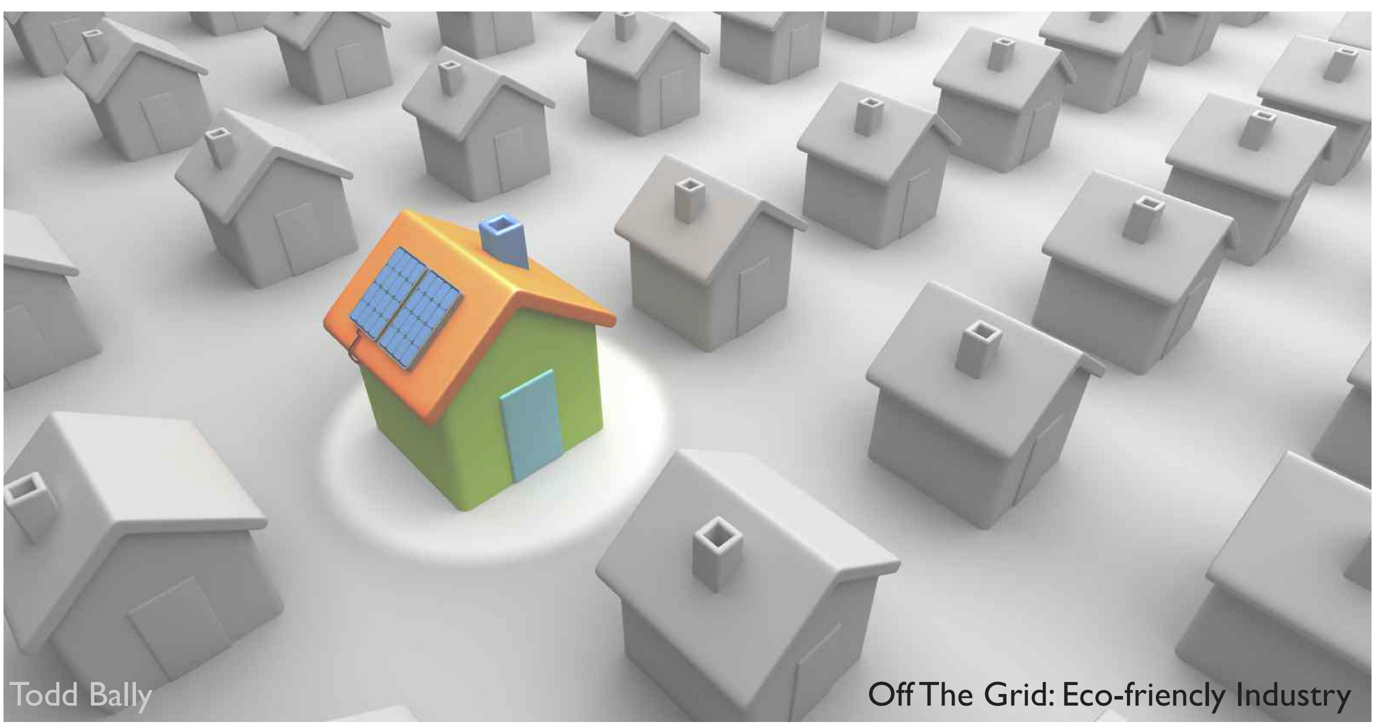
Todd Bally
Off The Grid: Eco-friencly Industry

Off The Grid: Eco-friendly Industry
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Abstract

Is looking at nature directly a major factor in determining a sustainable building? Some architects are concerned with how humankind can integrate itself with nature in a sustainable way, reducing energy, materials, and resources. Why integrate with nature when all of the architectural solutions lie directly within nature's designs and processes. Nature's organisms seem instilled from birth with a precise directive: knowing where to build, what materials to use and how those materials go together. If we are to learn how to build, we must go to the source. The idea is not to build with the environment, but to harvest ideas from nature and adapt them as an architectural model for buildings. Rules and guidelines can be established from lessons that are learned from nature. These ideas from nature can be applied to our own technological problems and begin growing architecture in new directions.

Is there a path for architecture that respects regional differences and environmental health while embracing appropriate technologies that can respond to the methods and processes found in nature?

The idea is to blend aesthetics and program with architecture, finding useful systems from natural forms and organisms and incorporating the attributes into design projects. Architects may begin to conceptualize a building in a different, more organically expressive form than anything ever built. This innovative type of architecture will reveal both poetic and structural information. By creating a hybrid of these elements: nature and architecture through the fusion of environment, technology, and program, we can more fully understand and appreciate the importance of both. Buildings and communities will be restorative, pedagogical and inspirational living buildings.

Thesis Statement

Preface

Architecture is life taking form. It meets functional and aesthetic needs that change as a result of place and environment. Local conditions allow a building to be part of its place. Unfortunately, to assimilate to the natural environment building design uses vast materials and resources. Architecture as an industry claims about forty percent of the energy, forty percent of the virgin minerals, and twenty five of the virgin wood consumed worldwide per year. Up until now, sustainable design has been essentially an effort to minimize damage so that we can at least maintain what we still have. While this is an acceptable reaction, it is only a temporary solution that needs to be expanded upon. Another option would be to design a dynamic physical space that adapts to its environment through ideas from nature and its processes. Responsive architecture is aimed at changing the shape of buildings so as to match the needs of the people inside and adapt to the changing weather outside. Nature, whose designs are inherently efficient, effective, and beautiful, offers us models of abundant, healthy production. Using nature as the basis for design is the force for solutions to age old issues that have overwhelmed humanity concerning architecture. Our inept ability to respond to challenges of climate, environment, energy consumption, and structural efficiency is of great concern to this thesis.

> “Architecture gives form to the invisible pulses and rhythms of life. It gives pattern to structure and structure to pattern. It is an elemental mystic power that is innate to all things. The physical manifestation of this power is a consequence of the desire for the invisible to be made visible. This desire, this great motivating force is essential to the life of a thing. It is a process which organizes and composes various interrelated forces into a unified whole. Architecture is the comprehensive expression of all science and art, the wellspring of interconnectness and functional art.
>
> Eugene Tsui

Some four billion years of evolution have exposed the design flaws of roughly ninety nine percent of nature’s creations, all recalled by the Manufacturer. The one percent that have survived can teach powerful lessons about how things should be built if they are to last. Humans are only one of 1.7 million classified species, and scientists estimate that those 1.7 million make up approximately one percent of all the living things that have ever occupied a piece of the Earth. We take up a severely disproportionate share of resources and allow ourselves a severely over-inflated sense of self-importance. We must take notice from years of evolution and thoughtfully recognize that serious problems exist in the way in which we design and construct buildings.

This thesis addresses a primary architectural question. What architectural response explores a path that respects regional differences and environmental health while embracing appropriate technologies that can respond to the methods and processes found in nature? This thesis will investigate the integration of a responsive architecture with consideration for a sustainable environment and integration within the surrounding community. Not only giving back to the surrounding neighborhood, but becoming a part of the whole.

According to Tsui, "If nature has built, tested and perfected architectural structures for more than four billion years, then what would our human-made structures and environments look like if we directly applied this knowledge from nature?"[2] An in depth study of nature's processes, organisms, structures, and materials at a multitude of levels and applying this knowledge to the design and construction of our built environment would allow for an architecture that is dynamic and timeless.

Human beings have come to create buildings that are, in comparison with nature, structurally inefficient, sometimes debilitating to our health, highly consumptive of natural resources, and are unable to adapt to climatic changes. Breaking away from popular image and conformity is key to the establishment of this approach to architecture. A sustainable approach to the environment is based on nature's optimal efficiency, which results in vast and astounding varieties of form that have nothing to do with popularity, familiarity, or conformity. "We are a society that seeks to create manageable uniformity," said landscape architect John Tillman Lyle.[3] In creating such regularity, however, we destabilize life-giving processes. Janine Benyus, a natural sciences theorist, believes that to heal the Earth, we have to fundamentally change our relationship with natural systems, from energy and water flows to nutrient cycles.[4] Instead of fighting against Mother Nature, we need to work with her to help stabilize nature's life giving processes. This kind of design goes beyond sustainable; it is evolutionary and regenerative. It revitalizes the underlying systems, both cultural and natural, so that architects can work efficiently to achieve and maintain a healthy environment. This thesis will seek to challenge notions of environmental and cultural health in the community and establish a sustainable option for a new paradigm.

Current sustainable movements mask some important issues at stake. Although the new "green" buildings begin to hint at a new ecological agenda, they often ignore issues of the built environment and responding to climatic conditions. According to Bill Reed, we could "have a world full of LEED platinum buildings and still destroy the planet."[5] These greener designs, though progressive, often stick too close to the existing standard in a way that is simply "less bad." William McDonough also rejects the current approach to sustainability in his recent book, Cradle to Cradle, "To be less bad is to accept things as they are, to believe that poorly designed, dishonorable, destructive systems are the best humans can do. This is the ultimate failure of the 'be less bad' approach; a failure of the imagination… What would it mean to be 100% good?"[6] Sustainability is working within our ecological systems to provide the healthiest environment to sustain both plant and animal life. McDonough contends that our current attitude should encourage ways to look at being better to the environment, while maintaining a high quality of life.

Natural Theories

Nature continues to surprise us and teach us how we might build more cleverly, economically, subtly, and ecologically.

Nature works with small feedback loops, constantly learning, adapting and evolving. We can also benefit from this thinking, evolving our designs in repeated steps of observation and development, unearthing new lessons and applying these constantly throughout our own design exploration.

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Biomimicry, as defined by Janine Benyus, is the practice of developing sustainable technologies inspired by ideas from Nature. While humans have a long way to go towards living sustainably on this planet, millions of species, each with nearly four billion years of field testing, contain technological ideas to help succeed in our all important quest to become a sustainable species on a biodiverse planet.[7] The methodology of biomimicry brings nature's wisdom not just to the physical design, but also to the manufacturing process, the packaging, and all the way through to shipping, distribution, and take-back decisions. Innovators from all walks of life can use biomimicry as a tool to create more sustainable designs. The biomimicry process of consulting life's genius can serve as a guide to help innovators use biomimicry to biologize a challenge, query the natural world for inspiration, then evaluate to ensure that the final design mimics nature at all levels: form, process, and ecosystem.

Janine Benyus, writer of Biomimicry: Innovation Inspired by Nature, explains biomimicry in three stages: nature as model, nature as measure, and nature as mentor.[8] Biomimicry is a new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems. Secondly, biomimicy uses an ecological standard to judge the "rightness" of our innovations. After 3.8 billion years of evolution, nature has learned what works, what is appropriate, and what lasts. Thirdly, biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world, but on what we can learn from it.

Evolutionary architecture, a concept introduced by Eugene Tsui, can be defined as an architecture that implements the evolutionary practices of nature as a synthesis of billions of years of evolution applied to immediate needs and circumstances of form, function and purpose.[9] It takes into account all the various natural forces and human concerns in a way that is ecologically and humanly productive. An evolutionary approach to design allows us to apply principles that have developed in nature over great spans of time without reference to past and present stylistic aesthetics.

Tsui states, "I do not look to nature as inspiration merely to mimic its forms as other architects have done. I am concerned with the profound intelligence of nature, the how's and why's of its designs and living processes, to understand the very mind of nature and the universe to free the heart and mind of man."[10] A building that mimics a living system would be able to sense and respond appropriately to exterior conditions like varying winds, temperature swings or changing sunlight. Inside, the building might change to accommodate crowd flow or better circulate warm air. The building is not a fixed object but part of the larger pattern that flows with change, a permeable membrane responding to changes in use and place. Using natural materials native to a place, earth, stone, reclaimed trees together with the native intelligence of place advanced technologies, scientific intelligence.

Although these theories are all valid and supported, it is time to look at nature in a different manner and adapt the knowledge gained from nature's wisdom into sustainable and self-sufficient design. This method would allow technology to be the backbone of a design, creating buildings that could interact with the users and integrate the exterior with the interior. In a sense, a biomimetic architecture that fuses high tech ideas with basic cellular functions to create living structures that operate like natural organisms.

Natural Systems

To create architecture of meaning and beauty we need to return to the source, nature. We should make use of the materials and innovation provided by the natural world and put them to good use according to their true nature, not merely to imitate the appearances of the past. In nature, form and function are not limited to the existing structure of organisms, but include the entire environment in which the organism exists and, most importantly, include the active and reactive relationships of that organism with its surroundings.[11] Form is shaped by the interactions of the environment; a living thing is dependent on its ability to comprehend and interact with the environment in order to survive. Therefore, form and function are not just attributes, but relationships. Function naturally proceeds to accommodate a relationship to the greater surrounding environment.

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As Buckminster Fuller once said, "we do not seek to imitate nature, but rather to find the principles she uses."[12] The intent is for entire cities or individual buildings to operate like complex ecosystems, processing water and waste while generating energy. Hypothetically, communities in desert regions will be designed to maximize the ability to collect water, and like the plants of the desert retain and conserve that water. In colder climates the focus will shift to retaining heat and capturing the available sunlight. From region to region the focus will change, but environmental performance will be constant.

Detroit is a city that was created by manufacturing. It identifies itself as the "motor city" and takes pride in the employee who slaves in a factory for wage. Today, this identification is merely nostalgic, as industry has moved elsewhere. Detroit's loss of industry is representative of the larger movement of global economics. This post industrial space now provides the opportunity for new ventures to bring back the prominent stature that once was spread through downtown Detroit as well as the Riverfront. Although much of the Riverfront is abandoned and undeveloped there is still opportunity for growth and community. The historic Detroit River is a gathering place for Detroiters, their families, friends, and visitors, a place where people want to live, work, and play. The Riverfront illustrates the ability to provide stewardship of our environment, confirms our ability to connect and care for people, and channels sustainable economic development for the benefit of all.

The Riverfront is undergoing a significant transformation, from a crowded, industrial shoreline with no real access to an active, vibrant series of greenways and new development, which will bring more people and opportunity to the area.

In the Midwestern post industrial cities, and in particular Detroit, one can see that a series of rapid socioeconomic shifts have occurred, drastically changing the way that buildings are used and whether they are used at all. In this voided space, where industry has fled the remnants of buildings are the only reminders of the past. Climatic adaptation and responsiveness becomes necessary in today's ever changing economy.

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This thesis addresses questions of climatic and environmental adaptability in a controversial setting; the program selected as a medium for this investigation is the operations and production for a sturgeon fish farm. The decision to name a program that is eco-friendly and susceptible to reuse of materials and energy, allows the project to ask an important question; can a corporation embrace the concept of adaptive technology and reduce energy use and still be successful?

Not only will the fish be raised to be harvested for the meat as well as the precious, ripe caviar, but a portion of the stock will replenish the deprived lake and the waterways in the surrounding community. These fish will be used for sporting purposes as well as rehabilitating the ponds of the adjacent area.

Community

The facility must be integrated within the community creating unity. Developing a sustainable, eco-friendly industry is not enough if it does not fit in with the surround context. The site as well as the functions of the program can be used to create a relationship with the neighborhood. People can not only shop in the retial space, but observe the process of raising fish at this scale and producing quality caviar.

Material Recycling

McDonough's book, Cradle to Cradle, can be seen as an important corollary to biomimicry. Following nature's economical model, where nothing is ever wasted, they propose developing products that can be fully recycled as either biological or technical nutrients. The former biodegrade fully, safely, and naturally into the environment and the latter return to industry as raw materials for future products.[13] Most products today are what McDonough and Braungart call "monstrous hybrids," in that they combine biological and technical elements in such a way that these materials cannot be recycled into either loop.[14] In addition, most products that claim to be "recyclable" are actually "downcyclabe" to a lower-quality product. Eventually, the quality becomes so poor that this material cannot be reused for anything.

The maintenance of the health of any living organism is crucial to its survival. Similarly, the maintenance and efficient workings of a building's health are crucial to its well-being and to the comfort its inhabitants. The use of nonharmful materials, materials that simultaneously resist climatic conditions qualifies this evolutionary approach. It is time that we human beings make a positive and clear shift from conventional architectural thinking to evolutionary architectural thinking for the sake of safety, sensibility, and beauty.

Technology

The study of natural systems will trigger innovations in building design and building product development that are resource efficient, environmentally benign, and aesthetically satisfying. The building acts as a living system, able to change shape to match the needs of the people inside and the changing weather outside.

The principles of evolutionary architecture also require a close study and profound understanding of form; form that accommodates and actively resists or reguides the stresses and strains of subtle and extreme loads and is governed by such loads to create its resultant shape.[15] Evolutionary principles imply using science and technology as tools for evolving and strengthening our constructed and natural environments and their processes.

Much of our past and current use of technology has become a detriment to our natural environment and has created unhealthy architectural examples. "Sick building syndrome" attests to a faulty use of technology. The common breakdown of our structures using outdated, ineffective materials shows the continued refusal to implement new technologies that are currently available.[16] This thesis intends to offer principles that attempt to raise the level of health of our architectural environments physically, psychologically, and spiritually.

Many technologies are currently in use or being developed that are biomimetic in nature and will contribute to making the living building possible. Perhaps the oldest of the biomimetic technologies are photovoltaics. Photovoltaics are a solid state technology that directly converts solar radiation into electricity that can be stored or used on demand while producing no pollution.[17] The technology has advanced considerably in recent years becoming more efficient and able to integrate seamlessly into architecture. Multi-tasking is integral to biomimetic technologies that often do more than one job at a time.

Multi-tasking can be interpreted into the processes of organisms and how different species function in diverse conditions while at the same time operating through movement, survival, protection, consumption, and composition of structure. Learning and using the knowledge inherited from specific organisms in the context of the community can be beneficial in developing a facility that can adapt to climatic changes and environmental conditions as well as operate at the most efficient levels of sustainability. This thesis intends to incorporate holistic ideas from nature's organisms that can contribute to the eco-friendliness and success of a building.

"The architecture of the future will build inspired by nature because it is the most rational, the most durable, and the most economic of all methods."[18] Architecture is the process that we instinctively recognize as the origin of growth and creation. At its most fundamental level, it is the force of life desiring to manifest itself in material terms.

A building should be a space that can adapt to people and is in harmony with the environment. "The more our world functions like the natural world, the more likely we are to endure on this home that is ours, but not ours alone."[19]

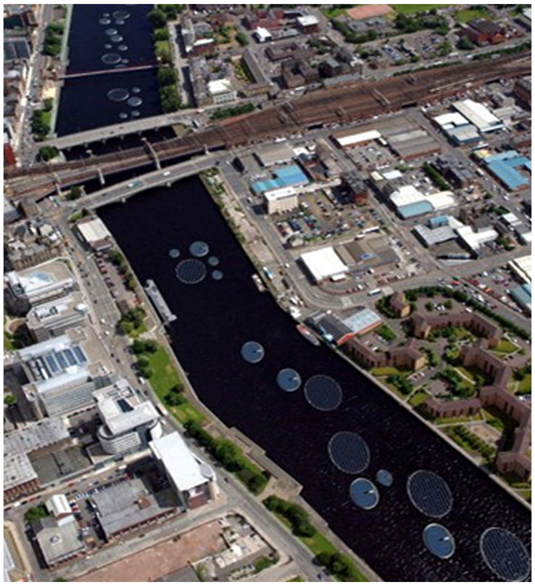
The intent is not to imitate nature's shapes. It is to enter into the very "mind' of nature, the source which creates the forms and processes, and apply this knowledge to create a different architecture, a new attitude of our living environments. Few other architects in history have looked deeply into nature, in a rigorous and scientific way, and then apply these discoveries to architecture.

Today, the technologies available to architects and builders are growing; however, architects need to be increasingly savvier about how they incorporate the new technologies. By understanding the faults of today's architectural systems and enabling new technologies that address these faults one can provide a smarter building which responds in an environmentally responsive manner. New technological architecture will allow for dynamic environments instead of static buildings. Ultimately, the strength of adaptive buildings is the ability to link interior and exterior with architectural form.

Precedents:

Lily Pad Proposal
Eastgate Centre
Tsui House
East River Turbine
River Rouge Plant

Precedents • Lily Pad Proposal • Peter Richardson



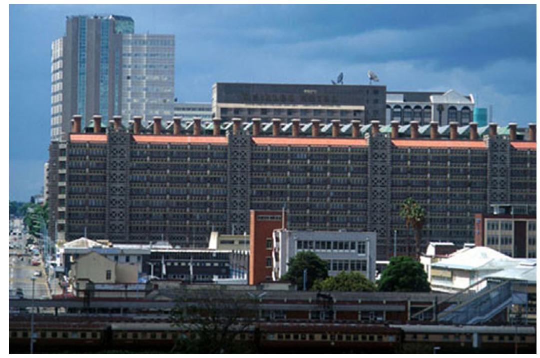
In an example of biomimicry, Scottish architecture firm ZM Architecture have come up with a brilliant scheme to provide solar power to the city of Glasgow and do so in a way that is provocative, creative, and aesthetically appealing. The proposal was to design solar lily pads which will float in Glasgow's River Clyde and soak up the sun's rays, sending electricity to Glasgow's grid while also stimulating urban riverfront activity.

Taking 1st place in the International Design Awards Land and Sea competition, the Solar Lily Pad proposal by Peter Richardson impressed Glasgow's City Council so much the city is now considering testing a small pilot project in conjunction with the Glasgow Science Centre.

This is an innovative thinking in a proposal for urban energy generation. Whereas most urban design schemes to generate more renewable electricity would usually focus on rooftop photovoltaics or wind turbines on public buildings, it takes a creative leap to envision Solar Lily Pads. Of course, the idea is perfectly natural and makes good sense when you consider that the intrinsic design of the lily pad is all about maximizing access to the sun's rays. This great idea should inspire both city and governments and other designers to get creative with the design of photovoltaics.

Precedents • Eastgate Centre • Mick Pearce

The Eastgate Centre is a shopping centre and office block in central Harare, Zimbabwe. Designed to be ventilated and cooled by entirely natural means, it was probably the first building in the world to use natural cooling to this level of sophistication. It opened in 1996 on Rubert Mugabe Avenue and Second Street, and provides 5,600 meters squared of retail space, 26,000 meters squared of office space and parking for 450 cars.



The Eastgate Centre's design is a deliberate move away from the "big glass block." Glass office blocks are typically expensive to maintain at a comfortable temperature, needing substantial heating in the winter and cooling in the summer.

Mick Pearce, the architect, took an alternative approach. Because of its altitude, Harare has a temperate climate and the typical daily temperature swing is 10 to 40 degrees Celsius. This makes a mechanical or passive cooling system a viable alternative to artifical air-conditioning.

Passive cooling was being used by the local termites. Termite mounds include flues which vent through the top and sides, and the mound itself is designed to catch the breeze. As the wind blows, hot air from the main chambers below ground is drawn out of the structure, helped by termites opening or blocking tunnels to control air flow.v

Precedents • Tsui House • Eugene Tsui

Eugene Tsui designed this house in Berkeley, California for his parents in 1995. The structure is based on the world's most indestructible living creature, the Tardigrade, with its oval plan and parabolic top it utilizes the same structural principles nature employs in creating a durable design. It is internationally known as the world's safest house. All forms are curvilinear for safety and ease of passing. Every part of the house is interconnected structurally with every other part of the house. The structure disperses stresses and strains that act upon it unilaterally. Manually operated opening and closing "nostril" windows let in fresh air without letting in insects.

The design program approached the house as a living organism capable of actively responding to various natural elements of the site. An example of this is the subsurface solar water tubes that are positioned to correspond to the sun ray like exterior motif that covers much of the upper level of the house. Water in the black tubes is heated by the sun throughout the day. At night the stored heat is radiated back into interior of the house walls and provides radiant wall heat.

The eye like window faces south and disperses sunlight inside the house and warms the floors surface. In the daytime the floor absorbs this solar heat. At night it radiates into the spaces within.

Precedents • East River Turbine • Verdant

The East River water turbines are near Roosevelt Island, New York. The turbines have been installed on the bottom of a narrow strip of the river's eastern channel. Commercial traffic continues to use the remainder of the east channel and the deeper, more navigable western channel.

The idea of generative electricity by harnessing the power of a flowing river, called hydrokinetic energy, is attracting growing attention.

Basically, the East River turns the turbines' blades as it flows past. The turbines, like windmills, generate electricity that is channeled through wires to a central control unit and from there to the existing electricity grid.

The East River project has generated about 7,100 kilowatt hours of electricity, which is a world record for hydrokinetic power. The turbines operated, on average, about 17 hours a day.

Hydro turbines have a few advantages over windmills. While winds are erratic, tides can be charted by the minute, which allows power companies to know exactly when the turbines will be generating power.

The company, Verdant, has made an effort to study the impact that the turbines might have on fish in the East River. The water is monitored 24 hours a day with sonar equipment to see whether fish are harmed by the blades, which move at a comparatively languid 32 revolutions per minute. The company has found that the few fish who are picked up by the sonar tend to swim around the blades.

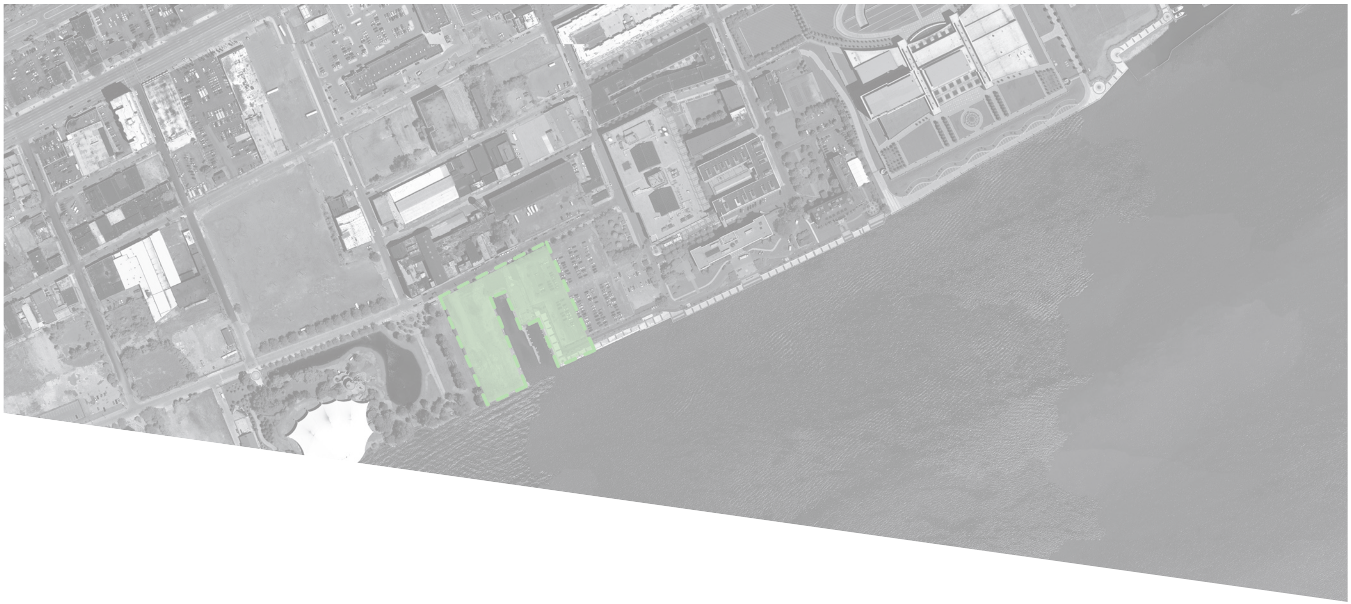
Precedents • River Rouge Plant • William McDonough

The Ford River Rouge Plant was first constructed in 1917. Throughout its lifetime it has produced anything from automobiles to war machines such as submarines and airplanes. A renovation of this historic industrial facility was begun in 2000. Bill Ford wanted the renovation to "Transform a 20th century industrial icon into a model of 21st century sustainable manufacturing."

Under the supervision of lead designer William McDonough, the result of the plant and landscape renovation includes the world's largest green roof at 500,000 square feet. It also incorporates many other green products and design principles that together make it one of the most environmentally friendly manufacturing sites in the world.

