Developing a Local Building Ecology

A THESIS PROJECT
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School is so insulated, and architects have this jargon—it becomes a game of speaking in clever ways to explain your design. It's really nice to get out in the community and see real-life issues and problems and how architecture and good design can play a part in addressing them—but just a part. When you participate in a project like this, you can appreciate that design is important, good construction is important, but so is being sensitive and open. It's common sense. There's no magic thing you do. Students learn that they aren't heroes, that they're part of a continuum of hardworking activists.

-Leslie Morishita *Studio at Large*

Acknowledgements

I would like to thank my committee, Dave, Loren, and Wynne, for the patience and encouragement throughout this thesis. I owe a great debt to my family for their unfailing support. Thanks are also due to my friends who helped me and distracted me in equal parts.

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Thesis

I set out to investigate the ideas of community-based design/build architecture. As a lifelong resident and former educator in small communities, my design interests have always been rooted to the cultural and physical aesthetics of small, connected communities. Through my formal education I grew interested in combining the resources of communities and their disparate and unique skills with the theoretical knowledge I have been exploring over the course of my architectural studies.

I believe in groups and that more voices involved in a project yield more robust outcomes. I therefore wanted to explore what happens when you involve a community in the design process? How does incorporating non-architects in the architectural process influence the results? What does collaboration bring to the formal process of an architect? These are questions that I wrestled with as I designed in the isolation of graduate school. This thesis sought to challenge the bias of the architectural process and the notion that the architect knows best.

I explored these questions within the context of Wolf Ridge Environmental Learning Center. Wolf Ridge fit many of my criteria: it is a small community, I have connections with Wolf Ridge from my year spent teaching as a student naturalist intern, their environmental and educational mission fit well with my interests, and Wolf Ridge needs a new building.

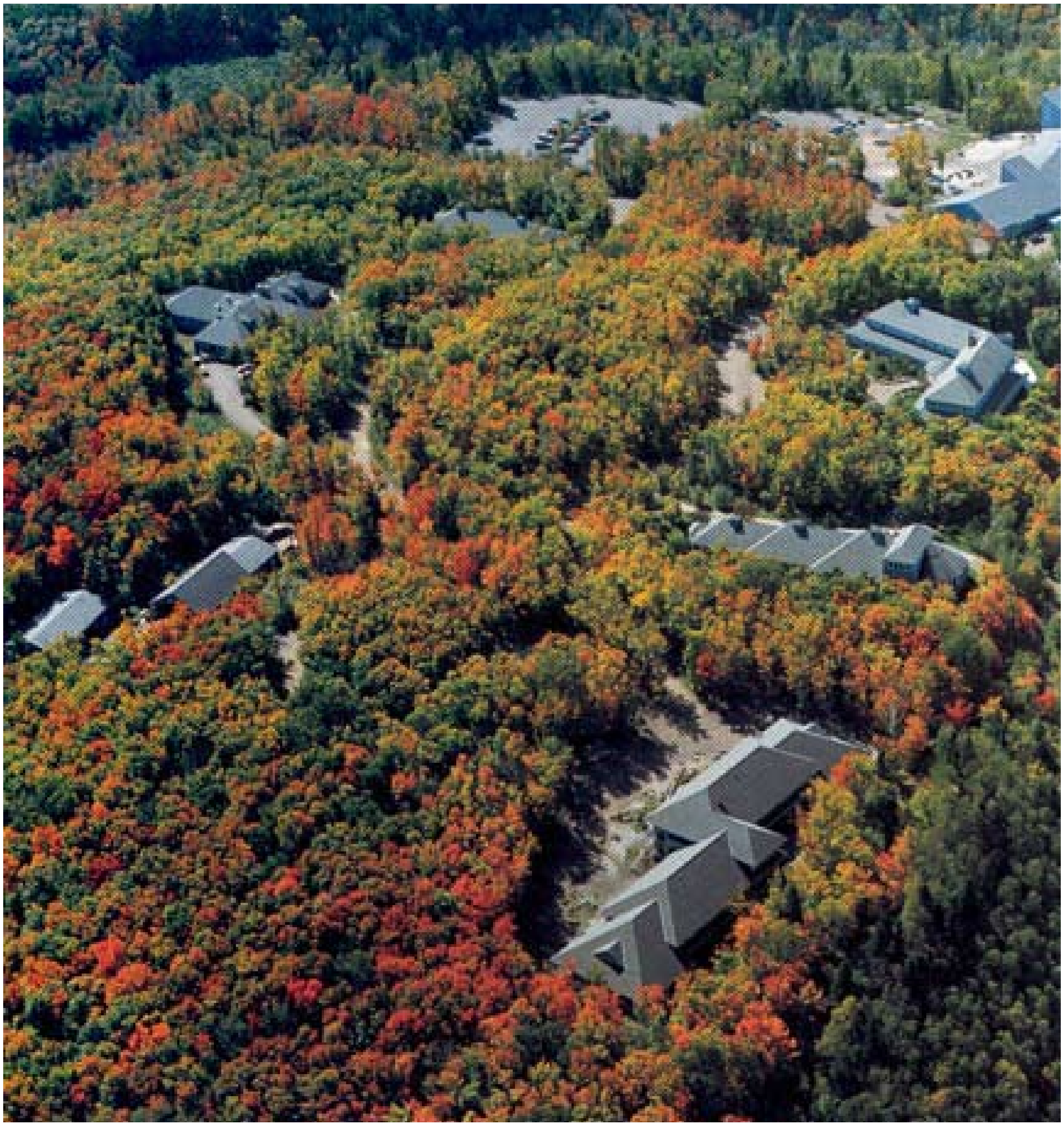


Figure 1: Wolf Ridge Environmental Learning Center

To develop a citizenry that has the knowledge, skills, motivation and commitment to act together for a quality environment

-Wolf Ridge Environmental Learrning Center Mission Statement

Wolf Ridge Environmental Learning Center

PROGRAM

Wolf Ridge Environmental Learning Center, located in Finland, Minnesota, offers experiential learning in the outdoors. The program focuses on natural history, ecology, and the cultural history of the Northwoods region. Wolf Ridge provides opportunities for school groups, family programs, Elderhostels, and summer camps. In addition, Wolf Ridge operates a naturalist training program that provides the naturalist interns valuable teaching opportunities and while sourcing instructors to the school, Elderhostel and family programs. These naturalist interns complete a one-year course of study as student naturalists and many elect to stay for a second year as professional naturalists, allowing them an additional year of teaching at Wolf Ridge.

NEED

With the expansion of Wolf Ridge's program and the evolution of social mores, Wolf Ridge has found that its current facilities are growing inadequate and outdated. The most pressing need is in housing, which is limited and does not meet today's standards for the school groups who stay at Wolf Ridge. Wolf Ridge would like to provide appropriate housing to three groups with the new structure: student naturalist interns, professional naturalist interns, and adult visitors. [1]

Figure 2: Minnestoa and key communtities map

As demonstrated by the course work offered by Wolf Ridge (animal ecology, plant ecology, aquatic ecology, cultural ecology, environmental issues, earth science, team skills, outdoor skills, and creative arts), their vision of "quality environment" not only entails the ecological environment but also the cultural environment. Therefore the implications of any expansion, programmatic or physical, of Wolf Ridge on its community must be considered. Currently Wolf Ridge is one of the largest employers in the Lake County, only surpassed by Lake County itself and North Shore Mining, which operates the Taconite Facility in nearby Silver Bay. While Wolf Ridge is an economic engine in many ways, it is self-contained. Its clients rarely venture off of the Wolf Ridge campus, thus there is limited local economic synergy.

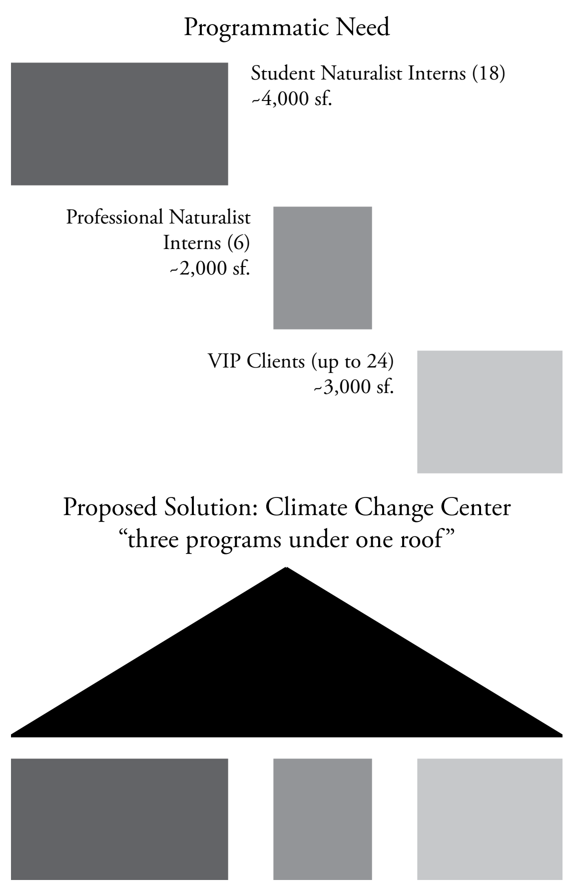


Figure 3: Programmatic Diagram

The need to update the existing West Dorm to provide more privacy will result in the loss of student naturalist intern housing. This group will need a new, purpose-built residence as part of the expansion.

For the last several years, Wolf Ridge has been renting a house in Finland to provide a residence for their professional naturalist interns. With the advent of adding a new building to the campus, the opportunity to move the professional naturalist into their own housing is fortuitous.

The final component of the new building is VIP client housing. Wolf Ridge would like to offer a few select rooms with adult accommodations, upgraded from the bunk beds in the dorms. This addition would improve Wolf Ridge's capacity to host corporate retreats, family groups, or even school superintendents when they come to visit.

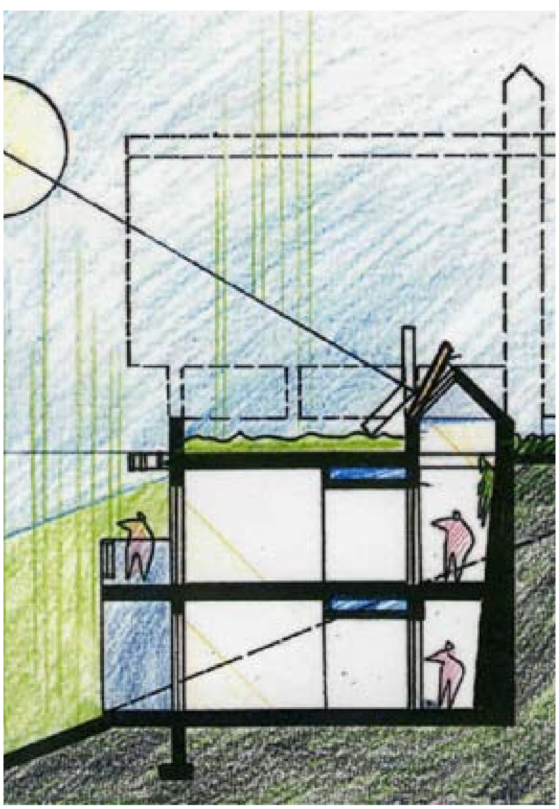


Figure 4: Rendering of Climate Change Center (M. Plautz)

Wolf Ridge's interest in this "three programs under one roof" program sparked this thesis project. Wolf Ridge's vision of this project is called the Climate Change Center, a roughly 10,000 sf. building holding these three different residential spaces. This new structure would be in line with the other ridge-top buildings at Wolf Ridge.

LOCATION

NORTH SHORE

Wolf Ridge is located a few miles inland from Lake Superior along the North Shore of Minnesota. The Lake Shore is dominated primarily by exposed bed rock cliffs and pebble beaches. The hills moving inland from the lake are covered in northern boreal forest mixed with various spruce bogs, cedar swamps, and tamarack marshes. Traditionally the North Shore has been dominated by mining and lumber industries, however over the last century there has been dramatic growth in year-round tourism. Along Lake Superior there are several State Parks, resorts, ski areas, and trail networks for visitors to enjoy.

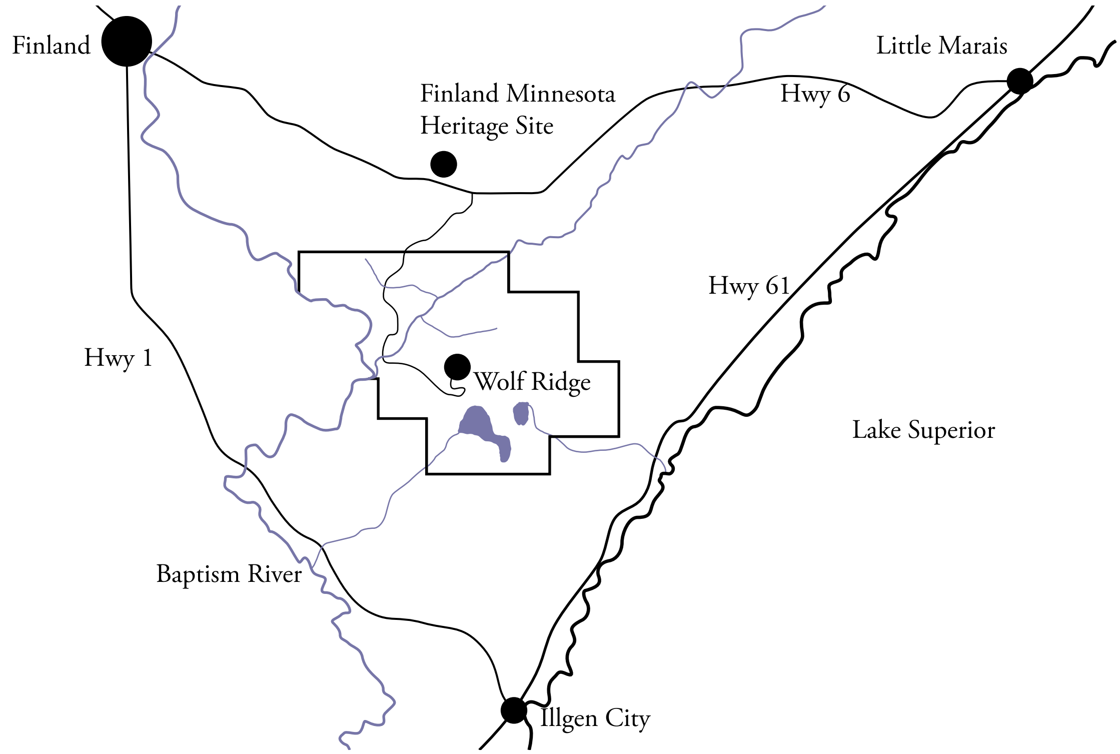


Figure 5: Map of the Finland and Wolf Ridge area

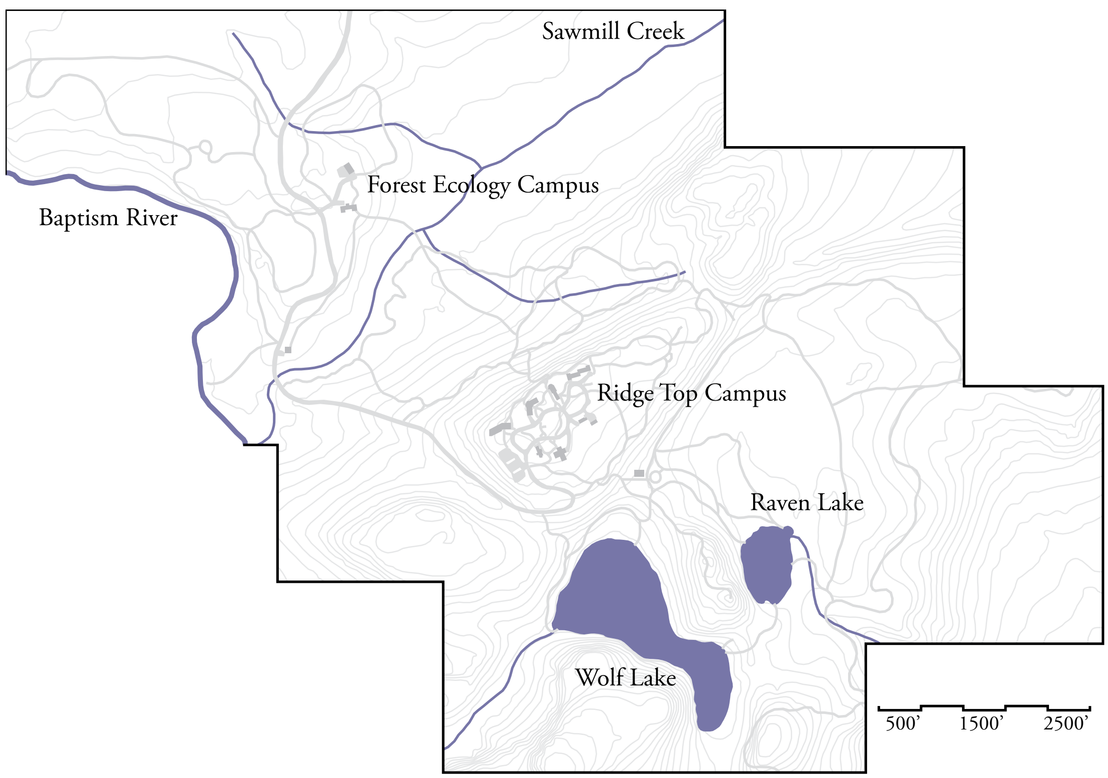


Figure 6: Wolf Ridge map

FINLAND

The town of Finland was founded in 1896 as a logging community. Located six miles upstream on the Baptism River from Lake Superior, travel to and from Finland as well as resupply were achieved via mail boat out of Two Harbors, until the first road was built in the early twentieth century. Today Finland is a scattering of 600 residents, a church, a general store, a gas station and several restaurants and bars centered on the intersection of Highways 1 and 6.

