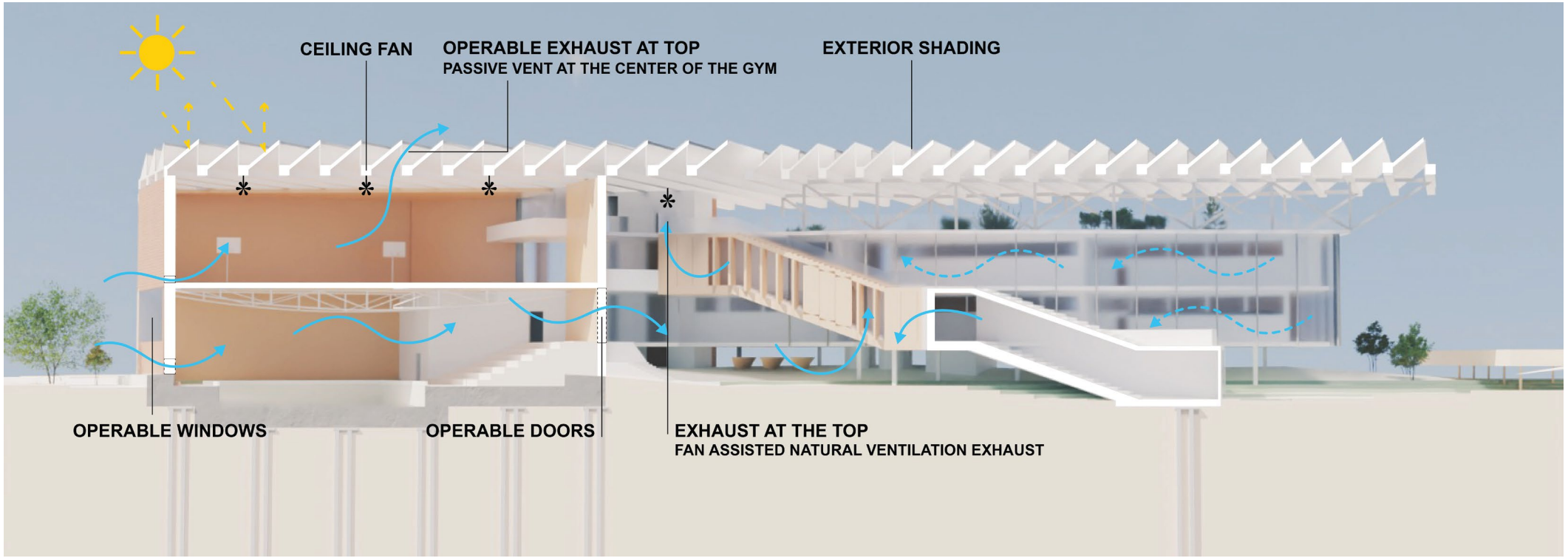
Comfort

Market Analysis

SUMMER

COOLING THE GYM / POOL

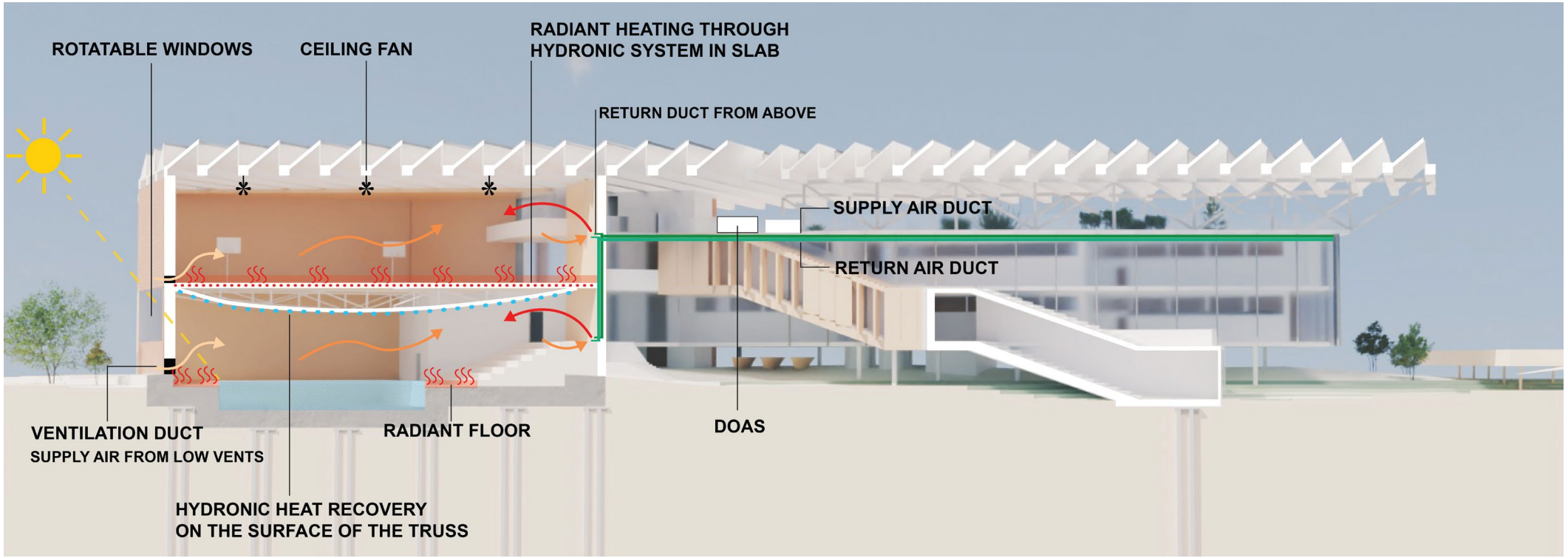
The cooling mode includes a small duct that lets in outside air to the second-floor gym, allowing cool air to circulate from the bottom, throughout, and to the top of the space. Then this cool air will make its way to the return ducts. The first floor is equipped with rotating doors that will be left open to allow for cool fresh air to flush out the humid air that is created by the pool. This fresh air will also go through the return ducts and will provide some cool air to the unconditioned promenade.



