Towards a closed-loop community:
Creating a sustainable seed in the urban environment.

A Thesis

Submitted to the

Faculty of Miami University

In partial fulfillment of

The requirements for the degree of

Master of Architecture

Department of Architecture and Interior Design

By

John Holtz

Miami University

Oxford, Ohio

2013

Advisor_____
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Table of Contents

Abstract 3
Thesis Paper 4
Thesis Conclution Summary 16
Site Analysis 17
- Area Map 17
- Existing Context 18
- Macro Site Analysis 20
- Climate Date 21
- Micro Site Analysis 23

Process 28
- Master Planning 28
- Key Ideas & Ground Floor Organization 30
- Study Models 31
- Site Model 32
- Site Development 33
- Plan Development 34
- Wind Studies 35
- Façade Studies 37

The Closed-loop Community 40
- Material, water, and energy exchange 41
- Detail explanation 42
- Closed-loop site map 45
- Closed-loop building map 48

Final Thesis Work 51
- 3D Site Plan 52
- Site 53
- Program 54
- Plans 55
- Elevations 66
- Sections 68
- Micro Climates 69
- Wall Sections 71
- Materials 73
- Renders 74
- Final Model 80

Presentation 84

Abstract

In the coming years resource stress and waste management will continue to become two of the world's biggest issues. If order to conserve resources and reduce waste that our cities produce I believe that we will need to begin to move towards a closed-loop pattern of consumption and away from the current, linear and wasteful pattern. If closed-loop systems are adapted and layered into our cities then resources and raw materials will have multiple lives and waste will be significantly reduced. Is it possible for our cities to begin to function according to closed-loop principles? This thesis is centered on three case studies of communities that are able to function as semi-closed-loops systems. The three communities include: Kalundborg Industrial Park in Denmark, the Mobius Project in London, and the Great Lakes Brewing Company in Ohio. Although these communities may not function strictly as closed-loops, they begin to move away from linear patterns of consumption towards closed-loop principles. Each community has been able to achieve a large cost and environmental savings by productively reusing waste products. This paper analyzes each case study and discusses the problems and opportunity that arise when considering closed-loop communities. I believe that adapting closed-loop principles will be the only way for our cities to make significant progress with the sustainability movement.

Thesis Paper

Closed-loop communities: Creating a sustainable seed in the urban environment

Introduction

I believe that the over consumption of the world's natural resources will be one of the biggest problems facing the world in the coming years. The vast majority of the world population is not aware of the amount of raw materials that they are actually consuming on a daily basis. It is not always easy to realize the amount of resources that one is consuming. To gain some perspective on what I as an individual consume I picked one resource, water, and tracked how much I use daily. To conduct this experiment I created several ways to measure the volume of water I was consuming. In my calculations I accounted for such things as showers, drinks, toilet flushes, dishes and others. Over a three day period I averaged 55 gallons a day. But after doing some further research I found that my actual water footprint was much larger. In my experiment I was only accounting for my household activities, and was not including the water that was used in the industrial and agricultural processes that support my lifestyle. I discovered that the average American's household water usage only accounts for about 5% of their total water consumption footprint. So in total I consume about 1100 gallons a day, after I include industrial and agricultural processes[1]. Like most people I was a bit surprised by this number, I had not given much prior thought to the amount of water I was consuming.

Water as a resource is very important, but the overuse and the abuse of fresh water and aquifers can cause major problems such as desertification or contaminated drinking water. This experiment revealed to me the amount of water that I was actually consuming and that it will be important in the future for our society to employ responsible resource management. The responsible use of resources is more important today than ever before due to: Growing wealth around the world, that leads to an increased consumption of resources; Changes and instabilities that climate change will bring about; and a Rapidly growing world population, all of which increase the human impact on earth[2]. Americans are one of the world's largest consumers of water along with other valuable recourses. And like water many other important resources such as plastics, metals, and land are also consumed in a linear and wasteful pattern. The problem of over-consumption and waste will continue and likely get worse, so long as our habits remain unchanged. A change in attitude towards the way our society uses resources and consumes energy needs to occur, if we are to ensure a reasonable quality of life for future generations. This thesis addresses the problems of waste and over-consumption as both an opportunity and a solution, by moving towards a closed-loop pattern of consumption. What if we were able to turn the problem of

1. Information from National Geographic: The average American uses 2000 gallons a day. Only 5% is used in house hold activities.

2. The idea that a growing world population, increasing world wealth, and the level of technology (increasing CO2 emissions and climate change instabilities) can be used to calculate the human impact on the earth, comes from Jeffery Sachs' I=PAT Equation. This equation, I=PAT, where P=world population, A=the environmentally impact per dollar, and T=technology with a high environmentally burden. Sachs illustrates in his book Common Wealth that the human impact on earth or I can be lessened by changing T to S (sustainable technologies) to change the equation to I=PA/S. This thesis will show how city can become the S in this equation to lessen consumption and a growing world population.

waste, into an opportunity that created profits, created jobs and helped to reduce environmental degradation? By moving away from a linear pattern of consumption towards a closed-loop pattern, our communities can begin to adapt to a more holistic approach to becoming sustainable.

Questions

What is the best way to create a more sustainable built environment and how can we begin to move towards an all-encompassing approach that addresses the effects of over-consumption, climate change and a growing population?

How can implementing closed-loop patterns of consumption and adapting closed-loop systems at the urban scale begin to create more sustainable communities? How can implementing closed-loop systems at the urban scale begin to generate sustainable growth within urban areas?

Methodology

Throughout this paper I will argue that adapting closed-loop principles and systems within a community is one way to become more self-sufficient and sustainable. I will discuss how a community can begin to operate according to closed-loop principles and what types of closed-loop systems can be adapted. I will give examples of communities where synergetic relationship exists successfully: the Kalundborg Industrial Park in Denmark, the Mobius project in London and the Great Lakes Brewing Company in Cleveland. I will also discuss the problems and secondary benefits of adapting closed-loop systems.

Discussion

The idea of implementing closed-loop principles can be done on different scales; I will focus on closed-loops at an urban scale. For me, the idea of closed-loop systems comes from and is inspired by the way nature functions. The principles of nature are that nothing is wasted; one organism's waste product becomes food for another. If the principles of nature are used as a design model for creating our cities and communities then they can begin to function like ecosystems. With the exception of a few things, like input from the sun, ecosystems effectively operate in a closed-loop. Michael Pawlyn, the author of Biomimicry in Architecture, illustrates that using nature as a model for design allows us to make significant progress towards a more sustainable future.

During an interview with the RSA (The Royal Society for the encouragement of Arts, Manufactures and Commerce), Pawlyn describes the differences between man-made systems and biological systems that need to be considered in the design process (figure 1). The left hand side of this list is very descriptive of our communities and the companies that operate within them. Adapting closed-loop systems can help our communities begin to move away from the typical

Man-made systems	Biological systems
Simple, disconnected and mono-functional	Complex, interconnected and symbiotic
Linear / wasteful	Closed loop / zero waste
Resistant to change	Adapted to constant change
Long-term toxins	No long-term toxins used
Centralised /mono-cultural	Distributed and diverse
Fossil-fuel dependent	Run on current solar income
Maximise one goal	Optimised as a whole system
Extractive	Additive

Figure 1

man-made systems, towards functioning more like biological systems. The study of closed-loop systems relies heavily on the study of material and energy flows within a community. If we are to compare our communities to nature, then perhaps studying the operation of closed-loop systems within communities would be a lot like studying ecology. Kevin J. Gaston, author of Urban Ecology defines ecology as: "The study of processes determining the abundance and distribution of organisms, of the interaction between organisms, and of the flows of energy and materials through ecosystems" (Gaston page 1). If companies or the entities of the community replaced organisms in this definition, then studying closed-loop systems could be described as the study of energy and material flows within a city.

Perhaps nothing, including nature, operates in a strictly closed-loop. The goal is not to function strictly in a closed-loop, but rather to move away from a wasteful, linear pattern of operation towards a circular, closed-loop pattern. This is an important concept that our society can and should adapt in order to become sustainable. By using closed-loop concepts as a tool of sustainability we can improve our cities by moving them from a disconnected, mono-functional, and wasteful system to a more complex, interconnected, and zero-waste system.

If our cities are to move towards a circular pattern of consumption, then managing material flows will be a key component in doing so. To implement a regenerative economy, a material's life will need to be thought through from its production to its disposal. This concept is described in the book Cradle to Cradle: remaking the way we make things, by, William McDonough and Michael Braungart. The title Cradle to Cradle refers to the complete reuse and recycle of our consumer products. For example, once a product renders itself useless, like an old car, computer or shoe, that product would be returned to the manufactures, disassembled, melted down and reused. Once the product has been disassembled, then the parts that were made out of organic materials, could be composted and safely decompose, while more valuable resources like heavy metals and plastics, could be reused in future products. The use of this concept would result in a regenerative economy (figure 2). This would result in better use of our resources, better products, safer products, and less of a strain on our environment. With a Cradle to Cradle system the raw materials never leave the industrial cycle as junk; so instead of materials having only one or two useful lives in products, they would have the ability to be reused infinitely.