WOLF RIDGE

Situated on nearly 2,000 acres of mixed maple, birch, and spruce forest along the North Shore of Lake Superior, Wolf Ridge encompasses ridges and valleys, rivers and lakes, and more than 18 miles of trails. The primary campus is situated atop a ridge running roughly east-west with a southern view toward Lake Superior. To the south lie Wolf and Raven lakes and Marshall and Mystical mountains. To the north Sawmill Creek runs through many beaver ponds before draining into the Baptism River, Wolf Ridge's western border.

EXISTING BUILDINGS

When Jack Pichotta, Wolf Ridge's founder, moved his fledgling environmental learning center to Finland, he built purpose-designed structures. The campus was begun in late 1988 with a core of five buildings positioned atop the ridge. By 2000 these buildings had been joined by two more on the ridge as well as several smaller ones scattered about the property including the satellite Forest Ecology campus located to the north near Sawmill Creek.

The original campus was designed by a Minneapolis firm and built by a Cloquet contractor. The structures adhered to common building practices of the times: concrete foundations, stud framing, baffle insulation between studs,

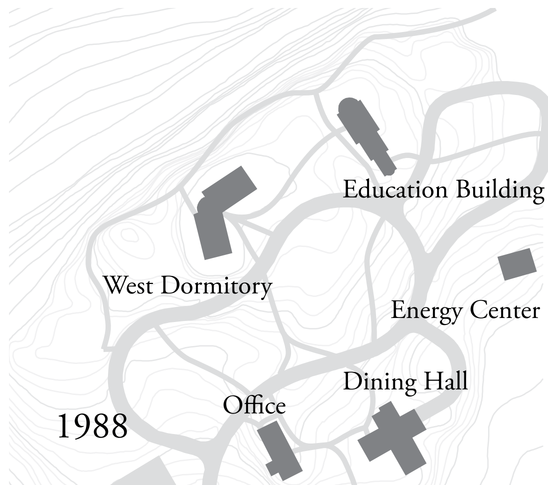


Figure 7: Ridge top map, 1988

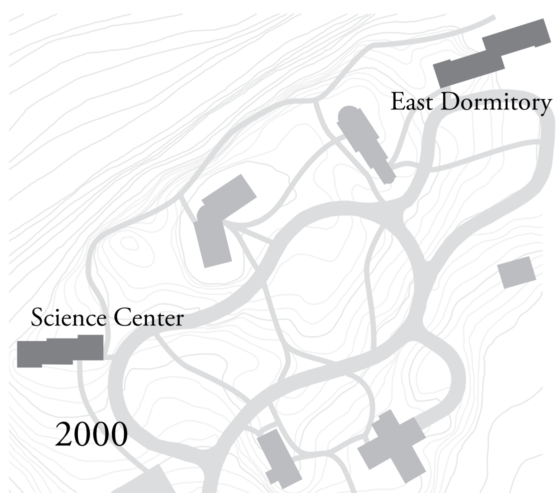


Figure 8: Ridge top map, 2000


Figure 9: Office Building


Figure 10: Education Building


Figure 11: West Dormitory


Figure 12: Dining Hall


Figure 13: Energy Center


Figure 14: East Dormitory


Figure 15: Forest Ecology Building


Figure 16: Science Center

asphalt-shingled hip roofs and drywall interiors. One of the buildings, the Energy Center, houses four Garn wood-fired boilers which provide the heat for all the ridge-top buildings. There is a centralized septic system positioned slightly downhill from the main campus.

The later buildings, designed by a different Minneapolis firm and built by contractors from Hibbing between 1996-2000, show many of the same characteristics as the earlier structures and most rely on the existing centralized systems. The sole exception is the science building. This building was designed to incorporate alternative energy demonstration systems: a 1 kW solar-tracking photovoltaic panel as well as a small wind turbine. An electric resistance heating system was installed in the new science center to augment the hot water supplied via the central heating system. These systems were intended not only to provide an educational component, but also to provide partial relief to the overburdened central heating system. [2]

COMMUNITY

I set out to investigate the application of community-engaged design and building. My original approach was to partner with the key communities and stakeholders to design and build a structure utilizing their knowledge, skills and resources. However, the level of investment from community members for such a project to succeed would have been extraordinary, particularly without the certainty that their investment would result in a building since this is a thesis project.

Thus much of the community engagement was distilled into a set of design principles to address the challenges of engaging the community with a theoretical exercise. In an effort to simulate some of this missing input, definitional questions about community design were asked: What is a community? How do you define a community? What are the extents of community? When combined with a particular community, in this case Wolf Ridge, additional related questions became pertinent. What is Wolf Ridge's community? How does the transitory nature of interns influence and create community? Does community extend beyond the human one? Do the values of community connote how the design should work?

One of the key steps was defining the key communities of which Wolf Ridge is a member and who would therefore have a stake in the new building. These communities can be categorized into four main groups: Employees, Finland Residents, Educational, and Environmental.

EMPLOYEES

The first community, employees, constitutes all the people who work at Wolf Ridge. They establish the culture present at Wolf Ridge. There are two subsets within this group: naturalists,

Figure 17: Wolf Ridge Communities Map

both staff and interns, and support staff. A new building needs to serve the needs of the all Wolf Ridge employees, and also the specific needs of those who will live in it, both the student and professional naturalist interns.

FINLAND RESIDENTS

The second community is the slightly larger, local population termed residents. Finland is the community in which the staff live and send their children to school. Many of the support staff are originally from the Finland area and so are deeply integrated into the history and traditions of the community. This is also a group of people who support Wolf Ridge through local businesses, resources, and community activities. Wolf Ridge supports Finland in return via educational opportunities for the local schools and jobs for many Lake County residents.

EDUCATIONAL

Even broader than the local area is the educational community of which Wolf Ridge is a part. This includes the teachers from across Minnesota with whom Wolf Ridge works, the students and their families that visit Wolf Ridge during the school year, and other participants of Wolf Ridge's programs.

NORTHWOODS ECOSYSTEM

The final community of relevance is the ecosystem of the Northwoods of Minnesota. This includes the natural non-human elements that support and allow Wolf Ridge to flourish and fulfill its mission: the underlying geology, the soils, the plants, the animals, the water and nutrient cycles, and the overall ecosystem structure.

SUMMARY

Each of these communities has a vested stake in any addition to Wolf Ridge; each community has different priorities from any new construction. The challenge, therefore, is balancing "community design" across multiple communities with different goals and needs.

DESIGN PRINCIPLES

By evaluating each community's key objectives, three community-based design principles came to the forefront. These principles shaped the entire process; suggested evaluation criteria; and informed the project decisions.

PRINCIPLE ONE: Be Comfortably Private

The primary goal of this structure is one of housing—providing a place to live for the two different intern groups and for specialized clients. The intern housing, in addition to providing a space for the interns to live, must offer a retreat from the rigors of work while still allowing the interns ease of access to Wolf Ridge. With the combination of intern and client housing in the same building, the facility necessarily becomes a public one.

This principle of comfortable privacy is most closely linked to and required by the Wolf Ridge employee community, but also has ties to the educational community who may stay there.

PRINCIPLE TWO: Be Educationally Transparent

Beyond meeting a housing requirement, in adhering to the vision of Wolf Ridge, the new structure should be another tool in the organization's educational program. This precedent was set with the Science Center which was designed to offer an alternative view of a building and its interaction with the environment. In the ten years since that building was complete, not only has the technology advanced dramatically, but cultural acceptance of green building has expanded. Using this new building to offer another, updated take on sustainable building not only provides a great opportunity to illustrate the impact of buildings on the environment, but also to comment on changes in society through the microcosm of Wolf Ridge's buildings.

This principle also means that the building needs to be sufficiently public to serve Wolf Ridge's educational community and mission; raiding potential conflict with Principle One: Be Comfortably Private. Principle Two is of primary relevance to the educational community, but secondarily relevant to employees and Finland residents.

PRINCIPLE THREE: Be Locally Integrated

Over its more than twenty-year history in Finland, Wolf Ridge has slowly integrated into the regional community. With this new building, Wolf Ridge has the opportunity to further benefit the Finland community and the whole of the North Shore by using local resources, including labor and materials. In addition to providing the community with much-needed work, Wolf Ridge can further its stated environmental mission by using local resources and ensuring that these resources are harvested in an ecologically friendly manner.

This local principle would serve Wolf Ridge's immediate community of Finland and the broader Northwoods ecological community. This principle implies the need for the final structure to exist in harmony within its ecosystem, suggesting a responsible green building campaign.

Design

While the architectural design process ends with a series of drawings describing a building, the beginning of the process is much less concrete. I began by thinking about the community design process, the difficulties this thesis faced, and the communities I hoped to serve. From that I developed the three Design Principles, which were critical to shaping decisions. While my primary interest for this project is community design, Wolf Ridge brought its own goals and previous work on this project that had to be considered. This included an existing conceptual sketch for the building. While this provided a strong point from which to begin the design, I conducted additional research to inform the process.

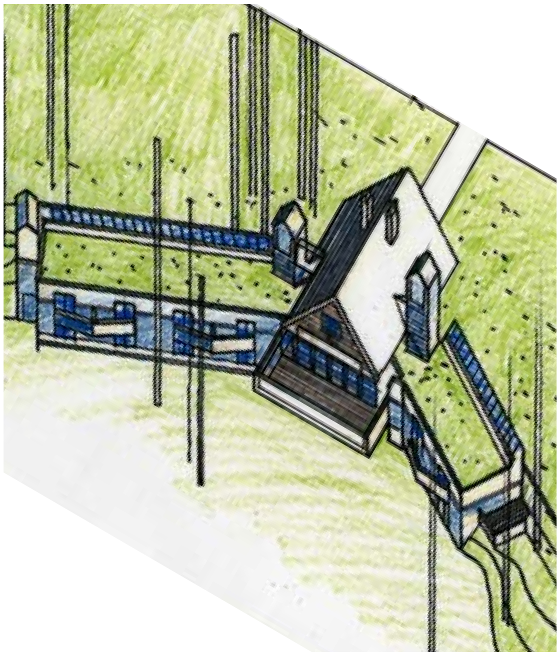


Figure 18: Rendering of Climate Change Center (M. Plautz)

I conducted four types of research to inform this project: Conceptual, Resource, Systems, and Design. I started by looking at several existing community designs or building examples in addition to structures that were typologically and technologically relevant. From these examples and the design principles, I looked for other materially based case studies from which to draw inspiration for ways to use the local resources. Principle Three: Be Locally Integrated has implications for the building process and also the way the building functions once constructed. The building must work within the local ecosystem, which means I investigated various building systems to ensure that the specified systems were ecologically friendly. My design solution synthesizes across all this research, creating a structure that satisfies the three design principles as well as the four communities involved.

CONCEPTUAL RESEARCH

This research consists of a series of case studies that examine a particular topic of relevance for this project. These are projects that primarily have been built and published in the architectural press. The three topics I researched were: educational typology, community-based architecture, and sustainability.

EDUCATIONAL TYPOLOGY

This first set of case studies is an investigation into existing educational housing types. These case studies offer several different ways to create privacy within a public residence. While at its most basic this building will be a residence, due to Wolf Ridge's mission, the building will take on a greater purpose that is not reflected in all of these studies. Despite the differences in programs, these examples offer insight into the complexities of balancing Principle One: Be Comfortably Private and Principle Two: Be Educationally Transparent.

GARDEN HOSTEL

Kings College in Cambridge, England, added 33 en suite rooms in the new Garden Hostel by Nicholas Ray Architects. Due to the presence of a large beech tree on the site, they modified the traditional, double-loaded corridor by adding a bulge. The bulge compensated for the loss of space and preserved the tree, a nod to Principle Three: Be Locally Integrated. One of the common short-comings of double loaded corridors is the absence of natural light in the corridor. Not only does the bulge allow for the beech tree, but through the use of glass block, light penetrates into the corridor, creating a pleasant and lively connection with the outdoors. Another benefit of the shift from a purely linear building is the communal terrace situated atop the three-story bulge. The hostel also houses four public kitchens, one per floor. The 33 rooms each include a balcony, providing views and individual access to the outside. [3]

This hostel demonstrates many of the current norms for making student housing comfortably private, both in the basic parti of the double-loaded corridor, as well as the en suite rooms with personal balconies or exterior access. While there are still communal areas within the building—including the kitchens, the terrace, and central corridor—Principle One: Be Comfortably Private clearly trumps community in this building.

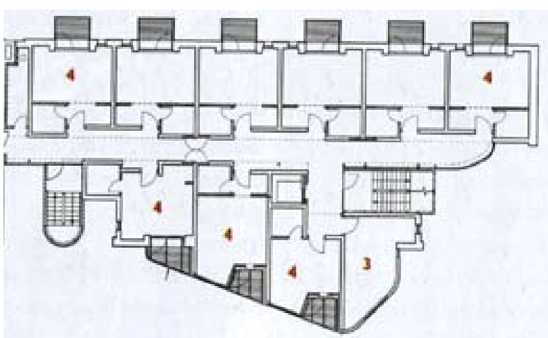


Figure 19: Garden Hostel, Second floor plan

Figure 20: Glass block light core

CLOISTER SCHOOL

Gion Caminada's new girl's dormitory for the Cloister School in Disentis, Switzerland, dramatically shifts the emphasis of dormitory from that of individual rooms, to the communal space linking them. Rather than tying the rooms together via a hall, Caminada settles them in a horseshoe around a lounge. This central courtyard space, which includes a building core housing the stairway, kitchen, seating and fireplace, features a large window for natural light and visual connection to the city. The inclusion of the core in a new and unique combination on each floor suggests individuality. Off of the lounge, each student is given an en suite room for privacy with a window seat which helps to reduce the potential cell-like quality of an otherwise standard room. Due to the rotation of the orientation of the lounge each of the four floors offers a different view of the city. Despite the changes in lounge orientation and the morphological changes of the core on each floor, continuity is maintained through use of local Disentis brown concrete for the core, tying the whole structure together. [4]

The overall effect of the structure is that of a court that encourages those living around it to

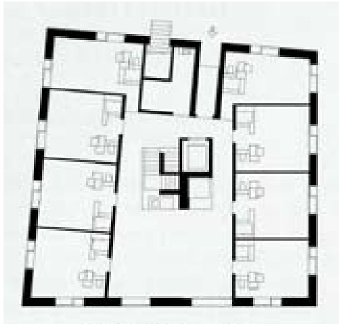


Figure 21: Cloister School, Third Floor Plan

Figure 22: Central Stair

partake in the center and leave the periphery behind. This dormitory, while still allowing for Principle One: Be Comfortably Private, certainly encourages more communal interaction than the King's College example.

BIOHAUS

Geographically nearer to Wolf Ridge is the Biohaus, which balances Principle One: Be Comfortably Private and Principle Two: Be Educationally Transparent. The Biohaus is part of Waldsee, the Concordia College Language Village German camp located in the lake country of northern Minnesota. While the Biohaus is a little closer to home, it still maintains a European sensibility and lineage. German Minnesotan Stephan Tanner designed the small classroom/residence building and used many German-manufactured materials and systems.

The Biohaus includes four rooms on the lower level with public areas located above, including a classroom. Due to the use of the building by a much larger number of people than those who dwell there, the separation between public (upstairs) and private (downstairs) is emphatic through the formal separation and material choices. This distinction is architecturally reinforced on the exterior with the use of masonry and smaller windows on the bottom floor, and a lighter cladding on the upper combined with

Figure 23: Biohaus, Waldsee

Figure 24: Utility Room, Biohaus

large panes of glass. The structure is the first Certified Passive House in the USA. The Passive House Standard stipulates passive systems (high performance triple-glazed windows, super-insulation, an airtight building shell, limited thermal bridging and balanced energy recovery ventilation) to reduce energy inputs into the house. [5]

This building is an effort to accommodate both the privacy needs of its residents and the larger educational mandate of Concordia Language Villages. Also the Biohaus features technology that demonstrates Waldsee's and Germany's environmental commitment in building.

SUMMARY

These three case studies demonstrate some of the current trends in dormitory housing. The two European examples offer models for communal living: the double-loaded corridor and the courtyard. These two different forms embrace slightly different takes on community. The Biohaus addresses many of the same public/private issues that the Wolf Ridge building will need to navigate, but it does not sufficiently integrate into the local environment to satisfy Principle Three: Be Locally Integrated. The interaction of students and residents and the technology included in passive structure can be a model for reinterpretation at Wolf Ridge. Thus while none of the case studies is necessarily the correct parti for Wolf Ridge, all three are useful references.

COMMUNITY-BASED ARCHITECTURE

In the spirit of serving the needs of the four identified communities (employees, Finland esidents, educational, and Northwoods ecosystem), this series of case studies investigated community-based architecture. I looked at classic examples such as Habitat for Humanity and Auburn University's Rural Studio as well as area-specific examples including North House Folk School's new Milling Shop and Residence in Grand Marais and Finland's proposed Community Center. This research was conceived as a way to understand existing models of community design and building that might provide methods to support the design principles established earlier in this thesis. I anticipated developing arguments that would primarily support Principle Three: Be Locally Integrated. Through the research, however, I also found evidence to support Principle Two: Be Educationally Transparent.

HABITAT FOR HUMANITY

Habitat for Humanity is a well-established, global program that uses volunteer labor to construct housing for people in need. Habitat for Humanity has excelled at organizing large groups of volunteers, creating powerful community bonding opportunities, and quickly constructing affordable housing—all of which can be construed as Principle Three: Be Locally Integrated. The use of unskilled labor under the guidance of skilled team leaders presents certain inherent limitations, the largest one of which is how to promote safety on the construction sites. As the labor force is volunteer and not professional, the safety requirements shape the overall scope of what can be done through Habitat for Humanity, and therefore dictates the scale of buildings and the techniques used in construction. Most often the simplest and most well known building methods are employed with little creativity in terms of material use, detailing, or design, in order to keep the structure simple for volunteer labor. Traditionally, Habitat for Humanity has placed an emphasis on economic and social sustainability, but not on ecological sustainability. This is evidenced by their material choices, including relatively cheap and environmentally damaging vinyl siding. While Habitat for Humanity builds inexpensive houses for those otherwise unable to afford their own residence, the community it draws on to support this is vast, with volunteers frequently hailing from all over the country, if not the world, and generally spending no more than a week working on a project. [6]

Figure 25: Volunteers working for Habitat for Humanity

Figure 26: Volunteer safety meeting, Habitat for Humanity

Habitat for Humanity's model offers a way to incorporate all of Wolf Ridge's communities into the building process: through volunteer labor. Such a plan would require skilled oversight which is abundantly available along the North Shore. Additionally Habitat for Humanity volunteers not only reinforce community by providing for those in need—but through informal learning, volunteers develop new skills and knowledge which links directly with Principle Two: Be Educationally Transparent.

