BIOCLIMATIC ARCHITECTURE:

INCORPORATING SUSTAINABLE DESIGN METHODS IN COLD CLIMATES

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INCORPORATING SUSTAINABLE DESIGN METHODS IN COLD CLIMATES

A Design Thesis Submitted to the
Department of Architecture of
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Completed By:

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THESIS ABSTRACT

Sustainable practices have been a topic of interest for decades within the design community. Architects and engineers alike are keen on the use of alternative energy sources such as wind and solar, but only recently have they shifted focus to building materials and methods as a potential solution for more environmentally conscious design. Our material selections and where they are sourced impacts our carbon footprint in ways we are just beginning to understand. One such material is the use of mass timber or cross laminated timber (CLT).

Introduced in Europe, mass timber construction has slowly grown in popularity internationally. After years of implementation overseas, CLT has finally made its appearance in the U.S. and has now even been incentivized in cities such as Portland and Seattle to meet sustainability requirements both locally, and at a state level. Unfortunately these recent innovations in sustainable design are slow to be implemented inland in areas such as the Midwest.

This thesis explores the use of CLT and other sustainable materials and strategies in a Midwestern context. The intent of this thesis is to educate, inform, and inspire people to invest in our environment and design for the future by making sustainable building decisions in cold climates. To do this, I developed a Sustainable Design Learning Center in Duluth MN that uses design methods such as green building certifications like LEED and WELL, the use of CLT, daylighting and other materials to educate people on how we can build more intelligently for the future of our planet.

THE PROPOSAL

NARRATIVE

Since the beginning of time, humanity has sought ways to improve our way of life. From the discovery of fire and the invention of the wheel, to modern day solutions such as 3D printed organs, we have always sought to improve our quality of life. In an architectural sense, the spaces where we frequent the most; where we live and work, have evolved from a space of pure necessity to a place of luxury. Innovations in structural strength, forms, and artistic expressions are being made around the world in an effort to push the envelope. Yet there's one market that may be underutilized - sustainable materials and building methods. While we are always pushing the capabilities of tried and true materials such as concrete and steel, what innovations have been made in an effort to not only improve our current quality of life, but those of future generations as well? Humanity has overcome the challenge of creating survivable spaces, and should now look towards creating thriving and sustainable spaces for the benefit of our planet and our future.

In the present day, innovations in structural strength, forms, and artistic expressions are being made around the world in an effort to push the envelope. Humanity has overcome the challenge of creating survivable spaces, and now looks towards creating thriving and sustainable spaces for the benefit of our planet and our future. There's only one problem - these strategies are currently the most effective and efficient in warm climates. Where does that leave the rest of the world in areas further from the equator?

This design thesis explores sustainable materials and building strategies in cold climates with the intent to educate, inform and inspire people to invest in our environment and design for the future - regardless of where they are in the world.

PROJECT TYPOLOGY

This thesis intends to create a community based Sustainable Design Learning Center focused on the education of topics such as environmental design and green building materials. This facility would support local schools, design professionals, and regional experts to learn more about the impact of building and the benefits of designing for our environment.

The importance of educational facilities such as this one cannot be overstated. Within a community, educational institutions are often directly related to the economic development, historical and cultural preservation, and overall success of the community. These factors represent the idea that knowledge is a catalyst for revitalization, innovation, and progressive thinking within a community.

With this motive in mind, the potential for a facility that introduces groundbreaking technology to a region that could greatly benefit provides the ideal opportunity for growth.

To determine the feasibility and narrow down the direction for this thesis, I have conducted various case studies to set the precedent of similar building typologies from around the world. These precedents will help inform my future design thinking and innovative solutions.

When selecting the following case studies for precedent research, four major factors were given consideration:

1) TYPOLOGY

2) CONTEXT

3) URBAN IMPACT

4) ENVIRONMENTAL IMPACT

PROJECT EMPHASIS

1) INTEGRATE INNOVATIVE SUSTAINABLE STRATEGIES:

Incorporate strategies and materials that can showcase the capabilities of current green building technologies.

2) EMPHASIZE THE IMPORTANCE OF THE ENVIRONMENT:

Display the impacts of construction on our environment by the numbers, and show the importance of conservation.

3) EDUCATE ON SUSTAINABILITY IN THE MIDWEST:

Provide educational spaces, signage, and programming to encourage future implementation within the community.

4) CREATE AN INCLUSIVE LEARNING ENVIRONMENT:

Implementing different learning styles and spaces allows for users of all abilities and disabilities to participate in sustainable design. These will include auditory, visual aids, and hands-on learning opportunities

PROJECT GOALS

1) DISCOVER HOW ARCHITECTURE CAN EDUCATE:

Investigate the ways that architecture can educate and inspire a community to utilize sustainable building strategies.

2) IDENTIFY REGIONALLY APPROPRIATE STRATEGIES:

Learn more about what sustainable strategies are being utilized in the Midwest, and focus on implementing additional materials and methods for continued innovation in the region.

3) EDUCATE ON THE IMPORTANCE OF SUSTAINABILITY:

Inform the general public about their individual impact on our environment and how their choices can create positive change. This includes builders, designers, families, kids, and more.

4) LEARN ABOUT CONSTRUCTION TECHNIQUES:

Research current construction methods to learn not only the impact of sustainable strategies, but the skills required to use them as well.

SITE CONTEXT

REGION:

Known as the "Land of 10,000 Lakes," Minnesota is home to over 14,000 bodies of water, western prairies, deciduous forests, and dense woods used for mining, forestry, and recreation. The region is abundant with wildlife and showcases the natural beauty of the north along the Canadian border and the coast of Lake Superior.

REGIONAL DEMOGRAPHICS:

Population: 5.7 Million
Land Area: 86,943 Miles^2
Water Area: 7,309 Miles^2
Counties: 87
Density: 66.6 Persons/Mile^2

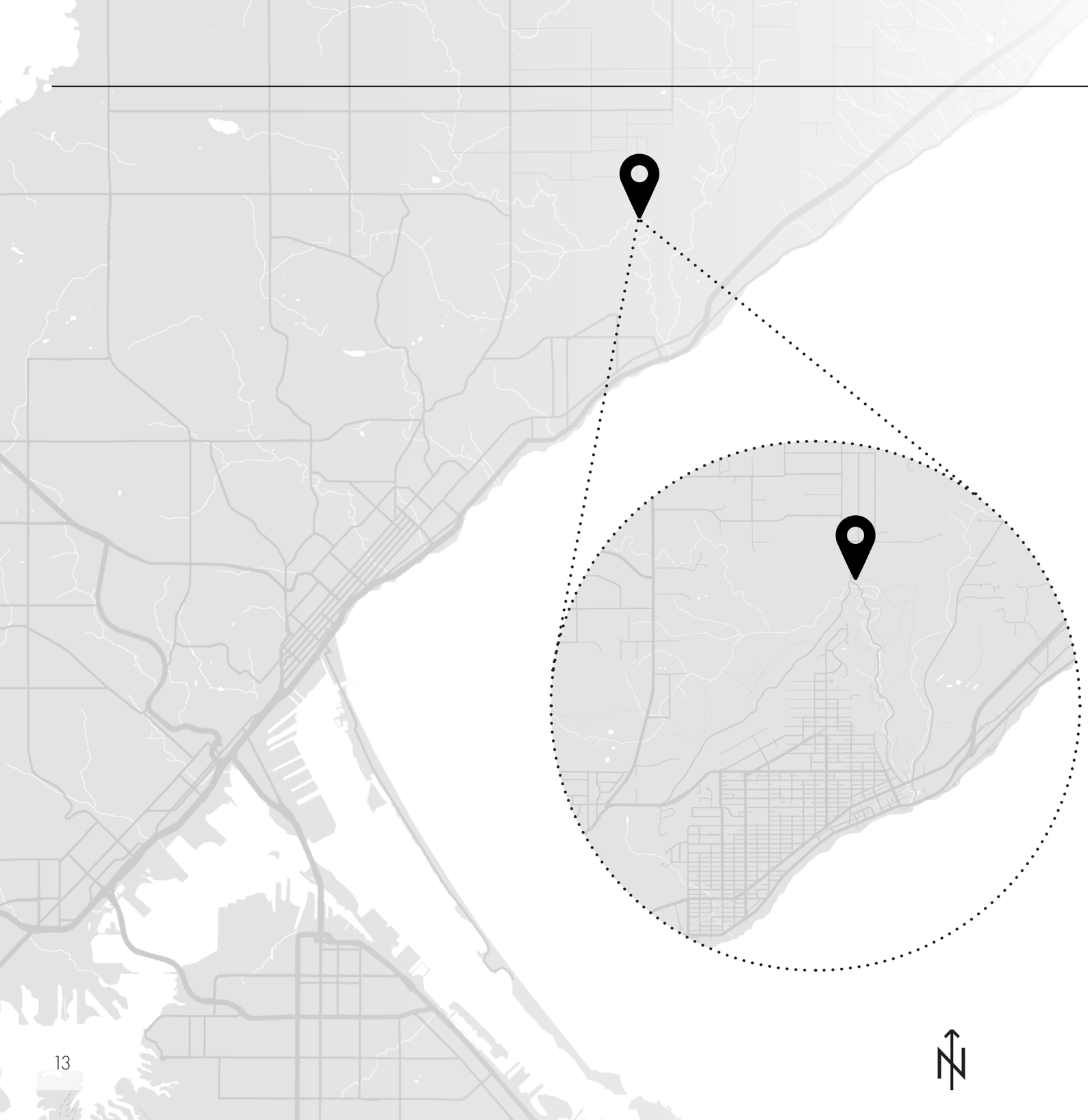
CITY:

Situated on the North Shore of Lake Superior, Duluth is a bustling port city that's accessible to the Atlantic ocean 2,300 miles away via the Great Lakes Waterway. The Port of Duluth is the world's farthest inland port accessible to oceangoing ships, and is the largest and busiest port on the Great Lakes. Located in the Minnesota Arrowhead region, the city is a hub for cargo shipping. Exports include coal, iron ore, grain, limestone, cement, salt, steel coil, and wind turbine components.

CITY DEMOGRAPHICS:

Population: 86,697
Land Area: 80.16 Miles^2
County: St. Louis
Density: 1,209 Persons/Mile^2

THESIS SITE



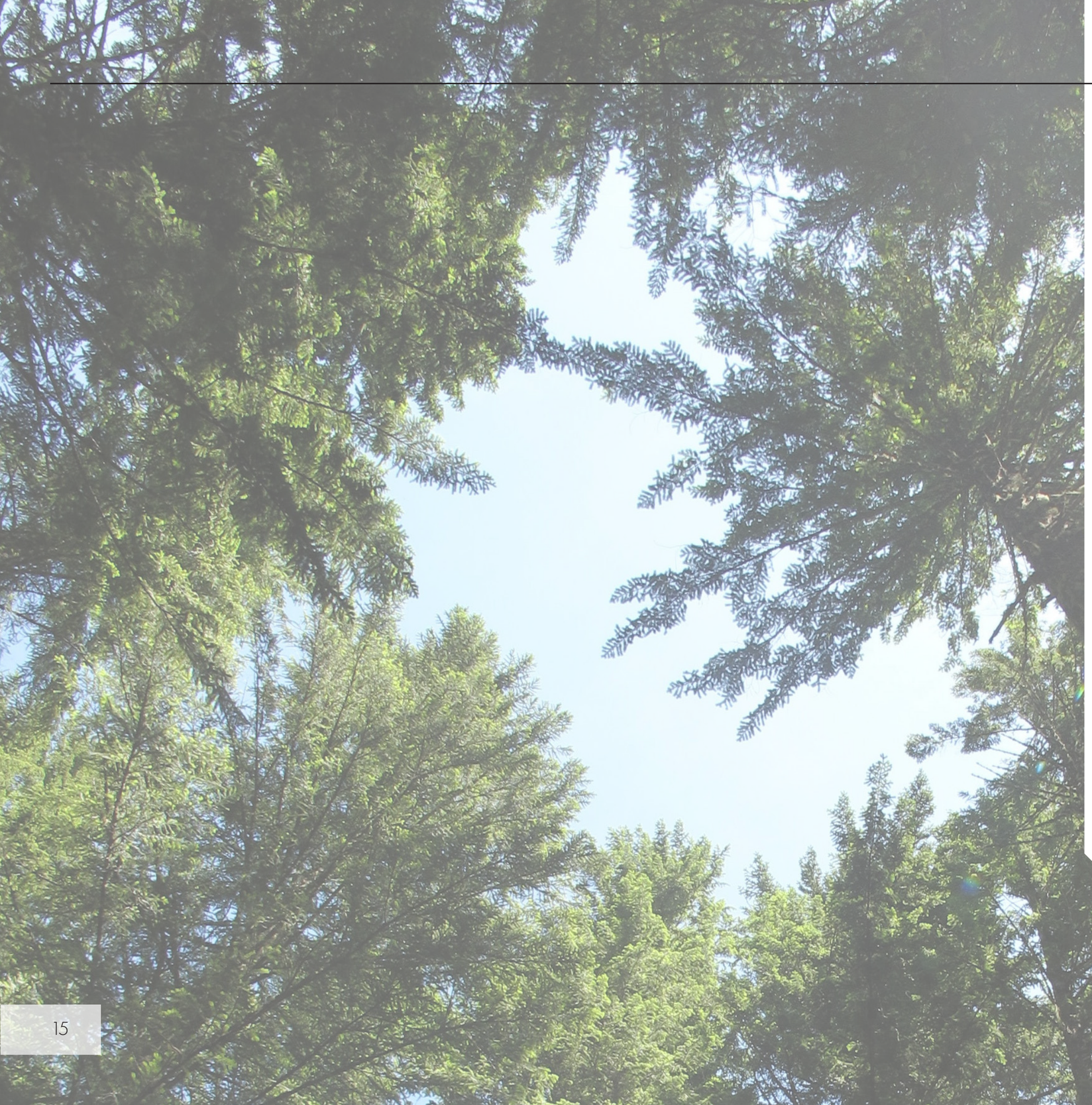
SITE SELECTION:

Selected for its port access, thriving ecosystem, and regional connections, Duluth Minnesota serves as a prime location for a facility focused on sustainable construction. The region is an outdoor enthusiasts' paradise - densely wooded, countless rugged rock formations, and inter-weaved with streams, the area provides an oasis from the rest of the city.

The site itself is in the northern part of Duluth in Lester Park and is immersed in the dense forests of the North Shore. Located on a highpoint in the area, the site can overlook Lake Superior and observe the comings and goings of ships in the port. The proposed site allows future development to be fully immersed in the forest, and connects to the world through a complex trail system for cross country skiing, hikers and bike enthusiasts, and locals can be found in the stream in the summers.

Duluth has many conservation efforts, and the region brings scientist and conservationists from all over the world to the area. A facility highlighting sustainability and eco-friendly design would not be out of place in Duluth or in Lester Park. Organizations such as the Hawk Ridge Nature Reserve and Bird Observatory are in close proximity to the site.

LOCATION:	Lester Park | Duluth, Minnesota | United States
SITE TYPOLOGY:	Rugged | Forested | Dense Foliage
NOTES:	Selected site is elevated for occasional view points of Lake Superior to the east



MAJOR PROJECT ELEMENTS

1) ASSEMBLY SPACES

Assembly spaces provide an area to gather with experts in the field, or host local or regional events such as AIA Lectures, design competitions, etc. This capability addresses the auditory aspect of learning.

2) EXPLORATORY SPACES

Creating hands-on exploration spaces allows visitors to interact with the building to see how intentional design directly impacts the functionality of a space and its environment. This could include windows and lighting, heating and cooling strategies, ventilation etc.

3) DISPLAY SPACES

This project element provides gallery space with informational signage such as building statistics, utilized building methods, donors, an energy usage dashboard and more. This method addresses the visual aspect of learning.

4) SUPPORT SPACES

Includes facilities such as a loading area for materials and supplies and public viewing areas of the building's mechanical systems. This emphasizes the inner-workings of the building instead of hiding and tucking them away in traditional construction

USER DESCRIPTION

DESIGN PROFESSIONALS

Architects, Interior Designers, Acoustic Designers, Lighting Designers and anyone related to design and construction that wants to positively influence designs for both the human experience and the environmental impact can benefit from learning sustainable strategies. Regional experts could utilize the space to educate area designers on the subject through lectures, workshops and more.

BUILDERS/GENERAL CONTRACTORS

On the construction side, builders and general contractors that want to keep a competitive edge by learning about new design materials and solutions can visit the facility. Workshops and training on product installations would be an ideal use of the space for this user market.

STUDENTS

Students and educators from all age levels can visit the Sustainable Design Learning Center to learn more about their impact on the planet, how building and construction affects it, and what they can do to make a change. This can be used as a fun informational field trip for K-12 students, or a more technical learning experience for college students in related fields.

COMMUNITY MEMBERS

Members of the local community and environmentally conscious visitors can enjoy the facility to learn more about how they can use sustainable design strategies and materials in a smaller scale.
This could include small local businesses or residential projects.