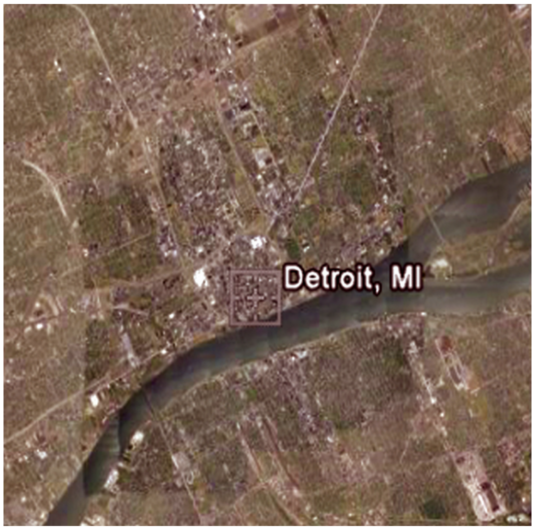
Ford's River Rouge Plant Renovation is a local, large-scale example of the remediation of an industrial site. The unique part of this overhaul is that the Rouge Plant was never shut down completely. The largest strength that I draw from this case study is the innovative way of thinking about how we construct our manufacturing facilities today. Another important incorporation into the Rouge Plant overhaul is the opportunity for the public to visit and tour the facility. This provides the public a source to understand the most up to date principles of green design and see the benefits of operating from a clean industrial site.

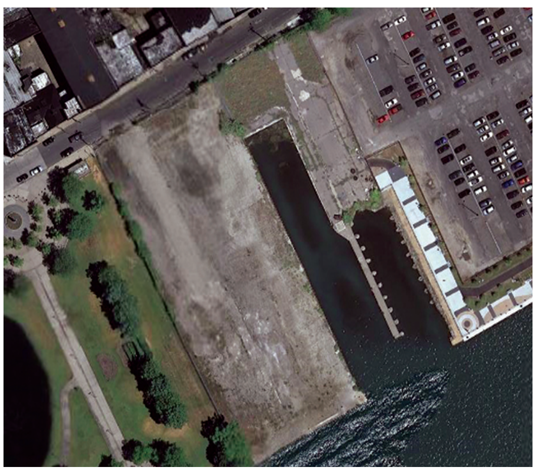
The green roof collects rainwater while keeping the building insulated and providing nature the opportunity to exist on top of the plant. William McDonough's concept for Ford's plant is a revolutionary way of thinking about how industry can interact with a site, and also exemplifies how architects can intervene with the industrial process in order to improve its efficiency and relationship with the environment.

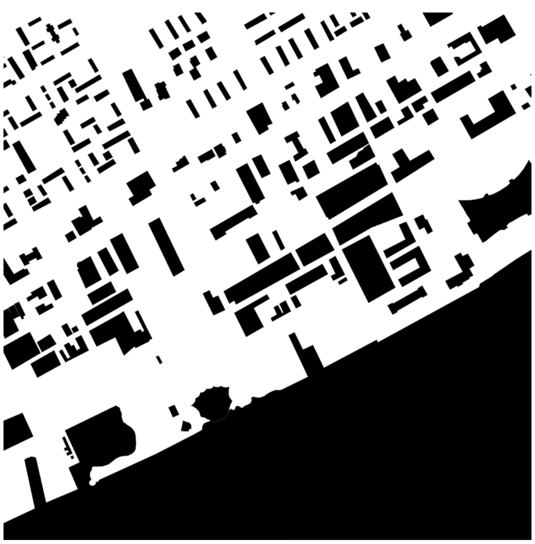


Site:
Detroit, MI

Site • Detroit, Michigan







Site Criteria

The chosen site is place which has connectivity and adequate exposure to the natural cycles of its environment. Locating in an area with a variety of environmental and climatic characteristics will be beneficial in providing a level of challenge and opportunity to the exploration.

The site is one which provides a variety of different surrounding characteristics which will provide challenge and opportunity for an adequate architectural exploration of how a building can respond to its surrounding environment.

Another beneficial piece to the prospective site is that it has an adequate level of traffic and usage on a regular basis, regardless of the time of day, month, or year. This will provide an adequate base of existing activity into which the project can situate itself.

Other defining characteristics include things such as adequate visibility, vehicular and pedestrian accessibility, and potential for further development of the surrounding area.

The site chosen is along the Detroit Riverfront at Chene and Atwater Street. This post industrial space now provides the opportunity for new ventures to bring back the prominent stature that once was throughout downtown Detroit as well as the Riverfront. Although much of the Riverfront is abandoned and undeveloped there is still opportunity for growth and community.

Site • Detroit, Michigan • Panorama

Southeast View

Site • Detroit, Michigan • Panorama

North View

East View

Site • Detroit, Michigan

History

The city of Detroit was founded just over 300 years ago, and runs for 13 miles along this river. A rich life emerged along the riverfront, from the French ribbon farms to the underground railway, to rum smuggling and the many recreational pursuits still thriving today. From fur-trading in the 1700s to lumber and farming in the 1800s to significant commerce on the river in the 1900s, Detroit became one of the busiest ports in the world. It still remains one of the busiest ports on the great lakes, moving about 80 million tons of cargo every year.

The Ambassador Bridge crosses the river and links Detroit with Canada, while the Detroit-Windsor Tunnel remains one of the largest underwater international automobile tunnels in the world.

The Detroit River runs 32 miles between Lake St. Clair to Lake Erie, the Detroit River is an American Heritage River, and is the only International Heritage River in North America. More than five million people live, work, and play in the river's watershed.

The land is nearly flat, rising gently north westward from the waterways, then becoming rolling terrain. The climate is influenced by the city's location near the Great Lakes. The city enjoys four distinct seasons. Winters are generally long and cold, and storms can bring combinations of rain, snow freezing rain, and sleet with heavy snowfall possible at times. Annual snowfalls average around 45 inches. During the summer, storms pass to the north, allowing intervals of warm, humid weather with occasional thunderstorms that are followed by days of mild, dry weather.

Climate

Area: 138.6 square miles
Elevation: 581 feet above sea level at Detroit River
Average Daily Temperatures: January 28.1˚ F, July 72.3˚ F; annual average, 48.6˚ F
Average Annual Precipitation: 30.97 in. of rain, 45 in. of snow
Average wind velocity: 10.4 mph
Average current velocity: Below Jefferson Avenue are normally 0.05 – 0.1 ft/sec, 7-9 mph
General wind direction: From Southwest

The Riverfront

The Michigan Department of Natural Resources and Ontario Ministry of Natural Resources recognize the Detroit River as having one of the highest diversities of wildlife and fish in all of the Great Lakes. More than 29 species of waterfowl and 65 kinds of fish make their home in the Detroit River.

The Detroit River has one of the highest diversities of wildlife and fish in all of the Great Lakes.

The Detroit River generates millions of dollars in recreational sales for waterfowl hunting, fishing, bird watching and more.

The Riverfront is undergoing a significant transformation, from a crowded, industrial shoreline with no real access to an active, vibrant series of greenways and new development.

The last of three cement silo structures along the Detroit River has been demolished, making way for a host of new riverfront projects in Detroit. The Department of Environmental Quality (DEQ) dedicated more than one year and $2.7 million in cleanup funds to the silo project, and will be able to recycle nearly 90 percent of the concrete and steel structures.

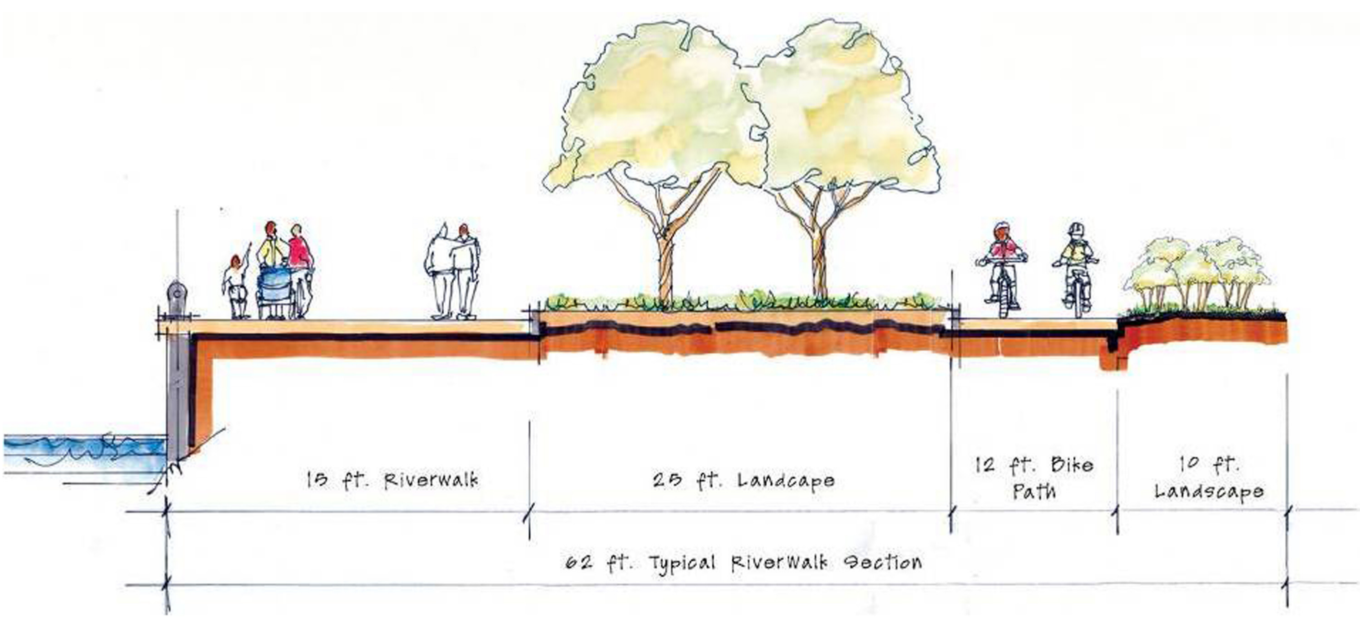
Site • Detroit, Michigan

The historic Detroit River is a gathering place for Detroiters, their families, friends, and visitors, a place where people want to live, work, and play. The Riverfront illustrates the ability to provide stewardship of our environment confirms our ability to connect and care for people and channels sustainable economic development for the benefit of all.

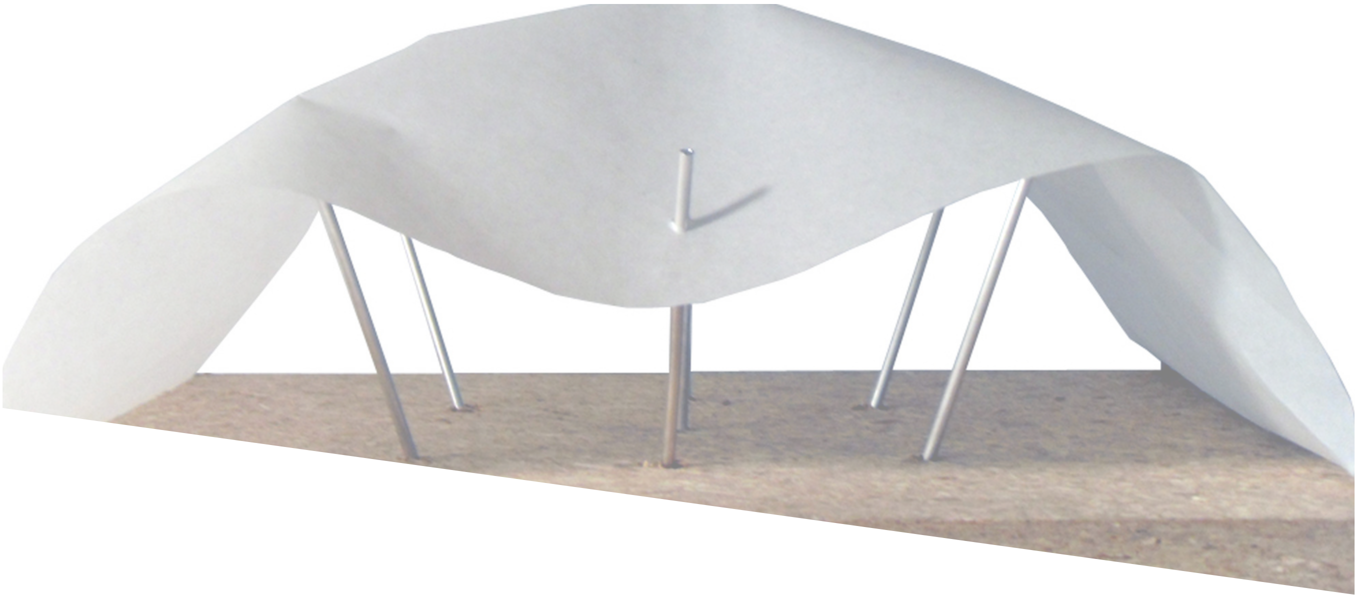
Perhaps the most sizeable element of transformation planned along the Riverfront is the creation of a Riverwalk, which ultimately will span from the Ambassador Bridge to the West beyond the MacArthur Bridge on the East side, into Gabriel Richard Park, about a 5 mile stretch.

This is the basic design for the Riverwalk, which will be an average of 62 feet in width where permitted, with two paths, one for pedestrian traffic and one for wheeled traffic, such as biking and roller-blading. Generous native landscaping will be incorporated into the walk's design. The walkway will vary in look and feel along the river, based on the shoreline, existing structures and conditions.

The Conservancy will continue to work with environmental organizations, such as the Nature Conservancy, Wildlife Habitat Council, the Audubon Society, the U.S. Green Building Council and others, to seek feedback and involvement.



Site • Detroit, Michigan



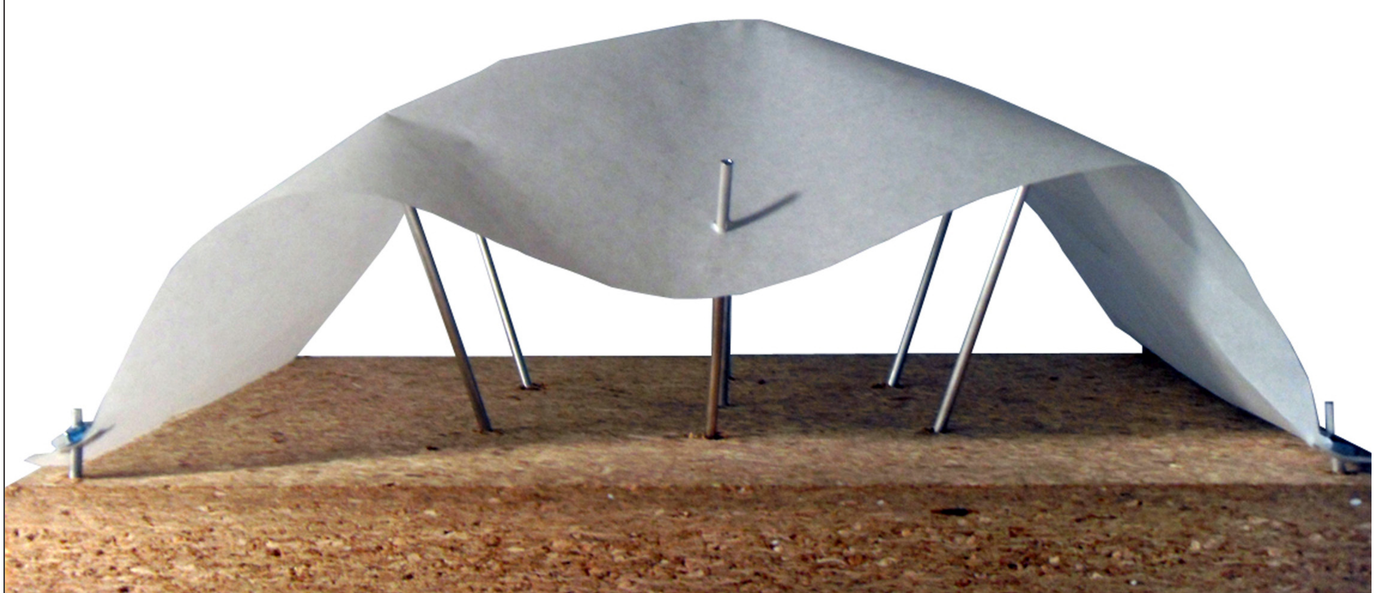
Building Components:

Porcupine Pufferfish: Diodon holacanthus
Largemouth Bass (Gills): Mircopterus salmoides floridanus
Roly-poly: Armadillidium vulgare

Building Component • Puffer Fish

This study was done to explore the skin of the puffer fish. The puffer fish expands its lungs and fills them with water when it feels that it is in danger. As it expands the puffer fish wards off enemies with spikes that protrude from its skin.

This model was a preliminary attempt to model the skin of the puffer fish as the exterior surface of a building or space. The spikes of the puffer fish could hypothetically act as structural supports for a skin that can expand and contract to change the interior space of a building.



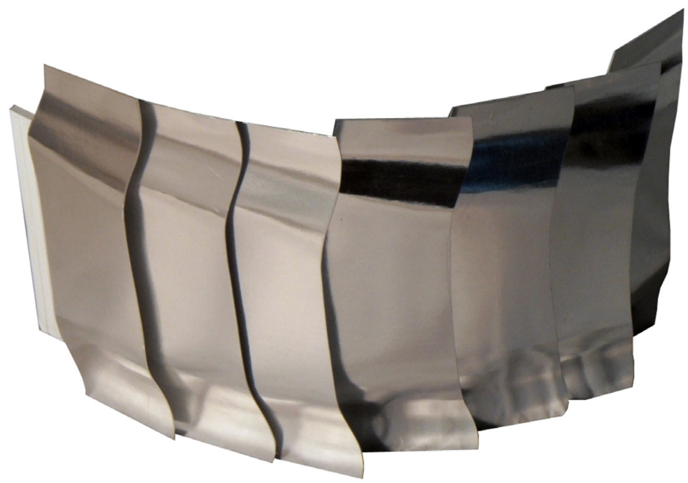
Building Component • Bass Gills

This model constructed from plexi-glass, lag bolts, and wood is intended to understand and adapt the gills of a bass and incorporate it into an exterior wall of a building.

Simulating the way a bass breaths, hypothetically, this building component would control ventilation through the exterior wall.

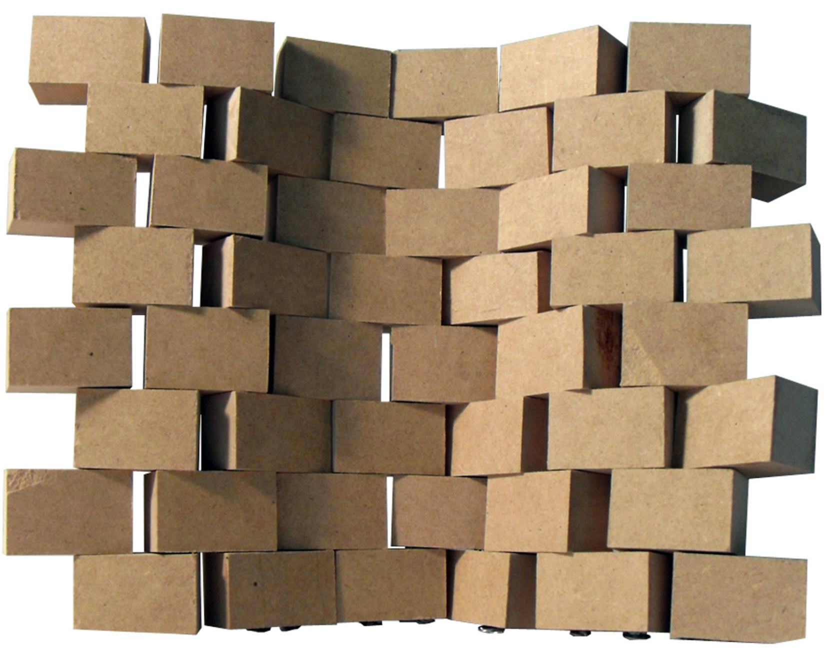
Building Component • Roly Poly

These studies were done to analyze the segmentation and form of the roly poly. The upper model investigates the flexibility of the organism while the model underneath explores the characteristics of the roly poly through design of rigidity and segmentation.



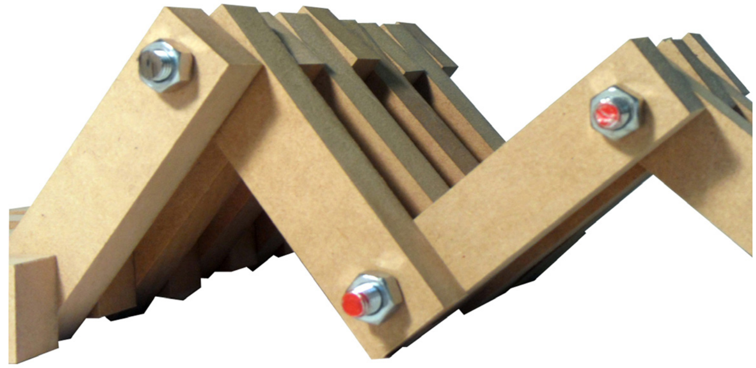
Building Component • Roly Poly

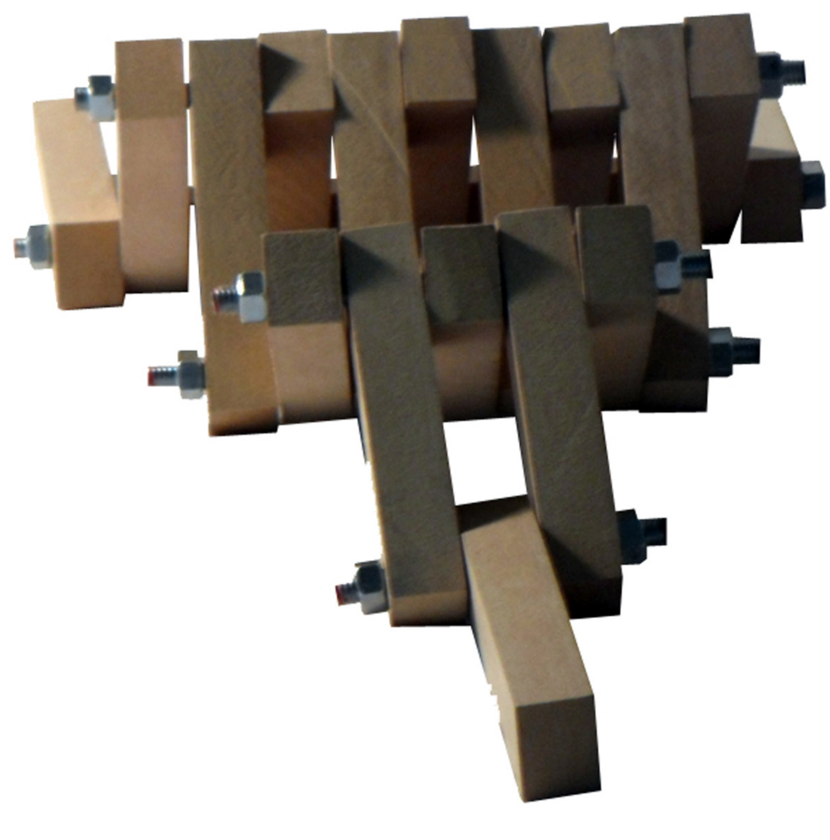
This model like the previous ones delves deeper into the form of the roly poly and investigates its flexible exoskeleton.



Building Component • Roly Poly

Similar to the model on the previous page, this model, constructed of bolts and wood, explores joints and movement.

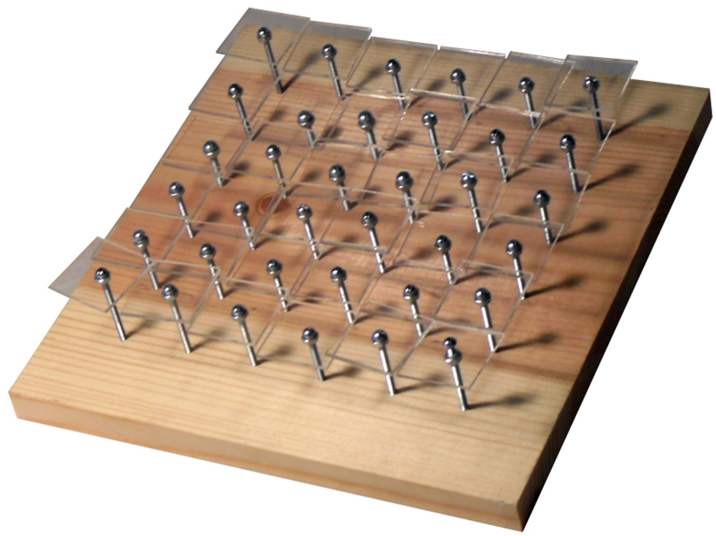


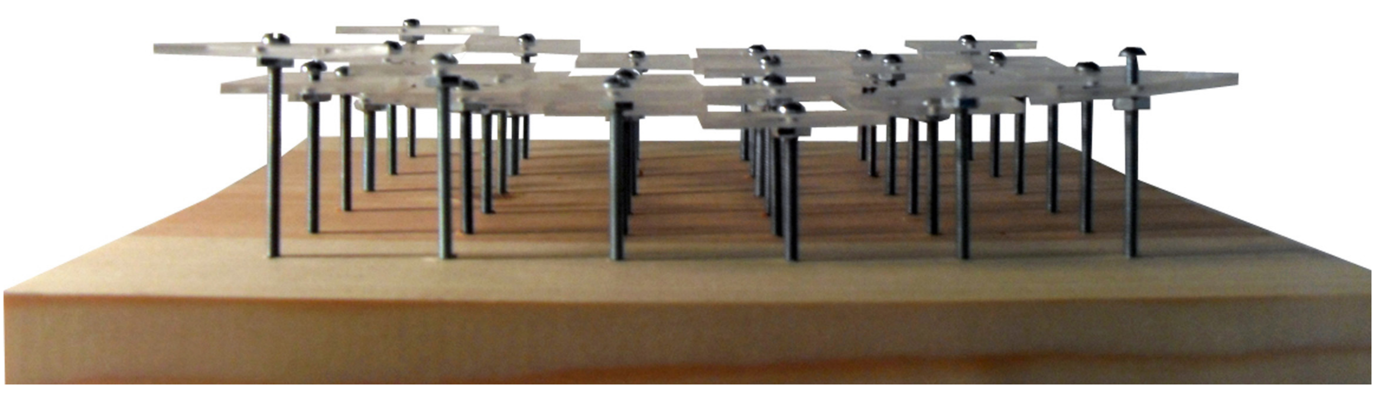


Building Component • Roly Poly

This model takes a look at the segmentation of a roly poly, but from a different perspective.

Building Component • Roly Poly





Program:

Fish Farm and Hatchery

Program Statement

Project Identification

The program is defined as an eco-friendly fish farm along the Detroit Riverfront. The functions of corporate office, manufacturing, processing, mechanical spaces, and retail sales will be included. One possible product of manufacturing, other than fish meat, could be fish roe or caviar produced from female sturgeon that are grown and fed on site. The caviar is only of the best quality and is made available to the market for a considerable profit. The spaces of manufacturing, processing, and packaging are inherently connected. The manufacturing function is considered to require the most adaptability and responsiveness. The office program would involve a majority of the other functions, while the retail showroom would be another separate entity. The program creates an interdisciplinary collaboration, where the complete environment is inclusive and dependent upon the whole.

Articulation of Intent

This thesis intends to provide a facility that is responsive to the needs of the user and program with consideration to climate and environment. The architecture should allow for responsive characteristics that can be utilized within the program of the facility. Responsive, in this case, means moveable parts that react to different environmental conditions, specifically climate. Conceptually, the building will grow with the neighborhood and become a part of the live/work district. Historically, strong communities have survived with homes surrounding a place of work. This facility would encourage its employees to inhabit the immediate context, possibly the developing residential lofts, conserving energy in transportation, and strengthening the community as a whole.

Program Breakdown

The manufacturing aspect implies mass production of fish for profit. The building skin generally has the most design opportunity. This part of the facility requires large amounts of daylight in order to grow algae as a source of food for the raising and growing of fish. The program should allow for movement of employees as a method of transit for fish between the raising and processing phases. Organization is typically linear in arrangement with strong relation to the input and output of fish and their byproducts. This space is large in volume with double to triple heights allowing for big open spaces. This space is very flexible as the quantity of fish increases or decreases. This space has direct relationships to the processing and packaging areas.