RURAL STUDIO

Rural Studio, an outgrowth of Auburn University's architecture department, brings students into the most impoverished areas of Alabama to garner hands-on experience designing and building for those who need it the most. This studio whole-heartedly embraces Principle Two: Be Educationally Transparent. The hallmark of this program is the creative use of unconventional materials. For over fifteen years, the students of Rural Studio have been innovating by building houses and community spaces out of the unexpected (bales of cardboard, car windscreens, bottles, carpet squares, etc.). These materials choices were driven by local

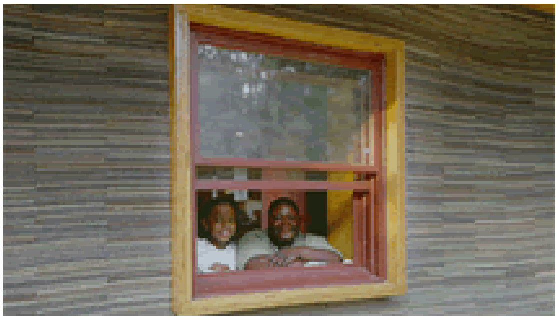


Figure 27: Lucy/Carpet House, Rural Studio

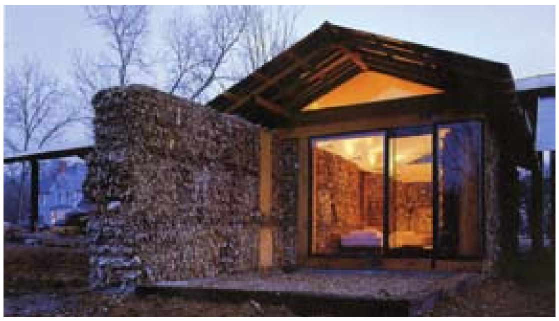


Figure 28: Corrugated Cardboard Pod, Rural Studio

availability of free materials, which works well with Principle Three: Be Locally Integrated. The desire for progress has driven much of the architecture, sometimes producing structures that are dynamic and creative but not necessarily what the studio's clients need. The communities and individuals, however, have derived an overall benefit from involvement in the program through the receipt of housing and other buildings that would otherwise be unavailable to them. Recently Rural Studio has shifted focus away from material innovation and toward replicable affordable housing projects, as demonstrated by their series of 20K houses. [7]

One of the largest lessons from Rural Studio's work for Wolf Ridge is the creative use of locally available materials. While Wolf Ridge and the Northwoods might lack the myriad non-standard materials that have been used over the years at Rural Studio, Wolf Ridge can draw on that spirit of innovation through creative use of the local raw resources.

NORTH HOUSE FOLK SCHOOL

North House Folk School, located in Grand Marais, Minnesota, strives to enrich lives and build community by teaching traditional northern crafts in a student-centered learning environment that inspires the hands, the heart, and the mind. Coursework at the Folk School is in traditional construction of buildings, boats, skis, bowls, clothing, and food. The Folk School instructor and student base is drawn not only from the immediate area but the greater upper Midwest.

The construction of the new Milling Shop and Residence incorporated several of the Folk School's classes. Students cut all of the structural timbers in timber frame classes. Similarly, students installed the solar thermal system under an instructor's guidance. This format for construction not only uses volunteer labor, but actively and formally instructs those participating in the process. Thus the emphasis becomes not building, but learning.

However the Folk School faced challenges incorporating student and professional builders.

Figure 29: Students sawing a timber, North House Folk School

Figure 30: Milling Shop and Residence

The need to schedule courses months in advance required accurately anticipating the construction timeline, which proved extremely challenging and at times unsuccessful. Despite these difficulties students have played a significant role in the creation of the Milling Shop and Residence. [8]

As Habitat for Humanity offers a model of informal education through the building process, North House Folk School presents a formal model. Such a model could utilize Wolf Ridge's existing educational community and expand it. The Folk School advances an interesting hybrid system of using local resources while making the process educational, thus demonstrating both Principle Two: Be Educationally Transparent and Principle Three: Be Locally Integrated.

FINLAND COMMUNITY CENTER

The town of Finland, Minnesota, is constructing a new community center. The community has been working on this for several years, driven by the fact that the costs to heat and maintain the previous center grew beyond the town's financial capacity. The community involvement in the decade-long process ranges from advocating and fund raising for the new building to deconstructing the old one. The community hired a Duluth firm, Wagner Zaun Architects, to design the new community center. The architects actively engaged with

Figure 31: Rep. Obermayer presenting the Finland community

Figure 32: Residents preparing to demolish the old community center

the community to better understand the needs and vision of the community. The resulting design incorporates several elements provided as in kind donations from community members, including an entry pavilion to be built by an area timber framer. While many local residents will participate in the construction, it will not rely solely on volunteer labor for completion. [9]

This project provides evidence of the type of work that immediate residents are capable of doing to support community constructed effort, but also offers another hybrid model of volunteer and professional labor for the design and build phases of the project.

SUMMARY

The community-based architecture case studies offer ways that differently scoped and defined communities are involved in architecture. In keeping with Principle Three: Be Locally Integrated, the success of all these programs is heavily dependent upon the willingness of participants to volunteer their time and the availability of skilled leaders. With the breadth of community of which Wolf Ridge is a part there is potentially a huge contingent of volunteers who, through formal classes or volunteer work weekends could be incorporated into the effort. The above examples, however, clarify that once volunteers are engaged in the process, success is dependent upon either their own construction knowledge (as in the case of the timber framer working on the Finland Community Center) or the oversight of a skilled group leader (e.g. a builder, an architect, an instructor, or a professor). Using skilled leaders would require a commitment from Wolf Ridge to employ knowledgeable builders to lead the technical effort. All of these case studies were socially engaged, though not all were environmentally sustainable, which is also integral to Principle Three: Be Locally Integrated.

As most of these case studies actively incorporated education into the process there is clearly great overlap with Principle Two: Be Educationally Transparent. As a learning center, Wolf Ridge is well poised to incorporate some of these community-based design and building processes into existing and new curriculum. By employing local contractors to build a progressive, alternative, and efficient structure there is education of the trade people about sustainable construction techniques which may bleed over into their own projects.

SUSTAINABILITY

Intrinsic to the idea of Principle Three: Be Locally Integrated is that of sustainability. By keeping materials and labor local, Wolf Ridge would be supporting its community by creating jobs, leveraging local knowledge, and developing skills of participants. This local focus offers the financial multiplying force of local investment—local wages go to local people who then buy other goods and services locally. While this is an important part of sustainable local agenda, so too are the more traditional architectural attitudes toward sustainability (renewable energy and green materials). To this end several sustainable buildings were reviewed to provide information to help craft a relevant definition of sustainability for this project.

LEWIS CENTER

Oberlin College's Adam Joseph Lewis Center for Environmental Studies, constructed in 2000, is one of the more prominent early designs that focused on sustainability. William McDonough + Partners designed the building to be a net exporter of energy that would process its own waste on site. To help keep the building within the energy budget, the structure was designed with both passive and active systems. The east/west structure was earth bermed to reduce convective cooling and to increase ground contact and utilize the Earth's constant temperature. A geothermal system was installed to further harness the heating and cooling potential of the Earth. At a material level the use of recycled, FSC certified, and low VOC materials helped the building to achieve sustainability. The Living Machine, a series of tanks of plants used to digest waste, proved to be much more energy intensive than early modeling suggested. Therefore when opened, the Lewis Center did not meet its energy goals. Eventually sufficient new funds were raised to place additional photovoltaic panels as a canopy over the adjacent parking lot, meeting the building's energy goal. [10]

Figure 33: Oberlin's Lewis Center for Environmental Studies

Figure 34: Lewis Center's Living Machine

Overall the Adam Joseph Lewis Center for Environmental Studies is an early study in combining several systems to push sustainability on multiple levels. The mixed success of the Lewis Center makes it an even better example for study, since it provides the opportunity to study not only the initial intents of the building but also the ways the systems were adjusted to meet the goals over time.

Particularly relevant to Wolf Ridge is the idea that fitting into an ecosystem requires changes in behavior. While the Lewis Center budgeted for a certain amount of energy use, it exceeded the allowance. At that point there were several choices available to the architects and the college management: they chose to increase energy supply instead of adjusting energy use. This example is useful for illustrating a potential challenge and tension between Principle One: Be Comfortably Private and Principle Three: Be Locally Integrated.

ALDO LEOPOLD LEGACY CENTER

The first LEED certified carbon neutral building in the USA is the Aldo Leopold Legacy Center in Baraboo, Wisconsin. Designed by the Kubala Washatko Architects, the Legacy Center uses local resources in the building and heating of the structure. Volunteers harvested trees from the Aldo Leopold Foundation's land, and in doing so improved forest health and provided material used in the whole-tree trusses that are highlighted throughout the structure. A salvaged stone Rumford fireplace was installed, and local earth plaster was used to finish the interiors of the buildings. Material choices are only the beginning of the sustainable moves incorporated into the building. Like the Lewis Center, the Legacy Center relies on photovoltaic panels to provide energy for the building. Passive systems were included to help keep the building within the allocated energy and carbon budget. These architectural moves include day lighting, natural ventilation, overhangs, high levels of insulation, and the inclusion of a thermal flux zone. Heating is achieved through a combination of earth tubes, an in-floor hydronic system, and wood stoves and fireplaces. While not endeavoring to clean its own waste on site, the facility does include rain gardens to manage rain water. [11]

Figure 35: Aldo Leopold Legacy Center

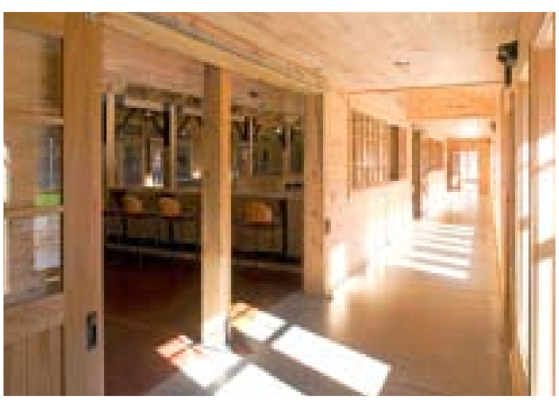


Figure 36: Thermal Flux Zone, Aldo Leopold Legacy Center

The Legacy Center is a successful building that has achieved carbon neutrality through the use of local renewable resources to power its heating and electrical usage. The forested site and carbon sequestration capacity was also critical to reaching a carbon neutral standing. The example of the Legacy Center certainly suggests a possible goal for the new Wolf Ridge building: carbon neutrality. It is important to recognize that being energy neutral and carbon neutral might not be one in the same.

HARTLEY NATURE CENTER

Even closer to Finland, Minnesota is the Hartley Nature Center in Duluth, Minnesota. Hartley Nature Center does not have the same financial resources as either Oberlin College or the Aldo Leopold Foundation had to build as comprehensive sustainable structures. Stanius Johnson Architects, the designers of Hartley Nature Center, rely more heavily on passive systems—orientation, day lighting, and solar wall heaters—than the other two centers. Despite the limited budget for the Hartley Nature Center, photovoltaic panels were deployed for energy generation, but at a demonstration level rather than at a net zero level. Materials also play an important role in Hartley Nature Center's sustainable agenda, with the inclusion of recycled aluminum shingles, recycled carpet, recycled paint, pervious pavers, and FSC certified wood. While not achieving the same levels of self-sufficiency as the other two projects, Hartley Nature Center does strategically mix active and passive systems effectively to achieve a high level of sustainability and provide educational opportunities with demonstration systems. [12]

The Hartley Nature Center is a useful example for how to achieve a high degree of sustainability and low environmental impact on a tight budget—which is a constraint for Wolf Ridge, as well. Beyond the fiscal constraints and resulting compromises, Wolf Ridge will need to be prepared for other compromises that may be necessary between the three design principles.

Figure 37: Hartley Nature Center

Figure 38: Skyline House

SKYLINE HOUSE

Another building that could inform the decision-making around Wolf Ridge's new building is the Skyline House, also located in Duluth, Minnesota. The Skyline House is a private residence, unlike the other case studies reviewed, all of which are, to some degree, educational facilities. Wagner Zaun Architecture strived to achieve the Passive House standard with this structure—emphasizing passive techniques and systems over active systems. The house is super-insulated, with strategic window placement to allow ample solar gain as well as day lighting. The house also is incredibly tight, with very few air exchanges per hour and requires a ventilation system to maintain proper airflow. The lot on which the house is constructed is not ideal for solar orientation, so the structure does not maximize the solar resource as it could in another location. Heating is provided via a combination of a fireplace and a solar thermal water heater, which also supplies domestic hot water. This combination requires almost no non-renewable energy to heat the house or water. While the house does not quite meet the Passive House standards, it is projected to use between 10-20% of the energy of a standard house, making it an energy efficient dwelling. [13]

The project offers a comprehensive system to help minimize energy demands so that integrating with the ecosystem in terms of energy usage is easier to achieve. Such passive structures also alleviate the need for behavior modification as was considered at the Adam Joseph Lewis Center for Environmental Studies.

SUMMARY

While there are no universally accepted definitions of sustainability in architecture, these case studies offer differing perspectives on ways to make buildings sustainable and integrated into the local ecosystem. They all employ passive and active strategies that can be adopted for Wolf Ridge. Since many of the projects are located in environments similar to the North Shore they provide strong examples of what could work in such a harsh climate. One of the key lessons is the importance of reducing energy requirements prior to introducing active systems, such as photovoltaic panels.

In addition these examples beg the question: should being locally integrated by becoming self-supporting outweigh the use of local materials and methods which might be more costly than traditional building methods? This is a conflict that exists within Principle Three: Be Locally Integrated, one that is difficult to address without the constraints of fiscal reality.

EVALUATION SYSTEM

There are no universal evaluation systems to guide design and quantify sustainability, in part due to the lack of any single definition of sustainability. There are several different systems in the USA and even more world-wide. I have chosen to use the Living Building Challenge's criteria to inform my design. The Living Building Challenge is a new, progressive system, one that seeks to adjust how such systems approach building. With an emphasis on systems and resources that buildings use over their life, rather than just in the construction process, the Living Building Challenge seeks sustainability not just green construction. The Living Building Challenge works well with the design principles set out for this project, particularly Principle Three: Be Locally Integrated, supporting both local resource use but also integration into the existing ecosystem.

LIVING BUILDING CHALLENGE

This evaluation system was developed by the Cascadia Region Green Building Council in the Northwest to further the LEED standard beyond a series of applications that "green" buildings. Using a framework similar to the LEED system, Living Building Challenge (LBC) proposes that rather than making a series of prescriptive applications to improve existing building technology, structures should strive for performance. As an example, a building should be "net zero water" rather than reducing "overall irrigation demand by at least 20%". The structure of the Living Building Challenge is composed of six modules containing 16 prerequisites. These modules are site, energy, materials, water, indoor quality, and beauty and inspiration. [14]

Figure 39: Living Building Challenge diagram

Site

The site module, intended to curb sprawl, includes three prerequisites: responsible site selection, limits to growth, and habitat exchange. Responsible site selection focuses on stopping sensitive habitats from being developed. Much of Wolf Ridge's land is considered "sensitive"; there is, however, an educational exemption for facilities teaching about these sensitive ecosystems. Similarly there is an educational exemption for the limits to growth prerequisite which states "projects may be built on previously developed sites, either greyfield or brownfield".

The final provision of the site module is habitat exchange in which each acre of developed land is matched with an acre of preserved land. Wolf Ridge easily has sufficient acreage on site that is preserved as natural habitat to meet this prerequisite. Thus all of these stipulations can be met while staying true to Principle Three: Be Locally Integrated and maintaining the local ecosystem.

Energy

The energy module includes one prerequisite: net zero energy. This means that 100% of the buildings' energy is supplied by on-site renewable energy on a net annual basis. Any combination of energy sources is available for the new construction at Wolf Ridge from wind, solar thermal, photovoltaic, micro-hydro, and geothermal; some of these are already in use as part of the energy supply and as demonstration projects. The Living Building Challenge does not endorse the use of wood heating in its energy module, yet due to Wolf Ridge's location and forest resources wood is an abundant and, through careful usage, a renewable resource.

Materials

The five prerequisites that make up the materials module are: materials red list, construction carbon footprint, responsible industry, appropriate materials/services radius, and leadership in construction waste.

The materials red list contains chemicals and materials that may not be used in the project due to their toxic nature. Most of these materials are easy to avoid, as alternatives exist for them.

Construction carbon footprint is a one-time carbon offset based on the size and type of the building. This is a purchased offset based on many factors however design can reduce the overall amount of carbon needing to be offset.

Responsible industry stipulates that all wood must be FSC certified or from salvage sources. Not only are there FSC certified forests in the region, but wood for harvest is available on-site and Wolf Ridge can determine how the timber is harvested.

The fourth prerequisite for the materials module is appropriate materials/services radius. This covers from how far away materials or services may travel to be included in the building, in an effort to reduce the carbon footprint of the building. The heavier the material, the closer it needs to be sourced with the exception of renewable energy technologies. These technologies are granted a much greater distance to ensure the inclusion of sufficient technology that achieves the other prerequisites (e.g. net zero energy). Consultant travel is limited to 1500 miles, providing a strong point of reference for labor sourcing. Given the richness of certain resources—both human and material—along the North Shore, the bulk of the foundation, structure, interior, and exterior finishes for the Wolf Ridge project could be limited to even tighter radii, to highlight and increase the use of local materials.