WINTER

HEATING THE GYM / POOL

The heating mode has the radiant panels engaged and fans located on the roof circulation air to prevent stratification. Air is also being moved into return ducts to be circulated throughout the building. The passive diagram of the building would primarily show that the building is gaining heat through solar radiation from the sunroof.



GYM & POOL DAYLIGHTING ANALYSIS

SPATIAL DAYLIGHTING AUTONOMY (SDA)

Lighting is an essential component to occupant comfort and building energy use. We integrate the architecture through the skylights of the sawtooth roof above the gym and the curtain glass adjacent to the hallways for increased natural lighting. A daylighting analysis conducted using Climate Studio in Rhino found that around 89 percent of the space has spatial daylight autonomy, meeting the 300-lux (28 Foot-candle) standard for 50 percent of operating hours. This significantly reduces the lighting energy needed for the pool and gym. It was then estimated that around 185,300 kBTU can be saved annually with natural lighting.

Architecture

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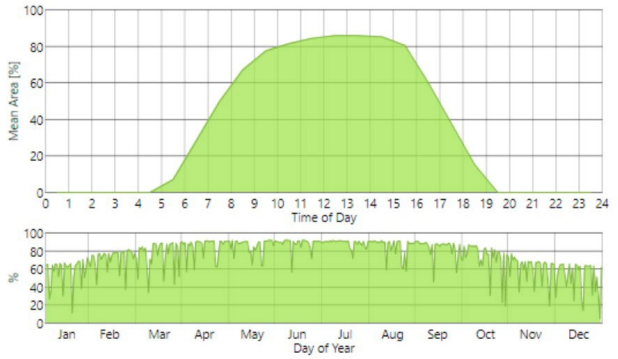
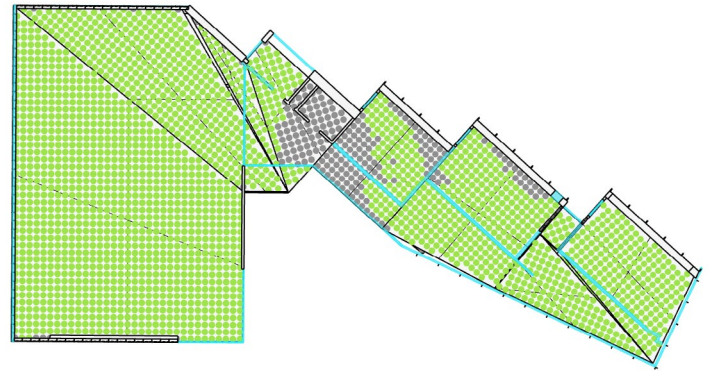
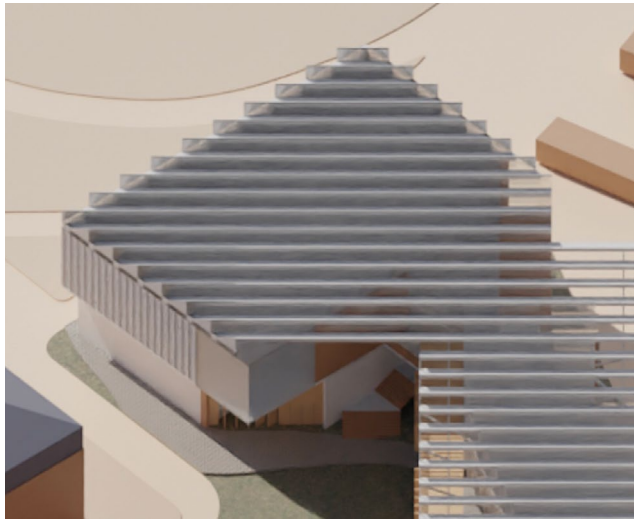
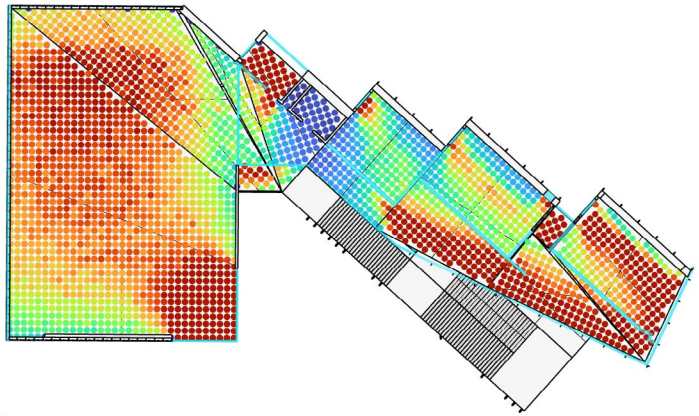
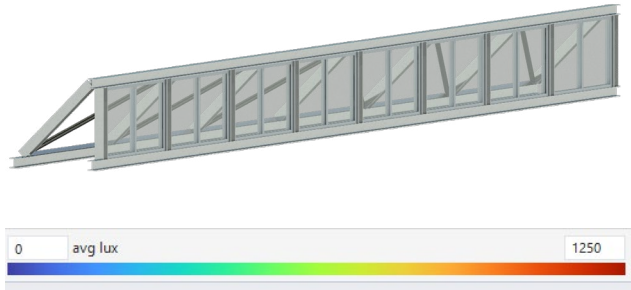
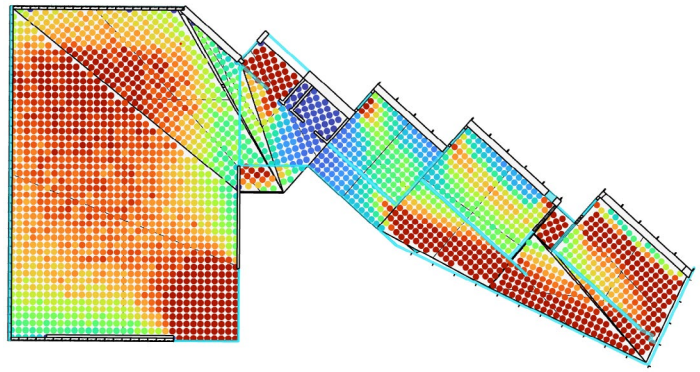