The outdoor cage systems allow for different types of fish to be raised, from bottom feeders to fish for meat. The space will be adjacent to the manufacturing or outdoor tank facility to allow for the ease of transport of fish from cage system to tank. There is opportunity for the system to expand into the Detroit River if necessary with the growth of the business venture. Fish from the cage system and tanks will be used not only as fish meat for the consumer, but to supply certain species back into the Detroit River for sport as well as in the surrounding pond developments in the area for recreational fishing. The space allows for the integration of the Riverwalk and allows it to pass directly over for the involvement and visual pleasure of a typical passerby. The space will be maintained and observed constantly by employees.

The retail aspect of the program displays the presentation of goods for the consumption of the product. There is a possible connection that buying can become a participatory act of the fish farm process. The space is closest in proximity to the street for easy access and full visibility from the outside through large storefront glazing. The space allows for natural light to overwhelm the area to create a warm atmosphere for the passerby consumers.

Program Statement

The office program is where all of the people with shirts and ties reside. Their duty is to oversee the operations of the buildings by direct observation, conduct meetings with big business consumers, analyze various reports, budgeting, etc. This is a private space, separate from other entities of the program with an open office environment. There is proximity to the other office functions.

The storage of both raw and packaged or finished product will be kept on site. The space is adjacent to the packaging and manufacturing areas. This space has very few specific needs, the need of a durable floor surface and ability to move large quantities of product with ease. Again volume requirements of double or triple height to allow for mass storage.

The mechanical aspect of the program is specifically for the maintenance and observation of the water turbines that generate energy not only for the facility, but for the surrounding community as well. The space will have the most advanced technology for water turbines to allow for the most efficient and eco-friendly energy producing facility of its kind.

The exterior green space serves as the environmental connection for all employees and community members. The space could be a variety of hardscape and landscape spaces that could be both public and private. Outside, in good weather, employees can relax, hold meetings, eat lunch, walk around, and enjoy many other activities that the green spaces have to offer. This is an important space in that it provides the inhabitants connection to the natural landscape.

Program Quantitative Summary

	Program Space	Quantity	S.F.	Subtotals	
A	Manufacturing				
A.1	Hatchery		3,700		
A.3	Restrooms	1 - 400	400		
A.4	Mechanical Room		250		
A.5	Circulation		750	Subtotals	
					5,000
	Parking Required	1/1000	5 Spaces		
B	Office				
B.1	Office Space	5 persons	500		
B.2	Restroom	1 - 400	400		
B.3	Conference		500		
B.4	Reception		250		
B.5	Mechanical		200		
B.6	Circulation		300	Subtotals	
					2,150
	Parking Required	2/1000	4 Spaces		
C	Shipping/Packaging				
C.1	Shipping		600		
C.2	Packaging		1,000		
C.3	Mechanical		150		
C.4	Circulation		300	Subtotals	
					2,050
	Parking Required	1/1000	2 Spaces		
D	Retail				
D.1	Retail Showroom		2,000		
D.2	Storage		400		
D.3	Restrooms	2 - 350	700		
D.4	Mechanical		200		
D.5	Circulation		700	Subtotals	
					4,000
	Parking Required	1/1000	4 Spaces		
E	Processing				
E.1	Processing		2,600		
E.2	Circulation		400	Subtotals	
					3,000
	Parking Require	1/1000	3 Spaces		
F.1	Cage System		32,700		
F.2	Outdoor Tanks		18,500		
				Totals	
					16,2000

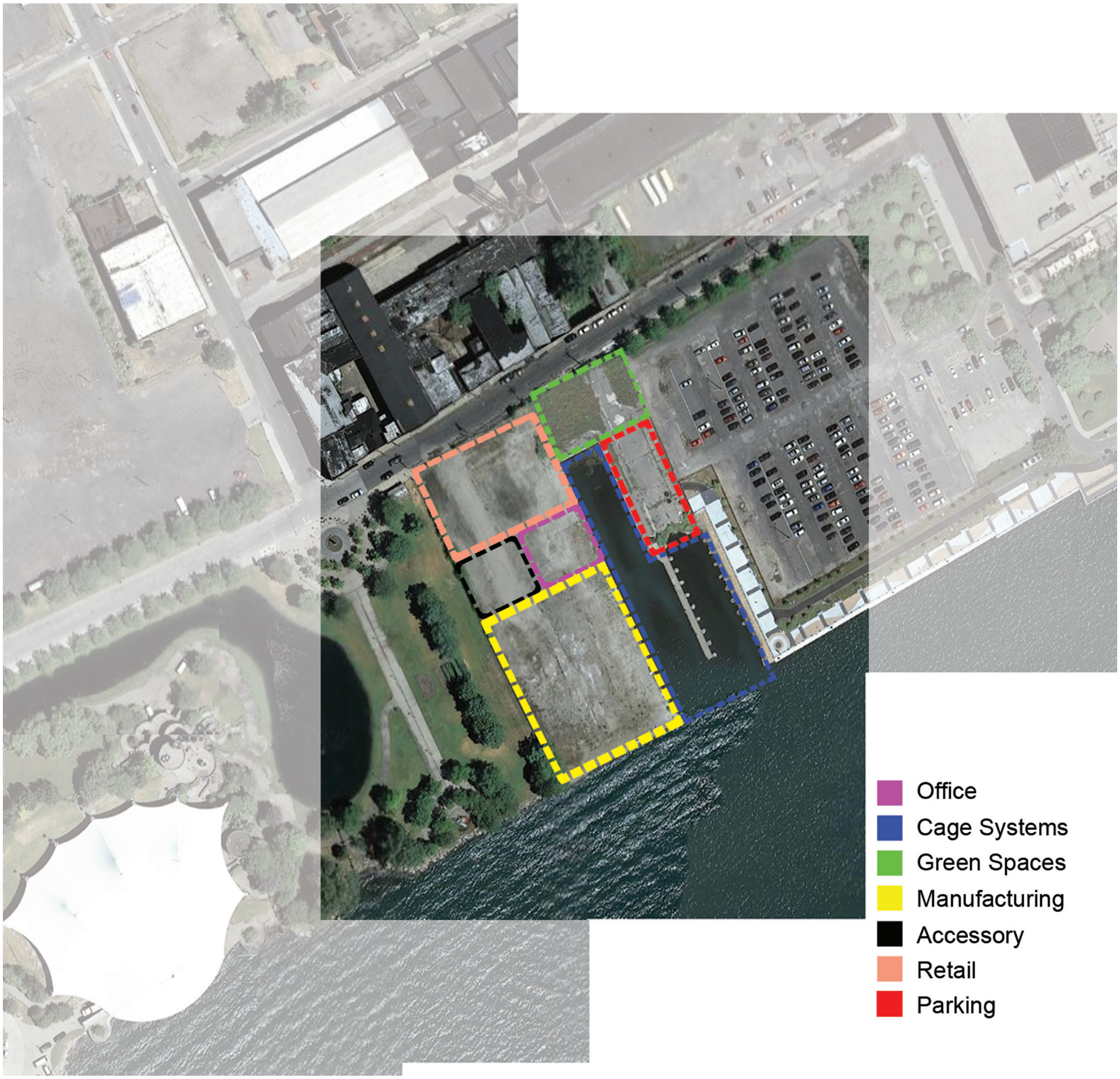
Program Quantitative Summary

Parking			
	Parking Total	18	Parking Spaces
	200 Square Feet/Space	3,600	Square Feet For Parking

E				
E.1	Exterior Green Space		20% of site	
	Site Areas in S.F.		Green Space	
	Site A 51,200	10,240		
	Site B 16,200	3,240		
	Site A+B			13480

Total Square Footage for Building
16,200

Program • Initial Diagram



Program • Initial Diagram

Space Detail Summaries • Retail/Showroom

A. Quantities

Occupancy varies between 20 and 25 users
1 Unit
4,000 square feet
1 unit x 4,000 sq. ft. = 4,000 square feet

B. Purposes/Functions

This space is an interactive space to view the fish products, meat and caviar. It is intended to give the consumer a new experience by exposing them to the many processes that contribute to producing the finished products.

C. Activities

The primary activity for this space is shopping and viewing. Secondary activities would include selling, informing, buying, tasting, and questioning. By viewing the other parts of the facility, consumers can also observe, smell, and hear.

D. Spatial Relationships

This space is the first floor of a two story space and half of the space containing a double height ceiling. In plan, this space must be longer and stretched in order to access all of the other functions.

E. Qualitative Consideration

This space should have an open, industrial feel. The space should be adaptable for different showroom arrangements.

F. Equipment/Furnishings

Equipment in this space would include a sales desk, where items could be ordered and paid for; with several stations for this task. A large assortment of displays and partitions will be distributed all over the retail space. Also, refrigerated display cases for the processed fish products.

G. Behavioral Considerations

H. Structural Systems

This space should have standard structural systems

I. Mechanical/Electrical Systems

This space should have standard electrical systems

J. Site/Exterior Environment Considerations

Natural daylighting from above should be used. Access to the exterior is not necessary except at the entrance, which should be readily identified.

Space Detail Summaries • Hatchery

A. Quantities

Occupancy varies between 10 and 15 users
1 Unit
5,000 square feet
1 unit x 5,000 sq. ft. = 5,000 square feet

B. Purposes/Functions

The purpose of this space is to raise fish from the first stages of development providing adequate nutrition and climate conditions. Workers would simply maintain the efficiency of the systems in place.

C. Activities

The primary activity for this space is the growth of juvenile fish.

D. Spatial Relationships

This space has a double ceiling height and must have access to the outdoor grow out tanks for ease of transport.

E. Qualitative Consideration

This space should have an open, industrial feel allowing the optimum growth of the different species of fish being raised.

F. Equipment/Furnishings

Equipment in this space would include the recirculating aquaculture system that provides an adequate environment for baby fish.

G. Behavioral Considerations

H. Structural Systems

This space should have standard structural systems

I. Mechanical/Electrical Systems

This space should have standard electrical systems

J. Site/Exterior Environment Considerations

Natural daylighting from above should be used. There is access to the exterior for workers to transport fish to the growout tanks with ease.

Space Detail Summaries • Processing

A. Quantities

Occupancy varies between 15 and 20 users
1 Unit
3,000 square feet
1 unit x 3,000 sq. ft. = 3,000 square feet

B. Purposes/Functions

This purpose of this

C. Activities

The primary activity for this space is the processing of fish. For example, skinning, gutting, and cleaning of the fish for consumers to buy. Also, harvesting ripe caviar would be done in this area as well.

D. Spatial Relationships

This space needs a minimum of regular 10 foot ceiling height with large open spaces for ease of movement. Also, proximity to the exterior grow out tanks is critical.

E. Qualitative Consideration

This space should have an open, industrial feel.

F. Equipment/Furnishings

Equipment in this space would include long tables allowing room for fish to processed in different ways and equipment to move large quantities of fish with ease.

G. Behavioral Considerations

H. Structural Systems

This space should have standard structural systems

I. Mechanical/Electrical Systems

This space should have standard electrical systems

J. Site/Exterior Environment Considerations

Natural daylighting from above should be used. Access to the exterior grow out tanks is also very critical.

Space Detail Summaries • Packaging/Shipping

A. Quantities

Occupancy varies between 10 and 15 users
1 Unit
2,000 square feet
1 unit x 2,000 sq. ft. = 2,000 square feet

B. Purposes/Functions

The purpose of the packaging and shipping room is to prepare finished products for delivery. This is a private space that serves as the collection and distribution space for fish and materials.

C. Activities

The activities of this space are relatively simple. Packaging, organizing, and storing processed fish are some of the tasks.

D. Spatial Relationships

This space has a minimum 15 foot ceiling height with stackable storage units. The larger open space is located near the garage door entrance and several access points allow vehicles to travel from this space easily.

E. Qualitative Consideration

Physical access to the exterior transportation space is critical.

F. Equipment/Furnishings

Equipment in this space would include a sales desk, where items could be ordered and paid for; with several stations for this task. A large assortment of displays and partitions will be distributed all over the retail space. Also, refrigerated display cases for the processed fish products.

G. Behavioral Considerations

H. Structural Systems

The preferable structural system would allow for large clear spans and extremely flexible internal spaces.

I. Mechanical/Electrical Systems

This space should have standard electrical systems

J. Site/Exterior Environment Considerations

This space should be located near the rear of the site at grade.

Space Detail Summaries • Administration

A. Quantities

Occupancy varies between 10 and 12 users
1 Unit
2,000 square feet
1 unit x 2,000 sq. ft. = 2,000 square feet

B. Purposes/Functions

This space is for business purposes.

C. Activities

The primary activity for this space is for workers to have a quiet area to plan marketing strategies to increase sales.

D. Spatial Relationships

This space is the second floor of a two story space and is located directly above the retail space. This is a private space for workers only.

E. Qualitative Consideration

This space should be designed like a typical office environment.

F. Equipment/Furnishings

Equipment in this space would include desks, chairs and other office furnishings.

G. Behavioral Considerations

H. Structural Systems

This space should have standard structural systems

I. Mechanical/Electrical Systems

This space should have standard electrical systems

J. Site/Exterior Environment Considerations

Natural daylighting from above should be used.

Space Detail Summaries • Landscape

A. Quantities

Occupancy depends on number of grow out tanks

B. Purposes/Functions

This space is intended for exterior grow out tanks that are partially underground in the mounds.

C. Activities

The primary activity for this space will be the development and growth of larger fish or fish at later stages in their lifecycle. Secondary activities will be the transportation of fish from tank to tank.

D. Spatial Relationships

This space is intended to be behind the building so it can not be seen from the main road.

E. Qualitative Consideration

The hills and mounds should be designed for ease of movement for the workers.

F. Equipment/Furnishings

Equipment in this space would be large fish tanks that are 16 feet in diameter. Also, vehicles would be needed for the movement of fish throughout the site.

G. Behavioral Considerations

H. Structural Systems

I. Mechanical/Electrical Systems

J. Site/Exterior Environment Considerations

The hills are intended to grow out of the site with paths for workers to access individuals tanks.

Space Detail Summaries • Bathroom

A. Quantities

Occupancy varies between 3 and 6 users
2 Units
600 square feet
2 units x 600 sq. ft. = 1,200 square feet

B. Purposes/Functions

The restrooms will serve consumers and workers. The two restrooms will serve as one men and one women.

C. Activities

This space is typically comprised of the requirements of handicapped stalls and the associated 5' circle by the ADA.

D. Spatial Relationships

This space should have adjacencies to retail and office spaces and have good proximity to those functions expected to use this facility.

E. Qualitative Consideration

Interiors should be durable with cleanable surfaces such as tile flooring.

F. Equipment/Furnishings

Furnishings include the necessary number of toilets, sinks, and stalls per occupants. Outside this space should include a drinking fountain.

G. Behavioral Considerations

H. Structural Systems

This space should have standard structural systems

I. Mechanical/Electrical Systems

This space should have standard electrical systems

J. Site/Exterior Environment Considerations

This space has no requirements to have exterior views.

Space Detail Summaries • Exterior Green Space

A. Quantities

There is not any maximum occupany loading
Any number of spaces
20% of site square footage

B. Purposes/Functions

The exterior space serves as the environmental connection for all employees. This is an important space in that it provides the inhabitants connection to the natural landscape.

C. Activities

Outside, in good weather, employees can relax, eat lunch, walk around, and enjoy many other activities that the green spaces have to offer.

D. Spatial Relationships

The exterior green space should have a strong relationship with nearly all of the functions. It is important that it receives generous amounts of sunlight as well.

E. Qualitative Consideration

The space could be a variety of hardscape and landscaped spaces that could be both public and private.

F. Equipment/Furnishings

Furnishings include the necessary number of toilets, sinks, and stalls per occupants. Outside this space should include a drinking fountain.

G. Behavioral Considerations

H. Structural Systems

I. Mechanical/Electrical Systems

J. Site/Exterior Environment Considerations

This space could possibly operate as a storm water runoff or constructed wetlands.

Program Research • Lake Sturgeon

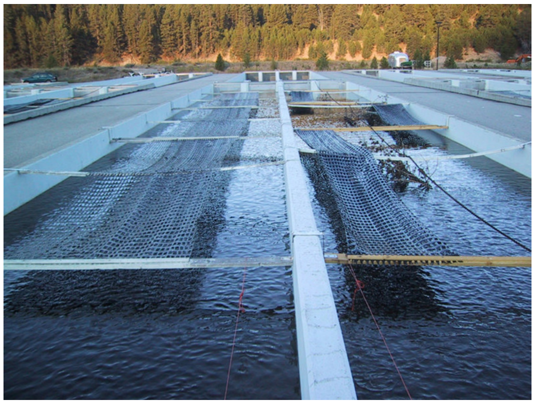
Lake sturgeon live in both rivers and lakes in Canada and the eastern half of the United States. Lake sturgeon grow rapidly the first 10 years of their lives, but reach sexual maturity more slowly than any other freshwater fish. Females release 50,000-700,000 eggs.

Sturgeon culture has the potential of a well-paying business with long term high revenues, but with a long start-up period of 5-7 years.

Sturgeon is most famous for the Caviar. These are the eggs of the female sturgeon, just before the final ripening. Eggs are harvested from the fish, lightly salted and packed in jars or cans for consumption. The "berries" are normally 2-3.5 mm in size and colors range from black to grey to golden. Less well known is Sturgeon meat. The meat is normally smoked and has a texture more like meat than like fish. Young Sturgeons also have a ready market as ornamental fish for garden ponds.

Lake sturgeon eat leeches, snails, small clams, insects, and sometimes small fish and plants. They swim slowly across the river or lake bottom.

The most interesting Sturgeon species require culture temperatures in the range of 18-26 degrees Celsius and fresh or brackish water.

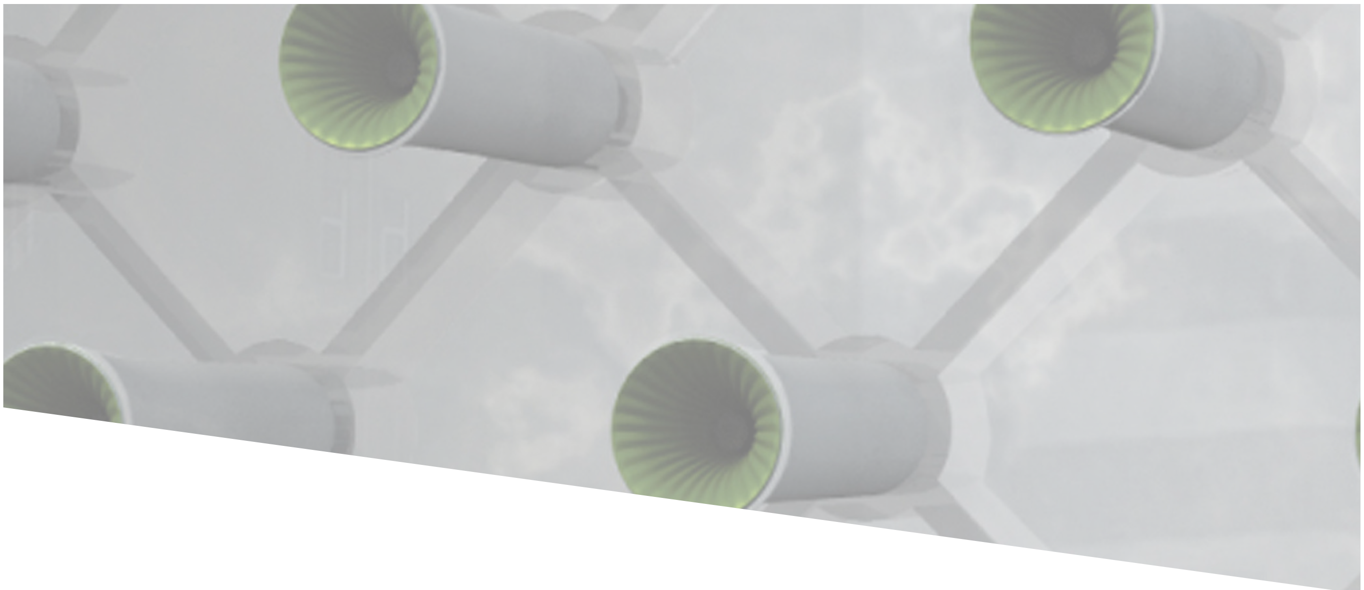


The Sturgeons are housed in tanks or raceways that are continuously provided with clean water from a river, spring or well. Farms use recirculation technology where the culture water is continuously cleaned by filters and recycled. The advantage of this technology is that the farmer can control and manipulate the culture environment.

Most farms are intensive farms; the fish are kept in high densities to reduce the farm size and to increase control over the stock.

A Sturgeon farm will only give revenues after about 2-3 years (males for meat production) with the major cash flow starting afer 6-8 years (Caviar). High quality management and farm equipment are needed to minimize the culture risks and maximize output.

An intensive sturgeon farm must include a broodstock unit; a hatchery/nursery and a grow-out system. These culture systems are housed in fixed buildings (the first 2 phases) and greenhouses (grow-out). Each system is split up in several stand alone units to reduce disease risks and has its own filtration system. Besides the systems there are shared facilities that include offices; a generator/electrical room; food store; workshop and processing and storage units for the products.

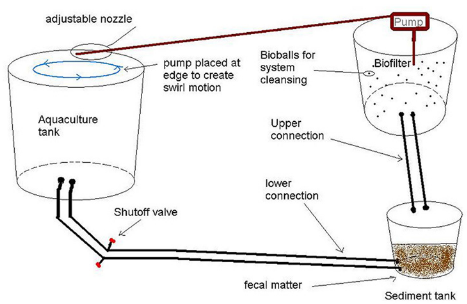


Additional Research:

Recirculating Aquaculture System
VIVACE
Living Skin

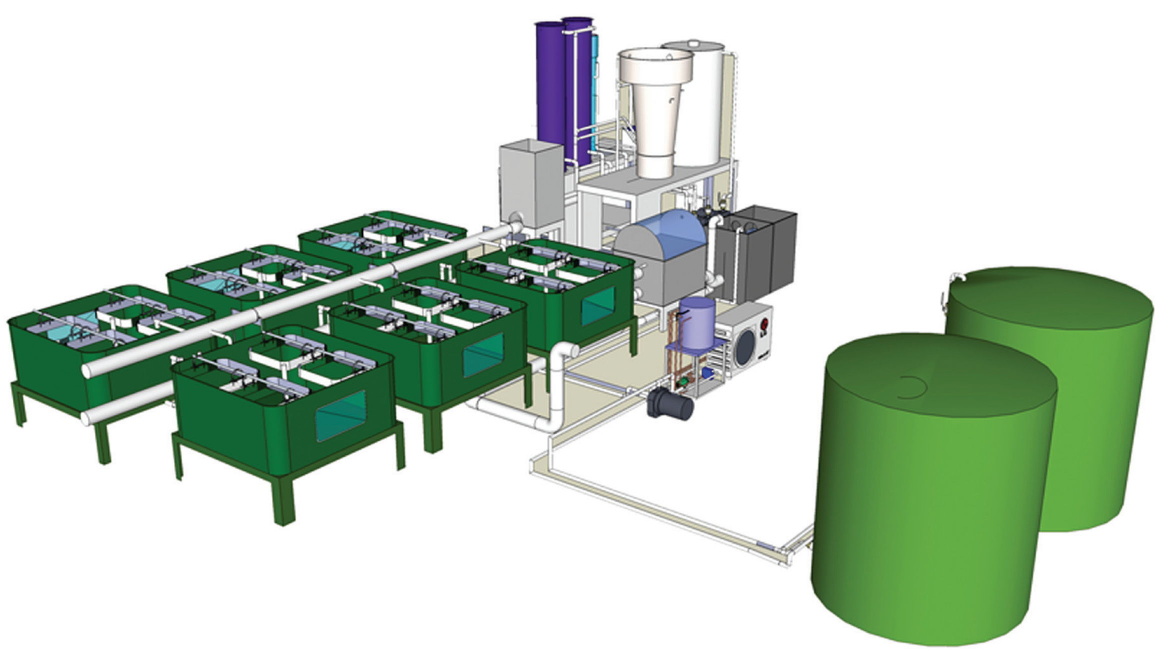
Recirculating Aquaculture System (RAS)

An alternative to open ocean cage aquaculture, one in which the the risk of environmental damage is substantially eliminated is through the use of a recirculating aquaculture system (RAS). A RAS is a series of culture tanks and filters where water is continuously recycled. To prevent the deterioration of water quality, the water is treated mechanically through the removal of particulate matter and biologically through the conversion of harmful accumulated chemicals into nontoxic ones.



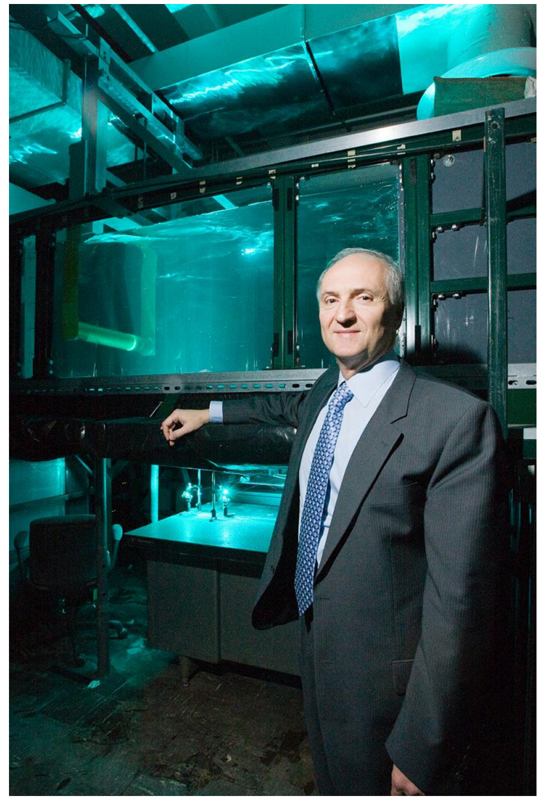
Because of its high capital and operating costs, RAS has generally been restricted to practices such as broodstock maturation, larval rearing, fingerling production, research animal production, specific pathogen free animal production, and caviar and ornamental fish production. Although the use of RAS for other species is considered by many aquaculturalists to be impractical, there has been some limited successful implementation of this with with high value product such as barramundi, sturgeon and live tilapia in the US.

Each system is split up in several stand alone units to reduce disease risks and has its own filtration system.



Additional Research • VIVACE • Mike Bernitsas

Vortex Induced Vibrations for Aquatic Clean Energy

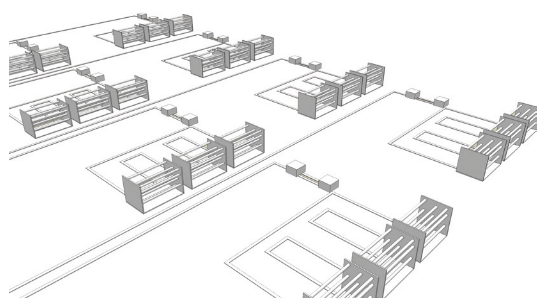


The VIVACE system can harness energy in slow moving water currents across the globe and turn it into electricity. The system mimics the way fish swim in currents.

It's one of a handful of new techniques to use water to create clean, renewable energy. Unlike water driven mills, turbines or dams, VIVACE doesn't require fast moving water, most streams on the globe are slow moving, and doesn't harm the environment.

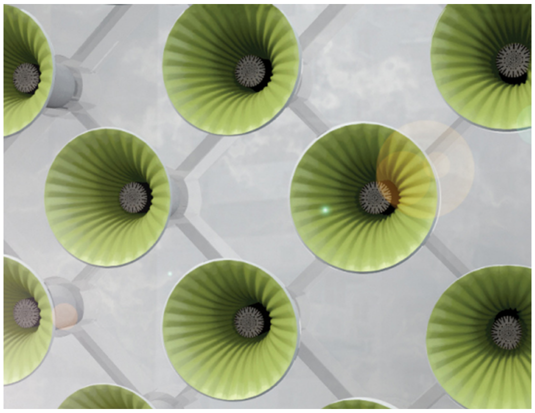
This device was by Mike Bernitsas, director of the Marine Renewable Energy Laboratory at the University of Michigan. He came up with the idea four years ago and is developing it with a team of more than 30 students and researchers for commercial use. He patented it and started a company that hopes to manufacture it in Michigan in a few years.