Living Building Challenge

Material or Service	Distance (miles)
Ideas	12,430
Renewable Energy Technologies	7,000
Consultant Travel	1,500
Lightweight Materials	1,000
Medium Weight Materials	500
Heavy Materials	250

Local Modifications to LBC

Material or Service	Distance (miles)
Constracting and Labor	50
Timber, Stone, and Siding	50

Table 1: Resource Distance Requirements

The final prerequisite, leadership in construction waste, stipulates percentages of building waste that must be diverted from landfills. The North

Shore has extensive recycling programs in place and any wood waste from the site can be used to heat the building.

Water

The fourth module, water, is similar to the energy module. The two prerequisites are net zero water and sustainable water discharge. Net zero water means that all water used on site must either be captured or reused. Therefore there must be an on-site water purification system that does not use chemicals. While residential scale water purification is uncommon, this can be integrated into the building and site.

The second prerequisite, sustainable water discharge requires all discharge to be handled on site. Thus there must be water retention systems, as well as a natural filtration system for water leaving the site. While there are many wetlands within Wolf Ridge's property, a constructed one can be incorporated into the design, filtering the water before it rejoins the Sawmill Creek watershed, and from there, Lake Superior.

Indoor Quality

The indoor quality module includes three prerequisites. The first is a civilized work environment, which requires access to fresh air and daylight for every occupied space. This is easily integrated into the design. The second is healthy air—source control, which requires a series of measures to reduce the presence of toxins in the air and provide separate ventilation for kitchens, bathrooms, chemical storage, copy rooms, and janitorial closets. These stipulations can be integrated into the design. The final prerequisite for the indoor quality module is healthy air—ventilation, which requires air change rates in compliance with California Title 24 requirements. With the intent of making the building as efficient as possible and limiting the amount of energy to make it comfortable, the design will be for a tight structure, which in turn necessitates mechanical ventilation.

Beauty and Inspiration

The last module in the Living Building Challenge is beauty and inspiration. The two prerequisites that constitute this module are beauty and spirit and inspiration and education. To satisfy the beauty and spirit prerequisite the design must contain "features solely intended for human delight and the celebration of culture, spirit and place". Many off the efforts to build locally, both with materials as well as traditional construction techniques fit well with this prerequisite. The second, inspiration and education, requires that educational materials be available and that the public be afforded access at least one day per year. This final prerequisite fits entirely within Wolf Ridge's mission and would be a core requirement of the new building.

RESOURCE RESEARCH

One implication of Principle Three: Be Locally Integrated is the emphasis on productive use of local resources. Other industries, most notably food, have been embracing the "local" movement. Many restaurants and groceries are highlighting their use of local resources. This movement is rooted in improving the economic, environmental, and social health of an area. Additional benefits include reductions in transportation costs, fossil fuel usage, and the associated pollution.

Like the food industry, the building industry has become international. As a case in point, an Indian company recently bought one of the iron mines in Northern Minnesota. The company's intent is to build a steel furnace that can process and finish steel that will be shipped directly from the mine to India.[15] While the building industry has not made very much movement toward the "local" philosophy that is a strong trend in the food industry, the Living Building Challenge stipulates distance sourcing limitations. These limitations help achieve similar savings, both financially and environmentally, as purchasing local foods.

Three of Wolf Ridge's communities are local (employees, Finland residents, and Northwoods ecosystem) and would support a movement from international to local building. These communities offer a diverse set of resources to be leveraged by Wolf Ridge. These resources can be considered in three groups, human, cultural, and material. Human resources are those of local residents, whether they are employees or neighbors, who have skills useful to the building process. Cultural resources are those that inform the design about the human history of area. Local material resources are those available throughout the Arrowhead region of Minnesota.

HUMAN RESOURCES

While the Living Building Challenge does not focus on the value of using local resources, it does stipulate travel distances for design consultants: 1,500 miles. The Living Building Challenge does not, however, stipulate travel distances for labor. In keeping with Principle Three: Be Locally Integrated, labor sourcing should be constrained to the North Shore. Finland is situated at the midway point of the coast. Limiting labor to 50 miles allows access to everyone along the North Shore, from Two Harbors to Grand Marais and inland as far as Ely. Many people along the North Shore have great skill in some element of building. While there are few large-scale construction businesses, the area is home to numerous small-scale builders, timber framers, log cabin builders, electricians, plumbers, heating specialists, painters, earth movers, tilers, furniture builders, joiners, roofers, lumberjacks, millers, and many other skilled artisans. To achieve Principle Three: Be Locally Integrated, I compiled a list of potential local contributors to the building design and construction process. Interviews to gain a deeper understanding of the particular

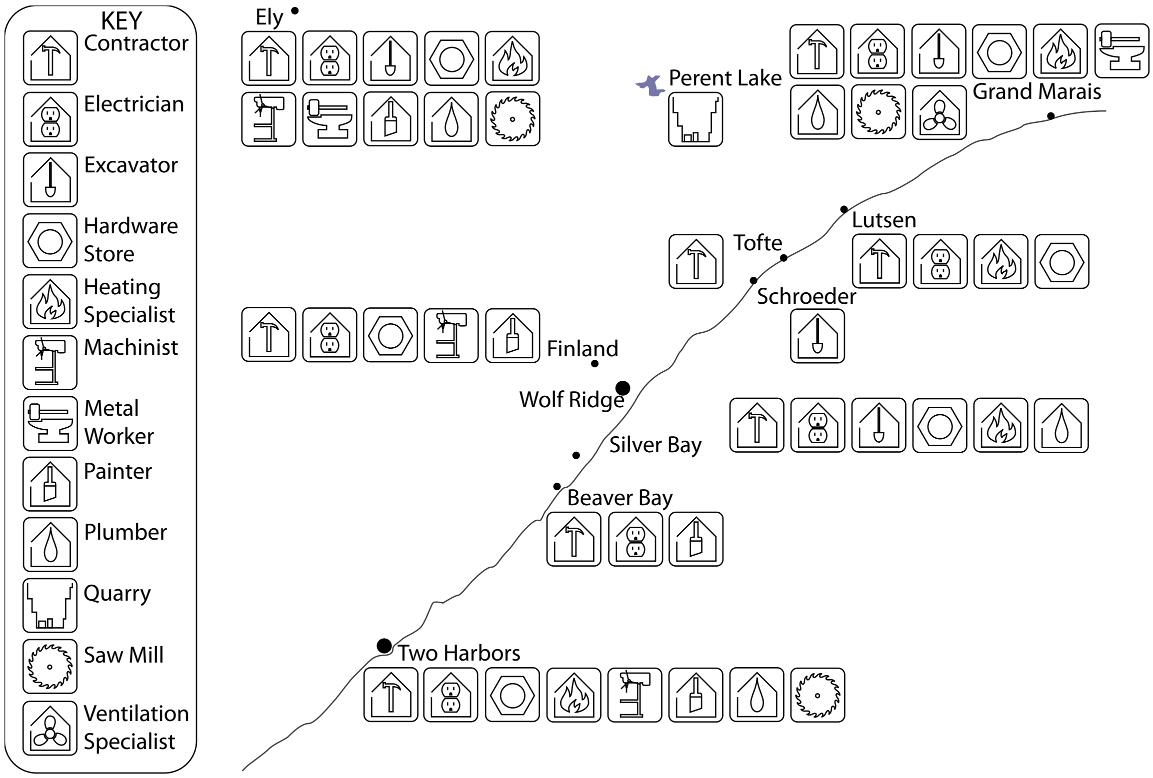


Figure 40: 50 mile resource map

skills of each artisan would be beneficial, but were beyond the scope of this project.

CULTURAL RESOURCES

In 1986, 18 Finland area families created the Finland Minnesota Historical Society to conserve the abandoned John Petaja (Pine, in Finnish) homestead. With the county's deeding of the land to the Society, the Finland Minnesota Heritage Site was created. Formed around the home of John Petaja, over the last 24 years the Society has added several original area buildings preserving early pioneer life of eastern Lake County. The site now contains six structures, five of which are original to the region. The nexus of the site is John Petaja's home built by John when he arrived in Finland in 1906. He used his axe to fell, square, and dovetail a two room, stacked timber home for himself. Also on the site is the heritage sauna, another hand-hewn, stacked-timber structure. Unlike the house, the sauna is not original to the site; it was moved from another homestead located along the Baptism River. The Minnesota Forestry building, built in 1927, is also a stacked timber structure, but instead of squaring the timbers, the logs they have been left in their natural round form. The building is currently used as the visitor center. The last stacked log structure on site was moved uphill from Fenstad's Resort on Lake Superior; it has been repurposed from rental cabin to restrooms and site storage. The Park Hill School, from 1917, the area's first one room schoolhouse, is the final original building on the site. This is the only structure that was built using milled lumber and a balloon frame structure. In an effort to expand the heritage site, the historic society built, with the assistance of Finish American Architect David Salmela, a museum building. This is a simple one room stacked timber building that fits in with the other existing structures and provides space for expansion and an assortment of displays. [16]

Figure 41: John Petaja Cabin

Figure 42: FMHS Sauna

Figure 43: FMHS VIsitor Center, former MN Forestry Building

Figure 44: FMHS Restrooms, Former Fenstad's Resort Cabin

Figure 45: Park Hill School

Figure 46: New FMHS Museum Building by Salmela

MATERIAL RESOURCES

Local suggests not just the use of local skilled labor, but the incorporation of area materials. The North Shore offers prodigious natural resources—enough to build an entire home much like John Petaja did over 100 years ago. Modern sustainable structures with their complex wall sections rarely can be built with just the resources that can be regionally harvested, particularly in a harsh environment such as northern Minnesota. For example, the Petaja cabin does not have insulation, running water, or electricity in it, but the professional naturalist building will need these in support of Principle One: Be Comfortably Private.

In keeping with Principle Three: Be Locally Integrated and the 50 mile local labor zone introduced above, any materials available within that zone should take priority over others found further afield. Two of the primary materials available within 50 miles of Wolf Ridge are timber and stone. The North Shore is dominated by northern boreal forests which are rich in maple, birch, aspen, fir, pine, and spruce. All of these trees are harvested across the Arrowhead Region and all occur on Wolf Ridge's land. Under the soil, to varying depths is the Canadian Shield, igneous rock that varies from rhyolite to granite to banded iron formation. Within 50 miles of Wolf Ridge there are several mines harvesting granite as well as iron ore. Steel, however, is not currently being made locally eliminating that as a possible primary material.

While many elements of a modern building are not available within 50 miles (e.g. insulation, glazing, wiring, plumbing), the Living Building Challenge offers a set of distances from which such materials should be specified. These distances are 250 miles for heavy materials, 500 miles for medium weight materials, and 1,000 miles for light weight materials. The two local materials, timber and stone, available within the 50 miles radius, warranted further investigation in current methods of building.

TIMBER

Northern Minnesota is forested terrain and timber is in plentiful supply. As a result, there is a great deal of infrastructure including several commercial lumber mills and private portable mills, built up around this resource. In Two Harbors, located 35 miles west of Wolf Ridge, a Louisiana Pacific siding manufacturing plant processes area birch trees into wood composite siding in many different styles, including: shingles, lap, and panel. There are also many skilled craftsmen—timber framers, log cabin constructors, stud framers, finish carpenters,

Figure 47: LP SmartSide Cedar Shakes

fine cabinet makers, furniture builders, and woodcarvers—who work with wood all across the Arrowhead Region. [17]

Much of the literature about wood frame systems in building focuses on new massive timber wall systems and solid timber modules. These are interesting systems but ones that are common in Europe and unavailable in Northern Minnesota due to lack of supply. There are, however, a few case studies available on stacked timber systems that are examined below.

Stacked Timber

Stacked timber is an old, straightforward building system. These are frontier log cabins of an earlier era and the house that John Petaja built for himself when he arrived in Finland, Minnesota. Stacked timber has generally been displaced in the building industry by the standardization of lumber brought on by saw mills. Log cabins have been relegated to vacation homes and lodging meant to inspire the cultural history of the West. Senty Log Homes is based in Grand Marais and builds log cabins all across the Northwoods. The following examples demonstrate ways stacked timber is being used in Europe and suggest possibilities that are not so cliché.

The first stacked timber example is a school in St. Peter, Switzerland that uses a two-layer wall system. On the inside are the stacked, tongue and groove, 4”x8” timbers, which make up the load bearing as well as the interior finish. Attached via dovetails are vertical posts that allow for shrinkage in the wood as well as create an insulation cavity to the exterior of the stacked

Figure 48: St. Peter School

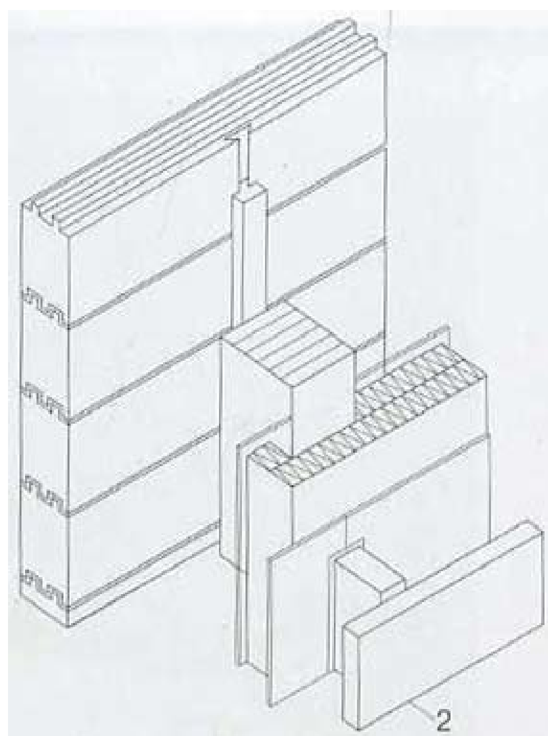


Figure 49: Wall construction detail

timber. The cladding is attached to these vertical elements. This system provides strength, mass, and with the combination of the tongue and groove and the vertical posts sufficient shear resistance. While this system offers a solution for shrinkage as well as shear, there are no sawmills currently milling tongue and groove timber along the North Shore. This system offers an example of a stacked timber structural system that successfully manages the complexities of modern wall sections. [18]

The Cultural Center in Kuhmo, Finland, offers another example of stacked timber. In this case the timber is treated in a more traditional manner, with cupped tops and bottoms instead of the tongue and groove, and dovetailed corners to help manage shear forces and to tie the whole structure together. The timbers make up the entirety of the wall, they are both the interior and exterior finish. Vertical posts again are used, though in this case they are moved away from the structure, becoming a series of verticals supporting the roof and creating a loggia. With the presence of the columns to support the roof, the wall-roof connection is allowed to be a sliding one to account for the shrinkage of the timbers over time. These stacked timbers more closely match the materials available to Wolf Ridge, though the wall section presented would be insufficient for the needs of modern buildings. [19]

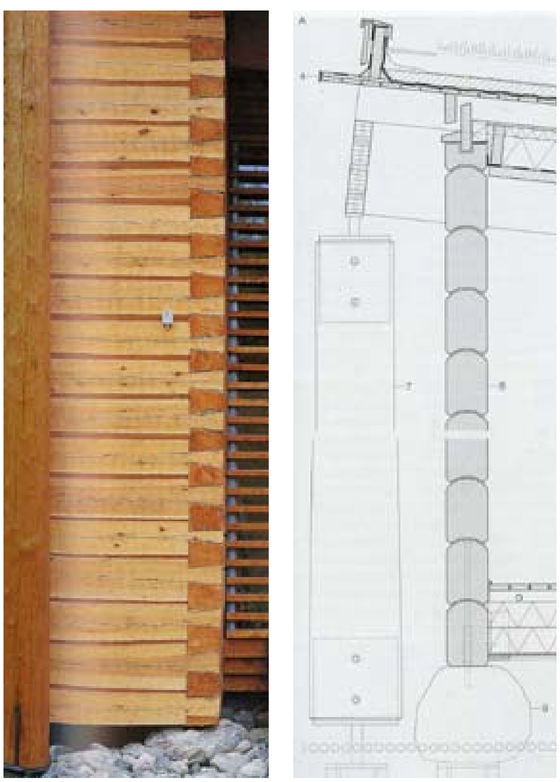


Figure 50 + 51: Corner detail + wall section

Timber Frame

Timber frames are not a subject often explored in architecture periodicals. There are, however, many books on the subject. More importantly there are many skilled and qualified individuals throughout the Northwoods who timber frame. Timber framing was one of the first classes offered at North House Folk School and continues to draw and fill several courses during their summer season. The instructors are local and alumni of Wolf Ridge's naturalist training program. One of the maintenance workers at Wolf Ridge has experience working in this medium and will be volunteering his time to construct a timber frame entry sequence for the new Finland Community Center. I consulted with Peter McKinnon of River City Builders in Kenyon, Minnesota, who has extensive experience with timber framing. While there are many ways to approach timber framing, he was of the belief that timber framing should be viewed as a structural system with a traditional language, but that need not stay within that tradition as modern structural engineers offer alternative ways to achieve structural stability. The timber frame fulfills all structural needs yet the question of insulation and skin must still be addressed. These systems are in many ways independent of the structural frame and so will be addressed separately.

Platform Framing

Hedstrom's Lumber Mill in Grand Marais can provide timbers for stacked timber and timber framing, but also produces standard dimensional lumber for use in traditional platform framing. Most builders along Lake Superior are very familiar with platform framing, the predominant wood construction system in the USA. While this system is incredibly simple to build it presents many challenges. Recently there have been many improvements to this system, particularly focused on moisture control and insulation, making it a viable option for Wolf Ridge. [20]

Engineered Wood

There are many different types of engineered timber materials available, from the ubiquitous plywood and OSB, to the less common glu-lams, LVLs, PSLs, and solid timber modules. None of these are produced near Wolf Ridge, except the previously-mentioned Louisiana Pacific siding

Figure 52: Hedstrom's Lumber Mill, Grand Marais

Figure 53: Lumber, Hedstrom's Lumber Mill

from Two Harbors. Therefore all the wood that would be used in the structure would be pure timber that is either rough sawn, or finished. The type of available wood leaves several different structural systems possible and creates the option of using the same wood for flooring, cabinetry, furniture, finishes, and heating.