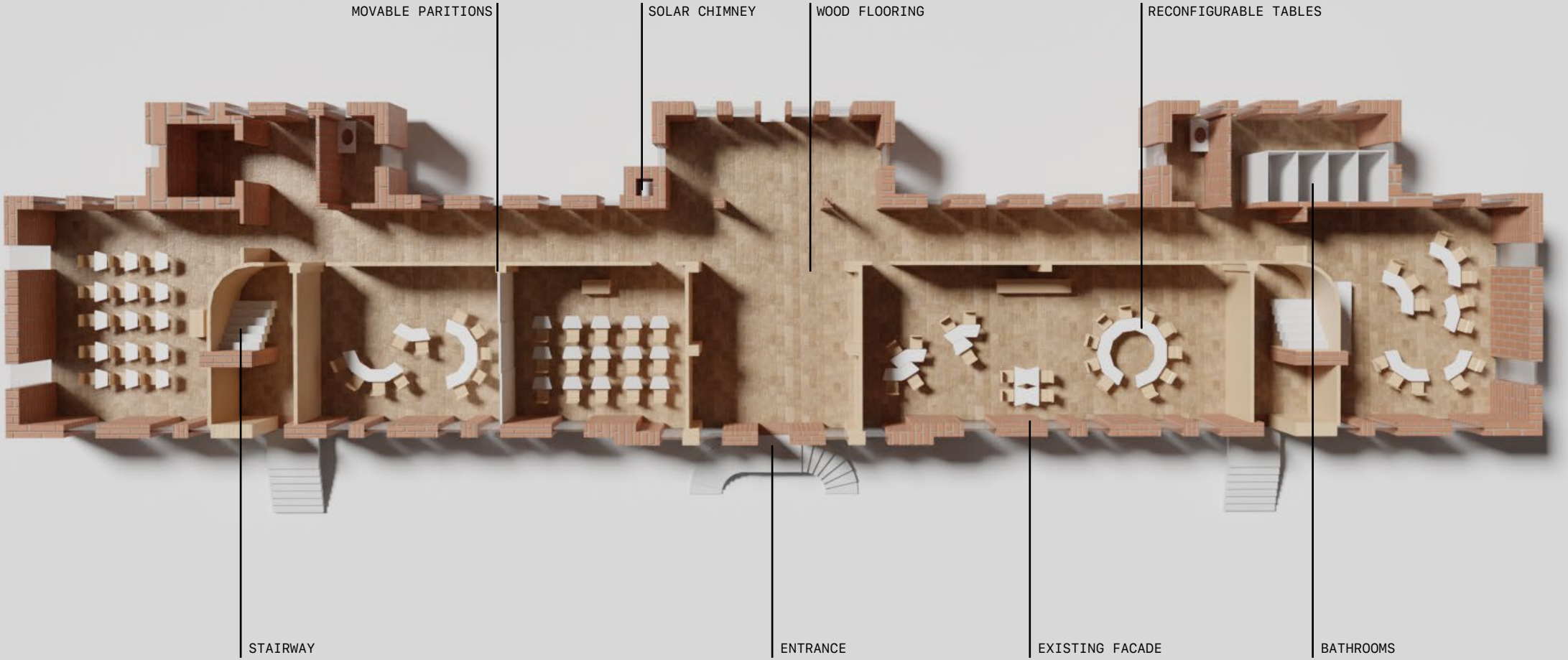








BUILDING 555



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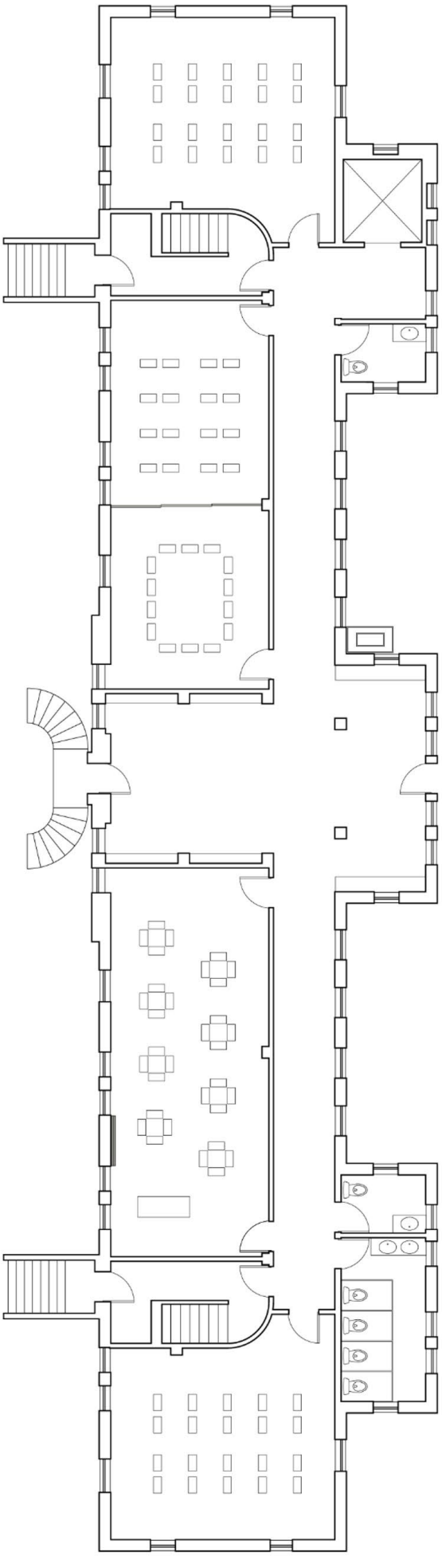
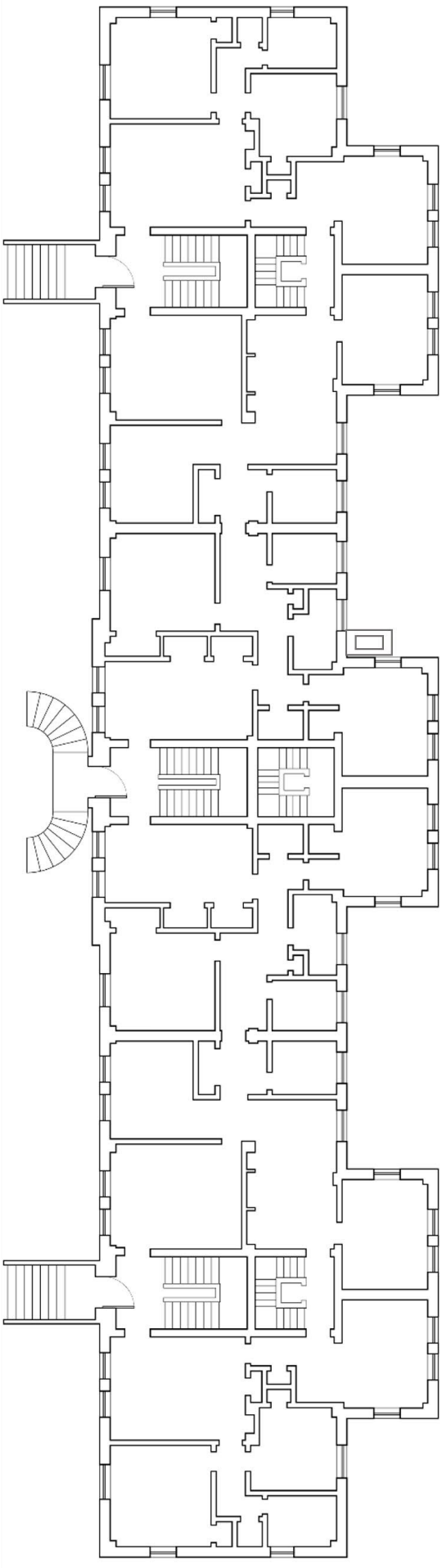