PLAN FOR PROCEEDING

RESEARCH DIRECTION:

This thesis implements a mixed method of qualitative and quantitative research. Related research will be conducted based on typology, context, urban impact, and environmental impact. Case studies, architectural guidelines, peer-reviewed journals and studies will be used to fulfill the programmatic requirements and establish a meaningful design solution. Further site analysis will be conducted to better determine environmental factors and programming strategies for the site.

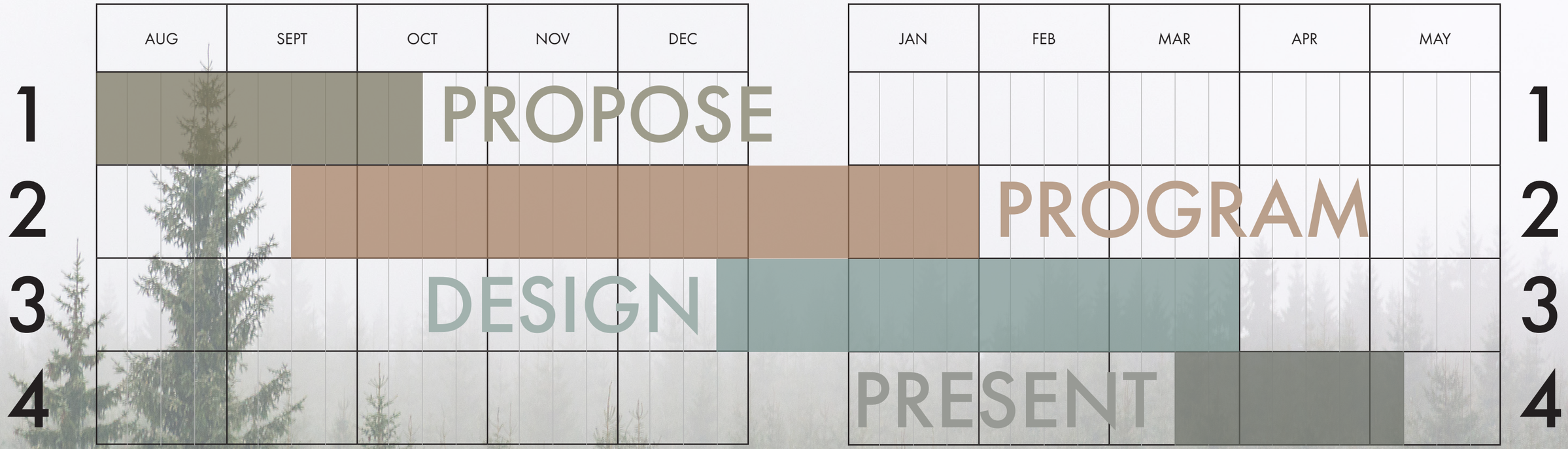
DESIGN METHODOLOGY:

The utilized thesis method in this project is a mixed method that will follow structured design,object oriented design, and inclusive design methodology. This mixed method will employ both qualitative and quantitative research collected during the programming stage to accomplish an inclusive and universal design. The information will be thoroughly analyzed and visually represented through infographics and renderings.

DOCUMENTATION OF DESIGN:

All research is collected and documented digitally, and is combined and implemented into the thesis program and proposal. The design process is shown through sketches, conceptual drawings, photos, and other various graphics. The end result is a digital representation of the research collected and the design solution. The final project in its completed state is presented orally with a digital presentation, and the research, text, and graphics will be documented in the thesis book. This book is available in the NDSU Library database upon completion in May of 2023.

PROJECT SCHEDULE



1) PROPOSAL:

This phase began in the very beginning of the semester where we were encouraged to think about our areas of interest and potential research topics.

2) PROGRAMMING:

Phase 2 began with our final site selection for our chosen typology. Students were also asked to submit a draft thesis proposal document and to continue with in-depth site analysis and research.

3) DESIGN

The Design Phase begins at the end of the first semester in late December when programming is complete and research has been submitted.

4) PRESENTATION:

The final phase includes a final presentation of the thesis. Presentations began in the end of April and finished in early May.

THE RESEARCH

BUILDING STATISTICS

ARCHITECTS: Valerio Dewalt Train

LOCATION: Chicago, Illinois, USA

AREA: 9,300 ft²

COMPLETED: 2021

SUSTAINABLE STRATEGIES:

- Nail Laminated Timber (NLT)
- Daylighting
- Shading for bird migrations
- Constructed Wastewater Wetlands

HISTORY

Once an ecological sanctuary dominated by wetlands, the Calumet Region was altered by more than a century of industrialization. With little to no environmental regulations until 1970s, Big Marsh Park is the Chicago Park District's largest reclamation project—a natural landscape damaged by slag from nearby steel mills. But in recent years, restorative efforts have aimed to set the park on a new course where industry, nature, and culture can safely coexist.

Big Marsh Park is now home to a 45-acre bike park and a series of walking trails that provide eco-recreation opportunities in Chicago's Southeast Side. At the park's entrance, the Ford Calumet Environmental Center (FCEC) serves as both a gateway and a hub—educating visitors about its past and setting precedent for a new, sustainable future throughout the Calumet Region.

CONTEXT

The 9,300-square-foot facility is designed for education and park services, featuring a permanent exhibit about the site and region, classroom spaces, offices, a bike repair area, restrooms, and storage spaces. Two large rooftop light monitors clad in wood cantilever over the entrance, flooding the interior double-height exhibition area with daylight.

The Ford Calumet Environmental Center is an excellent example of designing for the future while remaining sensitive to the site's past. The use of weathered steel cladding pays homage to it's roots, while the use of NLT alludes to an environmentally-responsive future.

CONCLUSION

Every detail of the space was well thought through as it even addressed the bird migration patterns in the area. With the Midwest region being highly trafficked by migratory birds, this may be a design consideration as well. Delving deeper into the sustainable strategies utilized by the FCEC, the facility uses a constructed wastewater wetlands system. This means that the plants and other organisms in the ecosystem are used to filter the buildings blackwater instead of putting it into the city's sewer system.

Overall, this is an excellent example of different design strategies in use in the United States, and how the facility is used to educate visitors on the topic of our environment.

BUILDING STATISTICS

ARCHITECTS: Bohlin Cywinski Jackson

LOCATION: Pittsburgh, Pennsylvania, USA

AREA: 15,570 ft²

COMPLETED: 2018

CERTIFICATION: Living Building Challenge

SUSTAINABLE STRATEGIES:

- Photovoltaic array
- Geothermal heating/cooling
- Continuous daylight dimming controls
- Occupancy sensors
- Reclaimed water system

HISTORY

The Frick Environmental Center, the first municipally-owned, Living Building Challenge targeted project in existence, is a world-class center for experiential environmental education. As a joint venture between the City of Pittsburgh and the Pittsburgh Parks Conservancy, the new Environmental Center serves as a gateway to Frick Park (the city's largest public park at 644-acres) and embodies the "neighborhood to nature" ideal that served as inspiration for its formation more than 80 years ago.

CONTEXT

The Frick Environmental Center encompasses nearly four-acres of development, including restored historic gatehouses and fountain, visitor parking, a service barn, extensive landscaping and ecological restoration, and the new Environmental Center. The building's exterior, clad in locally and sustainably harvested black locust, blends with the surrounding woods, evoking a tree house quality. Inside, full-height wood windows emanate warmth and allow for expansive views of the park. The 15,600-square-foot facility features a public living room and gallery, classrooms for K-12 environmental education programs operated by the Parks Conservancy, and offices, storage, and support space for Parks Conservancy staff.

CONCLUSION

This project is inspiring in the way that it engages users and accomplishes the Living Building Challenge standards. The clients' mission was to educate and engage, and this project incorporates the sustainable strategies discussed as interactive elements in the building and site design to provide users with hands-on environmental education. The Frick Environmental Center essentially serves as a living laboratory for the Pittsburgh community.

BUILDING STATISTICS

ARCHITECTS: SmithGroup

LOCATION: Virginia Beach, Virginia, USA

AREA: 10,518 ft²

COMPLETED: 2015

CERTIFICATIONS: Living Building Challenge
LEED Platinum

SUSTAINABLE STRATEGIES:

- Natural Ventilation
- Daylighting & Shading
- Geothermal Wells
- Solar Power
- Rainwater Collection
- Composting Toilets
- Constructed Wetlands
- Salvaged Materials
- Runoff Mitigation
- Wind Turbines

HISTORY

The Brock Environmental Center is a hub for the Chesapeake Bay Foundation's (CBF) Hampton Roads office, supporting their education, advocacy and restoration initiatives. The Center is designed to express CBF's mission of collaboration to protect one of the nation's most valuable and threatened natural resources—the Chesapeake Bay. CBF aspired to manifest true sustainability, creating a landmark that transcends notions of "doing less harm" towards a reality where architecture can create a positive, regenerative impact on both the environment and society. The Center surpasses LEED achieving net-zero CO_2 emissions, zero waste, and Living Building Challenge certification from the International Living Future Institute.

CONTEXT

The curved building form responds to the nearby shoreline, maximizes daylight, and embraces passive solar principles. Prominent, curving roofs recall forms of the site's wind-swept oaks, the wings of a gull, and the protective shell of an oyster; while also embodying rainwater collection. The material palette references the site's colors and textures – zinc shingles recall fish scales, cypress cladding reinforces the site's colors and horizontality, and metals mimic the glistening Bay. Outdoor spaces allow for a reduction in built area, while connecting occupants to the site. A south-facing porch doubles as outdoor workspace. A prominent, outdoor classroom hosts thousands of students each year.

CONCLUSION

This is one of only a dozen projects to be certified to the Living Building Challenge, achieving net-positive water, waste, and energy while addressing health, materials, and equity. It also achieved LEED Platinum. The building design was inspired by a biophilic design response to the site on Chesapeake Bay, providing a resilient design approach by raising the building to respond to future storm surges. This project broke new ground by becoming the first project in its state to gain approval for potable use of rainwater. Design for wellness is exemplary through avoidance of red list ingredients in materials, along with natural ventilation, daylight, and views.

PROJECT JUSTIFICATION

The project I have defined is important to me because over the course of my academic career and my travels, I have seen how the construction industry makes both positive and negative impacts on the planet. As designers, we tread a fine line to balance the wants and needs of the community and the needs of our environment. In my travels I have witnessed the impact we have made on our planet and how different cities are approaching this problem. I grew up in the Midwest where this type of thinking isn't a priority, but I believe it should be. Therefore, through this project I set out to find a way to change the perspectives and the knowledge on this topic.

In my first year of college, I distinctly remember being introduced to Environmental Design. Having grown up in small town Minnesota, I was never exposed to the idea of designing sustainably. Of course we were taught to turn off the lights, and conserve water, but the concept of solar panels and electric cars was something only west coast people did. Most of the time the concept was scoffed at within my community. Upon coming to college and being shown the incredible innovations that have been made in sustainable technologies and materials and the kind of impact they have made, my perspective completely changed. I have always had an innate desire to learn and understand how things work, so throughout my undergrad experience I have sought opportunities to find out more.

This hunger for knowledge has led me to pursue research and travel opportunities which exposed me to the sustainable design industry. These experiences reminded me of where I came from and inspired me to change the perceptions surrounding this topic back home in the Midwest.

Over the years I have come to learn that a major obstacle for sustainability in the Midwest is due to its bitterly cold and tempermental climate. My research solidified this, so my topic evolved into not only providing environmental education in the Midwest, but how to implement these sustainable strategies into cold climates such as this one.

If communities provided more education on our individual impact and how our daily decisions can benefit our environment, I truly believe that we can make the world a better place. Communities such as my own could adopt this way of thinking and create positive change at home and within their community as a whole. Design professionals, contractors, and everyone in between could see and understand the impact they have and see how these technologies are the way of the future.

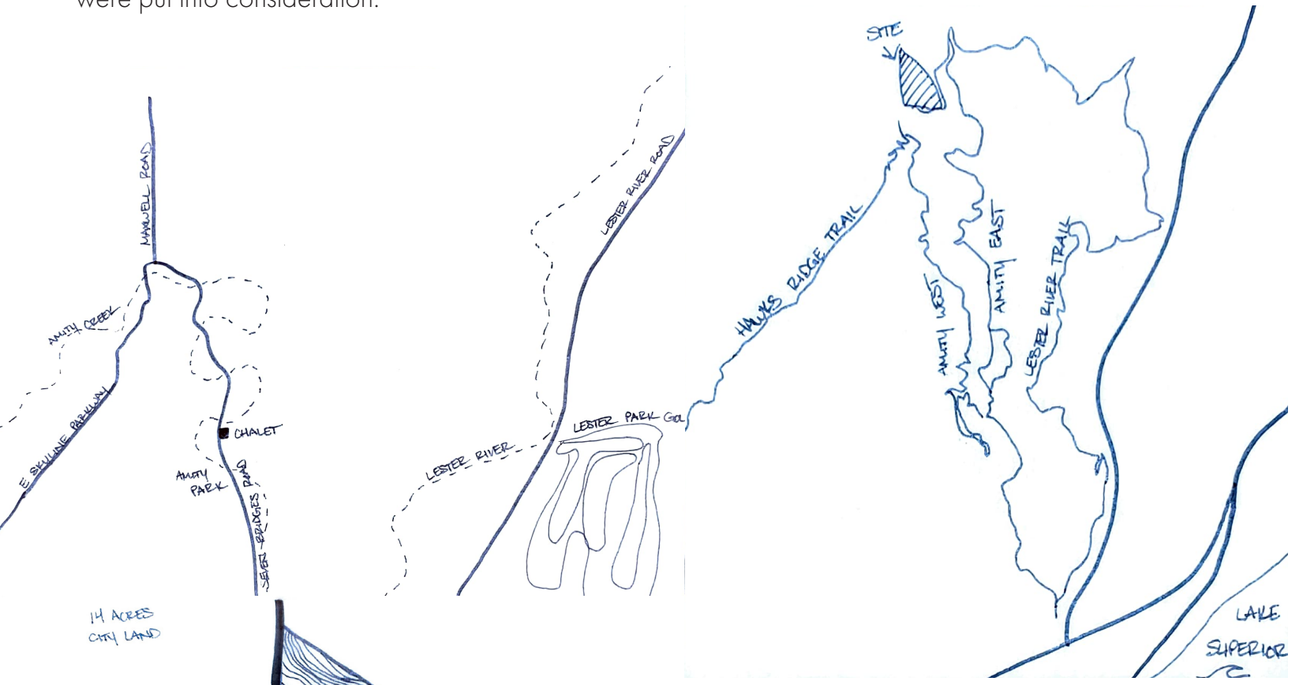
I strongly believe that sustainable design is the way forward, and despite the challenges of climate, we are capable of overcoming the cold and innovating for the future of our planet. It all starts with us. The climate we experience in the future depends on our decisions now.

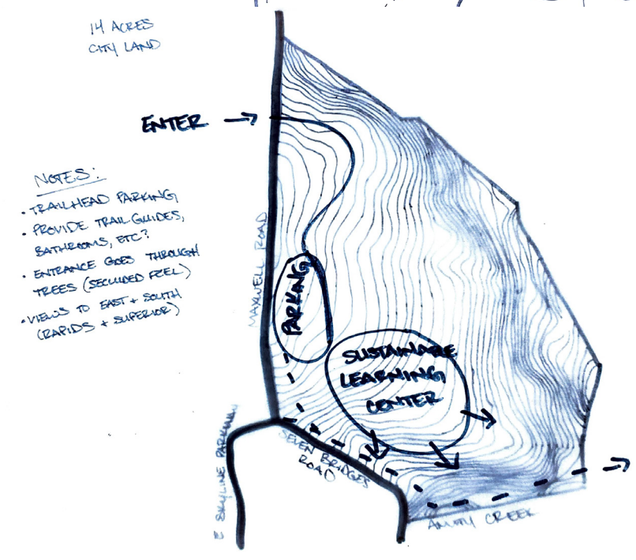
THE PROGRAM

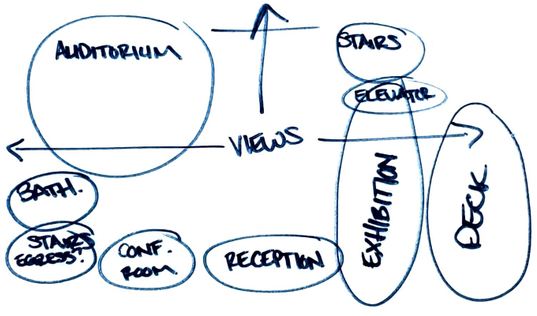
DESIGN PROCESS

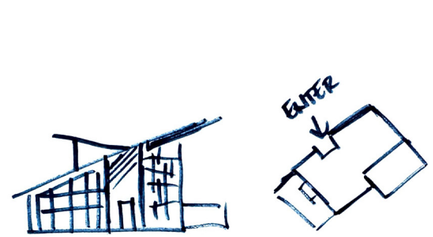
SKETCHES

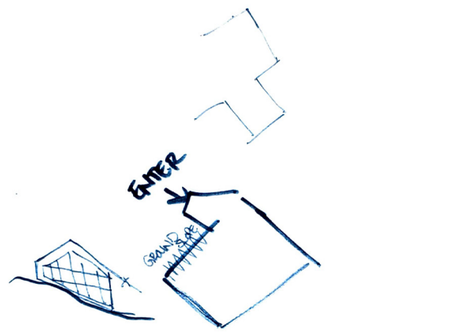
The primary process of design generation was executed through sketches and design ideation. The program for the Duluth Sustainable Design Learning Center was derived from iterative overlays of trace paper over a broader existing site plan. Views, daylighting, access, circulation, program, and seasons were put into consideration.