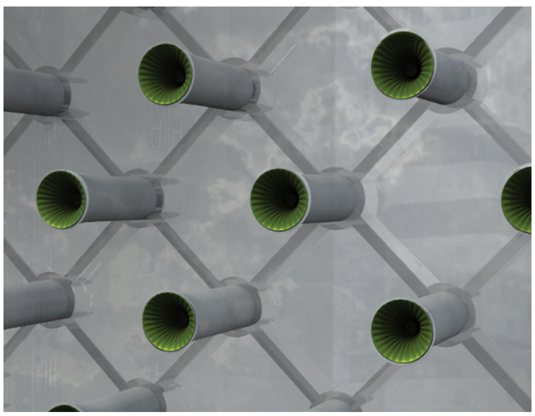
Bernitsas envisions a group of cylinders in frames on the ocean bed or in streams, perpendicular to currents. As the water flow hits the cylinders, it creates vortices that cause the cylinders to move up and down. That energy drives generators to make electricity, which goes through cables to the electrical grid on land. The size, number, and placement of the cylinders depends on the body of water.

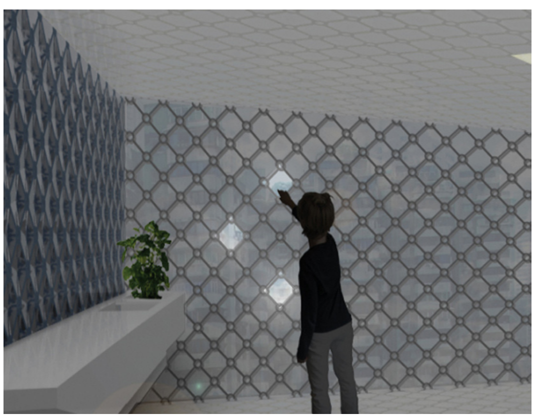


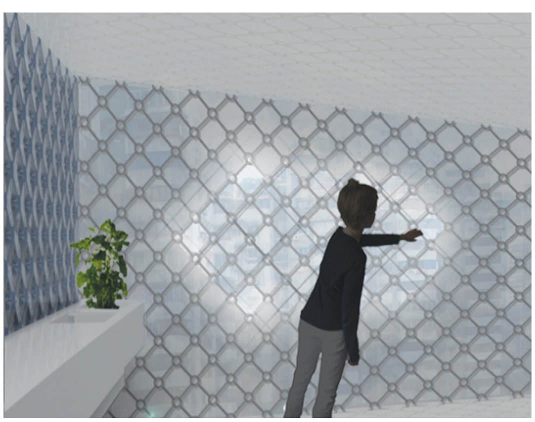
This electricity is clean, infinitely renewable and doesn't harm the environment. The cylinders will be far enough apart that fish can swim through them and deep enough to avoid ships, boats, and fishing lines. VIVACE's electricity will be cheaper to produce than solar or wind energy at 5.5 cents per kilowatt hour.

Additional Research • Living Skin • Philips Design







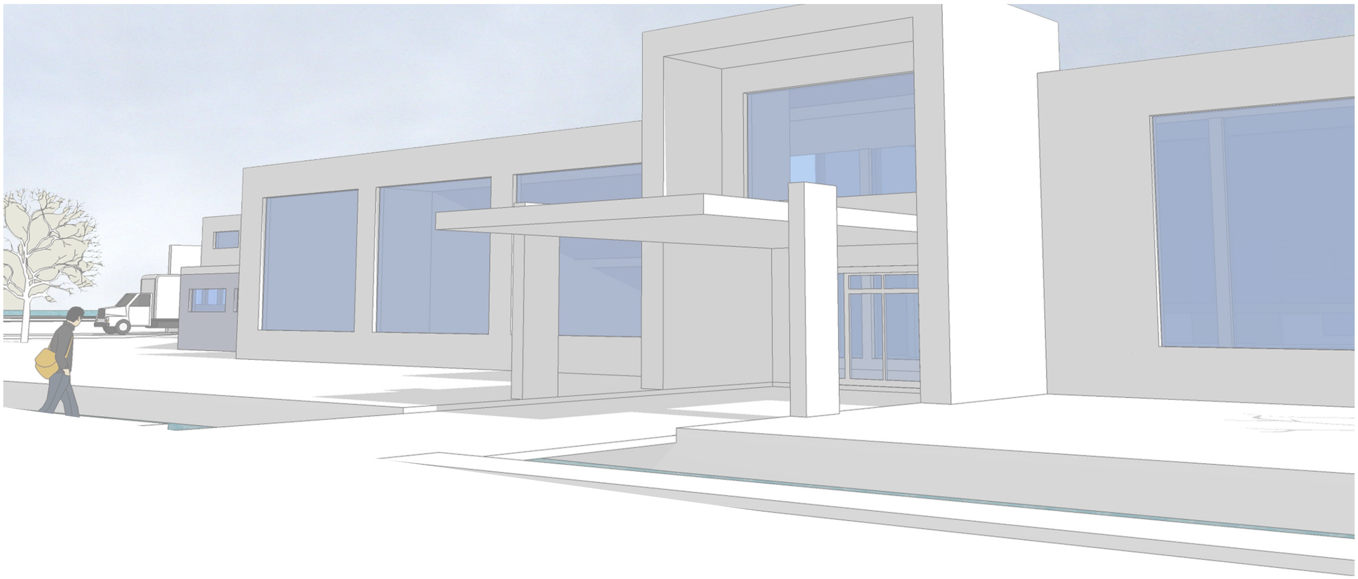


Living Skin

This is an example of biomimetic architecture that fuses high tech ideas with basic cellular functions to create living structures that operate like natural organisms. This nature inspired approach to city living looks at the urban landscape as a dynamic and ever evolving ecosystem. Within this cityscape, buildings open, close, breathe, and adapt according to their environment.

The exterior has been designed as a living skin, rather than a system of inert materials used only for construction and protection. The skin behaves like a membrane which serves as a connection between the exterior and interior of the space. The skin can be considered as the leaf surface having several stomata, cellular openings involved in gaseous exchange and transpiration in plants.

The surface would allow the entry of light, air, and water into the housing. It would automatically position itself according to the sunlight and let in light. Hypothetically, electricity for lighting would not be needed during the day. The air and wind would be channeled into the building and filtered to provide clean air and natural air conditioning. The active skin would be capable of rain water harvesting where water would be purified, filtered, used, and recycled. The skin could even absorb moisture from the air. The waste produced would be converted into biogas that could be put to diverse uses in the habitat.

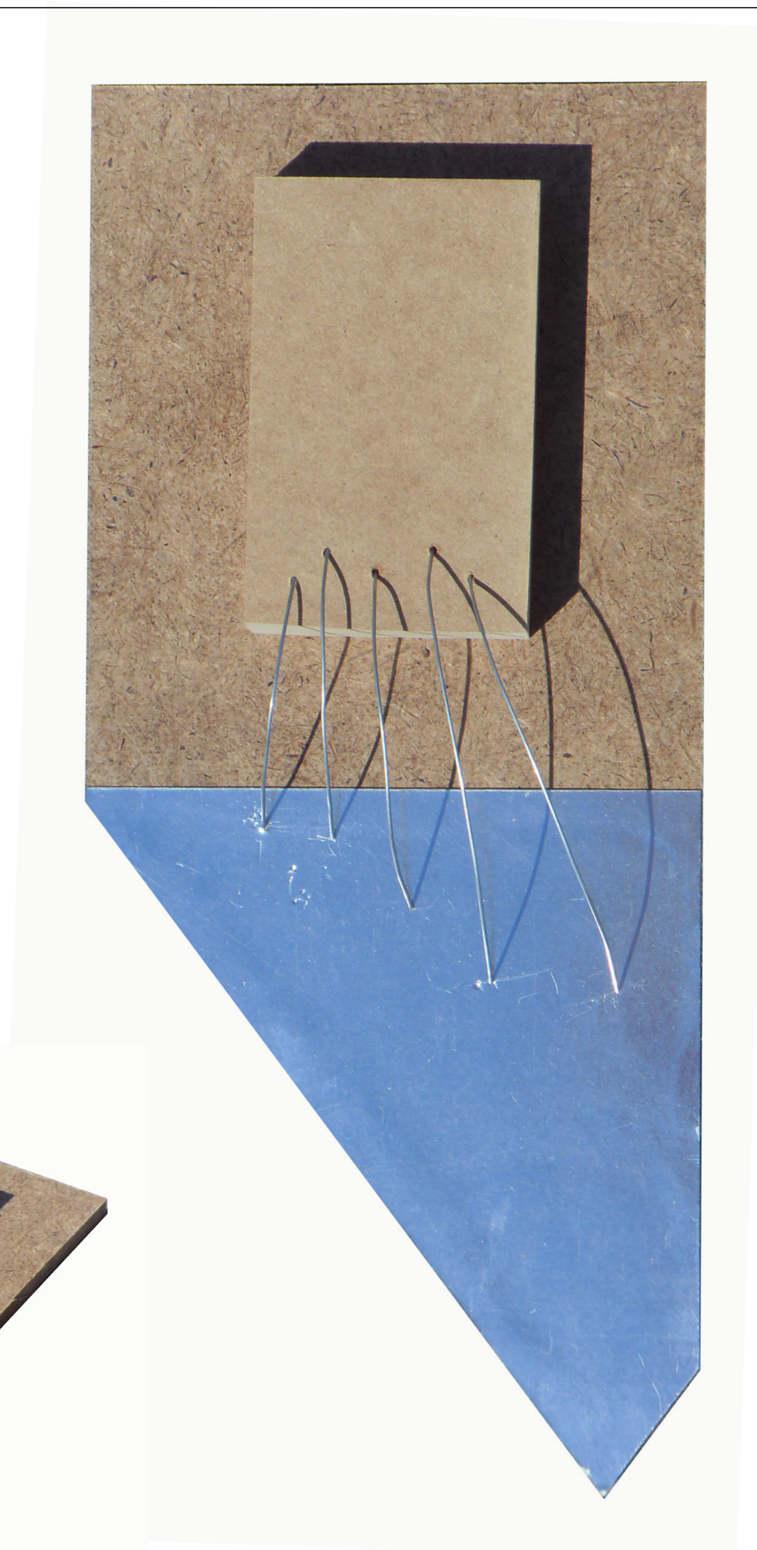


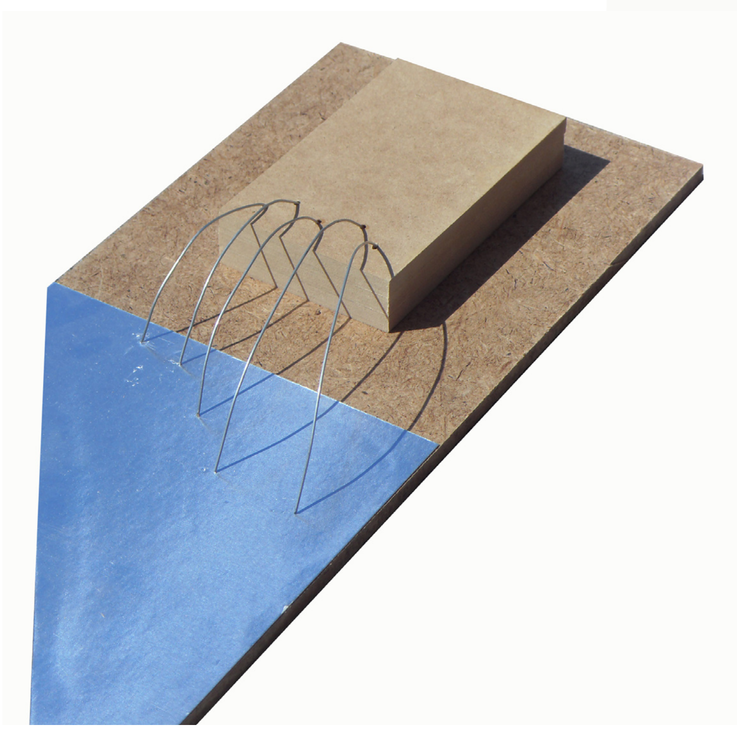
Schematic Design:

Fish Farm and Hatchery

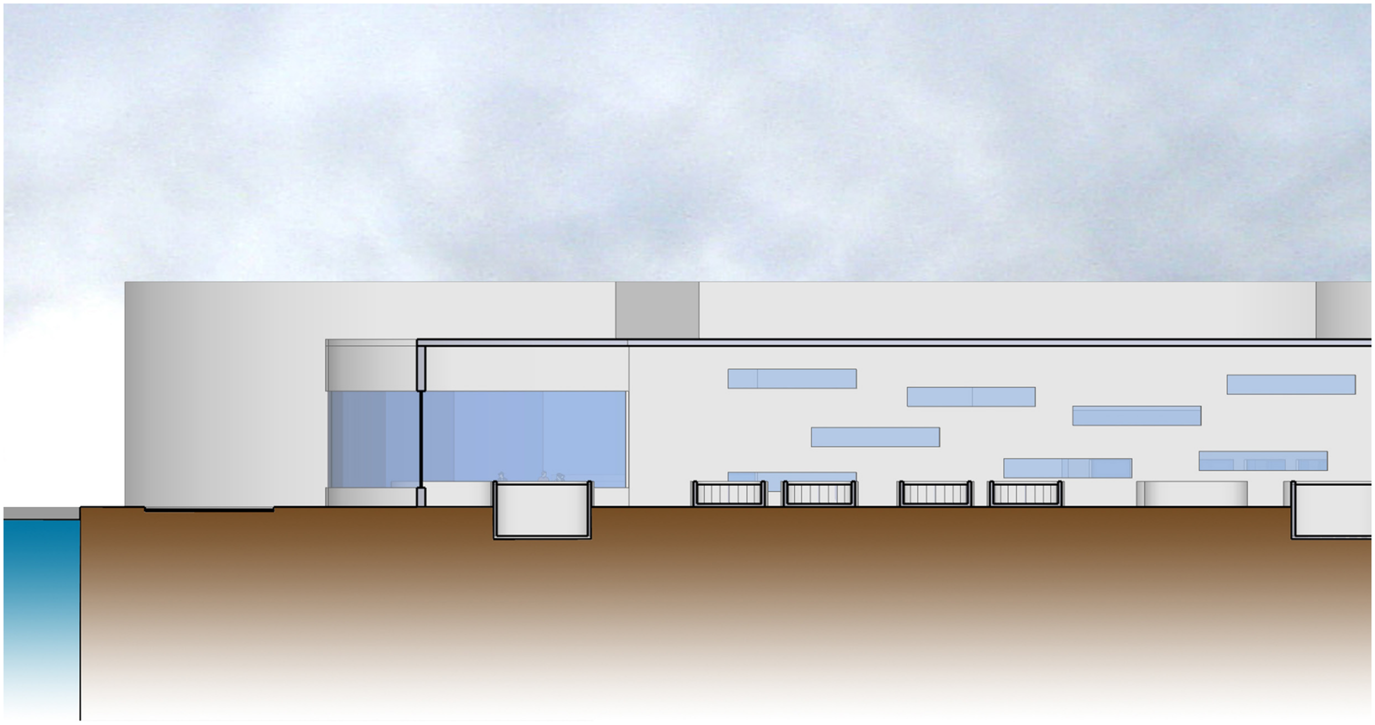
Schematic Design

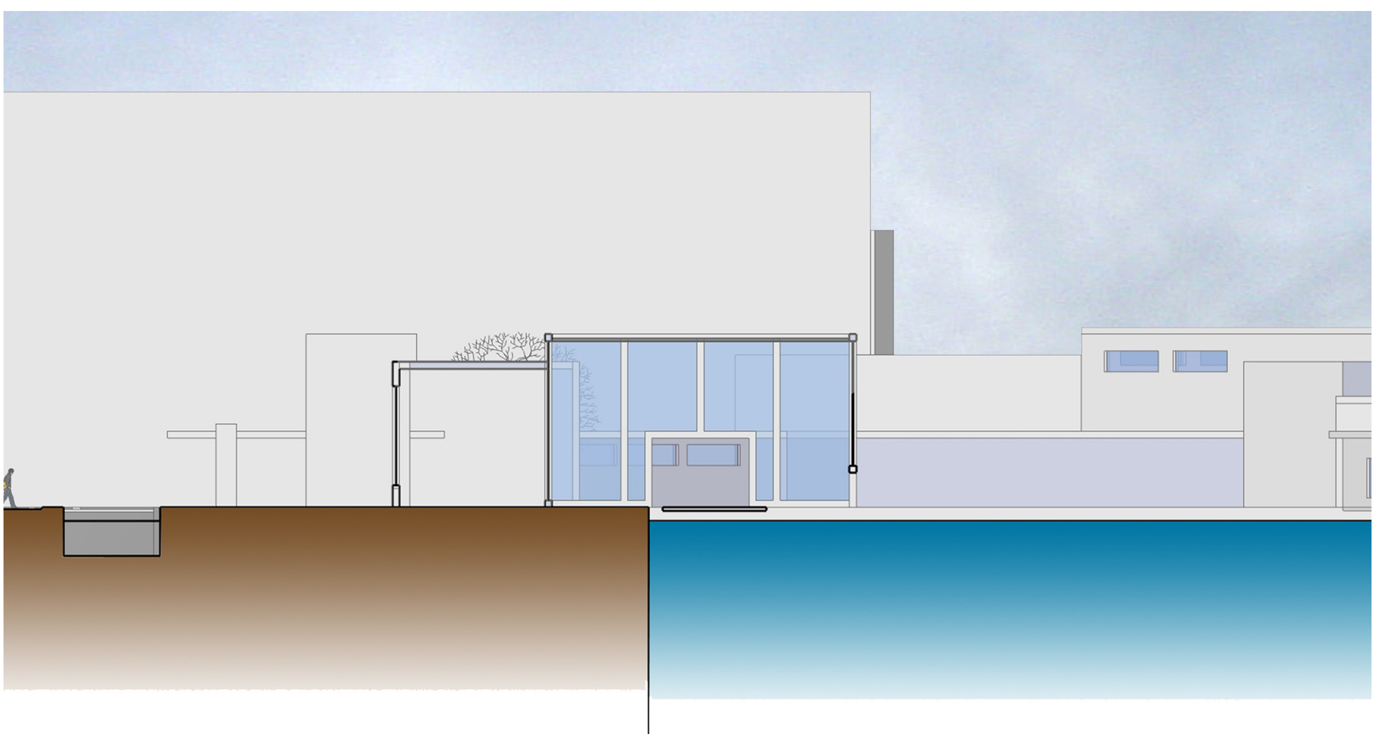
At this stage of development, relationship and connection to the Detroit River played a key role in the design.



