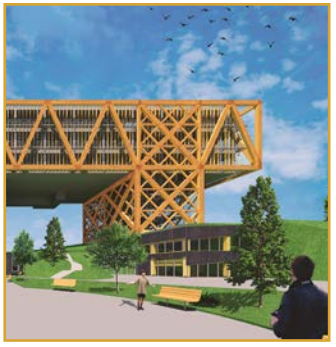
INNOVATION
IN
MASS TIMBER





CLACKAMAS COUNTY COURTHOUSE

Clackamas County Courthouse

University of Oregon Mass Timber Studio

Professors: Judith Sheine | Kevin Van Den Wymelenberg

Fall 2019

CLACKAMAS COUNTY

OFFICE OF THE COUNTY ADMINISTRATOR
PUBLIC SERVICES BUILDING
2051 KAEN ROAD | OREGON CITY, OR 97045

April 24, 2020

I am honored to have this opportunity to introduce you to this book of designs and concepts by Clackamas County Courthouse Mass Timber Studio students from the University of Oregon.

Clackamas County has had the pleasure of working with Professors Judith Sheine and Kevin Van Den Wymelenberg and their amazingly bright and creative students from the University of Oregon School of Architecture & Environment, College of Design to develop innovative ideas for creating a county courthouse utilizing mass timber construction.

This courthouse project is an incredible opportunity for utilizing mass timber in Clackamas County and the Pacific Northwest. Mass timber expansion will support countless industries and jobs, including loggers, architects, engineers, mill workers and construction workers.

In addition, mass timber fits with the Clackamas County focus on reducing our carbon footprint, since it has a lower carbon footprint than traditional building materials and can be a key technology to help combat climate change.

We appreciate the hours of hard work and exceptional creativity that Professors Sheine and Van Den Wymelenberg and their students have invested in this project. The unique concepts embrace the use of local materials and products, including mass timber.

Many thanks to the University of Oregon School of Architecture & Environment for facilitating the Clackamas County Courthouse Mass Timber Studio, the students who devoted their energy and their enthusiasm to improving our world, building by building, and to the United States Department of Agriculture Forest Service for funding support of this studio project through their Wood Innovations Grant program.

Gary Schmidt
Clackamas County Administrator

Introduction

This studio was sponsored by Clackamas County, Oregon to explore the possibilities for the design of their new County Courthouse showcasing mass timber in a very sustainable building. The county and state have had a long history with the timber industry and there is much interest in the potential of mass timber products manufactured in Oregon to promote significant economic development and environmental stewardship. Clackamas County would like their new Courthouse, a prominent civic building located in their county services campus, on a site identified in their Red Soils Master Plan, to act as a demonstration project for future public and private buildings featuring mass timber. The County received a Wood Innovations Grant from the United States Forest Service to support the studio, signifying the potential for this project to have national impact.

Contemporary mass timber or solid timber does not require cutting down large diameter trees. Large elements are manufactured by laminating or gluing together small pieces or layers of wood from small diameter logs to make larger structural members. While some mass timber products have been in use for a long time – glued laminated lumber (GLT), oriented strand board (OSB) and laminated veneer lumber (LVL), for example – new advanced wood products have been developed recently. Cross laminated timber (CLT), which consists of layers of 2" x 6" fir glued together perpendicular to each other, was developed in Europe more than 20 years ago, but the first structurally certified CLT was produced in the United States in 2015 by DR Johnson in Riddle, Oregon, and Freres Lumber in Lyons, Oregon is producing a new advanced wood product, mass plywood panels (MPP), certified in 2018. Both CLT and MPP are manufactured as large panels and have advantages over steel and concrete in a number of ways. Wood sequesters carbon and is substantially lighter than steel or concrete, which allows buildings with mass timber structural systems to have reduced structural loads and foundations. New lateral force resisting systems make mass timber very resilient and it is also fire resistant, with fire charring the exterior while protecting the interior of members. Timber panels can also be digitally fabricated and produced on demand with minimal waste and delivered "just-in-time" for rapid construction.

The approximately 250,000 square foot building program included the courthouse, along with the Sheriff's Department and offices for the District Attorney, the State, and Probation and Parole services. Due to the size of the program and the studio focus on an integrated design process, the students worked in teams of four in which they were expected to collaborate productively, to resolve complex issues efficiently and to present them effectively. The studio design process included engagement with Clackamas County staff and officials along with professional experts. We worked closely with Clackamas County staff: Rick Gruen, Manager, County Parks & Forest|Ag and Forest Economic Development; Sam Dicke, Economic Development; and Gary Barth, Clackamas County Courthouse Project Manager. County Commissioner Ken Humbertson was particularly supportive of the studio work, along with the entire Board of Commissioners and other County staff members.

The funding provided for external consultants to assist the students in this integrated design studio. Consultants included architects representing three firms with extensive courthouse expertise: Dennis McFadden, FAIA; Tim Ganey, Todd Orr and Carla Weinheimer of DLR; and building code expert Samir Mokashi of Codes Unlimited. Cal Poly Pomona Civil Engineering Professor Mikhail Gershfeld provided his specialized knowledge of timber structural systems, and Justin Stenkamp of PAE provided his expertise in environmental systems in mass timber buildings. Multiple reviews with the studio consultants and County administrators and staff provided feedback for the students, assisting them in integratng multiple considerations into their designs. The six student teams produced a broad range of approaches to the design project, giving the County much to think about and inspire them in the development of their new courthouse.

Student Projects

LUMBER LIQUIDATORS

Austin Gutierrez | Aizeder Iriondo Jayo | Alex McCord | Molly Winter

Funded by a grant from the US Forest Service, our studio partnered with Clackamas County to propose a new design for their future county courthouse using mass timber in an effort to demonstrate and promote tall wood design. Adhering to the county needs assessment, the program required 250,000 sf.

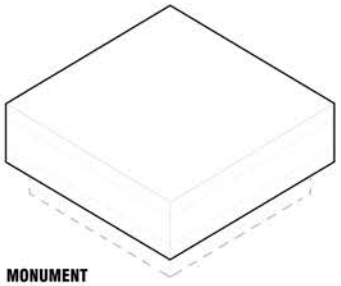
Often government buildings seem like they were dropped in from cookie-cutter assembly lines. While full of metaphorical and timeless archetypes, the 'courthouse' typically falls in this category. Understanding that courthouses are intimidating monuments in the urban fabric, this building strives to pertain to the subjective experience and progression through the justice system by providing meaningful space that cares for its occupants while maintaining iconic monumentality.

This building is an embodied image of Clackamas County's social contexts and judicial system as a framework of delicate parts that work together to create a strong structure.

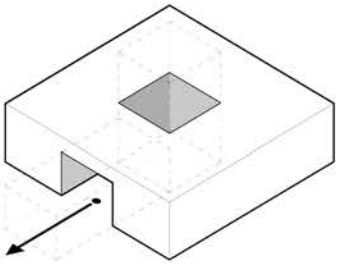

CLACKAMAS COUNTY COURTHOUSE


FUTURE COUNTY OFFICE BUILDING
FUTURE RETAIL AND OFFICE
FUTURE SHAVER BUILDING
N. RED SOILS COURT
FUTURE PARKING GARAGE
FUTURE COUNTY OFFICE BUILDING
LIBRARY COURT
BEAVER CREEK ROAD
FUTURE RETAIL AND OFFICE
EXISTING DEVELOPMENT SERVICES
EXISTING PUBLIC SERVICES
EXISTING UTILITY PLANT
FUTURE ADULT DETENTION FACILITY
S. RED SOILS COURT
EXISTING SILVER OAK
KAEN ROAD
FUTURE CENTRAL COMMUNICATIONS

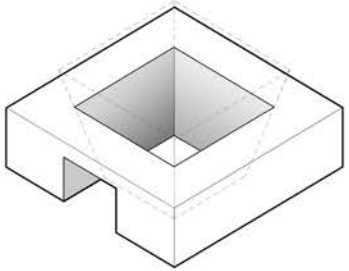
MASSING DIAGRAMS



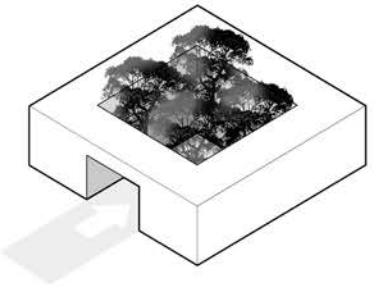
MONUMENT



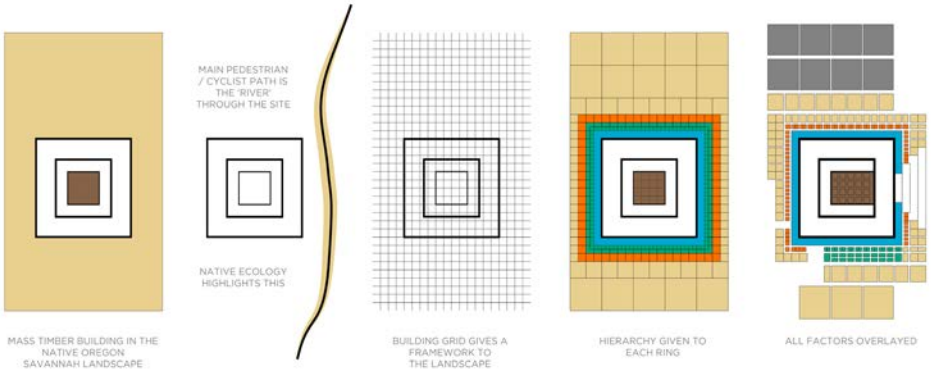
PORTAL & COURTYARD
ON AXIS WITH MT. HOOD



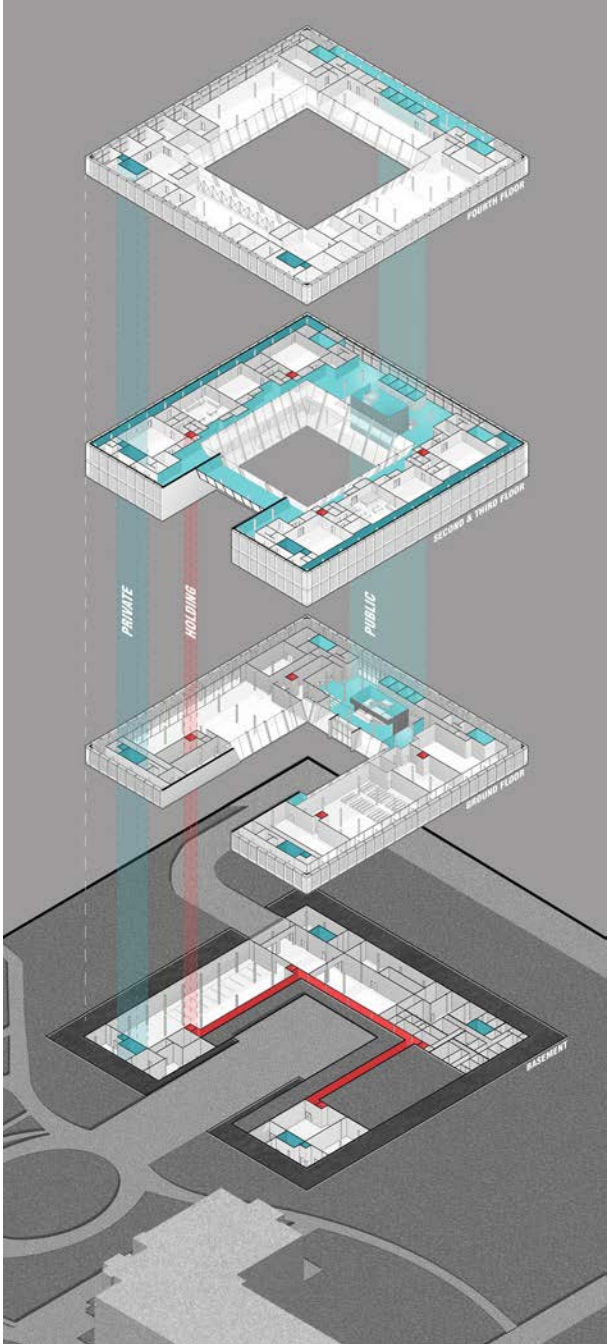
INVERTED VOID PYRAMID
ALLOWS FOR OPTIMAL DAYLIGHTING



ENTRANCE PROGRESSION
THROUGH COURTYARD



SITE PLAN



ZONING

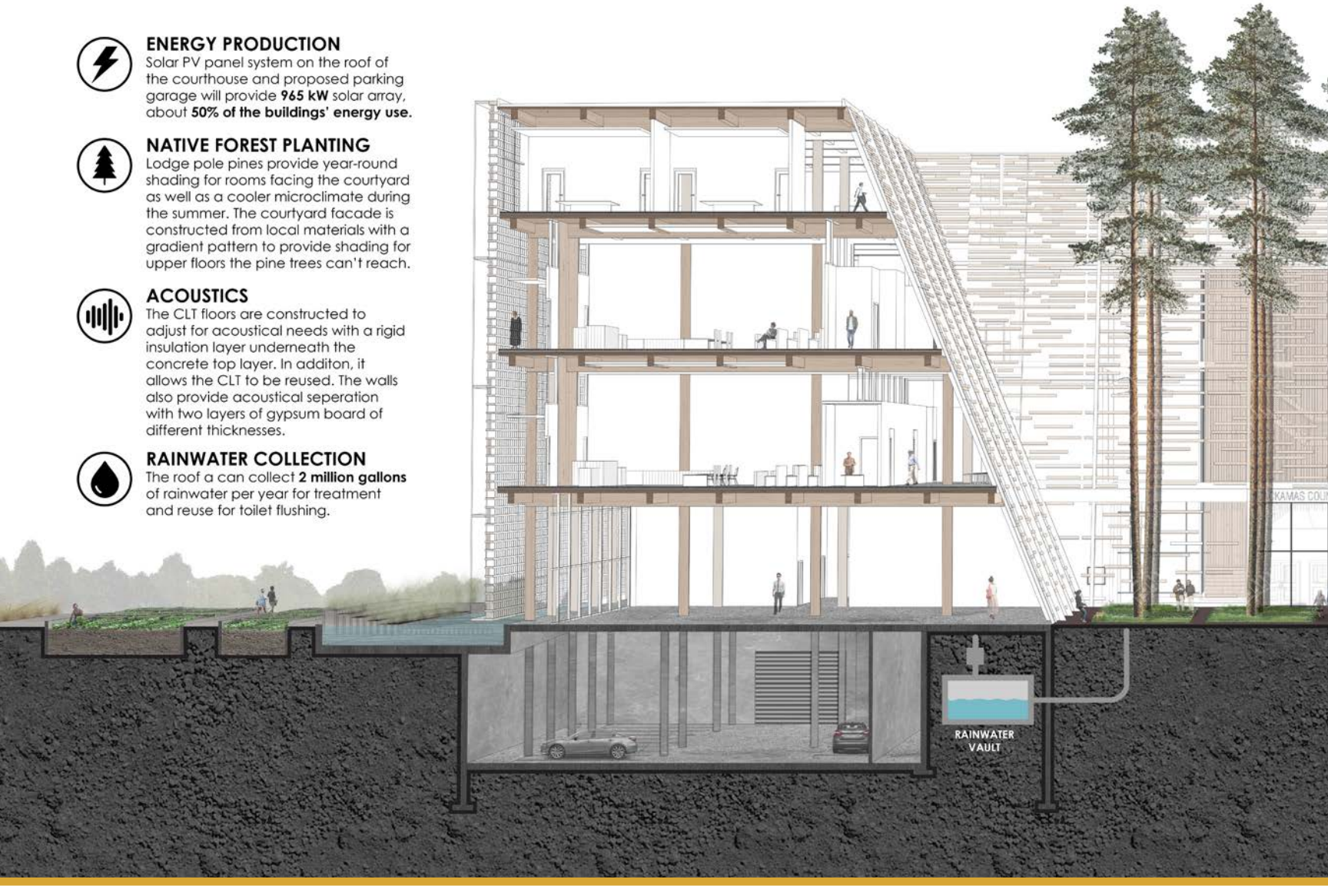
LONGITUDINAL SECTION

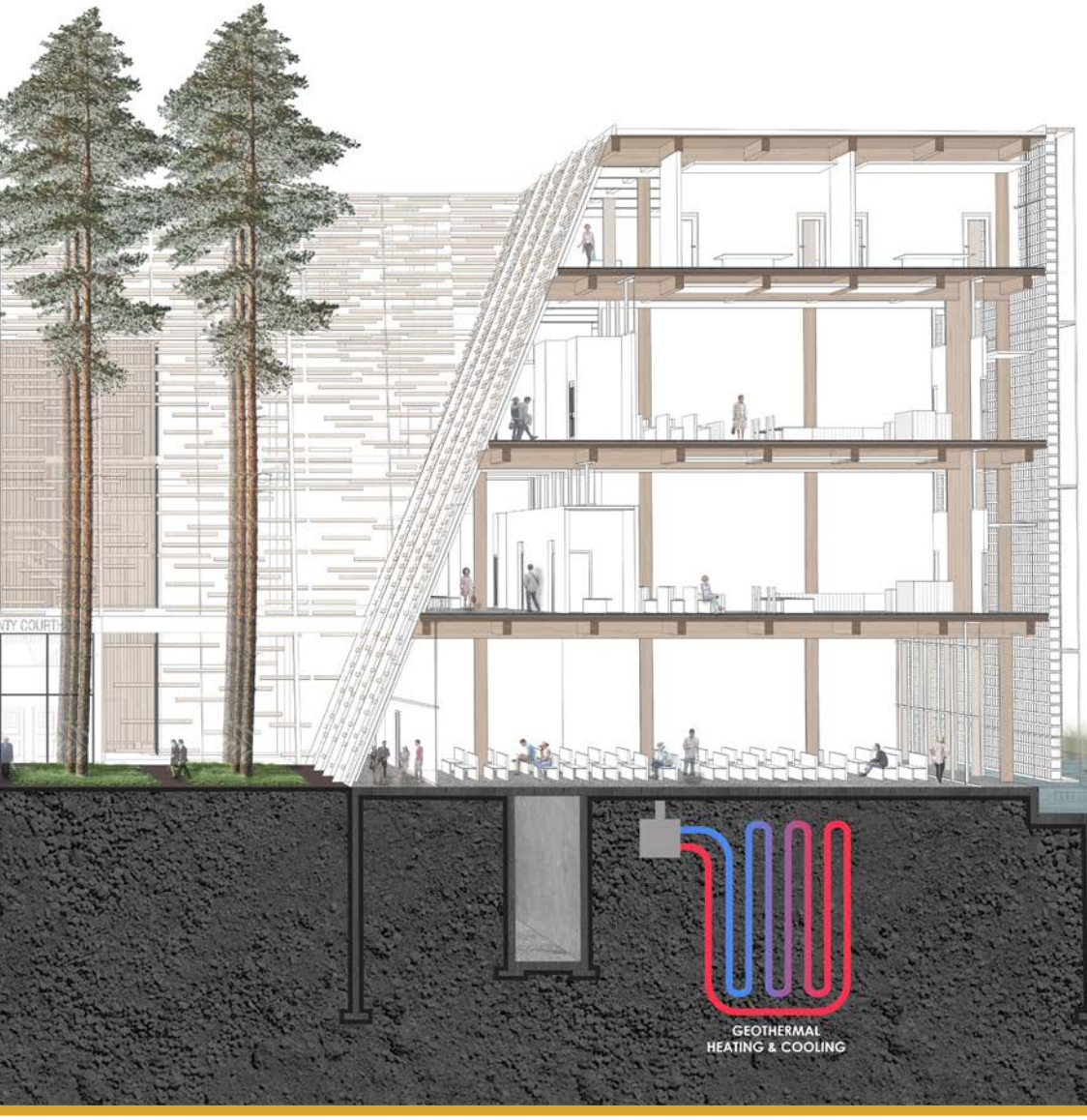
ENERGY PRODUCTION
Solar PV panel system on the roof of the courthouse and proposed parking garage will provide **965 kW** solar array, about **50% of the buildings' energy use.**

NATIVE FOREST PLANTING
Lodge pole pines provide year-round shading for rooms facing the courtyard as well as a cooler microclimate during the summer. The courtyard facade is constructed from local materials with a gradient pattern to provide shading for upper floors the pine trees can't reach.

ACOUSTICS
The CLT floors are constructed to adjust for acoustical needs with a rigid insulation layer underneath the concrete top layer. In additon, it allows the CLT to be reused. The walls also provide acoustical seperation with two layers of gypsum board of different thicknesses.

RAINWATER COLLECTION
The roof a can collect **2 million gallons** of rainwater per year for treatment and reuse for toilet flushing.





PASSIVE HEATING & COOLING

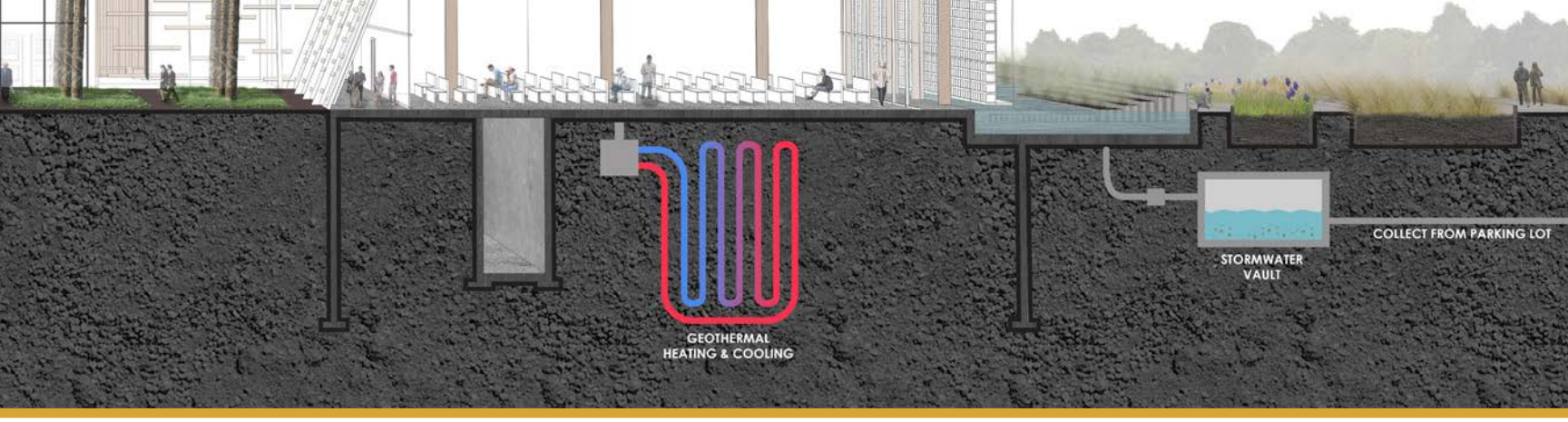
Geothermal heating and cooling is integrated in the building's systems to reduce energy consumption. The building also receives natural cooling from the retention pond that flows underneath the double-layer facade.

STORMWATER TREATMENT

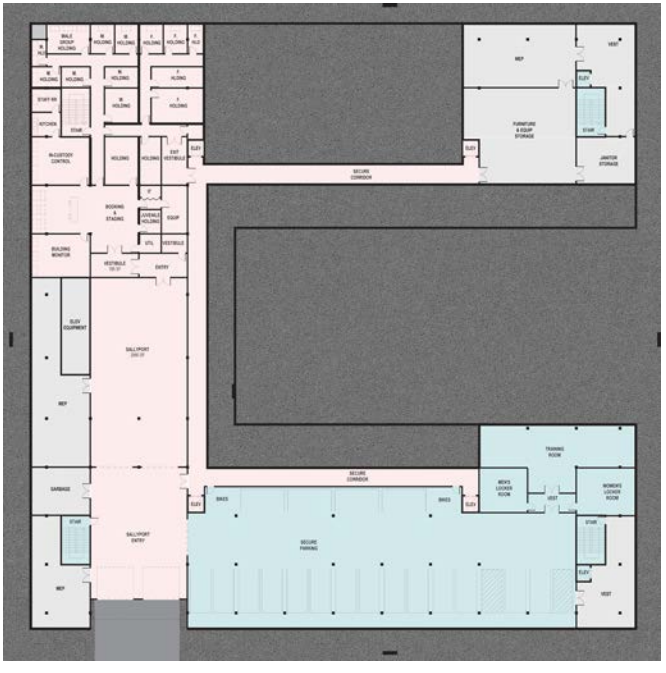
Stormwater is collected from the site and adjacent parking lot. It is drained to a stormwater vault for storage and heavy sediment filtration. From there, water is pumped up to the retention pond that surrounds the building for natural filtration through biofilters and phytoremediation.

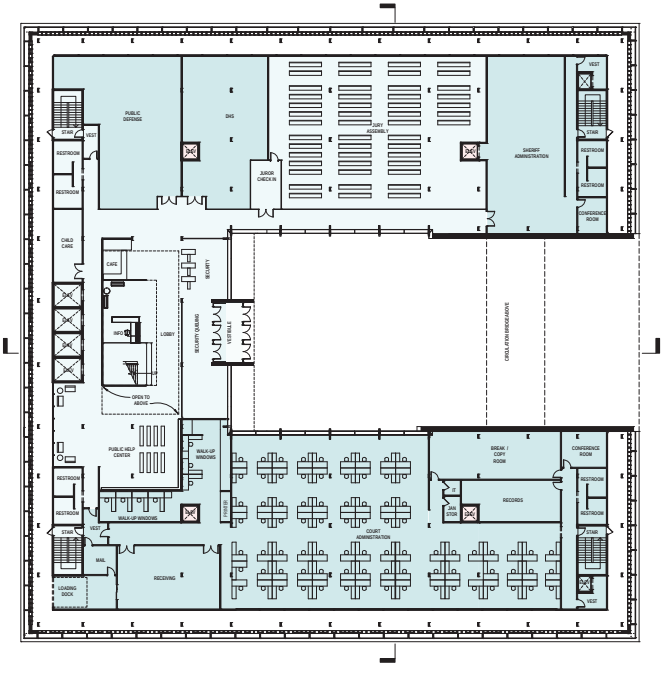
STORMWATER STORAGE

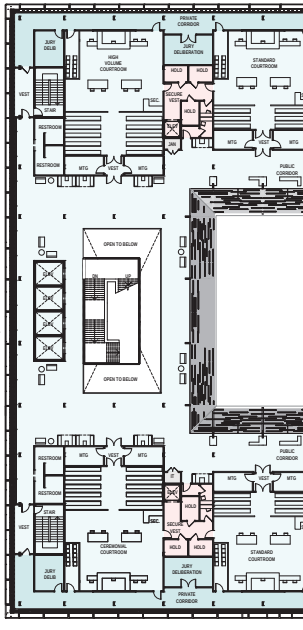
Preparing for the worst, stormevents can bring **500,000 gallons** of water to the 5 acre site in **24 hours**. Our site can hold **100%** of these 10 year stormevents with permeable surfaces, swales and 12 ft deep stormwater vault underneath the parking lot.