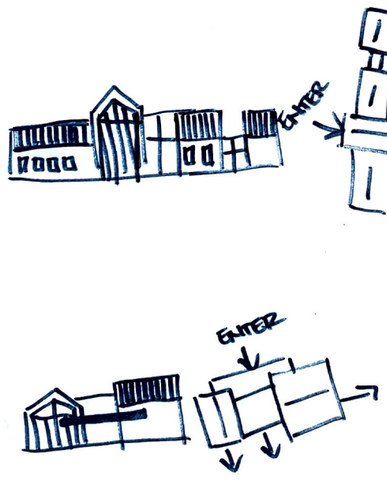


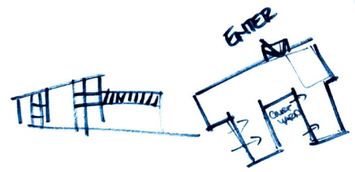


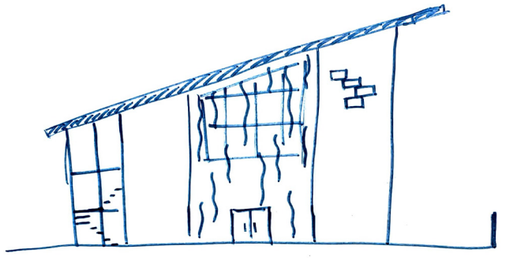


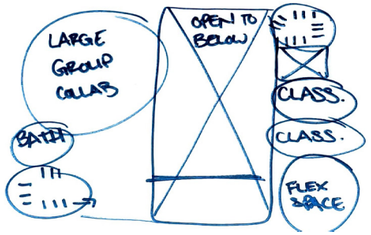


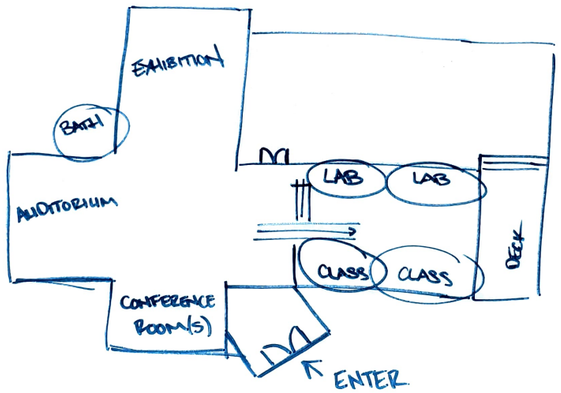












DESIGN PROCESS

USER ANALYSIS

The user analysis is vital in understanding how the facility will be used and sustained. The design profession demographic will be the main driver for continued knowledge and innovation within the center and the region. Conferences, meetings, trade shows and more could be conducted here, and design professionals can use this space to supplement their continuing education hours.

DESIGNERS

The builders and contractors are a large target group because a large issue in the colder regions of the world is that builders aren't informed on how to install these new technologies, and aren't familiar with how they work. By providing workshops and education for these trades, these materials and strategies can be more readily implemented.

BUILDERS

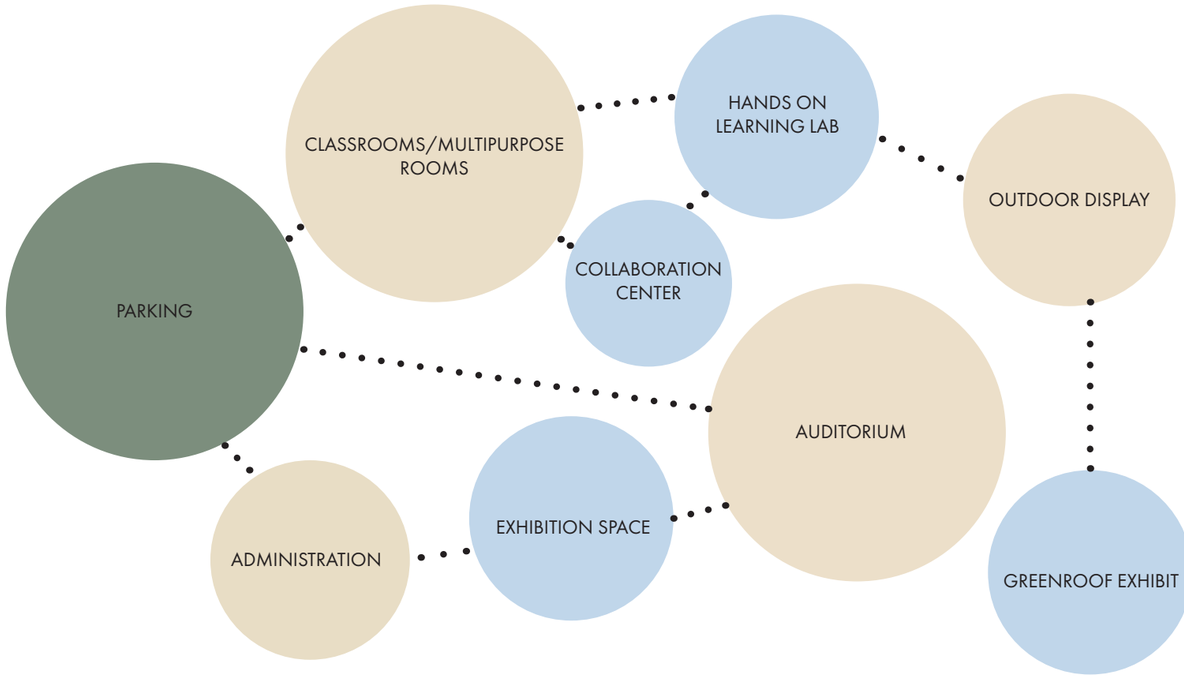
Students ranging from K-12 and beyond into college can benefit from this facility due to the lack of environmental education in our society. Students could partake in workshops, field trips, and more to learn about the landscape of Duluth, and how electricity works. High school students could attend career fairs to learn about trades in design and construction, or potentially the environmental sciences. College students at local and regional universities could visit the facility to conduct research - the possibilities are endless.

STUDENTS

Lastly, the design must provide a beneficial impact to the community. This is the people who aren't in education or in the construction industry who would still enjoy learning more about our environment, how buildings go together, and how they can make an impact.

COMMUNITY

PROGRAM DEVELOPMENT



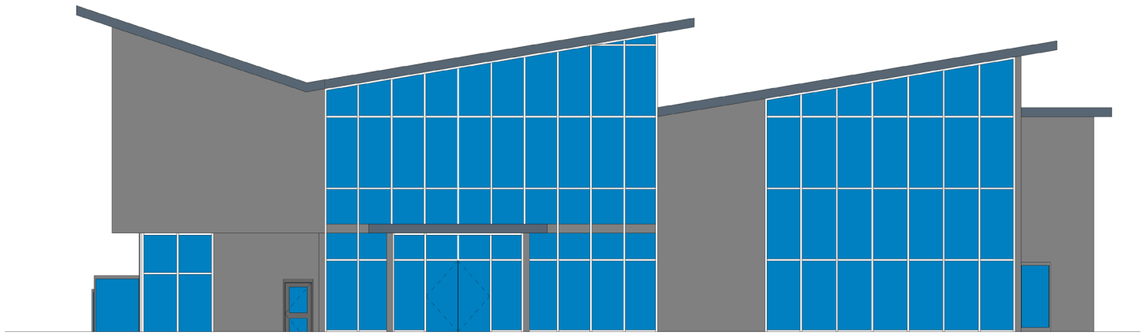
LEGEND

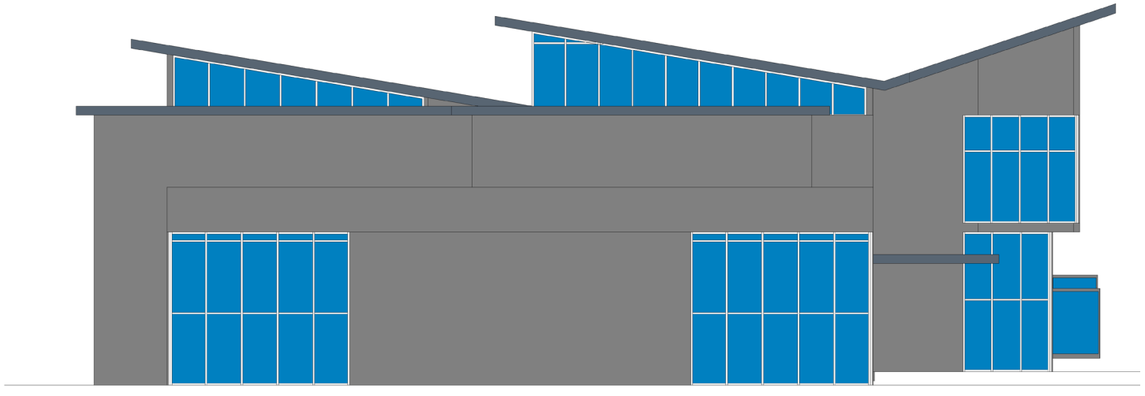
- Utilities
- Visual/Auditory Learning
- Visual/Hands On Learning

DESIGN PROCESS

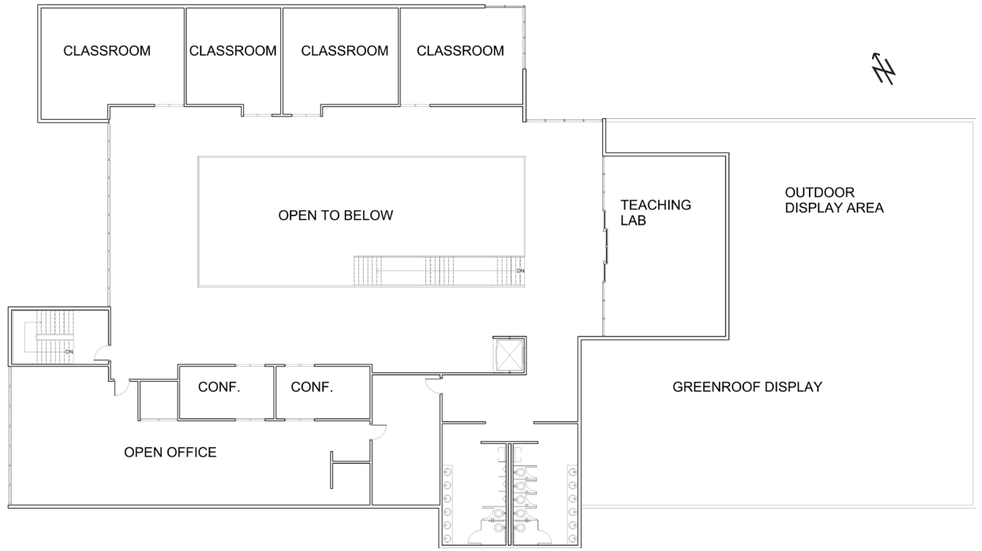
PRELIMINARY MODELING

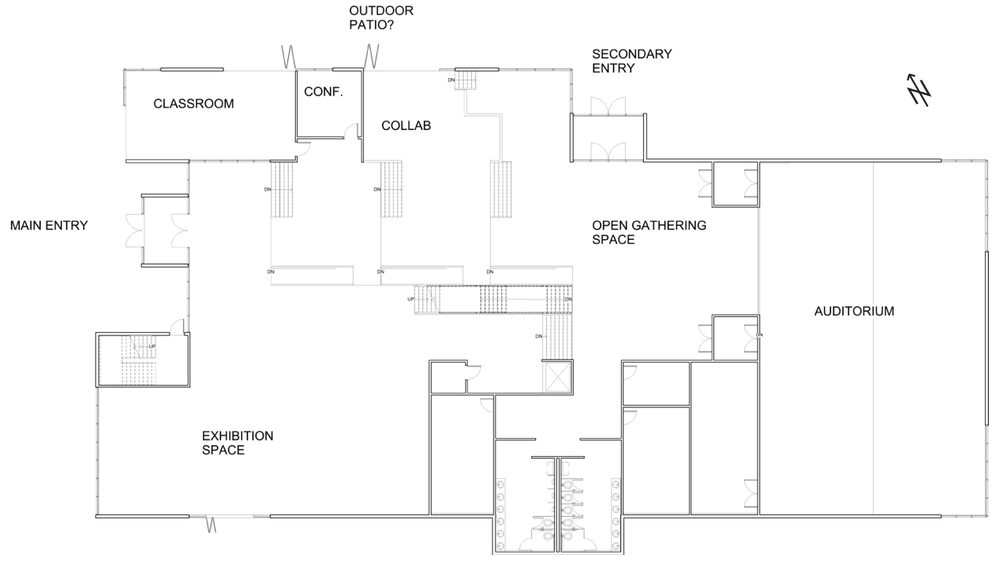
The included images are representations of the project progression at the mid-semester review. At this point the design program is organized, but the building lacks the materiality and overall character. This shows the groundwork for the final design solution.





PRELIMINARY FLOOR PLANS

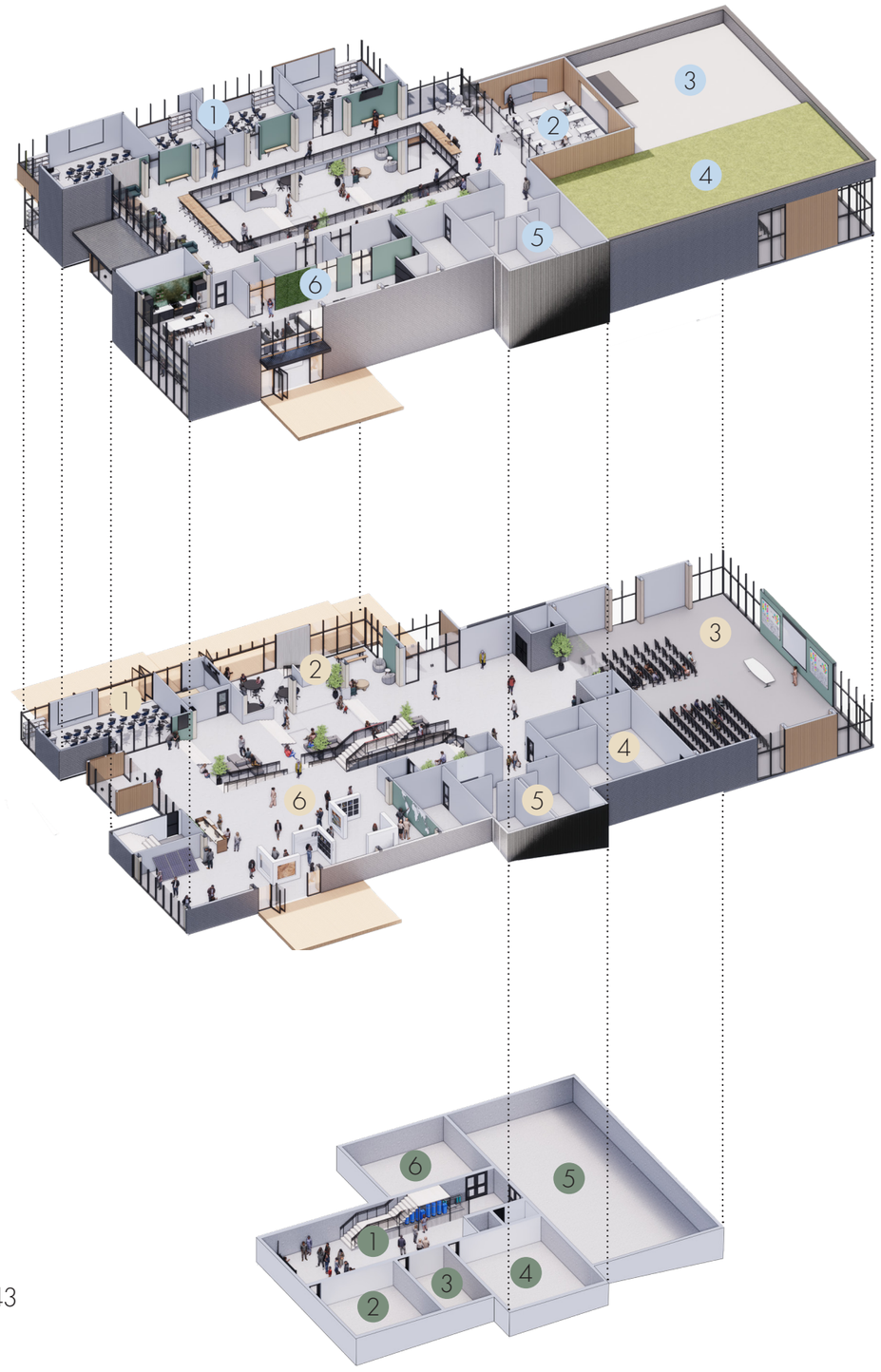




DESIGN SOLUTION

DESIGN SOLUTION

PROGRAM OVERVIEW



LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition
4. Green Roof
5. Restrooms
6. Open Office