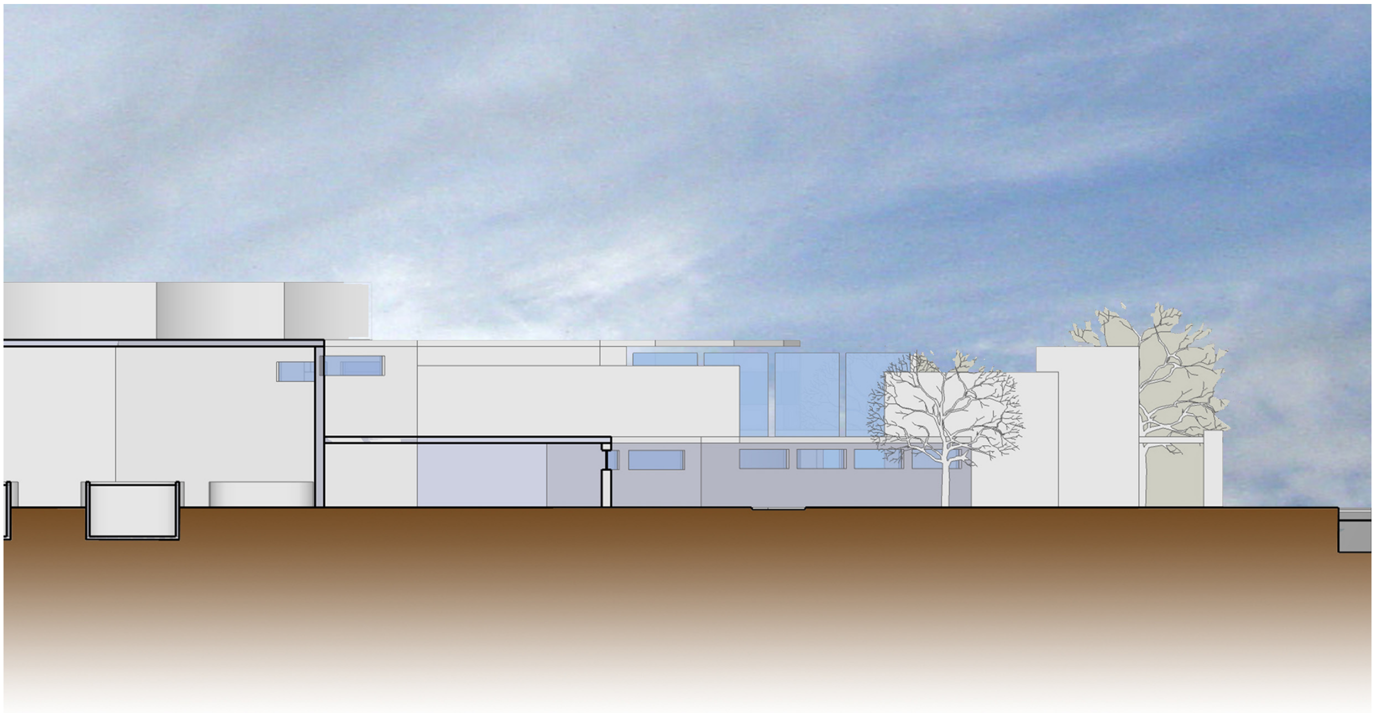


Schematic Design • Sections

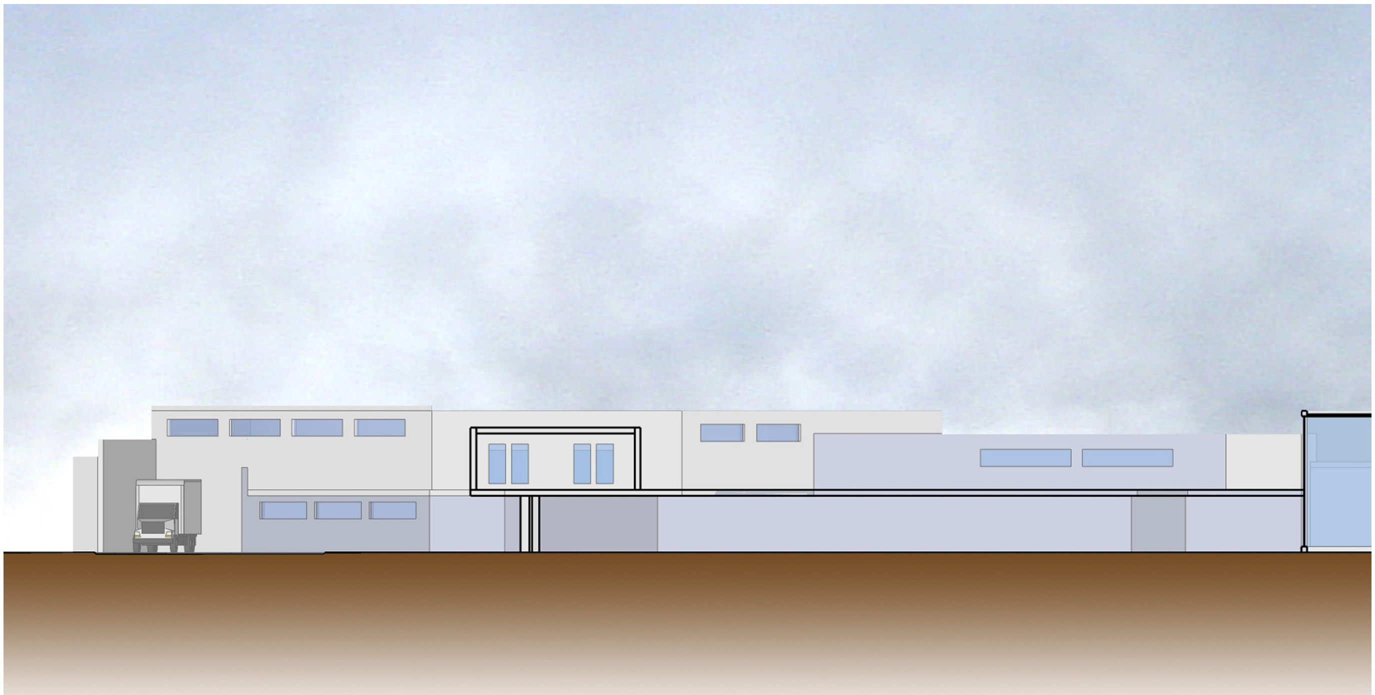


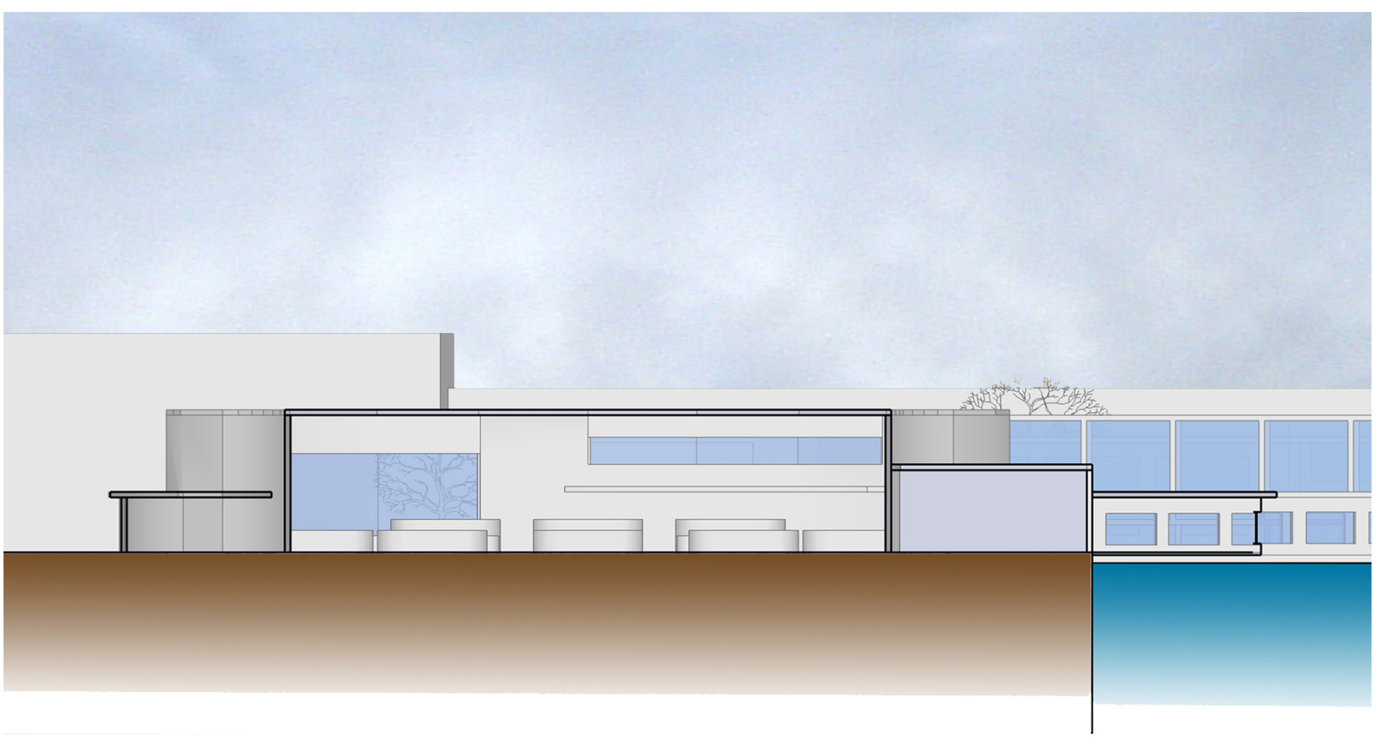


Schematic Design • Sections

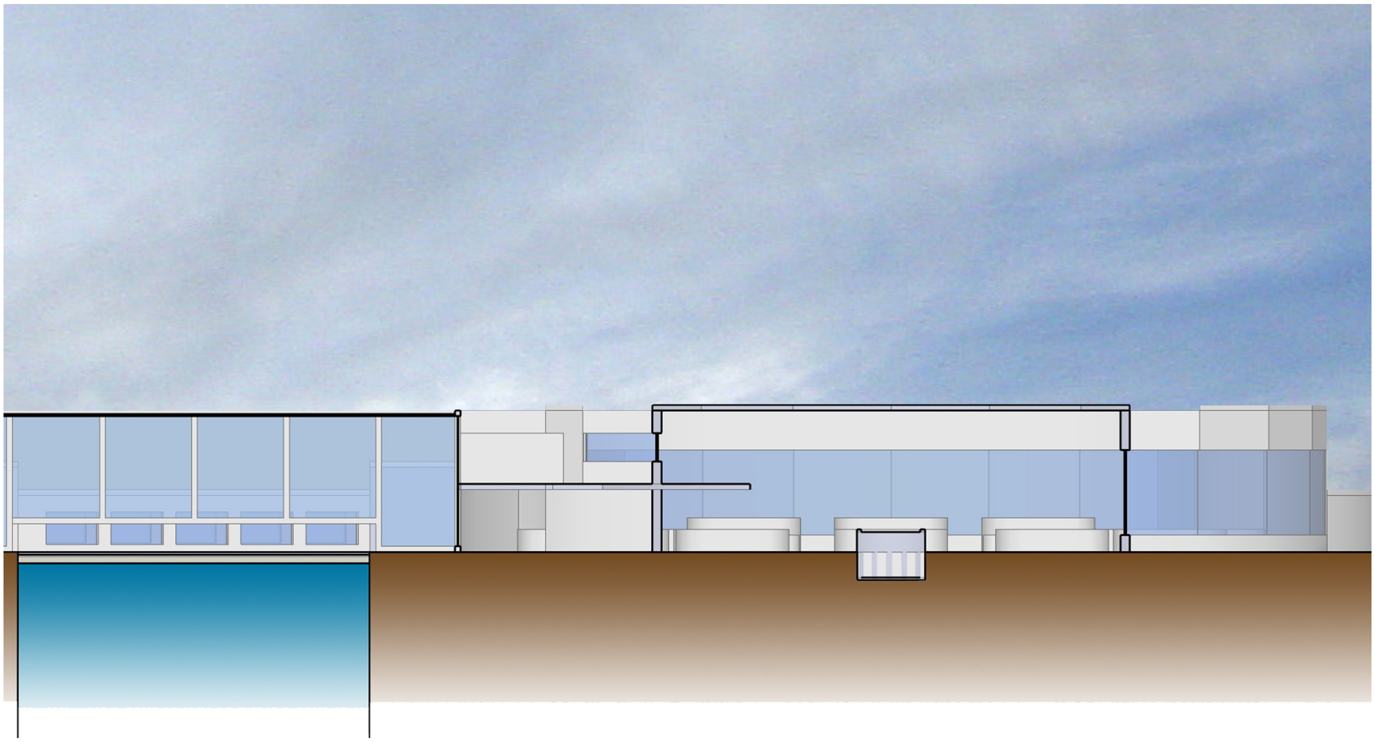


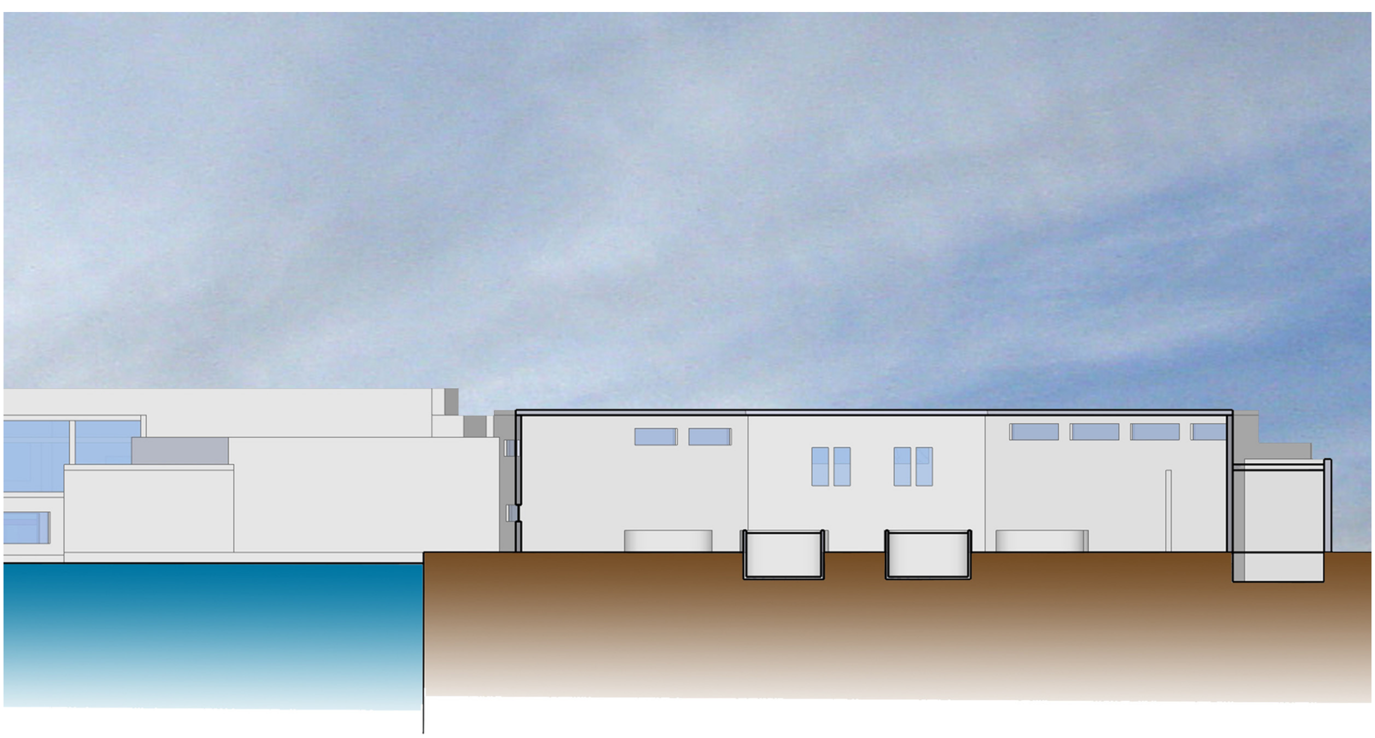
Schematic Design • Sections



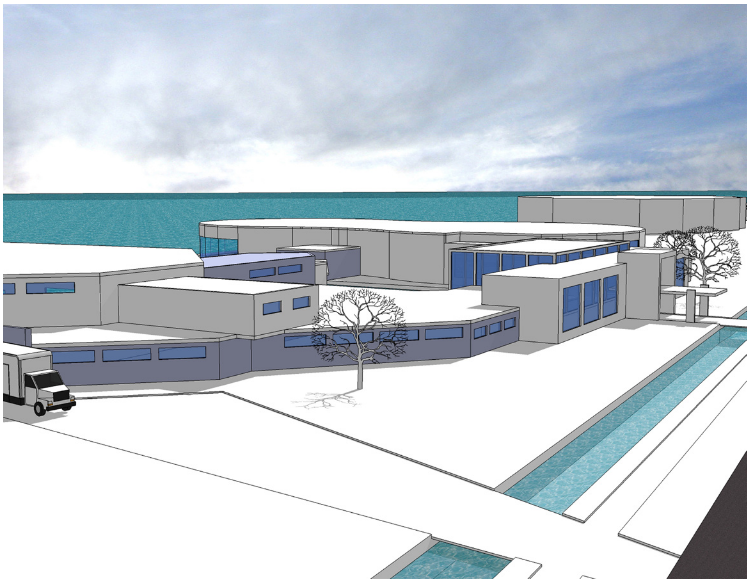


Schematic Design • Sections





Schematic Design • Perspectives

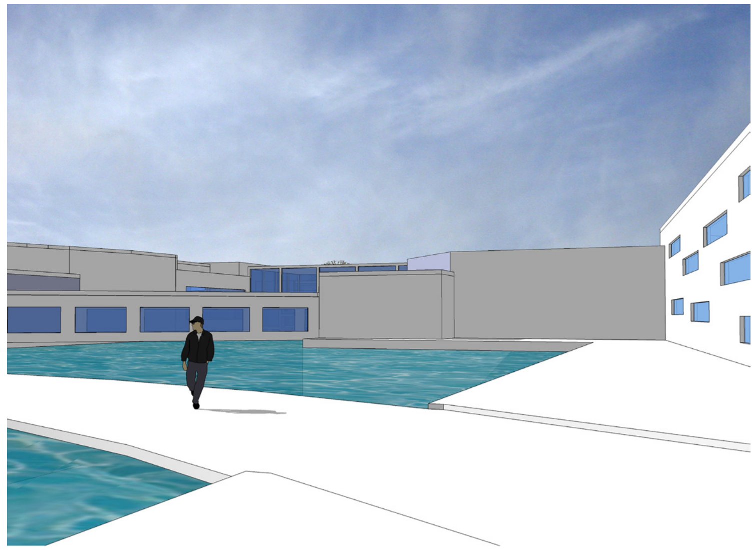


The front of the facility allows for the access of trucks for shipping and delivery as well as a main entrance into the retail space for consumers.

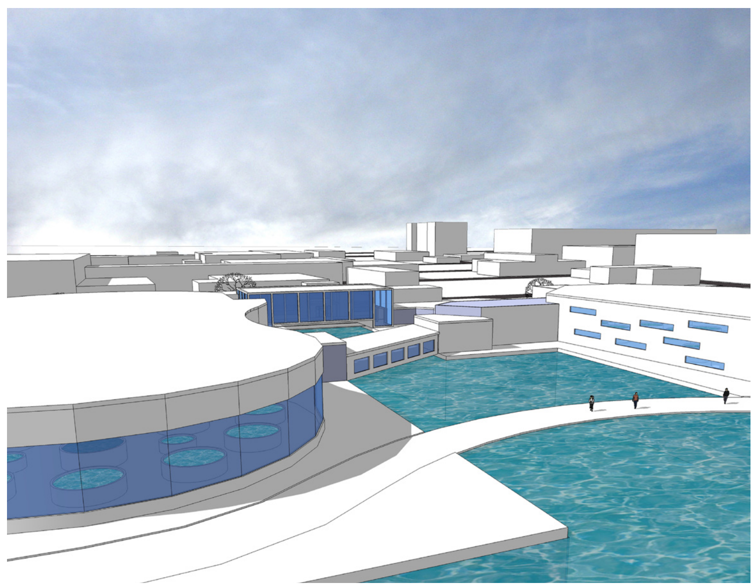
View of the retail space from the exterior.

Schematic Design • Perspectives

The design of the riverwalk was intended to be incorporated into the overall design of the facility. Allowing passerbys to view the growth process of fish as they walk passed the facility and over the slip.

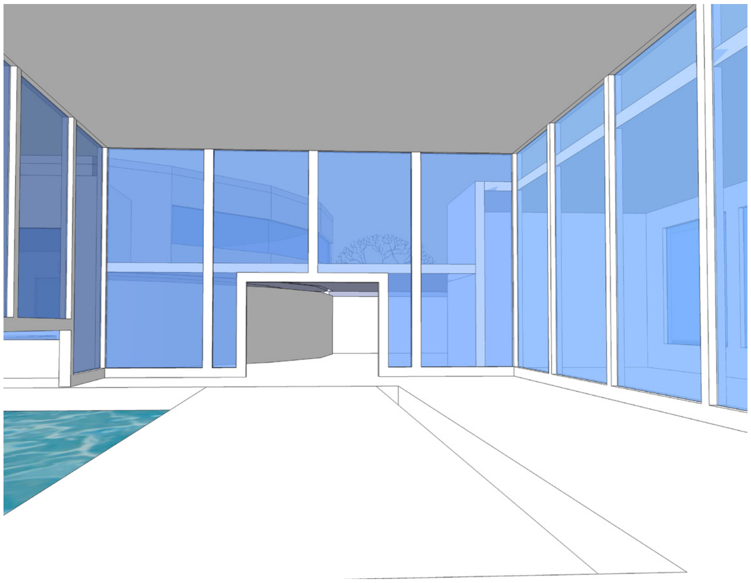


View of the riverwalk and the south side of the facility

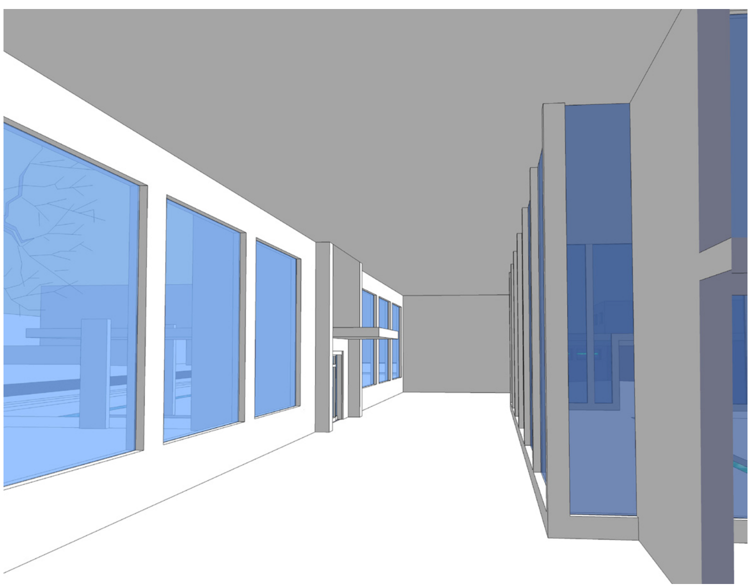


The main concepts that have derived the form of the building as well as the circulation are the organization of the tanks themselves and the process in which the fish are raised until they are ready to be harvested or ready to rejoin the natural ecosystem in the surrounding community. Also, the facility allows for users other than staff to experience the life cycle of a farm raised fish.

Schematic Design • Perspectives



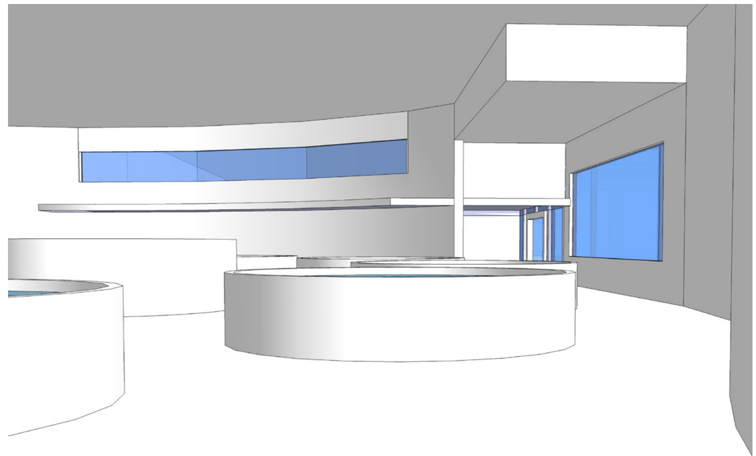
This transition space was for workers use only and allowed them to transport fish from one side of the facility to the other without having to be exposed completely to the outside conditions.



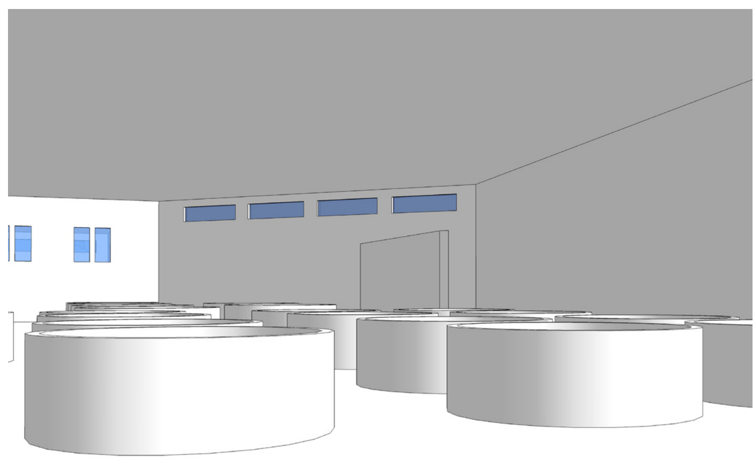
View of the retail space from the interior.

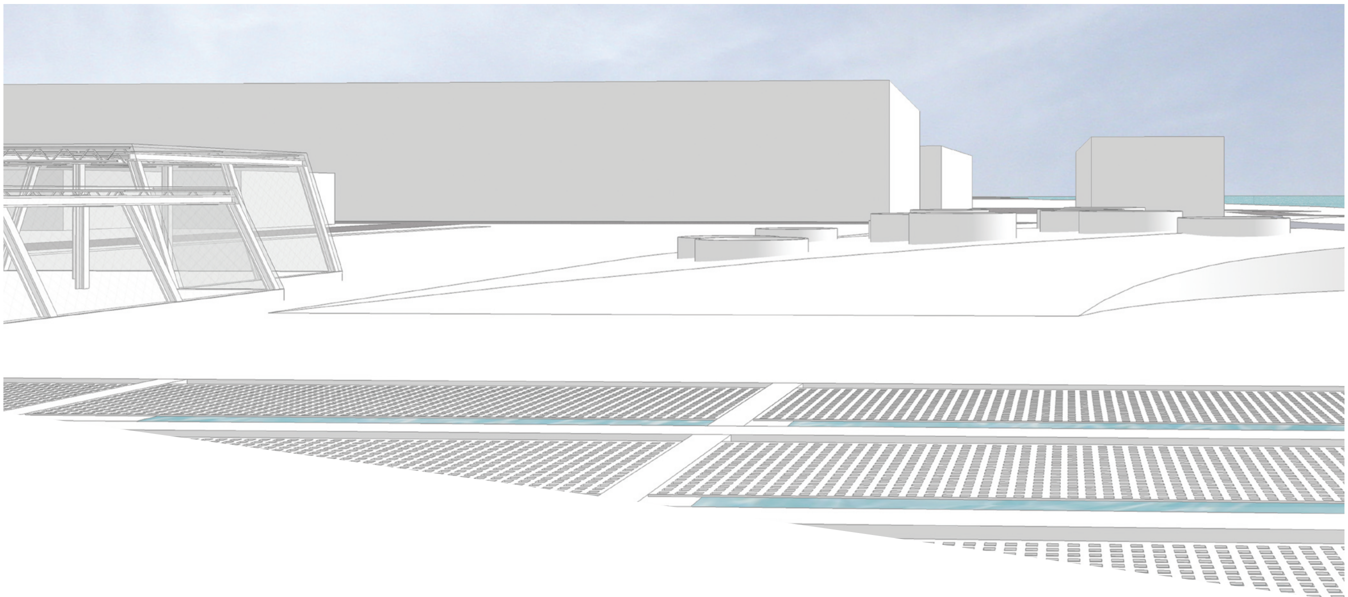
Schematic Design • Perspectives

View of the grow out tanks in the western program space.



View of the grow out tanks in the eastern program space.

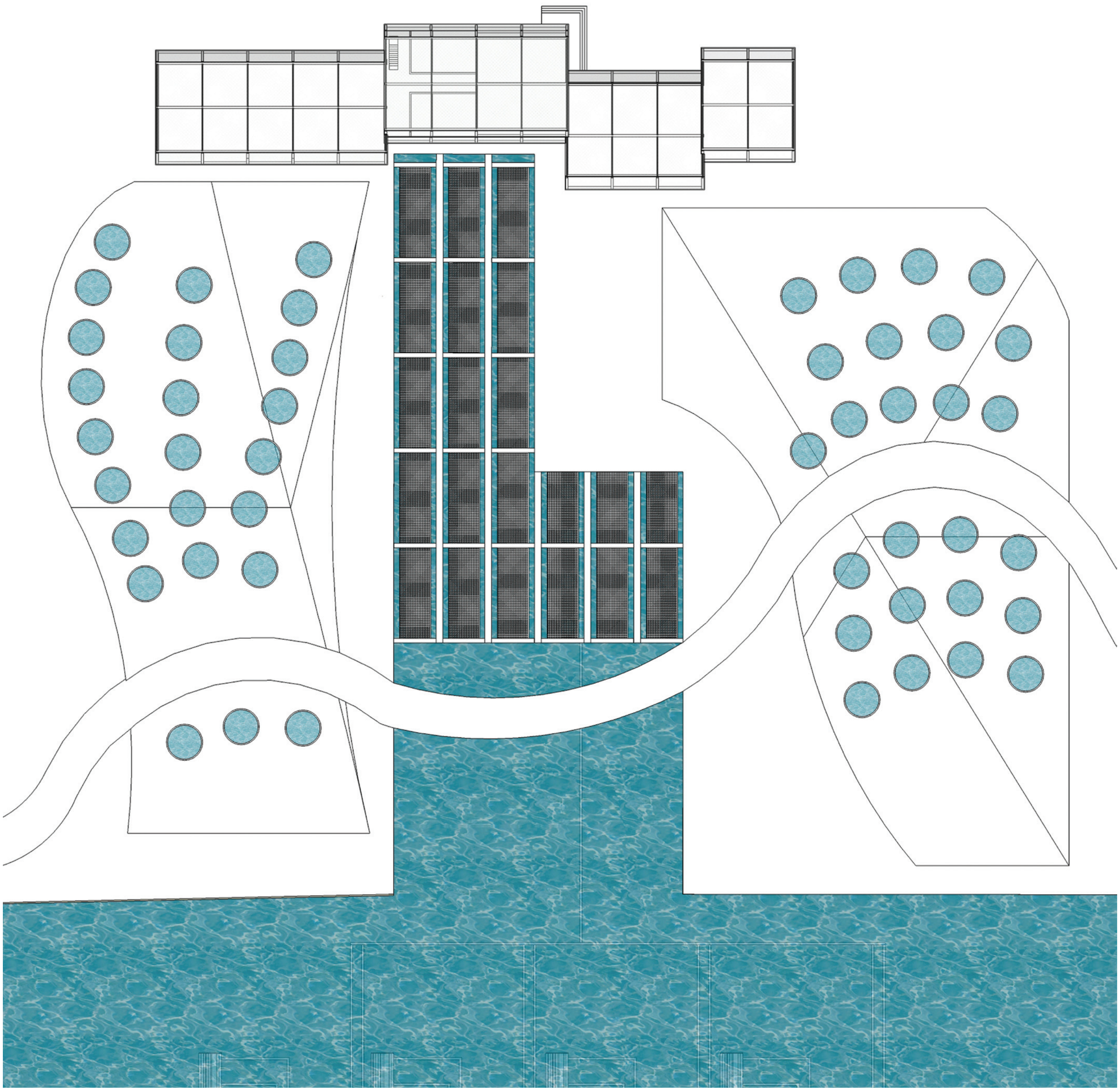




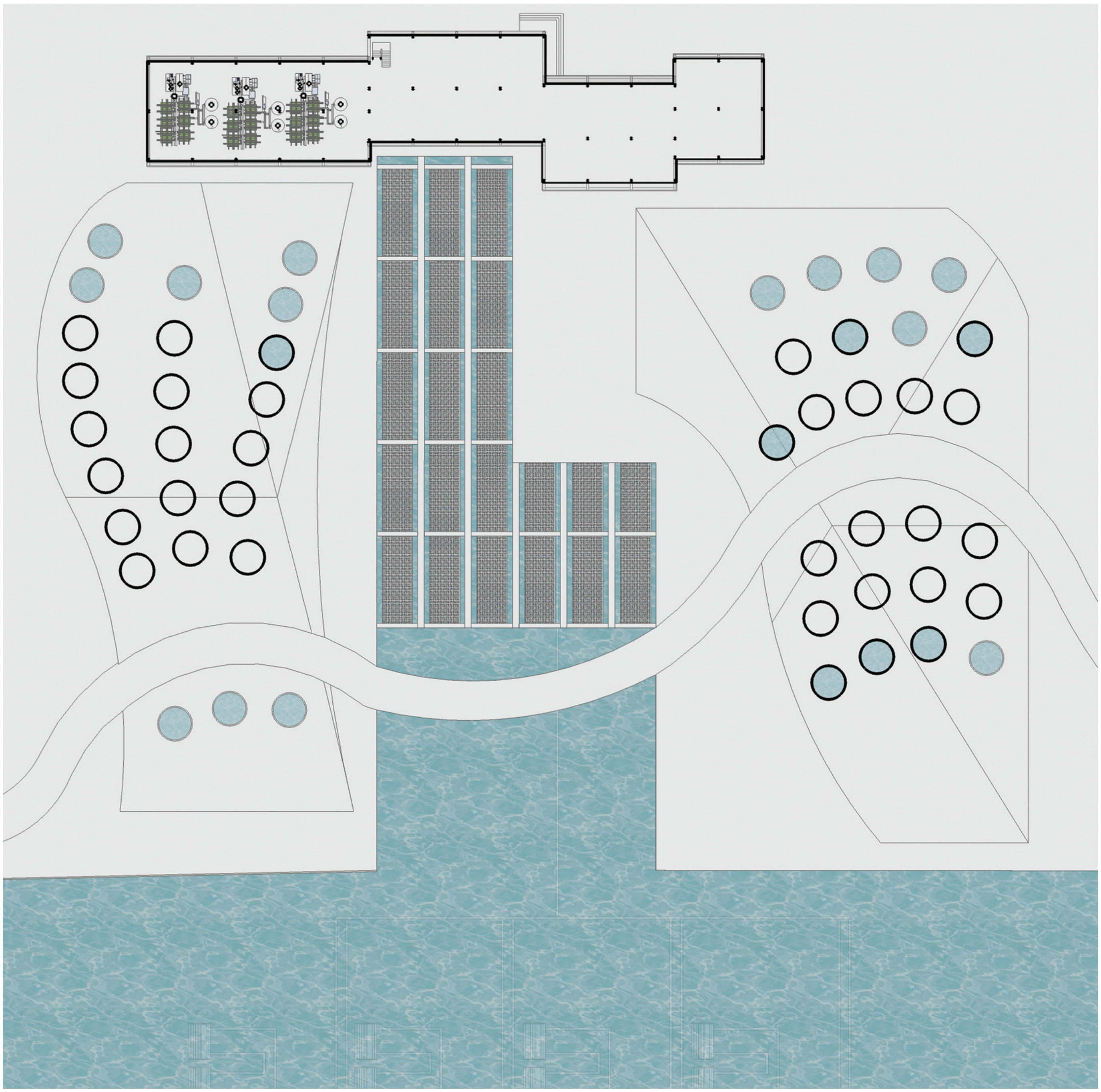
Design Development:

Fish Farm and Hatchery

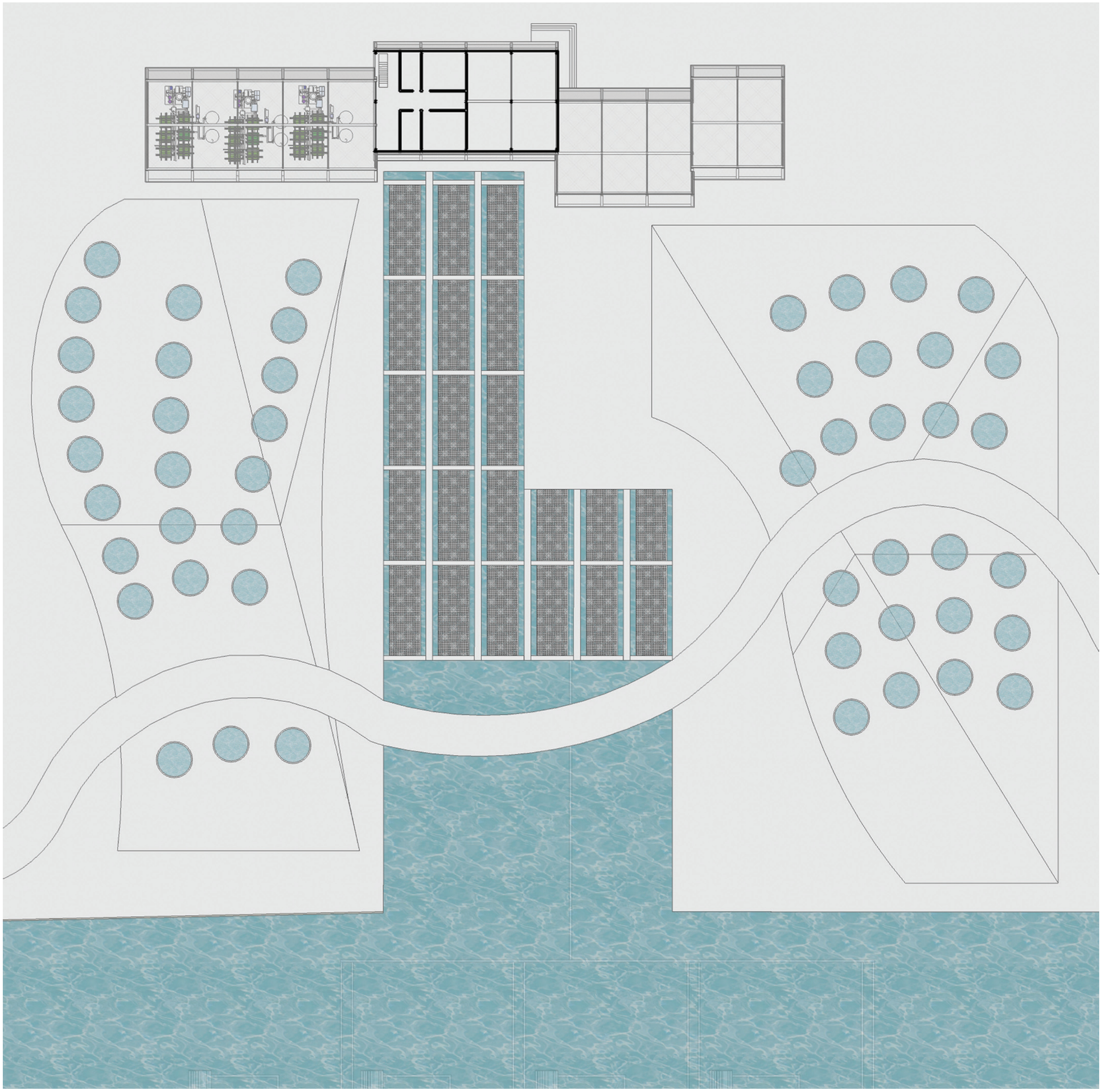
Design Development • Plans

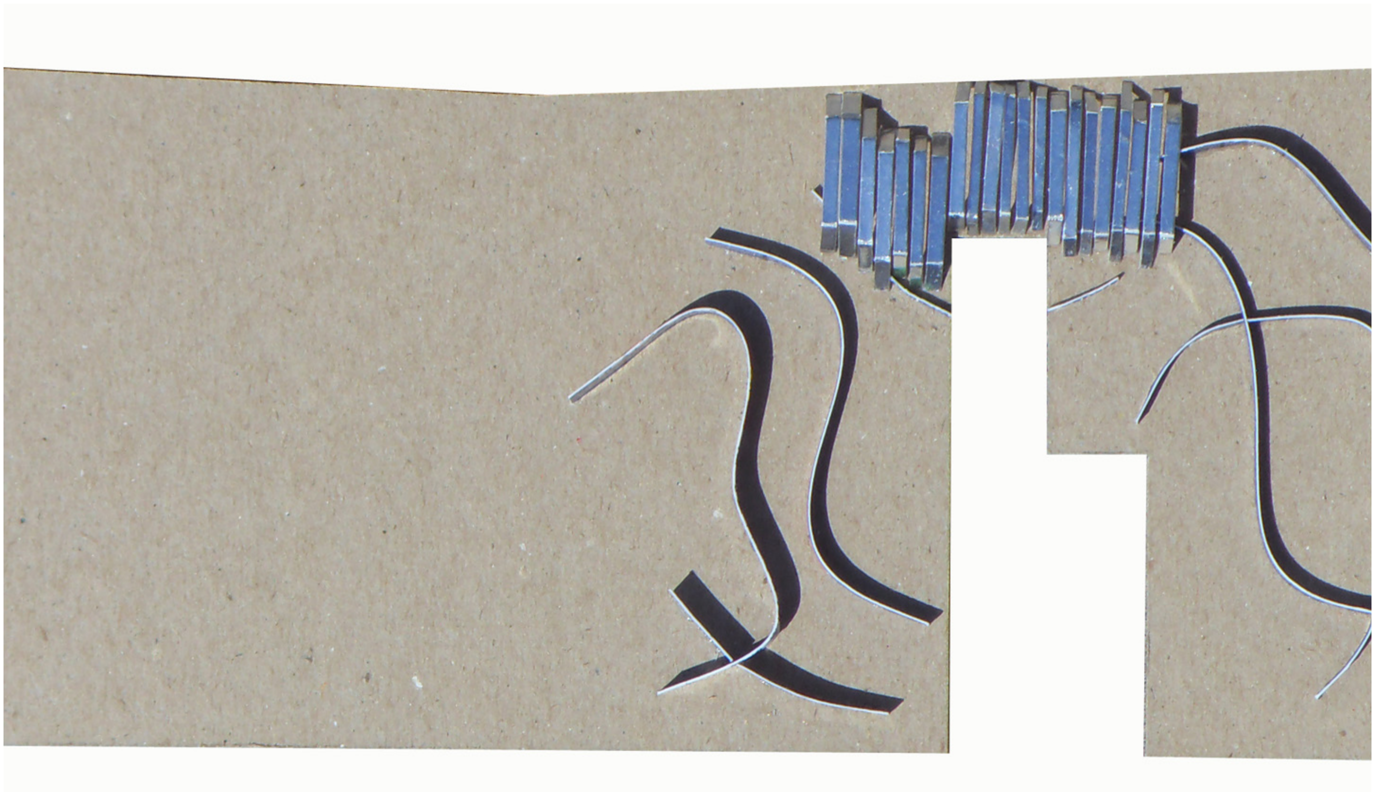


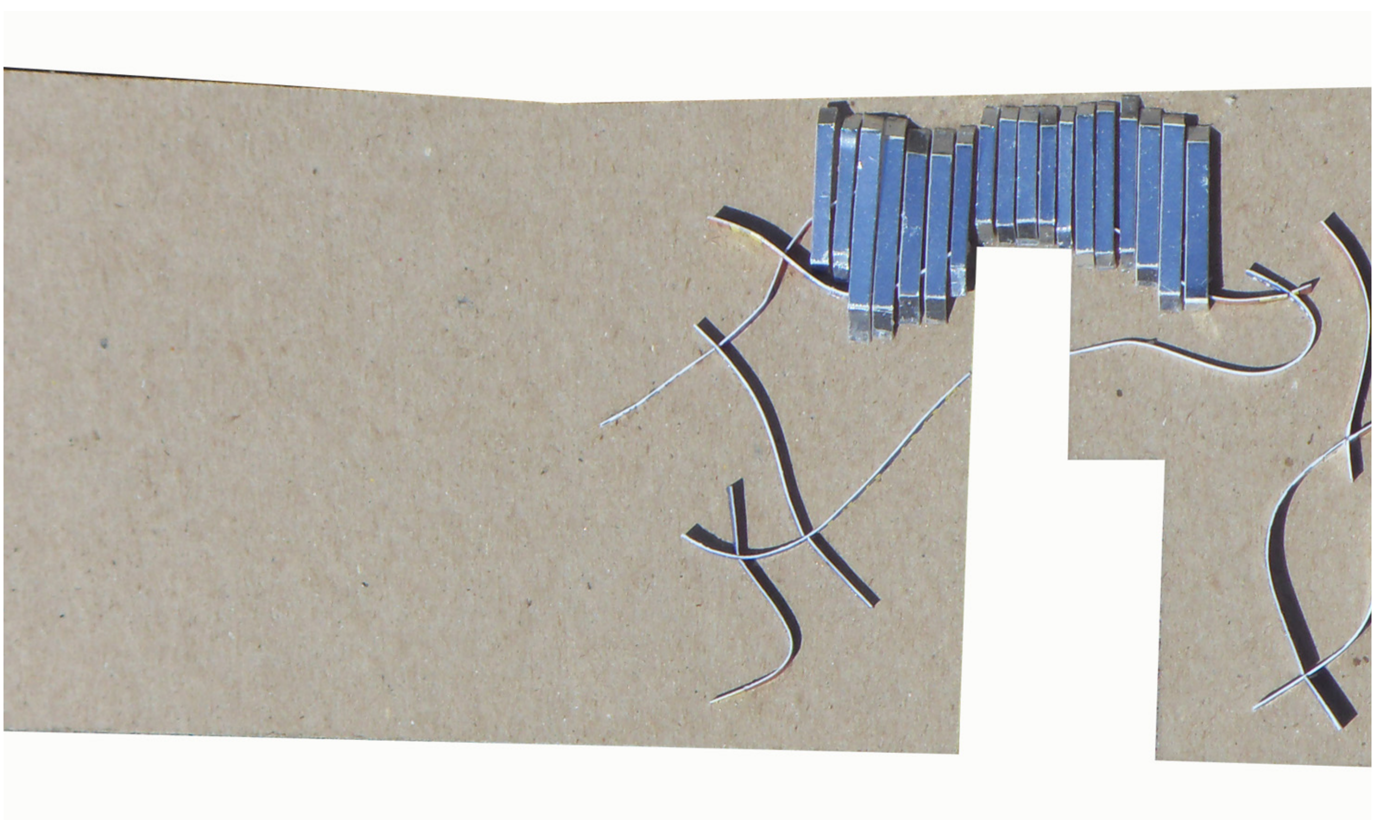
Design Development • Plans



Design Development • Plans



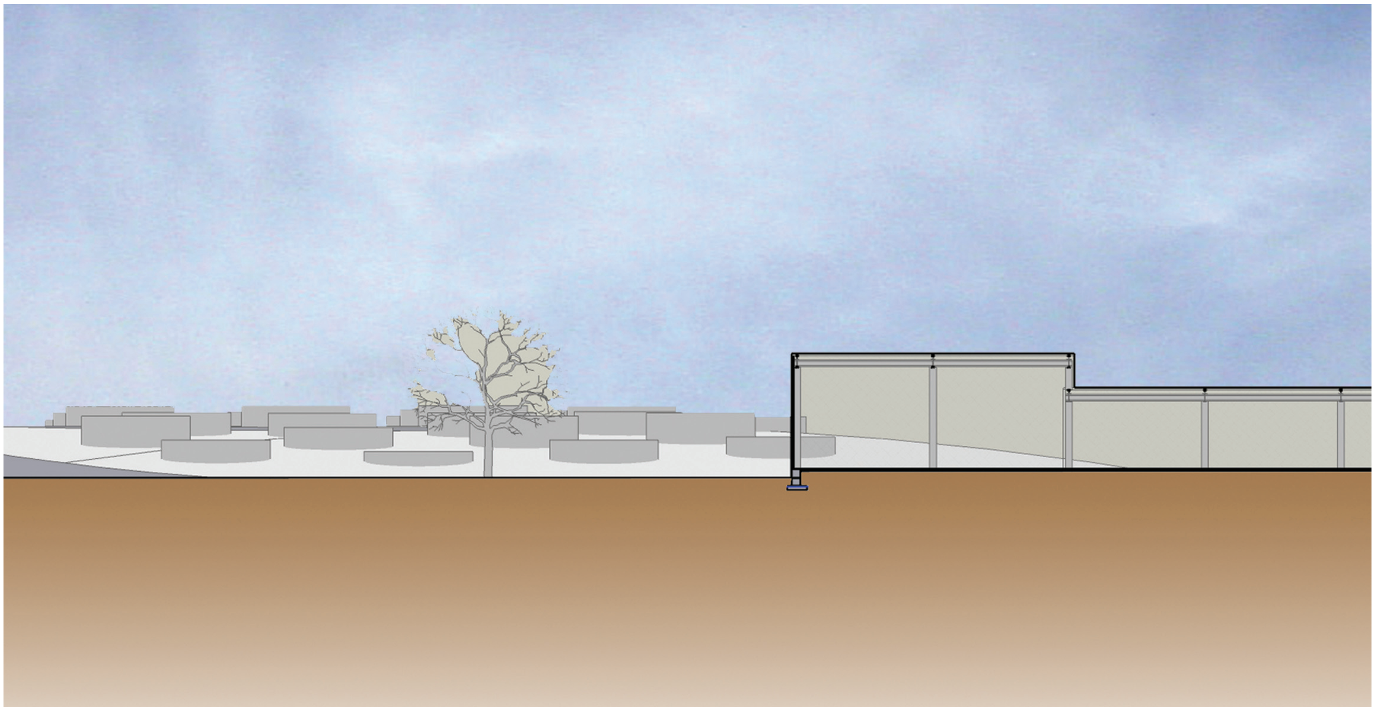


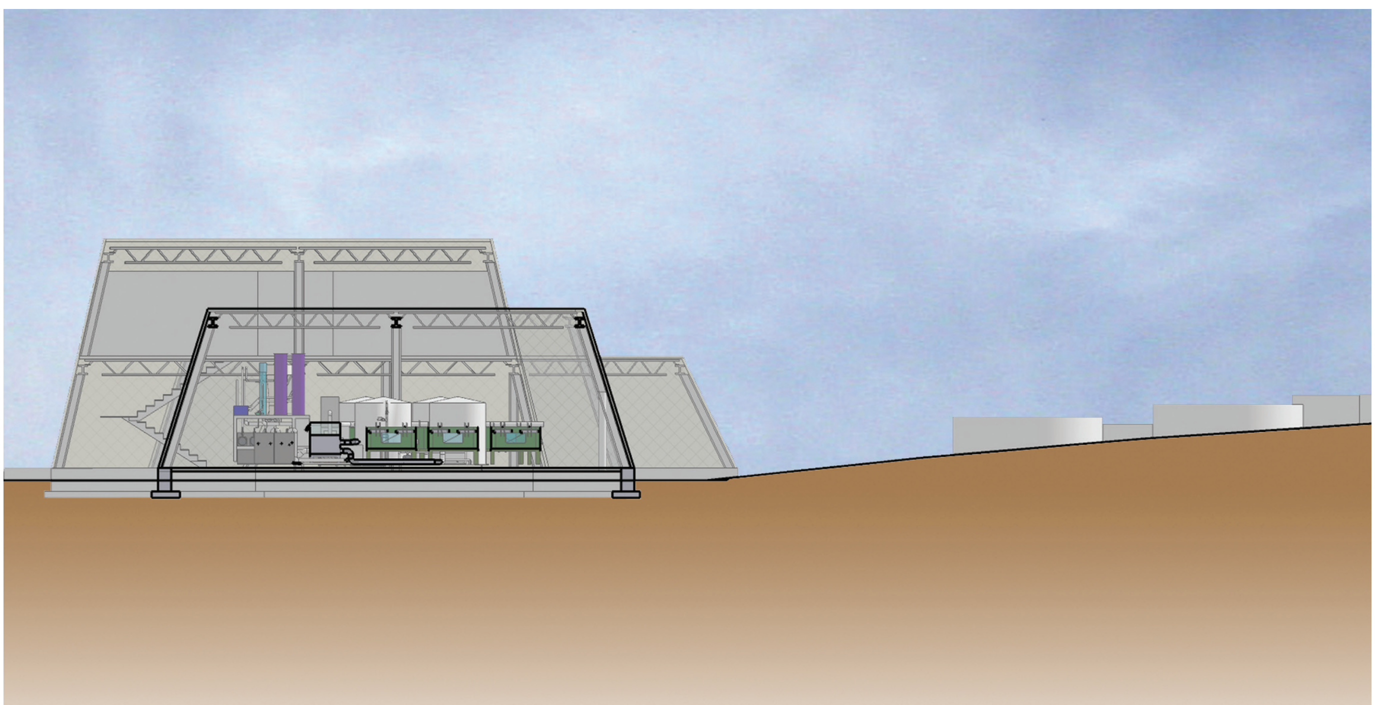


Design Development • Sketch Models

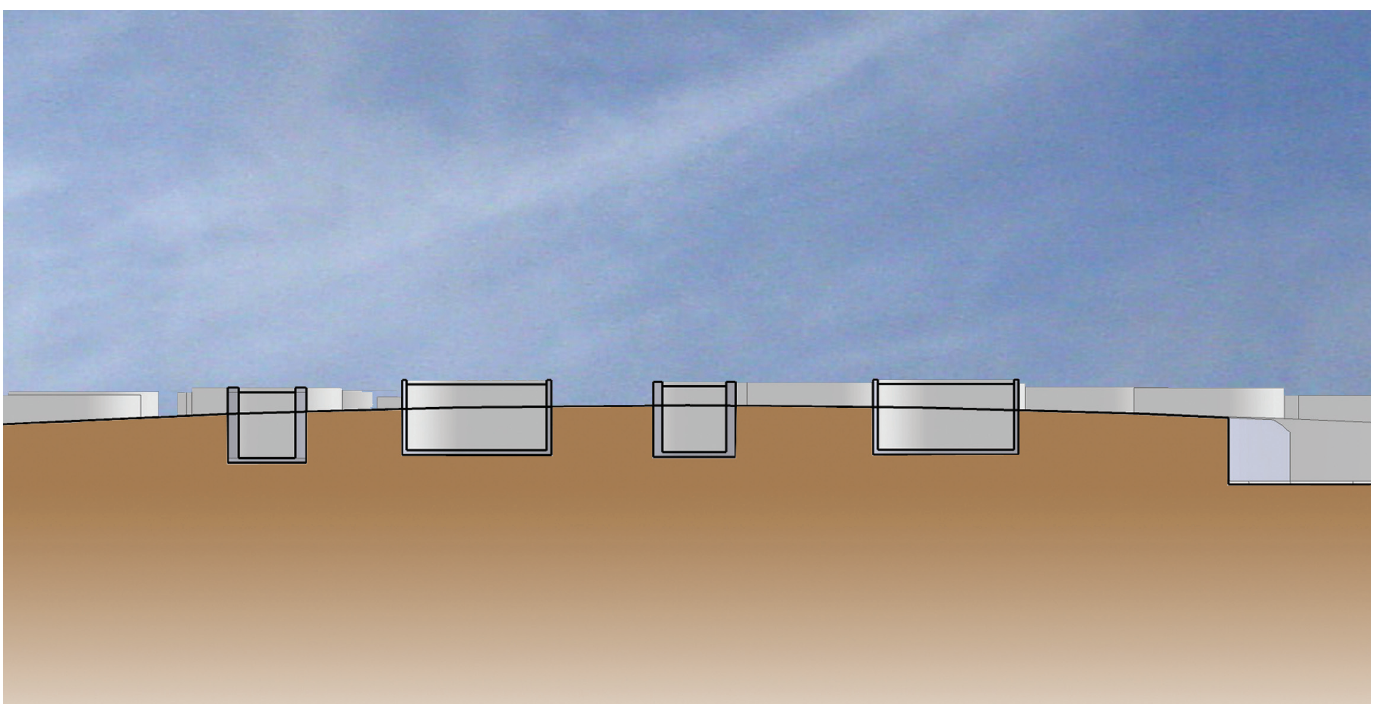
Each of these models, explores the form of the building in relationship to the exterior landscape where the grow out tanks are placed. The exterior of the building has taken a singular uniform shape to minimize the building footprint and maximize the efficiency of the buildings functions.

Each change in height or setback indicates a different function and program on the interior.

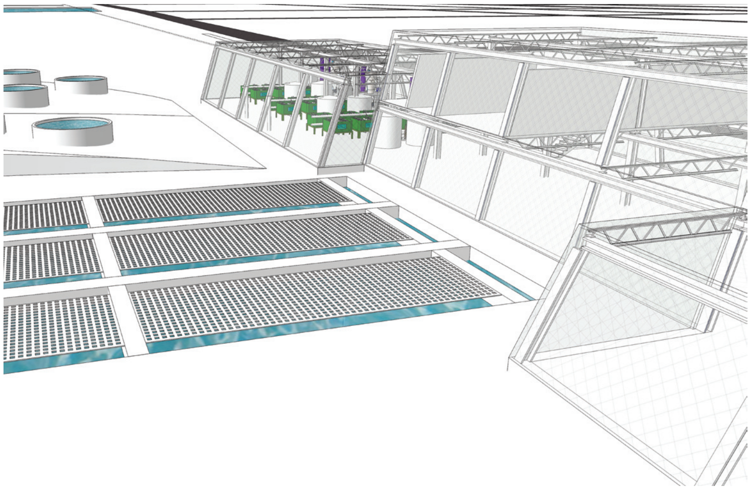




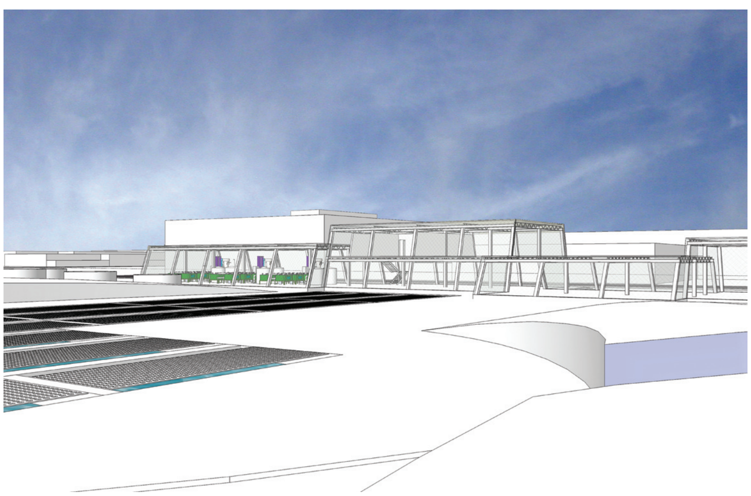
Design Development • Sections



Design Development • Perspectives



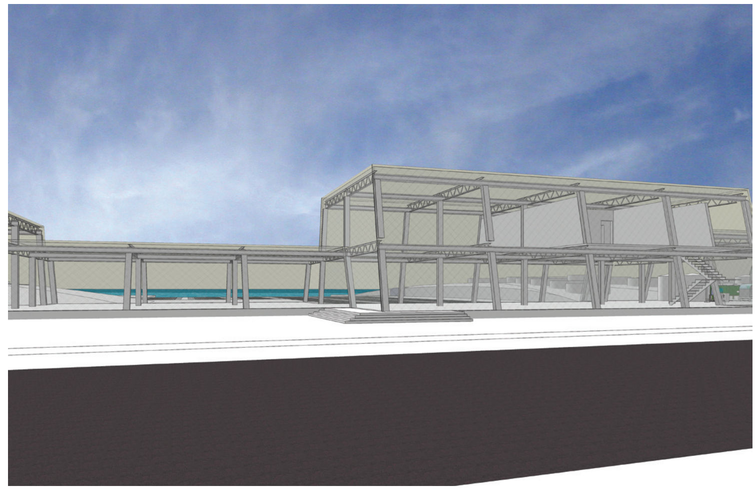
After the previous critique, the design of the building changed drastically to better suit the design intent, which is an eco-friendly light industrial building. To minimize the building footprint the grow out tanks were exposed to the open air and cut down the square footage by two-thirds.



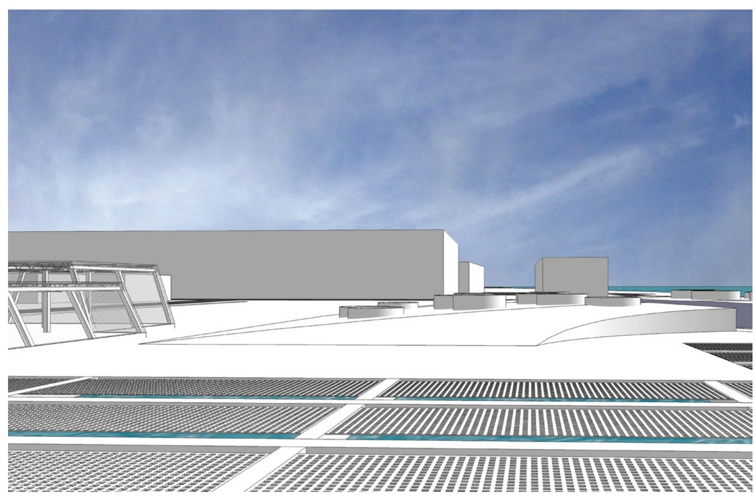
The initial design of the hills and mounds that, in essence, house the grow out tanks, were intended to seem to grow out of the earth and create paths for the workers to walk through to access the tanks.

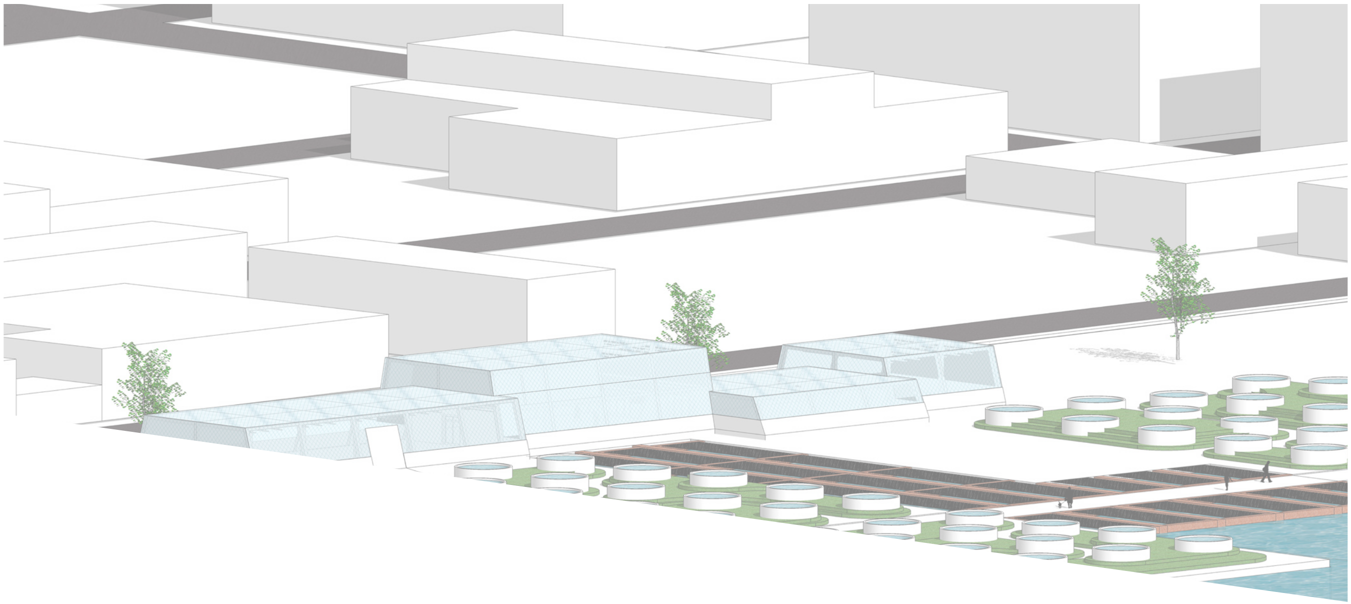
Design Development • Perspectives

The building is constructed of steel beams and columns as well as steel trusses that span the short length of the building.