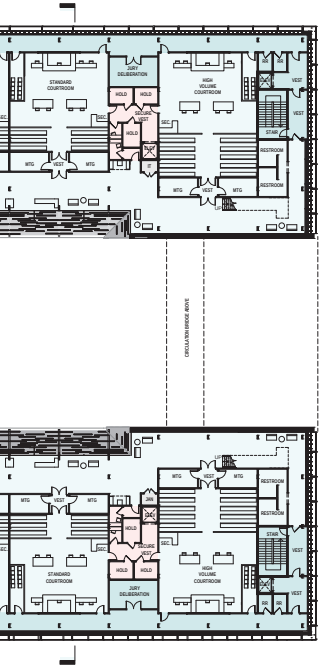


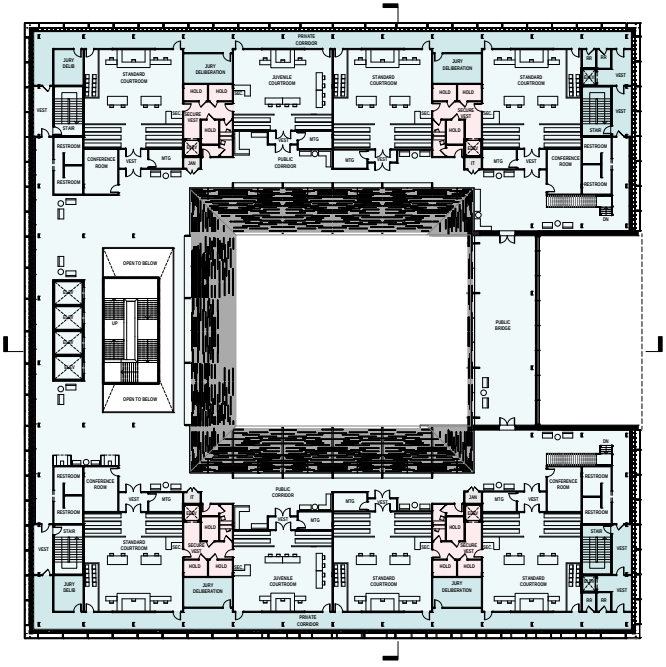
PLANS Basement - Fourth Floor

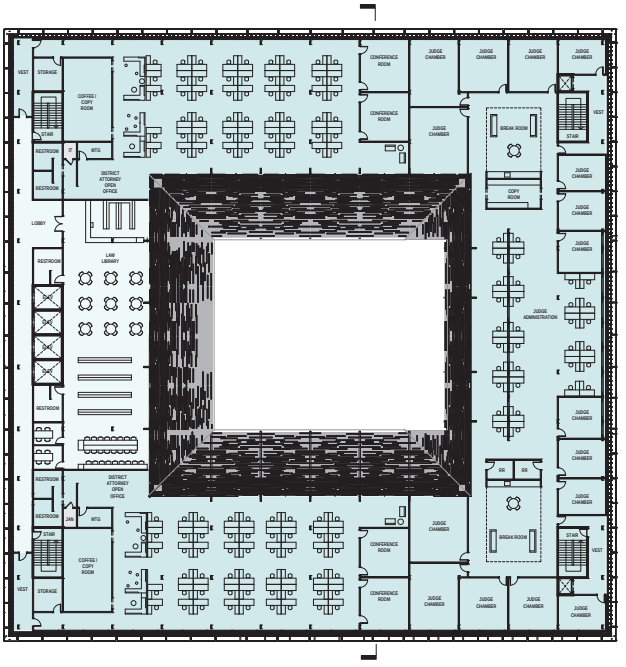




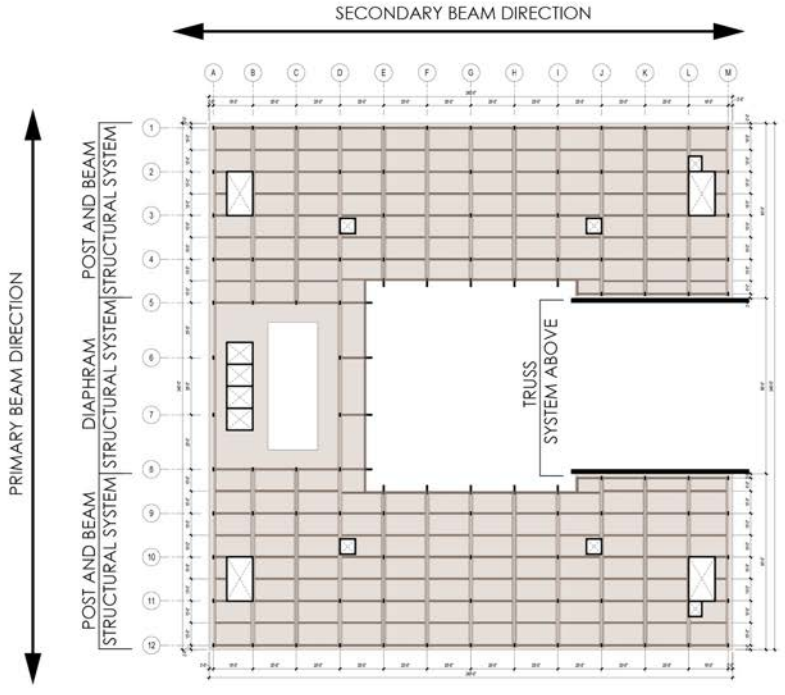



STANDARD COURTROOM
JURY DELIBERATION
HIGH VOLUME COURTROOM
VEST
HOLD
SECURE VEST
SEC
STAIR
RESTROOM
MTG
CIRCULATION BRIDGE ABOVE


PRIVATE CORRIDOR
JURY DELIB
STANDARD COURTROOM
JURY DELIBERATION
JUVENILE COURTROOM
PUBLIC CORRIDOR
VEST
STAIR
RESTROOM
CONFERENCE ROOM
MTG
OPEN TO BELOW
UP
DN
PUBLIC BRIDGE


VEST
STORAGE
COFFEE / COPY ROOM
CONFERENCE ROOM
JUDGE CHAMBER
BREAK ROOM
COPY ROOM
STAIR
RESTROOM
MTG
DISTRICT ATTORNEY OPEN OFFICE
LOBBY
LAW LIBRARY
JUDGE ADMINISTRATION
DN
UP
LWR

STRUCTURAL DIAGRAMS



TYPICAL STRUCTURAL LAYOUT

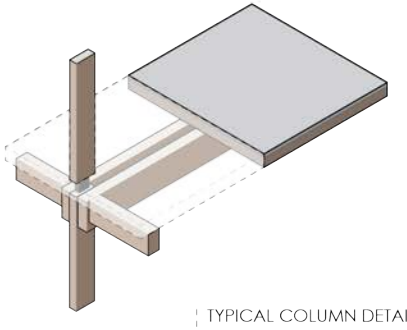
100,000 CF
DOUGLAS FIR CLT

42,750 CF
DOUGLAS FIR BEAMS

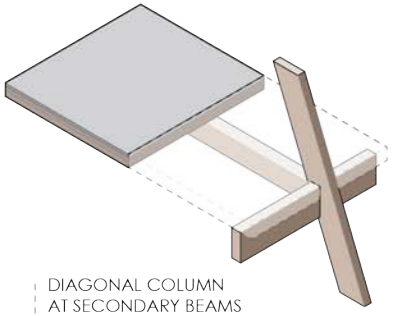
6,500 CF
DOUGLAS FIR COLUMNS

3,800
METRIC TONS
CO2 SEQUESTERED IN THE STRUCTUAL ELEMENTS

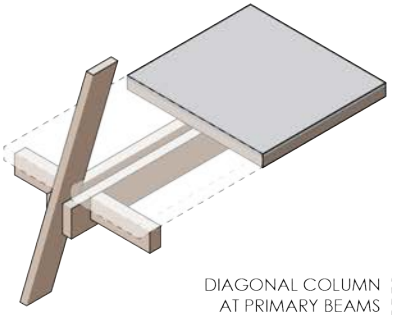
5,270
METRIC TONS
POTENTIAL CARBON BENEFIT



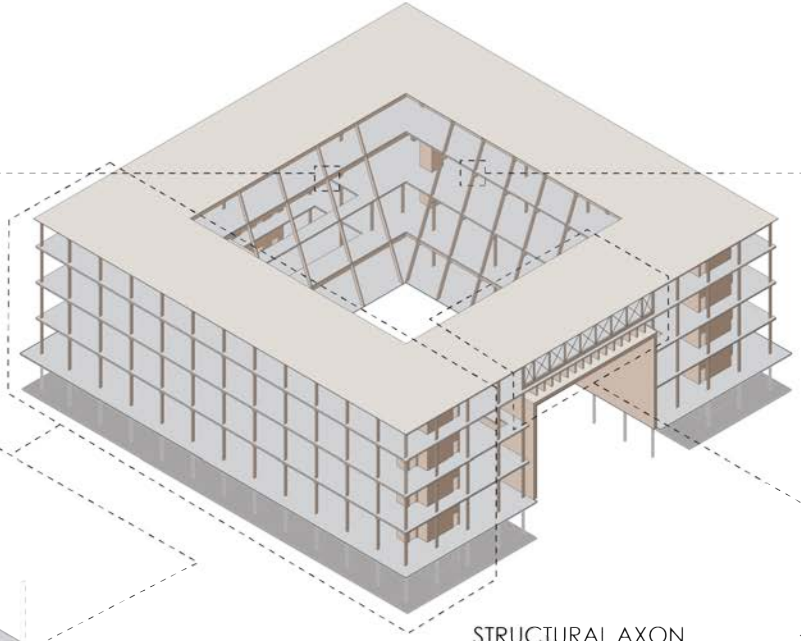
TYPICAL COLUMN DETAIL



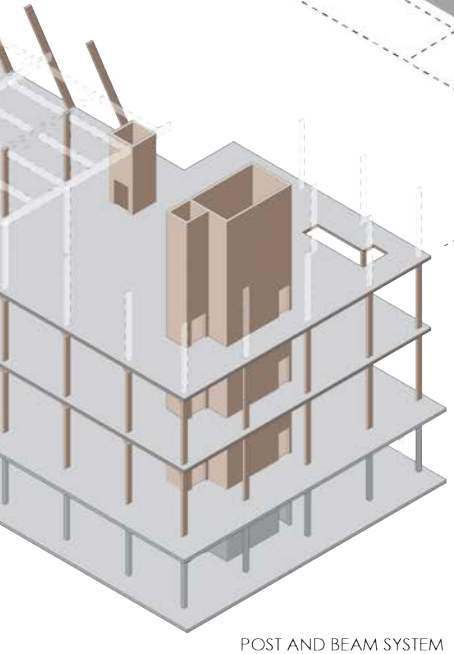
DIAGONAL COLUMN
AT SECONDARY BEAMS



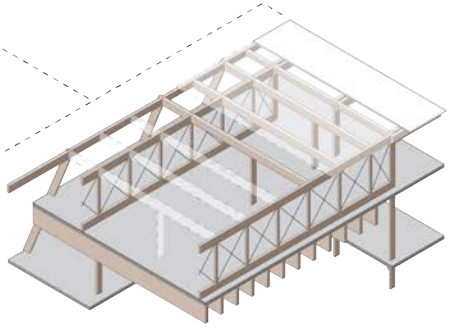
DIAGONAL COLUMN
AT PRIMARY BEAMS



STRUCTURAL AXON



POST AND BEAM SYSTEM



TRUSS SYSTEM

Carbon Summary

WoodWorks™
WOOD PRODUCTS COUNCIL

Results

Volume of wood products used:
4,226 cubic meters (149,250 cubic feet)

U.S. and Canadian forests grow this much wood in:
12 minutes

Carbon stored in the wood:
3800 metric tons of carbon dioxide

Avoided greenhouse gas emissions:
1470 metric tons of carbon dioxide

Total potential carbon benefit:
5270 metric tons of carbon dioxide

Equivalent to:

1114 cars off the road for a year

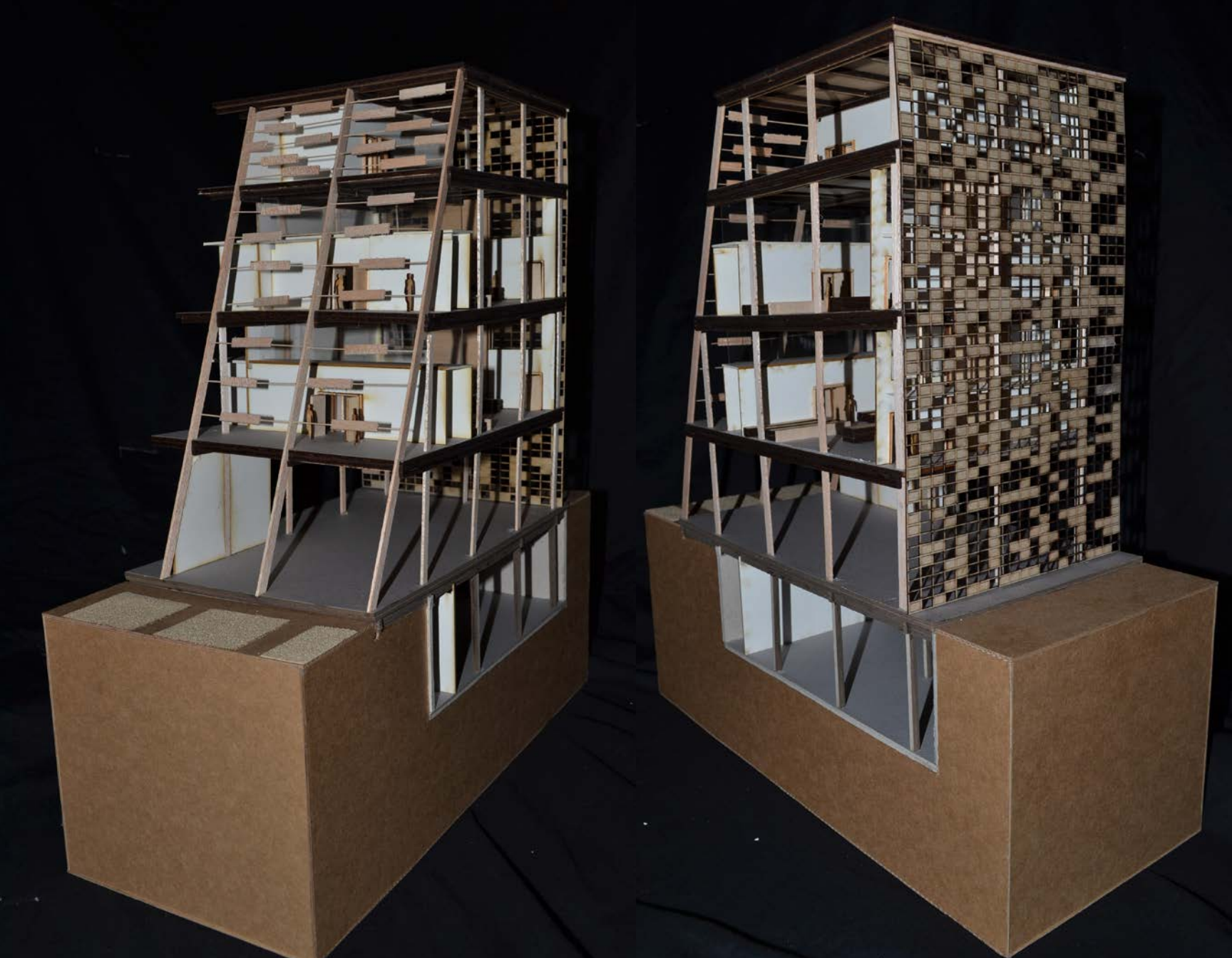
Energy to operate 557 homes for a year

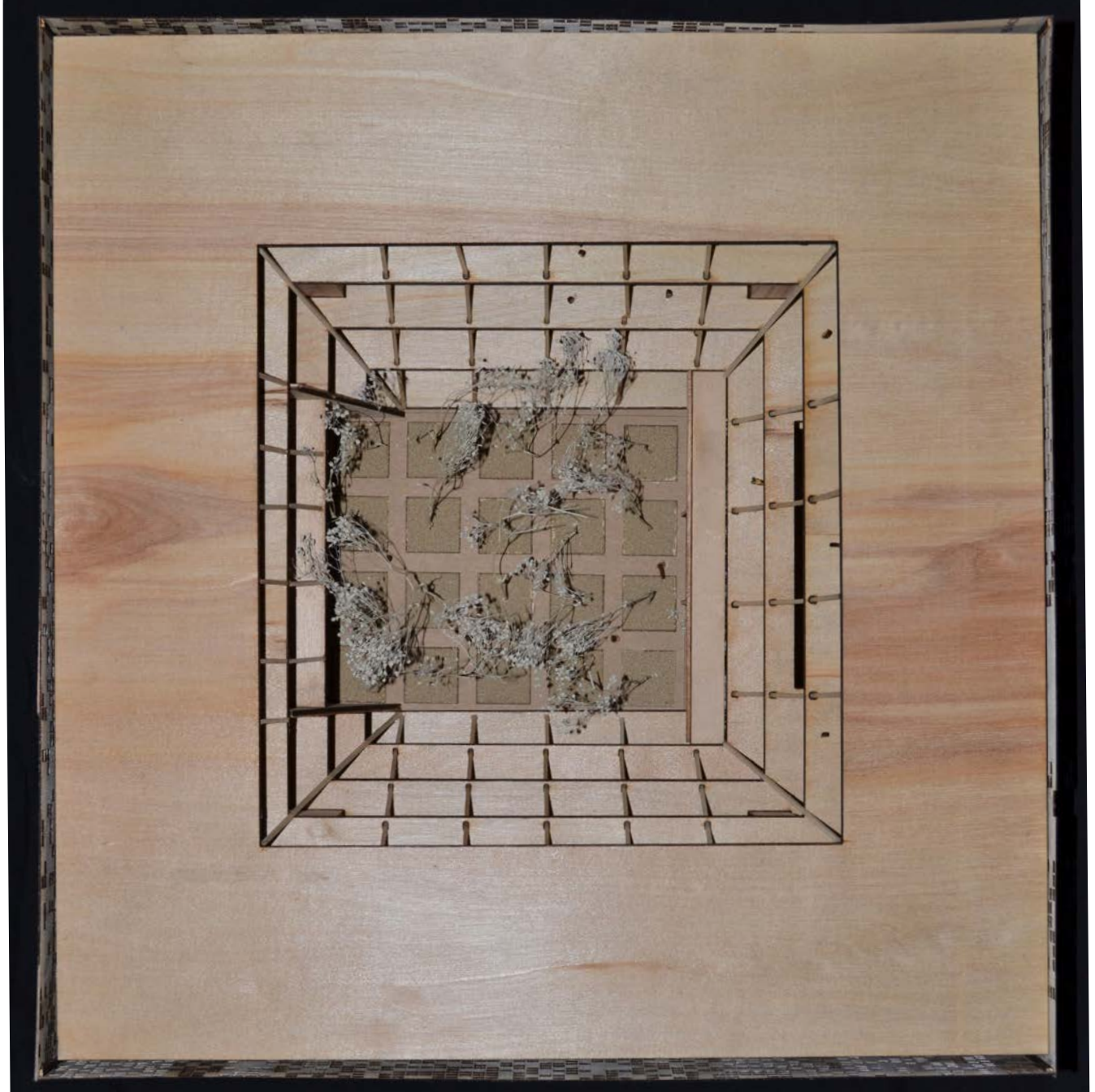
Project Name: Project Name (optional)
Date: December 5, 2019

Results from this tool are based on wood volumes only and are estimates of carbon stored within wood products and avoided emissions resulting from the substitution of wood products for non-wood products. The results do not indicate a carbon footprint or global warming potential and are not intended to replace a detailed life cycle assessment (LCA) study. Please refer to the References and Notes' for assumptions and other information related to the calculations.

CARBON DATA
above
INTERIOR PERSPECTIVES
right

MODEL PHOTOS

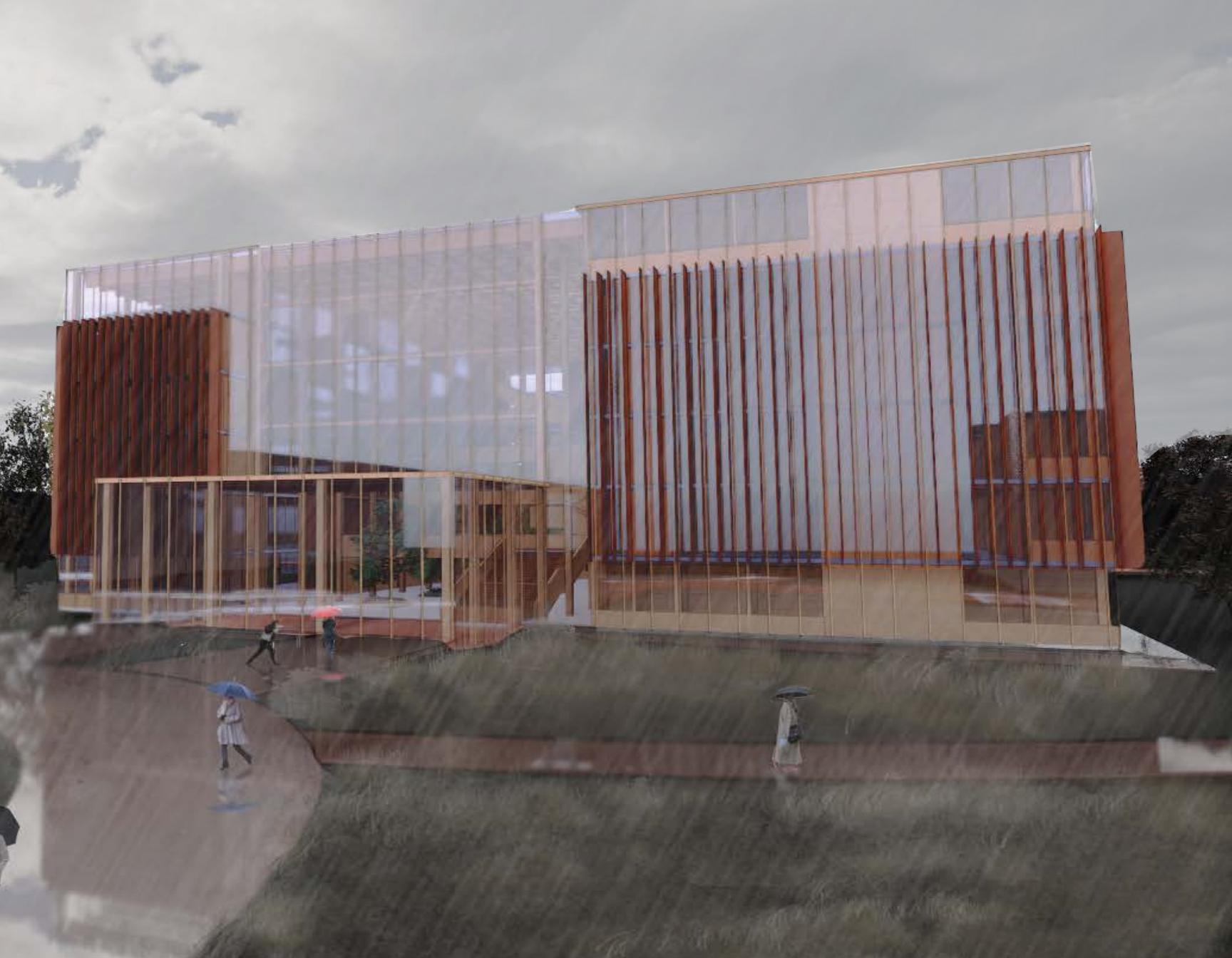




MASS TEAMBERS

Gemma Fucigna | Jessi Gahl | Aaryn Gray | Lorine Moellentine

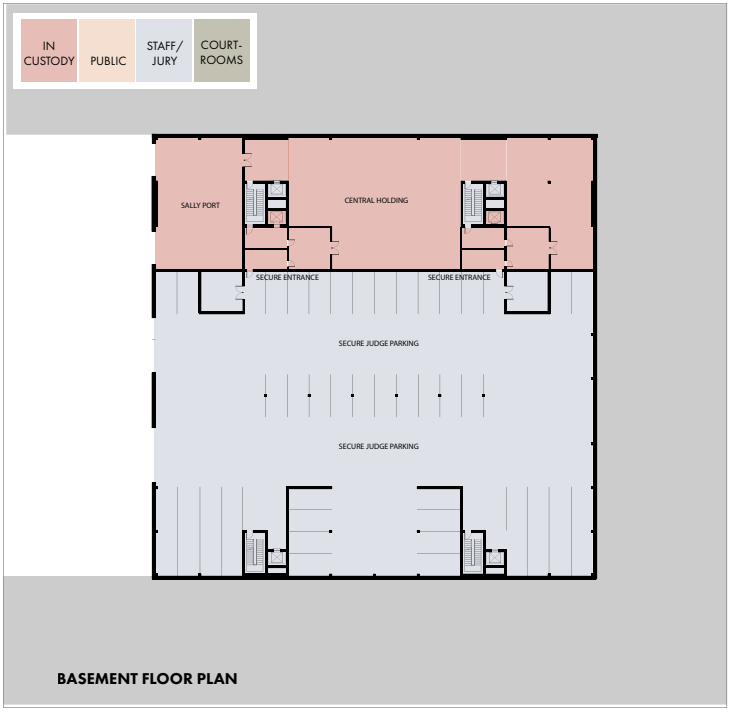
Nestled between two office administrative buildings, the mass timber Clackamas County Courthouse further completes the Red Soils Master Plan while creating another axis across the site. The building is composed of a single volume that is subdivided in response to light, circulation, and program. It is composed of two parallel bars and a smaller cube that pushes out from the main shape. These pieces are all stitched together with a central atrium space that serves as the main public circulation through the building. With the entry glass facade, the courthouse evokes a feeling of transparency within the judicial system. There is a screen on most of the exterior, providing shading and a reference to the interior program. With its well defined and visible structural grid, the mass timber building stands as a symbol for the timber foundation of Clackamas County and the region it inhabits.