BEFORE



BUILDING 555

HEATING & COOLING

The retrofit of Building 555 includes Radiant Ceiling Panels on the first floor for resiliency and in the slabs on the 2nd and 3rd floors, with the mechanical equipment on the 3rd floor. A solar chimney modifies an existing one, aiding passive heating and cooling of the space when needed. Mineral wool insulation will be used for its effectiveness, resilience, and soundproofing qualities.

- Architecture
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- Engineering
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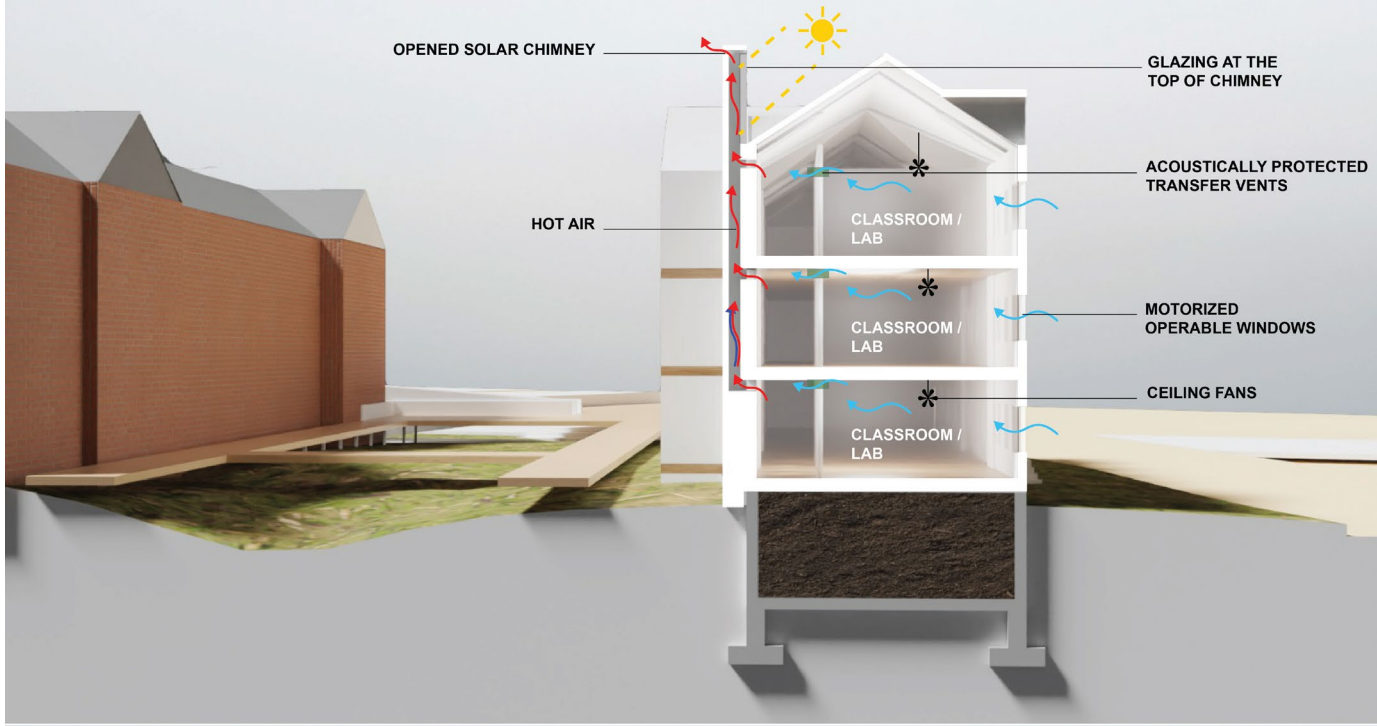
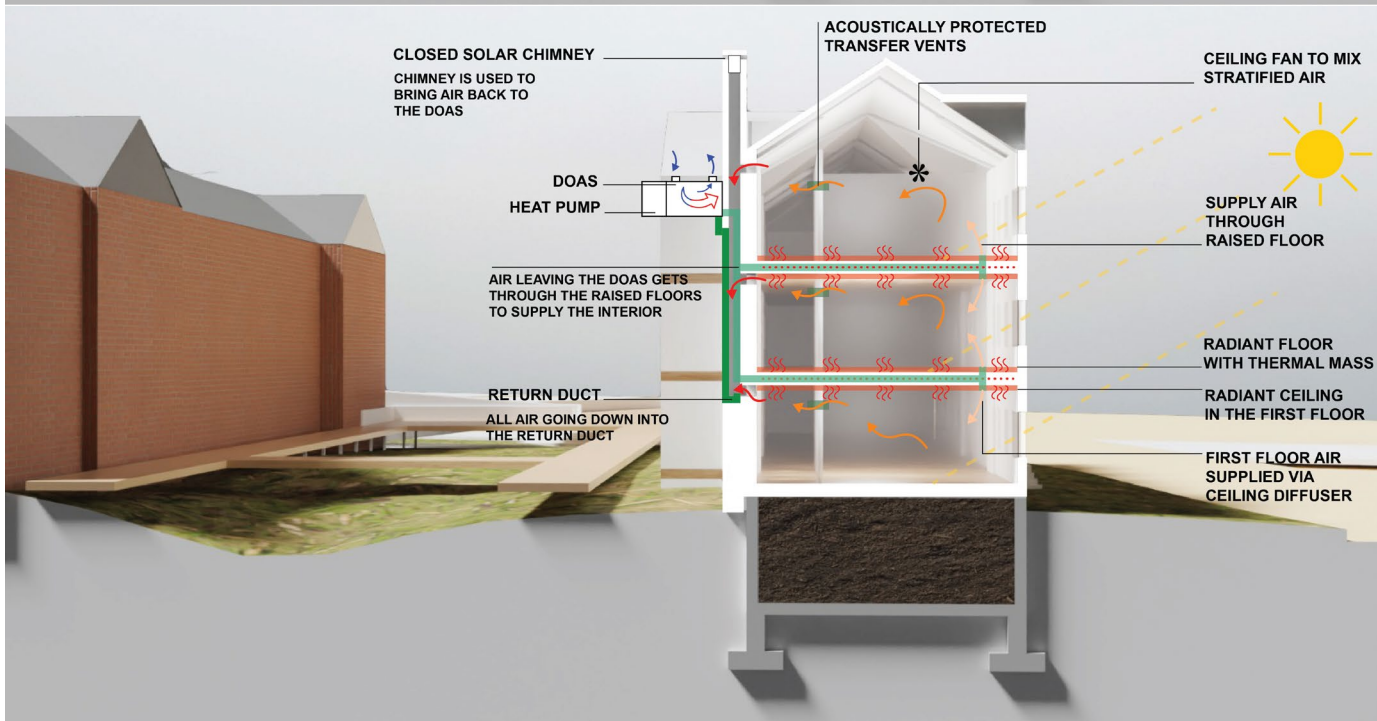
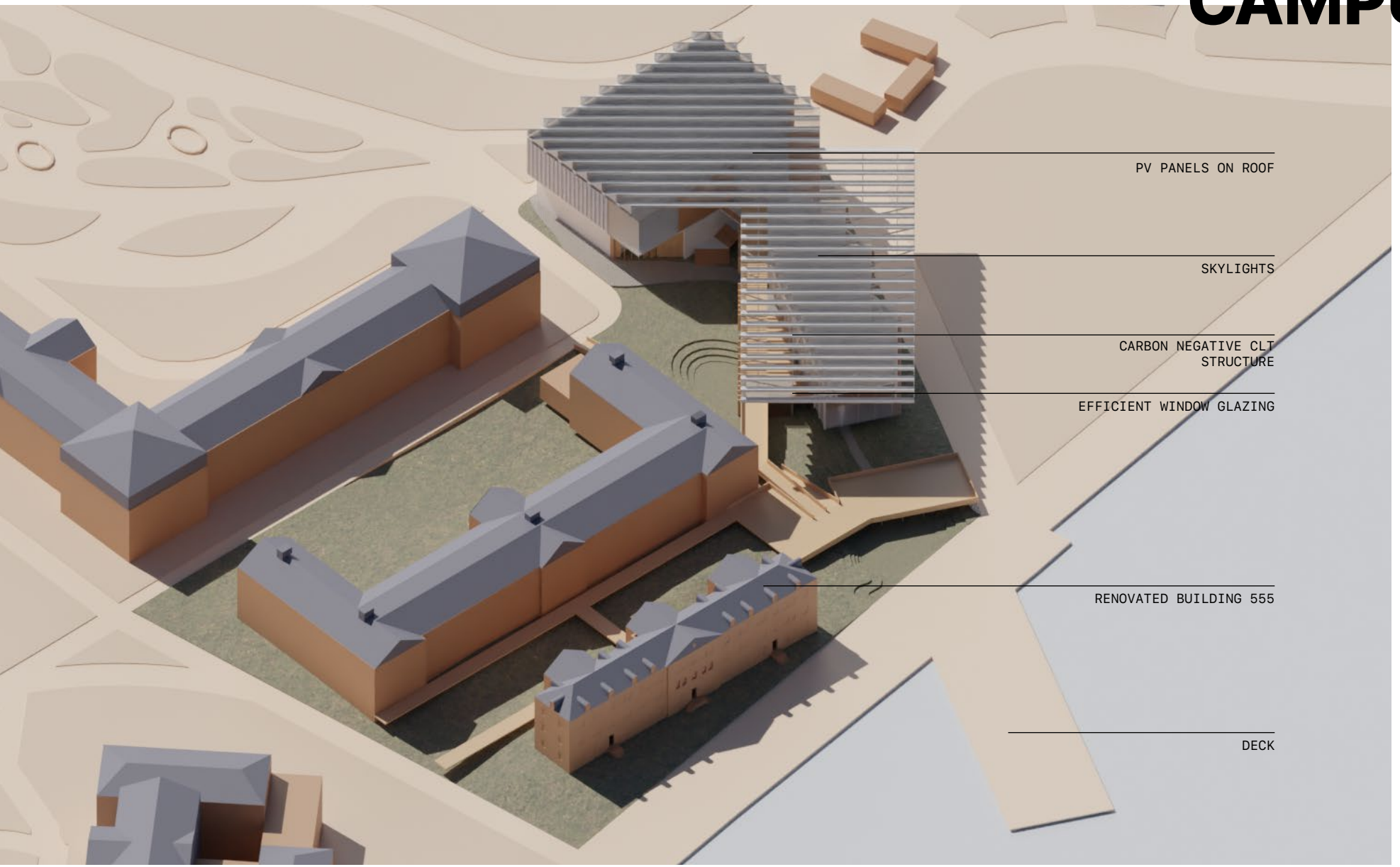
Building 555 EcoForest EcoGeo Geothermal Heat Pump