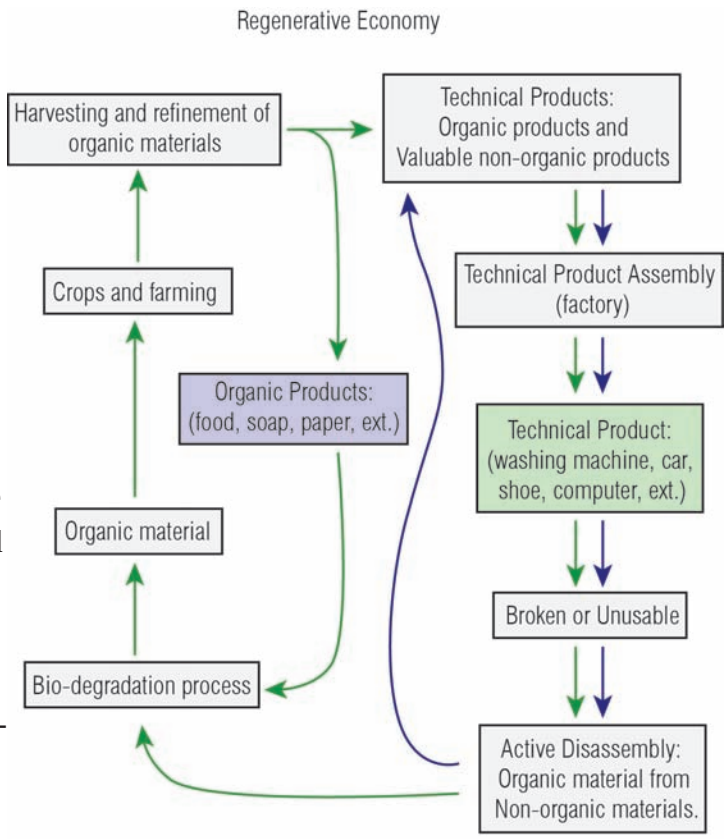

Figure 2

The concepts of Cradle to Cradle systems can be applied on different scales. I believe that by applying these theories to an urban scale we can begin to develop a new way to plan and organize our com-

munities. One of the typical ways that our society uses its resources is that they are mined, processed, sold, used and then thrown way. In the regenerative economy, like the one shown (figure 2), materials are reused and still have value. If this cycle is overlaid on top of a community then companies or other urban entities could share materials and productively reuse one another's resources and waste products. Creating an urban environment like this could attract new types of companies, require new types of infrastructure, and reduce waste. There are several examples of communities like this that show the successful implementations of closed-loop principles

Case Studies

Kalundborg

The first case study that applies closed-loop principles is Kalundborg. Established in the 1960s, Kalundborg Industrial Park uses closed-loop principles in a way that all the companies in the park interact with each other to productively use waste products. This type of relationship that the companies have with one another has many positive financial and environmental results which include, cost savings in ridding their waste products, extra income in selling their waste products, and use of less raw materials, energy, and water. According to the Environmental Management for Industrial Estates, Kalundborg has "effectively self-organized." This refers to the way that the park has grown over time; adding new companies that are able to use the waste products of the existing ones, making it more and more efficient. An important thing to note is that the park has naturally grown over time and has not just been imposed on an area (figure 3). Once a waste product is identified, a search is conducted for additional companies to capitalize on an abundant waste product. The Environmental Management for Industrial Estates refers to J. Christensen's illustration to explain how the companies are interconnected and interact with one another. Figure 4 shows the complex relationship that these companies have with one another and the material exchanges that occur between them.

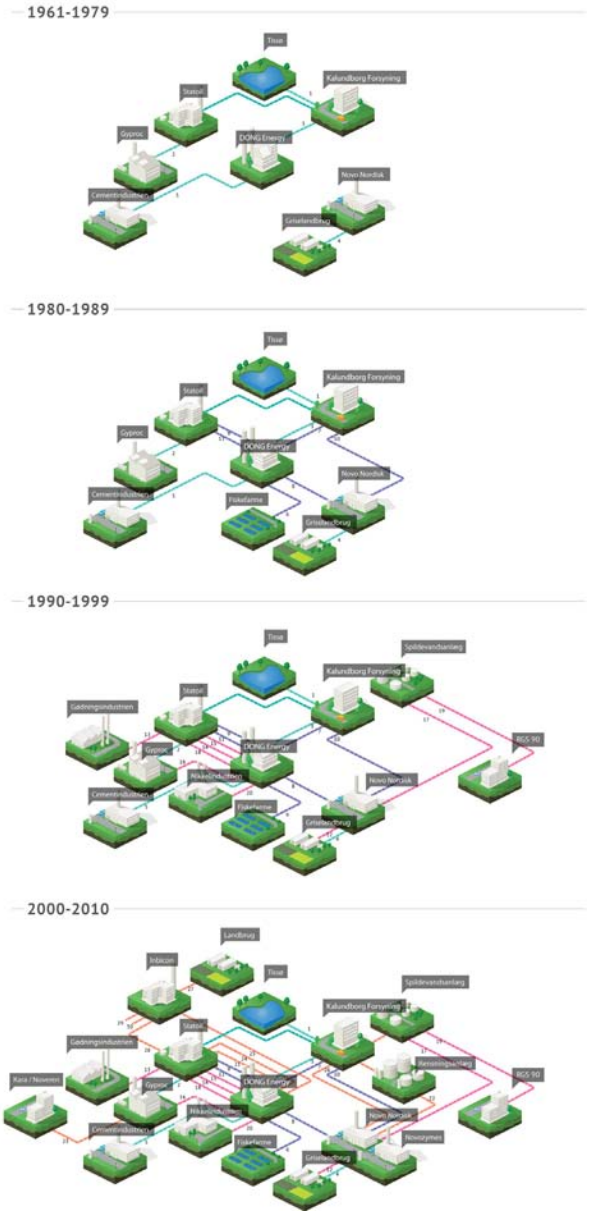

Figure 3

This type of relationship between the companies results in large cost savings. The average payback time for the companies' investments in the necessary infrastructure projects has been about five years. This depends on what type of infrastructure is needed and the

fact that the companies are located nearby one another. Not only does this type of relationship render a financial incentive for the companies but also an environmental savings. Christensen estimates that the resource savings of the park total: 45,000tons/year in oil, 15,000tons/year in coal and a deduction of 175,000 tons/year in carbon dioxide emissions.

The Kalundborg Industrial Park is a great example of how a community operates symbiotically. Although this community clearly has many benefits there are a few things that can be seen as problematic as well. One is that the community relies heavily of just a few of the companies to create these relationships. If one of the more important companies were to leave the community, the system would be significantly affected. If there was a more even playing field and a larger number of companies, then the community might be seen as more stable. The other issue with this scenario is that the companies that make up the community are very specialized. If another community wanted to adapt the same type of system they might have a difficult time doing so because it is an industrial park. I believe that it is not specifically this scenario that other communities should try to adapt, but the principles and ideas that Kalundborg has been built around. The following two case studies show other types of symbiotic relationships that are more adaptable to an urban setting.

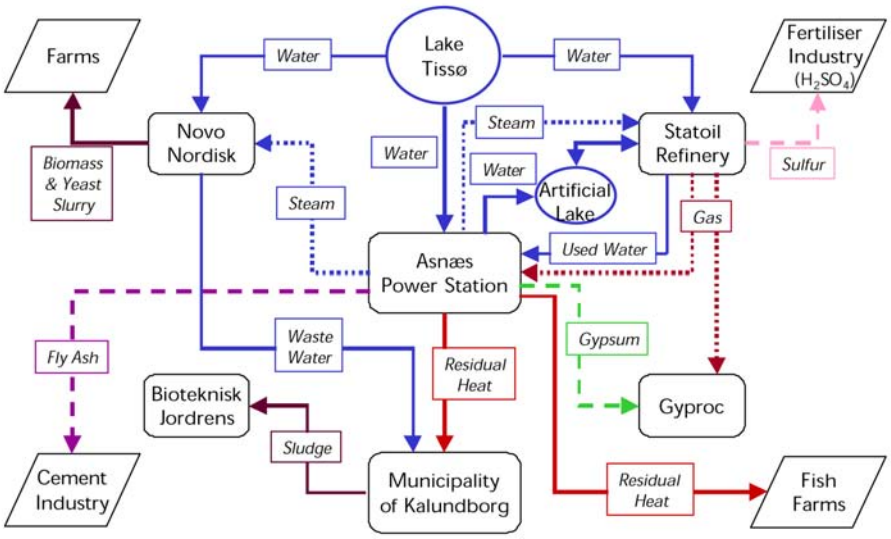

Figure 4

Mobius Project

The second case study is the Mobius Project, another example of how several entities can act in a closed-loop matter. The Mobius Project is a proposed building designed by Michael Pawlyn for an underutilized site in London. The project brings together several different processes of inputs and outputs to begin to create symbiotic relationships within the building. There are three main cycles that are incorporated into the building. They are: food production, energy generation, and water treatment. In order to create the first cycle, food production, the following elements are incorporated: a green house, a restaurant, a fish farm, and a food market.

The Mobius project's food production cycle was inspired by another, similar semi-closed-loop, food production cycle. The project is known as the Cardboard to Caviar project, developed by Graham Wiles. This project's cycle first starts with a restaurant that produces an excessive amount of cardboard waste. The cardboard is first taken from the restaurant, shredded, and given to a equestrian center for horse bedding. After the shredded cardboard is soiled, it is then composed in a wormery, the extra worms that are produced are then used as feed for a fish farm. The fish and caviar that is produced are then sold back to the restaurant that the cardboard originally came from. The material flow process of the Cardboard to Caviar project can be seen in figure 5. Wiles has continued to add more components to this system which can be seen in figure 6.

The Mobius Project will use a similar system that incorporates its green house, restaurant, food market and fish farm. In addition Mobius Project would also produce mushrooms, which would feed on old coffee grounds from a coffee shop in the building. The biodegradable waste from the restaurant would then be used in anaerobic generator which begins the project's second system, energy production. The biomass would feed a generator which would produce electricity to power the building and heat the green house. The third system that is incorporated into this project is a Living Machine in order to treat the building's waste water with plants and micro organisms.