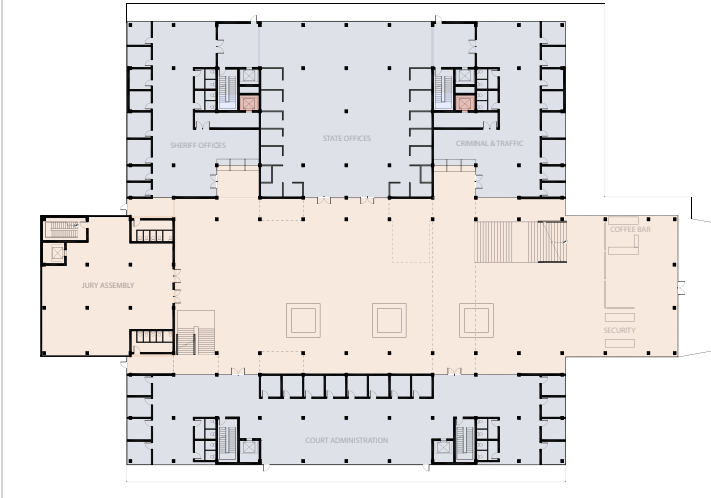
PLANS

THIRD FLOOR PLAN

FOURTH FLOOR PLAN



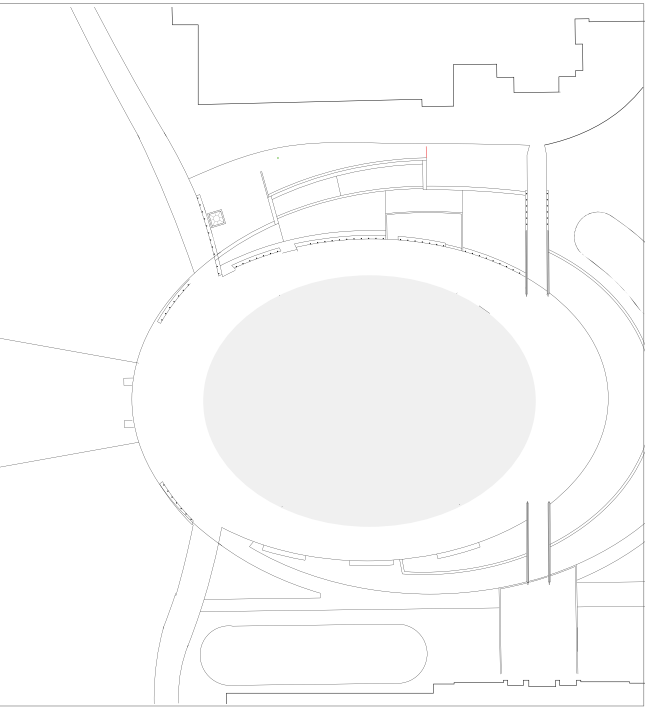
BASEMENT FLOOR PLAN



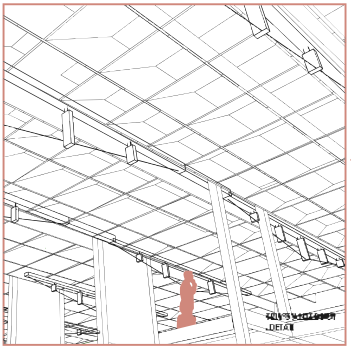
FIRST FLOOR PLAN

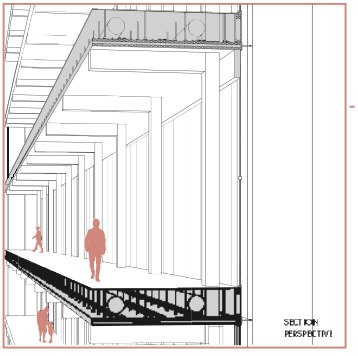
FIFTH FLOOR PLAN

SIXTH FLOOR PLAN

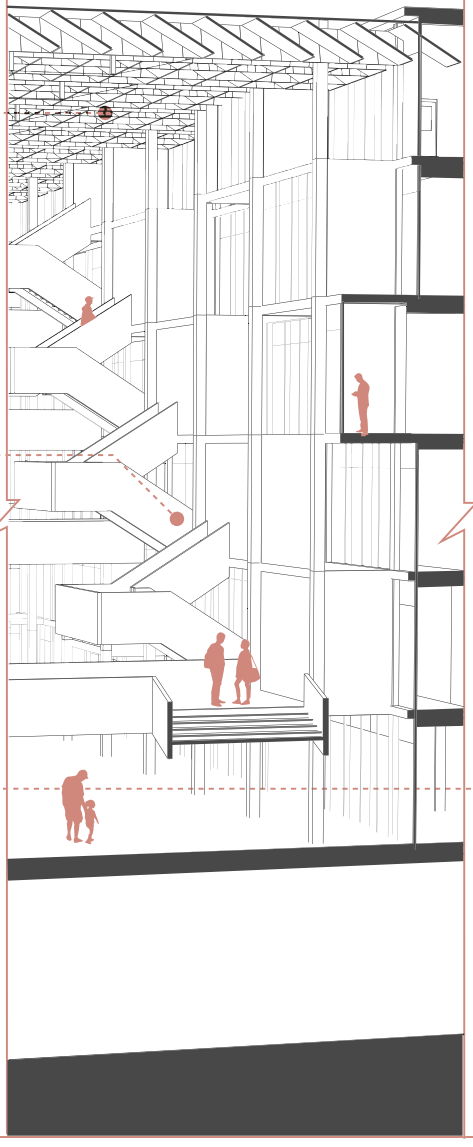


SECOND FLOOR PLAN

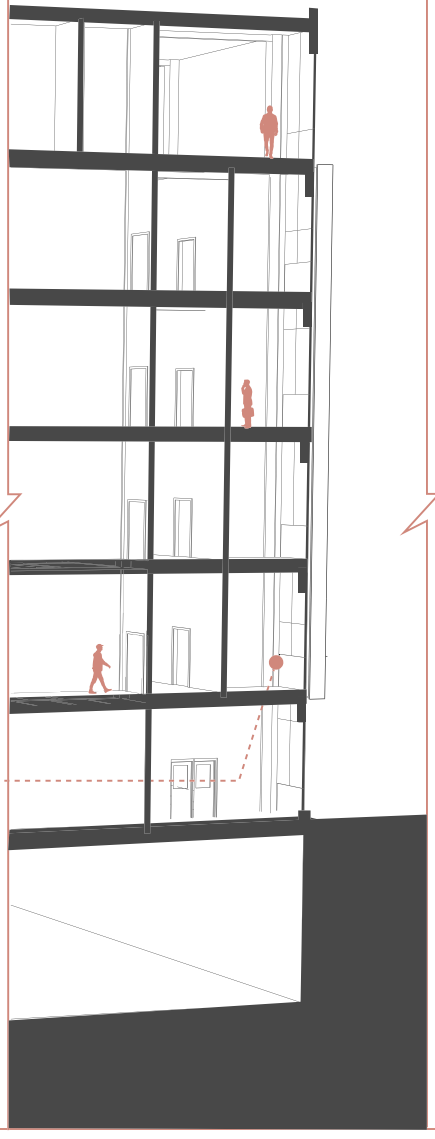




AT ATRIUM WALL

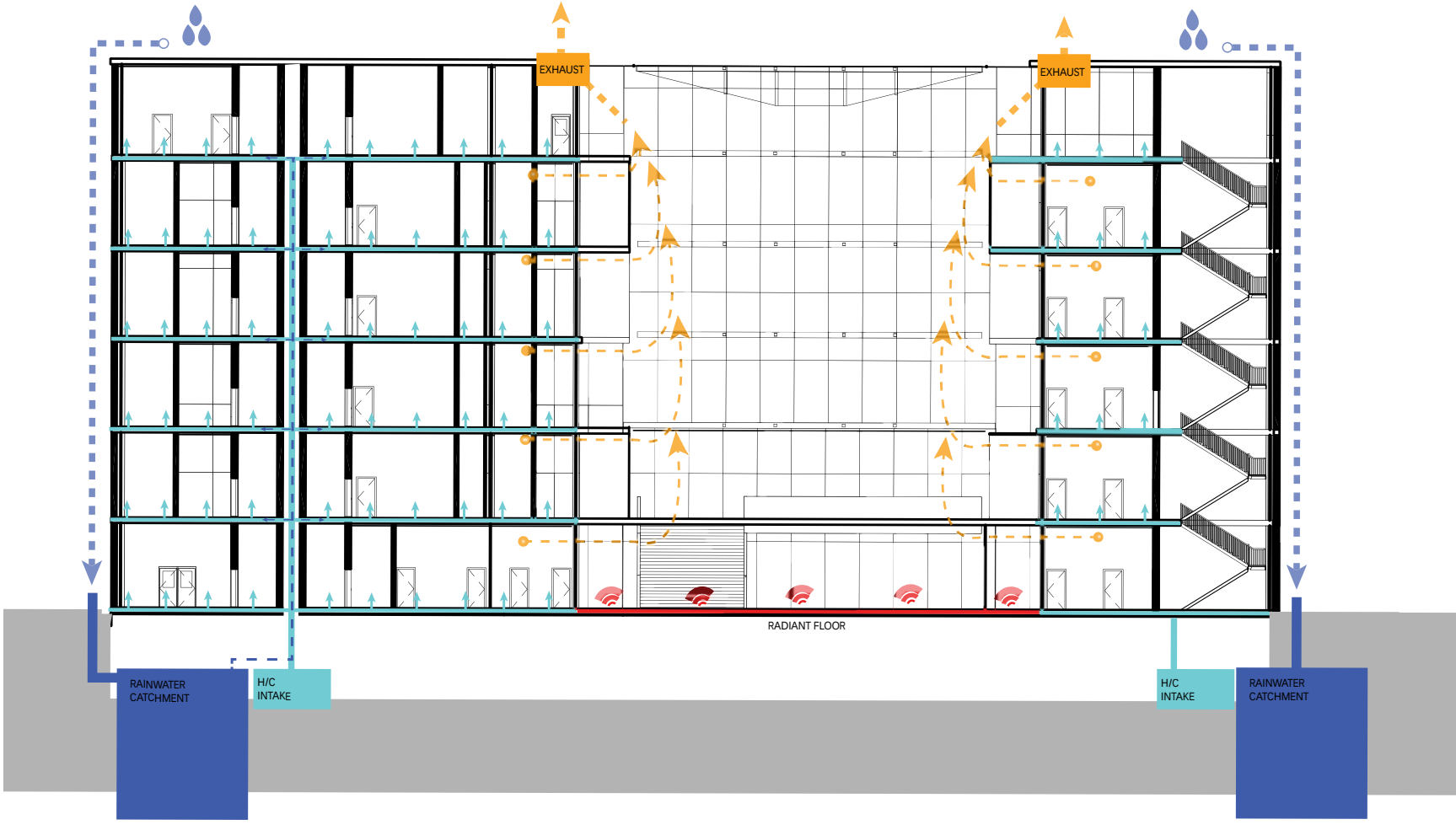


AT EXTERIOR WALL

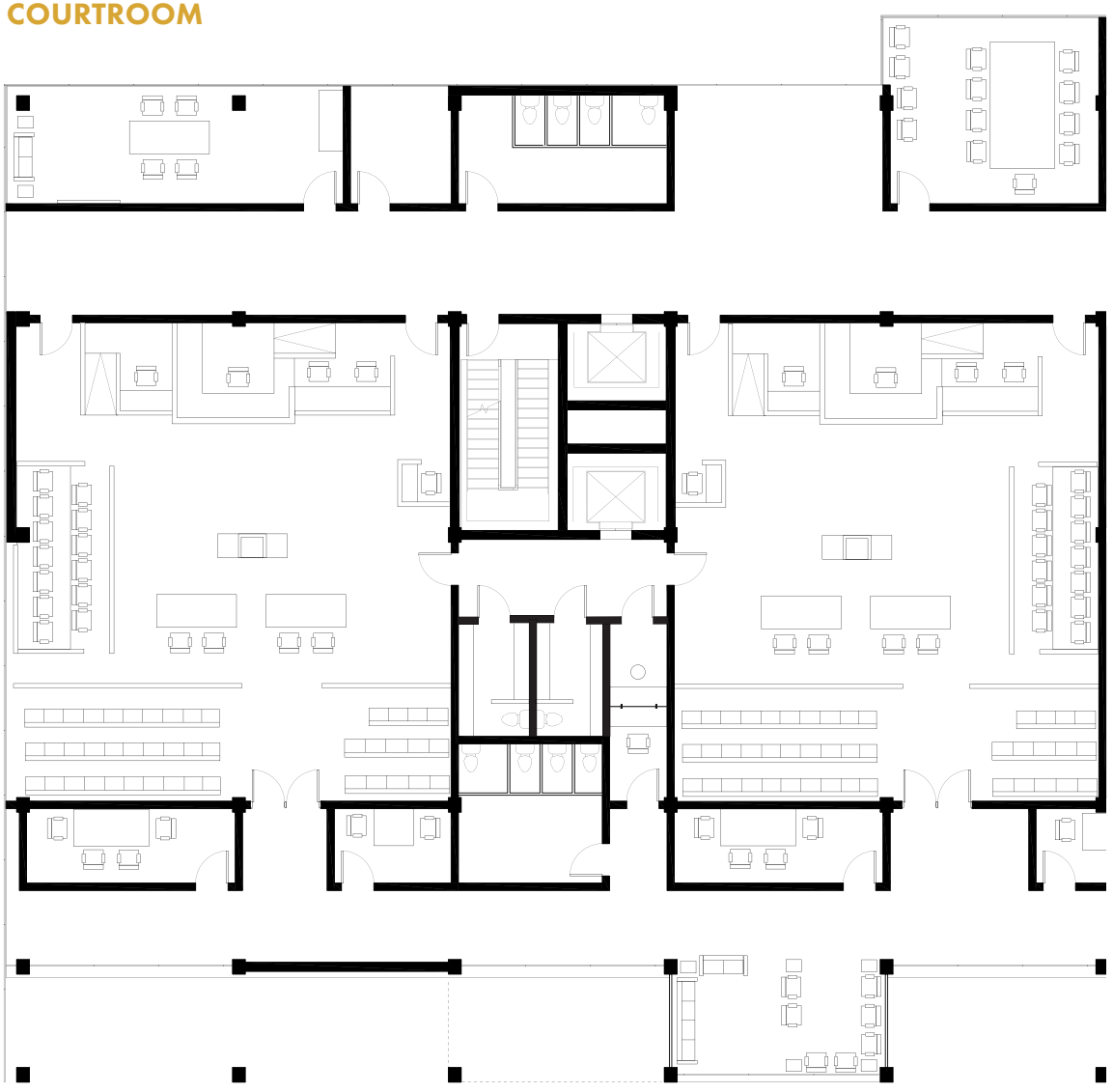


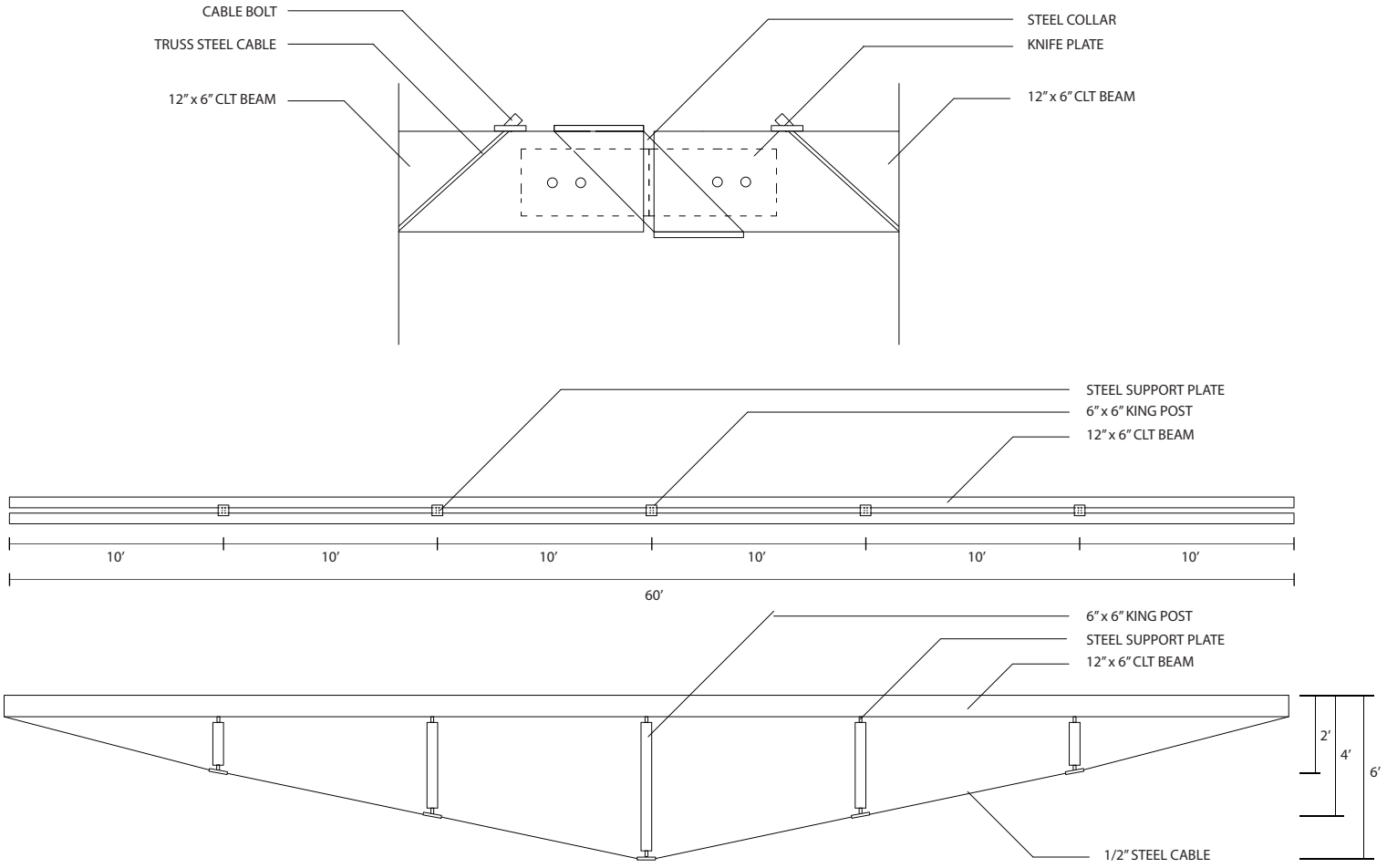
AXONOMETRIC DETAIL

ENVIRONMENTAL CONTROL SYSTEMS



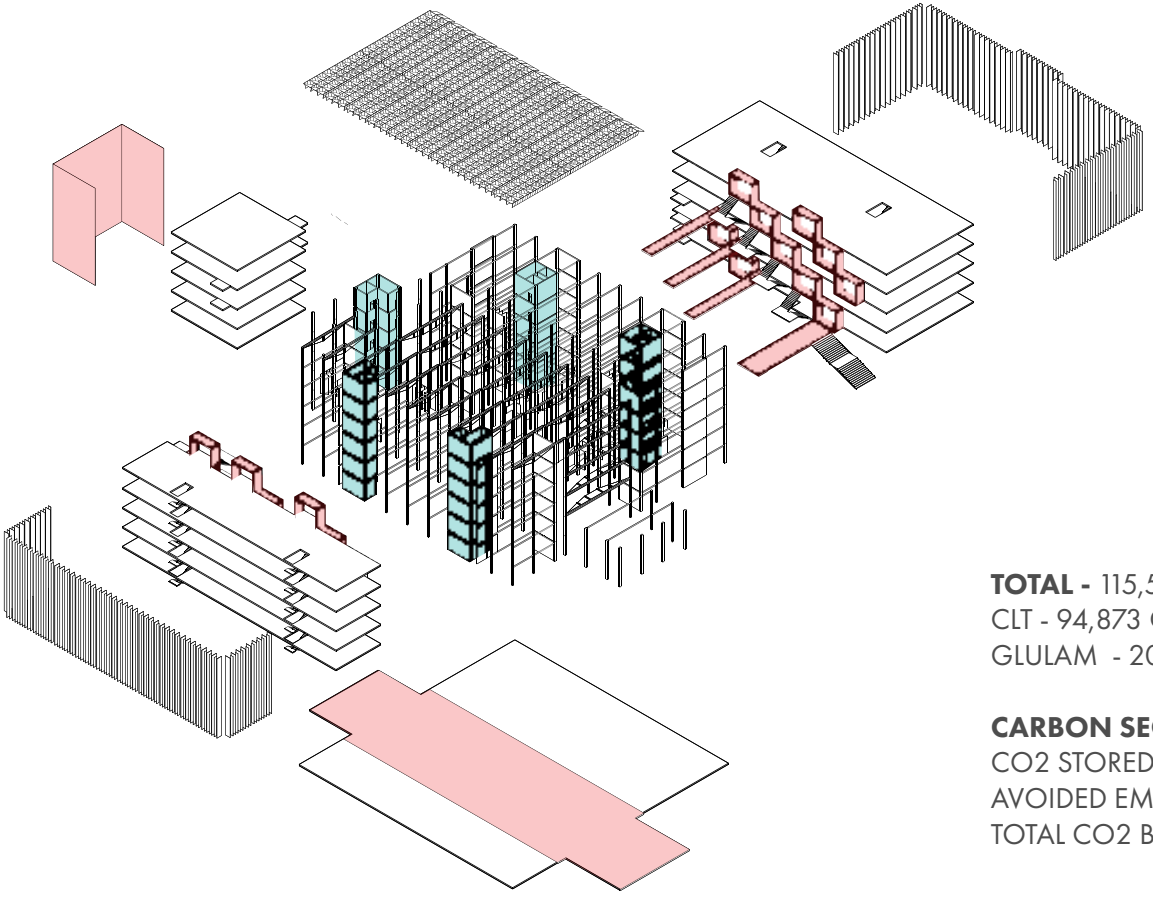
FURNISHED COURTROOM





TRUSS STRUCTURE

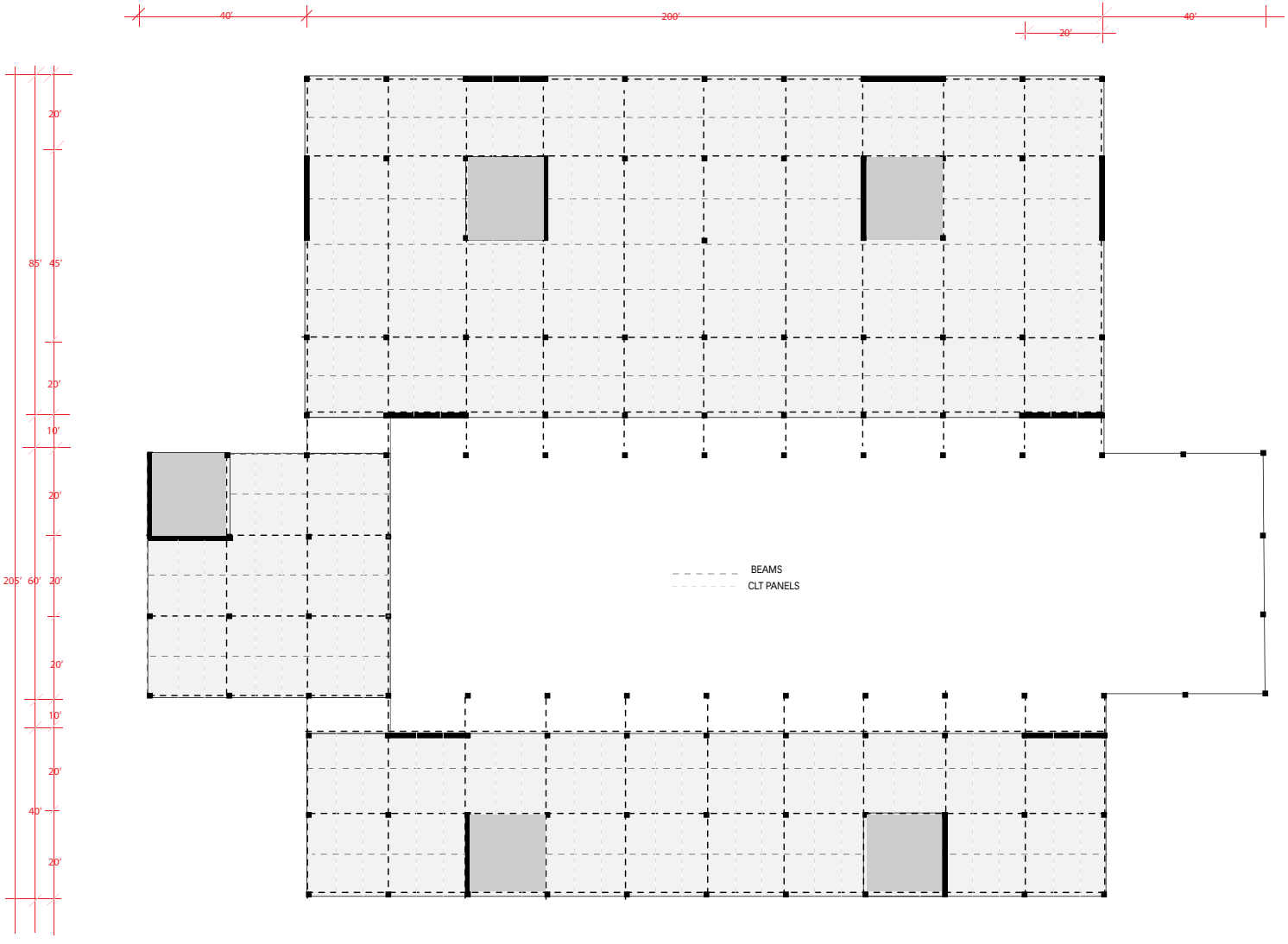
3D STRUCTURE



TOTAL - 115,531 CF
CLT - 94,873 CF
GLULAM - 20,658 CF

CARBON SEQUESTRATION
CO2 STORED - 2914 MT
AVOIDED EMISSIONS - 1127 MT
TOTAL CO2 BENEFIT - 4041 MT

WOOD CALCULATIONS

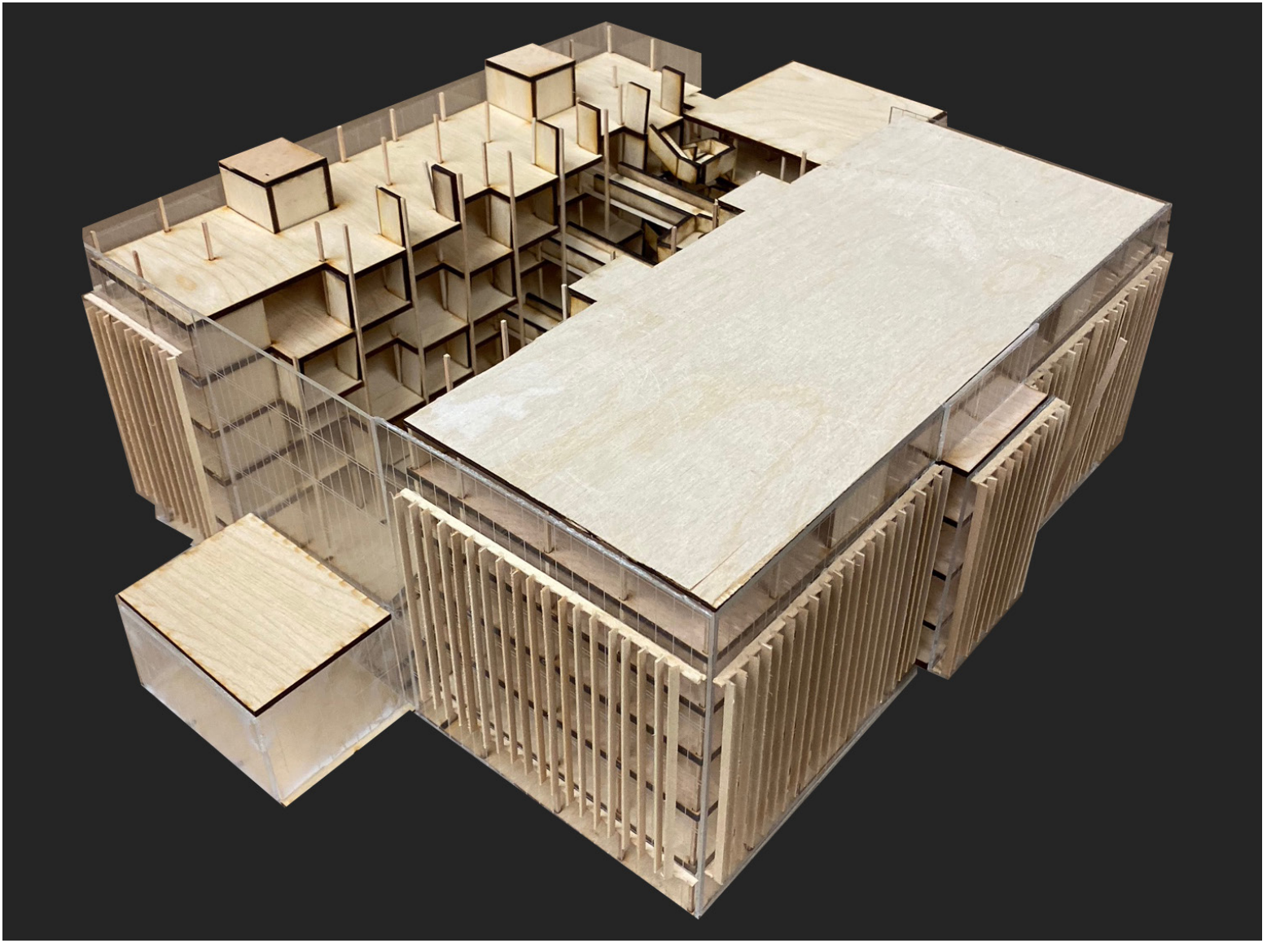


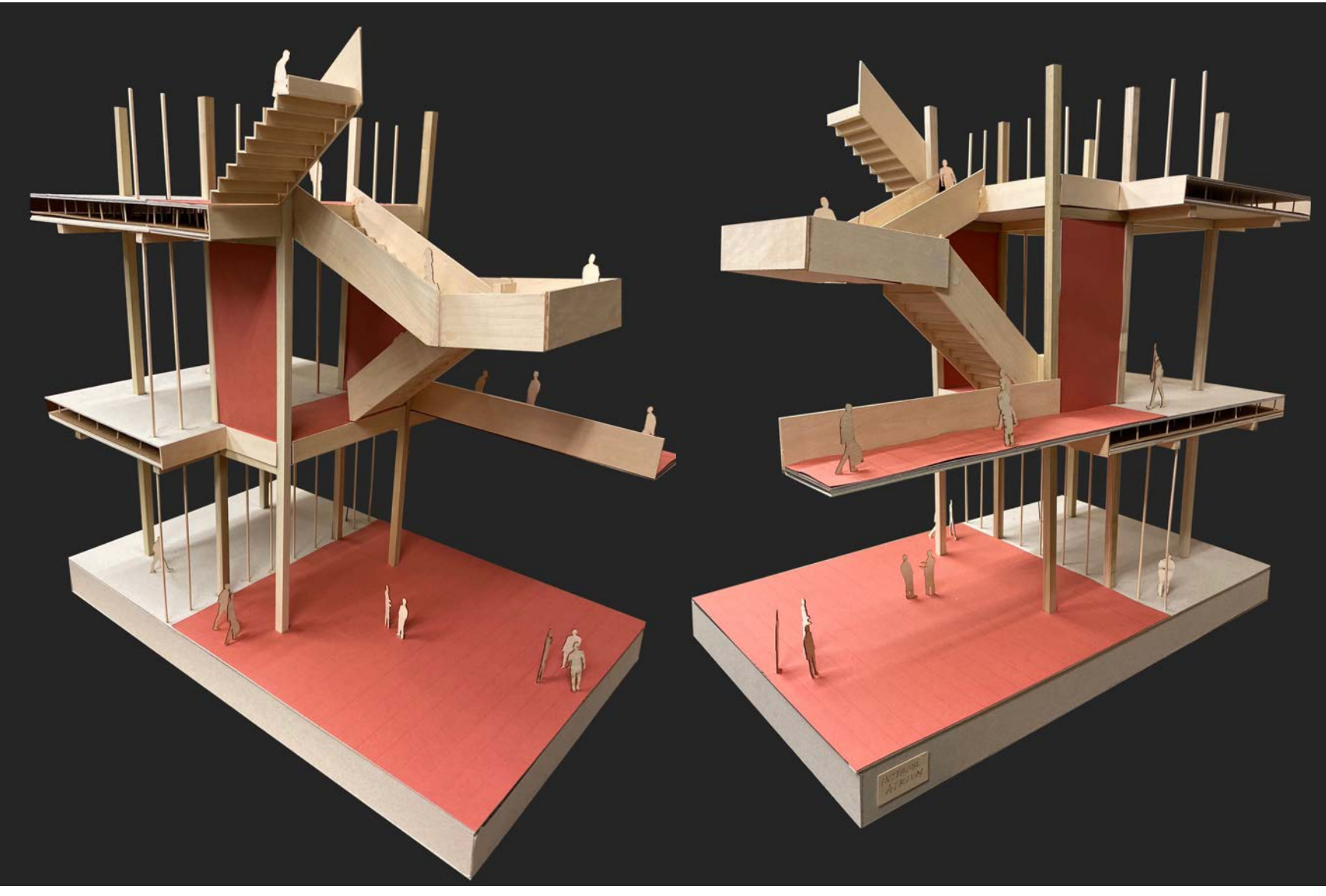
2D STRUCTURE

PERSPECTIVE left **ELEVATIONS** above

SECTIONS

MODEL PHOTOS

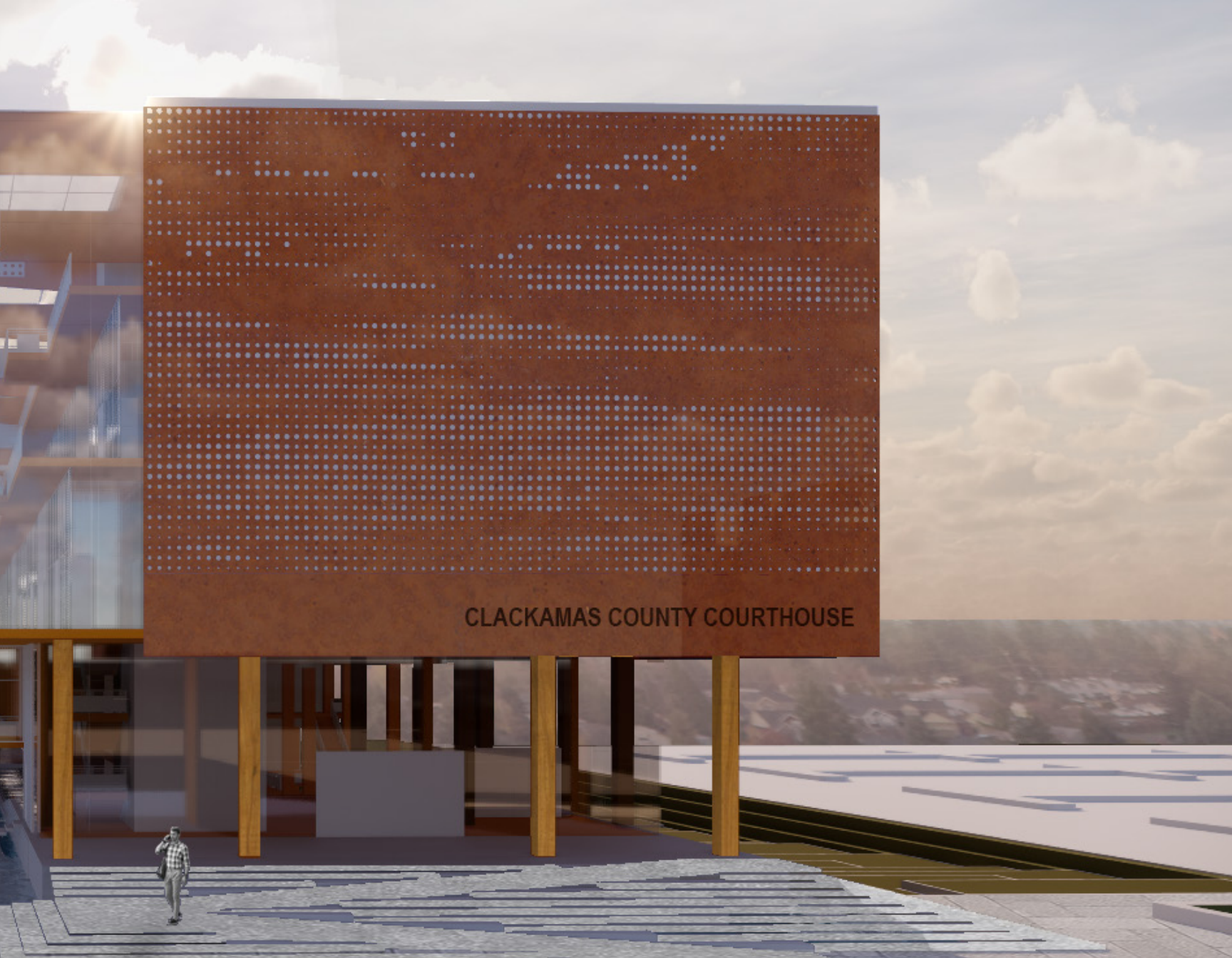


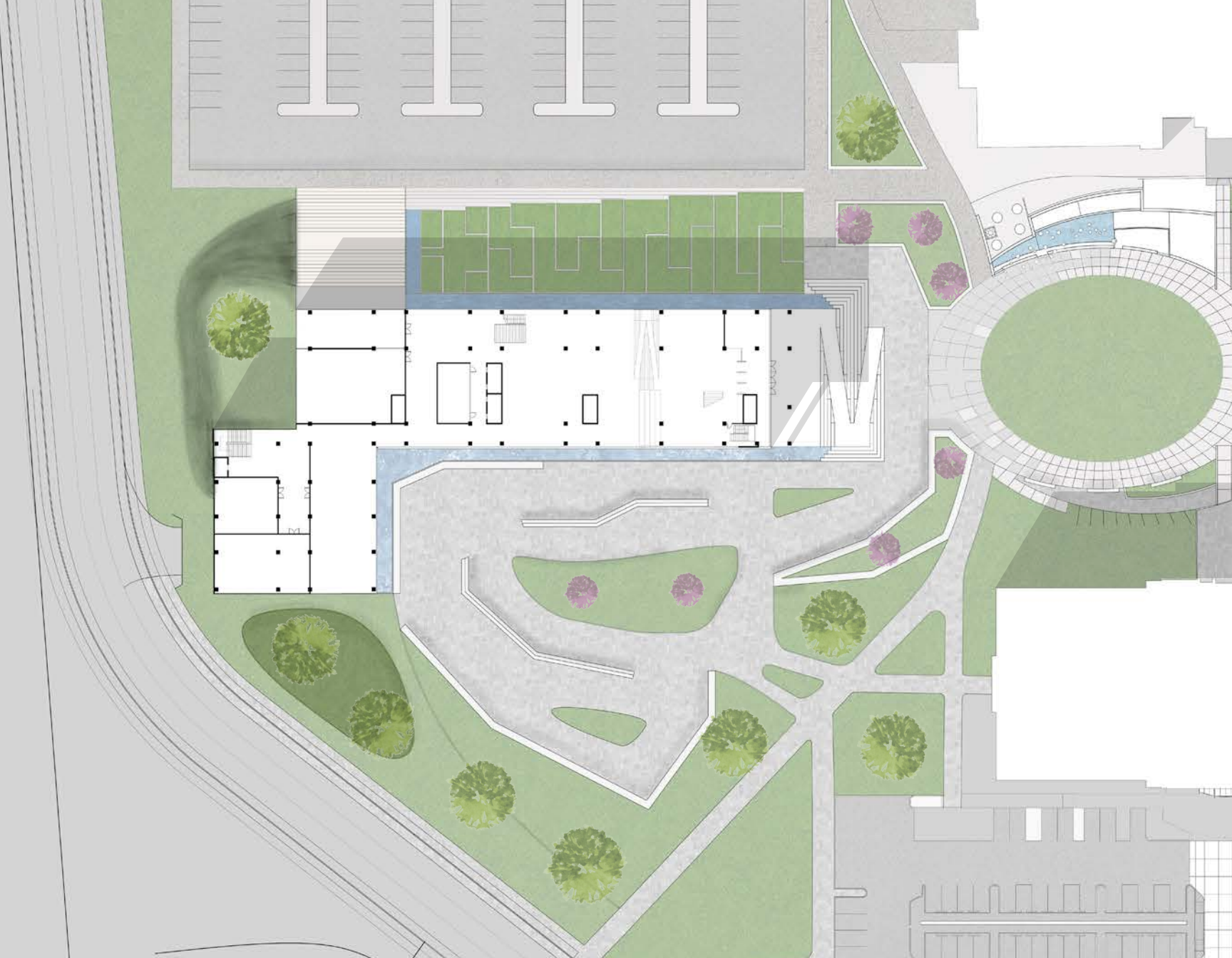


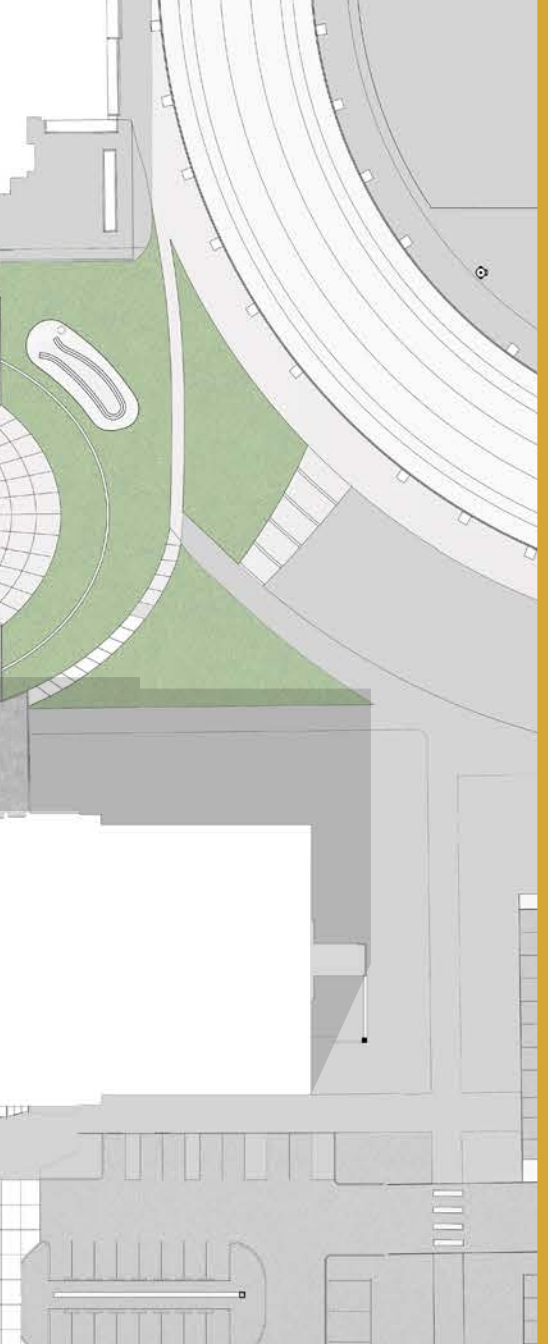
CHILES

Diego Cardiel | Brennen Donnelly | Isaac Hadnutt | Cameron Reid

This building seeks to represent Clackamas County by providing a vision of justice and innovation. The courtroom levels are held aloft by mass timber, revealing a transparent ground floor that engages the site. A great rift pierces through the building, the zenith of which provides a grand view of Mount Hood and the surrounding Clackamas countryside. This new courthouse promises to provide a strong civic presence in Clackamas County, a showcase of the county's natural resources, environmental stewardship, and burgeoning mass timber industry.