Building 555 Versetec 700 Indoor DOAS + ERV





CAMPUS ENERGY ANALYSIS



ENERGY MODELING

The pool is the largest consumer of energy, taking up half of the energy use, followed by the gym, classrooms and labs, resulting in the NAB with a source EUI of 50, Building 555 with a source EUI of 47 and an overall EUI of 51. Despite the energy intensive programs in the NAB, the building still falls well below the average source EUI of secondary schools in the same climate zone

Architecture

Durability and Resilience

Engineering

Integrated Performance

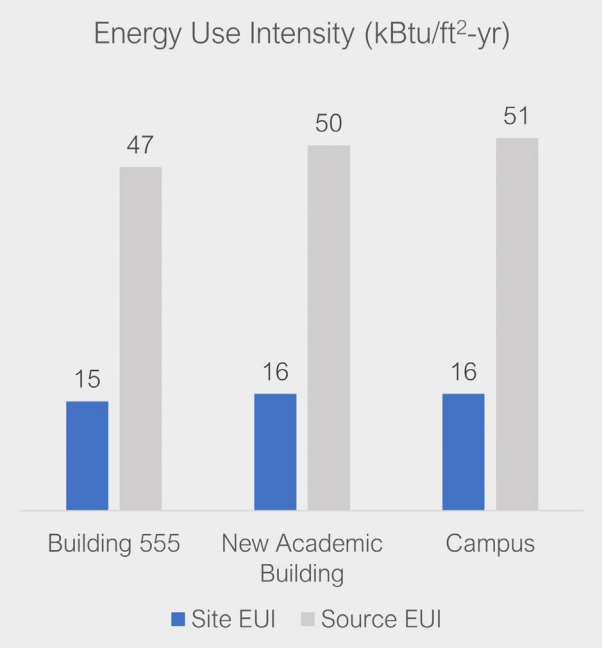
Energy

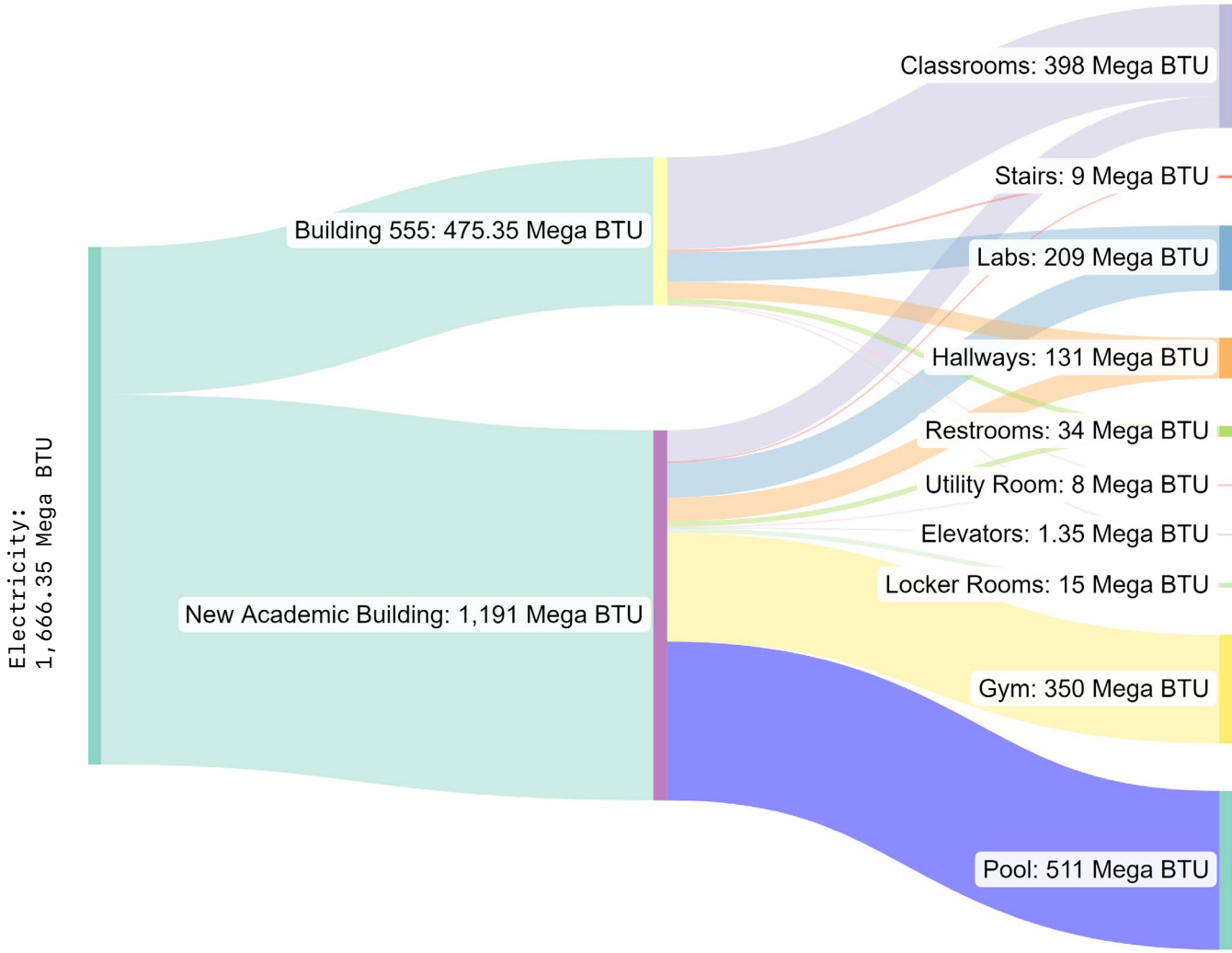
Embodied Environmental Impact

Occupant Experience

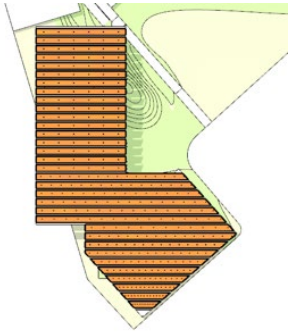
Comfort

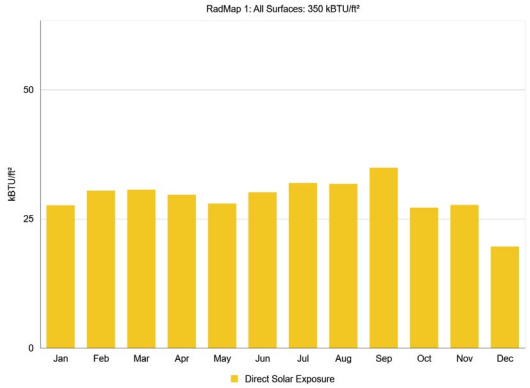
Market Analysis

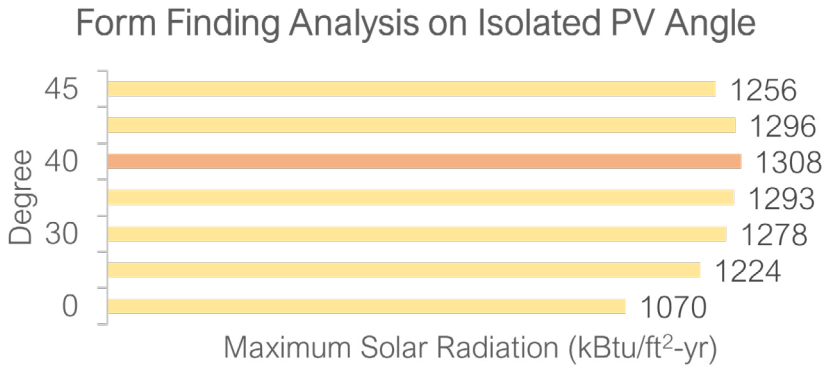