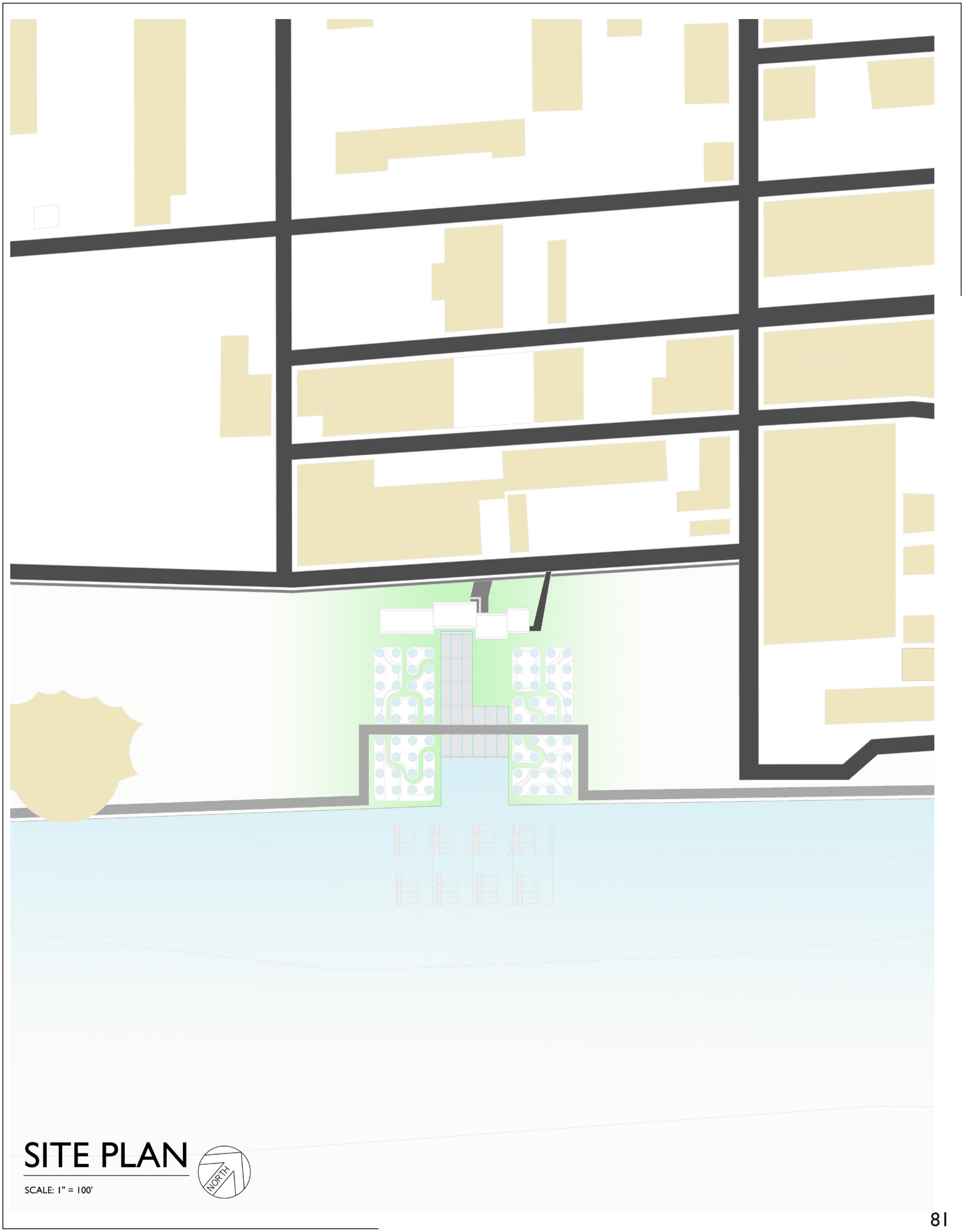


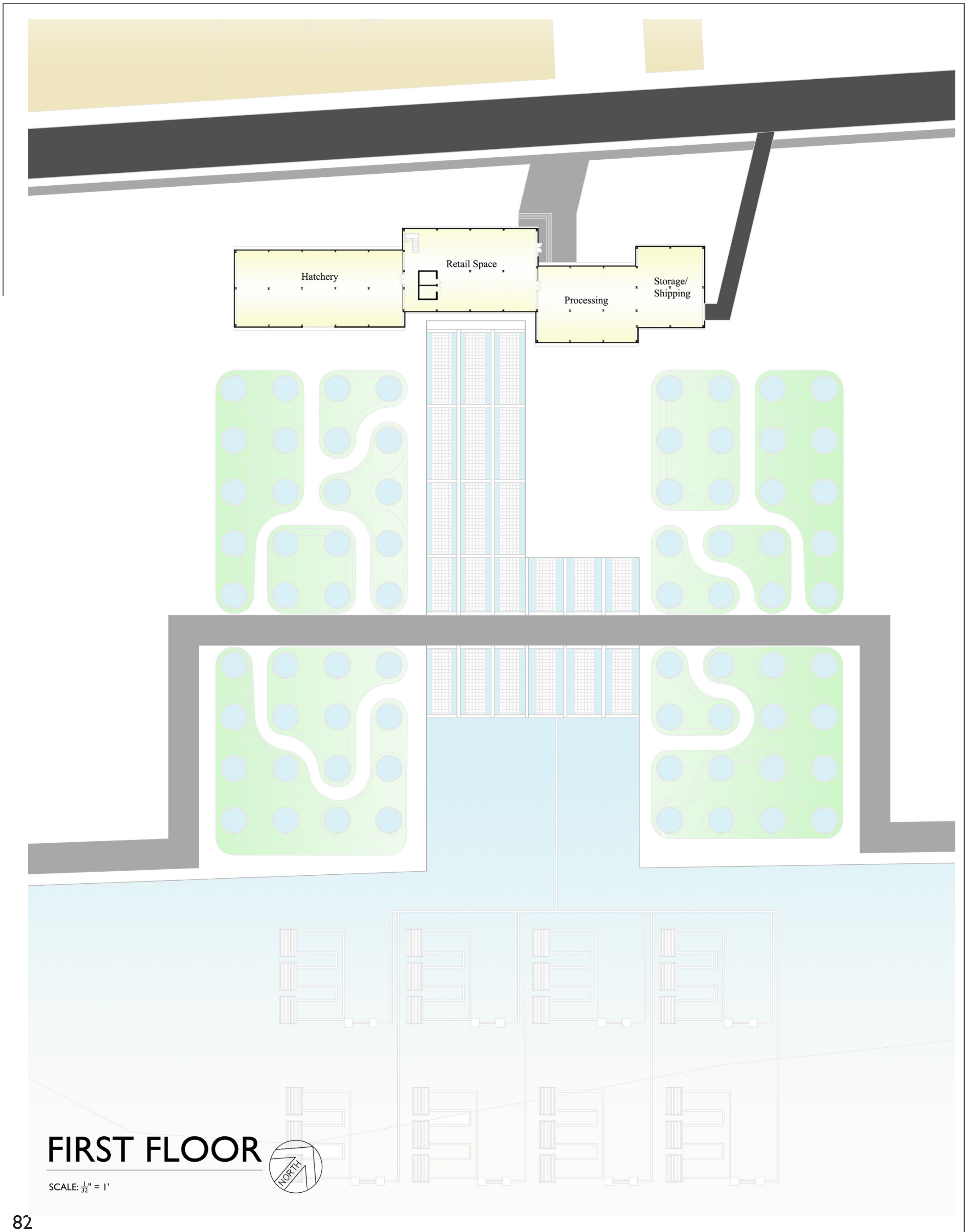
The cage system allows the opportunity for fish to exercise and grow in size. The insertion of the cage system into the slip also allows for a smooth transition from one side of the site to the other. Only workers would be able to cross over the cage systems for safety reasons.

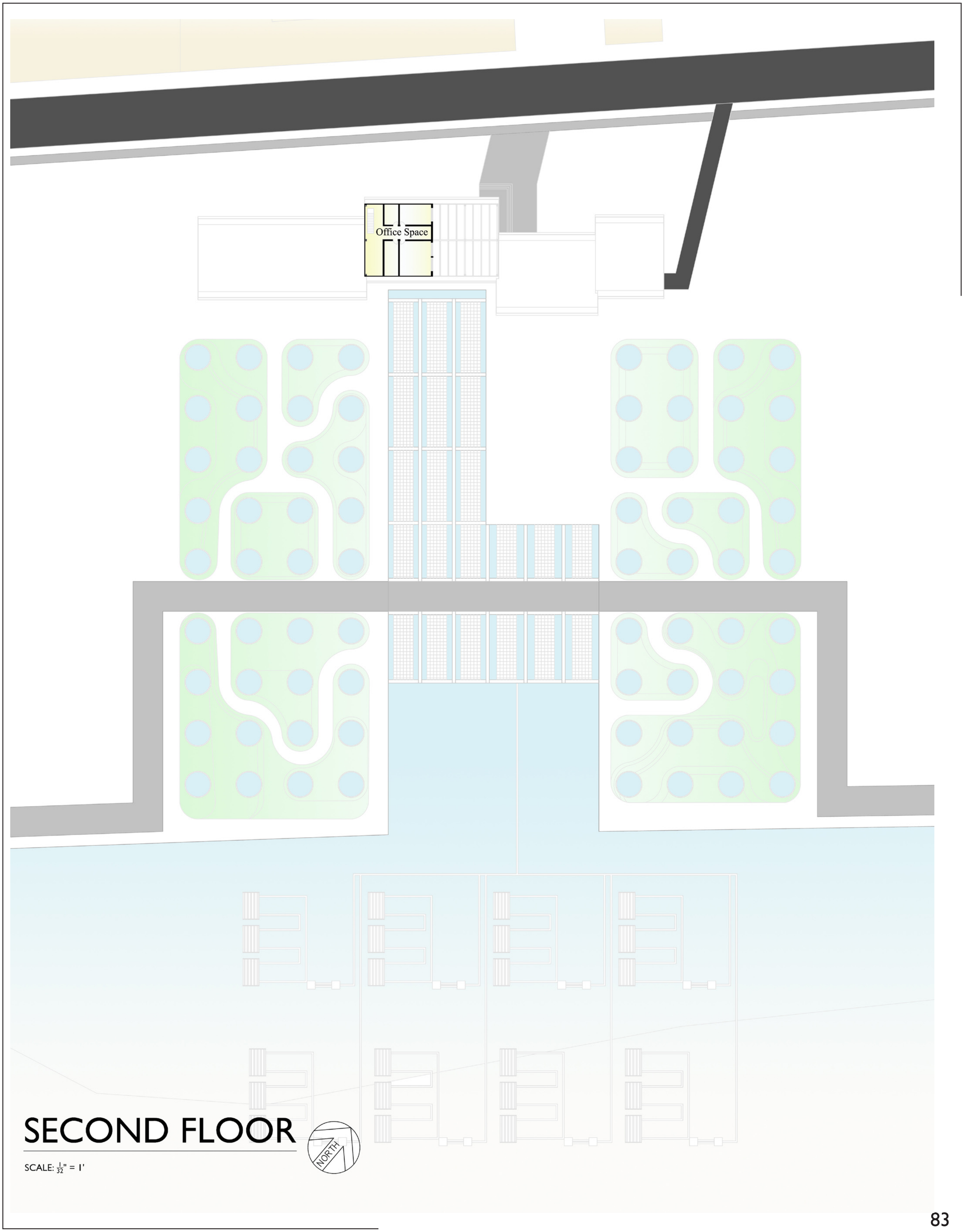




Final Design:
Fish Farm and Hatchery

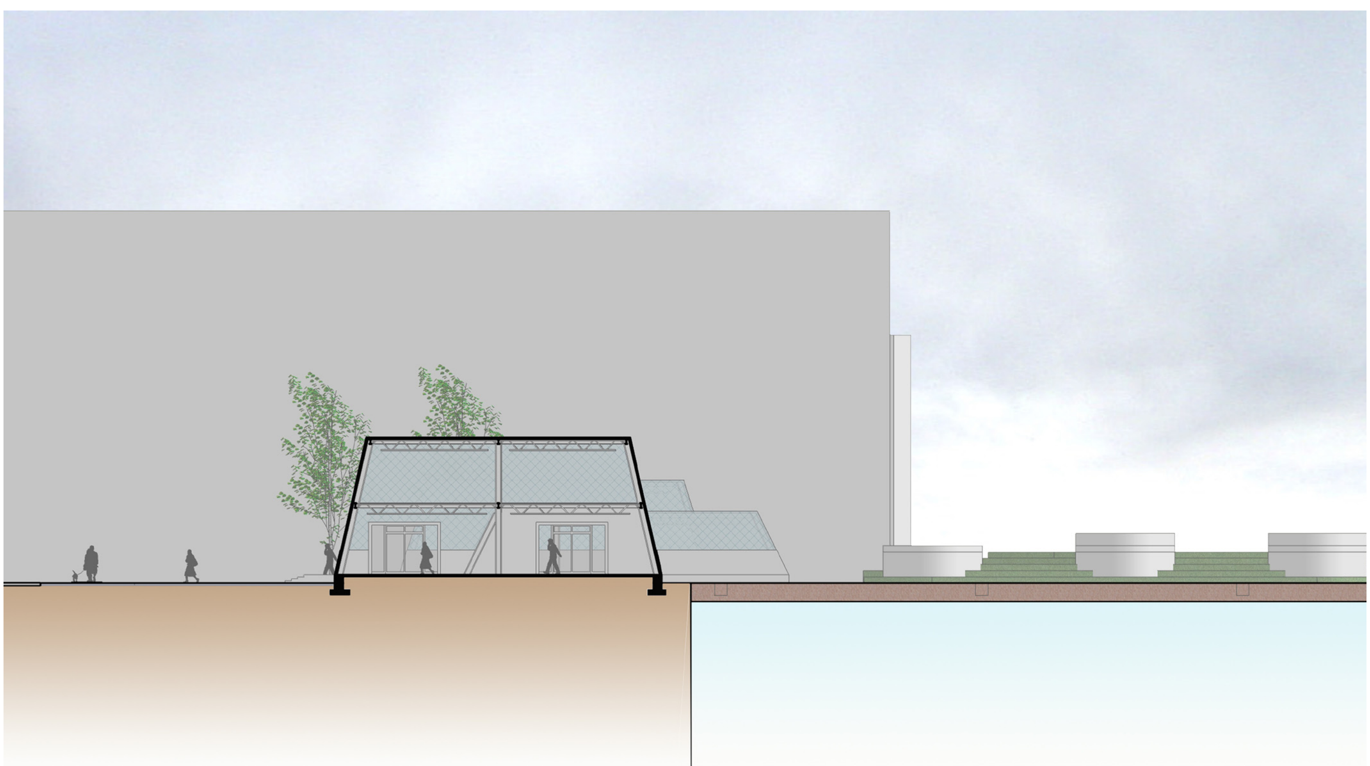

SITE PLAN
SCALE: 1" = 100'
NORTH


Hatchery
Retail Space
Processing
Storage/
Shipping
FIRST FLOOR
SCALE: $\frac{1}{32}$" = 1'
NORTH


Office Space
SECOND FLOOR
SCALE: $\frac{1}{32}$" = 1'
NORTH

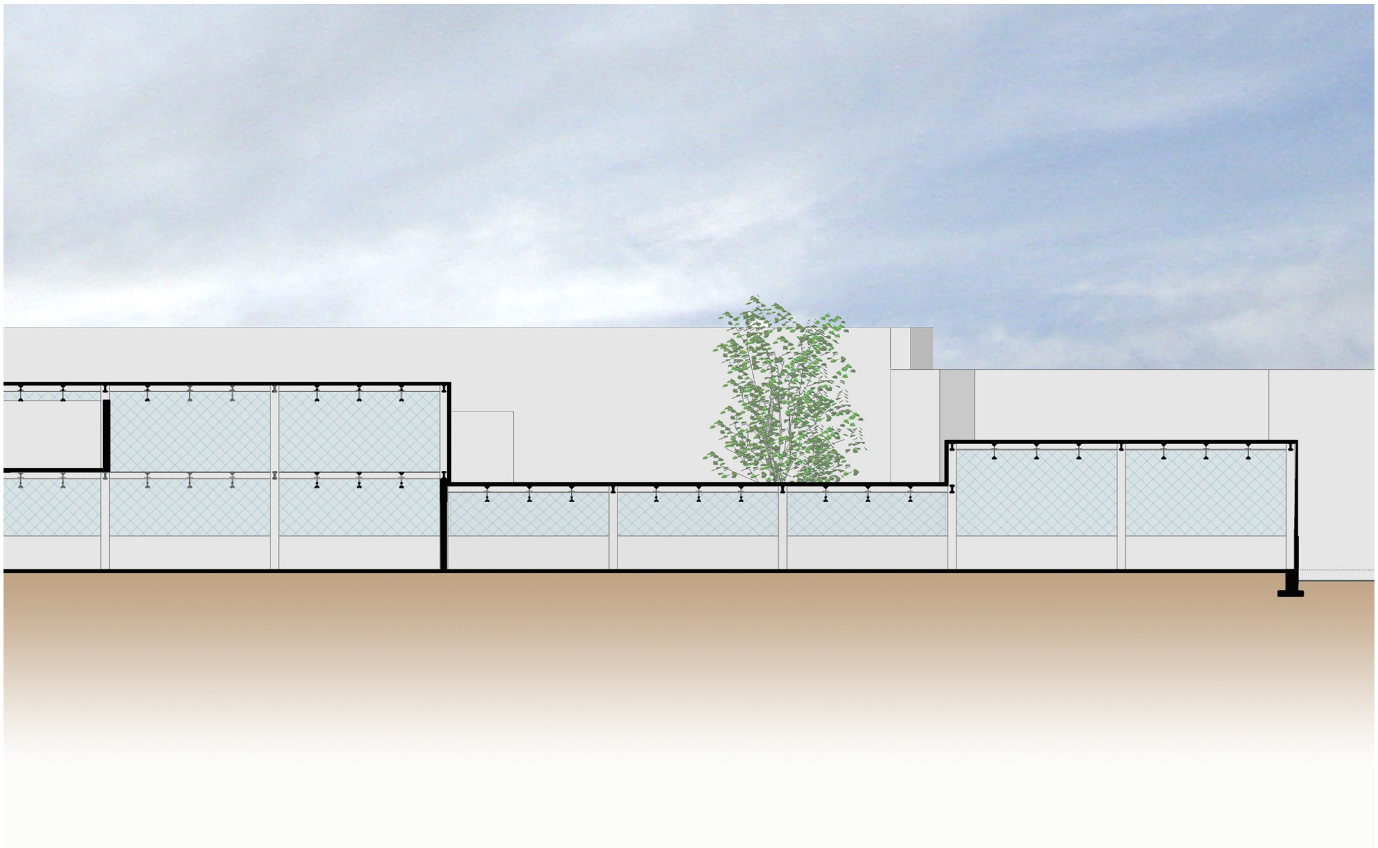
Final Drawings • Sections

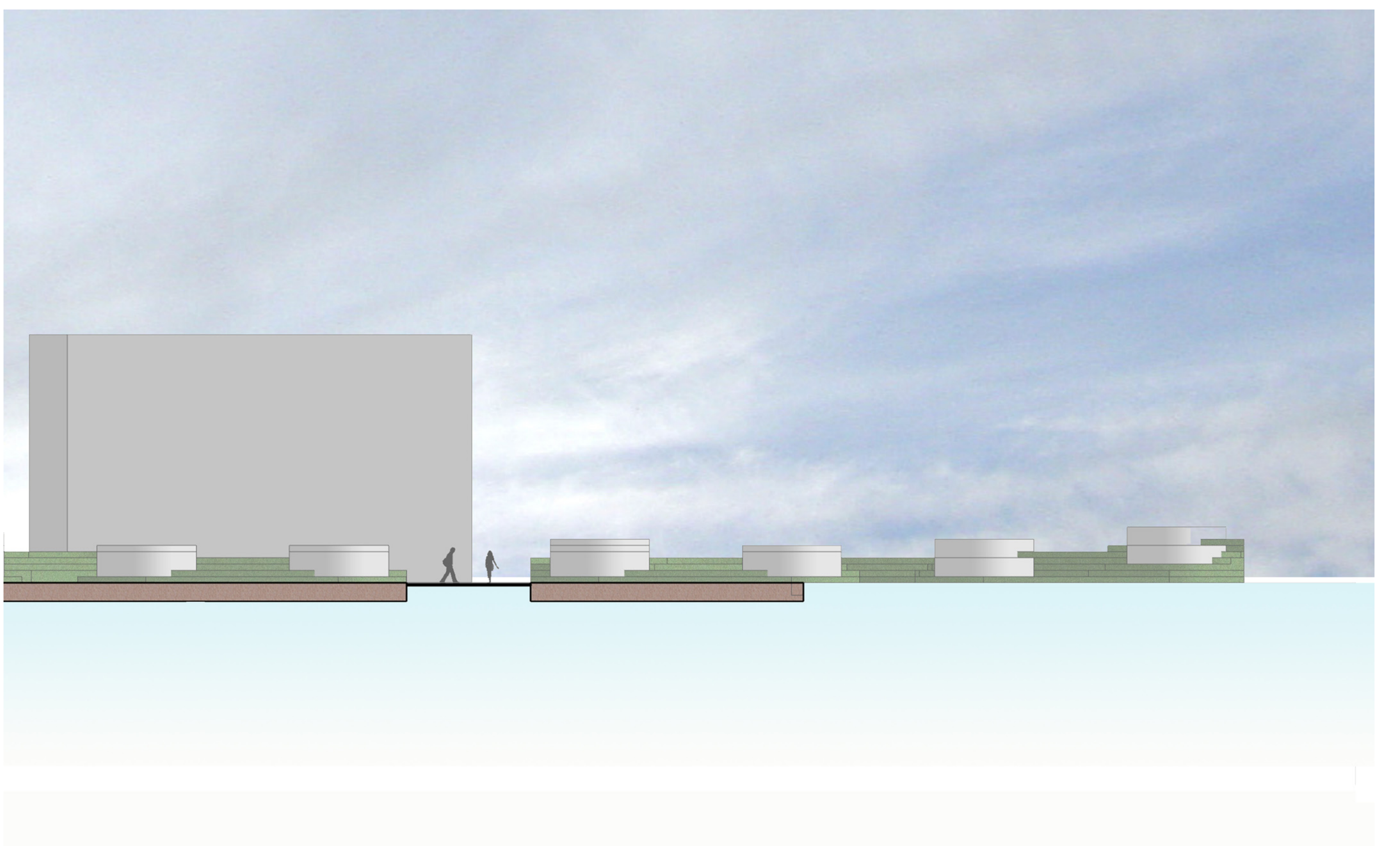
SECTION SCALE: 1/16” = 1’



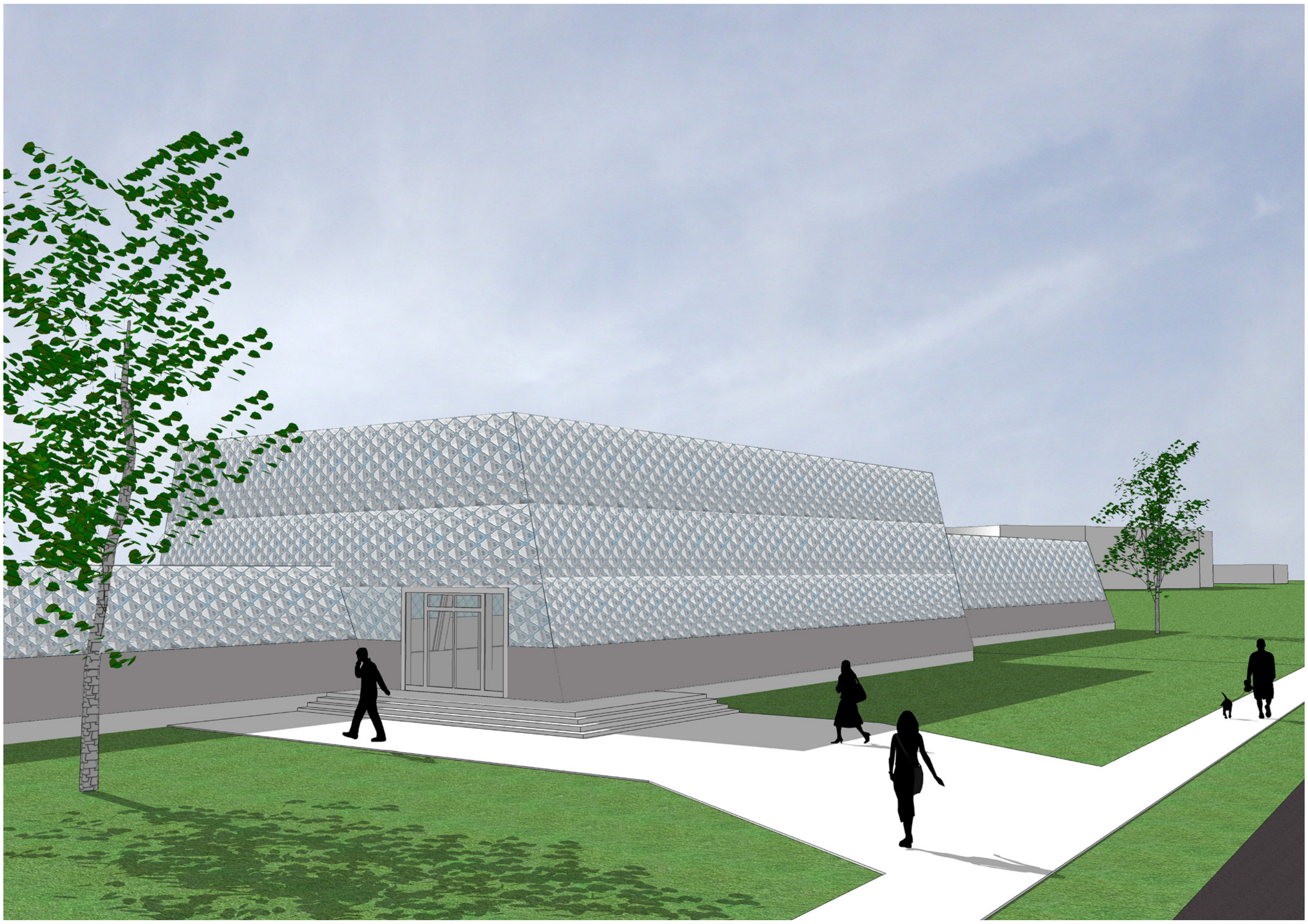
SECTION SCALE: 1/16” = 1’

Final Drawings • Sections



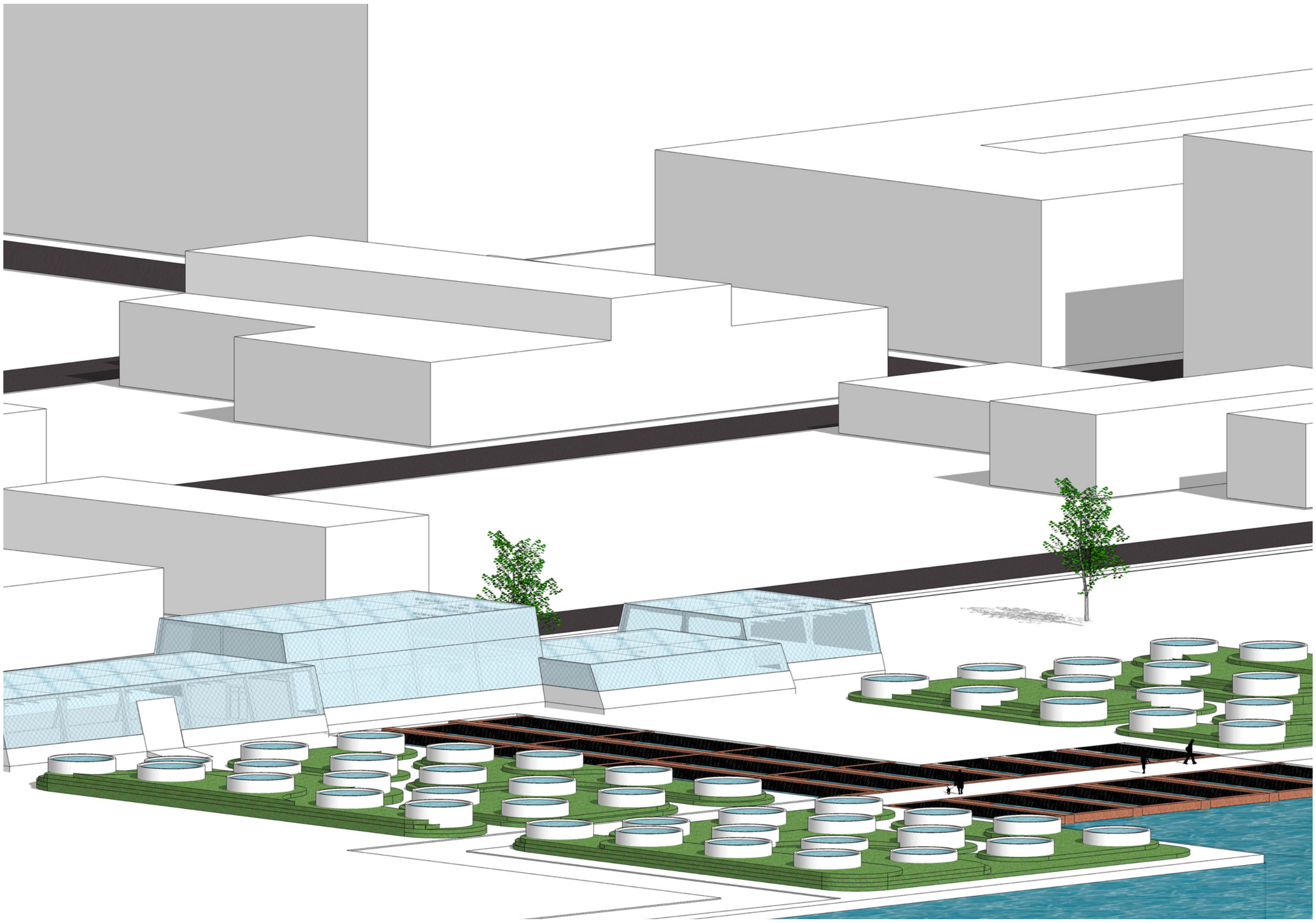


Final Design • Perspectives



This perspective illustrates the main entrance of the building. The exterior living skin blankets the entire building.