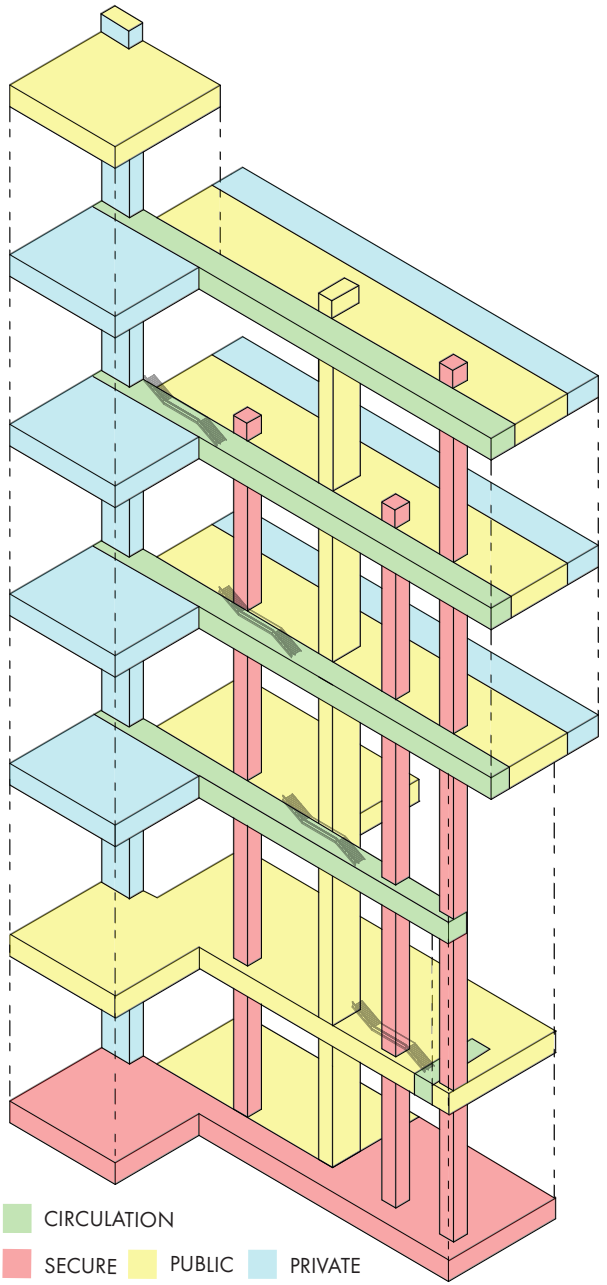

CLACKAMAS COUNTY COURTHOUSE



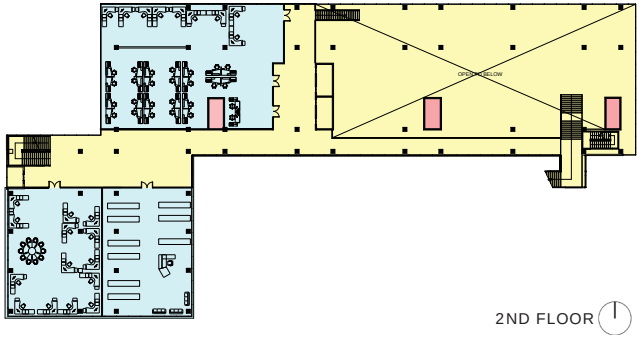


SITE PLAN
left

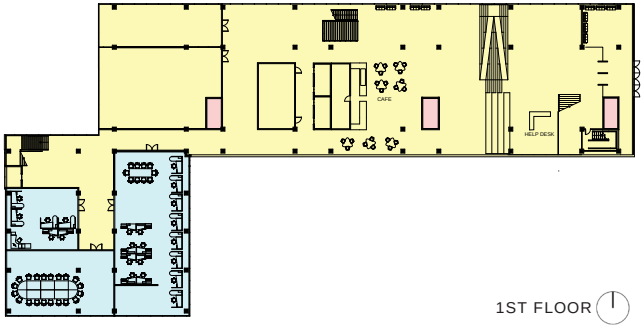
ZONING
right



PLANS



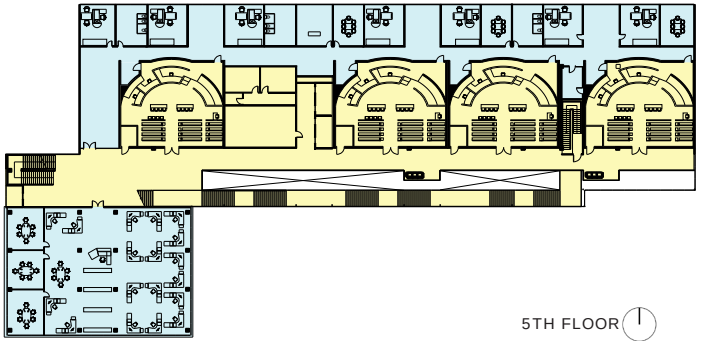
2ND FLOOR



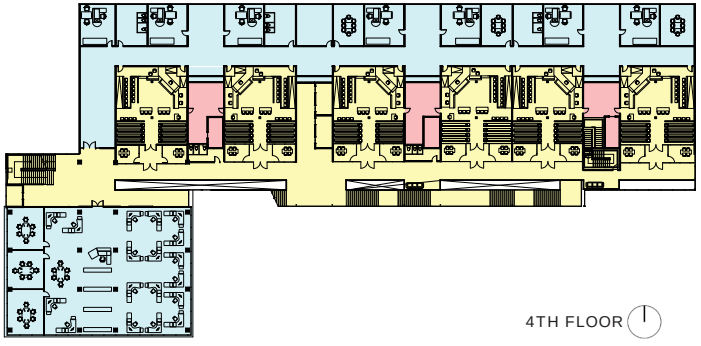
1ST FLOOR

BASEMENT

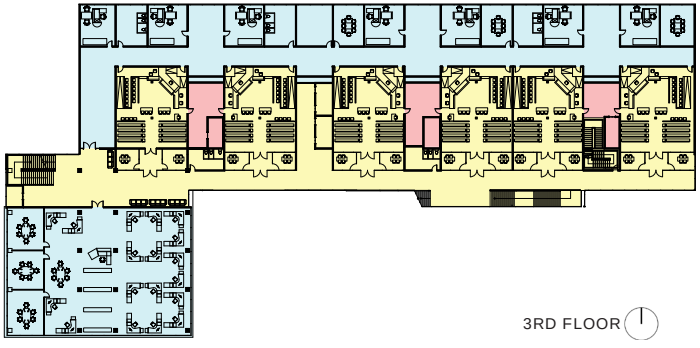
SECURE PUBLIC PRIVATE



5TH FLOOR

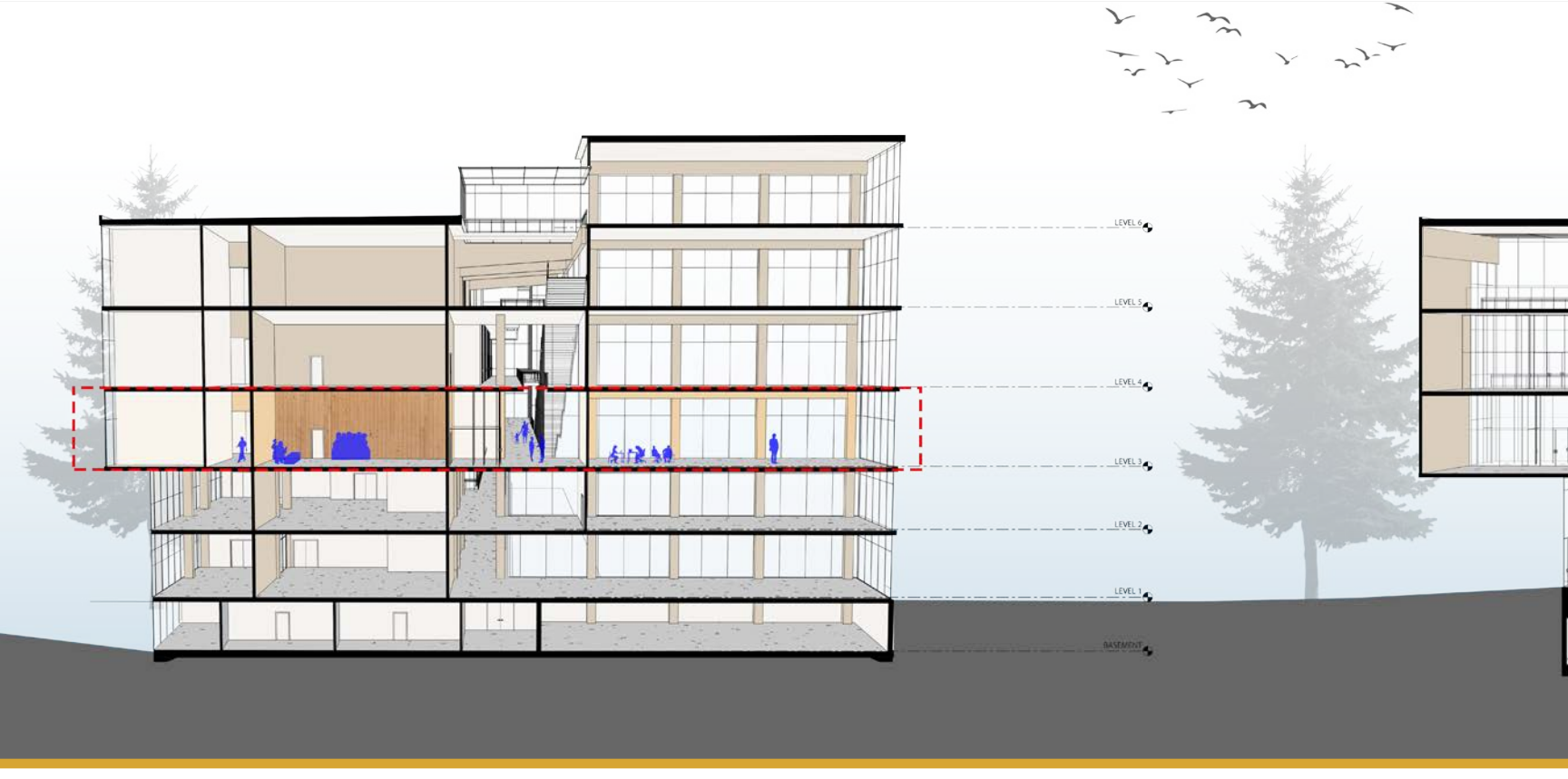


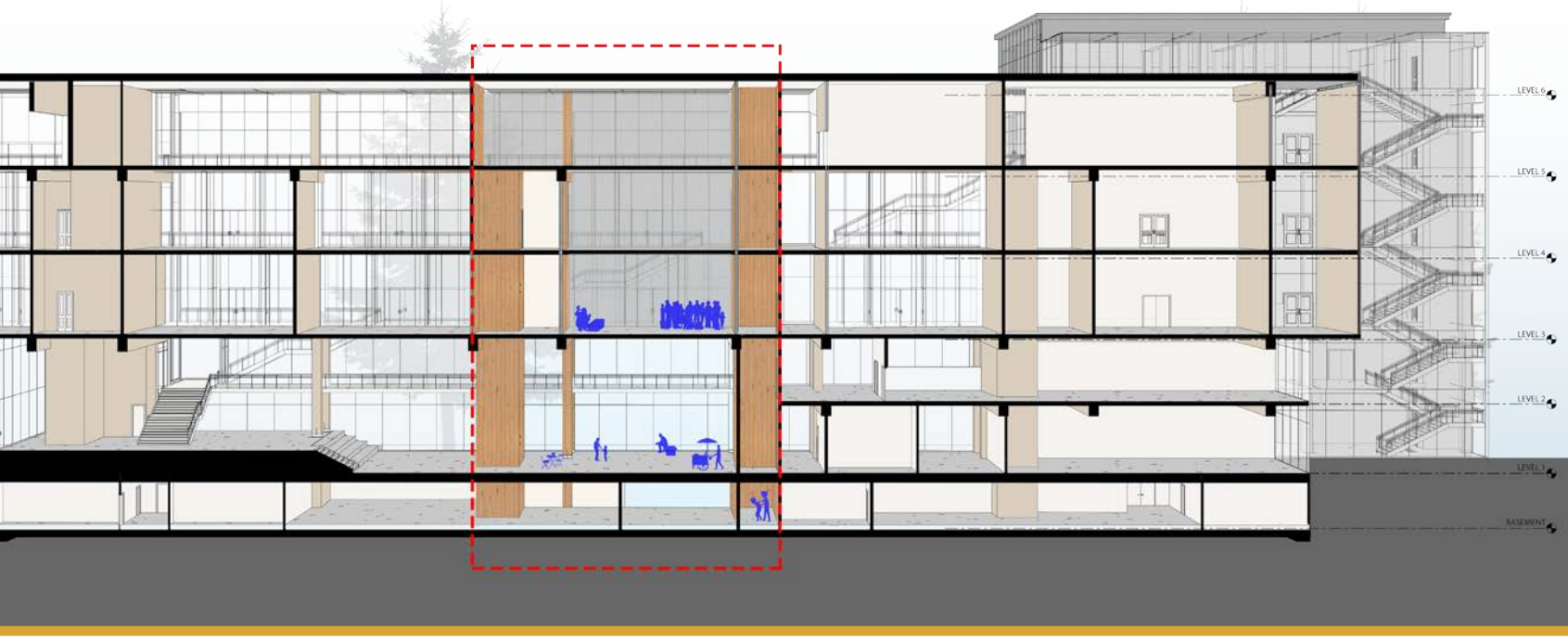
4TH FLOOR

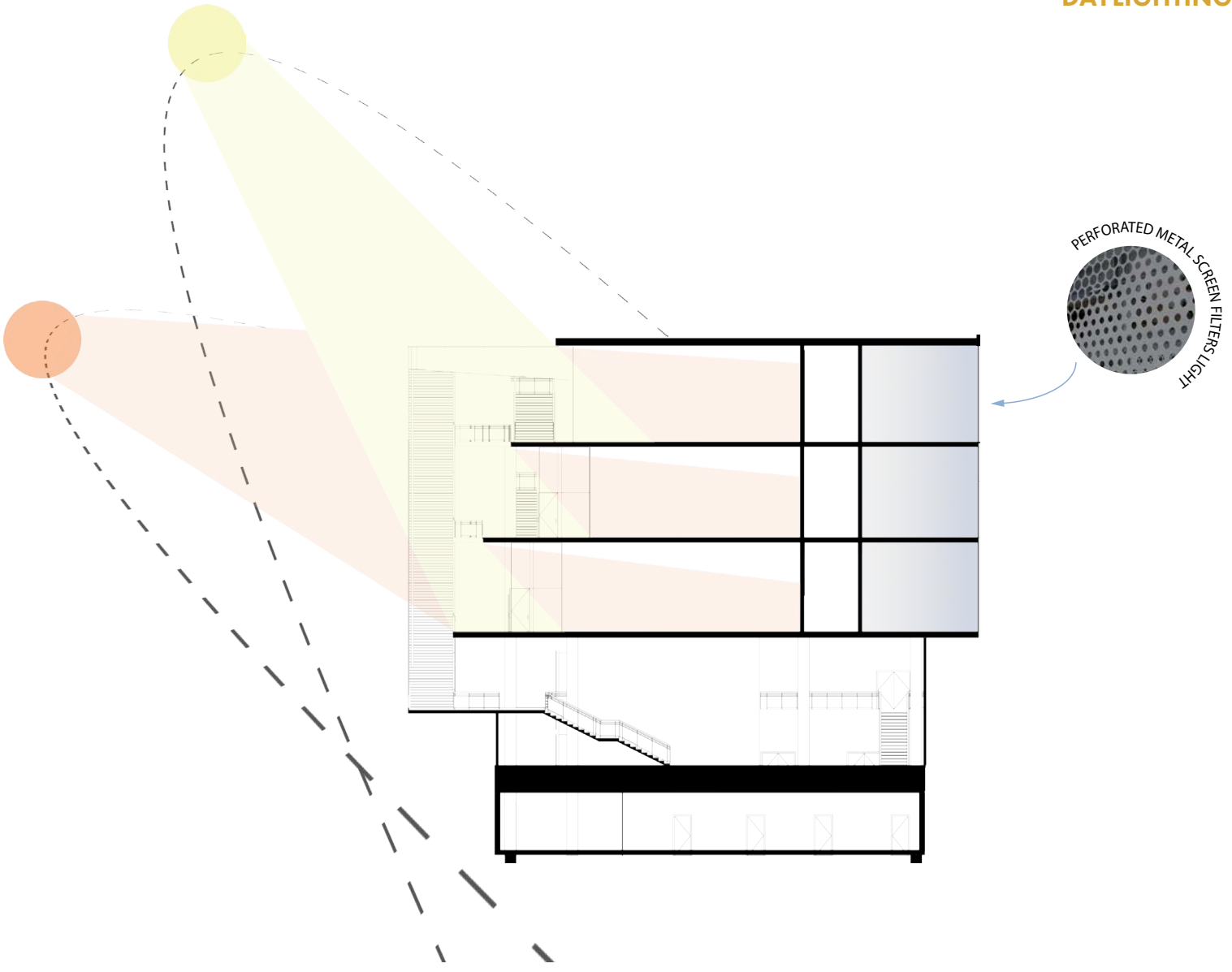


3RD FLOOR

SECTIONS

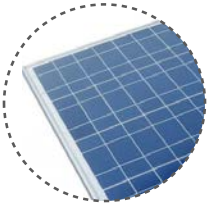



LEVEL 6
LEVEL 5
LEVEL 4
LEVEL 3
LEVEL 2
LEVEL 1
BASEMENT


PERFORATED METAL SCREEN FILTERS LIGHT

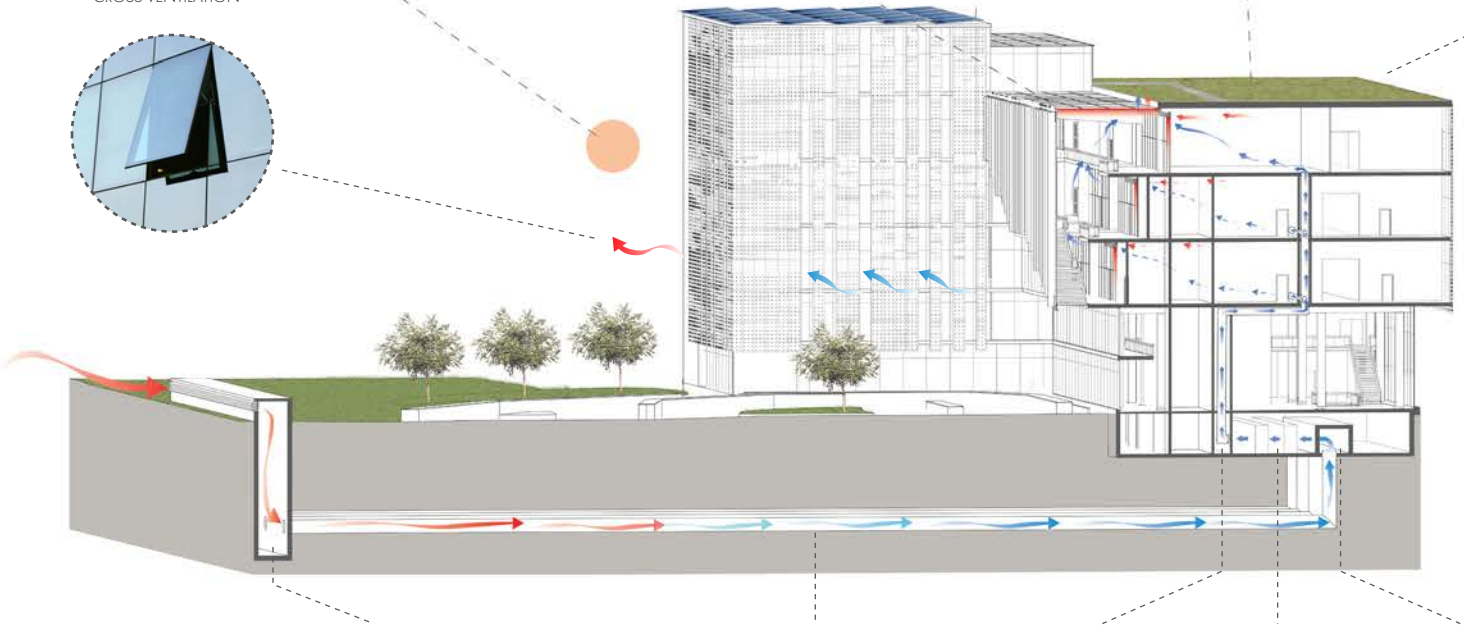
ENVIRONMENTAL CONTROL SYSTEMS

PHOTOVOLTAIC PANELS
COVERING ENTIRE TOWER MASS



LOW ROOTED SEDUM
GREEN ROOF

OPERABLE WINDOWS FOR
CROSS VENTILATION



PASSIVE FRESH AIR INTAKE

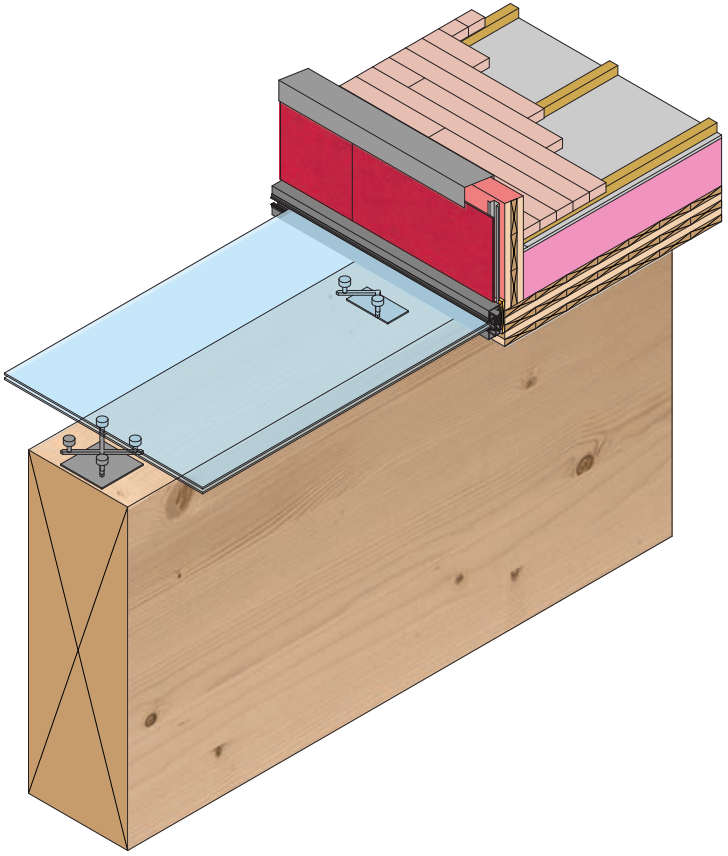
CONCRETE EARTH TUBES

HUMIDITY CONTROL

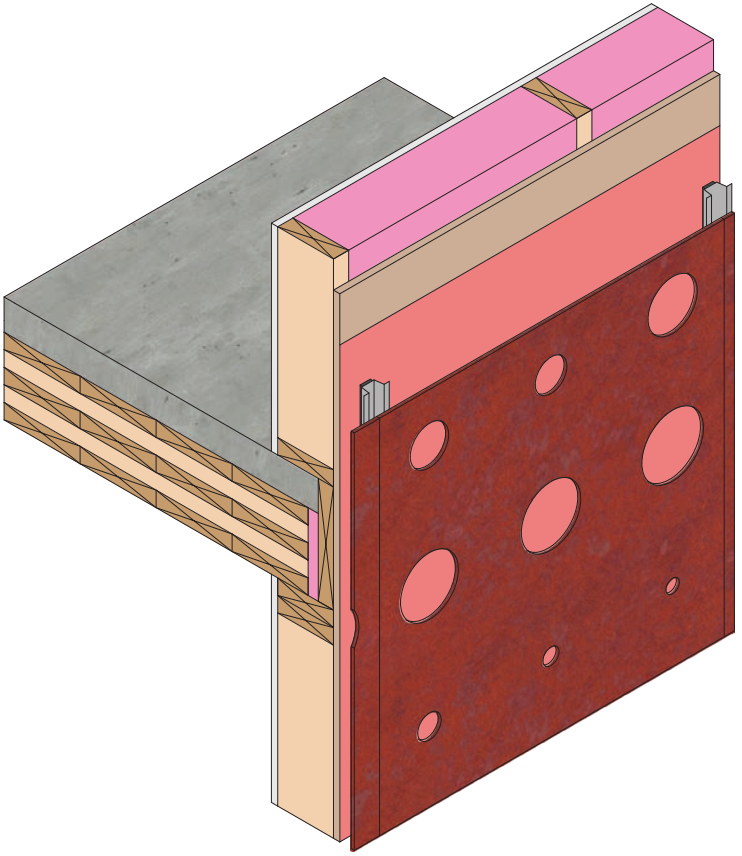
UV LIGHT FILTER

DOUBLE FOUNDATION WALL
PLENUM

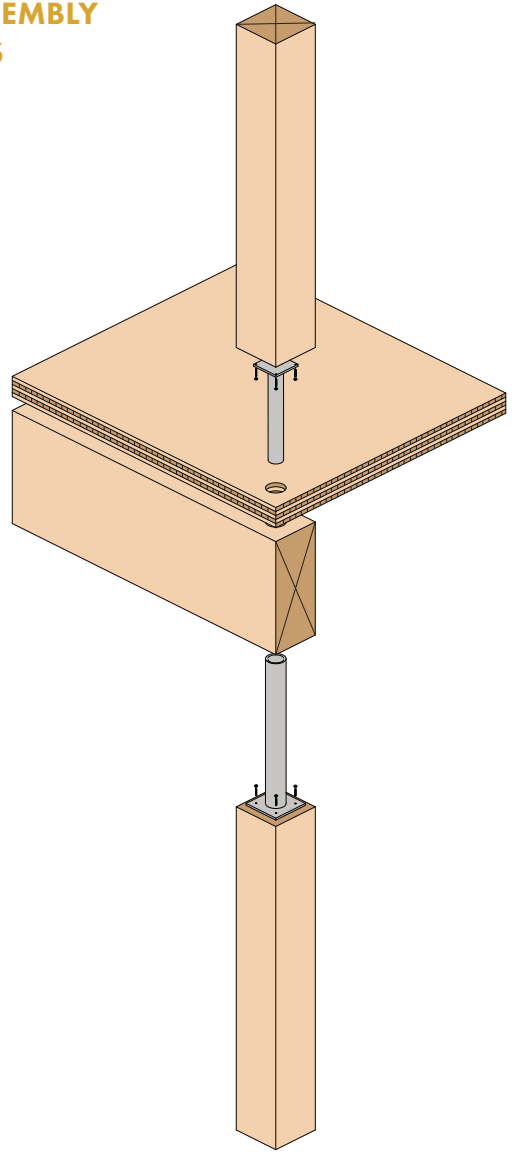
ATRIUM ROOF DETAIL

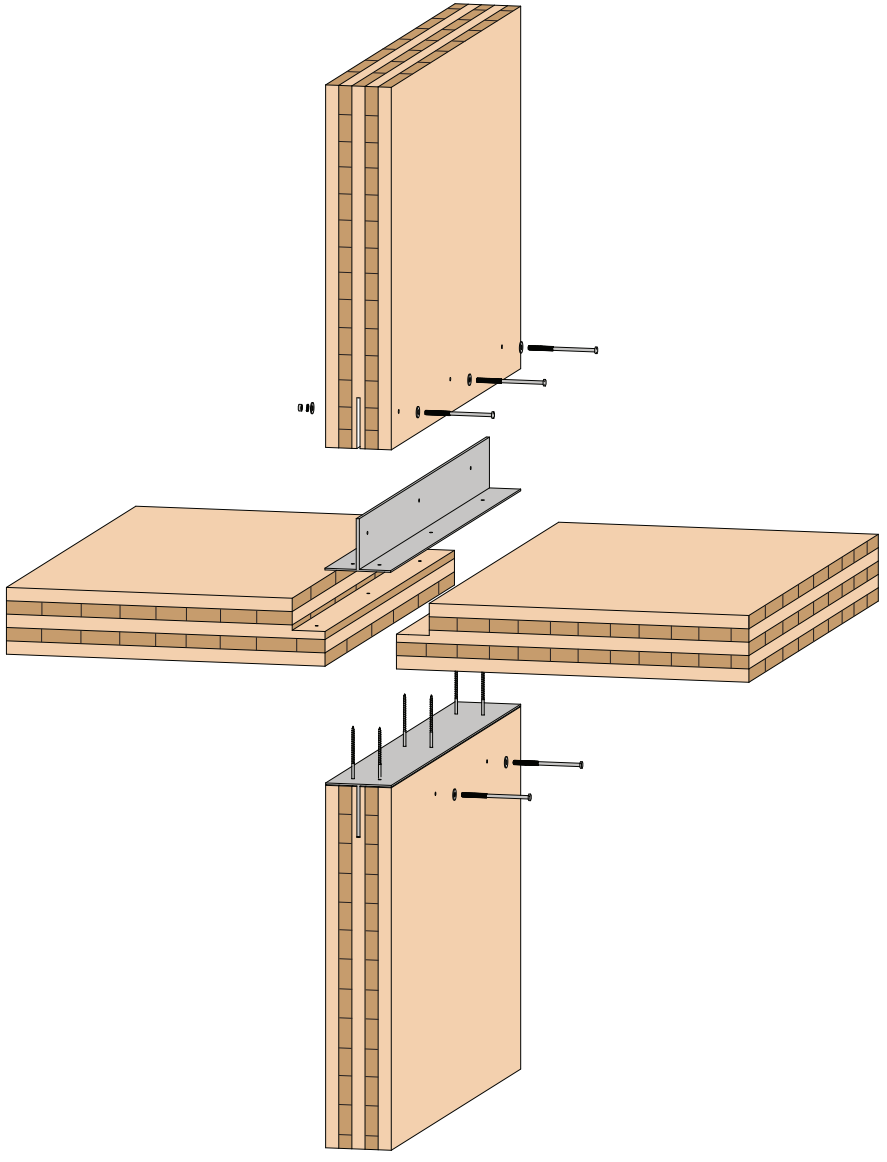


WALL DETAIL



CLT ASSEMBLY DETAILS





MODEL PHOTO

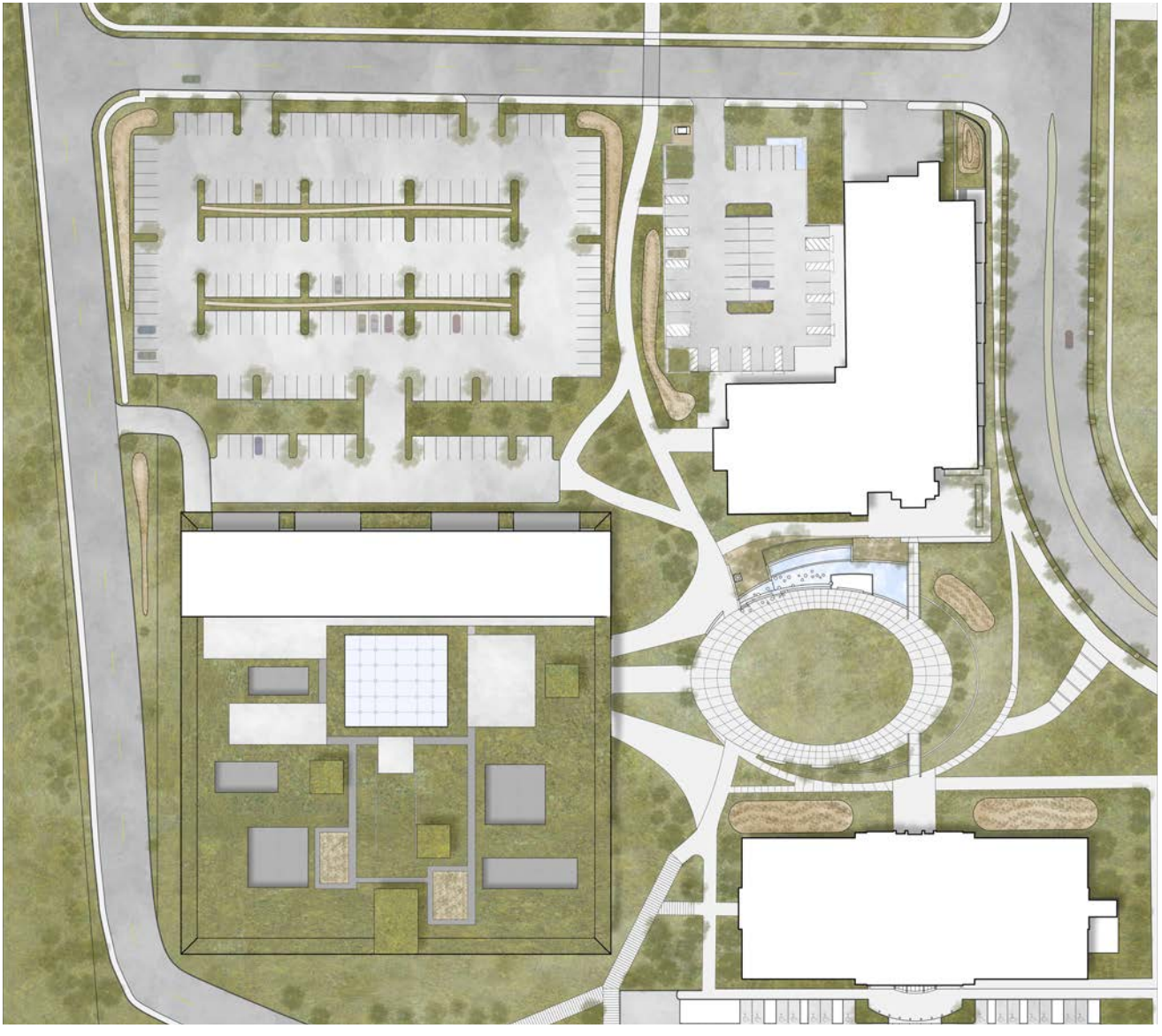
INTERIOR PERSPECTIVES

LOBBY VIEW

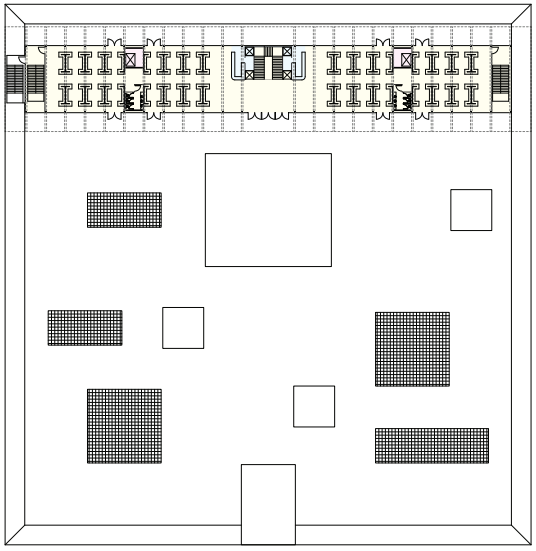
ARCHIDUCKS

Isais Lawrence | Zhixuan Liang | Matthew Robinson | Nicholas Stanek

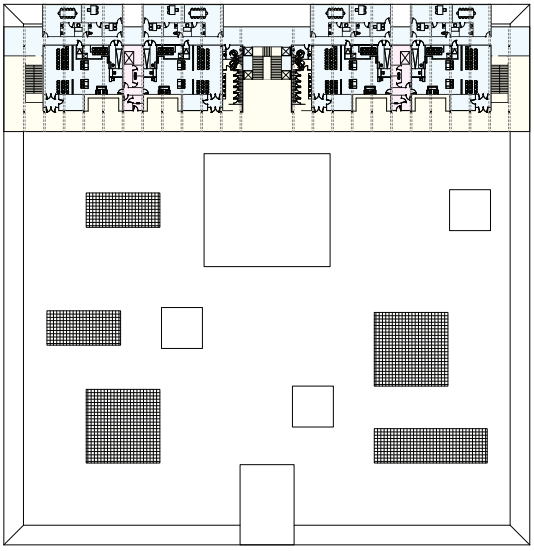
The 250,000 sq. ft. Clackamas County Courthouse project was a large task for our four person team. The program was complex and with the rise of mass timber construction, we wanted to implement its strength and beauty throughout the building. Because the idea of going to a courthouse can be stressful, we wanted to design the building in a way in which people could feel welcome. We also understood that people go through life-changing experiences, so we were experimenting with a biophilia approach to help ease the people who would use the building. Our building form is depicted as extruded from the ground, raising the landscape with it on its plinth roof in a basalt