LEVEL 1: COLLABORATION

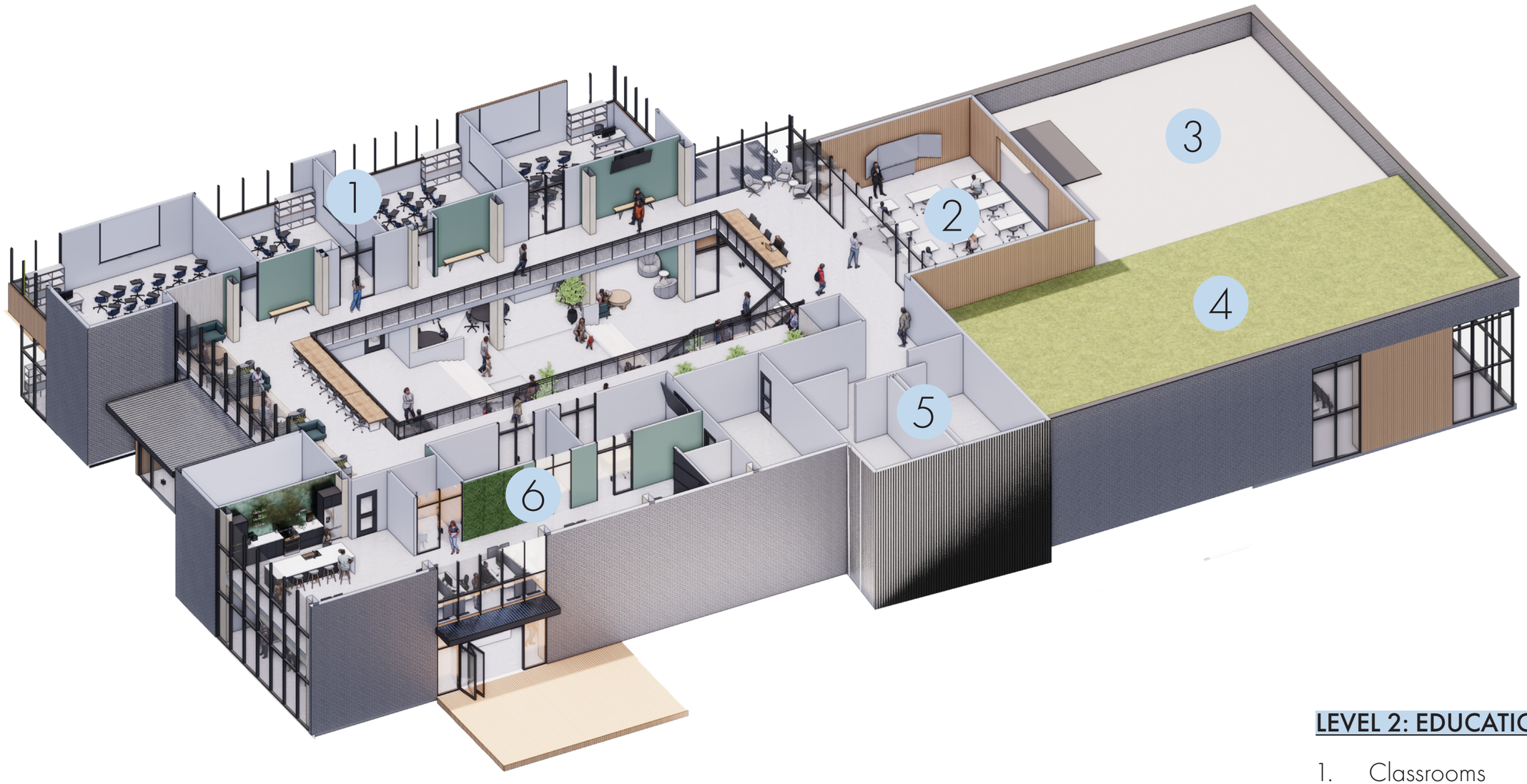
1. Large Classroom
2. Collaboration Center
3. Auditorium
4. Storage
5. Restrooms
6. Sustainable Design Exhibition

LOWER LEVEL: MECHANICAL

1. Mechanical Systems Teaching Lab
2. Backup Power
3. Custodial Storage
4. Water Filtration
5. Mechanical + Storage
6. Rainwater Collection Cistern

DESIGN SOLUTION

LEVEL 2



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DESIGN SOLUTION

LEVEL 1

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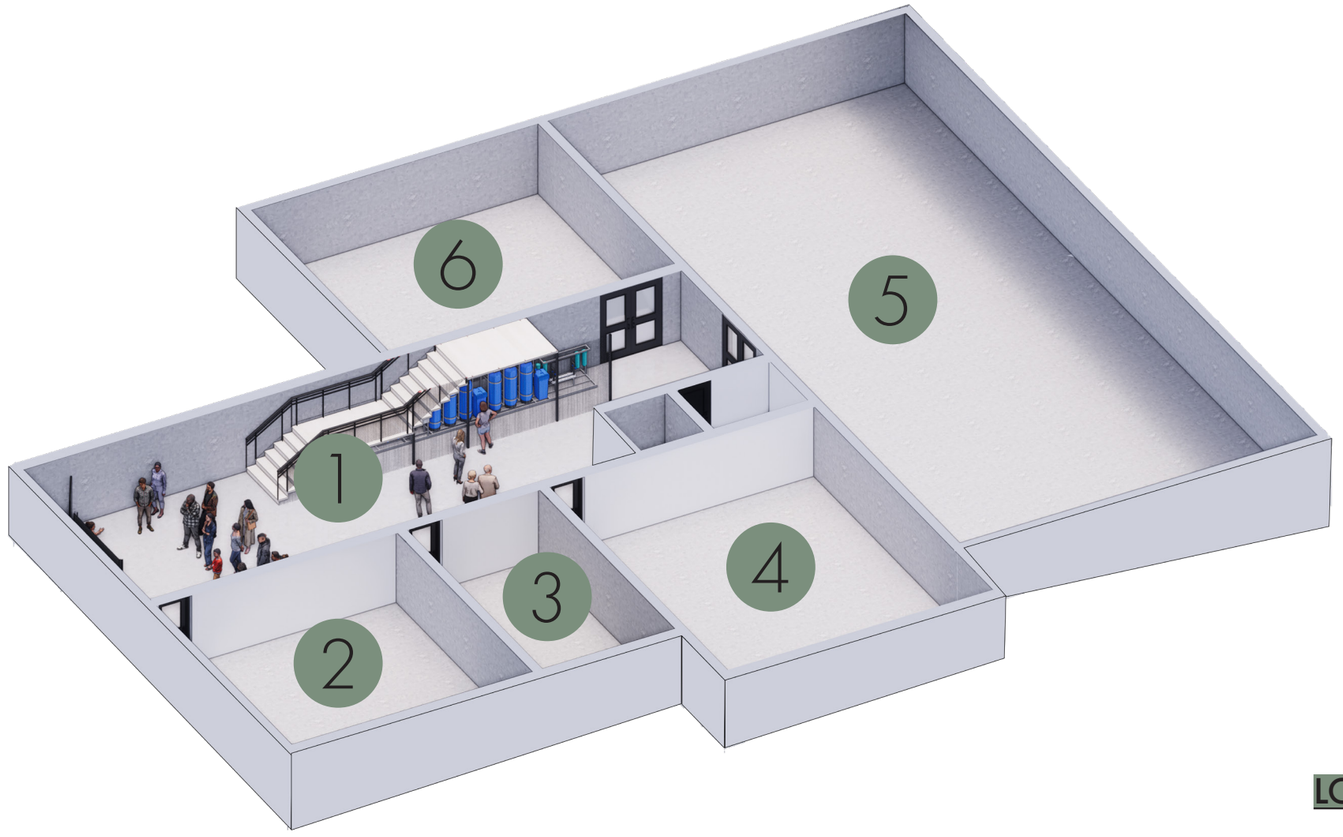
DESIGN SOLUTION

LOWER LEVEL



LOWER LEVEL: MECHANICAL

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DESIGN SOLUTION

MAIN ATRIUM

COLLABORATION CENTER

DESIGN SOLUTION

FLEXIBLE CLASSROOM & MECHANICAL LEARNING LAB

AUDITORIUM & SUSTAINABLE DESIGN EXHIBITION

DESIGN SOLUTION

UPPER LEVEL ATRIUM & LEARNING LAB

ADMINISTRATIVE OFFICES & BREAK ROOM

DESIGN SOLUTION

PERFORMANCE ANALYSIS: SITE RESPONSE

INITIAL PROJECT GOALS

SUSTAINABLE IMPLEMENTATION:

As stated in the design proposal, the project aims to embody bioclimatic design in how it responds to the environment. To do this, various sustainable strategies and methods were employed including the following.

ENERGY + POWER

ELECTROCHROMIC GLASS maintains optimal indoor lighting conditions and allows users to change the opacity.

ROOM OCCUPANCY SENSORS allows the building to maintain energy efficient lighting, heating and cooling.

The use of **DAYLIGHTING** brings sunlight into spaces without the use of fixtures.

HEATING + COOLING

PASSIVE COOLING is accomplished through the use of operable windows.

In winter months, **BIOMASS SPACE HEATING** is utilized by burning locally sourced wood pellets.

A **GREEN ROOF** helps reduce energy use by cooling roofs and providing shading, thermal mass and insulation.

GOALS RESPONSE

RESOURCE MANAGEMENT

REFORESTATION EFFORTS include forest maintenance and planting trees to replace those removed during construction.

A **RAINWATER COLLECTION** system located on the roof provides non-potable water for irrigation and plumbing.

WATER EFFICIENCY is achieved through low-flow plumbing fixtures.

MATERIAL SELECTION

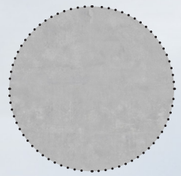
LOCALLY SOURCED MATERIALS such as wood harvested and processed in Two Harbors, Minnesota reduces transportation costs.

NO RED LIST MATERIALS OR CHEMICALS are used to improve the health of the building and its occupants.

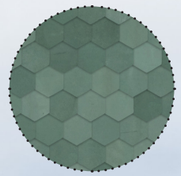
WOOD PLANK

GREY BRICK

FIR CLT



POLISHED CONCRETE

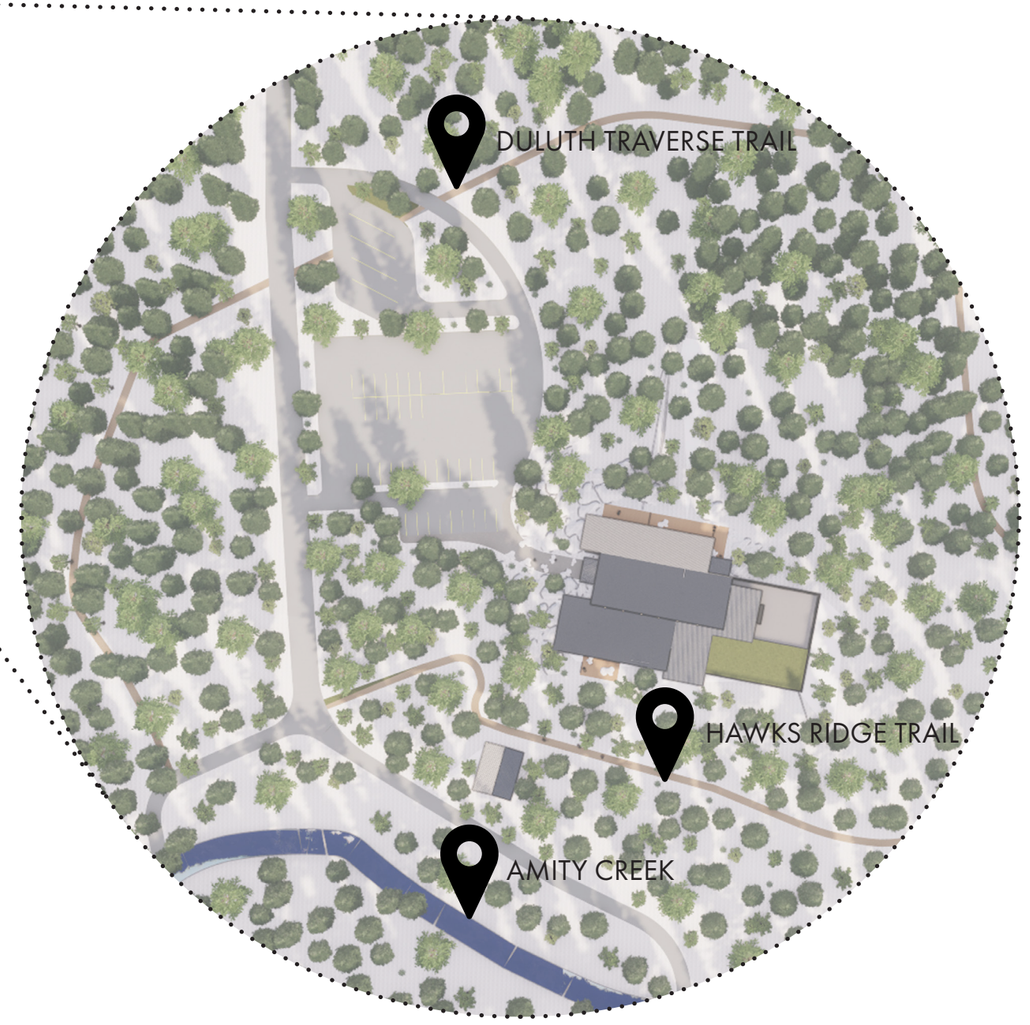


PATINATED TILE

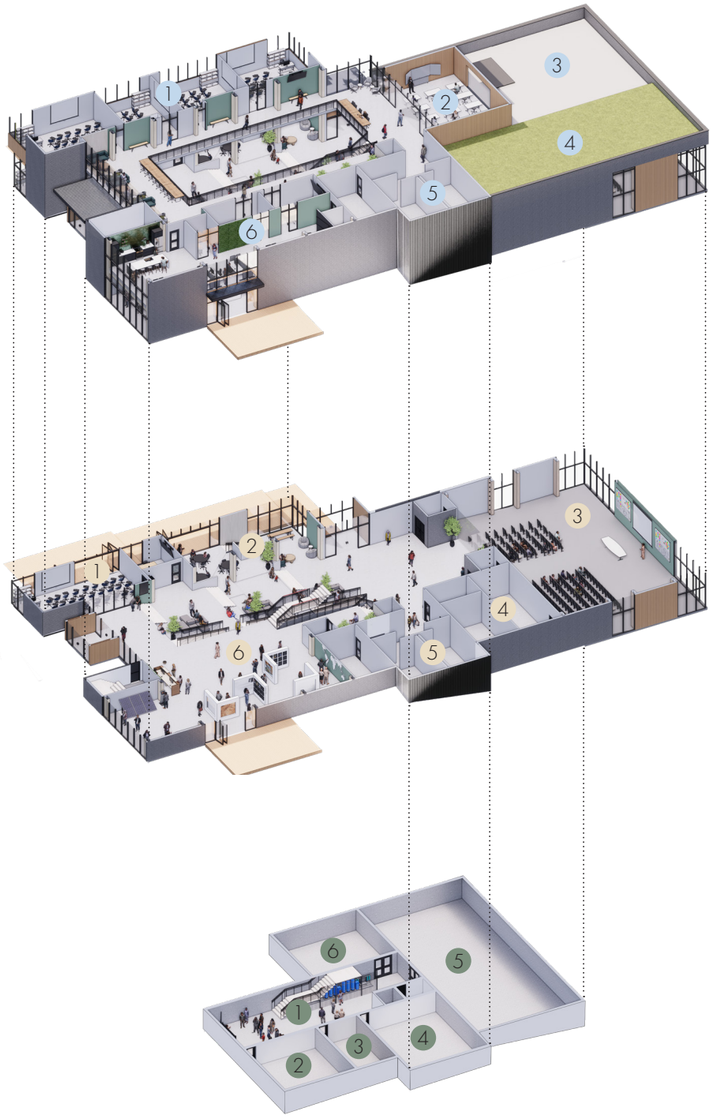
PERFORMANCE ANALYSIS: SITE RESPONSE

SITE SELECTION:

The Duluth Sustainable Design Learning Center responds to the surrounding forests, parks, and trails by providing a warming shelter and educational outpost for visitors right along major paths of travel. The forest is parted to allow for the facility, yet remains immersive to help shade and protect the area and remaing true to the concept of bioclimatic design. Visitors are only steps away from enjoying the Amity Creek, the extensive trail systems, the Hawk Ridge Observatory and more, providing a wonderful opportunity for the community.