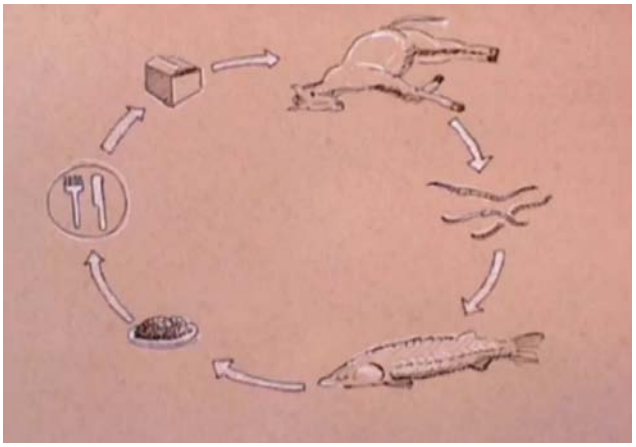

Figure 5

This case study uses the same principles of the Kalundborg example, but applies them very differently. Unlike the industrial park, this project has the ability to be placed in the middle of an urban environment, along with having the ability to be pedestrian friendly and visual pleasing. If this example is expanded and elaborated on, we can imagine how this system could act as a seed to inspire other communities of a city to function in a similar way and as a result creating a more complex and interconnected city.

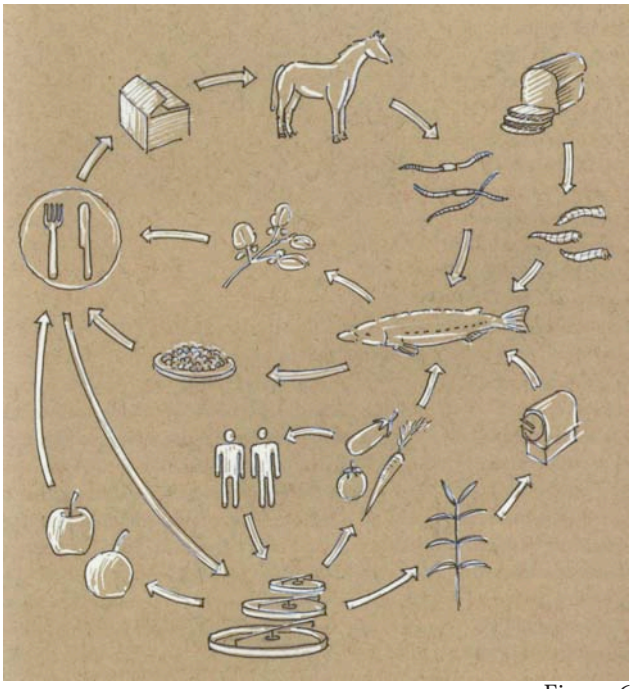

Figure 6

If we consider the list of man-made systems vs. biological systems (figure 1), this community becomes more descriptive of a biological system, as opposed to a typical community of businesses. Consider the material of cardboard in this system, typically the restaurant and the equestrian center would need to both buy and dispose of the material that they needed. And as a result they would be working as separate units in a community. In this scenario the material is bought only once from an outside source, exchanged, and then results in zero-waste with its use in the wormery. Unlike a typical scenario were the companies involved only maximize the goals of their own; this scenario optimizes the system as a whole and makes conserving resources and the interests of the community the primary goal.

Great Lakes Brewery

The third and final case study of closed-loop communities is the Great Lakes Brewing Company (GLBC) located in Cleveland, Ohio. The GLBC is a smaller sized brewing company that produces the Great Lakes beers, and has several sustainability initiatives, including having a closed-loop operation. The company has several other sustainable initiatives including: water stewardship, a green building, local foods and farming, renewable energy, employee engagement and bio fuels.

GLBC makes an effort to seek out local farms to grow their crops. In an effort to start farming



Figure 7

more sustainably and locally the company has recently begun The Sustainable Farming Initiative. This Initiative has established a farm called the Ohio City Farm, located across the river from downtown Cleveland (figure 7). Not only does this farm produce local food but it also utilizes undervalued human resources by involving The Refugee Reponses, which finds employment opportunities for refugees. The GLBC is the sole customer of the Ohio City Farm and uses the local food in their products and restaurant. The Sustainable Farm Initiative also involves Ohio City residences, and the Cuyahoga Metropolitan Housing Authority. The Ohio City Farm is one of the largest urban farms in the US. The farm will help the GLBC with its sustainable goals by providing local food, but the GLBC will also give back to the farm by providing spent brewery grain as organic fertilizer. The spent grain is also used as sub-straight for growing mushrooms, for feeding livestock, and is used in baked goods such as pretzels. All these items are then served in their restaurant; the material exchanges can be seen in figure 8. By reusing a large amount of their waste products, the GLBC is beginning to move from a linear consumption pattern of resource to a closed-loop pattern.

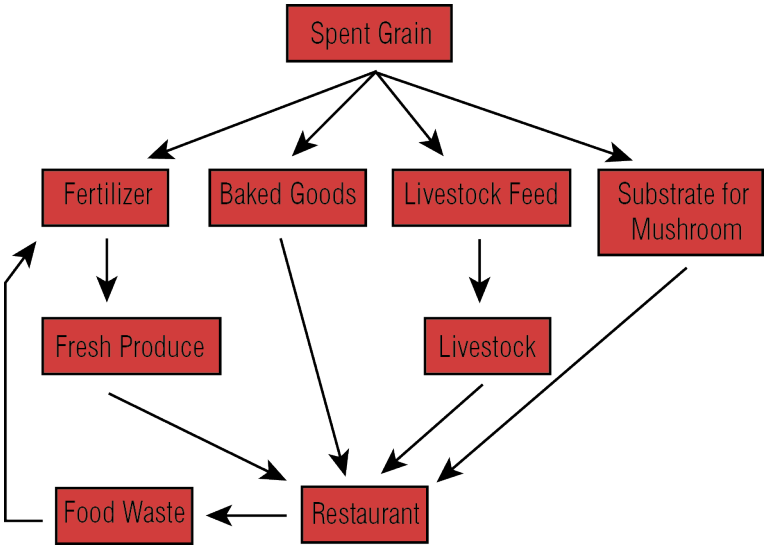

Figure 8

This case study shows how several organizations are able to work together to achieve a goal of sustainability and how one company is able to be economically profitable while incorporating closed-loop principles into their operations.

The Closed-loop Community

As seen in the above three case studies there are many ways in which a closed-loop, interconnected relationship can be formed between entities. In the case of Kalundborg, it is a community that has been developing over a period of about 50 years, slowly adding companies to the equation. In the case of the proposed Mobius Project, it was inspired from Cardboard to Caviar; a project almost completely engineered by one man. And in the case of The Great Lakes Brewing Company, it is one company that took leadership and set up other programs to manage its inputs and outputs. There are many ways for such

relationships to form, but what is the best way to seed, support and encourage their growth going forward? What problems will arise when encouraging this type of development? Is the answer with the public sector or the private?

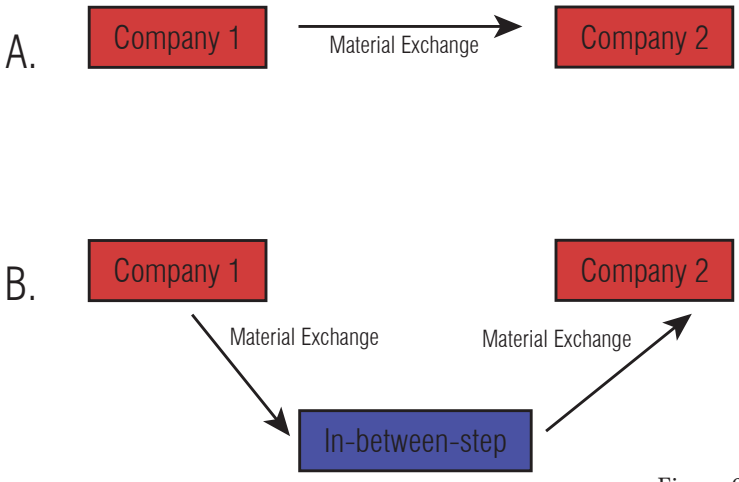

Figure 9

Often, two entities that help make up the system have the ability to directly interact with each other. One company produces a waste product, for example, gray water, and another company has the ability to productively use the waste product, perhaps the gray water is used in an urban farm. If physically located near one another, one could just pass the waste product on to the other. But in other cases, a direct interaction between the two existing companies isn't possible or as simple. For example, in a case where two companies are in need of something; company number one needs to rid itself of an excessive amount of waste, say a coffee shop that needs to get rid of their spent coffee grains; and company number two, say a fresh produce shop, is in need of mushrooms. In this case the produce shop couldn't directly use the coffee shop's spent grain, but an in-between-step would need to be set up in order to grow mushrooms in the spent coffee grain (figure 9). The setting up of the in-between-step would take extra effort and would further help the community move towards functioning in a closed-loop.

There are several other issues that can be seen as problematic as well when trying to develop a closed-loop system. One is that there is a lack of knowledge within the community about how to repurpose waste products. Creating a closed-loop community would require a whole new set of expertise that would be needed to grow and manage this system. There is also lack of knowledge about the poetical financial gain that could accrue from such a system. The case studies have demonstrated the ability to be financially profitable and like other types investments, money would need to be spent up front in order to save money and resources long term. What is the best way to support and encourage this type of system? There are several ways I think a system like this could begin to take shape:

1. The idea could be turned into a public program that is funded by tax payers and is part of a planning department. The planning department could facilitate this type of growth and actively seek out new companies that can absorb waste products. Extra help could be given to help companies with more complex connections of inputs and outputs.
2. Private companies, who would be a part of the system, could also organize themselves in to closed-loop connections with tax and subsidy incentives. Private companies could be taxed according to the percentage of resources that there were consuming in a linear pattern.
3. There could also be public or privately funded head-hunting companies that would actively search for opportunities to add companies to the closed-loop community, based on other existing companies' excessive or underutilized waste products. These separate companies would act as consultants to the companies.