form,. This would allow a secured rooftop green space that could be seen from outside the courtrooms and be accessible to everyone that passes through the security checkpoints. The idea is that this space would help people stressed by the justice system to momentarily step away from the courtroom into a peaceful environment.



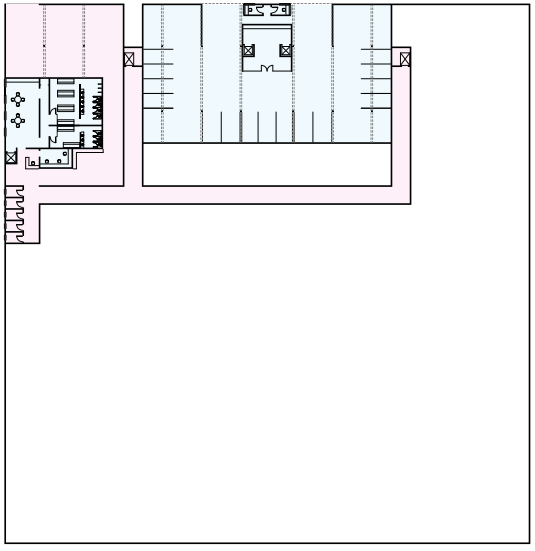
SITE PLAN



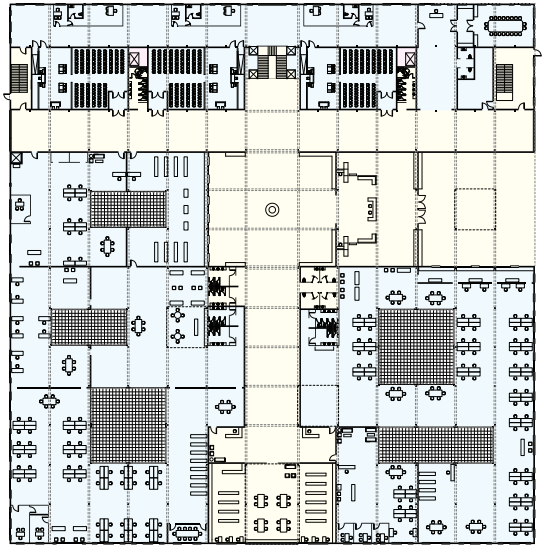
FLOOR 2



FLOORS 3-5

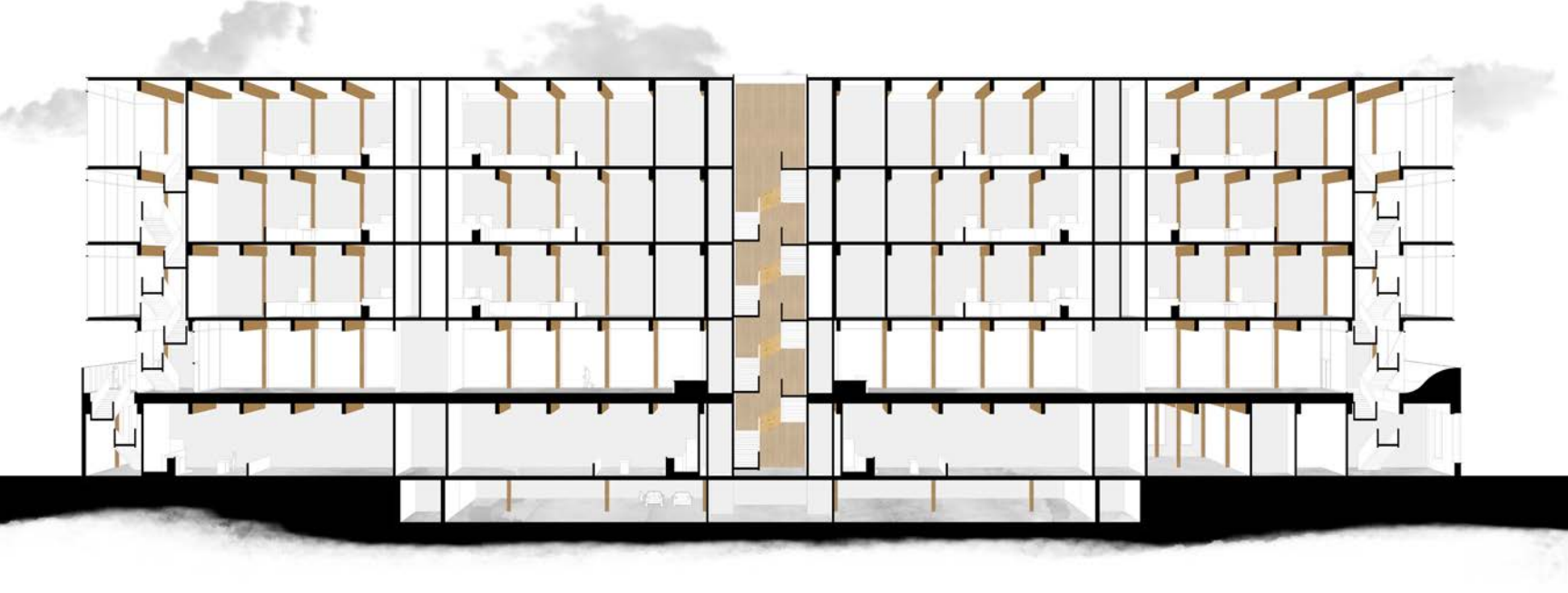


BASEMENT

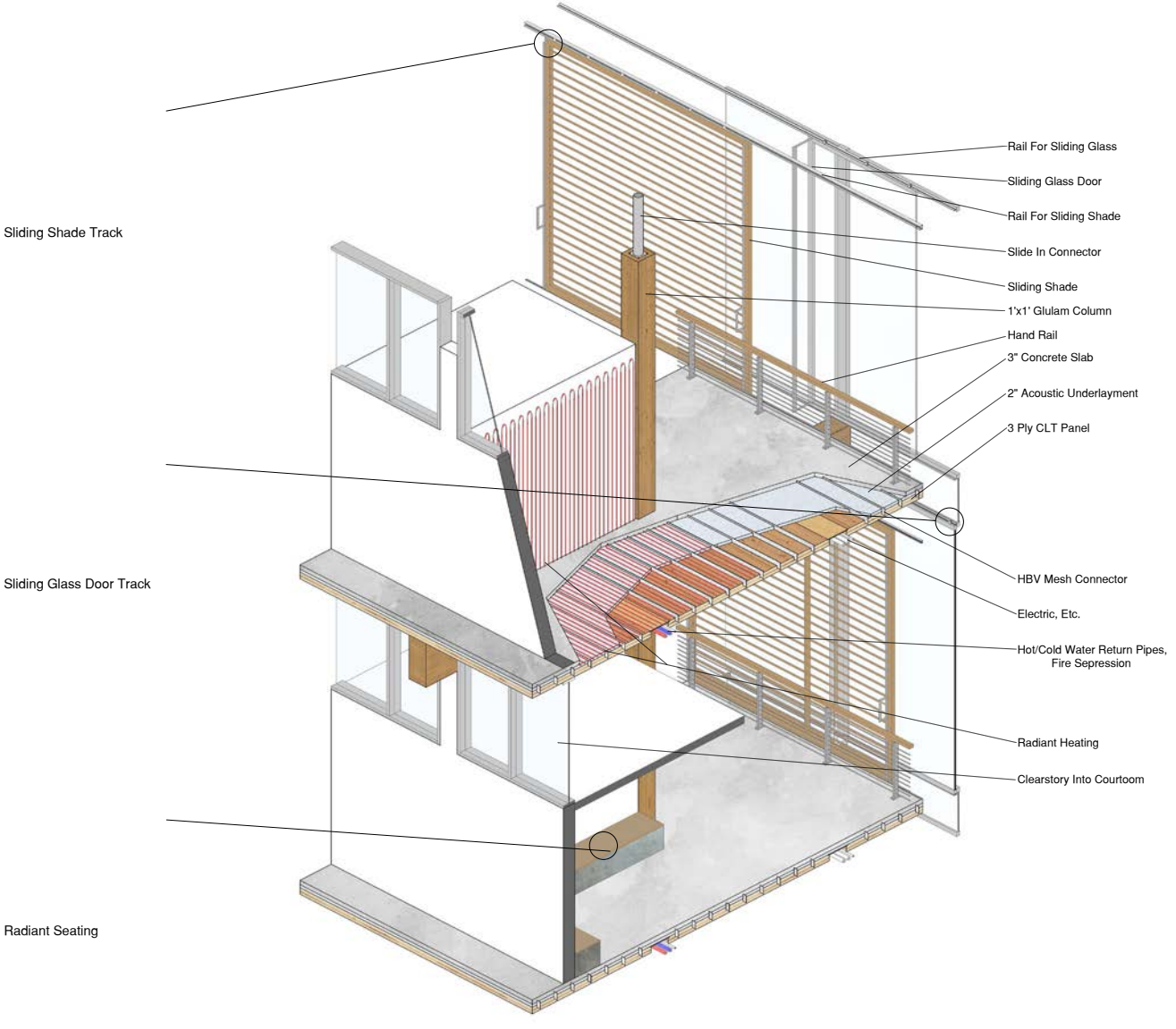


FLOOR 1

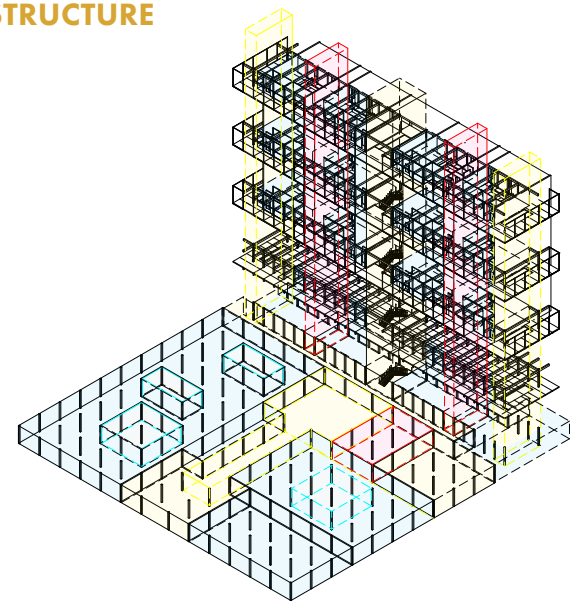
SECTIONS

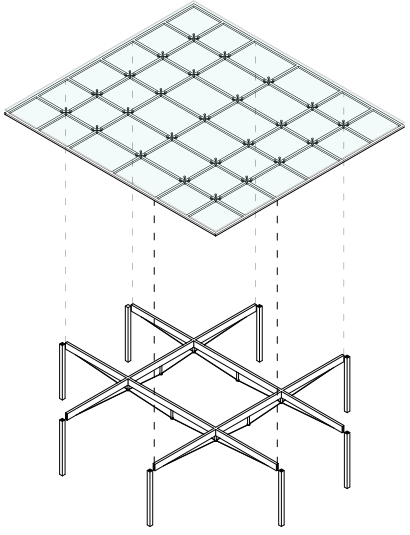


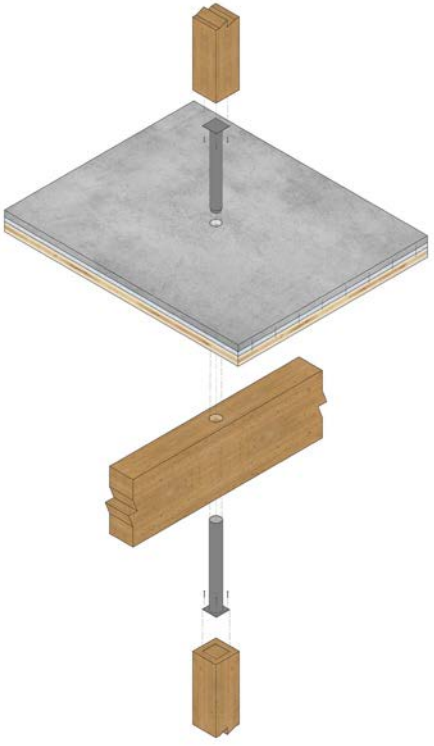
CONSTRUCTION DETAIL

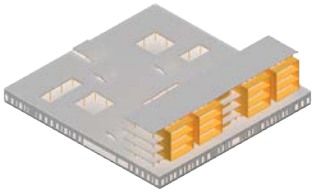


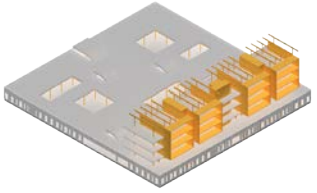
STRUCTURE

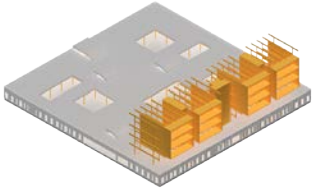


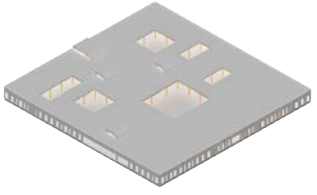


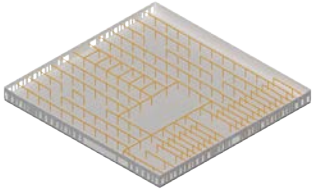




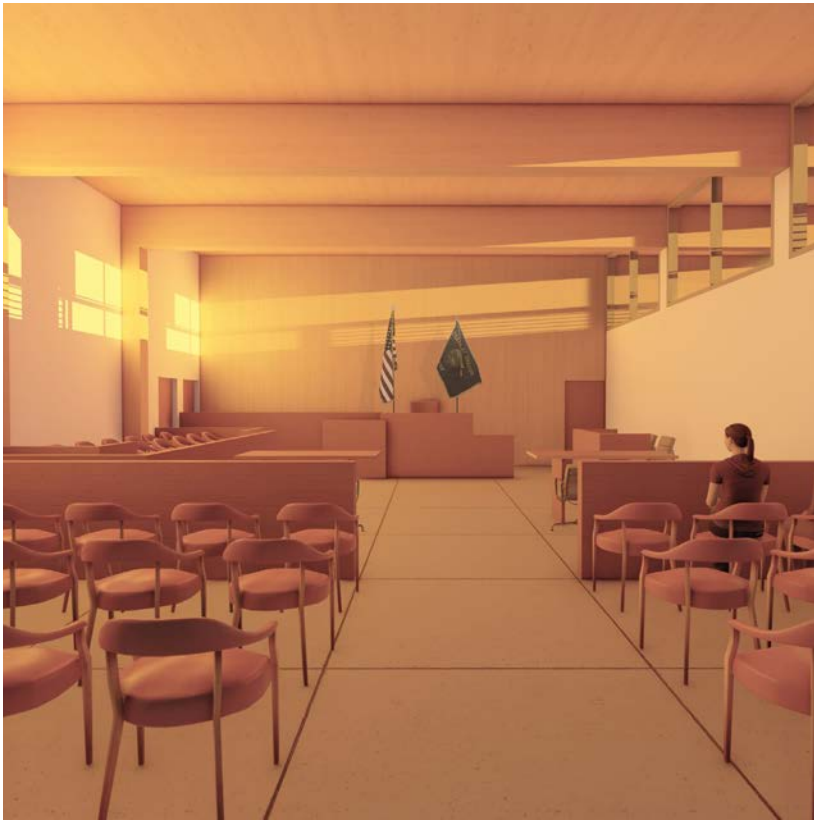








PUBLIC CIRCULATION



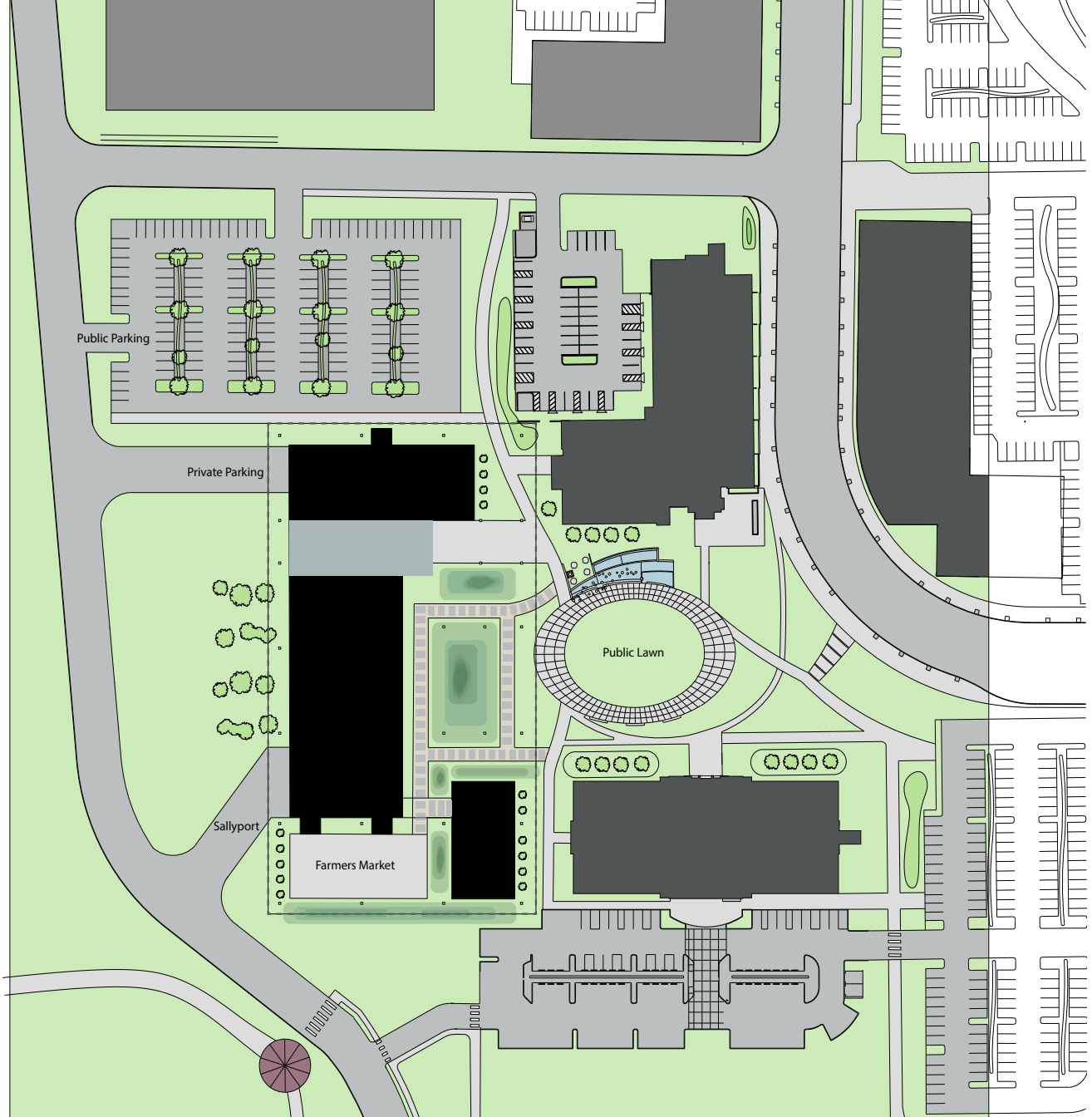
COURTROOM

ATRIUM
left

TEAM ROCKET

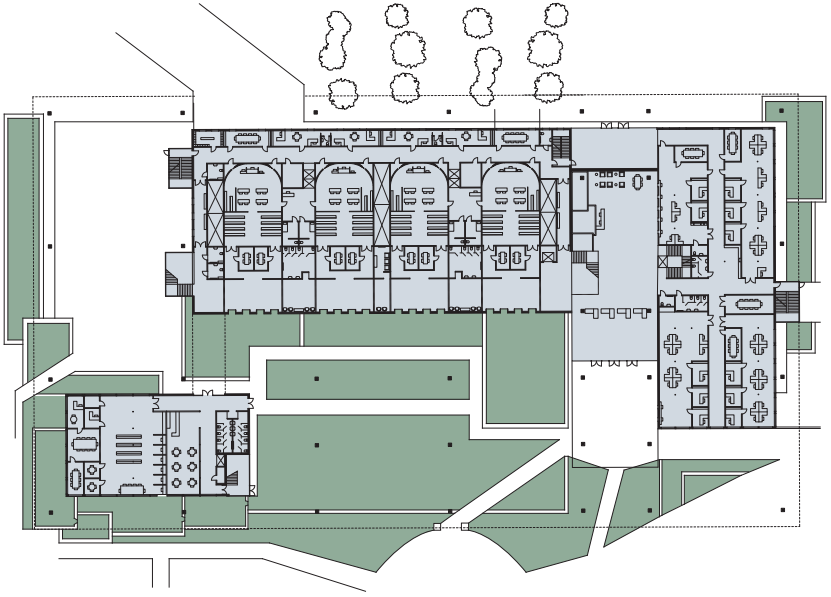
Chandler Arnsdorf | Brooke Everard | Chiara Maggiore | Matthew Weldon

For the future Clackamas County Courthouse we wanted to focus on showcasing the possibilities of mass timber construction, integrating sustainable solutions, and creating a courthouse that serves the community in more than just a legal manner. The oversized roof 'floats' above three structures that make up the courthouse functions, so that the courthouse is laid out clearly for ease of public access but unified under the roof. The roof also allows for massive amounts of PV panels and the option of rainwater collection. In the covered area in front of the building we have designed a constructed wetland to replace the ones displaced by the new building. This is also a way to comply with the Salmon Safe certification by cleaning the runoff and to educate the public by making it a park that people can visit. In the Southwest corner we have provided a space so that the farmers market can move from the adjacent parking lot into a covered area with power.