Summary

The combination of an abundant materials and a skilled labor force makes wood an ideal material to use in the construction of the new building. The different wooden structural systems offer advantages and disadvantages, though all of them work well with Principle Three: Be Locally Integrated. Thus they should be viewed through the other two principles to help clarify the possibilities and determine the optimal structural system. Since the new building will be serving multiple purposes, a hybrid of these different structural systems may be beneficial to the overall design.

STONE

On-site stone availability is limited to gravel and cobbles from Wolf Ridge's gravel pit. For larger stone, one option is the Perent Lake mine—less than 25 miles away—used by the Cold Spring Granite Company based out of Cold Spring, Minnesota. The company harvests rough blocks, as small as 2'x2'x8' and as big as 5'x5'x10', and ships them 200 miles to the cutting facility in Cold Spring. While the Cold Spring facility would still be viable according to the Living Building Challenge distance criteria, to avoid the cost and impact of transporting heavy stone all the way to the cutting facility and then back to Wolf Ridge, I focused on use of rough hewn stone and smaller pieces. This would include: quarry blocks, field stone and debris from the mining process, as well as what is available at Wolf Ridge. Some possible approaches for using these types of stone were explored as detailed below. [21]

Figure 54: Stone, Wolf Ridge gravel pit

Figure 55: Academy of Music, Santiago de Compostela

Figure 56: Detail, Academy of Music, Santiago de Compostela

Stone Panels

The Academy of Music in Santiago de Compostela is an example of a building clad in rough stone. The exterior is riddled with drill marks and presents a very uneven, albeit uniform, façade. The cladding is simply the exterior cuts from rough quarry blocks of stone. One side is left in quarry condition the other sides are finished to allow for ease of mounting and matching. While the building offers a visage of roughness, the work is in fact smooth and refined and cannot be created within the 50 mile local supply standard for Wolf Ridge. [22]

Dry Stacking

Another structure with a stone finish is a house designed by ARTAU SCRL in Ardennes, Belgium.

Rather than working with larger quarry blocks, the architects have specified smaller cobbles and stacked them. The use of field stone and quarry debris would eliminate the need for processing. To achieve a stable, elegant façade, however, would require skilled stone masons—not one of the artisanal skills identified in the area immediately surrounding Wolf Ridge. Thus while this option presents an effective method of using local material, the absence of skilled labor counter indicates the use of such a technique. A slightly less skill-intensive method would include the use of mortar beds rather than dry stacking. This is hampered by the lack of a local source for mortar. Therefore this method would not work

Figure 57: Detail, Residence, Ardennes

Figure 58: Residence, Ardennes

for the project at this time, but given that the shortage is human, rather than environmental, this could change and in the future be an option for Wolf Ridge. [23]

Gabions

Over the last fifteen years, the use of gabions, once a humble bank stabilization technique, has exploded into the world of architecture. Titus Bernhardt's house in Stadtbergen is a fine example. The house is covered, walls and roof, with gabions presenting a very classic house form made, apparently out of rubble. A more stylish iteration was done by Herzog and de Meuron for a vineyard in California. The use of gabions over glass intorduces an exciting play of light across the interior of the structure. This technique, filling wire mesh cages with cobbles and rubble, offers the use of local materials as well as reducing the necessity of skilled labor that a stacked stone wall requires. This method could work well for Wolf Ridge. [24]

Summary

While stone is abundant and an extremely durable material, the shortage of skilled artisans combined with a lack of local processing makes the use of stone in ways similar to these case studies difficult. These examples only demonstrated the capacity of stone as façade. The durability of stone makes it ideal for other building elements. The absence of locally available concrete and the desire to be locally integrated means stone

Figure 59: Residence, Stadtbergen

Figure 60: Gabion/Window detail

Figure 61: Vineyard, California

could be used as a foundation element. The local stone supply offers rough blocks, quarry debris, cobbles, and gravel. However filtering these materials through the shortage of local skilled labor suggests the use of unprocessed quarry blocks or gabions in the design.

SYSTEM RESEARCH

In addition to the use of local materials and labor in the construction, the use of local energy resources in the daily functioning of the building is also a critical element to fulfilling Principle Three: Be Locally Integrated. Wolf Ridge is situated in the midst of a prodigious natural resource: the North Woods. Already Wolf Ridge's central heating plant utilizes wood-fired boilers. Thriving within and as part of an environment requires not only the use of the environment, but also the ability to return useful resources back to the environment. This means striving to create a building that can function based on the local resources while also cleaning its waste before returning it to the local ecosystem. These ideas are an important part of Principle Three: Be Locally Integrated.

While primary building materials were localized for sourcing, the system components that are critical to making the building habitable are allowed a wider origin. This shift in sourcing is necessary due to lack of local heating, electrical, water, waste, and ventilation system resources—not to mention the importance of Principle One:

Be Comfortably Private. According to the Living Building Challenge, renewable energy systems may come from as far as 7,000 miles; which covers nearly75% of the world.

HEATING

While there are very few net zero energy buildings in existence, almost all of them take advantage of the huge mass of the earth and the efficiency of geothermal systems to moderate their heating and cooling needs. The most common system to employ the nearly constant temperature of the earth by using wells drilled deep into the earth to provide the geothermal energy. This is an expensive system and one that becomes more so when the underlying bedrock exists essentially at the surface of the site, which is the case at Wolf Ridge. Lake Superior has a powerful effect on the summer climate and the need for summer time cooling is minimal at best (70 cooling degree days at 75°F). Therefore the cost effectiveness of such an expensive solution is questionable, particularly in light of the abundant, renewable resource of the boreal forests. Systems that solely provide heating are significantly cheaper than geothermal systems and with the intense heating load (10,225 heating degree days at 65°F) are wiser investments for Wolf Ridge. [25]

Alternate systems that will provide for either carbon neutrality or net-zero energy for heating are photovoltaics and electric heating, solar thermal water heaters, solar wall heaters, and

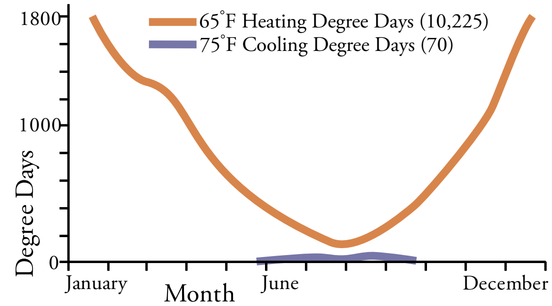


Figure 62: Heating and cooling degree day diagram

Figure 63: ScandTec Solo Plus wood gasification boiler

Figure 64: Heat storage system

a carbon-neutral locally available fuel source: wood. The use of only current solar input is feasible in a combination of photovoltaics and solar thermal. Due to the temperature extremes that Wolf Ridge can face, relying on one system is questionable. Thus solar thermal panels will be used to supply domestic hot water, with the excess contributing to the space heating needs of the structure.

The primary heat source will be the on-site renewable one—wood—in keeping with Principle Three: Be Locally Integrated. An ultra-efficient wood-fired gasification boiler pared with liquid heat storage unit and a hydronic heating system will efficiently and sustainably provide for the heating needs of the new building year round. Because such a system burns hot and quickly heating the liquid in the insulated storage system, the boiler will be fired only as needed rather than fulltime. An added benefit of the system is that Wolf Ridge's maintenance team that has over 70 years experience working with wood-fired boilers and will be able to not only maintain the system but train the student naturalist to operate it on-site. [26]

ELECTRICITY

The Living Building Challenge stipulates that a structure be net zero energy. This aligns well with two of the projects principles—Principle Two: Be Educationally Transparent and Principle Three: Be Locally Integrated. To meet this requirement, the structure, through sustainable, on-site energy generation, must supply sufficient power for the residents. The two most common systems to sustainably provide electricity are photovoltaic and wind. Both systems have been used at Wolf Ridge in some capacity for the past ten years, yielding sufficient data to understand the effectiveness of each system and their associated payback times. The new building will be situated with a southern solar window offering sufficient solar access for photovoltaic energy generation. Wolf Ridge's existing demonstration solar array has exceeded expectations and has proven the viability of photovoltaics where once they were thought untenable. Wind generators perform

Figure 65: Wolf Ridge's existing heliotropic 1 kW PV array

Figure 66: Wolf Ridge's existing 10 kW wind generator

best with constant medium speed winds, which is not the case at Wolf Ridge. The existing wind turbine, located at the Science Building, shows mixed results with large variability in winds speeds. Given the site, wind is not the optimal source for energy generation for the new structure. Therefore all of the electricity used in the new building will be supplied by photovoltaic panels. [27]

In contrast to the demonstration photovoltaic array that Wolf Ridge already has, a free-standing, solar-tracking unit, the new building will use a roof-mounted system. This different system will allow students to learn about two solar energy systems, linking back to the Principle Two: Be Educationally Transparent. In addition, by roof-mounting, Wolf Ridge will reduce the disturbance to the local woods around the new building, advancing Principle Three: Be Locally Integrated. The photovoltaic system needs to provide sufficient power to run lighting and appliances to support the work and entertainment of residents. While rules of thumb might suggest a larger array then specified, the use of energy efficient appliances in combination with encouraging conscious usage of power by the residents should allow for a smaller-than-expected array. Part of teaching the residents awareness of their energy use will be the prominent placement of electricity meters in the core of the building. These meters will provide residents—both permanent and visiting—with an instantaneous reading of their energy usage as well as overall trends relative to power produced. This not only helps individuals budget their usage but also promotes Principle Two: Be Educationally Transparent. The system will be grid-tied—using the power grid as a battery—to allow for power usage even during spells of bad weather.

WATER

Water is a growing element of sustainability, in part due to increasing awareness of how we use and pollute water as well as the ever-increasing demands for clean water. Embracing the Living Building Challenge's water module means net zero water usage and sustainable discharging of the water. Water needs to be captured, cleaned, consumed, and cycled back into the ecosystem—a requirement that is particularly critical for Principle Three: Be Locally Integrated.

The primary water source will be from precipitation that can be captured via the building's footprint. Rather than discharging rain, the roofs will collect the clean precipitation and store it in a cistern to be filtered prior to use in the structure. In addition to this initial cistern, there will be a smaller holding tank of treated water so that the residents will have visual access to their available water supply. This not only offers them a tangible reminder of their water usage, but based on Principle Two: Be Educationally Transparent acts as a learning tool both for guests who visit the house and the residents. While there are existing wells on-site, that system would only be connected to the new building for emergency use and to meet local codes.

The other element of the water system is the discharge of the water from the building. Unlike traditional systems, the waste water will not be processed together with solid waste in a septic system. Instead the water waste will be filtered and used to supply water for interior and exterior plantings. The plants will be supplied with the filtered water under the soil preventing human contact with any potential contagions. Principle Three: Be Locally Integrated suggests the need to work within the ecosystem; the natural processes that have cleaned and filtered water for millennia will be used to clean the water prior to its being released into the Lake Superior watershed. To meet local building codes, however, the new building will be plumbed to connect to the existing, on-site septic system.

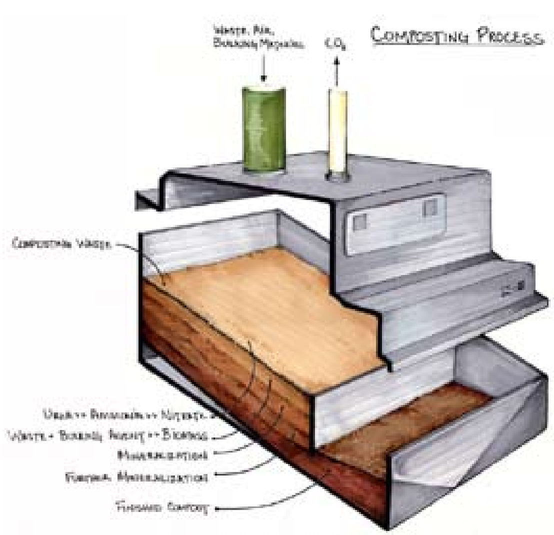


Figure 67: Clivus Multrum composter diagram

WASTE

Solid waste also will be treated without the use of the septic system. This will be achieved with the commercially available composting toilets that will eliminate any potential of contamination of ecosystem's water, in support of Principle Three: Be Locally Integrated. The composting toilets will empty into chambers located below the building in the utility space. In alignment with Principle Two: Be Educationally Transparent, this space will be externally accessible and used as a teaching site for visiting students. Once sufficient decomposition has occurred the waste can be used outside with plantings, once again returning useful products to the ecosystem in keeping with Principle Three: Be Locally Integrated. [28]

VENTILATION

In an effort to minimize air infiltration and resulting energy loss, the structure will be built to very tight standards necessitating the inclusion of active ventilation. The ventilation units will be energy recovery ventilators (ERV) allowing for heat recovery from the exhaust air to pre-warm

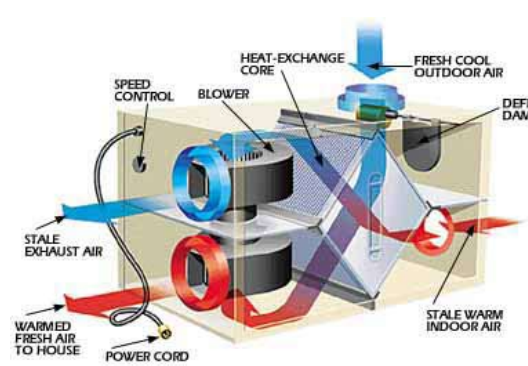


Figure 68: ERV diagram (Popular Mechanics)

the incoming air. These units will also draw air in through earth tubes, which, like geothermal pumps, use the uniform temperature of the earth to pre-condition the intake air. This process will pre-warm the winter air and cool the summer air. The intake will be located along one of Wolf Ridge's trails to provide another opportunity for educational discussion to further Principle Two: Be Educationally Transparent. There will be separate ventilation for the bath and kitchen areas, as well as a dedicated air supply for the wood gasification boiler, per the Living Building Challenge's stipulations. These additional air supplies will ensure the resident's comfort promoting Principle One: Be Comfortably Private. With these systems the air inside will stay fresh and there will be little chance of contaminating the general air with exhaust. In addition to these mechanical systems residents will be able to open and close windows and doors to manage their own comfort. [29]

DESIGN RESEARCH

Unlike the previous research sections, design research is not factual information found in books. This section marks the shift from other's work to my own as I begin sketching, modeling, and synthesizing my research.

BUILDING PROGRAM

I began this project by speaking with Peter Smerud, Assistant Director of Wolf Ridge. He introduced the problem that Wolf Ridge was facing with changing needs in client housing and demand for additional intern housing. He presented me with the schematic drawings that had been produced in an effort to secure a grant for these updates. I layered onto this project my own interest in community-based design. Through my research into Wolf Ridge I found a need to revise the program that had originally envisioned a single building that would meet the need for additional intern and client housing.

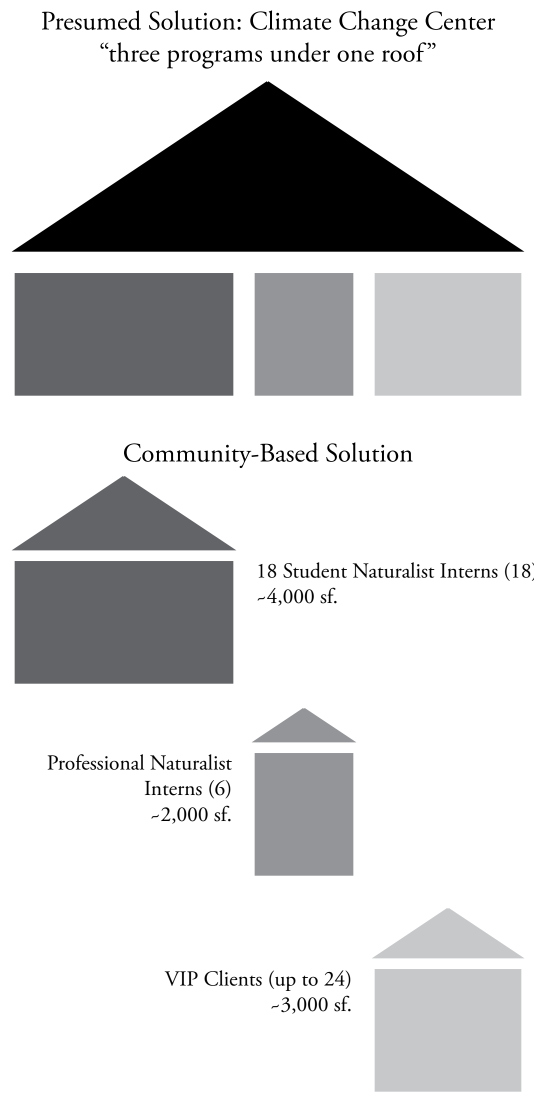


Figure 69: Community-Based Program

Principle Three: Be Locally Integrated was a particular driver of the programmatic adjustment. The lack of a local construction company capable of building a single structure of the scale specified by Wolf Ridge called into question the original intent of keeping everything local. Housing the three programs (student naturalist housing, professional naturalists housing, and special clientele housing) under one roof would suggest a structure of roughly 10,000sf. which is in scale with many of the existing buildings on site. Separating the project into the three respective programs and building a separate facility for each function reduced the scale of the undertaking. In doing so the scope of the project became one the area labor force is able to construct. Not only does this allow for the use of local labor, but it also permits the projects to potentially be spread among more contractors. Both the act of employing area talent as well as sharing the wealth amongst several neighbors improves the well being of the whole community, critical to Principle Three: Be Locally Integrated. Therefore only one of the buildings needed to be developed to express the ideas explored in this thesis and I chose to focus the project on the professional naturalist component of the program. The individuals involved in this program are in their second year at Wolf Ridge, having spent the previous year working as naturalist interns. Their previous experience sets them apart from the student naturalists and suggests a different housing option than the student naturalists.