PERFORMANCE ANALYSIS: RESEARCH RESPONSE



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PRECEDENT IMPACT:

The project responds to the precedent research through its program and form. As stated in the initial research, sustainable methods and materials are becoming more common in the U.S, but implementation has been painfully slow in cold climates due to the drastic changes in weather each year. Additionally, the general population lacks an understanding of sustainability, conservation, and the impact of their daily decisions on our environment. Cold climates face various challenges when implementing sustainable strategies and materials, so the response to these issues brings the focus of this project into the public eye.

The following describes the impact made by the initial case studies:

1. Solving the issue of education and exposure is carried out in the Sustainable Design Exhibition. This space features information on the evolution of sustainability and the rise of new technologies.

2. The Ford Calumet Environmental Center (FCEC) uses a constructed wastewater wetlands system. This means that the plants and other organisms in the ecosystem are used to filter the buildings black water instead of putting it into the city's sewer system. This became a valuable consideration for this project. Additionally, the building utilizes nail laminated timber (NLT) which is very uncommon in the United States. This reaffirmed the viability of using mass timber in this typology.

3. The Frick Environmental Center (FCE) is inspiring in the way that it engages users and accomplishes the Living Building Challenge standards. This project incorporates various sustainable strategies as interactive elements in the building and site design to provide users with hands-on environmental education. By doing this, the site creates learning opportunities for various ages and abilities, and the sentiment played a vital role in the development of this project.

4. Lastly, the Brock Environmental Center (BEC) is one of only a dozen projects to be certified to the Living Building Challenge, achieving net-positive water, waste, and energy while addressing health, materials, and equity. It also achieved LEED Platinum. Design for wellness is exemplary through avoidance of red list ingredients in materials, along with natural ventilation, daylight, and views. All of which play a key part in creating healthy and innovative buildings. The focus on wellness regarding red list materials, daylighting, ventilation, and the human experience was something carefully regarded for this project.

PERFORMANCE ANALYSIS: GOALS RESPONSE

INITIAL PROJECT GOALS

1

INTEGRATE INNOVATIVE SUSTAINABLE STRATEGIES:

Incorporate strategies and materials that can showcase the capabilities of current green building technologies.

2

EMPHASIZE OUR IMPACT ON THE ENVIRONMENT:

Display the impacts of construction on our environment by the numbers, and show the importance of conservation.

3

EDUCATE ON SUSTAINABILITY IN THE MIDWEST:

Provide educational spaces, signage, and programming to encourage future implementation within the community.

4

CREATE AN INCLUSIVE LEARNING ENVIRONMENT:

Implementing different learning styles and spaces allows for users of all abilities and disabilities to participate in sustainable design. These include auditory, visual aids, and hands-on learning opportunities

GOALS RESPONSE

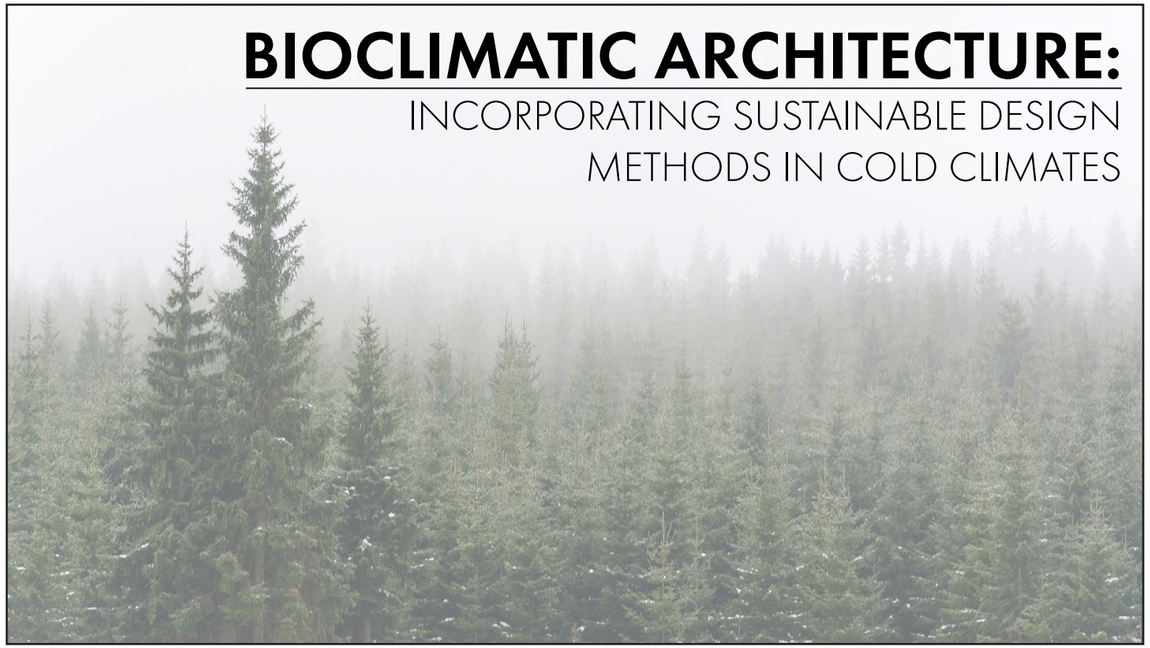
1 In depth research and precedent history informed the narrative for the final solution. The Duluth Sustainable Design Learning Center is a place for these technologies to be shared and archived.

2 The impact of construction on our environment is shown and explained through the informative dashboards, available throughout the facility. This space will evolve and grow over time with innovations in technology.

3 Classrooms, transparent design, and educational programming allow visitors to learn about sustainability in the region - Inspiring visitors to implement this knowledge in their lives resulting in positive change.

4 The use of hands on learning labs, visual and interactive displays and the transparency of mechanical systems throughout the facility makes for an educational experience for all abilities and disabilities.

PRESENTATION SLIDES



SLIDE 01

SLIDE 02

SLIDE 03

SLIDE 04

GOALS

1
GREEN CERTIFICATIONS

Explore the use of Green Building Certifications in the Pacific Northwest including:

- LEED
- WELL Building Standard
- Living Building Challenge
- Fitwel

2
MASS TIMBER

Research the uses and limitations of Mass Timber products - specifically the use of Cross-Laminated Timber (CLT)

3
INCENTIVIZED SUSTAINABILITY

Uncover the local and regional incentives for sustainable strategies and how they impact the construction process.

Incentives include:

- Solar
- Mass Timber
- Green Building Standards
- 2030 Challenge

SLIDE 05

GREEN CERTIFICATIONS

LEED:

Focuses on creating healthy & efficient buildings.

Rated Topics Include:

- Location & Transportation
- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Enivronmental Quality

WELL BUILDING STANDARD:

Focuses on creating a built environment that improves the nutrition, fitness, mood, sleep and performance of its occupants.

Rated Topics Include:

- Air
- Water
- Nourishment
- Light
- Fitness
- Comfort
- Mind

LIVING BUILDING CHALLENGE:

Focuses on creating buildings that are regenerative, self sufficient, and remain within the resource limits of their site.

Rated Topics Include:

- Place
- Water
- Energy
- Health + Happiness
- Materials
- Equity
- Beauty

FITWEL:

Focuses on the human experience.

Rated Topics Include:

- Walkability & Transit Incentives
- Bike Parking
- Restorative Gardens
- Indoor Air & Water Quality
- Daylighting/Views
- Active Workstations
- Hygiene Signage
- Lactation Rooms
- Exercise Rooms
- Health Programming
- Healthy Food Incentives & Vending

SLIDE 06

MASS TIMBER

CROSS-LAMINATED TIMBER:

Originally developed in Austria

- Uses dimensioned lumber from small trees harvested during forest thinning.
- Strong enough to replace concrete and steel up to 12 stories
- Lighter & more flexible
- Can withstand earthquakes and storms
- Fire-resistant due to charring
- Non-toxic manufacturing processes
- Insulation properties
- Absorbs carbon
- Reduces carbon footprint of a building
- Customized for each project

SLIDE 07

MASS TIMBER

MARKET FOR CLT:

- Mixed Use
- Multi-Family
- Offices
- Tiny Homes
- Military Housing
- Disaster Housing
- Modular Construction

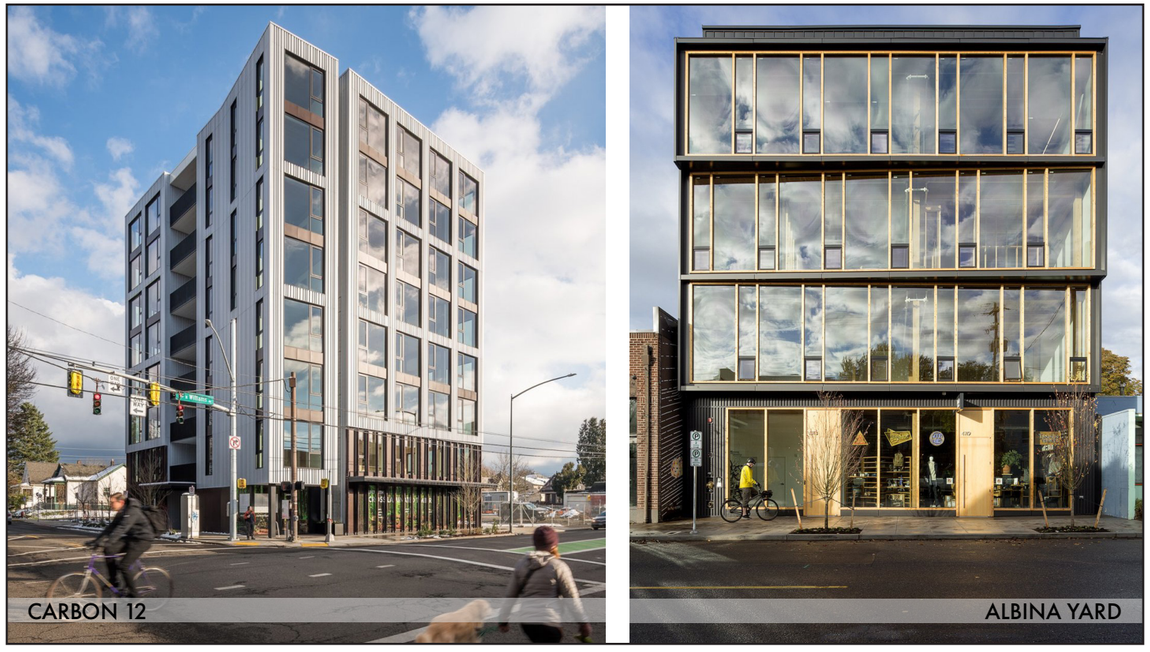
TYPES OF TIMBER:

- Glulam Beams
- Parallel Strand Lumber
- Laminated Strand Lumber
- Laminated Veneer Lumber
- I-Joists
- Dowel-Laminated Timber
- Nail-Laminated Timber

SLIDE 08

SLIDE 09

SLIDE 10

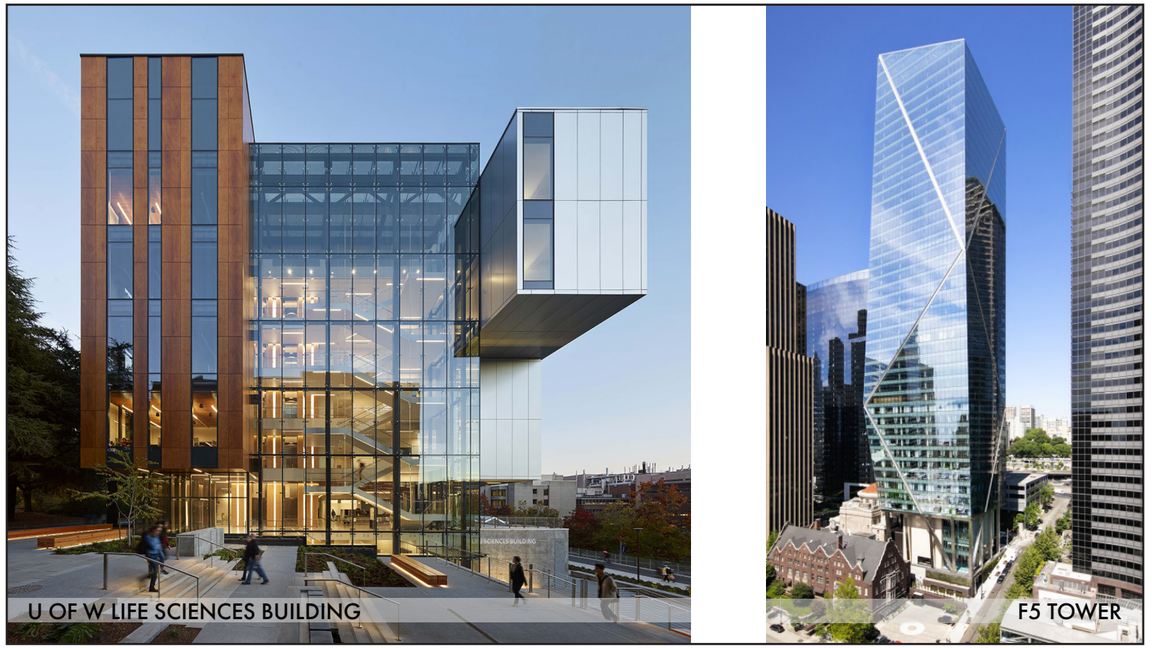


SLIDE 11

SLIDE 12

PRESENTATION SLIDES

SLIDE 13



SLIDE 14

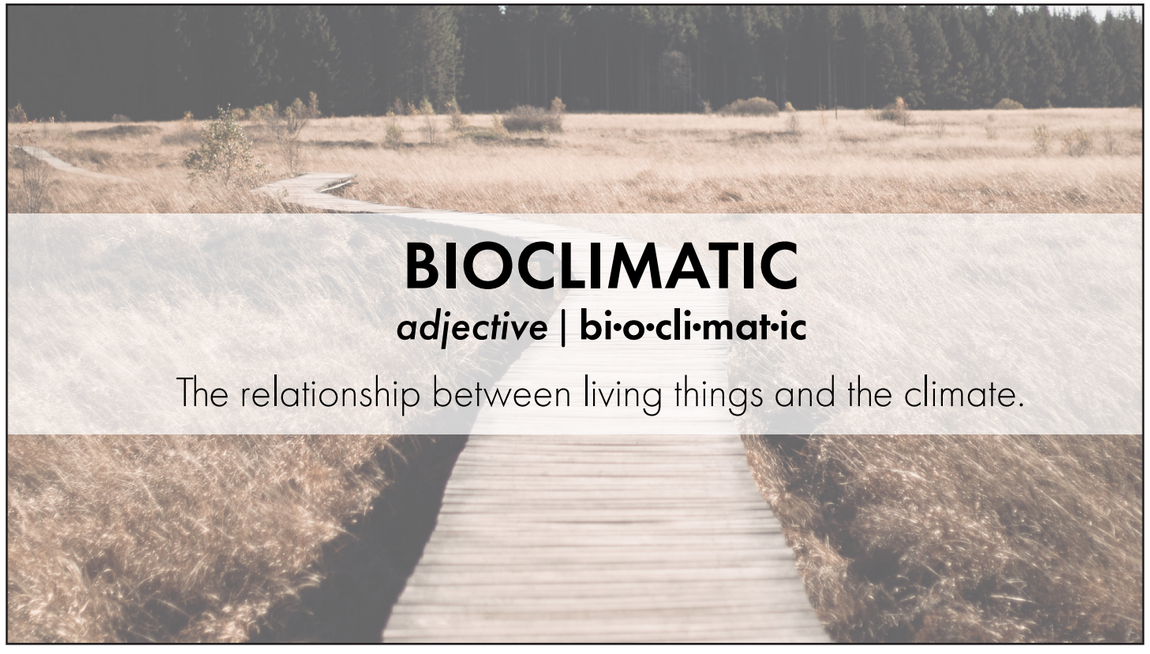
SLIDE 15

SLIDE 16

PRESENTATION SLIDES

SLIDE 17

SLIDE 18



SLIDE 19

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SLIDE 24

PRESENTATION SLIDES

SLIDE 25

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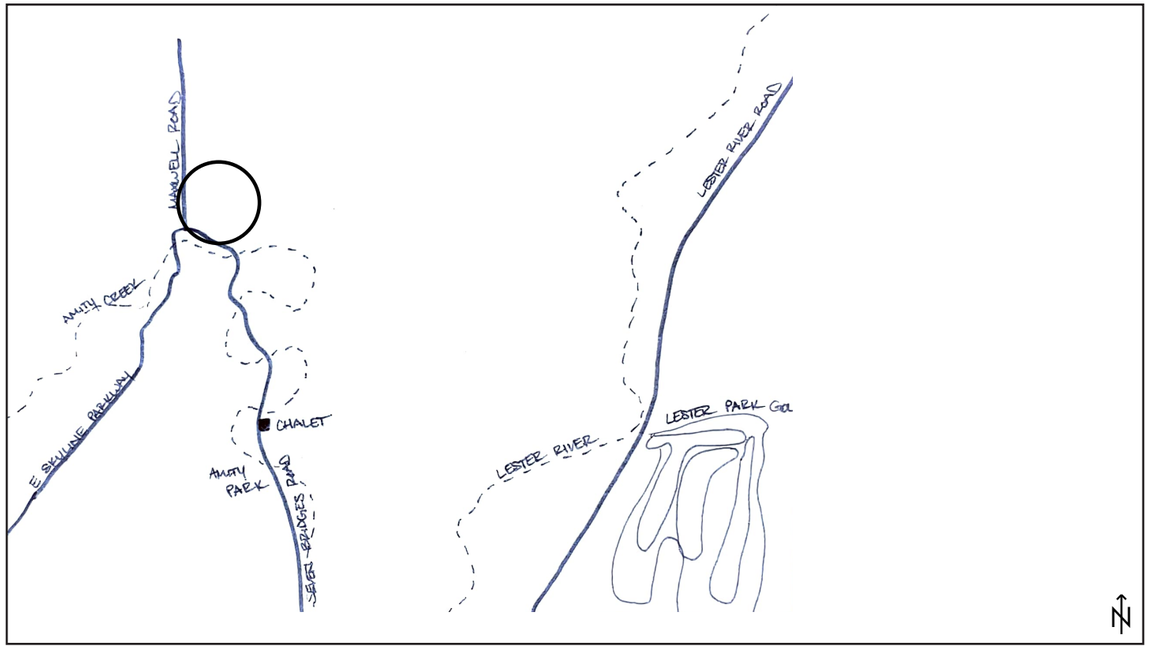
SLIDE 28