There are many ways in which a closed-loop development can begin to take shape. I believe that the organization of these interconnected systems could be a new model for urban planning, one that is

focused on seeking out waste as opportunities for new development.

Setting up a system like this would possibly require new organizations, new buildings, and new infrastructure. It would also involve many people, a lot of money, as well as a fair amount of risk. There appears to be many pitfalls to moving towards a new system of operation. But will significant progress with the sustainability movement be able to occur without large scale change? What other kinds of effects will moving towards a closed-loop model produce?

Secondary Benefits Discussion

The creation of a closed-loop community would largely benefit from a responsible materials flow and productive utilization of waste products, as stated above. But there are secondary benefits that might be able to occur as well if the closed-loop model is adapted. The following is a list of secondary benefits that closed-loop systems could help to bring about in a community.

1. The first is the productive use of under-utilized human resources. Like in the case of the Cardboard to Caviar project, Graham Wiles uses recovering heroin addicts to operate some of the facilities, like the fish farm. The addicts that are enrolled in this program have a significantly higher success rate in recovery then they otherwise would if they were enrolled in state programs[3]. The idea of using under-utilized human resources, doesn't necessary contribute to the sustainable use of materials and waste products, but it helps to sustain a city's people by providing a social service. A benefit like this would not be the main goal of a closed-loop system, but could be a secondary benefit.
2. Mixed-use communities. Another secondary benefit of closed-loop systems is that they have the opportunity to create more diverse and mixed-use communities. If communities were to develop as closed-loop system, then no one company would be a stand-alone entity. Because the company would require other companies and systems to interact with, and would need them to be in close proximity with one another, it might suggest that a more mixed-use, diverse and interconnected community would be the result of such development.
3. Sustainability through localization. Because more things become locally produced, no fuel and extra money is needed to ship and supply global goods. The same principle holds true with exporting waste products, there is a savings in the product because the waste is not exported to another place.
4. The creation of local jobs and a renewed economy. Currently there is a lot of attention given to the state of the jobs and unemployment rates. Because companies would have their "input creators" and "output absorbers" local, this idea has the opportunity to bring more companies and jobs to their area. The closed-loop city will also bring new problems to the cities, which will possibly give an opportunity to solve the problems with new industries which could further job growth.
5. Place. With the implementation of closed-loop systems companies will be making more of an investment to the area. It is more likely that the buildings they create and the operations they start will be more permanent because of the extra effort needed in order to become a part of a closed-loop system. This has the opportunity to create value within the community and make it a more

3. The local area of the Cardboard to Caviar project was spending £100,000 per person and had a 95% failure rate for recovering heroin addicts. After the addicts become involved in the project they have been able to achieve a 70% success rate.

unique place.

6. Footprint and biodiversity. Another secondary benefit is the possibility that the city's foot print will begin to shrink in size, leaving more space for biodiversity. If closed-loop principles are adapted then it will be to companies best interests to locate near one another, to lower cost of transportation and so forth.

Although there are lot of other factors at play when trying to create these secondary benefits, moving towards a closed-loop way of operation might be able to encourage their development.

Conclusion:

I believe that conserving resources and reducing waste will need to be one of the primary objectives of our cities if they are to move towards a sustainable future. Adapting closed-loop principles offers an opportunity for our communities to move away from a linear, wasteful, and disconnected way of operation to one that is interconnected, and moves towards producing zero-waste. As illustrated in the three case studies, creating a closed-loop community is very possible, and has the ability to be economically profitable. Communities like these examples have the ability to be generated using a number of tools such as land zoning and financial incentives Although the case studies may seem like a small solution for the enormous problems of waste and over-consumption, they have the ability to act as seeds in the urban environment, and encourage further growth throughout a city. If we are to begin to move towards a closed-loop system then our society will need to begin to value the importance of the world's resource. By placing a higher value on how our communities are consuming, we can begin to make a change. Although large scale changes are never easy, once a change is made, participating in a closed-loop system will become the norm for our communities and they will be consuming responsibility. Closed-loop communities have the ability to further the efficient use of the planets' valuable resources. I believe that moving towards a closed-loop model is necessary for cities and communities to become self sustaining.

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List of Figures

Figure 1: Pawlyn, Michael. *Man-made systems vs. Biological systems*. RSA Podcast.

Figure 2: Author. *Regenerative Economy*. Inspired from: http://designprocessen.dk/baeredygtigt/teori/vugge-til-vugge/

Figure 3: Kalundborg Symbiosis. *Kalundborg Symbiosis: Diagram 1961-2010.* http://www.symbiosis.dk/diagram

Figure 4: J. Christensen. *Material Flows in the Kalundborg Industrial Ecosystem.*

Figure 5: Pawlyn, Michael. *Cardboard to Caviar Diagram*. RSA Podcast.

Figure 6: Pawlyn, Michael. *Cardboard to Caviar Extended Diagram.* Biomimicry in Architecture.

Figure 7: Great Lakes Brewing Company. *Ohio City Farm*. http://www.greatlakesbrewing.com/sustainability/other-sustainability-projects

Figure 8: Author. *Great Lakes Brewing Company's Material Flow.*

Figure 9: Author. *The In-between-step.*

Thesis Conclusion Summary

After the written thesis and throughout the design thesis many sub-investigation took place in addition to the main exploration of a community that moved towards a closed-loop. Some of these investigations included; master planning, wind studies, structural studies, native species investigation, biophilia, social spaces, passive design strategies, and others. After the completion of the design portion of the thesis several of these sub-investigations stood out as having the ability to be developed further.

One was further urban development at a larger scale. The scope of my project dealt with about six blocks, this size was chosen to allow for a descent sized master plan and urban plan, but also allowed me to focus on details of the project. I thought a small urban design was necessary so that the whole project did not become an urban planning one. Now that the project is developed, I think that it would now enhance the project if further urban planning efforts were made. This would help the project extend out in to the city, furthering the "seed" idea of the community. The best place for this idea is to continue along the river and in the river valley. Areas of the river valley could be connected with the water, bike paths, possibly a bus or trolley system. Additional green spaces would also be proposed to allow for parks and nature preserves. This would be a large asset for the city, by creating a green tread through the city. This string of green spaces moving up the river valley also would be restoring the original plans for the city, created be Daniel Burnham during the city's growth period. This green thread also could continuous the effort made by the estuary part of my design, that to help clean and rejuvenate the river and its spices. Creating this larger green corridor could help jump start a green movement in the city.

A second effort that I would like to expand upon would be the materials and the energy performance of the building. The materials for the building and their performance could have been studies further. Although large design moves were made in terms of passive design, details and actually performance numbers for the glass, double facade and walls were not calculated. I think this investigation would enhance the project, to prove it is sustainable in a more holistic way.

Now that the project is complete I think that these other investigation would further enhance the project and add validity to the performance of the project.

Site Analysis

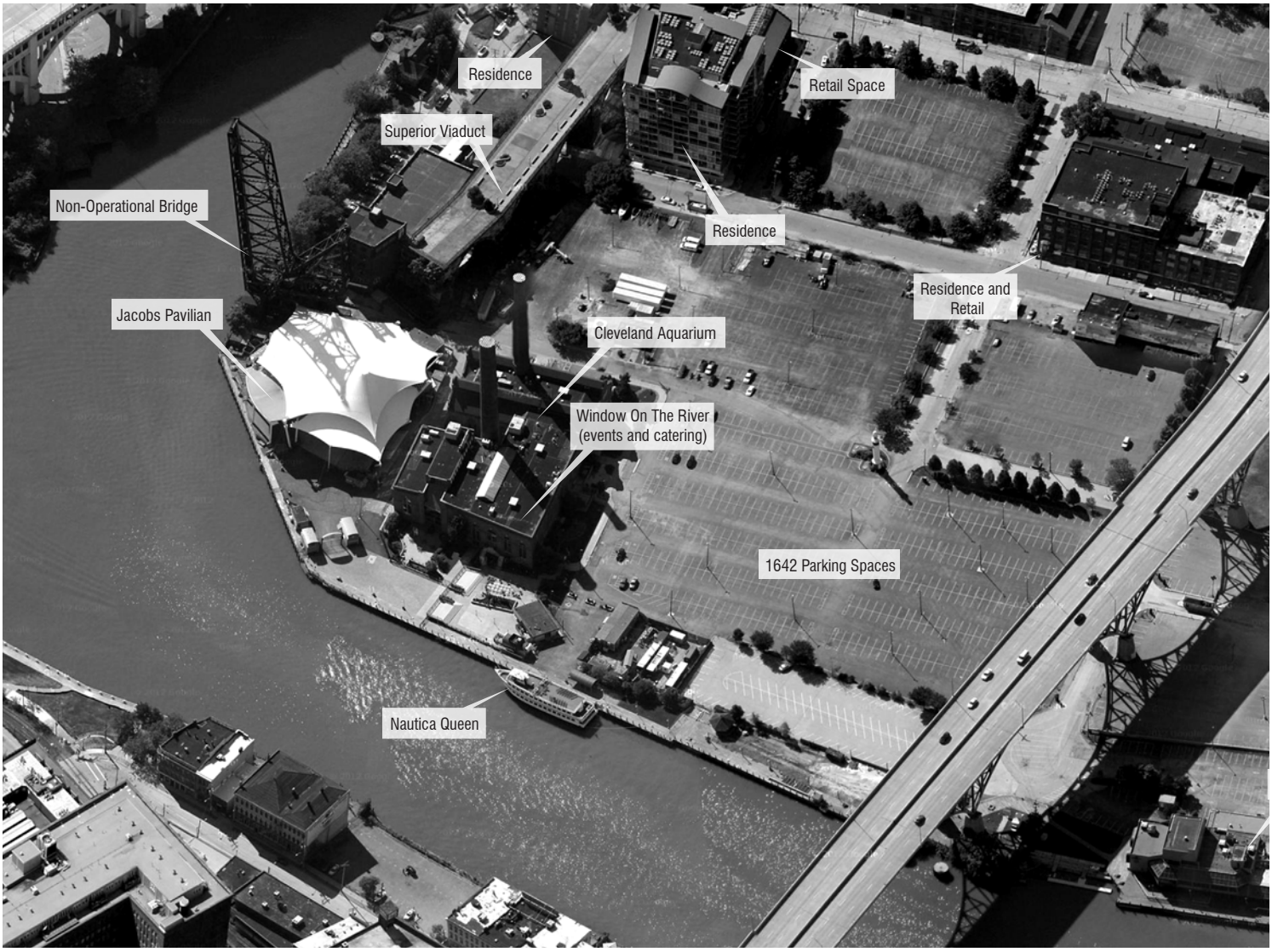
The site chosen to execute the thesis was Cleveland, Ohio. Cleveland was chosen for several reasons. One the project needed a site that was urban in order to become a "seed," this would allow the project to take advantage of a larger population, diverse set of companies, and existing infrastructure. Secondly the project wanted to be sited in a de-industrialized city, this would allow for the reuse of a wasted landscape. Thirdly Cleveland was chosen in response to my research on globalization. While the world population grow and become urbanized, it only make sense to reuse this city and its embodied energy, as oppose to building new cities for an urbanizing population. Cleveland's location is well suited to deal with the adverse effects of climate change because if it's geographical location. It is near large fresh water source, away from possible flood-risk areas, away from desertification regions, and in a risk-free area for hurricanes. After considering these condition I felt Cleveland was an ideal candidate for this type of development. Other cities that were considered in this process were Toledo and Detroit.