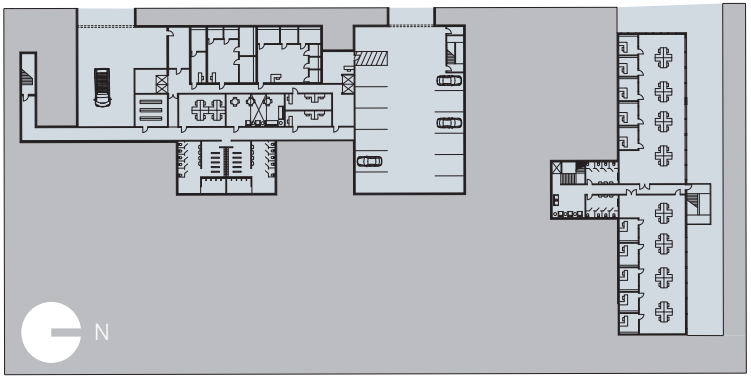

Public Parking
Private Parking
Public Lawn
Sallyport
Farmers Market

SITE PLAN

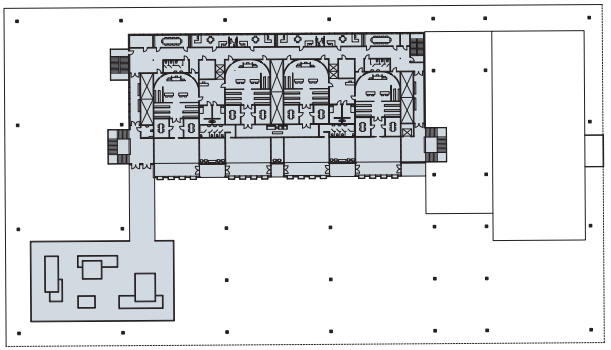
PLANS



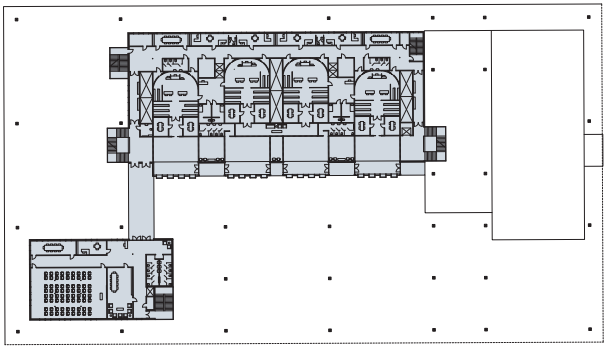
1st FLOOR



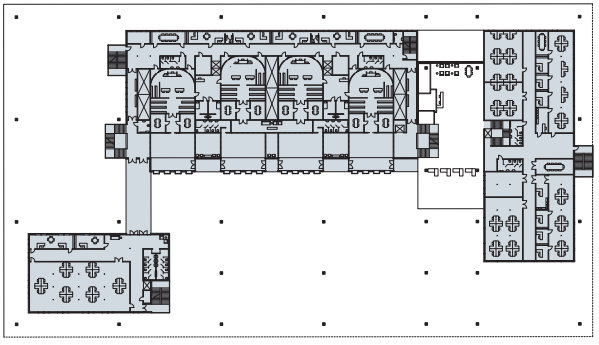
BASEMENT



4th FLOOR

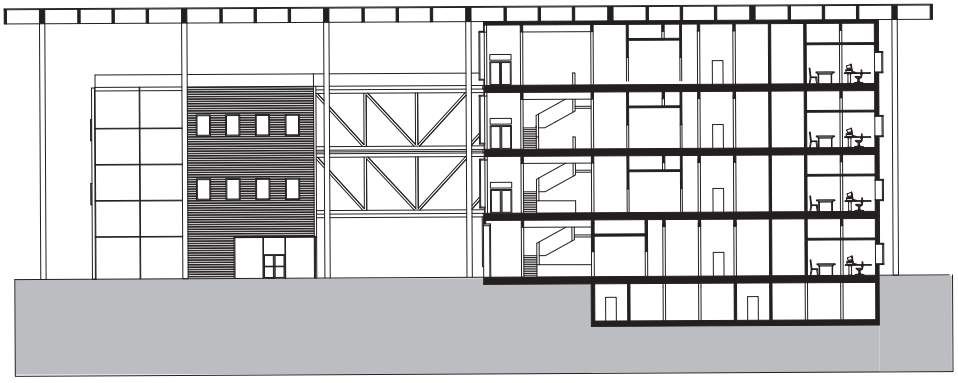


3rd FLOOR

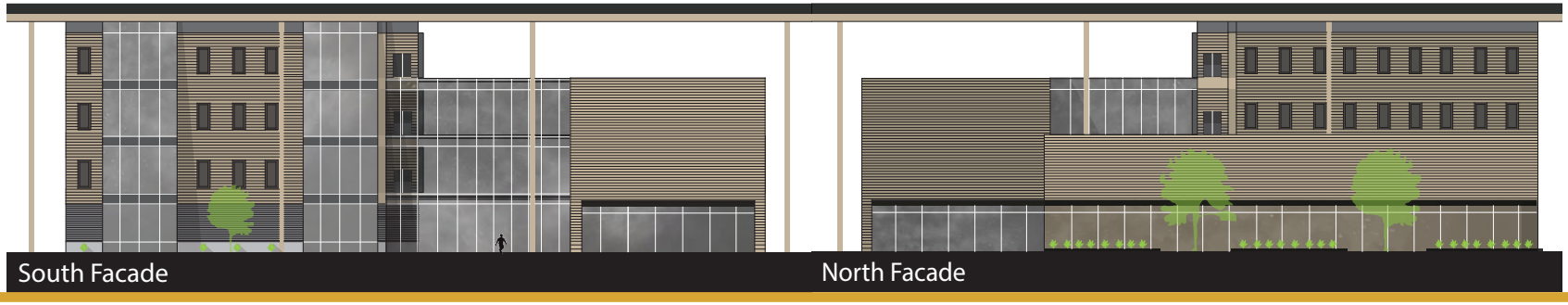


2nd FLOOR

SECTIONS



ELEVATIONS



South Facade

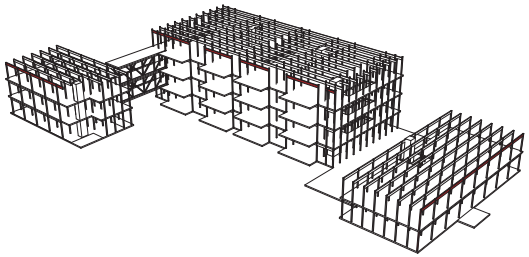
North Facade

East Facade

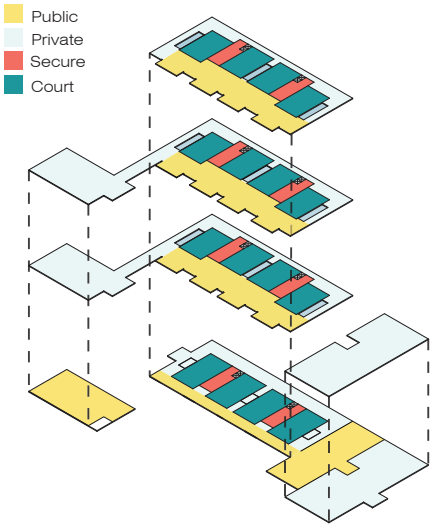
West Facade

Primary Structure

The structure within the building follows an A-B-A bay sequence running from North to South and an even ten foot bay sequence running from East to West. By keeping the bays small, it allows the beams to run along the long axis of the building with a composite three ply CLT and concrete slab spanning between. A series of elevator shafts and shear walls between courtrooms brings lateral loads to the foundation. Soaring above the structure is the unifying roof.

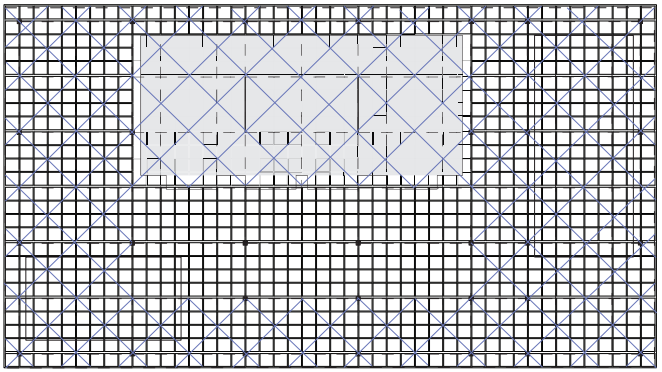


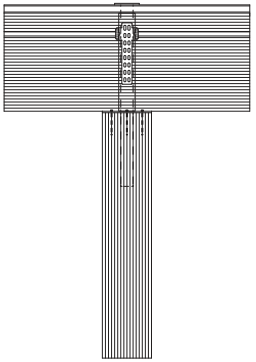
Programmatic Axon.



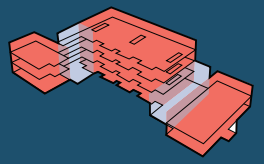
Roof Structure & Joints

Columns connect to the beams within the roof with a steel tube and plate that is inserted through a hole drilled through the overhead beams in a very similar way to the connection of columns between floors. Coffers are inserted into the larger beams via metal dovetail joints which also act as the anchors for the steel rod system. The roof is constructed with a series of post tensioned glulam beams with smaller coffers filling in the space between. Steel rods have been added within the coffers to create a rigid diaphragm capable of supporting massive snow and water loads. The field of columns under the roof serve only to support the gravity loads with the connection to the larger court block creating resistance to lateral loads.

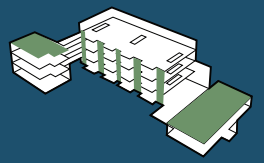




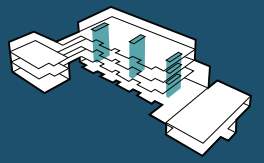
Parti



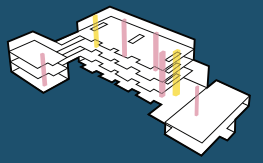
Green Architecture



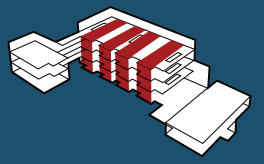
Air Stacks



Vertical Circulation

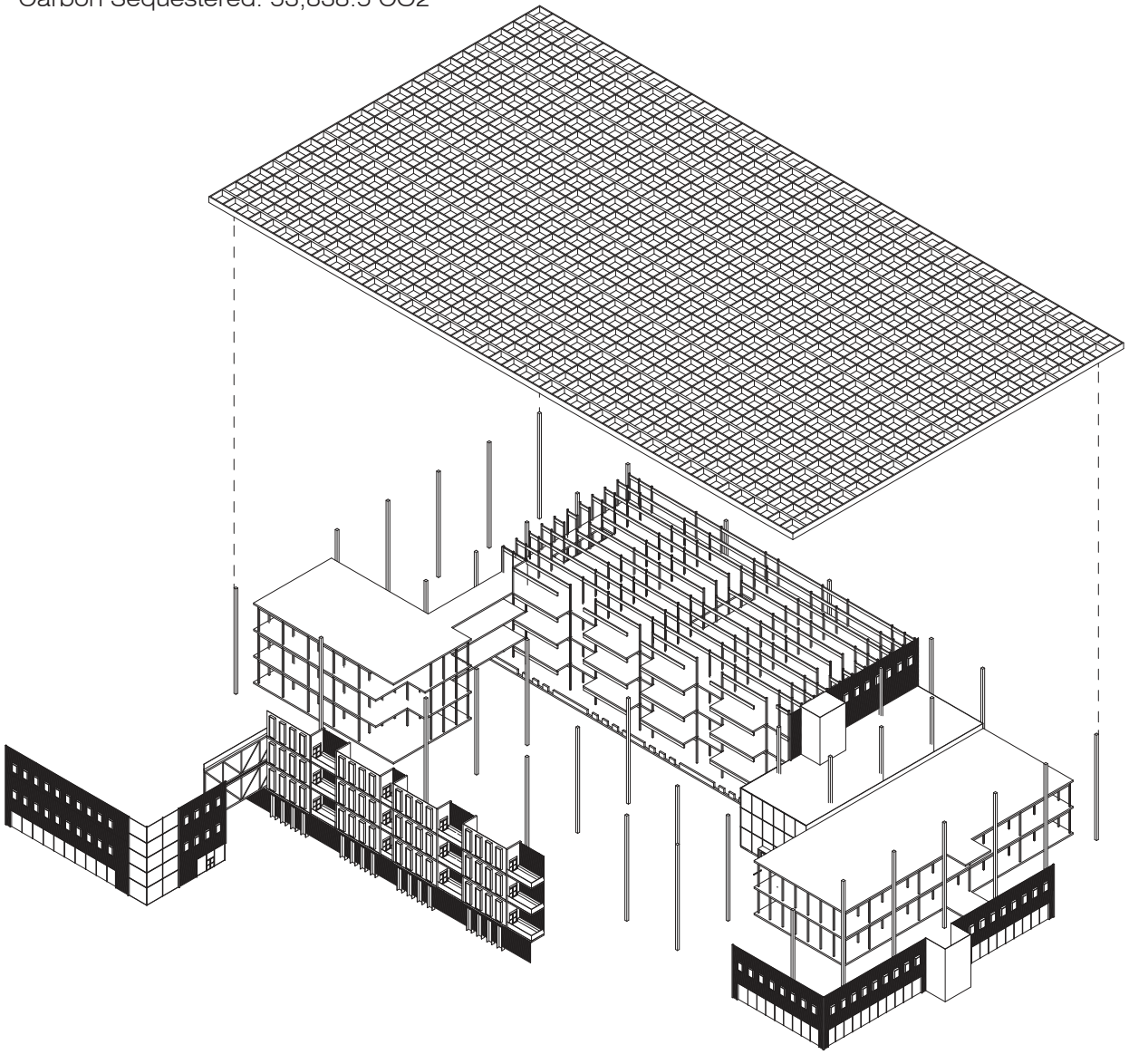


Structural Organization



Exploded Structure

Total Board Feet of Wood: 1,292,124ft
Total Cubic Feet of Wood: 107,677ft
Carbon Sequestered: 53,838.5 CO2

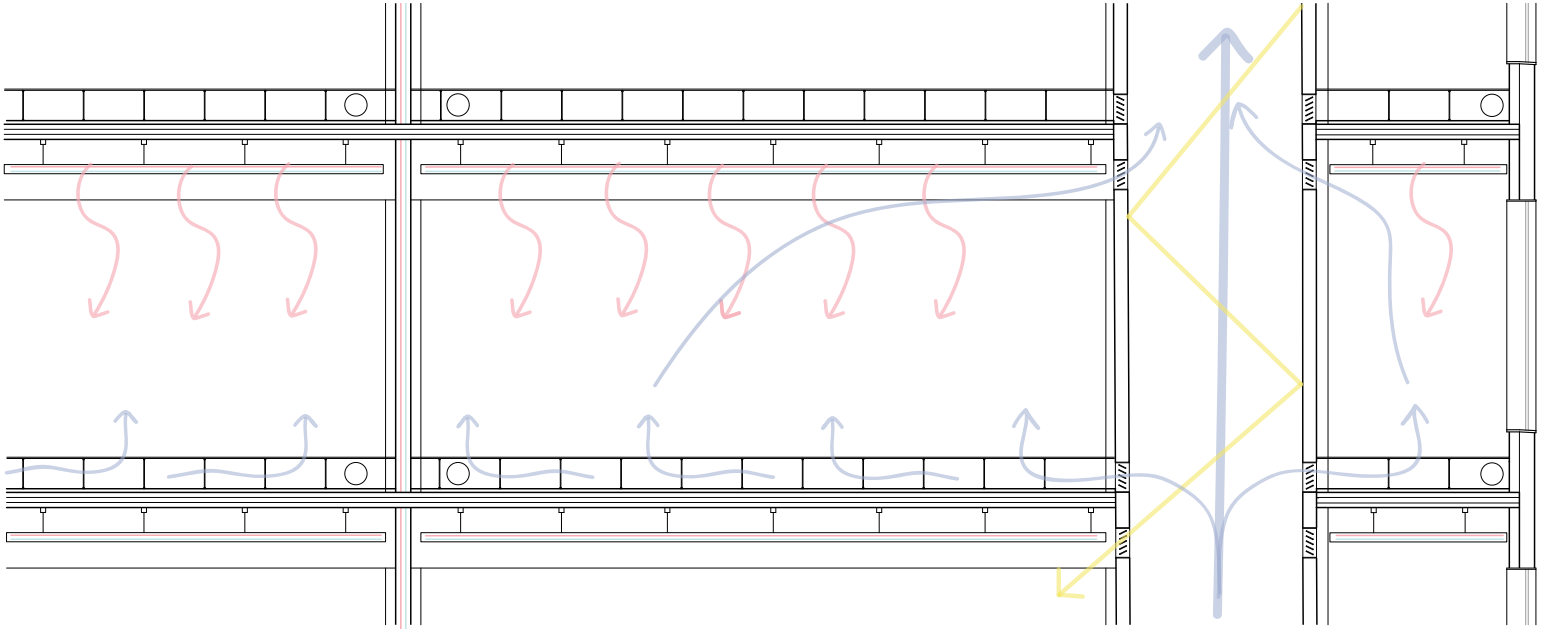


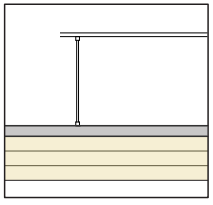
ENVIRONMENTAL CONTROL SYSTEM

Radiant sails hanging from the expoed CLT ceiling hydronically heat and cool the spaces.

Stack ventilation shafts allow for natural air movement through the spaces. Conventonal forced air systems act as a back up.

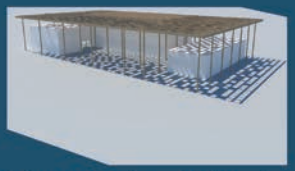
Mirored lightwells and clerestories into the courtrooms allow for access to daylight.



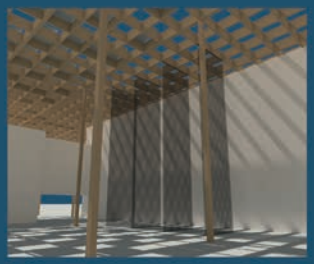


Floor plates are made up of 3-ply CLT, a 3” comcrete slab to provide rigidity, and an 18” riased floor to hold pumbing, electrical and data lines.

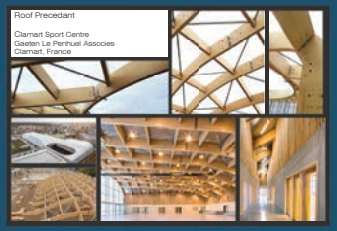
Net Zero Strategies



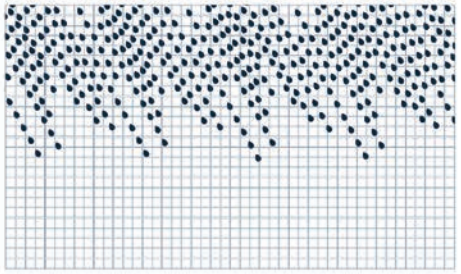
Roof creates an ample space for photovoltaic arrays to supply the building's power



Roof creates a vast surface to collect water to supply the building's water

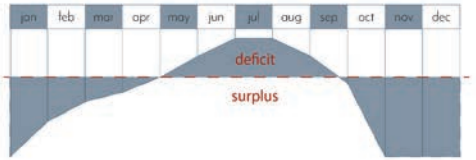


Water

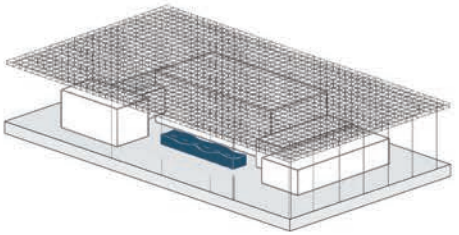


3.9M gallons of water collected on the roof annually

3.4M gallons of water used annually

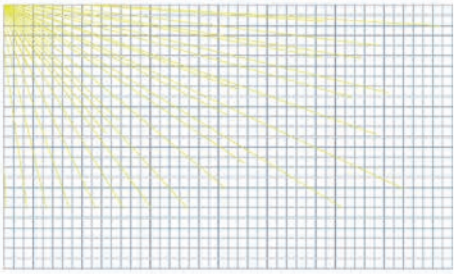


.5M gallons of water required to supply the building during summer months

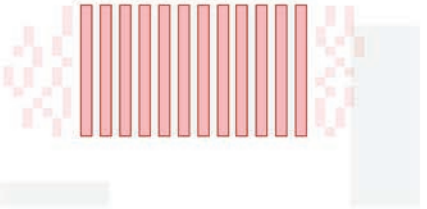


66,840 ft³ water tank constructed below-grade adjacent to constructed wetlands quenches building water demand

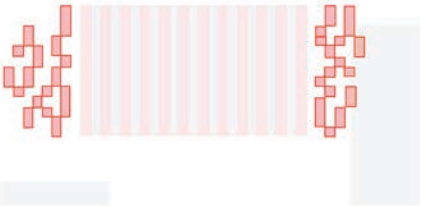
Solar



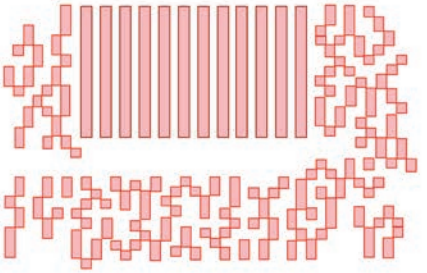
1.6M kWh annual energy demand (*30 kBtu/sf/year assumption*)

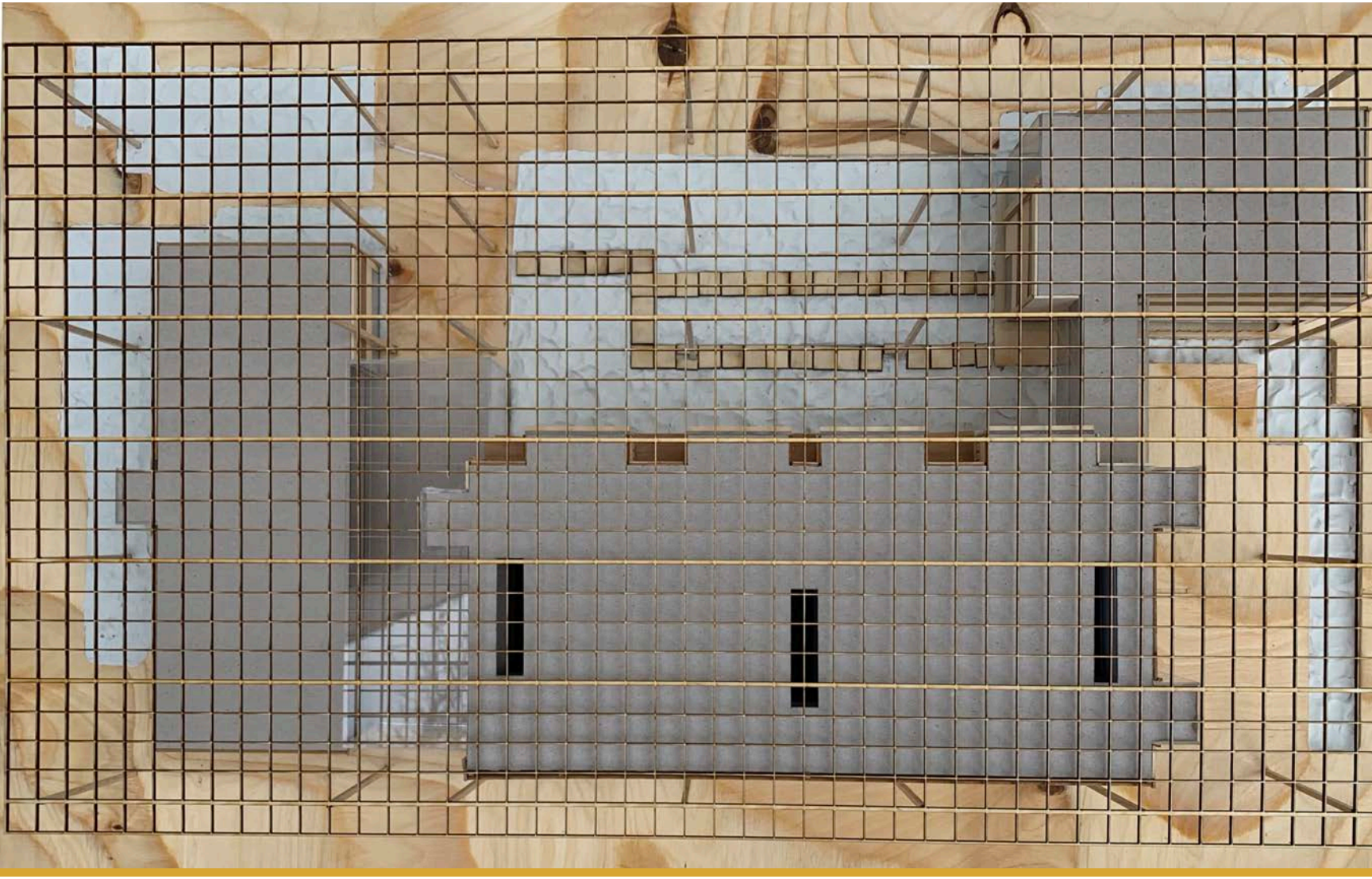


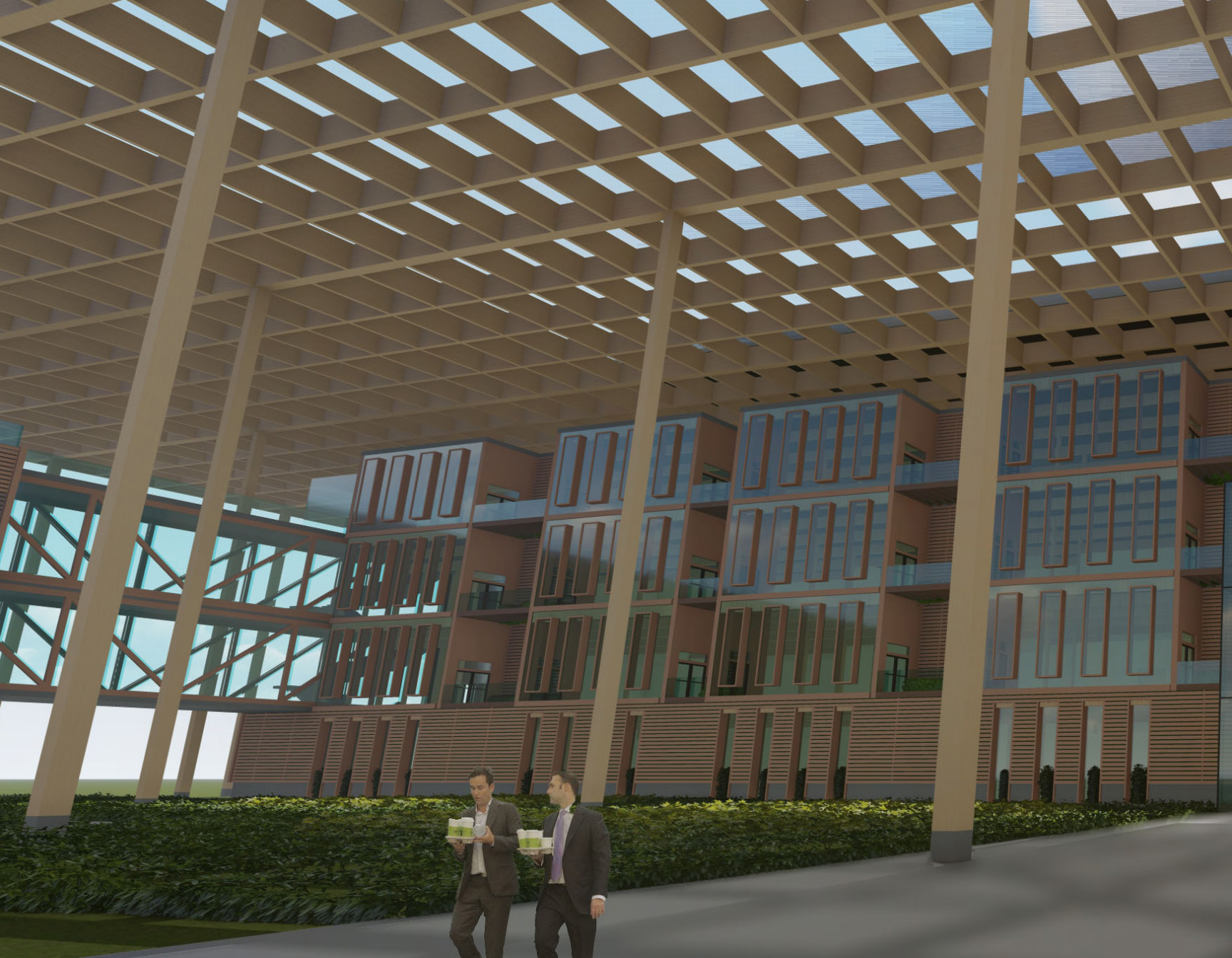
997,624 kWh energy produced on top of the courtrooms