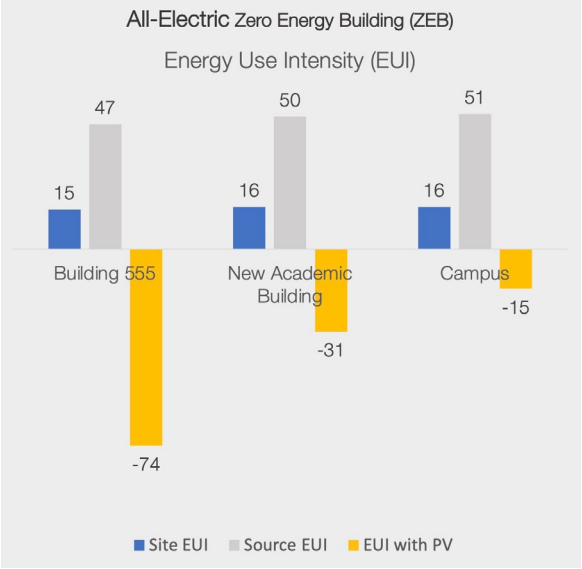


ENERGY MODELING









Architecture

Durability and Resilience

Engineering

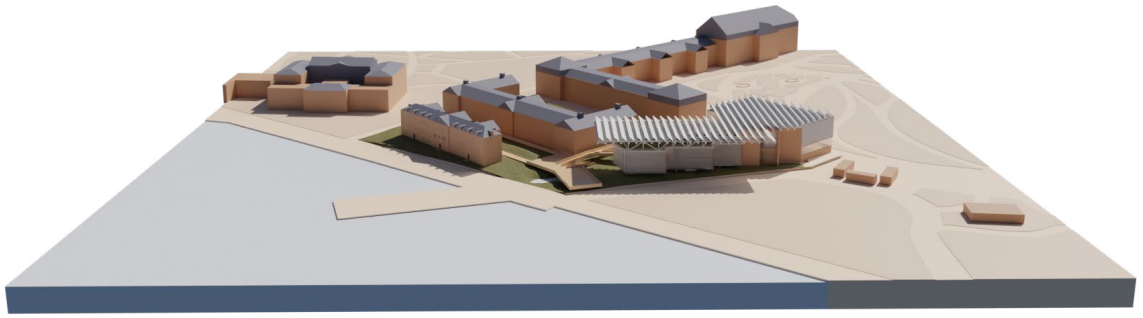
- Integrated Performance
- Energy
- Embodied Environmental Impact

Occupant Experience

Comfort

Market Analysis

Solar panels are only allowed on the new academic building, as Building 555 is a historical landmark building. We used the Climate Studio extension on Rhino to determine the optimal 40 deg tilt angle. The annual direct solar radiation is 350 kBTU/ft^2 and the 22% efficient sun power solar panels produce around 2.8 million kBTU a year, making our buildings, net- zero energy buildings with a net Source EUI of negative 15 kBTU/sf. The excess energy production will go into a battery pack system for grid-failure events or be sold back to the grid.