The specific site that was chosen within the city was in the river valley of the Cuyahoga River. This site was chosen because of its proximity to downtown, which current has a 96% occupancies rate. This is also a prime area because of its isolation from heavy automobile traffic, because the site is situated down in the valley, heavy traffic and interstates span over the valley and don't cut through it. This suggest that this area could potential be geared towards pedestrians, bike and bus traffic; while also benefiting from the close proximity to downtown. This area is also the good fit because of it industrial history; because this type of development will require all types of zoning and building types, the area will be receptive and a good fit to unconventional mixed-used development. Mainly because many of this area's uses, such as industrial, have or still exist presently. Not only is industrial a building type of this area but other building types near the site include: Jacobs pavilion (a summer concert pavilion), the Cleveland Aquarium, restaurants, new condos, warehouses, and a water sport venue.

Area Map



Existing Context







Existing Context







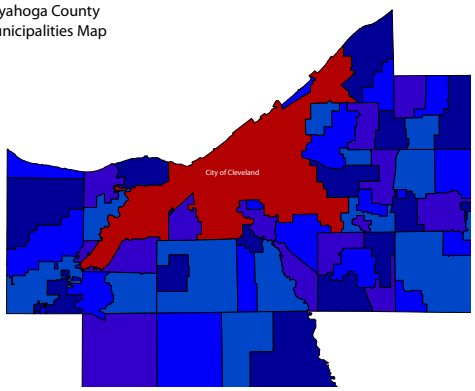




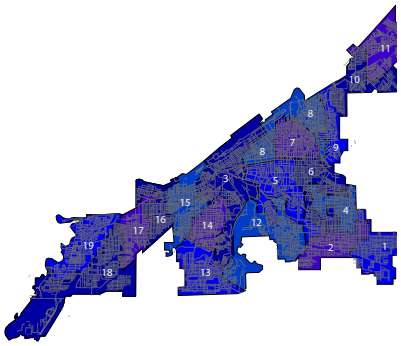


Macro Analysis

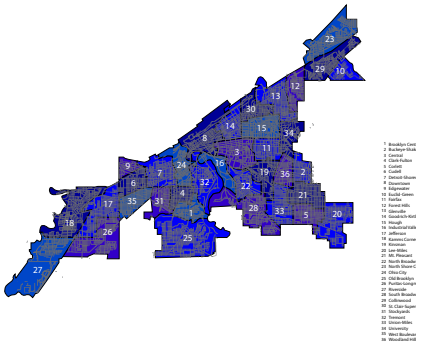
Cuyahoga County
Municipalities Map



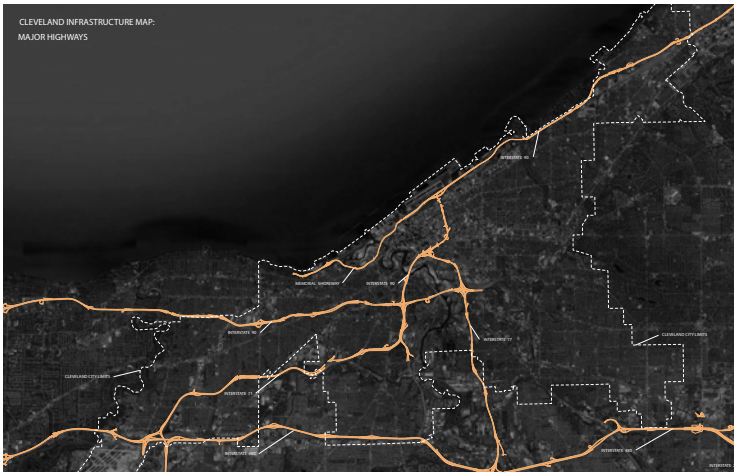
City of Cleveland
Wards Map

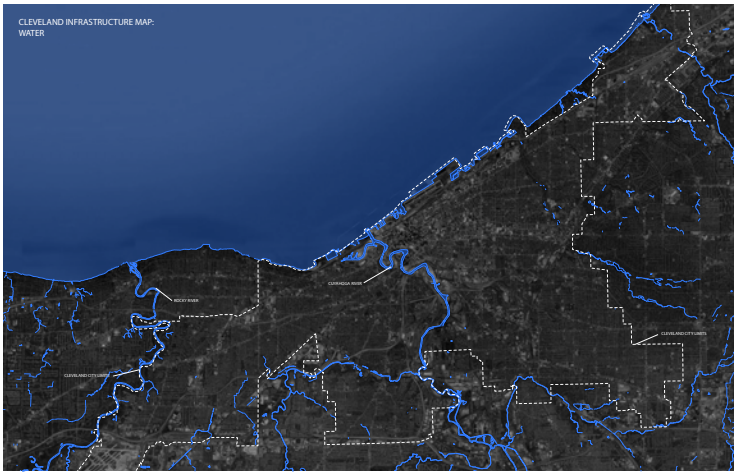


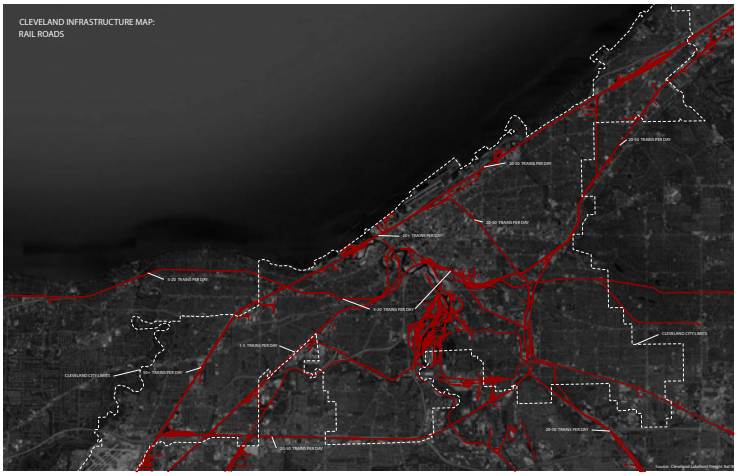
City of Cleveland
Statistical Planning Areas Map