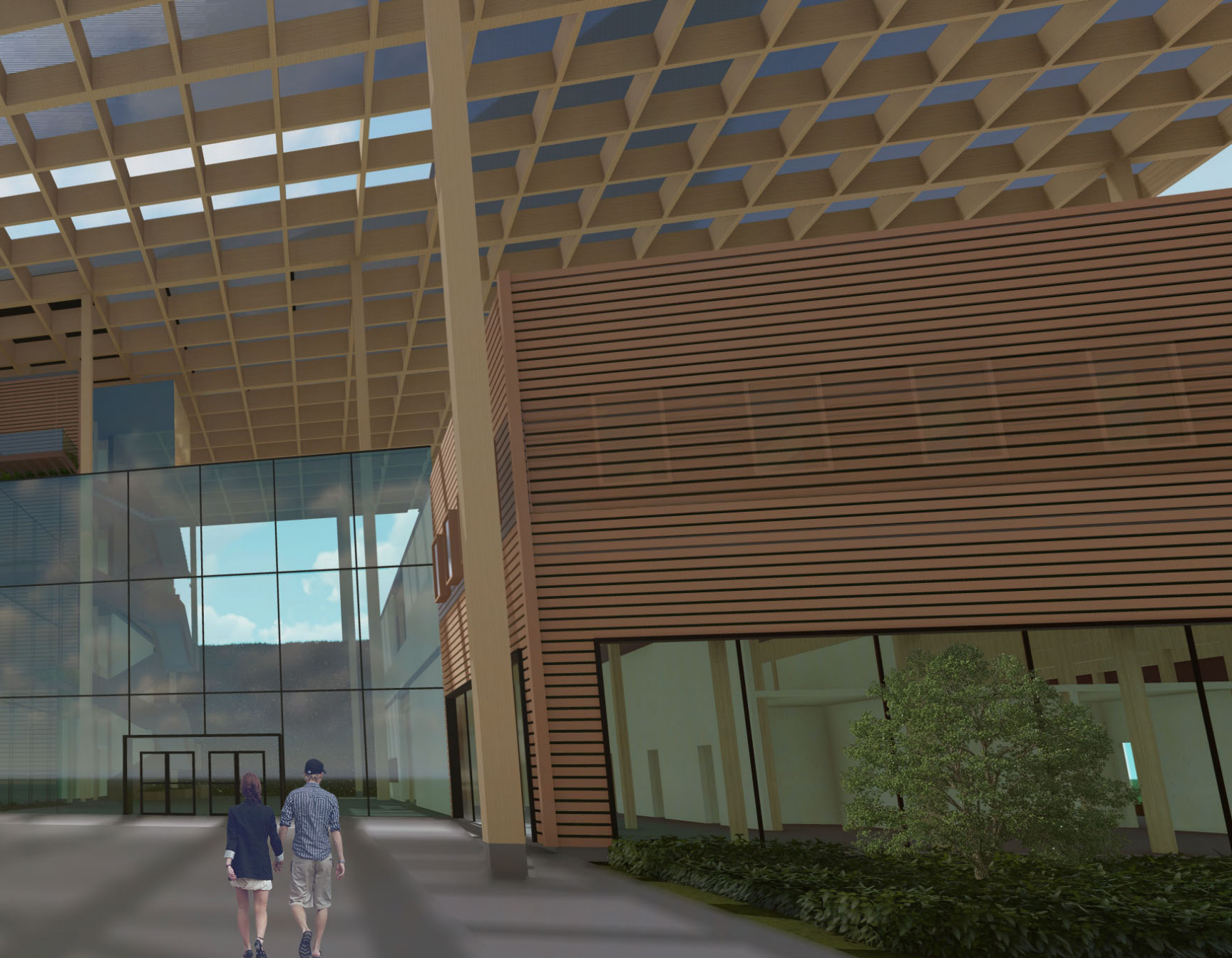


602376 kWh energy demand produced above the market and lobby with the capacity to expand to include future energy demands





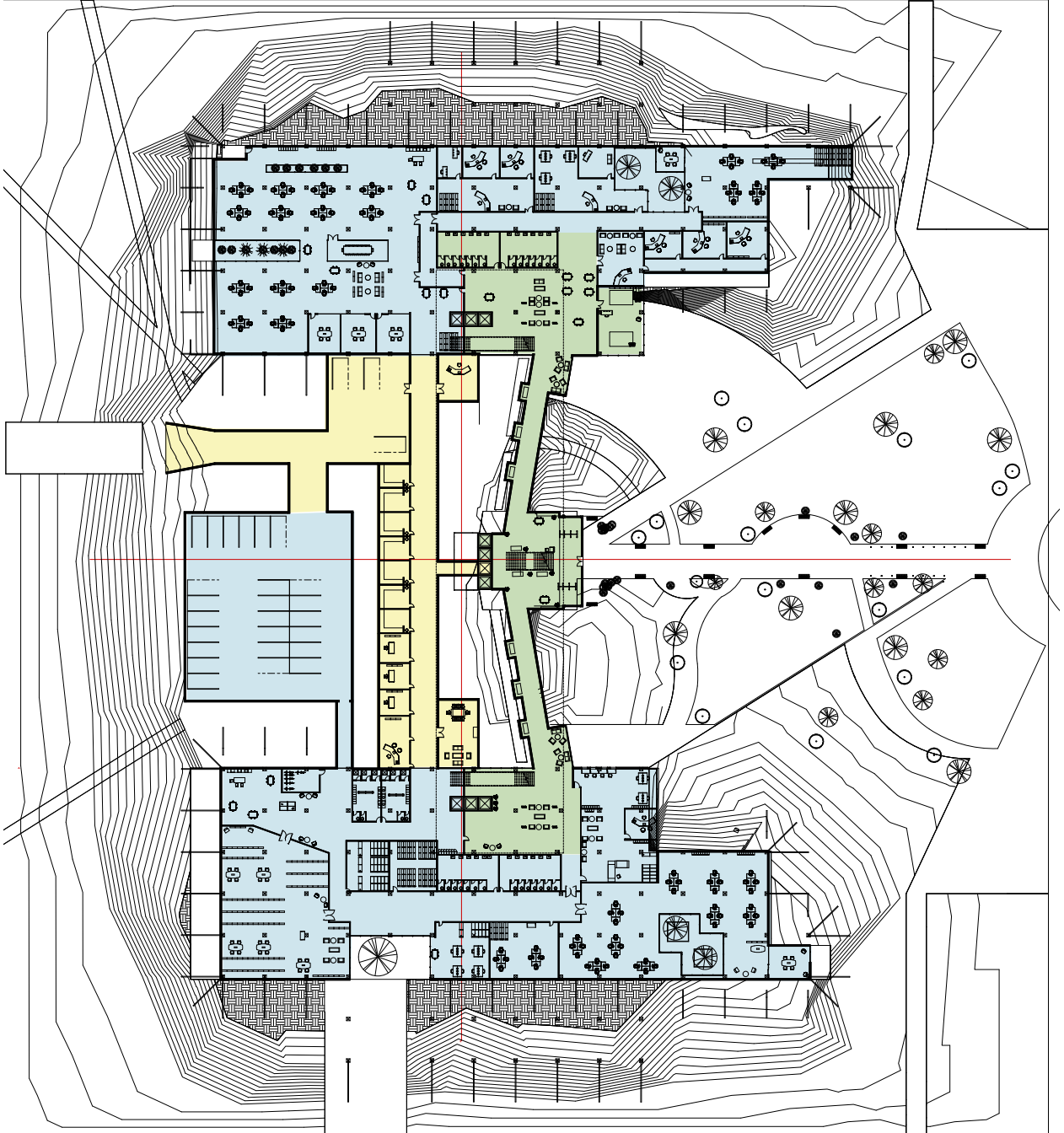




BRIDGE & BERM

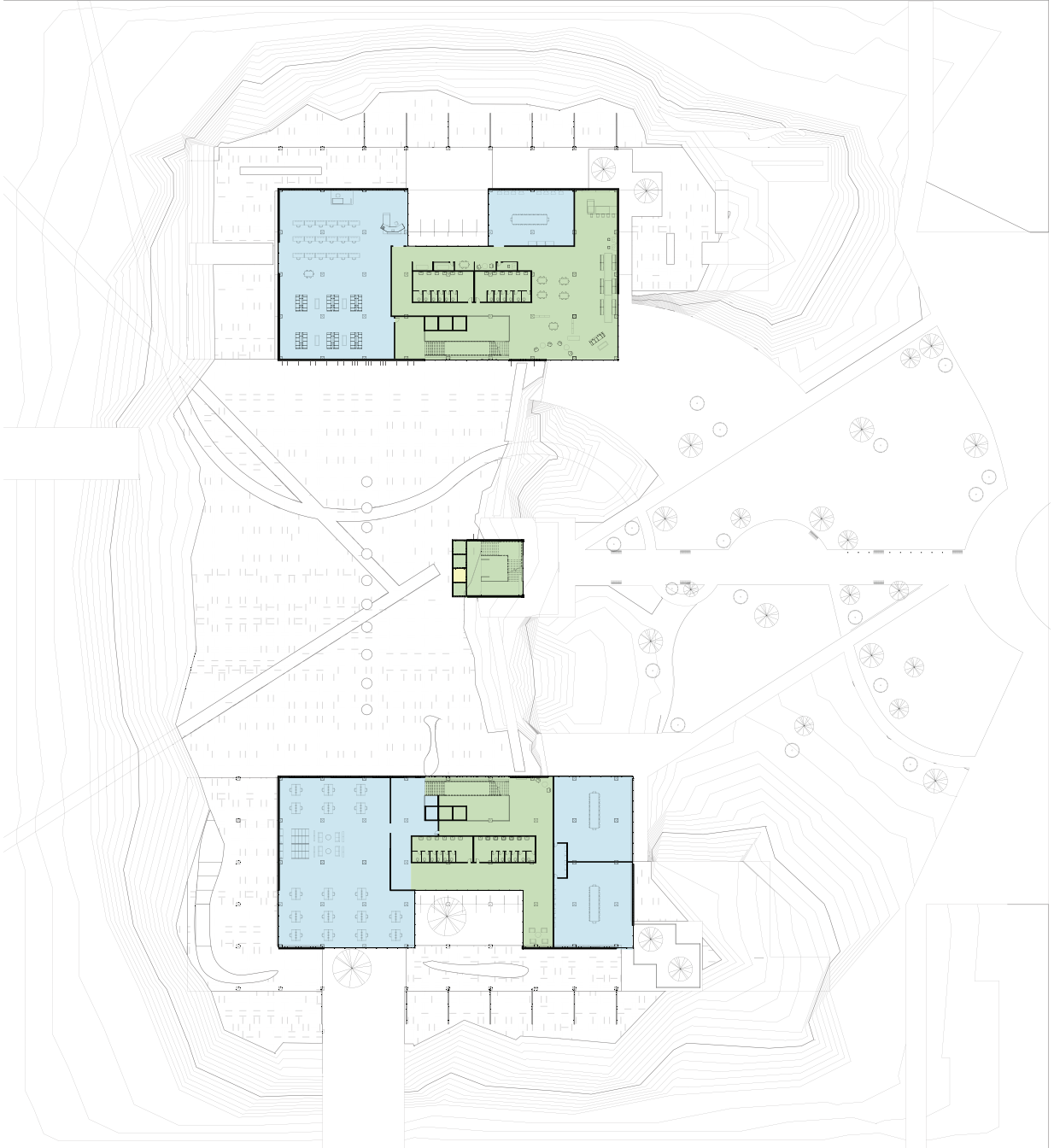
Ryan Andersen | Marin Nagle | Khang Ngo | Nicholas Vawter

The goal of our project was to take the common idea of transparency in courthouse design one step further and try to make a high security building more integrated and usable for the community and the public. We achieved this by creating spaces on the exterior accessible to anyone as well as connecting our building to the history of Clackamas County. Here we derived the "Bridge & Berm" form. The first use of mass timber in Clackamas County was to build bridges by the Barlow Travelers as they were moving west. The bridge-like facade of our structure metaphorically connects our structure to the county, and our integrated berm structure physically connects the surrounding community to the building. Users are able to walk up and interact with the berm, with sculptural seating that also acts as light wells, with better views to Mount Hood and with trees that continue down to interior courtyards. By having about 50% of the program underground, we also were able to achieve a closer connection to nature with users in the office space. Not only were we able to create a more biophilic office environment, but we also then were able to regulate the temperatures with passive heating and cooling from the earth in our building. Also with multiple innovative mass timber solutions, we were able not only to showcase a variety of ways to use mass timber in design but also to offset our carbon footprint for the project.



SITE PLAN

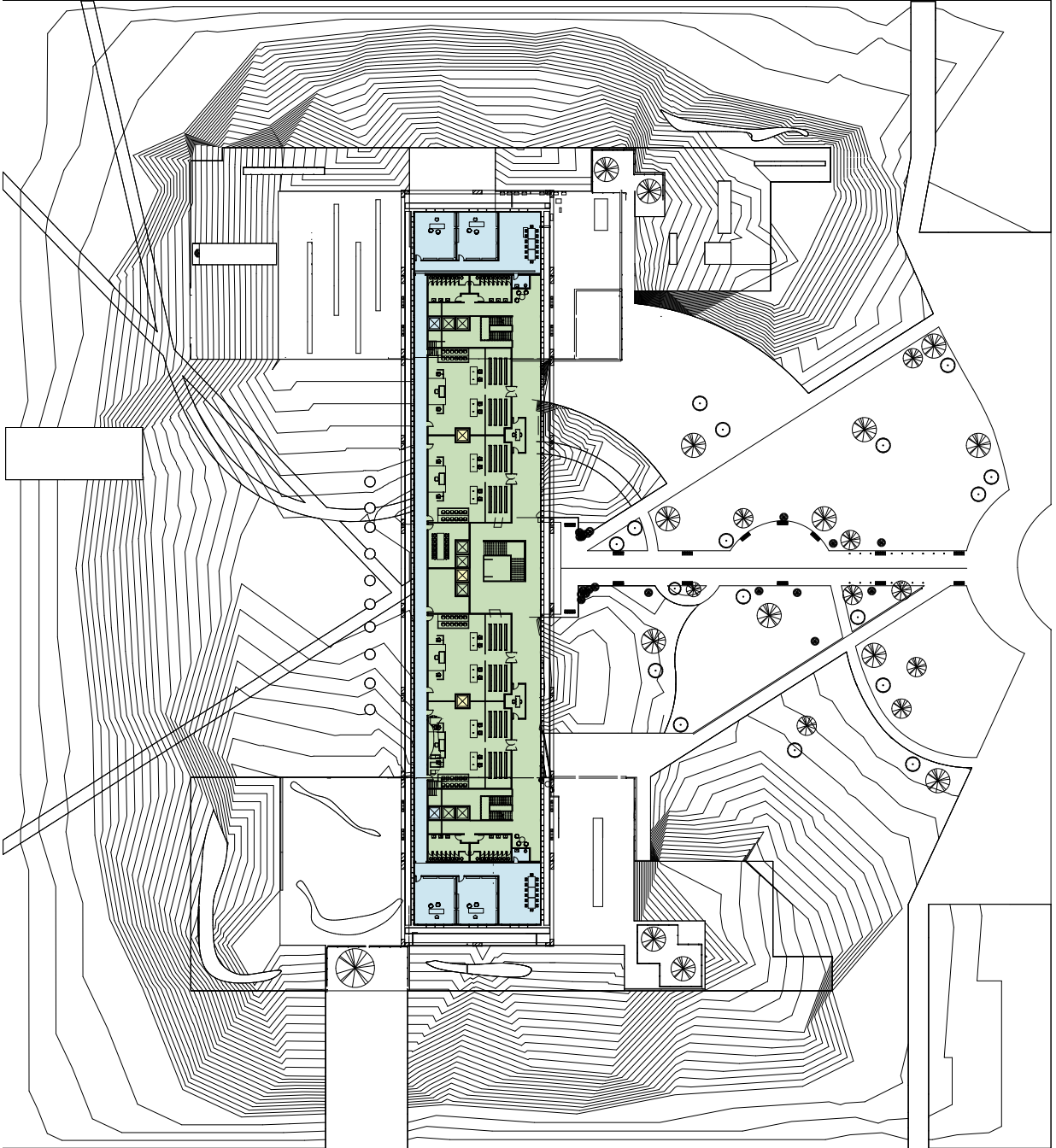
FIRST FLOOR



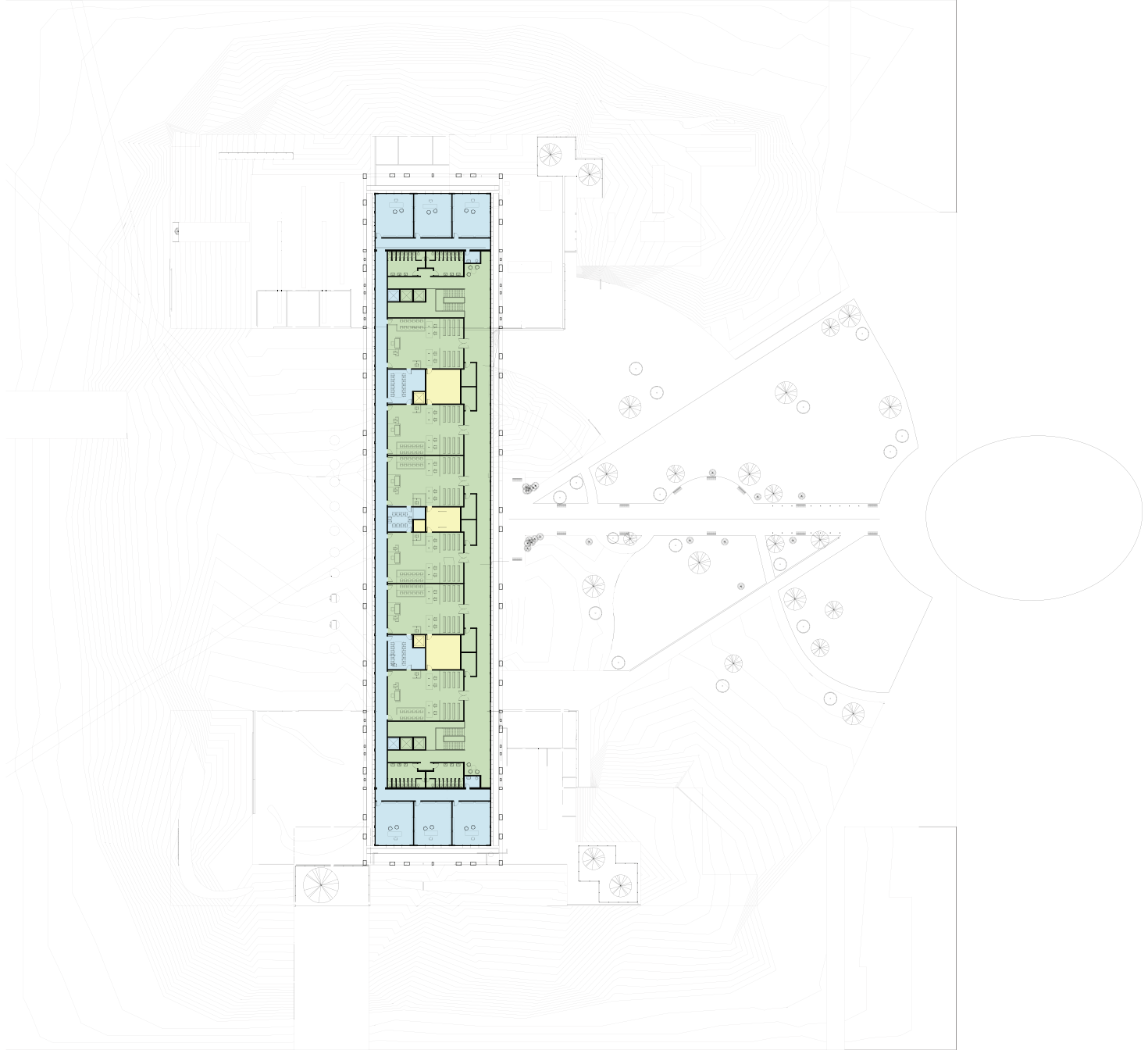
SECOND FLOOR

THIRD FLOOR

FOURTH FLOOR



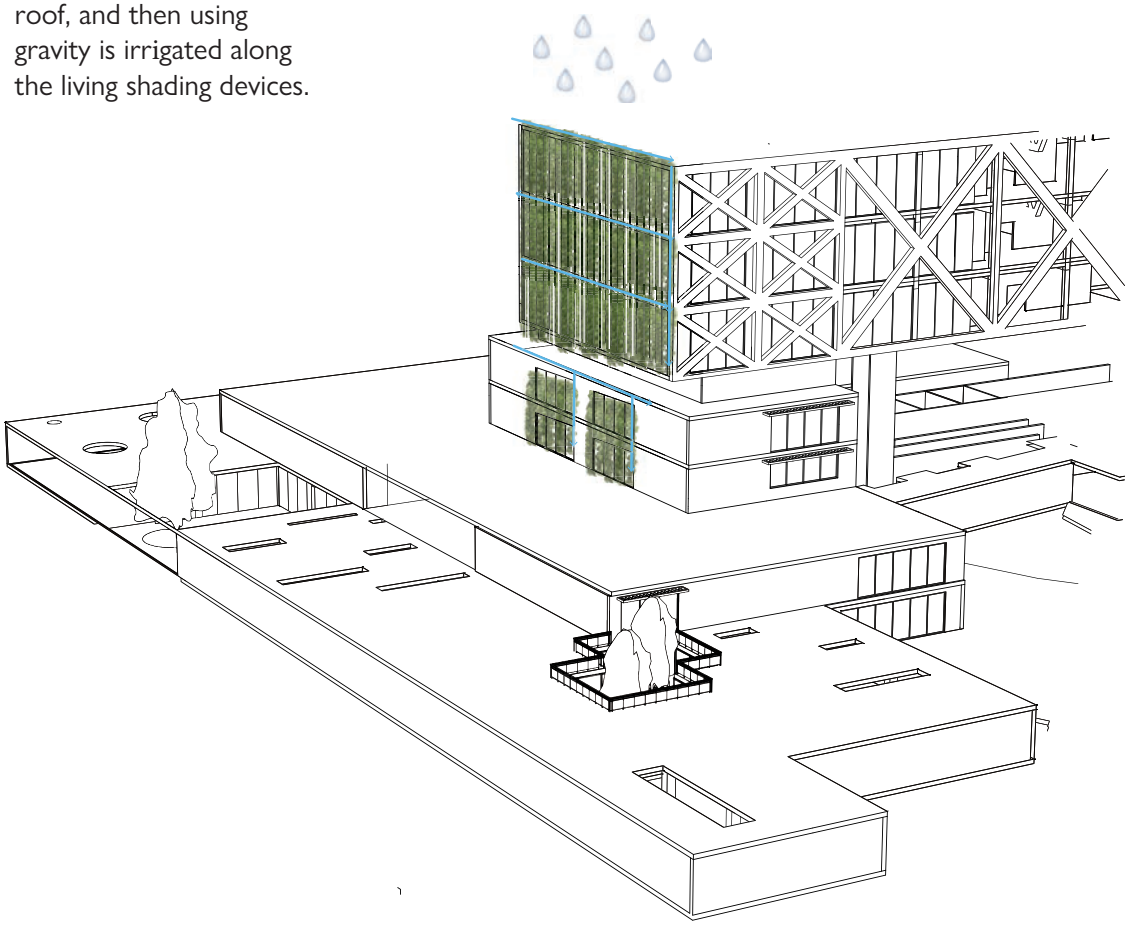
FIFTH FLOOR



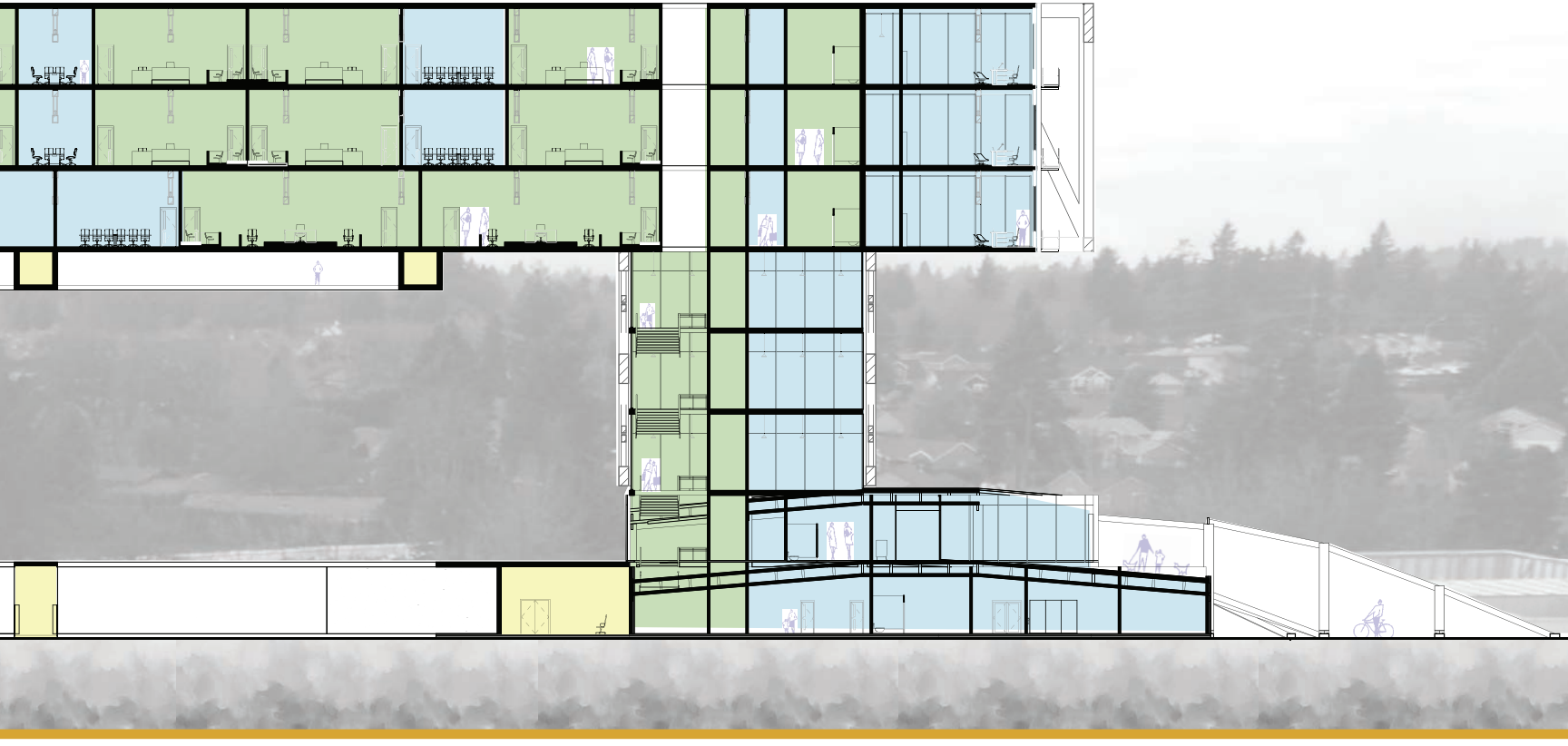
SIXTH AND
SEVENTH FLOORS

Rainwater Harvesting System

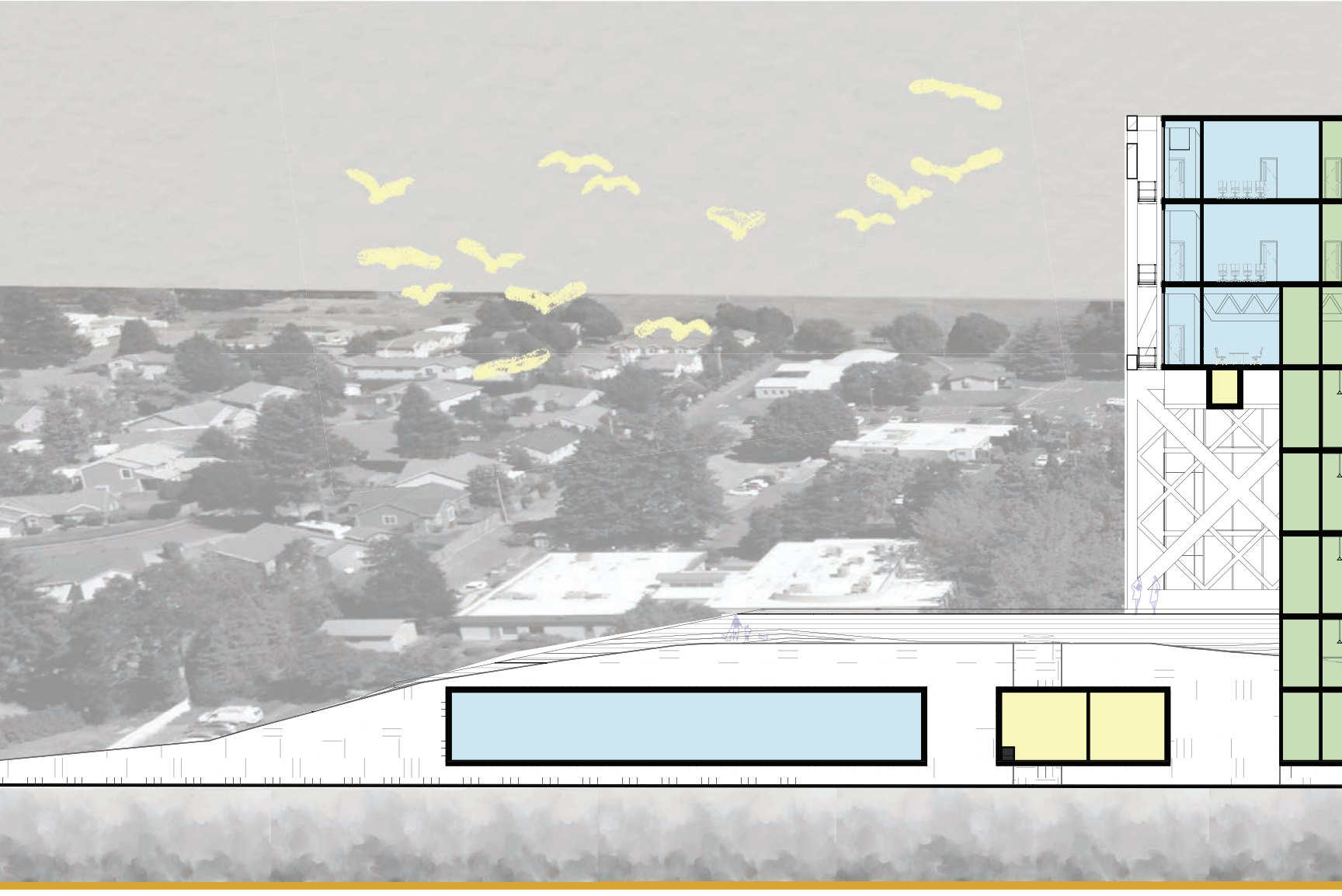
Rain is collected on the roof, and then using gravity is irrigated along the living shading devices.