SITE

Currently the professional naturalist interns are housed off-campus in a rented house within the community of Finland. This reflects their completion and independence from the first-year student naturalist life. In keeping with Principle One: Be Comfortably Private, the Professional Naturalist Residence has been placed at the remote Forest Ecology campus at Wolf Ridge. Located across the Sawmill Creek Valley to the north of the main campus, the Forest Ecology Building provides a venue for full-day excursions with bag lunches. The facility includes two classrooms, a lobby area, a kitchenette, storage for cross country skis for winter use, and composting toilets. There is a fire pit on one side of the building, and on the other a cord of wood, two saw horses, and misery whips (old-fashioned two-person cross cut saws) for educational purposes.

The building is one of the later additions to campus (circa 1996) and was designed with an east-west orientation to passively harness the sun for heating. Due to its distance from campus, the Forest Ecology Building is not on the centralized heat and septic systems. At the time of construction, however, the county was wary of composting toilets so a full septic field was installed as a precaution; it has never been used.

The Forest Ecology Building is underused. With the placement of the Professional Naturalist

Figure 70: Forest Ecology Building, South Facade

Figure 71: Forest Ecology Building, Interior

Residence at the Forest Ecology site, and the new educational resource it makes available to teachers, this might stimulate greater use of the Forest Ecology site. In addition the separation from the main campus will offer the professional naturalists a different experience, one of greater freedom and separation, than their previous year in which they lived on the main campus supporting Principle One: Be Comfortably Private—a physical manifestation of their development and independent new role.

In an effort to provide the new housing with a view and not be directly in-line with the existing building, it has been shifted to the north east to provide a little bit more privacy. This placement puts the new building right on the forestry ecology walking loop, providing another stop along this walking tour used to discuss forestry practices. This site easily integrates the building into the educational fabric of Wolf Ridge. Given the terrain and the county's requirement for standard back-up systems, the new housing will be situated with the existing septic system separating the two structures. By placing the new building on the north side of an existing clearing fewer trees need to be removed for the structure and its requisite solar window, keeping with Principle Three: Be Locally Integrated. This position also works well for the composting toilet chambers and the initial water collection reservoir. The terrain drops off to the east allowing for a utility room under the core without excessive excavation. This is particularly relevant given the unknown depth to bedrock, a cause of the relatively few basements in the existing buildings.

FOUNDATION

The decision not to use concrete due to the lack of nearby supply presented significant challenges. Concrete has almost entirely displaced all other foundation systems, limiting case studies. Two possible alternatives are pressure-treated wood foundations and rubble trench foundations. As there is no local sourcing available for treated wood, the former option was moot. A rubble trench foundation appeared to be a possibility, except that all modern examples of rubble trenches I was able to uncover use concrete to tie the trenches together at the top.

Figure 72: Forest Ecology site with new residence

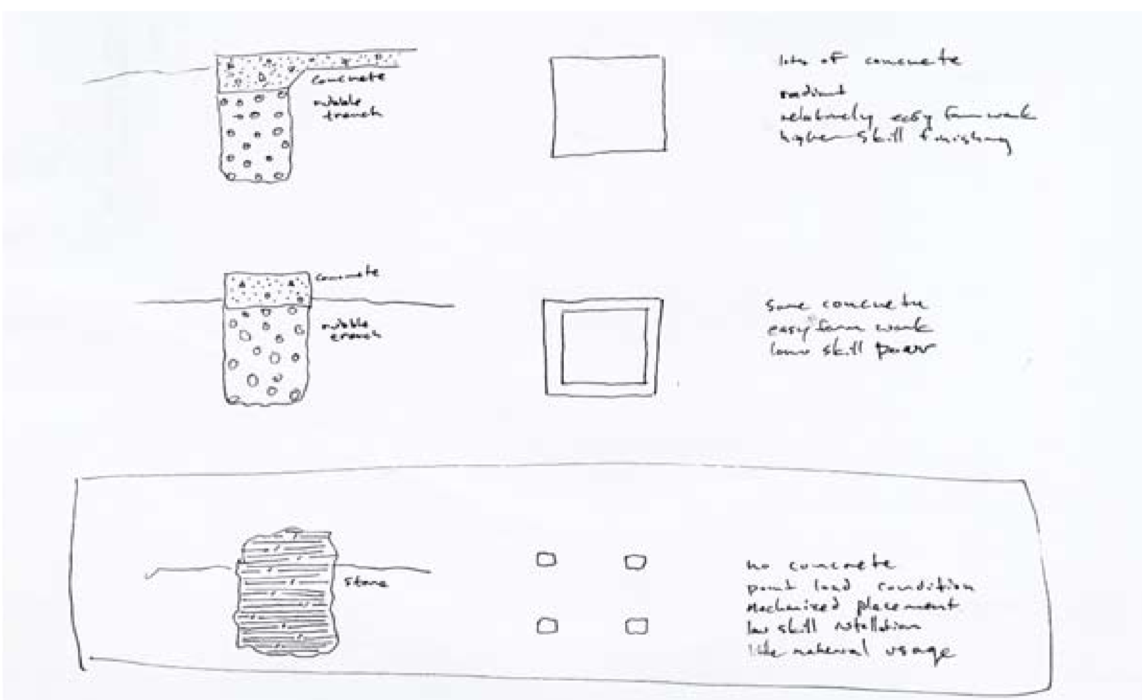


Figure 73: Foundation comparison

Stone is a resilient material that would effectively handle the needs of a foundation. Given the available forms of stone—quarry blocks, cobbles and smaller pieces—the options are relatively limited, a problem compounded by the lack of skilled masons in the area. Traditional foundations consist of foundation walls or slabs, neither of which can be achieved with quarry blocks. A pier foundation, however, offers possibilities. Commonly piers are formed out of concrete and for smaller projects pressure treated wood, neither of which are permissible for this project under Principle Three: Be Locally Integrated. One option, however, is to combine two of the North Shore's abundant materials, stone and timber, to create a pier. Rough stone quarry blocks set into the ground would provide a strong and durable earth connection. Timbers could be set on the stone blocks, creating a base for the structure. The use of stone blocks and timbers would require neither specialized skill nor processing infrastructure. Joining the stone and timber could be achieved with careful wood work or custom metal connectors, which could be fabricated by skilled metal workers in the local area.

STRUCTURE

As mentioned earlier, timber frame, stacked timber, and platform framing are each feasible wooden structural systems that would be supportable with local material and skills. These methods also need to be considered beyond their resource requirements to determine whether they are architecturally good solutions for Wolf Ridge. Timber framing suggests column grids; stacked timber implies cellular systems or thick walls; and platform framing is very open to interpretation. Through modeling and drawing, these three systems were researched and viewed through the lenses of column, wall, and roof.

Timber Frame

Column grids, a natural outgrowth of timber frames, suggest finding creative ways to break, shift, or reinterpret the grid. For this project, I focused on ways to move seamlessly from a quadrilateral to an alternate form while simultaneously delineating the private in one mass from the public in another mass. Through modeling and drawing I looked at intersecting simple rectangular forms and their sectional potential. I struggled to reconcile the conflict of exposing the craft of the timber frame—and with it the skill of the local artisan—with the need for interior divisions and residential privacy. I sought to explore buildings of one, two, three, and four column bays in widths, and cantilevering as a possible way to reduce the number of columns required. Most of these efforts lead toward double-loaded corridors, though there were explorations that presented a parti similar to the Cloister School in Disentis. Sectionally I explored traditional gabled roofs and shed roofs forms. Ultimately I decided that the simple frames were more appropriate for the requirement and fit the area cultural history and the simple natural surroundings. I settled on a traditional single bay, peaked roof form to use in areas that wanted larger openings for visual or solar connections.

Stacked Timber

Stacked timber forms are very reminiscent of the houses of the earliest inhabitants of Finland, such as John Petaja. While the form worked well then, with the addition of more modern elements, the simplicity of such a structural system faces challenges in modern times. The need to integrate into the ecosystem brings with it many new technical problems such as the addition of insulation and vapor barriers. Handling the shrinkage of the timber structure relative to the rest of the materials included in modern wall sections creates another challenge. The St. Peter School in Switzerland gives possible answers to these questions, and offers an answer to the appropriateness of the timber on the inside or outside of the wall section.

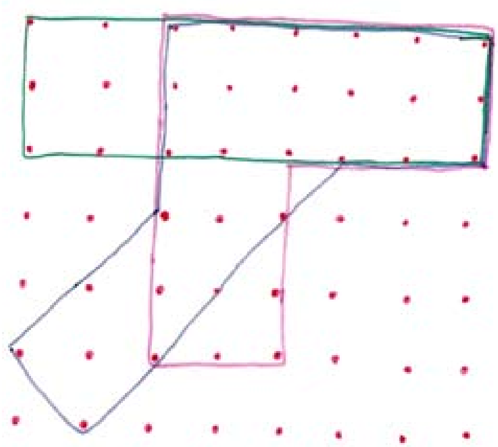


Figure 74: Column grid sketch

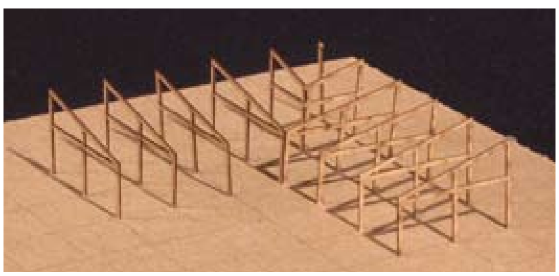


Figure 75: "Column" model

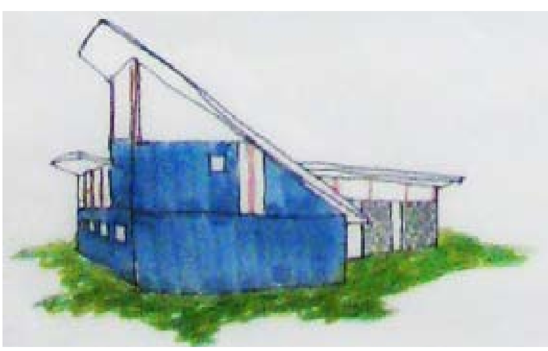


Figure 76: "Column" rendering

An additional challenge for stacked timber is the use of piles for foundation instead of a traditional slab or foundation wall. Rather than supporting the whole of the structure along the lengths of the timbers, the Professional Naturalist Residence will need to transfer the load from the timbers to piers. This can be resolved by building the foundation with an oversized timber resting on the piers on top of which the rest of the structure will rest.

Beyond these technical questions that had to be resolved, there are ones of form and space. Traditional stacked timber residences are small boxes to minimize the number for labor intensive connections. I started out attempting to make the form cellular but open. Due to the larger scale of this building and recognizing that much of the strength of stacked timber derives from the strong corner connections, I looked at staggered forms. That introduced an abundance of surface area, reducing the volume-to-surface area ratio and thus the efficiency of the structure.

I contemplated using the timbers as a thick wall that could be constructed much like wooden cribbing, perhaps even allowing for an open stacking to expose the void within. These central voids could contain services, storage, and thermal mass while still providing structure and shear resistance due to their box nature. The beauty of such a system offered not only storage within the wall, but the opportunity to leave openings in the timbers for windows and shelves. The system started to be a flexible play of parallel walls and the areas in-between flexible. This created a very modern aesthetic, particularly when paired with flat roofs. This approach also suggested a conversation between mass and void.

Platform Framing

The ubiquitous presence of platform framing in modern construction is a testament to both the flexibility of the system and its ease. Platform framing would work well for this structure, particularly if the goal to use volunteer labor, in a similar mien to Habitat for Humanity, is adopted. In this investigation, platform framing was seen as system that would accept any roof and did not necessarily suggest a particular form, unlike the other two systems. Thus this series of investigations focused on the roof, and more

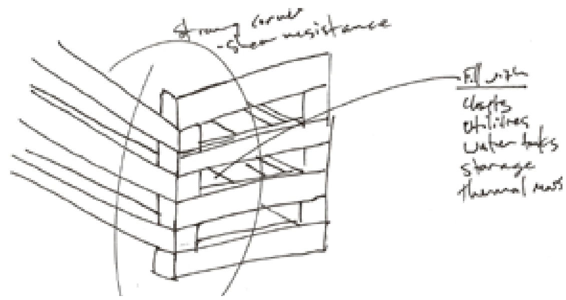


Figure 77: "Thick wall" sketch

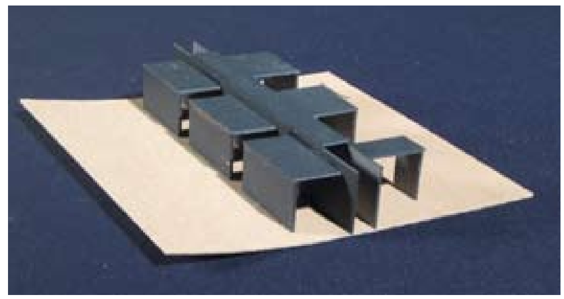


Figure 78: "Wall" model

Figure 79: "Wall" rendering

specifically what could happen under a big roof. The roof plane became a covering to allow for exterior connections between elements of the program, providing programmatic separation between the elements as well as an alternative connection to nature. Through this exploration the ideas of structure bridged forward to the next section of investigations those more specifically focused on spatial arrangement.

FORM

This next step in design is some of the most exciting work. During this exploratory phase all of the previous research that is open ended and nebulous begins to be woven together, subtly influencing other research areas. With time these competing ideas become more and more solid until a shape becomes visible which balances the goals, the principles and the communities to form a structure for Wolf Ridge.

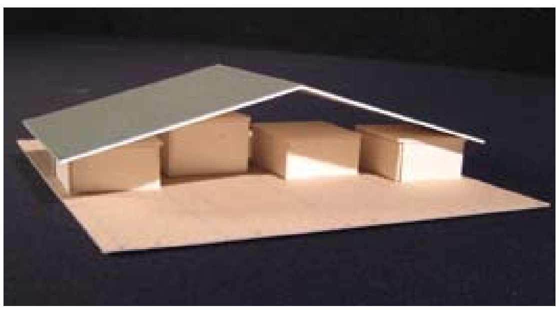


Figure 80: "Roof" model

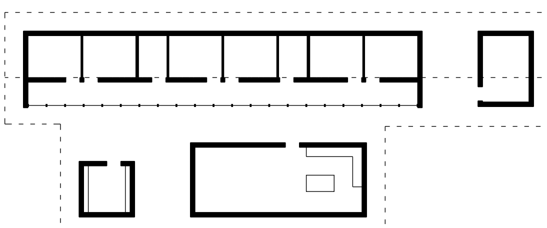


Figure 81: "Roof" plan

Figure 82: "Roof" rendering

Village

With the intent of providing greater individual autonomy, per Principle One: Be Comfortably Private, several ideas were investigated to provide both a sense of community for the six professional naturalist interns and also sufficient privacy from one another and the educational audience visiting their residence. Early explorations segregated each programmatic element into its own structure, allowing for a pure exploration of space. Could you go outside from sleeping to living quarters year round in northern Minnesota? This would allow for strict division between private and public spaces. This could be beneficial for the professional naturalist interns, in that it would allow privacy at their residence while also allowing the building to accommodate the educational goals for the thousands of students who pass through Wolf Ridge each year. This approach was an early attempt to balance Principle One: Be Comfortably Private and Principle Two: Be Educationally Transparent.

While complete separation strains connections between people and spaces, it also creates a series of 'in between areas' that offers additional opportunities. The built elements could be arranged to serve the specific needs of each program element, while also creating opportunities between them. These formal arrangements, particularly once divorced from the idea of "roof," came to embody what I eventually termed the idea of "village."

Key to the idea of village was the organic arrangement of the various building components. Initially these components included sleeping, living, studying, bathing, and a services area. These program elements allowed for voids in between them that could be used for entry, dining, lounge, and storage space. The realities of northern Minnesota weather pushed back against open air connections, and glass halls were considered as a climatic solution that still strengthen connections between spaces. This option held more potential and was further developed.

The need to consolidate sleeping and living spaces, with the studying, bathing, and service areas remaining floating apart dictated some of the considerations. As sleeping and living were linked in different ways, some of the 'in between areas' were brought back into the design as interior spaces. Eventually the studying space was minimized and incorporated into the main structure, as well as the services. The bathing component was transformed into a traditional free-standing sauna, only to be later brought into the residence. Due to the net-zero design intent and Principle Two: Be Educationally Transparent, the services were one of the most challenging program spaces to resolve. Their critical role at achieving full ecosystem integration as well as their usefulness as an educational element put particular emphasis on their design resolution. Their importance brought forth the idea of a core about which the structure radiates.

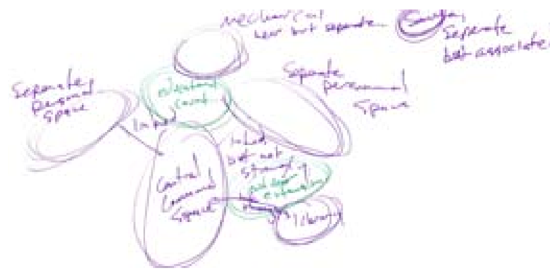


Figure 83: "Village" sketch

Figure 84: "Village" model

Figure 85: "Village" drawing

Core

The core concept originated with the peripheral services building. By housing the heat, water, air, and energy systems that allow for sustainability in a remote structure, the systems would be easily accessible for educational purposes. This would support Principle Two: Be Educationally Transparent while also allowing the professional naturalists Principle One: Be Comfortably Private. This separation of spaces also leads to the opportunity to provide visual cues to the building's function, such as using fire wood for walls, thereby integrating important storage into the structure while expressing the building function.