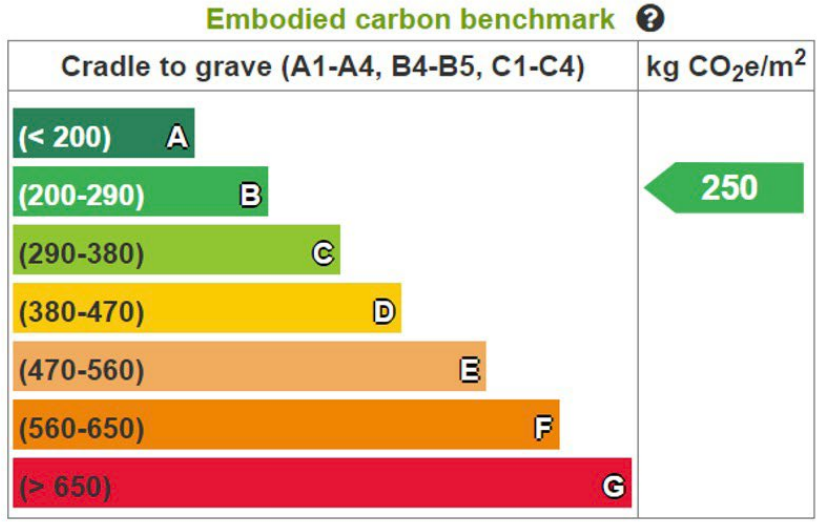
Annual Direct Solar Radiation	0.042 kBTU/ft^2-year
Total PV Panel Area	36,993 ft^2
PV Panel Efficiency	22%
Annual Energy Generated	2,848,461 kBTU/yr

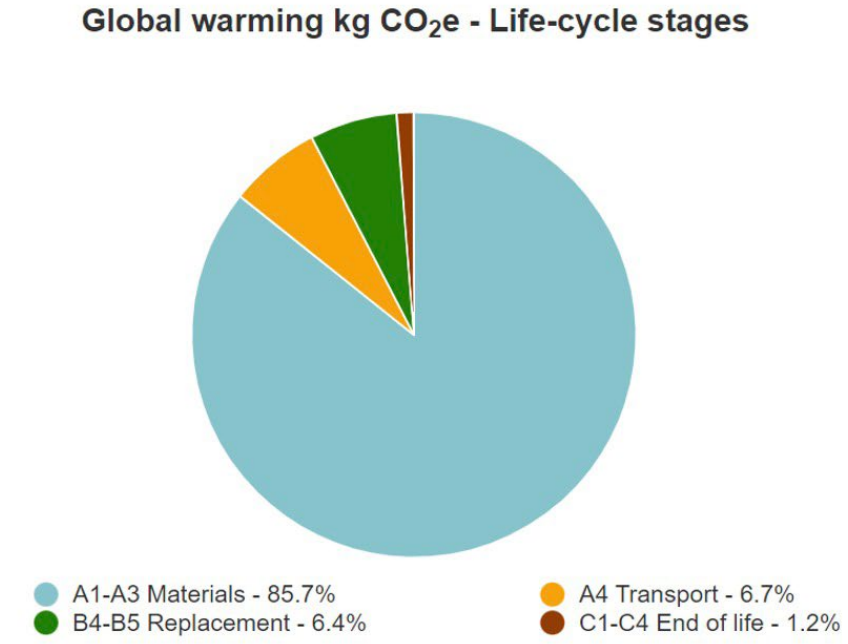
EMBODIED ENVIRONMENTAL IMPACT

Total Embodied Carbon Cost for Life of Structure + Envelope: 1,191 tons CO2e

Area Embodied Carbon Cost: 250 kg/m^2 C02e

Yearly Embodied Carbon Cost: 2.14 kg/m^2/year C02e





Carbon-negative CLT superstructure (85% reduction compared to equiv. conc. structure)

Local materials sourcing

Structural replacement redundancy + end of life harvest

Direct construction waste + excavated earth use

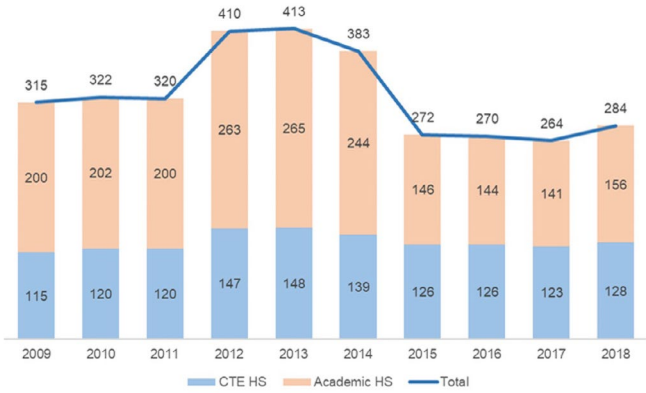
Carbon Cost Payback w/ PV to NYC electric: 10-12 years
Path to Grade A: Recycled Steel, Hempcrete, alt. Insulation

MARKET ANALYSIS

PLANNING FOR CLIMATE SOLUTIONS CENTER
CONCEPTUAL DRAFT RENDERING

The construction of the New Academic Building is part of the larger redevelopment plan of Governors Island as part of an effort to establish a Climate Solutions Center for New York City. The development aims to turn the island into a hub for climate research with a focus on environmental justice and resiliency. Developing new facilities for the Harbor school is expected to generate opportunity for research into climate change, providing an opportunity for student involvement as well as piloting solutions for NYC communities affected by extreme weather events, which disproportionally impact lower-income neighborhoods.

LABOR OUTLOOK FOR NYC
CTE PROGRAMS IN NYC, BY HIGH SCHOOL TYPE



Source: Research Alliance calculations based on data obtained by the NYC Department of Education.

Anticipated overall budget of **$84 Million**
$79 Million New Academic Building | New Construction
$5 Million Building 555 | Renovation

School Construction Authority budgets **$90,000** per new/renovated student seat on avg.

$20 Billion Available from NYC Department of Education (DOE)

Successful Local Construction Precedents

PROJECT IMPACT

THANK YOU!

Acknowledgements:

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