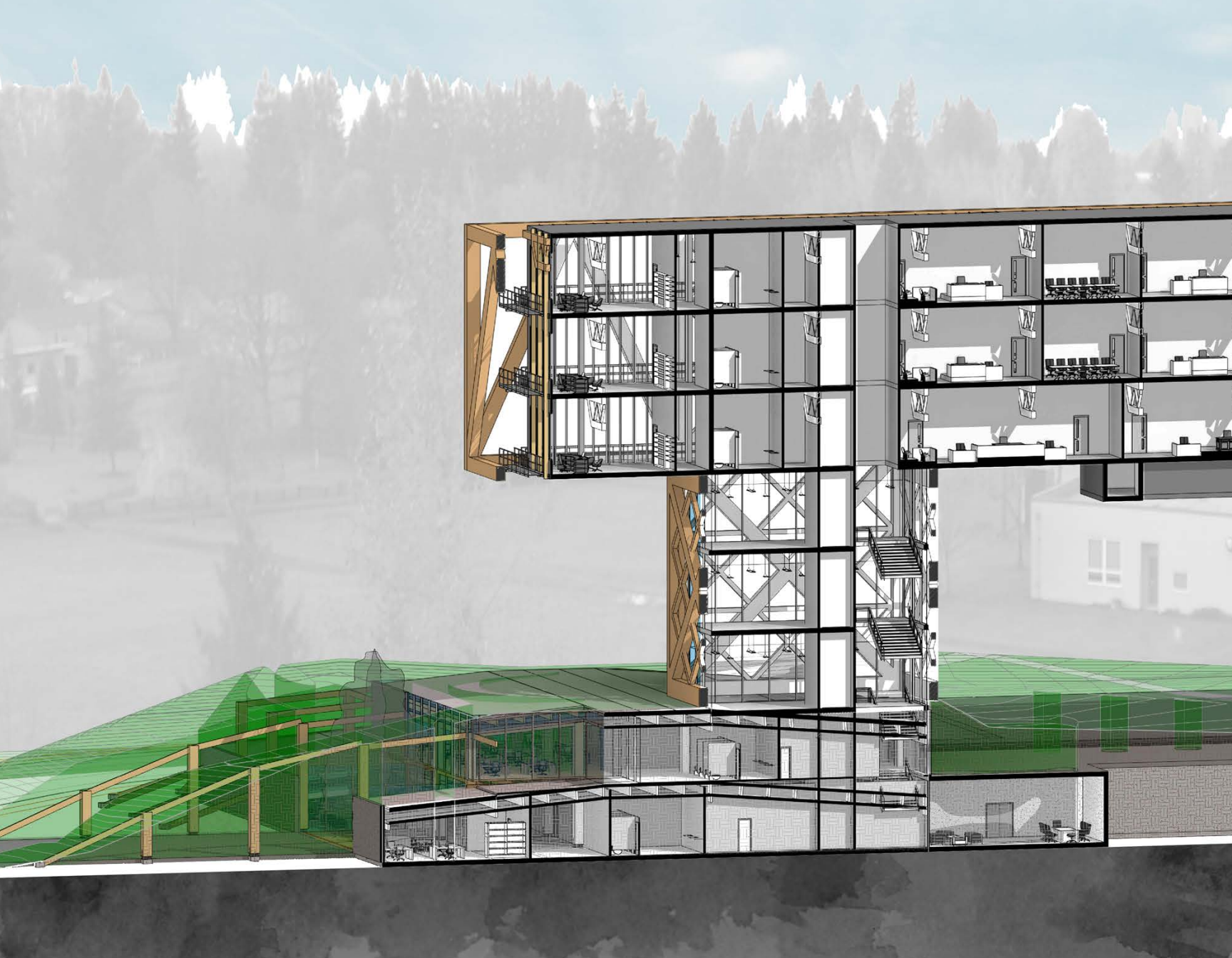


SECTION



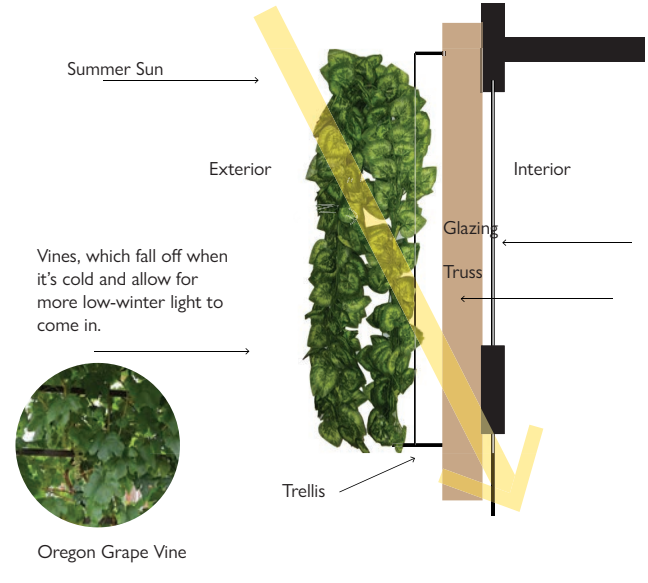
SECTION



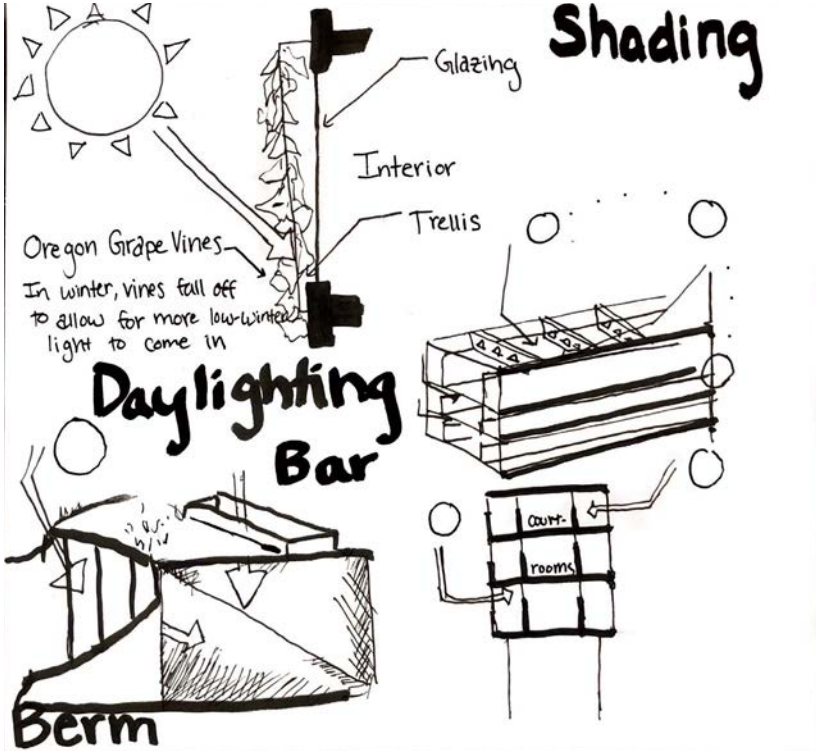


Shading Devices

Living Trellis• System

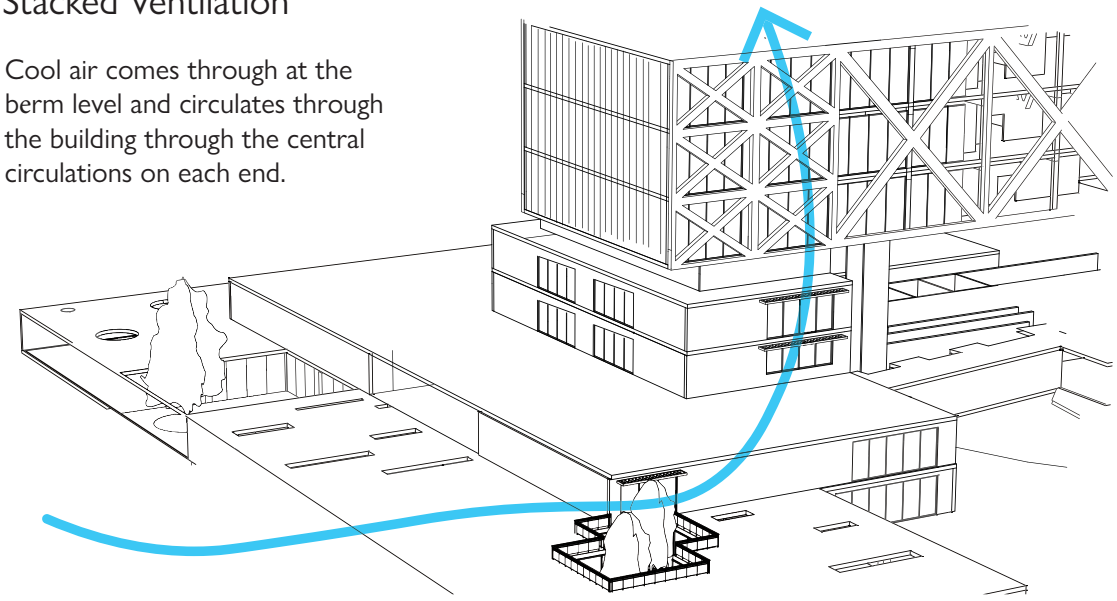


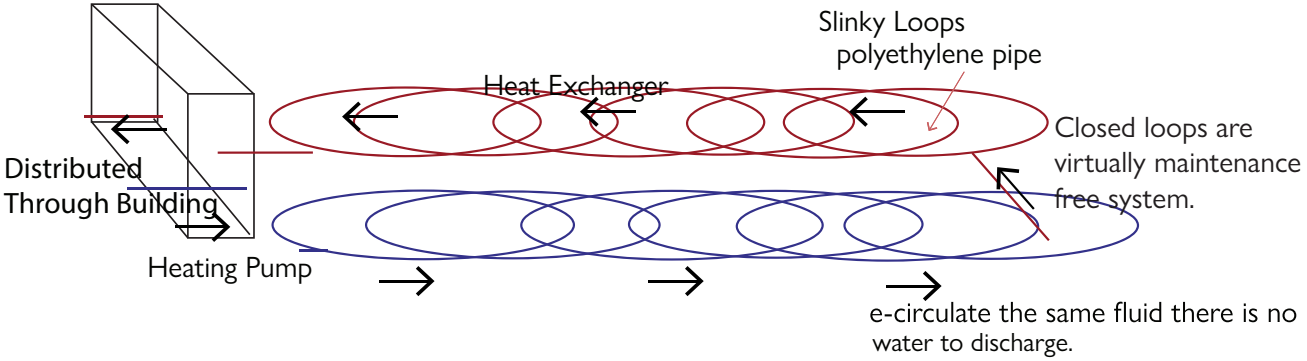
Geothermal Heating System



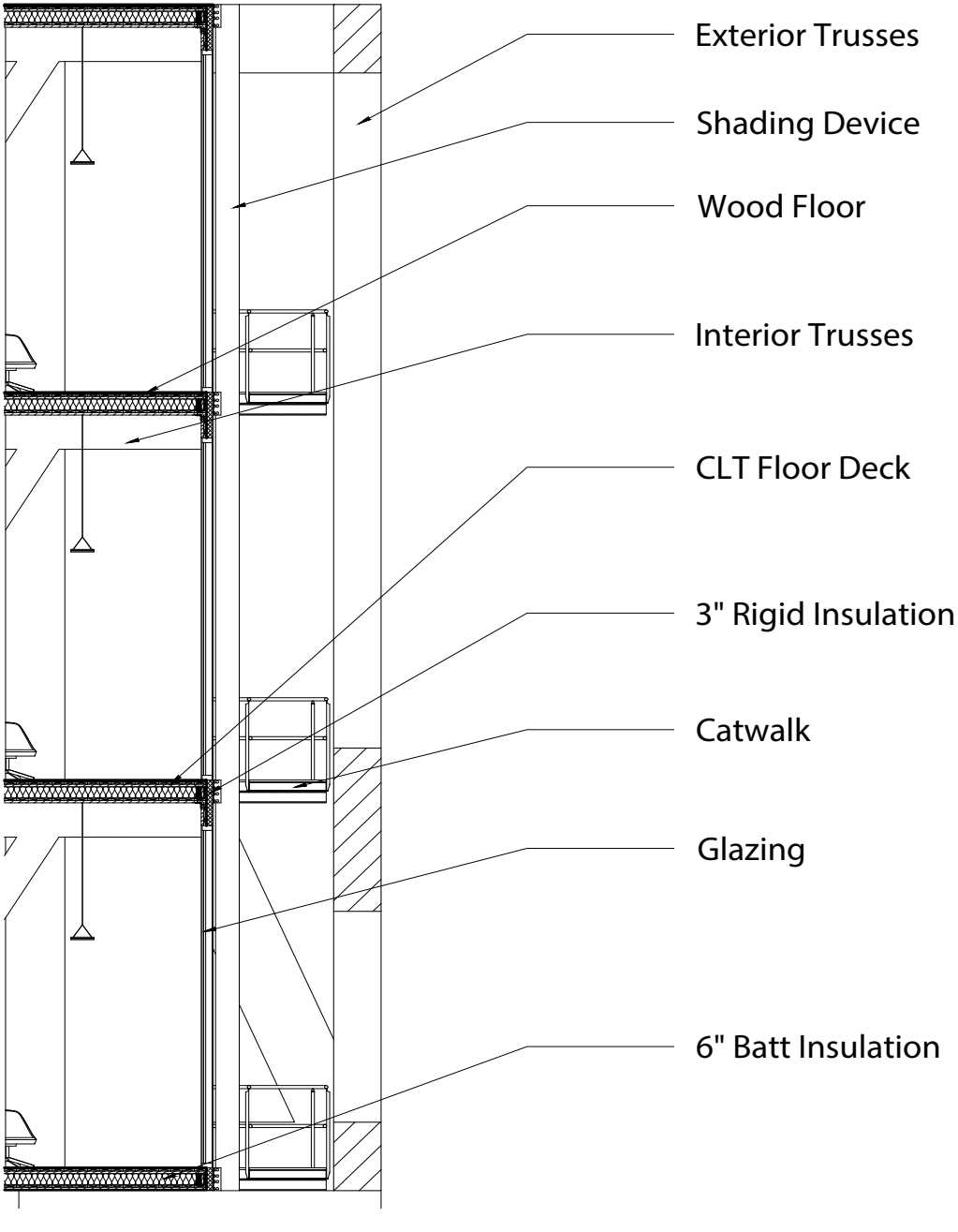
Stacked Ventilation

Cool air comes through at the berm level and circulates through the building through the central circulations on each end.





WALL SECTION



MASS TIMBER VOLUME

Columns Material Volume	12,926.71 CF
Floor Material Volume	255,816.08 CF
Wall Material Volume	84,391.70 CF
Interior and Exterior Truss Material Volume (lvl 3-7)	87,048.99 CF
Structural Framing Material Volume (lvl 1-2)	23,854.31 CF
Total Mass Timber Volume	464,037.79 CF

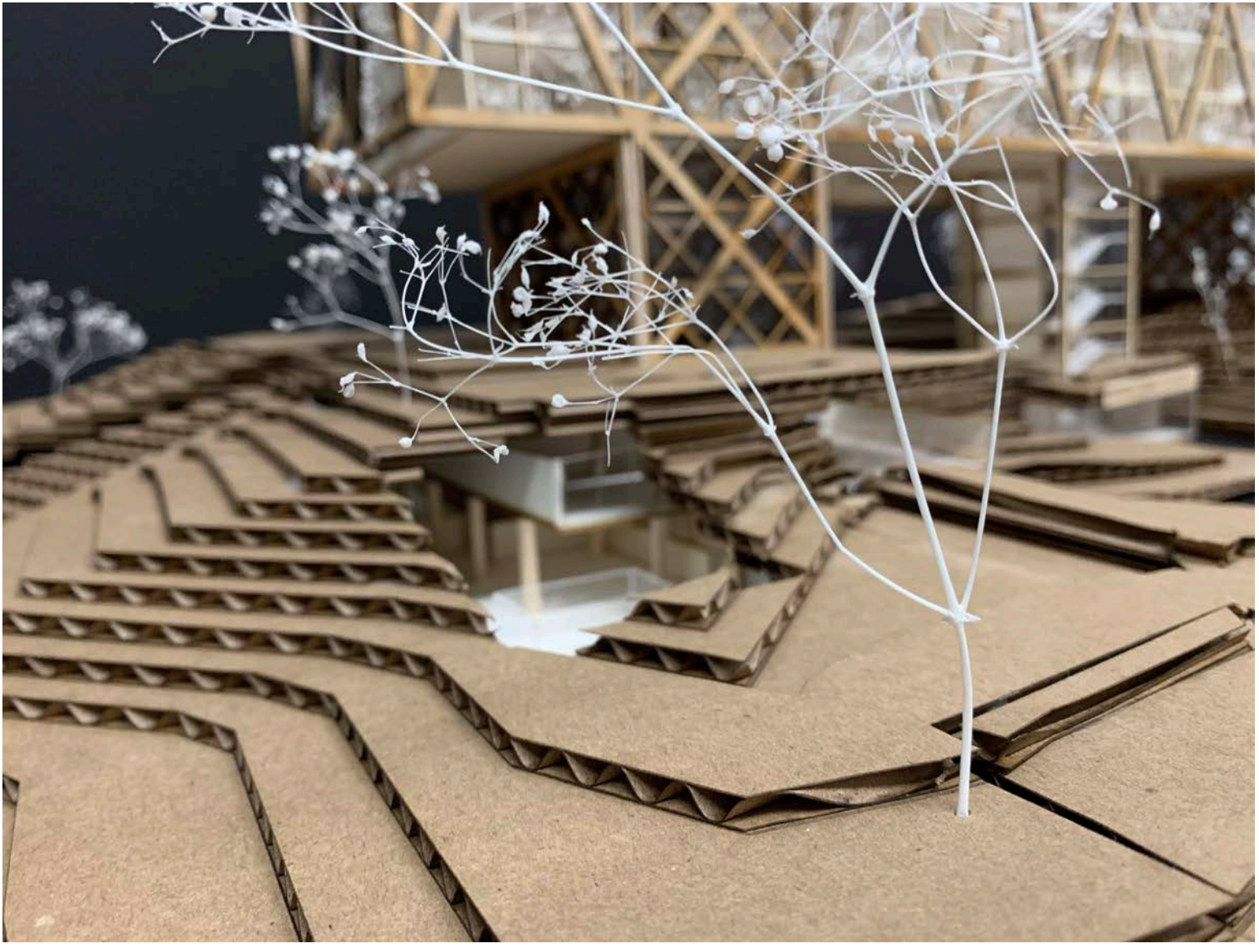
BY TYPES

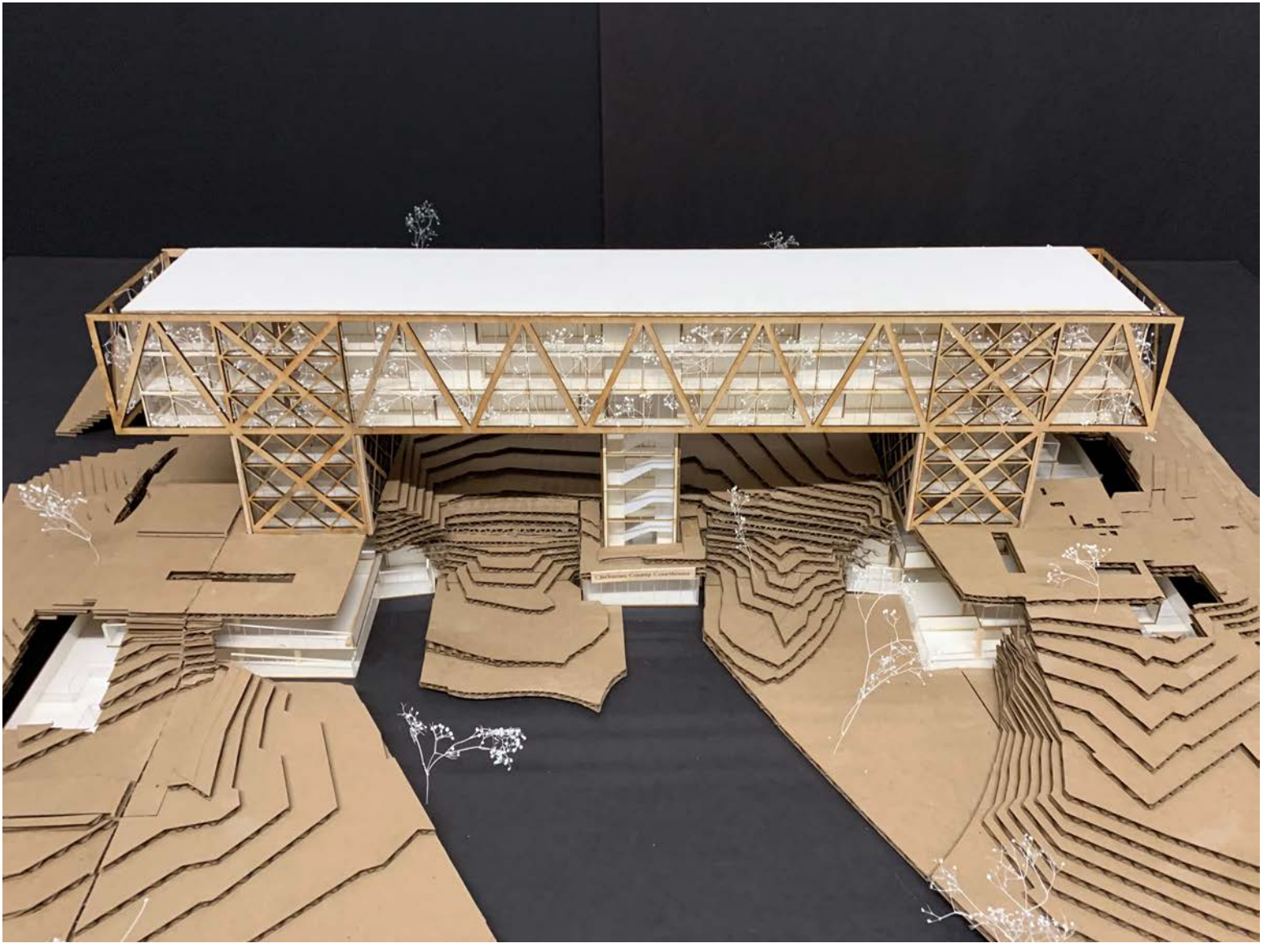
Glulam	123,830.01 CF
Cross Laminated Timber	340207.78 CF

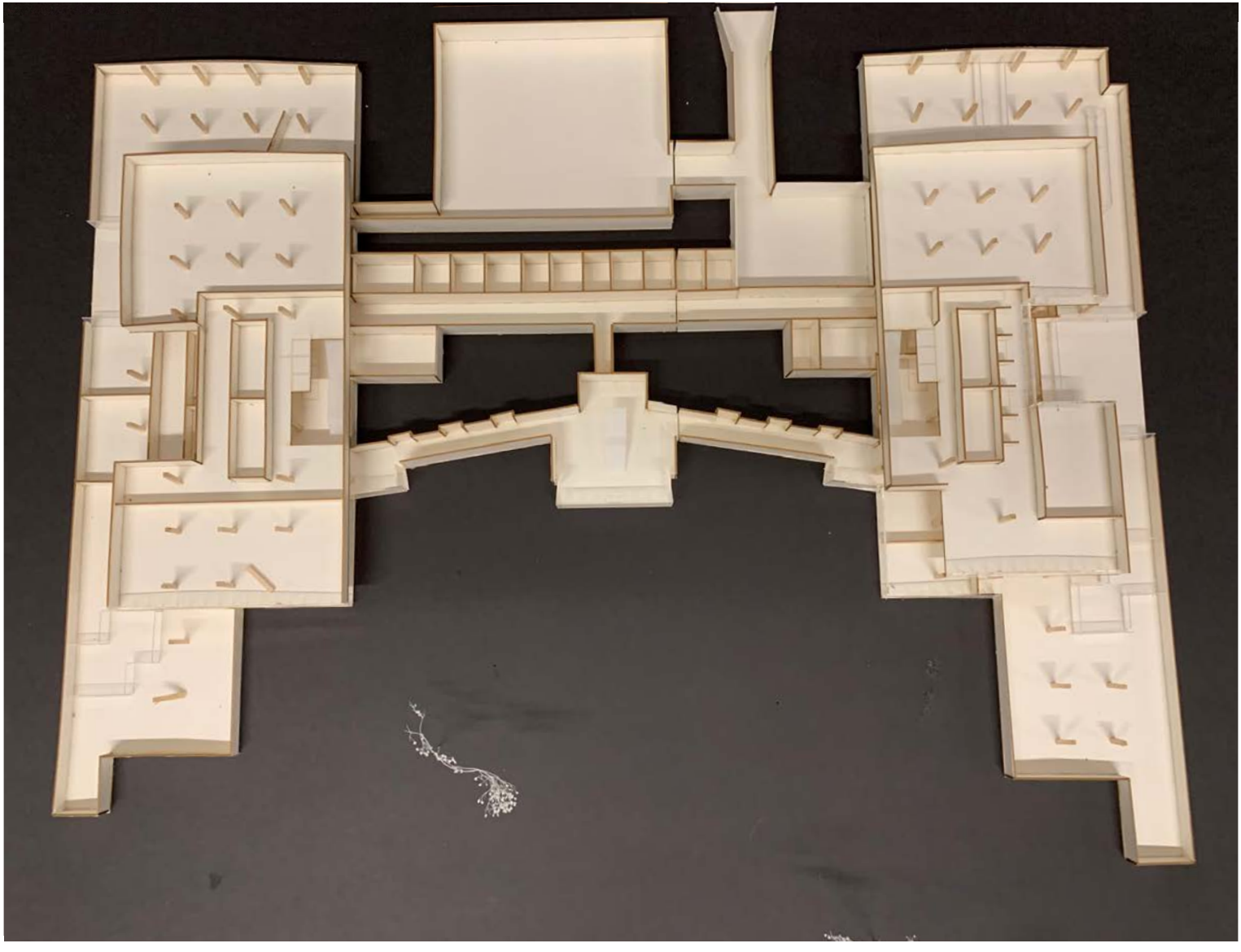
CARBON SUMMARY

Carbon Stored in the Wood	11685 Metric Tons of CO_2
Avoided Greenhouse Gas Emissions	4521 Metric Tons of CO_2
Total Potential Benefits Carbon	16206 Metric Tons of CO_2

MODEL PHOTOS








STATE OF OREGON
1859

INNOVATION IN MASS TIMBER - CLACKAMAS COUNTY COURTHOUSE

Studio conceived by Professor Judith Sheine and Professor Kevin Van Den Wymelenberg, School of Architecture & Environment, Department of Architecture, University of Oregon, in collaboration with Professor Mikhail Gershfeld, Department of Civil Engineering, California State Polytechnic University, Pomona, and with Clackamas County, Oregon.

Book Design: *Cameron Reid*

Courthouse Studio Students: *Ryan Andersen, Chandler Arnsdorf, Diego Cardiel, Brennen Donnelly, Brooke Everard, Gemma Fucigna, Jessi Gahl, Aaryn Gray, Austin Gutierrez, Isaac Hadnutt, Aizeder Iriondo Jayo, Isais Lawrence, Zhixuan Liang, Chiara Maggiore, Alex McCord, Lorine Moellentine, Marin Nagle, Khang Ngo, Cameron Reid, Matthew Robinson, Nicholas Stanek, Nicholas Vawter, Matthew Weldon, and Molly Winter.*