By segregating the services from the residents part of Principle Two: Be Educationally Transparent is sacrificed. These systems need to be accessible and present in the daily life to serve as a reminder to the inhabitants about the impact their behavior and choices have on the systems, resources, and community. Completely divorcing the systems from the building they sustain turns them into educational window dressing, rather than a visible lifeline that influences the naturalists' decisions about how to live within their ecological community. The aim is not to end up with just a demonstration project, but to create an elegantly functioning and functional residence for the professional naturalists.

To this end, the core systems were brought into the primary structure, initially in a utility room that was large enough to allow a group of students to enter directly from outside and see the functioning systems. This brought the services in greater proximity to the naturalists, though it still kept them separate and out of their daily thoughts and decisions. This meant the services were only providing for the residents' comfort, Principle One: Be Comfortably Private, and not their education, Principle Two: Be Educationally Transparent. Therefore, the core utilities were opened to the residents and given a place at the center of the structure. While this certainly makes a strong statement about the

Figure 86: "Core" evolution diagram

importance of such systems in the sustainment and life of this building, it does introduce a conflict between private and public spaces, for residents and visitors.

As a result of the decision to make the services an integral part of the naturalists' public space, Principle One: Be Comfortably Private had to be reconsidered. A design was developed to create different levels of privacy for the naturalists, as manifest in the structural systems. This had to maintain the idea of a separate entry for educational purposes and an exterior classroom space, as per the "village" concept. While visitors still gain access to the naturalists' home, the architecture minimizes the invasion and access to the purely residential spaces, maintaining a strong sense of public versus private while still allowing the crucial systems to be both present and available.

Design Summary

Professional naturalists enter the space through the covered deck on the western side of the timber framed living volume, a simple rectangular form with a peaked roof. In addition to protecting the primary entry, the porch assists in managing the low angle afternoon western sun. Immediately upon entering, the naturalist is in the open volume of the living room and dining room space; the mechanical core and bathrooms are housed at the other end of the room. There are extensive windows for passive solar heating due to the southern orientation of the volume. This also affords sweeping views toward Sawmill Creek valley and the main Wolf Ridge campus beyond. The existing septic system and the new manufactured wetland for waste water are located to the south of this space, creating an ample solar window for the building.

Figure 87: Professional Naturalist Residence

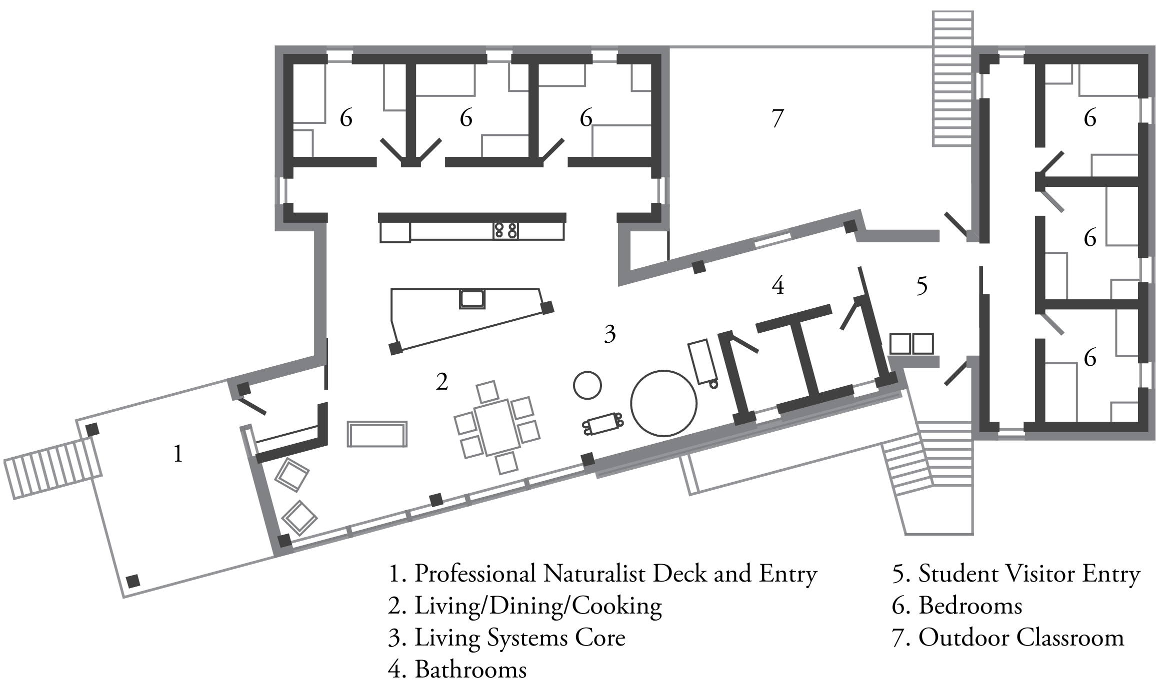


Figure 88: Diagrammatic plan

Figure 89: Professional Naturalist Intern entry

Figure 90: Communal living space

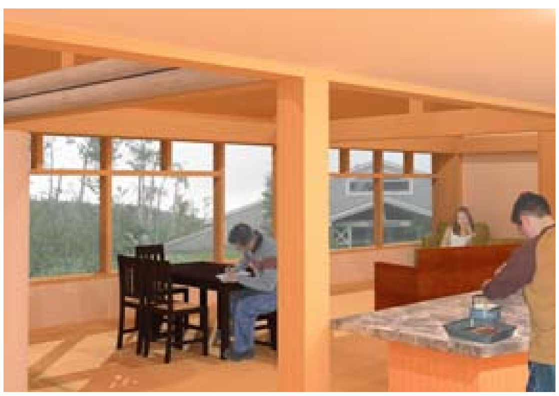


Figure 91: Visual connection to Forest Ecology Building

Figure 92: Professional Naturalist Intern bedroom

To the north, in one of the 'in between areas' is the kitchen, linking this main space and one of the sleeping wings. Past the mechanical core is the other 'in between area', offering outdoor access to the classroom deck and the stairs to the lower utility space. This link space acts as a library or office space for the residents and hallway connecting the other sleeping wing. These links are lighter framed connections between the primary living and sleeping volumes of the structure. The difference and transitional nature is expressed through lower ceiling heights and changes in materials.

The sleeping wings are identical rectangles that house three bedrooms each. The bedrooms are contained within the stacked timber elements of the structure, further emphasizing privacy in contrast with the much more open timber structure of the public areas. The windows are significantly smaller than in the rest of building and look directly into the woods since the structure is tucked in closely to the tree line along the north and east sides. Due to the 'in between areas', these two residential spaces are set apart from the public space ensuring personal privacy.

Visiting students at Wolf Ridge enter the structure via the eastern link hallway. Students will have already completed a tour of the septic mound, the constructed wetland, and the utility space beneath the core that houses the composting toilet chambers. In addition to the waste treatment systems already observed, the heating

Figure 93: Student Visitor approach

Figure 94: Student Visitor entry

Figure 95: Student Visitor core access

Figure 96: Outdoor classroom

and water systems will be visited in the house, before heading out to the northern deck that serves as an outdoor classroom. From the deck, a trail continues on to the Forest Ecology loop and the air intake for the Professional Naturalist Residence.

Conclusion

The initial idea of this thesis—to investigate community design/build process—is a worthy topic for a thesis. My initial attempts and desires for this project were flawed due to the challenges in harnessing a community's ideas and skills for a theoretical project. Using design principles based on the four Wolf Ridge communities was an effective substitution for community engagement, but it runs counter to the basic intents of community-based design. The three design principles acted as proxies, shaping all the phases of the process—from research through exploration—and ultimately the final design which reflects the four communities it was intended to serve and their resources. While a true community-based design process would have resulted in a different, likely richer product, the final outcome is unique to the design challenges and robustly delivers a space that is private, educational, and fits within the ecosystem of Wolf Ridge.

Additionally this thesis makes an argument that community design is sustainable design. Being forced to engage the Wolf Ridge community through analysis rather than participation brought light to communities that might not otherwise have had as strong a voice in this project. While the environment plays a role in any architectural endeavor, the specific naming of the Northwoods Ecosystem as one of the four communities was a critical step. Emphasizing working within the ecosystem brought the project from being a building with green technologies, such as the existing Forest Ecology Building and Science Center, to one that benefits its environment. While this shift furthers Wolf Ridge's educational mission, more importantly it demonstrates the need to be inclusive of more than the human community in any community design process. The active consideration of the environment in a community design/build project will complicate the process, but like any group effort, the more robust the input the more sublime the outcome.

End Notes

1. Peter Smerud, Personal Communication, February, 2009.
2. Ibid.
3. Peter Davey, Respect for King's, *Architecture Review*, October 2002.
4. Gion A. Caminda, Girl's Dormitory, Cloister Distentis, trans. Claire Bonney, *Architecture and Urbanism*, November 2004.
5. Concordia Language Villages, http:// waldseebiohaus.typepad.com/
6. Habitat for Humanity, http://habitat.org/
7. Andrea Oppenheimer Dean and Timothy Hursley, Rural Studio: Samuel Mockbee and an Architecture of Decency (New York: Princeton Architectural Press, 2002).
8. Greg Wright, Personal Communication, February, 2009.
9. Honor Schauland, Personal Communication, February, 2009.
10. Oberlin College, http://www.oberlin.edu/ajlc/ajlcHome.html
11. The Aldo Leopold Foundation, http://www.oberlin.edu/ajlc/ajlcHome.html
12. Hartley Nature Center, http://www.hartleynature.org/
13. Katrin Klingenberg, Mike Kernagis and Mary James, Homes for a Changing Climate (Larkspur CA: Low Carbon Productions, 2008).
14. International Living Building Institute, http://ilbi.org/: U.S. Green Building Council, http://www.usgbc.org/LEED/
15. Mining Top News, http://www.miningtopnews.com/
16. Finland Minnesota Historical Society, http://www.finlandmnhistoricalsociety.com/
17. Louisiana Pacific Corporation, http://www.lpcorp.com/
18. Schulhaus in St. Peter, Schweiz = School building in St. Peter, Switzerland, *Detail*, January 2000.
19. Kulturzentrum in Kuhmo, Finnland = Cultural centre in Kuhmo, Finland, *Detail*, January 2000.

20. Hedstrom Lumber Company, http://www.hedstromlumber.com/

21. Cold Spring Granite, http://www.coldspringgranite.com/

22. Musikakademie in Santiago de Compostela = Academy of music in Santiago de Compostela, *Detail*, June 2006.

23. Einfamilienhaus in Mont-Malmedy = House in Mont-Malmedy, *Detail*, November 2003.

24. Wohnhaus in Stadtbergen = House in Stadtbergen, *Detail*, November 2003: Herzog & de Meuron: Dominus winery, Napa Valley, California, USA 1995-1997, *A + U: Architecture and Urbanism*, April 1998.

25. Jay Johnson, Personal Communication, March, 2009.

26. Tarm Biomass, http://www.woodboilers.com/

27. Peter Harris, Personal Communication, February, 2009

28. Clivus Multrum Incorporated, http://www.clivusmultrum.com/

29. Popular Mechanics, http://www.popularmechanics.com/

Sources Consulted

Benson, Tedd and James Gruber. Building the Timber Frame House. New York: Charles Schribner's Sons, 1980.

Blackwell, Marlon. An Architecture of the Ozarks. New York: Princeton Architectural Press, 2005.

Bohlin Cywinski Jackson. Architecture of Bohlin Cywinski Jackson. Rockport, MA: American Institute of Architects Press, 1994.

Caminda, Gion A. Girl's Dormitory, Cloister Disentis. *Architecture and Urbanism*, November 2004.

Connah, Roger. 40/40 From Architects from Finland. Helsinki, Finland: Building Information Ltd, 2002.

Crosbie, Michael J. Jersey Devil Design/Build Book. Pergrine Smith Books, 1985.

Davey, Peter. Respect for King's. *Architecture Review*, October 2002.

Dean, Andrea Oppenheimer and Timothy Hursley. Proceed and Be Bold: Rural Studio after Samual Mockbee. New York: Princeton Architectural Press, 2005.

Dean, Andrea Oppenheimer and Timothy Hursley. Rural Studio: Samuel Mockbee and an Architecture of Decency. New York: Princeton Architectural Press, 2002.

Dernie, David. New Stone Architecture. New York: McGraw Hill, 2003.

Edwards, Brian. Rough Guide to Sustainability. London: RIBA Enterprises, 2005.

Einfamilienhaus in Mont-Malmedy = House in Mont-Malmedy. 2003. *Detail*. 43 (11):1270-1273.

Elliott, Stewart. The Timber Framing Handbook. York, ME: Housesmiths Press, 1977.

Fisher, Thomas. Salmela Architect. Minneapolis: University of Minnesota Publishers, 2005.

Forlag, Arvinius. Swedish Architecture in Wood. 2004.

Herzog & de Meuron: Dominus winery, Napa Valley, California, USA 1995-1997. 1998. *A + U: Architecture and Urbanism*. (4331):6-23.

Herzog, Jacques, Pierre de Meuron, and William J. R. Curtis. 2002. Herzog & de Meuron 1998-2002. *Croquis*. (109-110).

Jacobson, Rolf Erik. Place and Sustainability: A Symbiosis. CALA M. Arch Thesis, 2007.

Kachadorian, James. The Passive Solar House. White River Junction, VT: Chelsea Green Pulishing Company, 2006.

Kennedy, Alicia, Theresa Morrow, and Sheri Olson. The Best of Cutler Anderson Architects. Beverly, MA: Rockport Publishers, 2008.

Klingenberg, Katrin, Mike Kernagis, and Mary James. Homes for a changing climate: passive houses in the U.S. Larkspur, CA: Low Carbon Productions, 2008

Kulturzentrum in Kuhmo, Finnland = Cultural centre in Kuhmo, Finland. 2000. *Detail*. 40 (1):72-76.

Lstiburek, Joseph and John Carmody. Moisture Control Handbook. New York: Van Nostrand Reinhold, 1993.

McCamant, Kathryn and Charles Durrett. Cohousing: A Contemporary Approach to Housing Ourselves. Berkeley, CA: Habitat Press/Ten Speed Press, 1988.

Morrow, Theresa. James Cutler. Rockport, MA: Rockport Press, 1997.

Musikakademie in Santiago de Compostela = Academy of music in Santiago de Compostela. 2006. *Detail*. 46 (6):630-633.

Ngo, Dung. Tom Kundig: Houses. New York: Princeton Architectural Press.

Ojeda, Oscar Riera. Arcadian Architecture. New York: Rizzoli, 2004.

Ojeda, Oscar Riera. Olson Sundberg Kundig Allen. New York: Monacelli Press, 2001.

Ojeda, Riera Oscar. Ledge House. Glouchester, MA: Rockport Publishers, 1999.

Olson, Sheri. Cutler Anderson Architects. Glouchester, MA: Rockport Publishers, 2004.

Owens, Ted. Building with Awareness. New Society Publishers, 2006.

Parks, Whitney. Ingenuity in New Consumer Communities: Recycling Waste Materials for Building. CDES M. Arch Thesis, 2008.

Pehnt, Wolfgang. Lucien Kroll: Buildings and Projects. New York: Rizzoli, 1987.

Piedmont-Palladino, Susan and Mark Alden Branch. Devil's Workshop. New York: Princeton Architectural Press, 1997.

Quantrill, Malcolm. Plain Modern. New York: Princeton Architectural Press, 2005.

Schittich, Christian. Building Simply. Boston: Birkhäuser, 2005.

Schittich, Christian. Single Family House. Boston: Birkhäuser, 2005.

Schulhaus in St. Peter, Schweiz = School building in St. Peter, Switzerland. 2000. *Detail*. 40 (1):77-81.

Tiainen, Jussi. Wood: Architecture in Finland. Hämeenlinna: Rakennustieto Oy, 2007.

Timber-Frame Houses. Newton, CT: Taunton Press, 1992.

Wohnhaus in Stadtbergen = House in Stadtbergen. 2003. *Detail*. 43 (11):1274-1277.