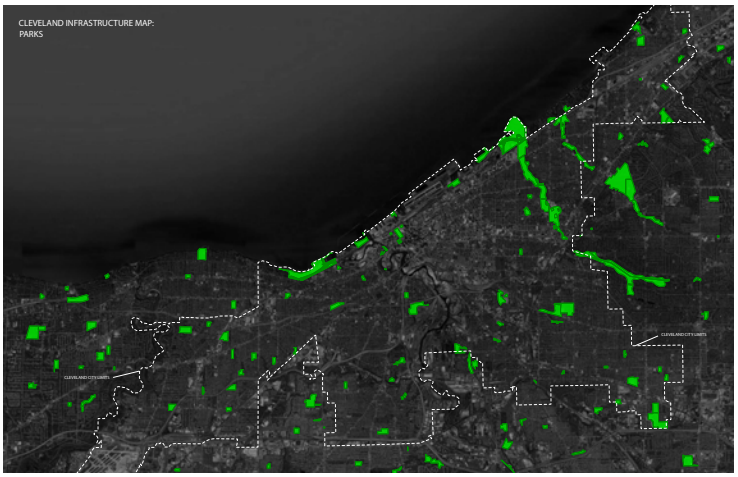




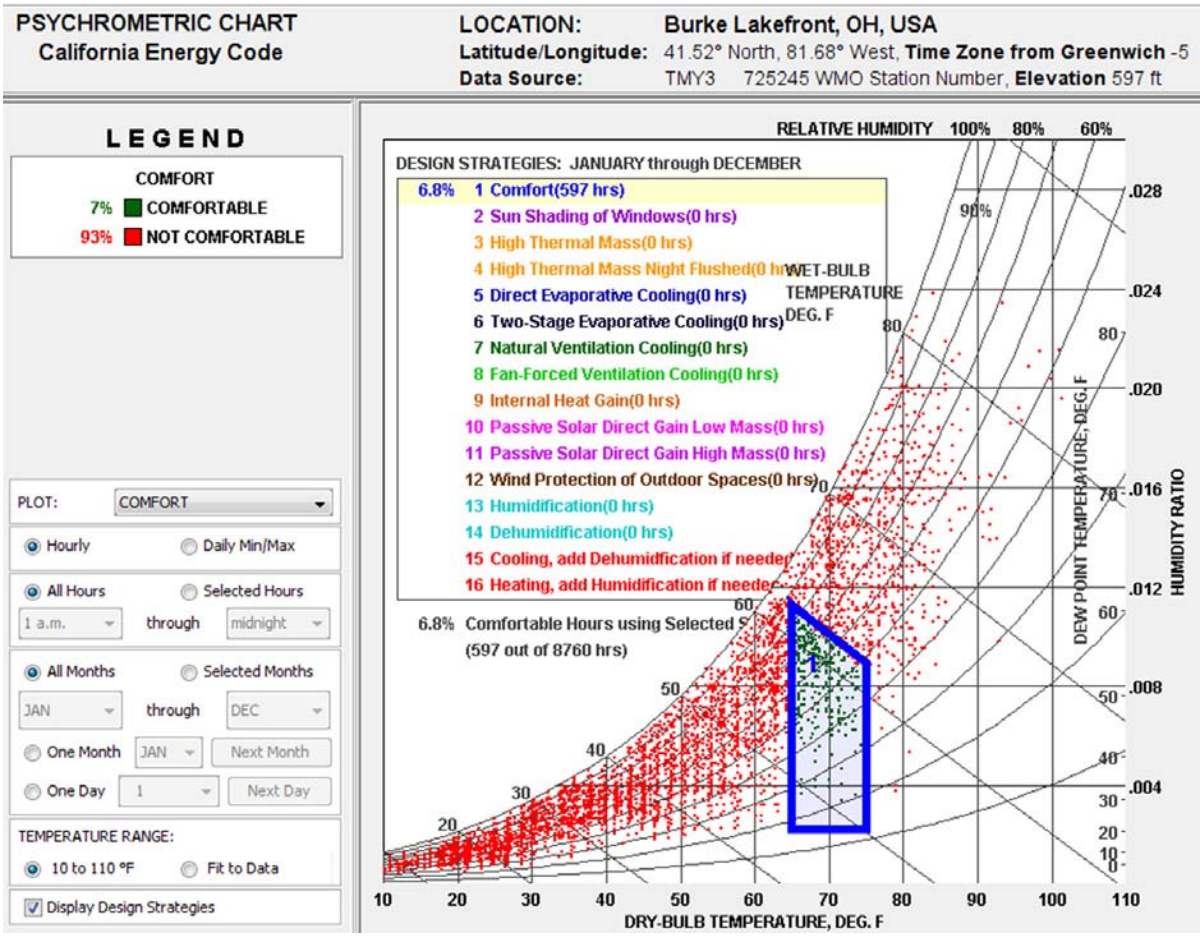


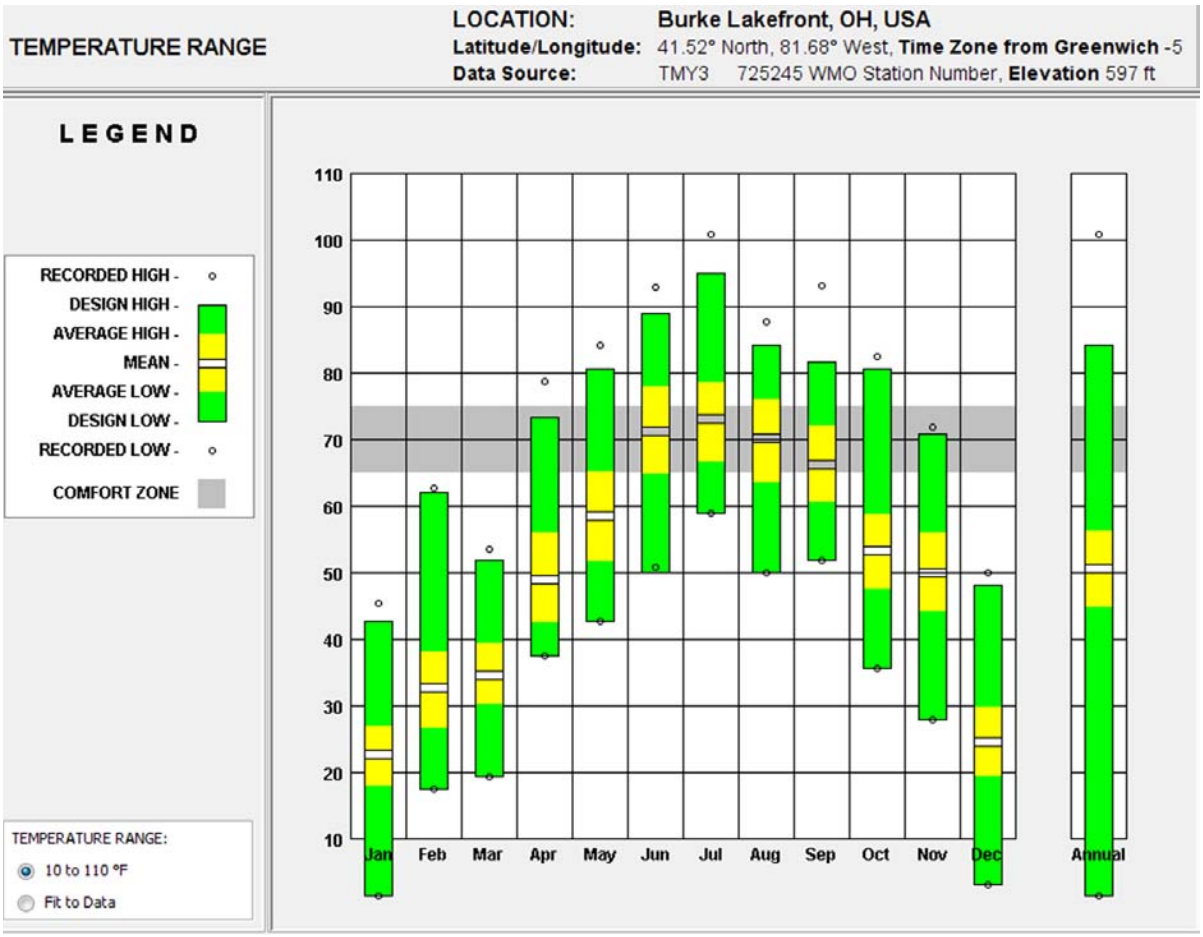






Climate Data