PRESENTATION SLIDES

SLIDE 29

SLIDE 30



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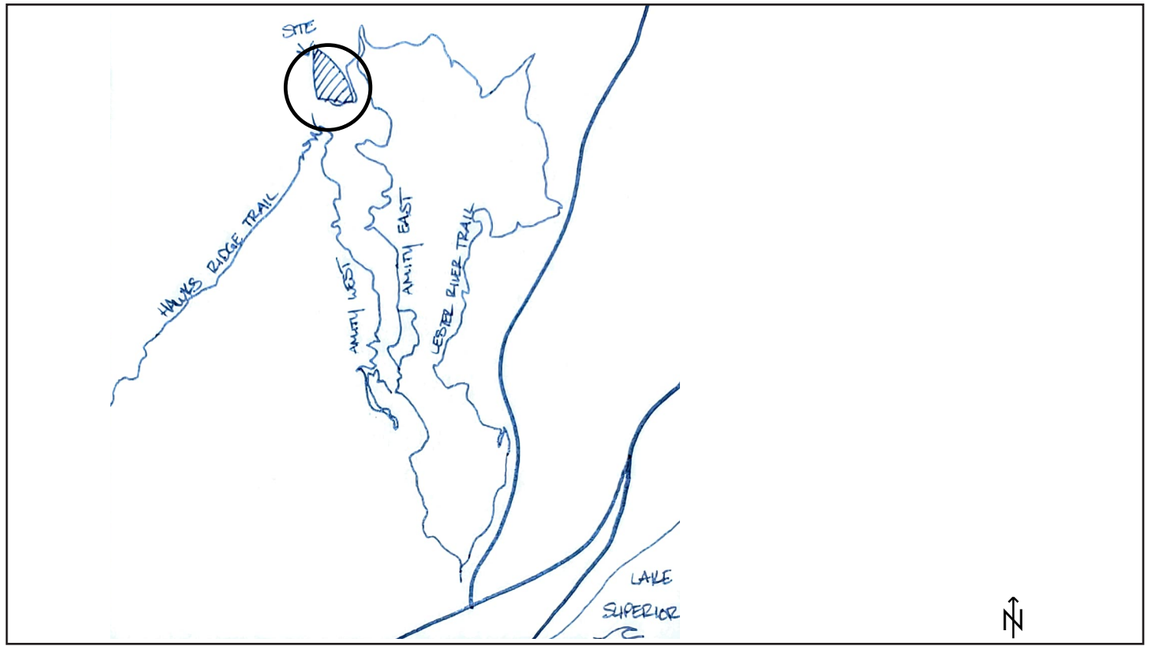
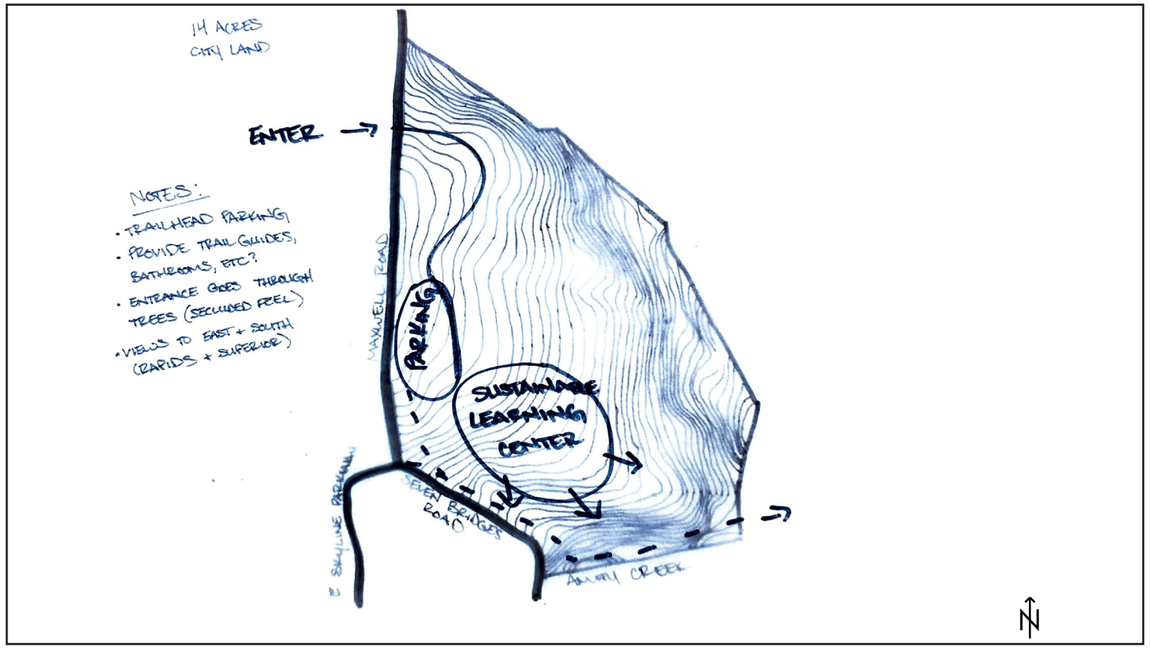


SLIDE 32

PRESENTATION SLIDES



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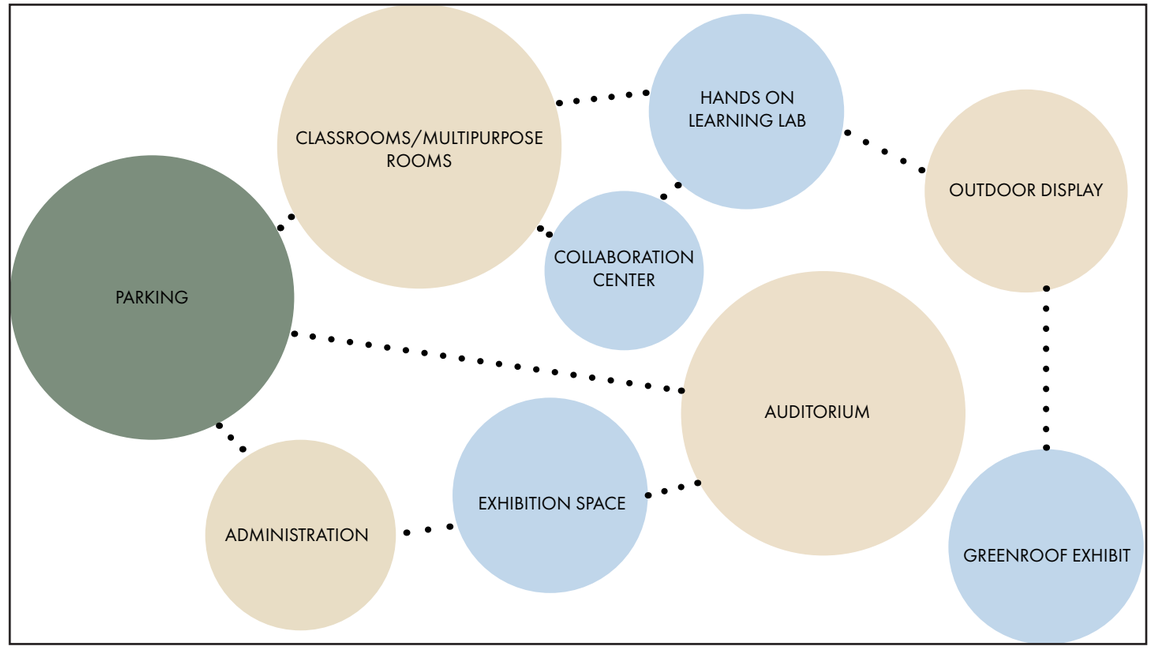

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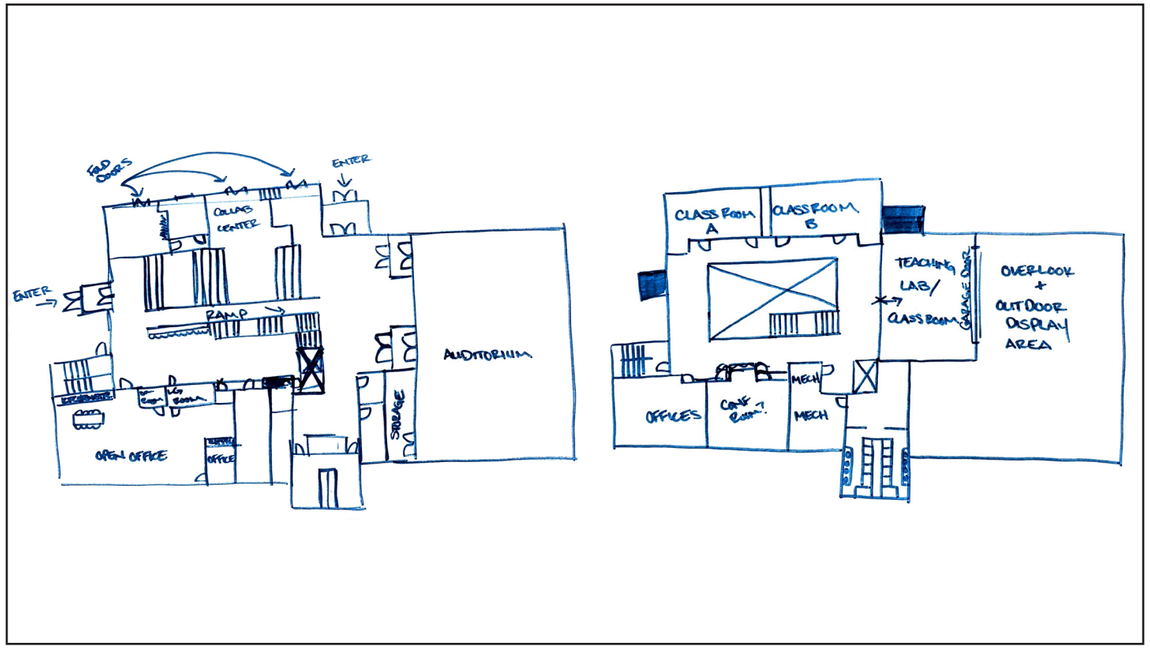
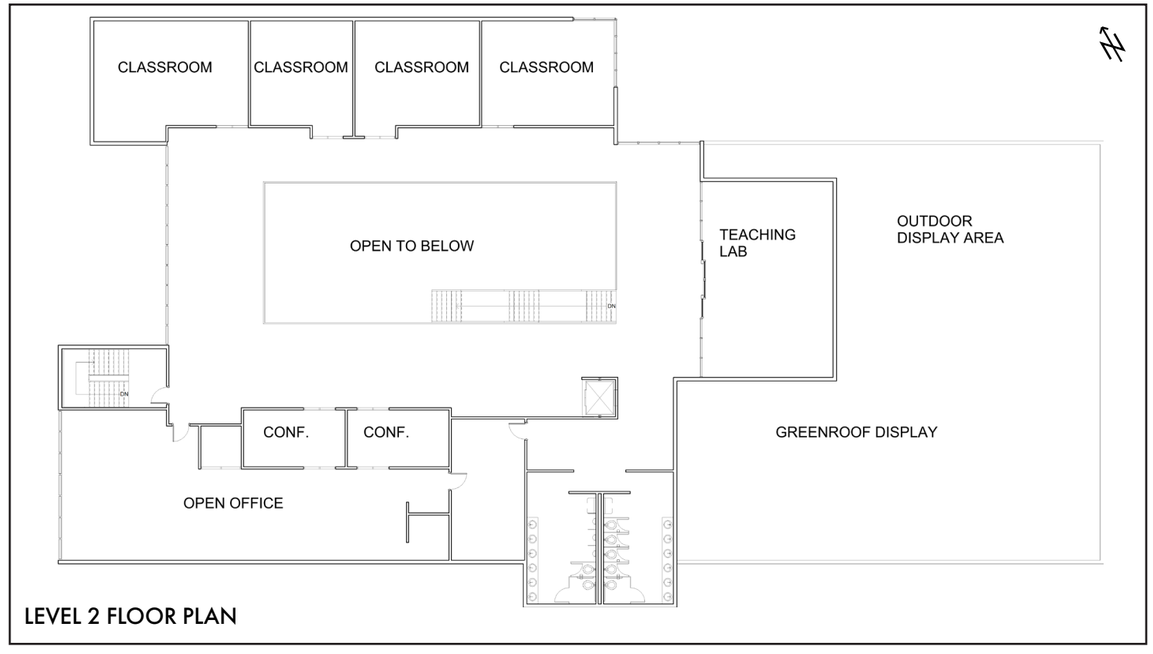
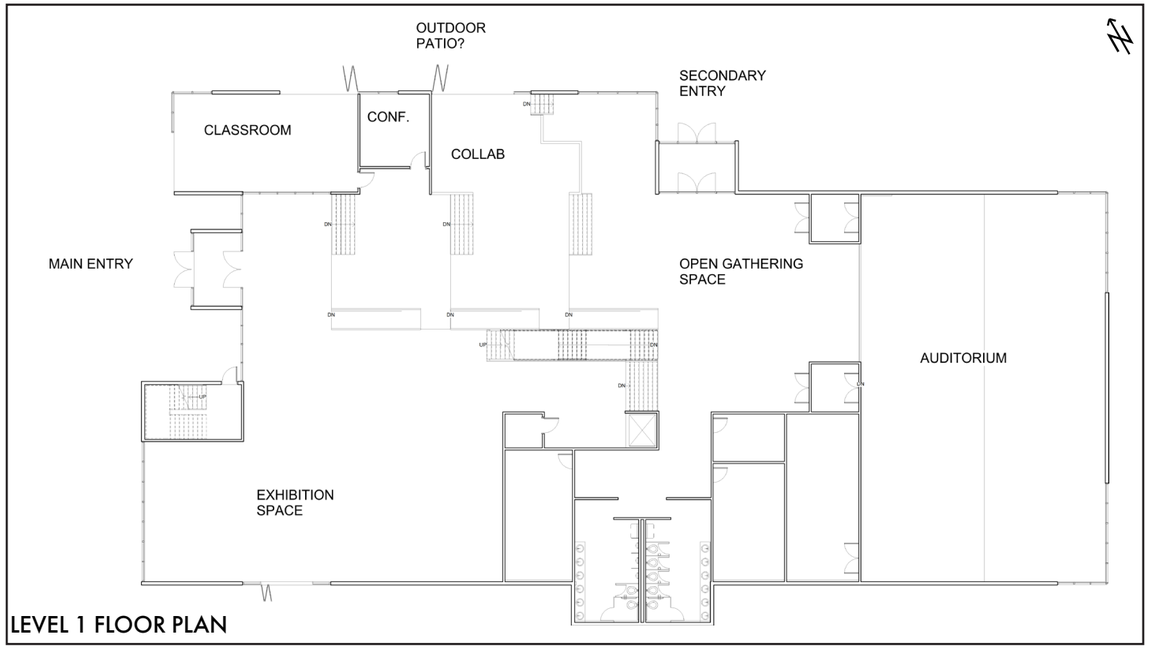