Appendix A: Presentation Boards

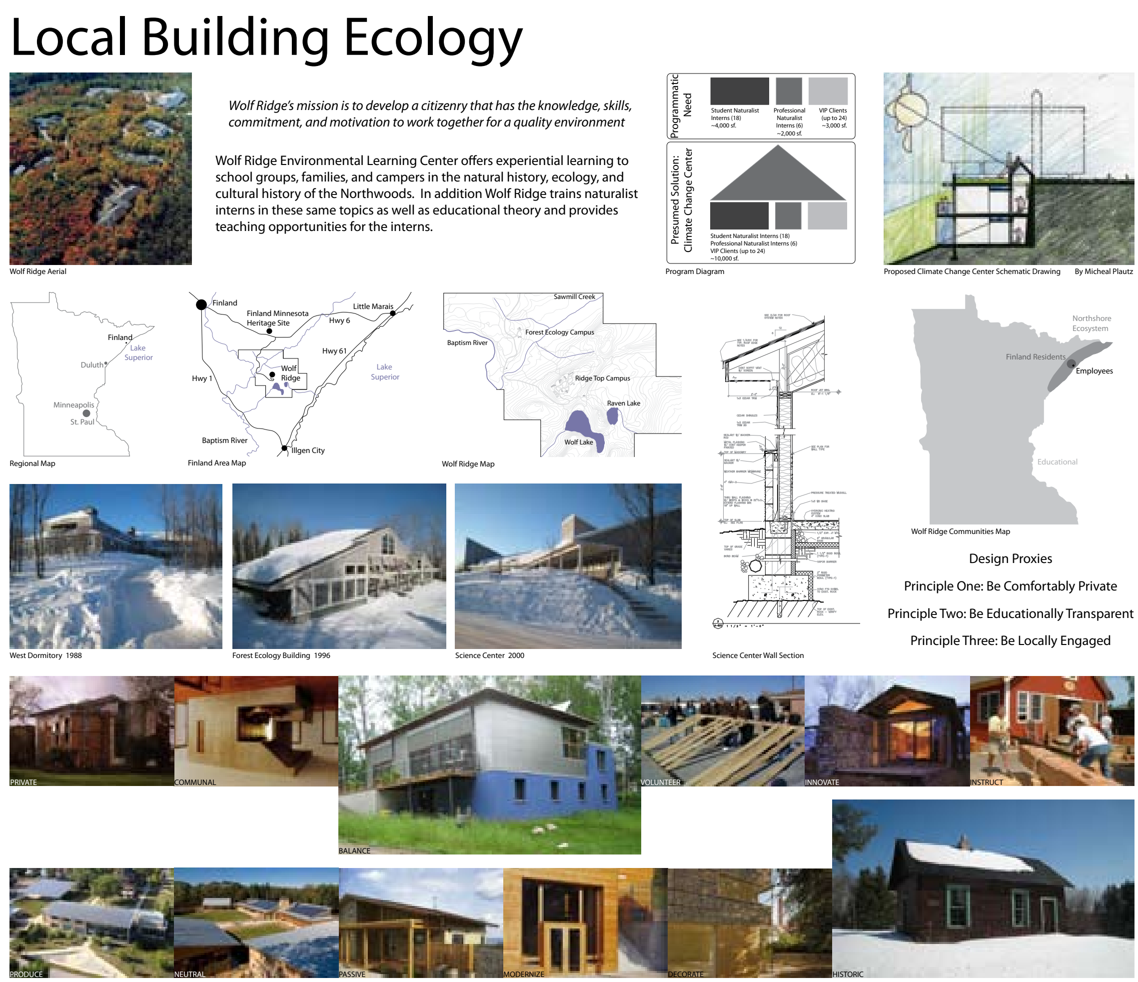


Figure A 1: Background Information

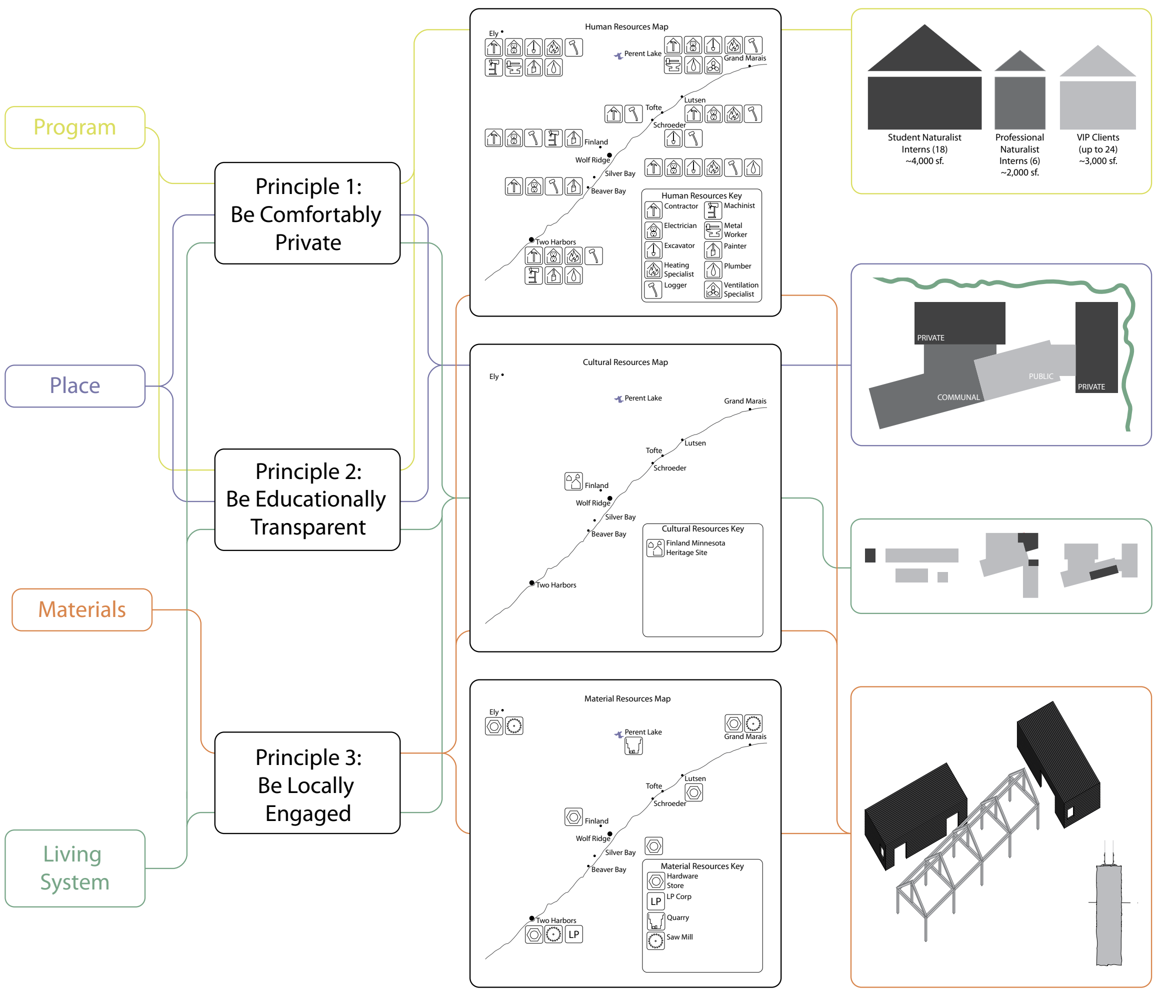


Figure A 2: Principle and Resource Diagram

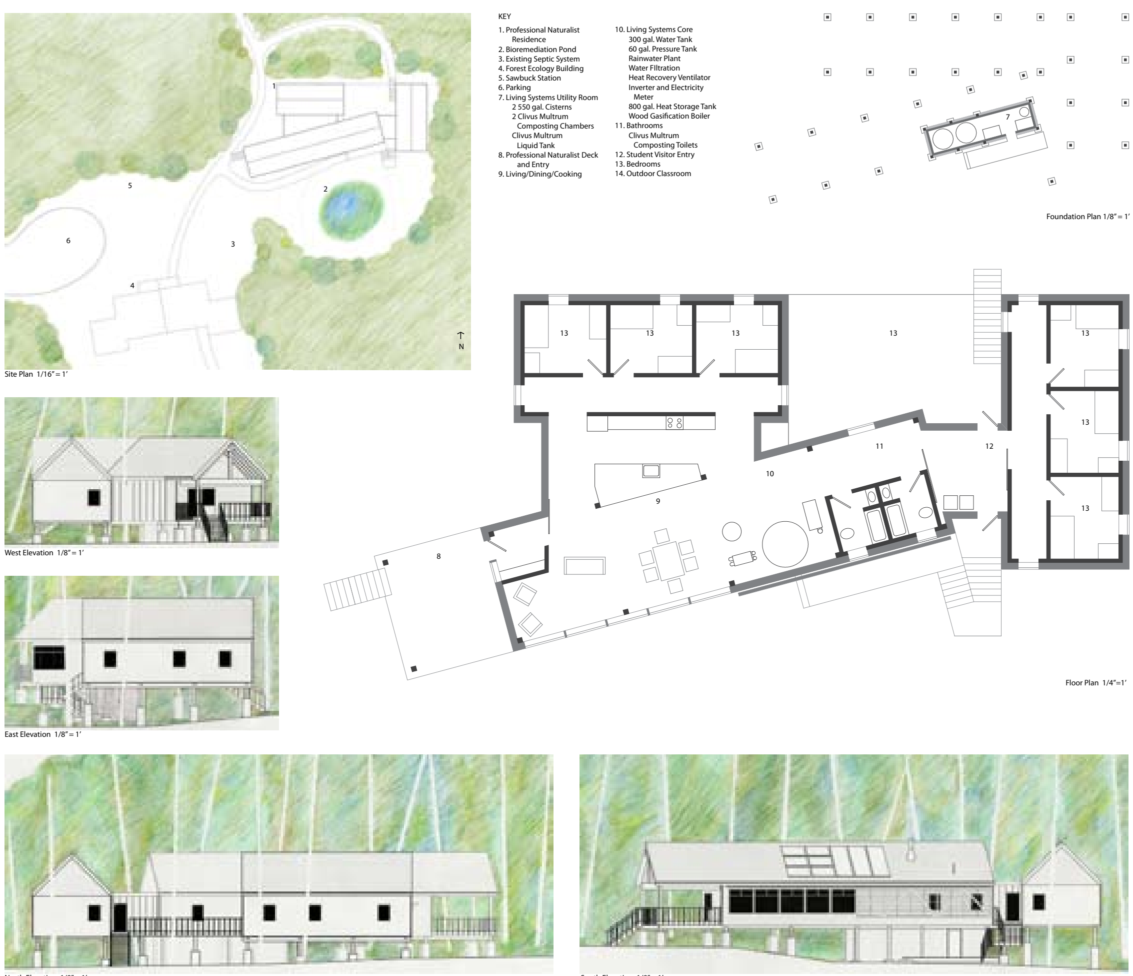


Figure A 3: Plans and Elevations

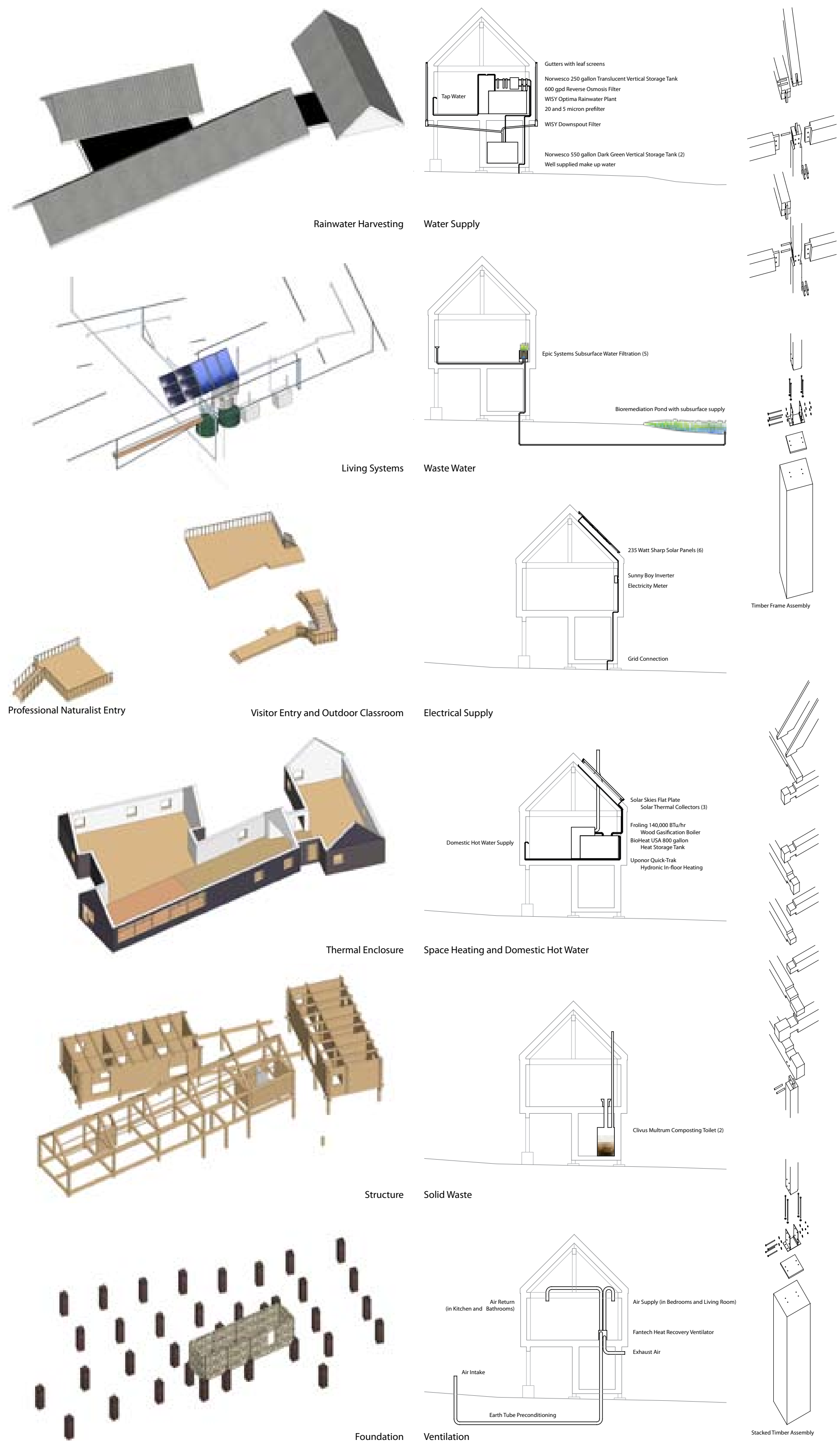
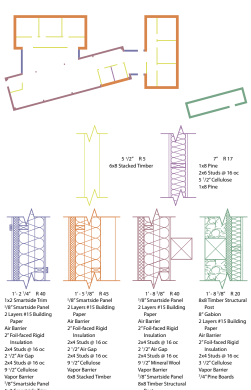
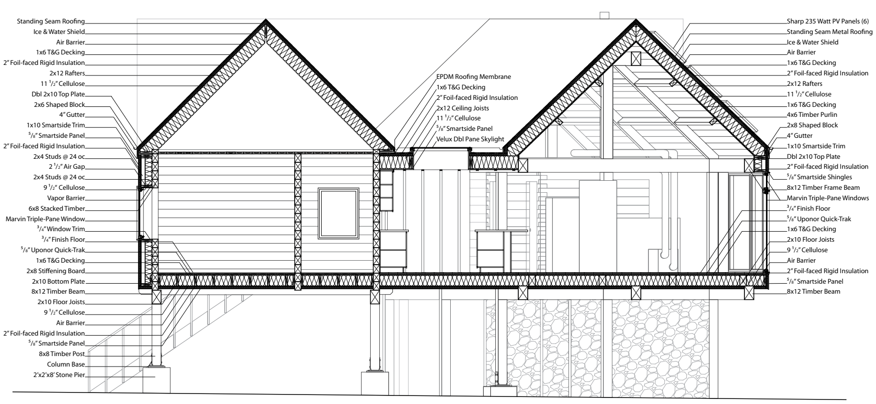


Figure A 4: Axonometric and System Diagram





Section 1/2" = 1'

Figure A 5: Sections

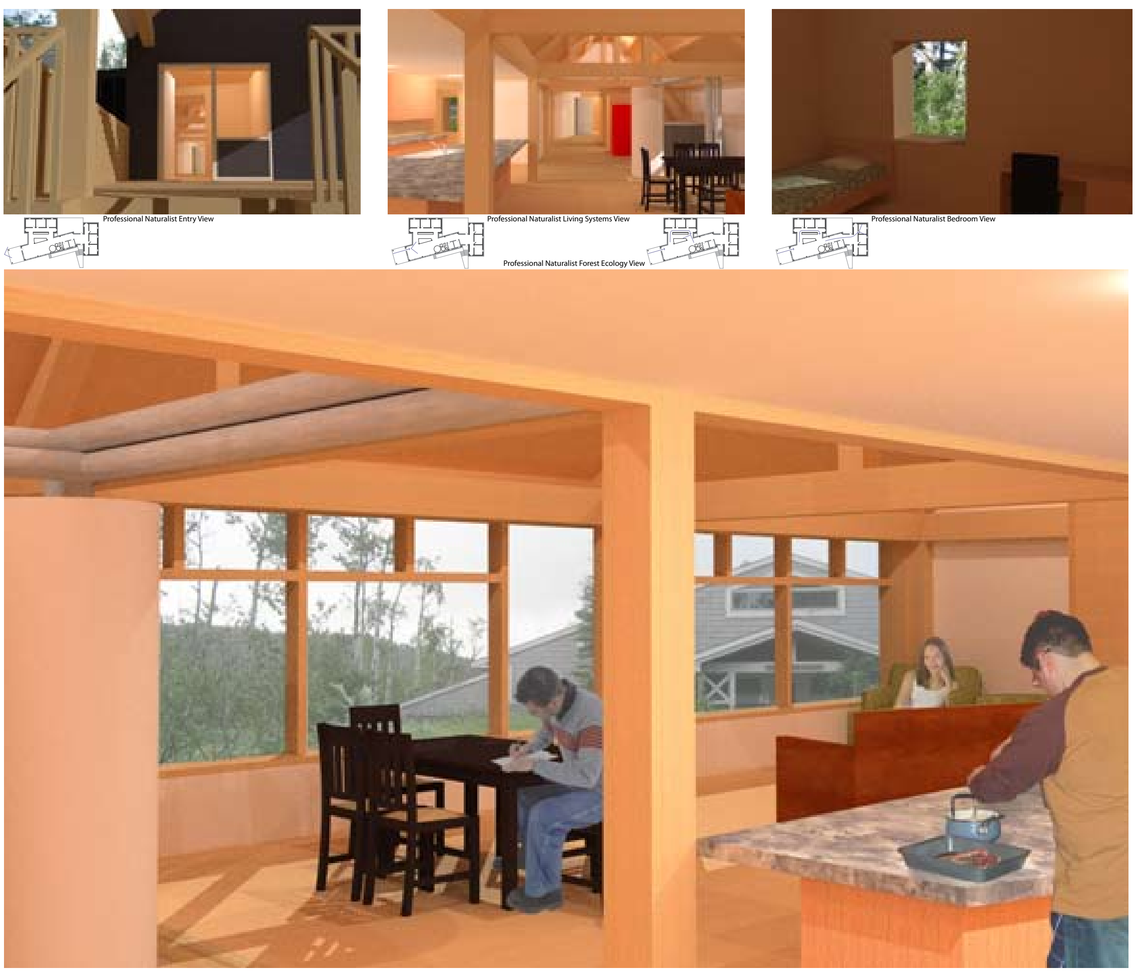


Figure A 6: Professional Naturalist Experience

Figure 119: Student Visitor Experience