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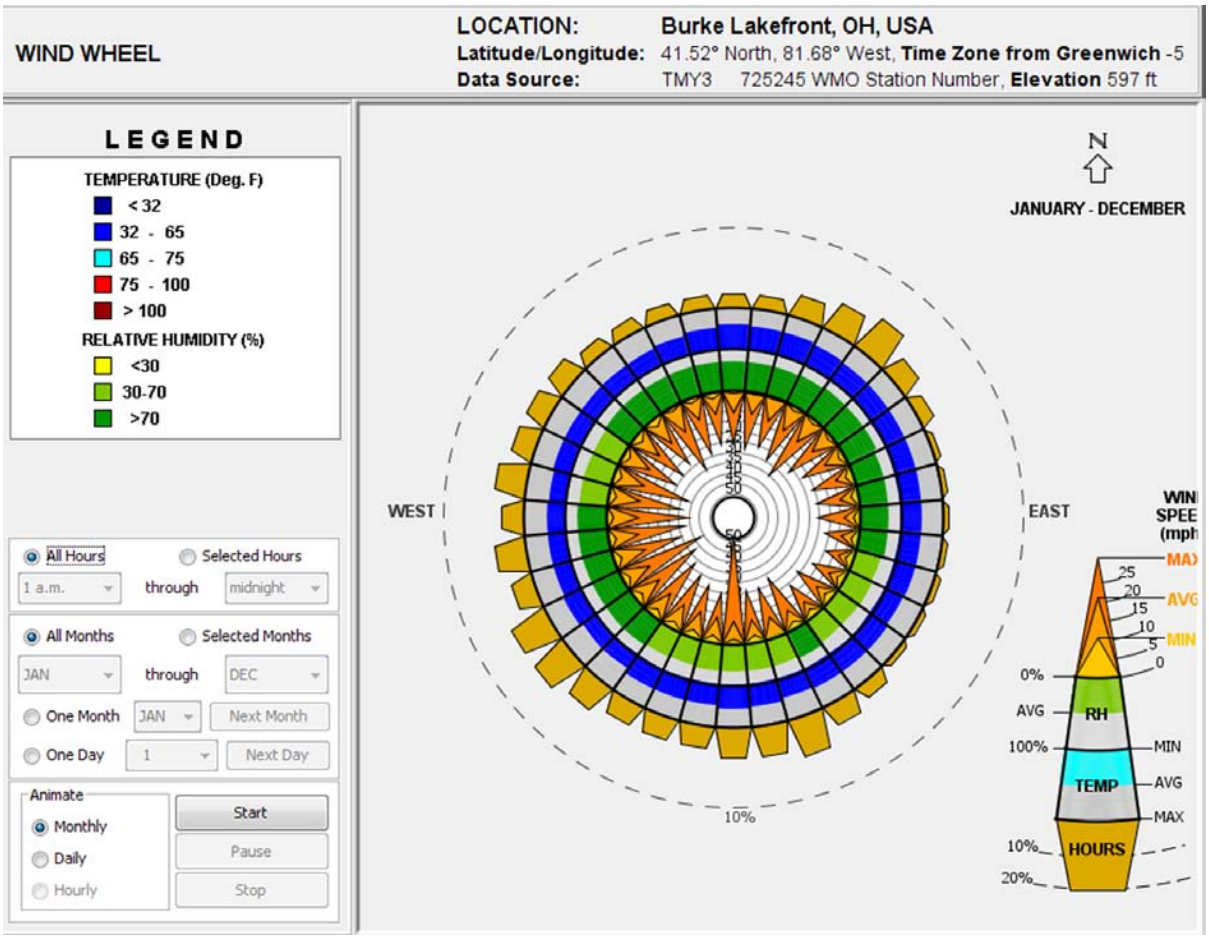
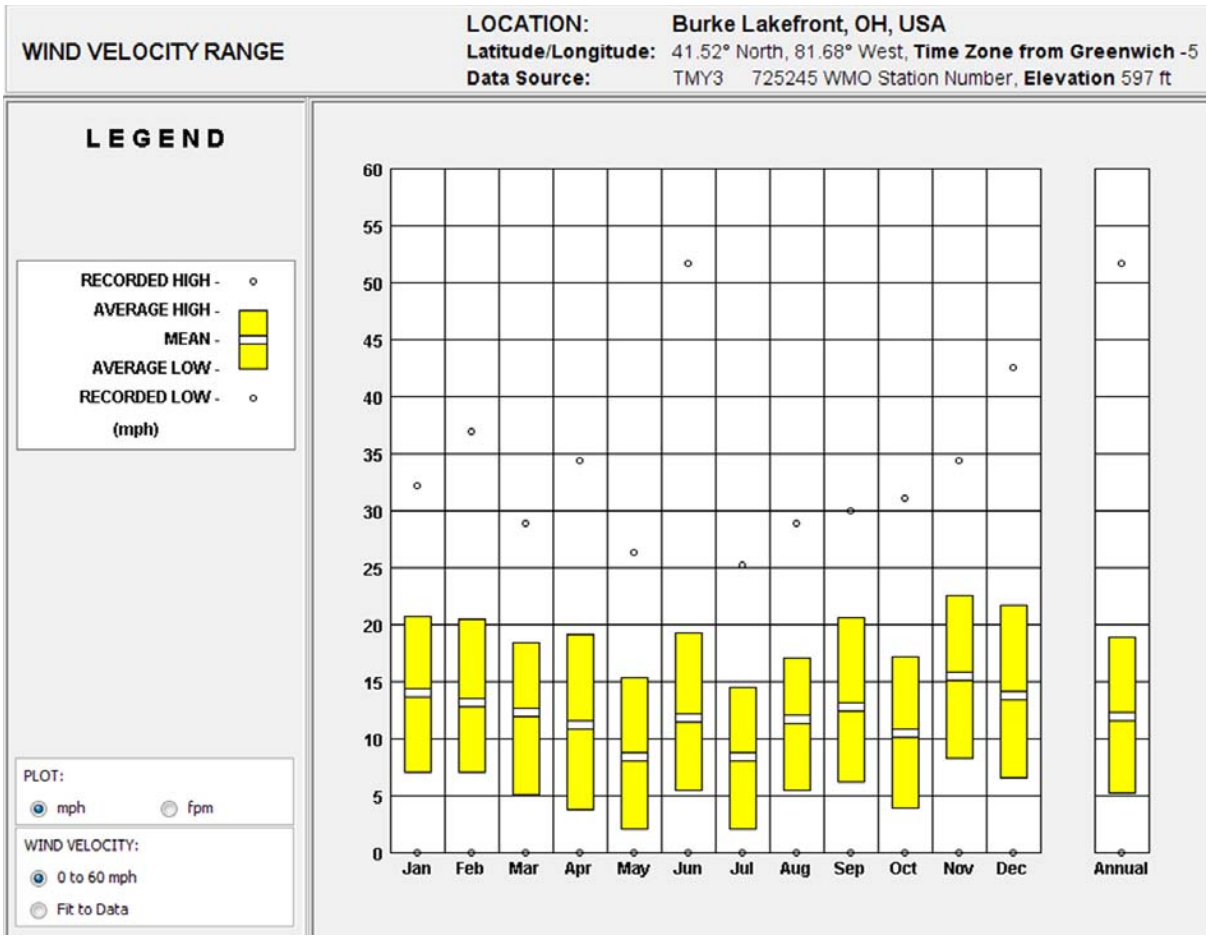