SLIDE 35



SLIDE 36

PRESENTATION SLIDES



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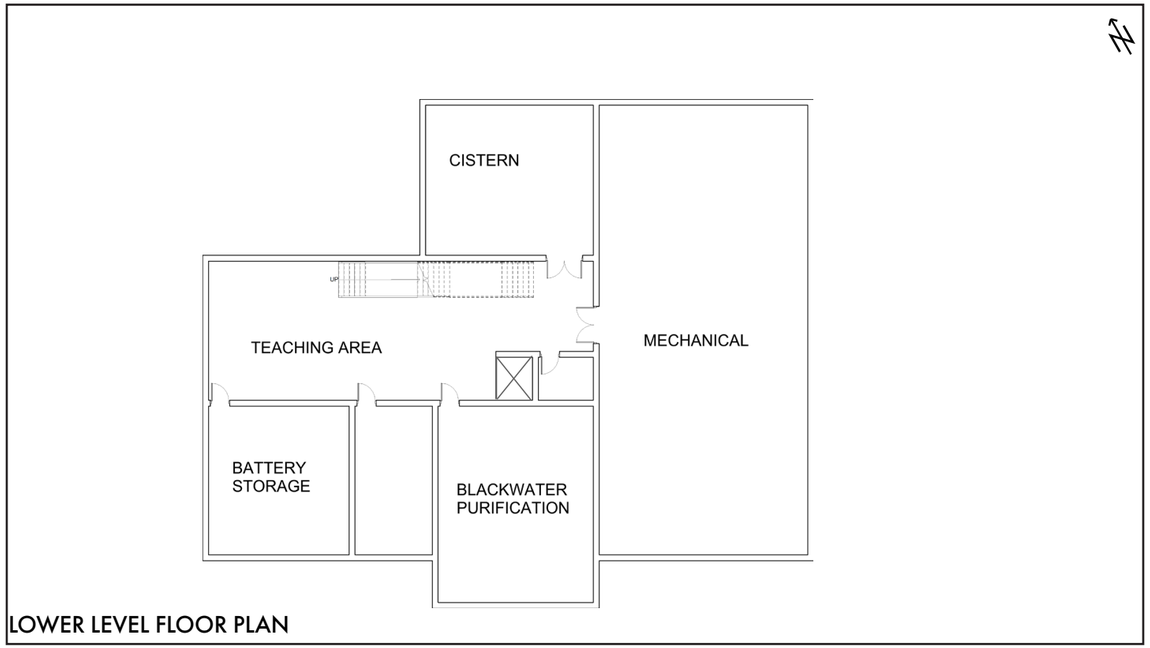


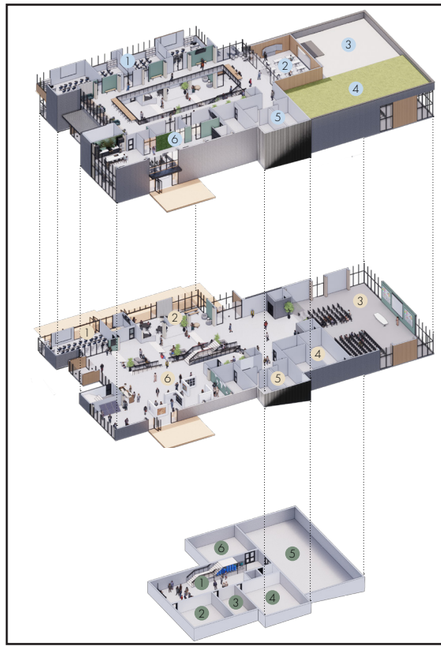
SLIDE 38

SLIDE 39

SLIDE 40

PRESENTATION SLIDES

SLIDE 41



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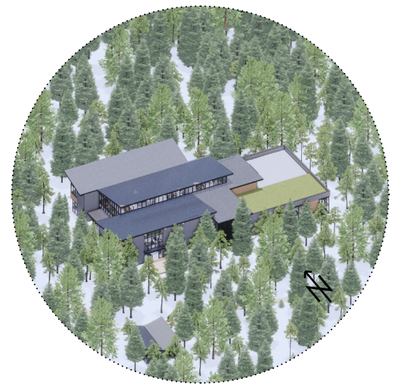

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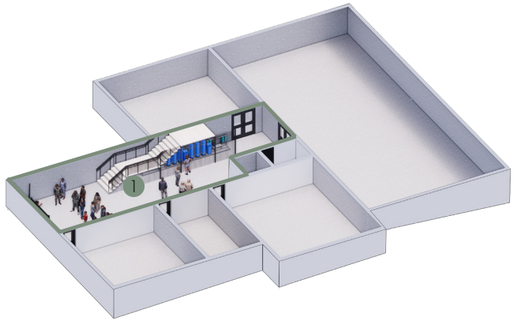

LOWER LEVEL: MECHANICAL

1. Mechanical Systems Teaching Lab

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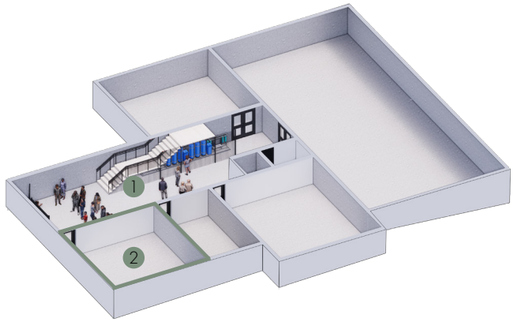
SLIDE 44

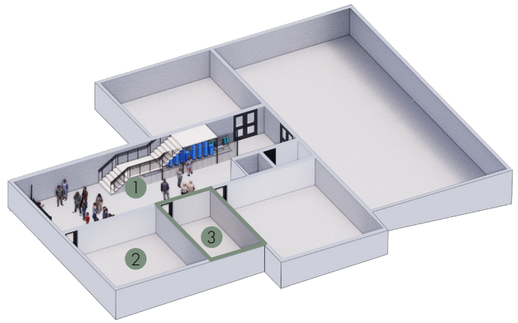
PRESENTATION SLIDES



LOWER LEVEL: MECHANICAL

1. Mechanical Systems Teaching Lab
2. Backup Power + Battery Storage

SLIDE 45



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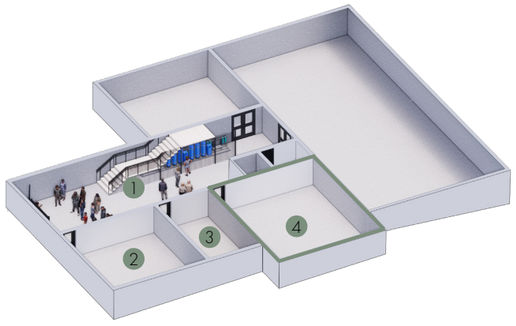
SLIDE 46



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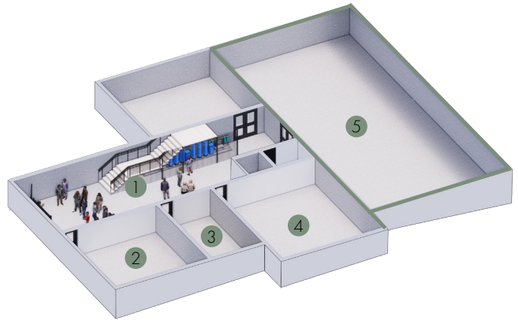
SLIDE 47



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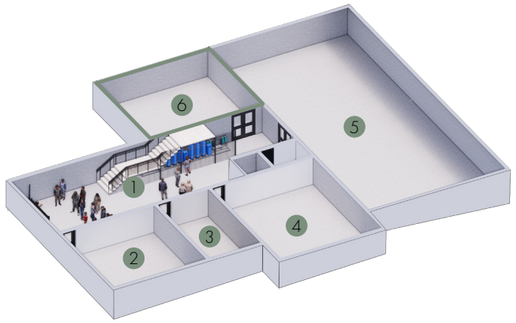
SLIDE 48

PRESENTATION SLIDES



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LEVEL 1: COLLABORATION

SLIDE 50

ENTRY COMMONS & ATRIUM

SLIDE 51

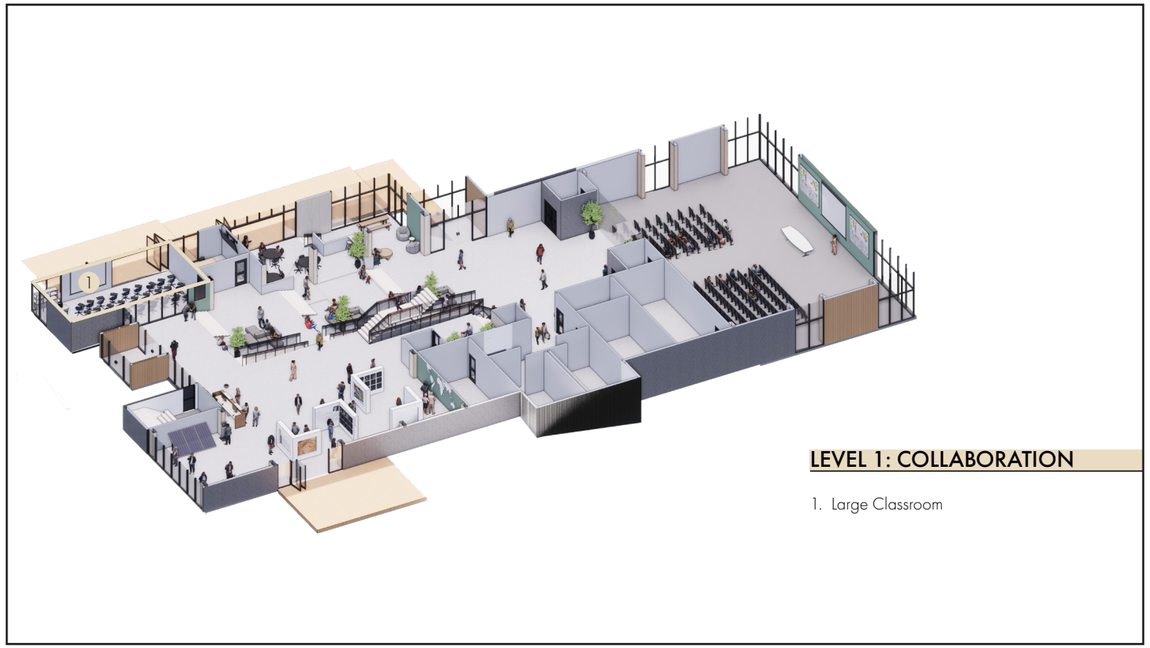
COMMONS & ATRIUM

SLIDE 52

PRESENTATION SLIDES

SLIDE 53

SLIDE 55



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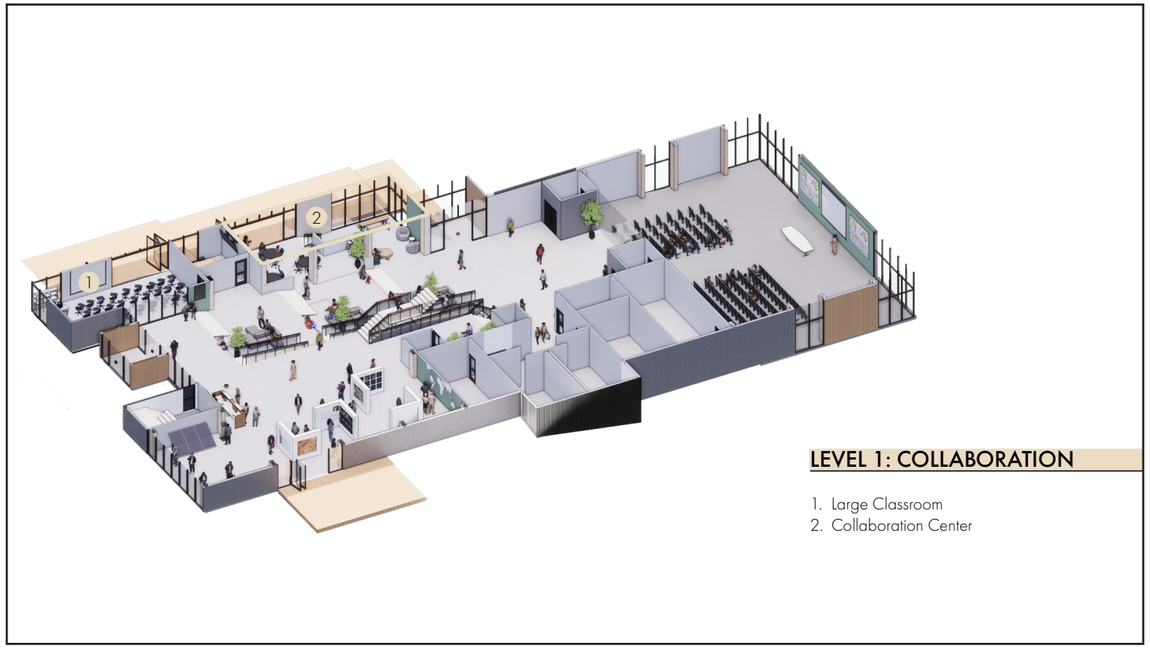
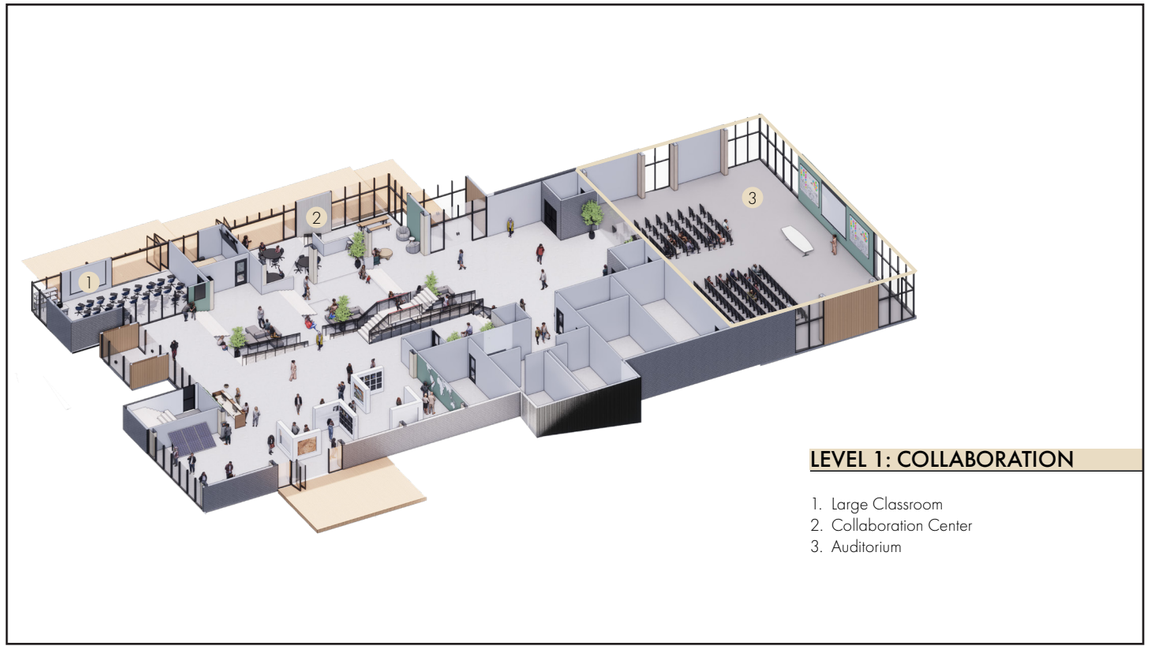