Final Design • Perspectives



The building itself is composed of 5 different functions: the hatchery, retail, processing area, shipping/storage area, and the office space on the second floor.

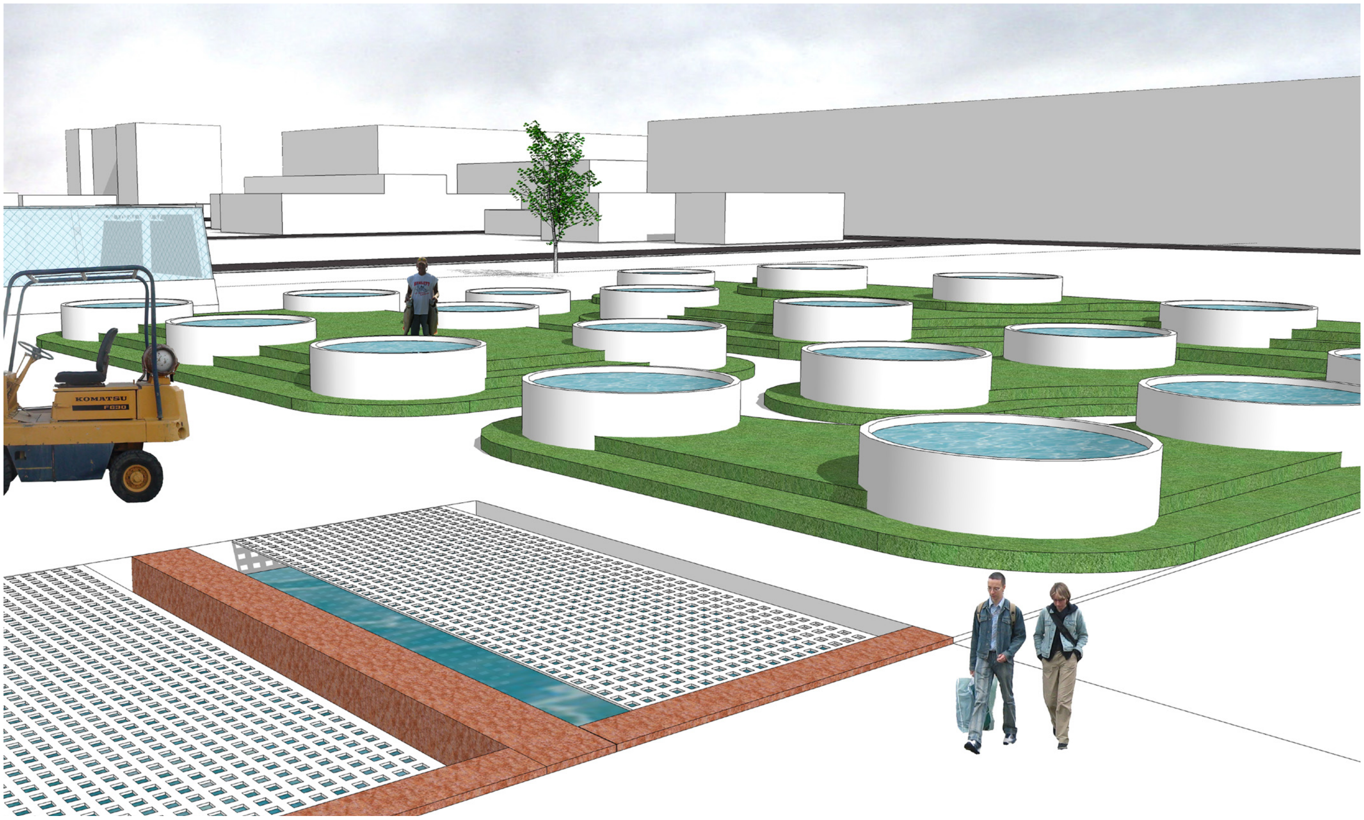
Final Design • Perspectives

The retail program provides the opportunity for a successful and profitable business venture: selling of fish meat as well as caviar.

Final Design • Perspectives

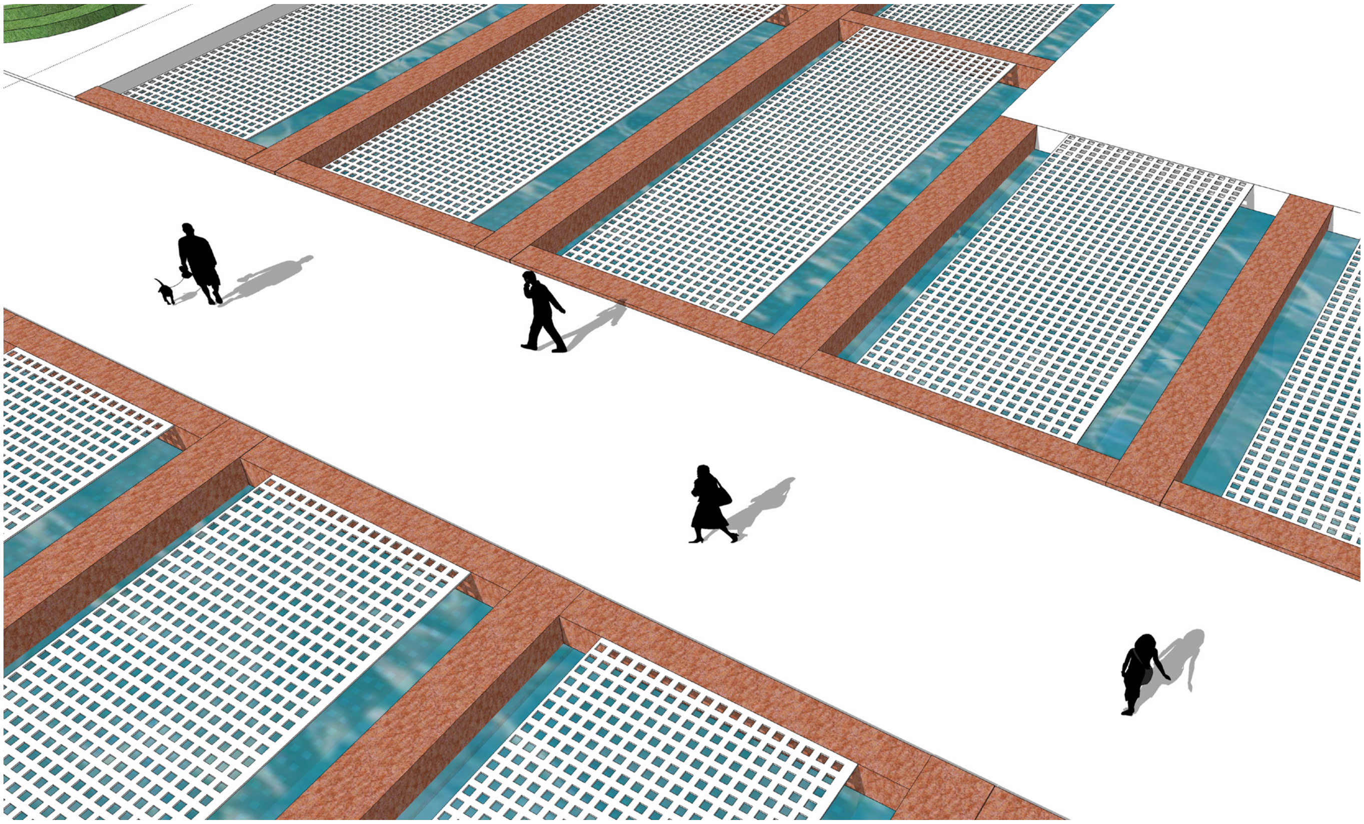
The landscape is composed of hills that I developed to connect the building with the landscape and create a path for workers to access the grow out tanks. The hills in essence house these tanks. Each tank is dug into the landscape, which provides adequate control of temperature.

Final Design • Perspectives



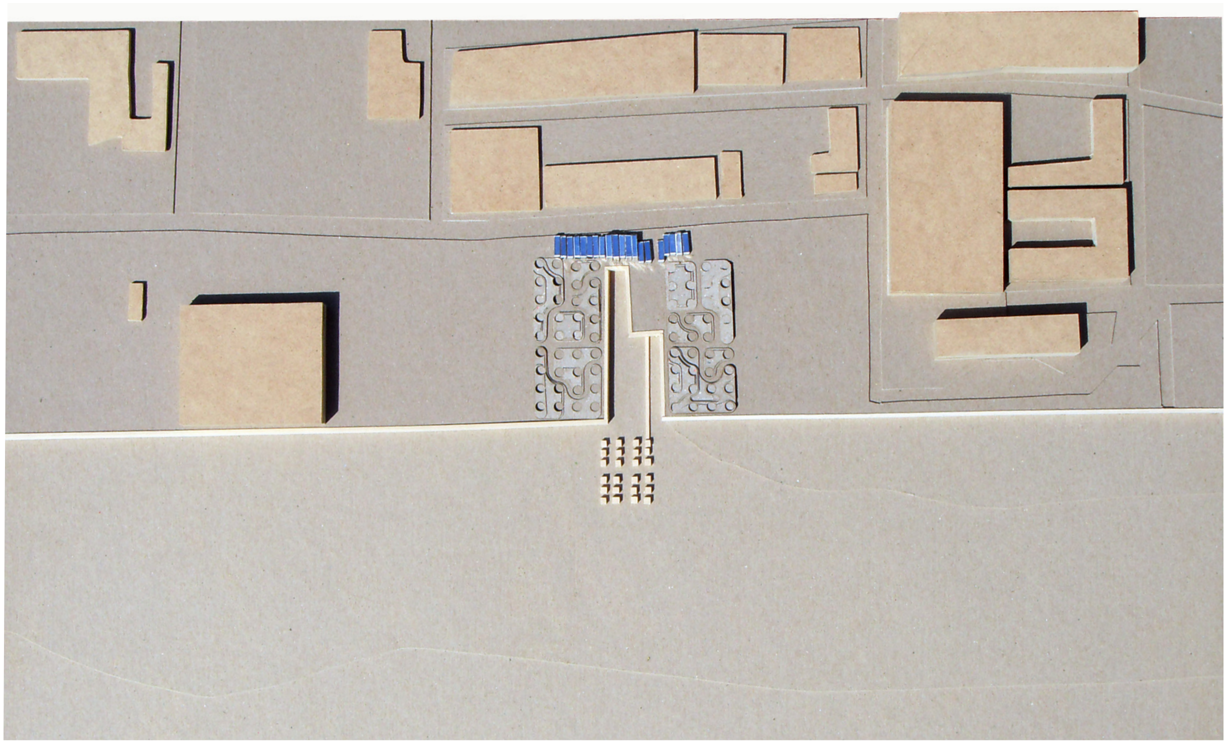
The cage system is placed in the slip which connects the opposite sides of the site. The cage system was designed to integrate the river into the program, which would allow for more space for fish to be grown and harvested. Also, it allows the workers to cross from one side to the other.

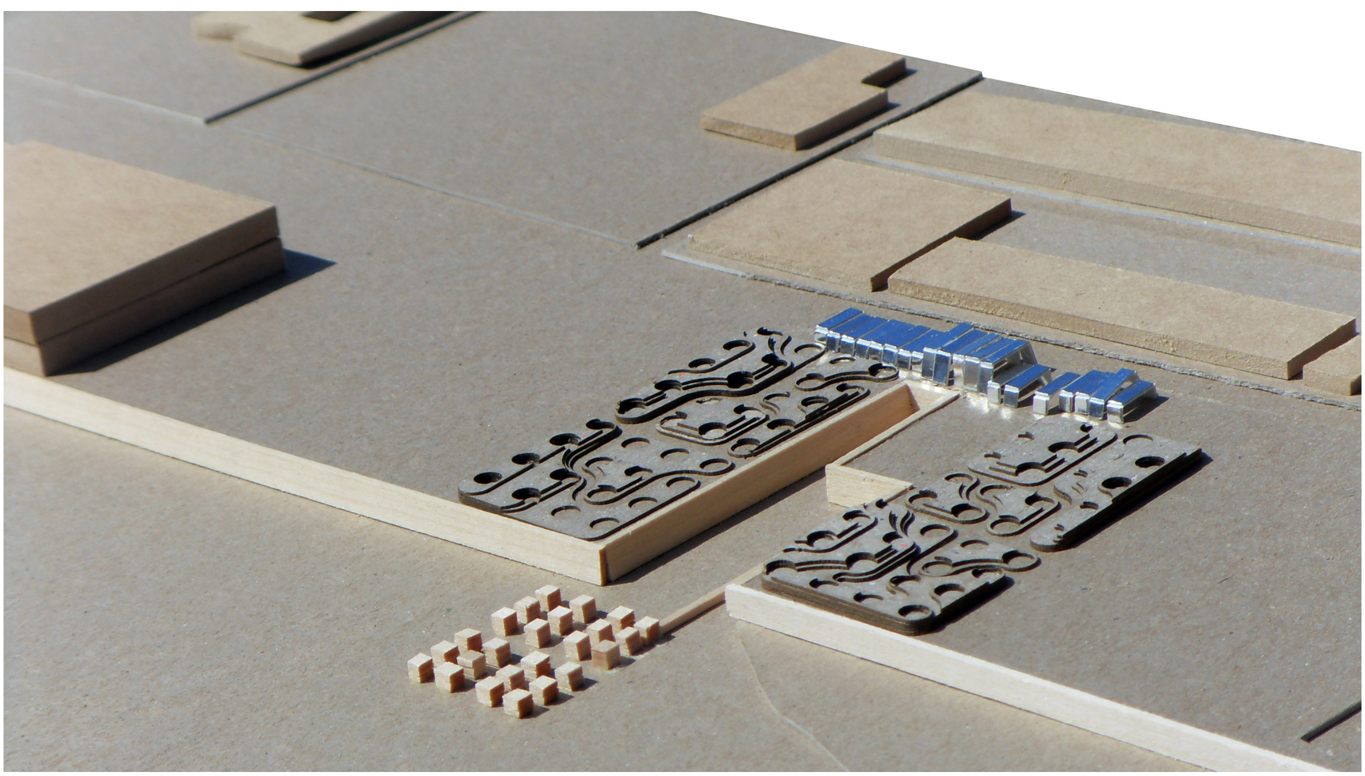
Final Design • Perspectives



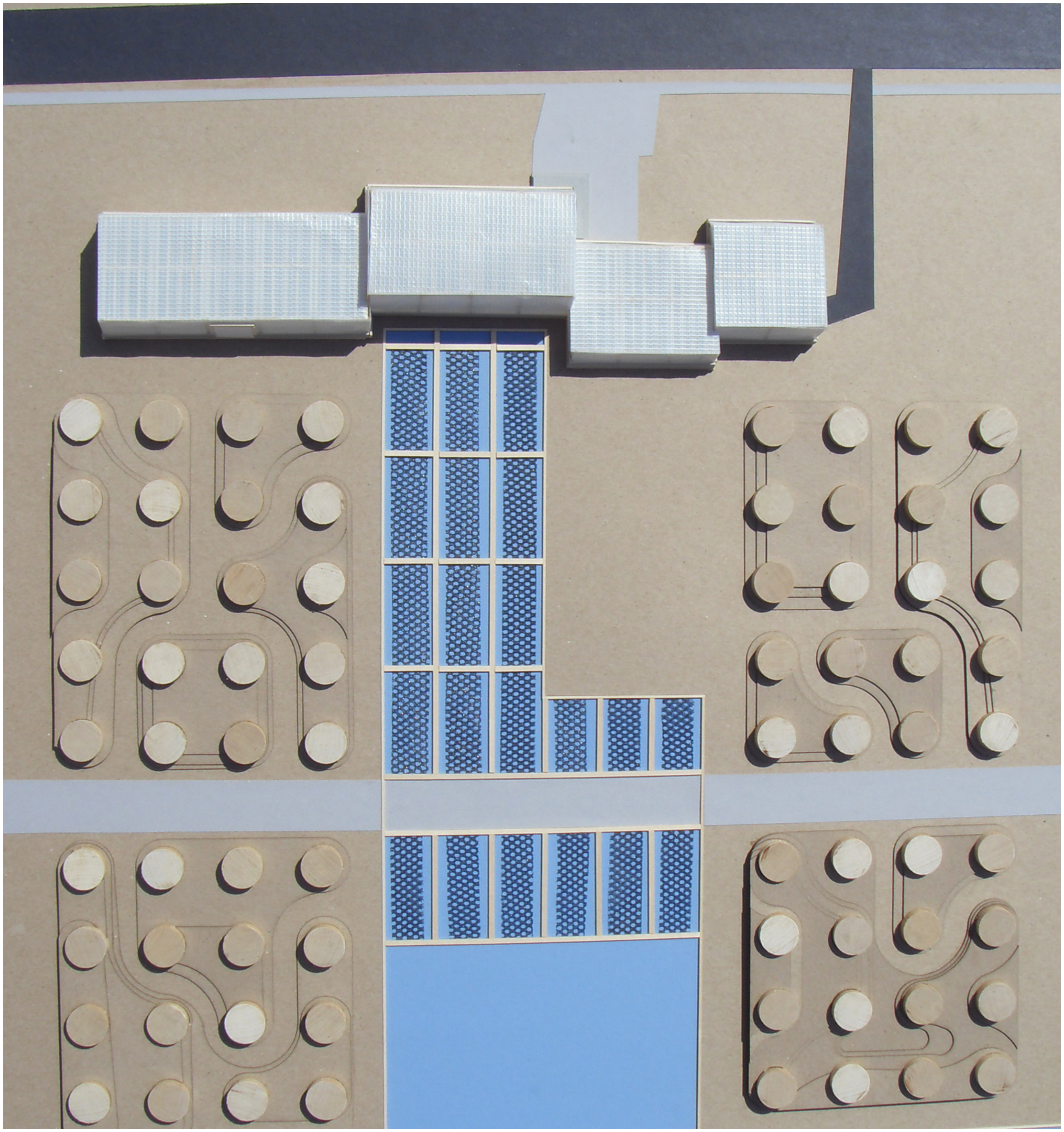
Another design aspect was incorporating the riverwalk within the site. The riverwalk crosses over the slip and allows pedestrians to view parts of the process of the facility. The riverwalk allows for views of the grow out tanks, and the cage system. Passer-bys can view workers transporting fish from tank to tank or simply watch fish swim as they cross over the slip.

Final Design • Site Model

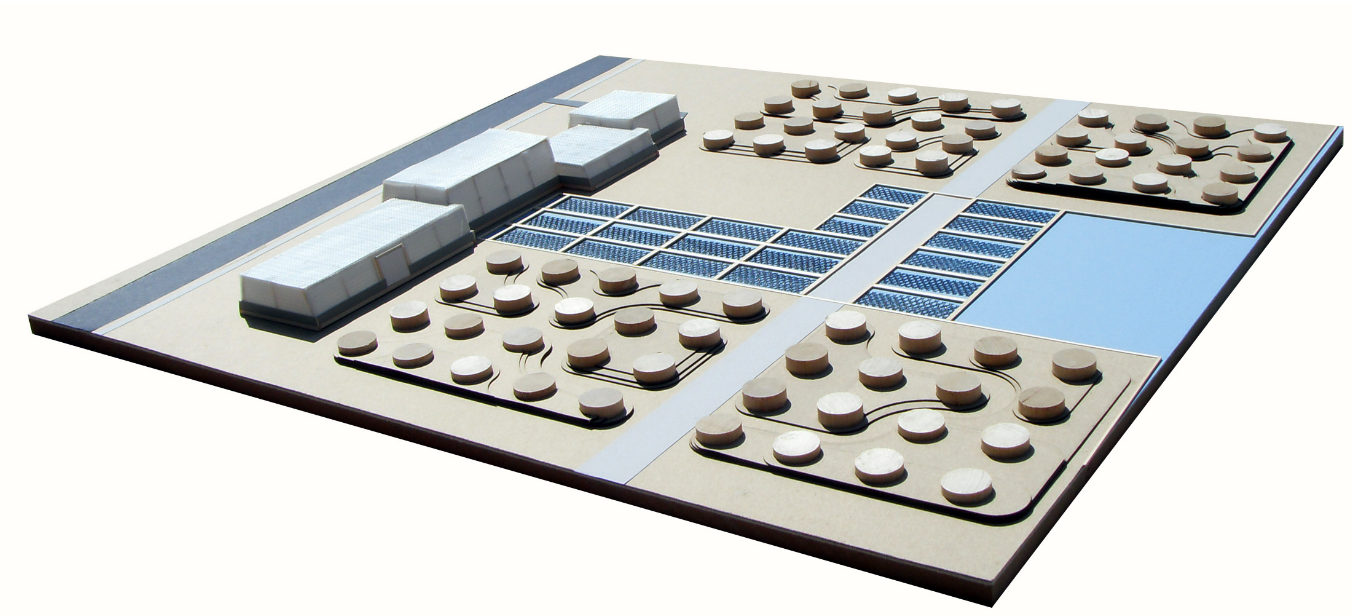




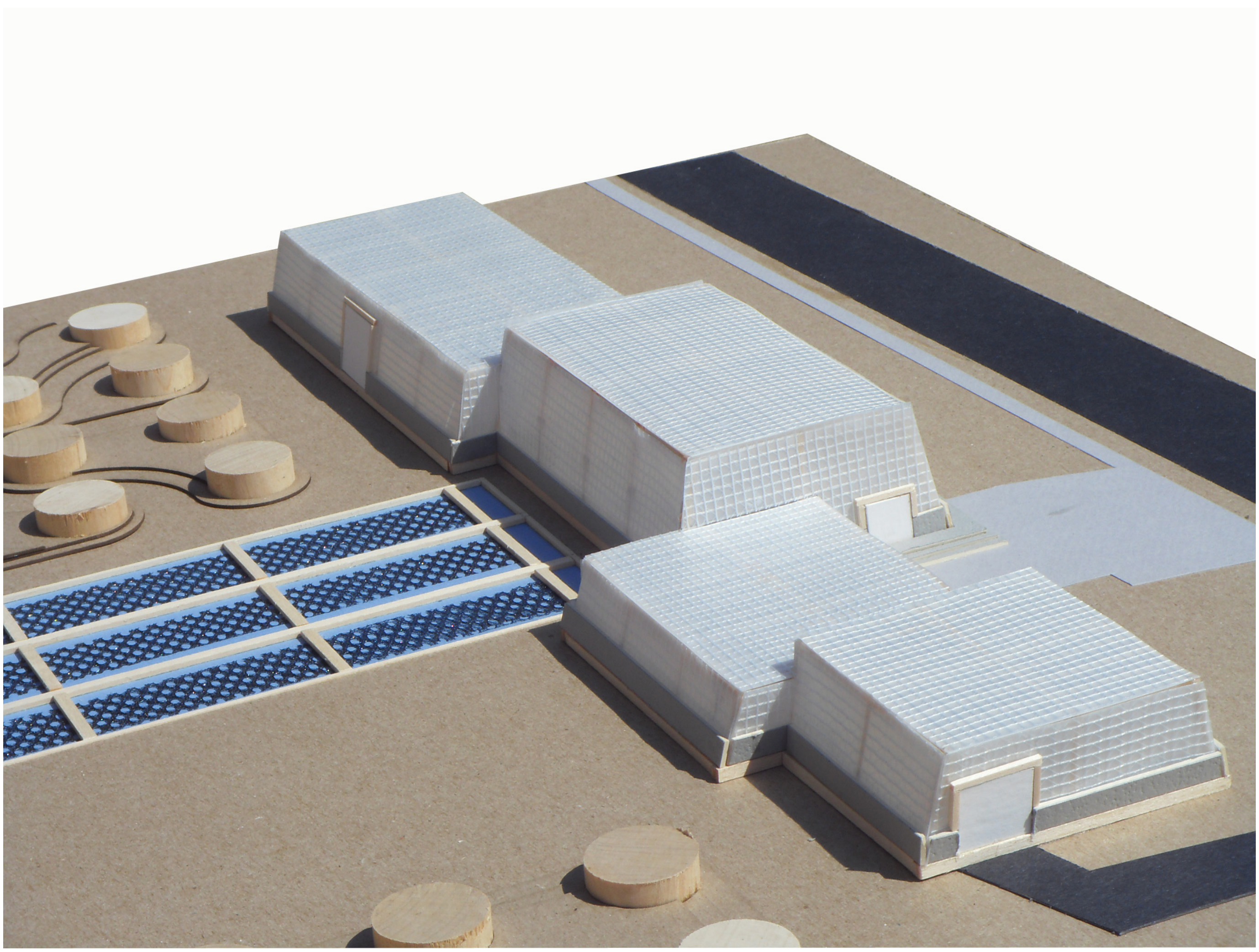
Final Design • Site Model



Final Design • Model



Final Design • Model



Conclusion:
Fish Farm and Hatchery

Conclusion

In conclusion, I feel that developing technologies that are derived from nature's processes are beneficial in architecture because it provides spaces and forms that will endure the test of time and will give way for a more healthy and sustainable way of living.

After the long process, there seem to be parts of the design that are disconnected from the initial intent and design interventions. One aspect of the project that needed a more in depth study was the direct use of materiality in respect to the building as a whole.

Throughout the process, I have learned that it is never too late to research and continuing research can drive and motivate a project to find the best possible solutions.

In the end, the project, like most thesis projects, could have been pushed further in the direction of a deeper thesis, which would have helped me learn more as a student going into the field of architecture. At the same time the direction that I took has taught me a significant amount and I am very happy with the project that I decided to explore.

Endnotes

1 Eugene Tsui, Evolutionary Architecture: Nature as a Basis for Design (Danvers, MA: John Wiley & Sons, Inc., 1999), 6.

2 Tsui, 9.

3 Janine Benyus, Biomimcry: Innovation Inspired By Nature (New York, NY: William Morrow and Company, 1997), 20.

4 Benyus, 33.

5 Benyus, 45.

6 William McDonough and Michael Braungart, Cradle to Cradle (New York, NY: North Plains, Inc., 1998), 100.

7 Benyus, 88.

8 Benyus, 90.

9 Tsui, 15.

10 Tsui, 18.

11 Tsui, 22.

12 Benyus, 77.

13 McDonough, 55.

14 McDonough, 120.

15 Tsui, 30.

16 Tsui, 32.

17 Tsui, 35.

18 McDonough, 88.

19 Benyus, 50.

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