SLIDE 56

PRESENTATION SLIDES

SLIDE 57



SLIDE 59

SLIDE 58

SLIDE 60

PRESENTATION SLIDES

LEVEL 1: COLLABORATION

1. Large Classroom
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3. Auditorium
4. Storage

SLIDE 61

LEVEL 1: COLLABORATION

1. Large Classroom
2. Collaboration Center
3. Auditorium
4. Storage
5. Restrooms

SLIDE 62

LEVEL 1: COLLABORATION

1. Large Classroom
2. Collaboration Center
3. Auditorium
4. Storage
5. Restrooms
6. Sustainable Design Exhibition

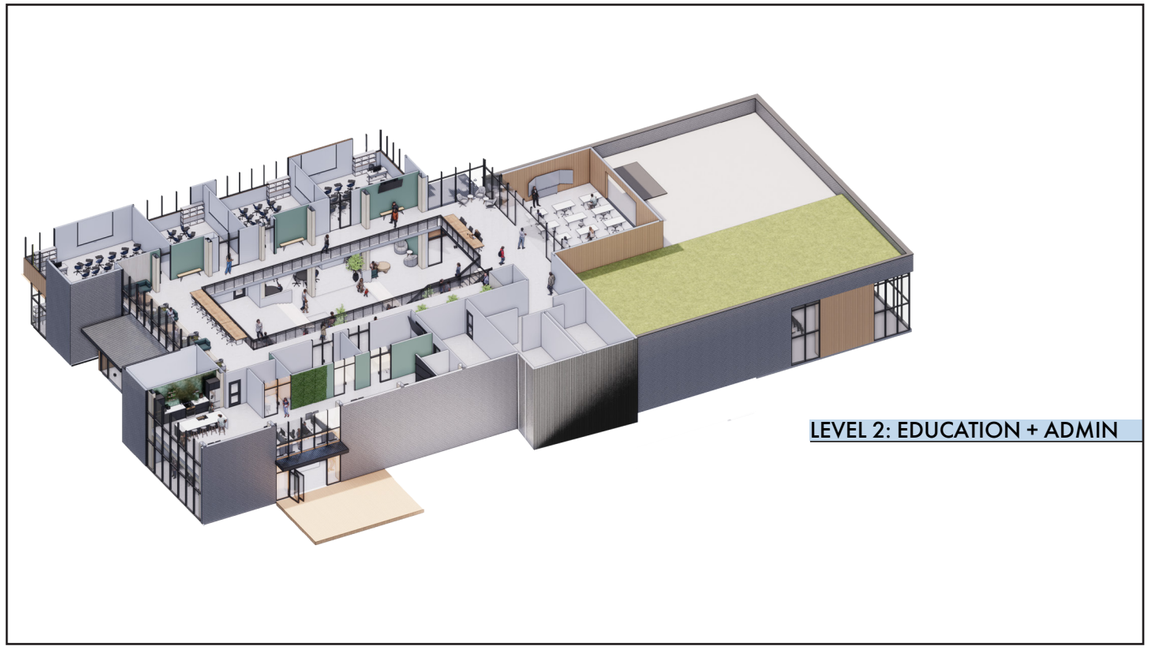
SLIDE 63

SLIDE 64

PRESENTATION SLIDES

SLIDE 65

SLIDE 67



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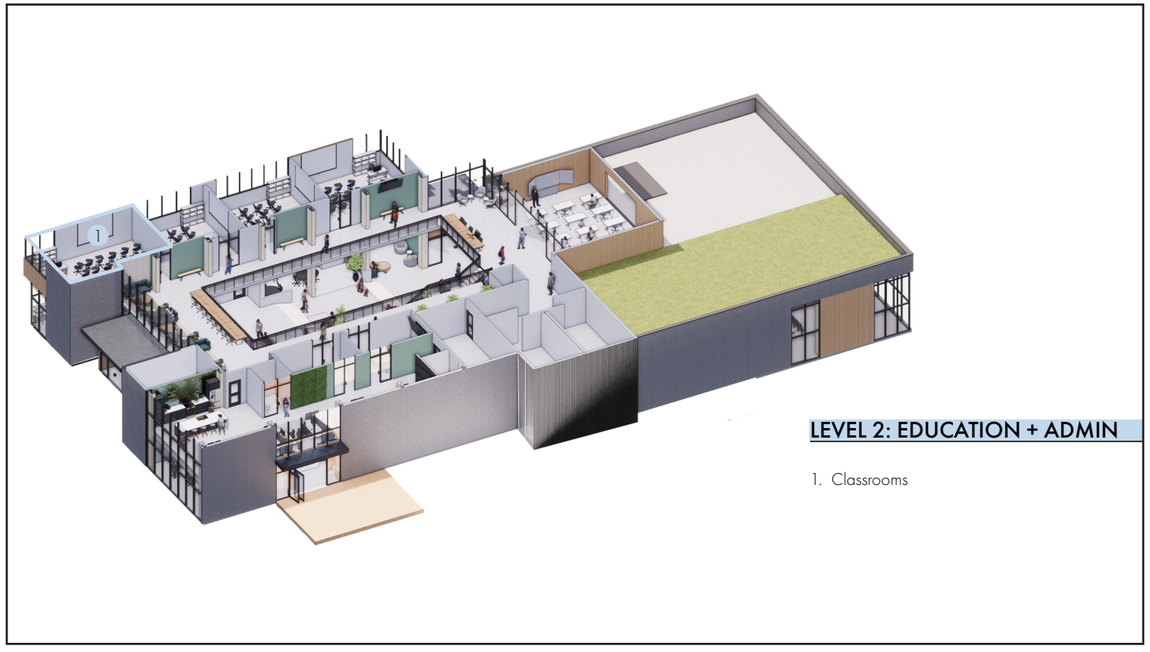

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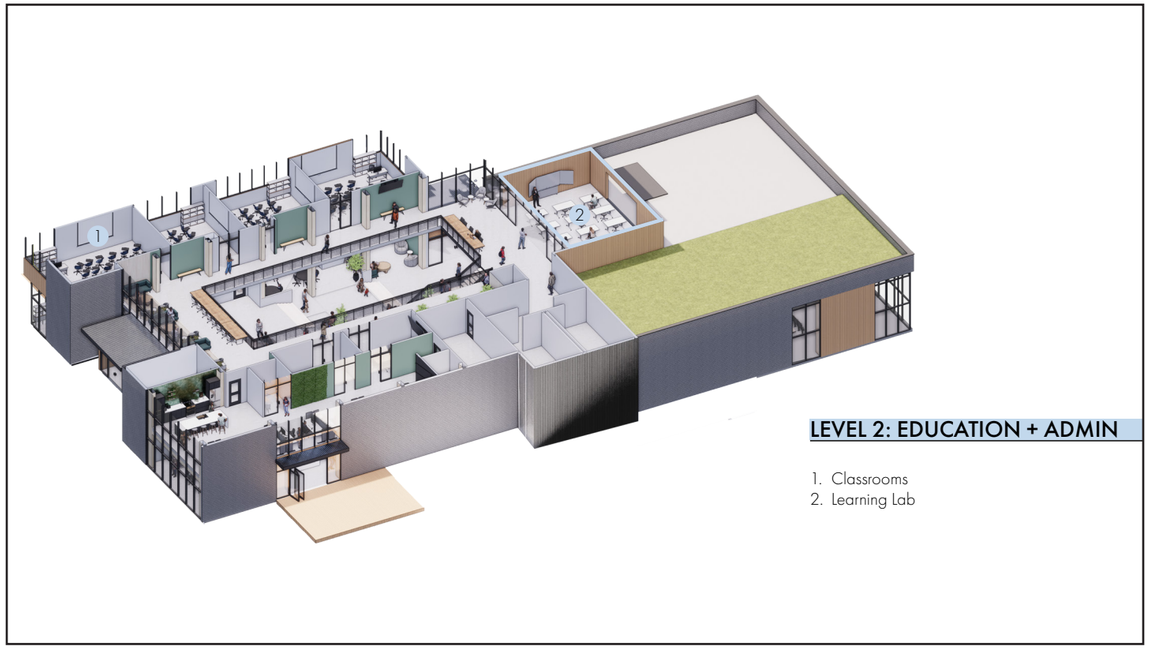
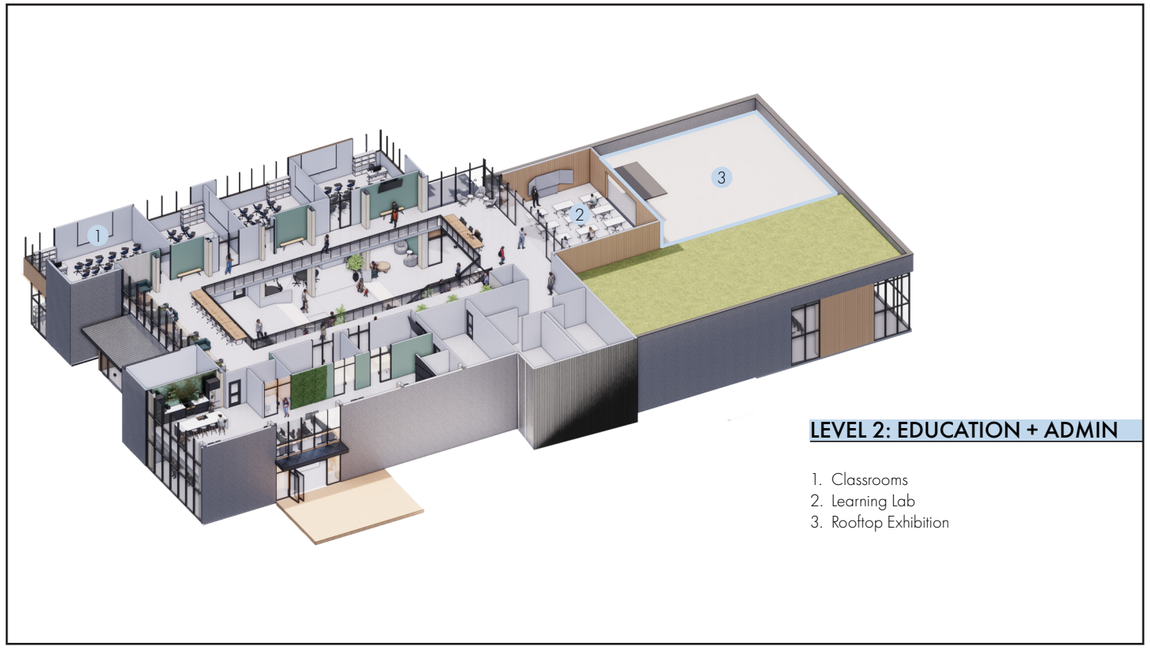
PRESENTATION SLIDES

SLIDE 69



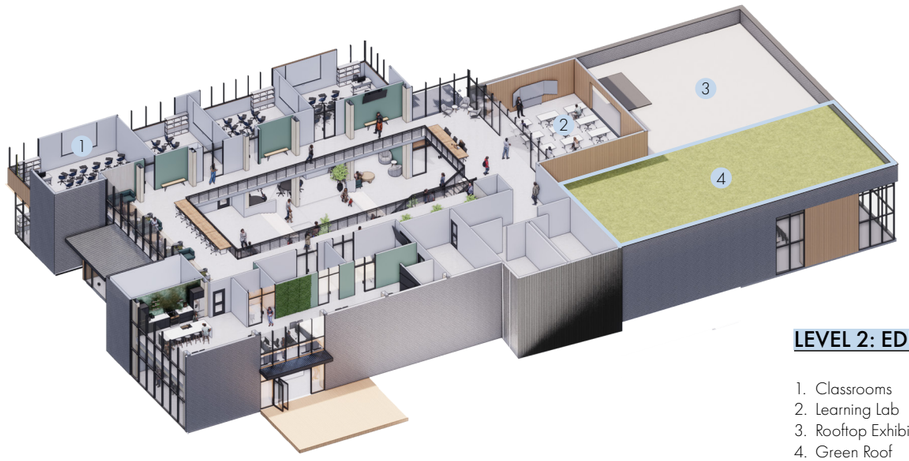
SLIDE 70

SLIDE 71



SLIDE 72

PRESENTATION SLIDES

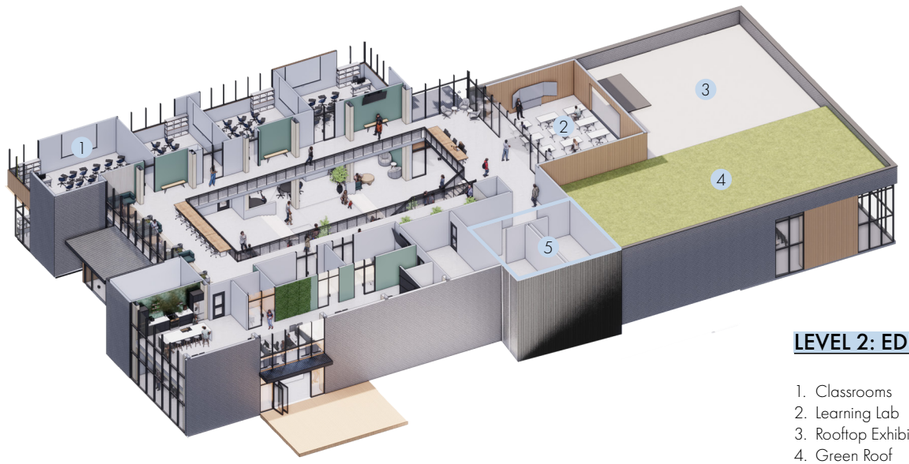


LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition
4. Green Roof

SLIDE 73

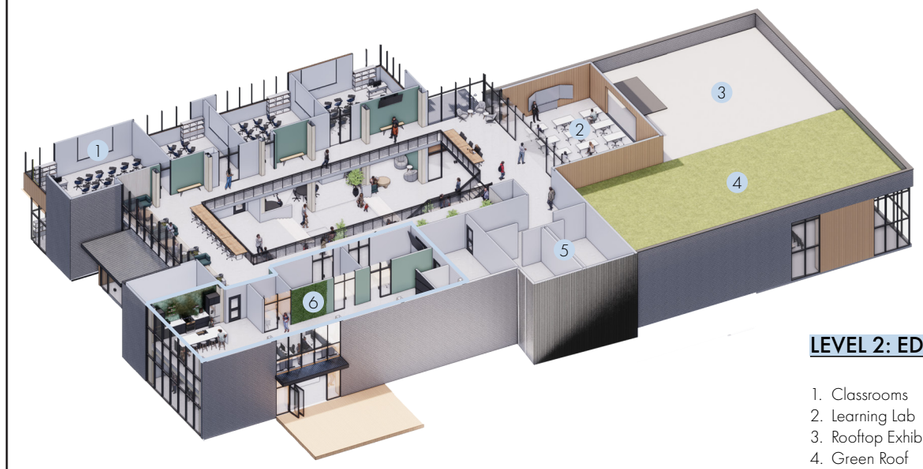
SLIDE 74



LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition
4. Green Roof
5. Restrooms

SLIDE 75



LEVEL 2: EDUCATION + ADMIN

1. Classrooms
2. Learning Lab
3. Rooftop Exhibition
4. Green Roof
5. Restrooms
6. Open Office

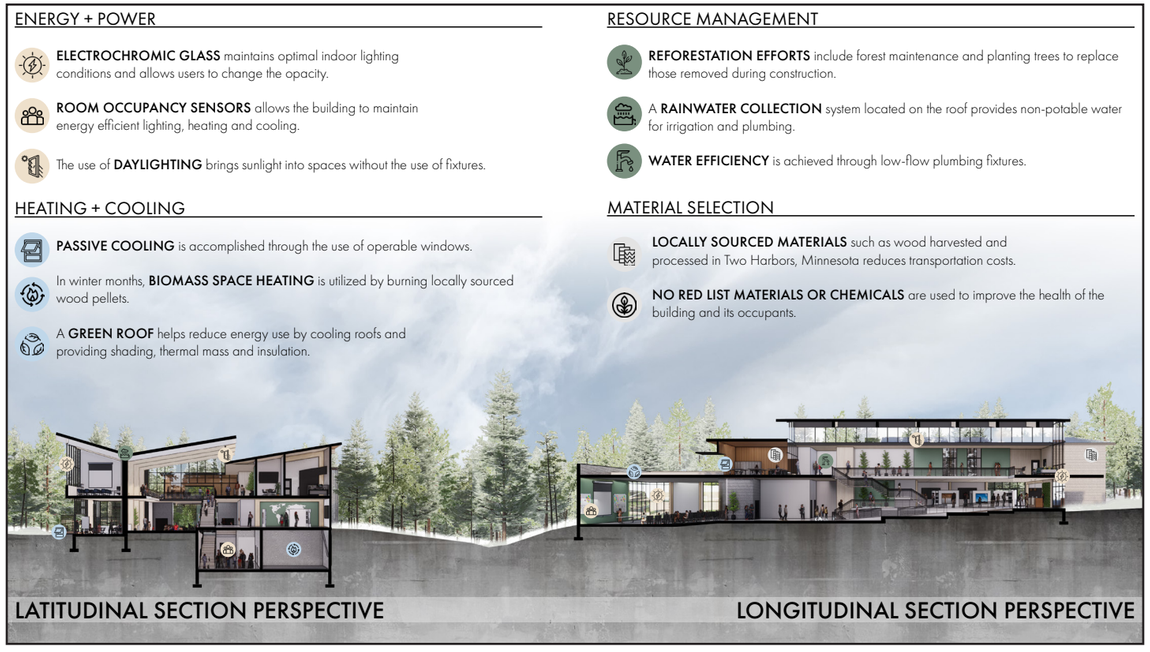
SLIDE 76

PRESENTATION SLIDES

SLIDE 77

SLIDE 78

SLIDE 79



SLIDE 80

PRESENTATION SLIDES

SLIDE 81

SLIDE 82

SLIDE 83

SLIDE 84

PROJECT INSTALLATION

Below is an image of the final display board file which shows the project in its entirety. To the right is an image of the boards installed for viewing on the 5th floor of Renaissance Hall in downtown Fargo.

THE APPENDIX

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PREVIOUS STUDIO EXPERIENCE

KATIE KENT
M.ARCH CLASS OF 2023

YEAR 2

Emily Guo
Land Artist's Studio
Minneapolis Rowing Club

Milton Yergens
Dwelling Project
Mixed-Use Project

YEAR 3

Bakr Aly Ahmed
School of Design Architecture & Art
2020 Olympic Fitness Center

Paul Gleye
New American Cultural Center
Symphony Trails

YEAR 4

Cindy Urness
Miami Highrise Capstone

Kristi Hanson
Medora Masterplan

YEAR 5

Cindy Urness
Otte Wetlands Research Campus

Bioclimatic Architecture:
Incorporating Sustainable Design
Methods in Cold Climates