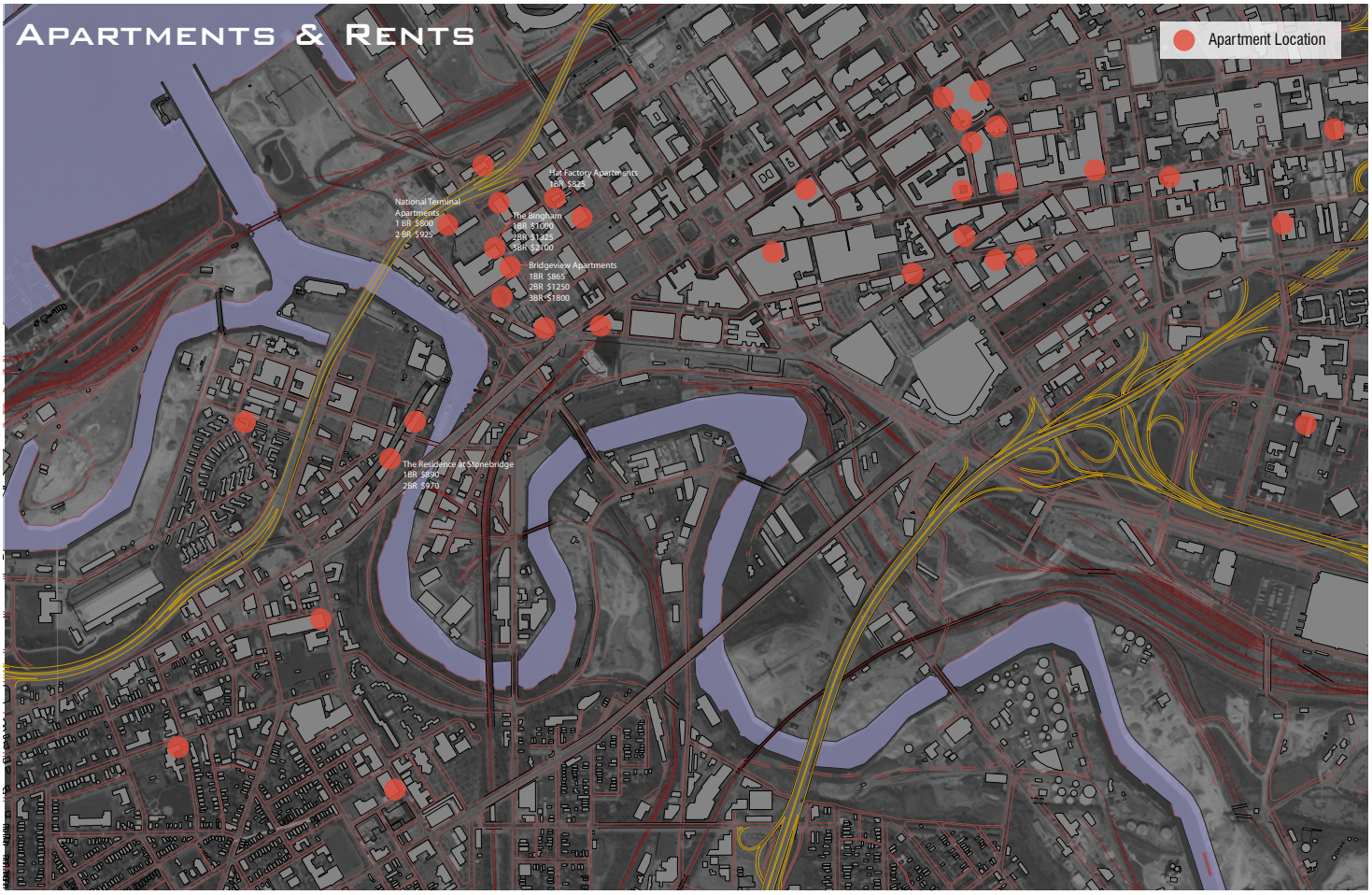


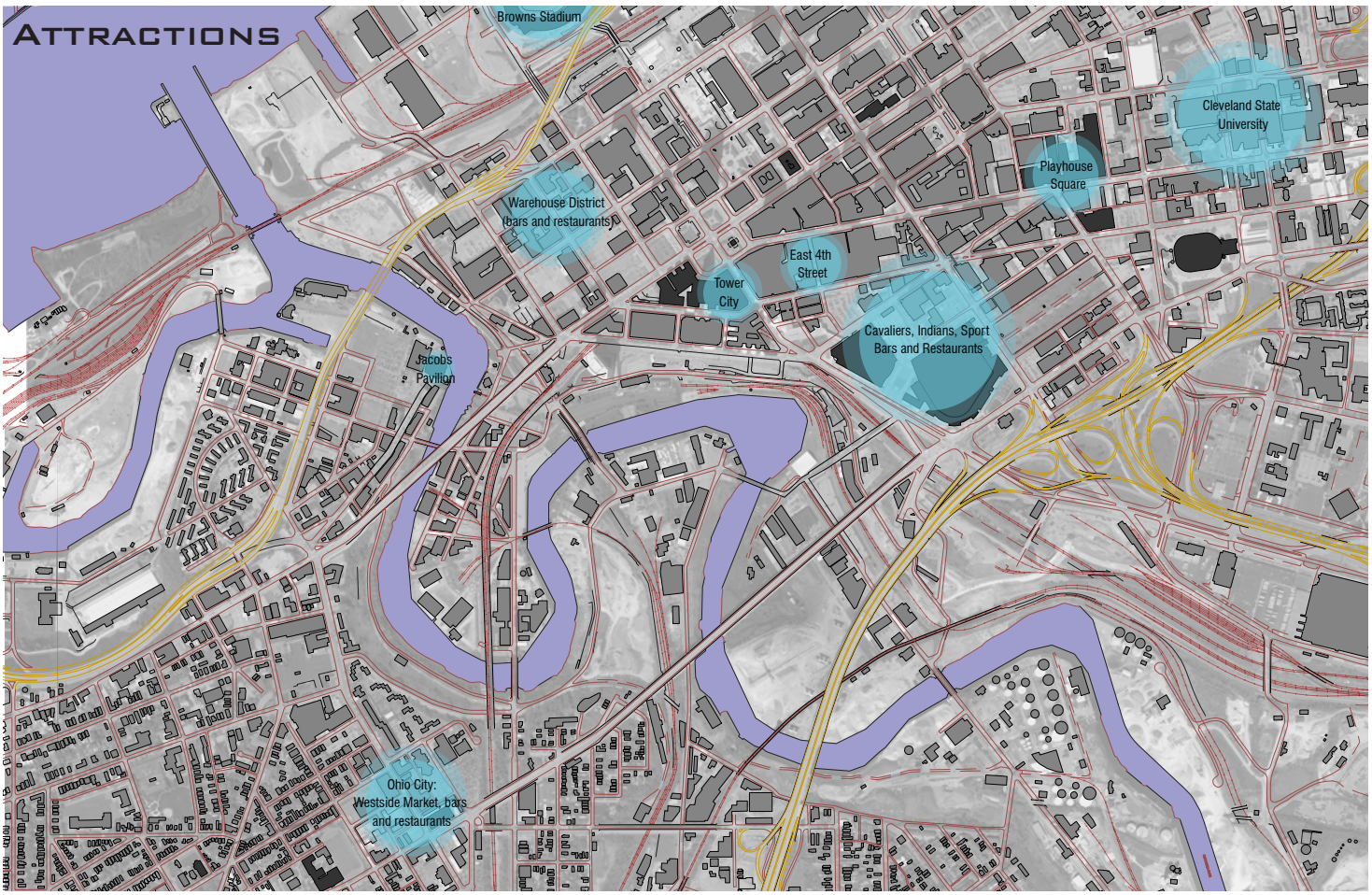
Possible Sites



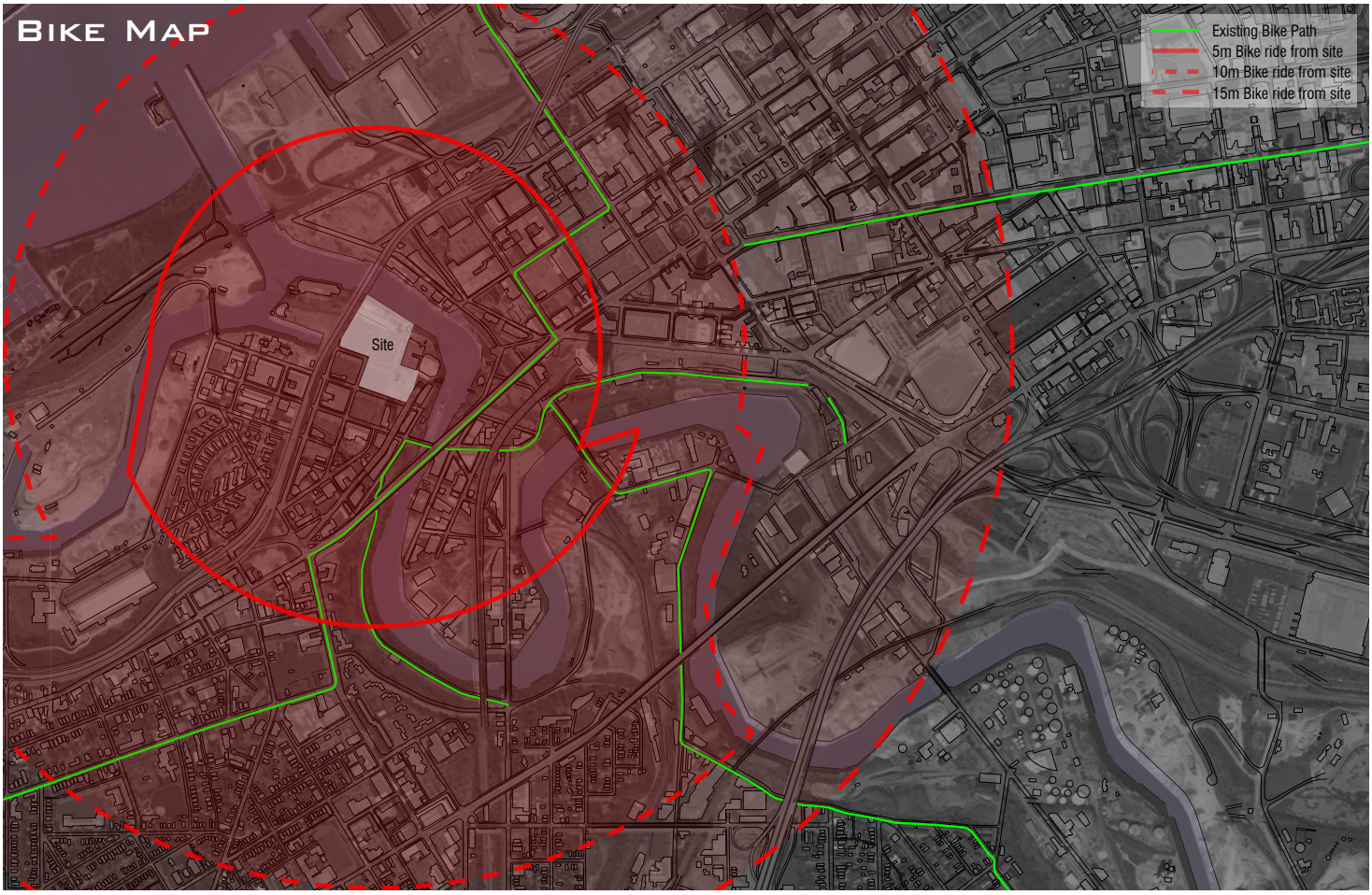
Figure Ground Plan



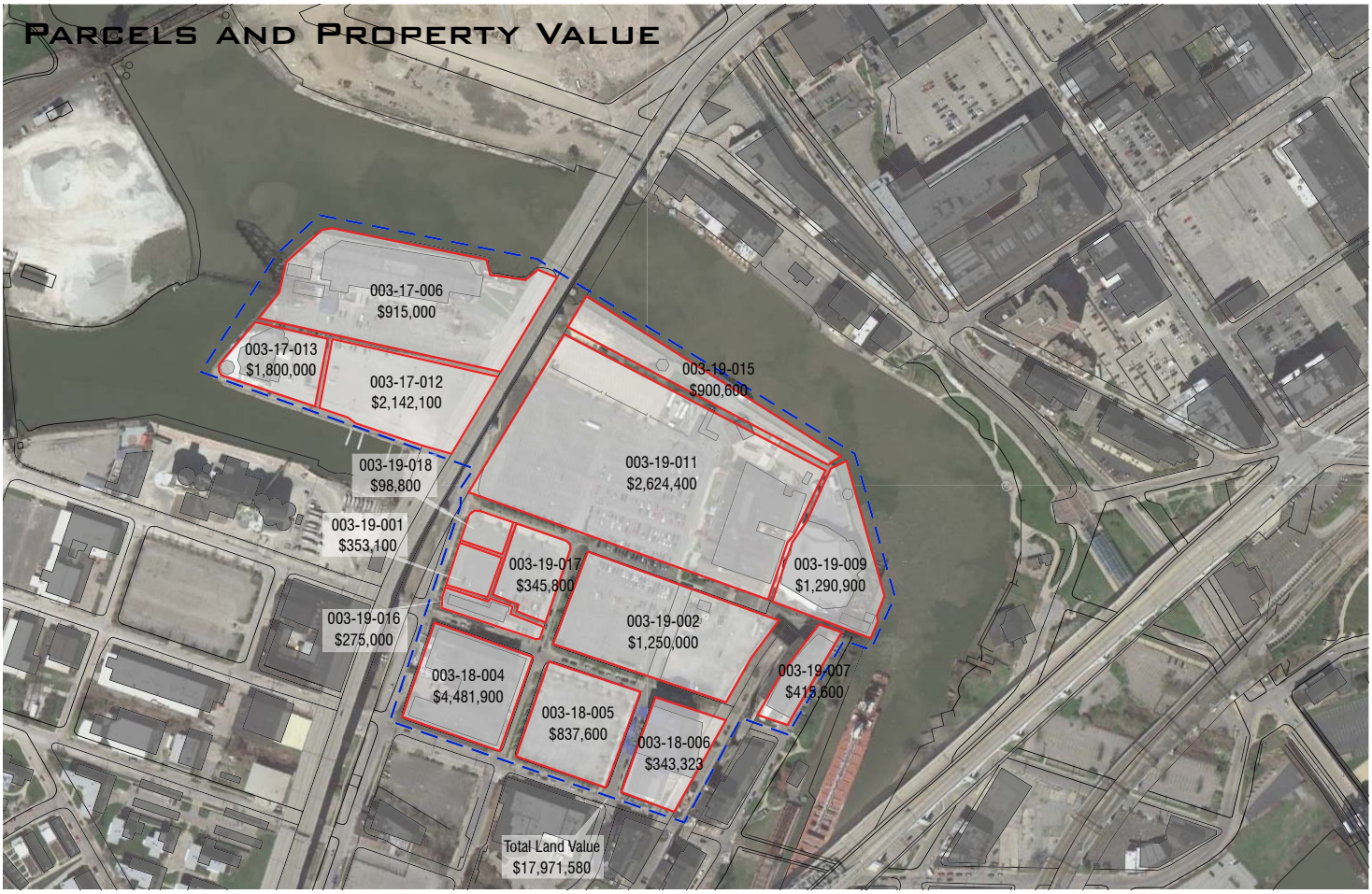

Apartments & Rents
Apartment Location
National Terminal Apartments
1 BR $600
2 BR $925
Flat Factory Apartments
1BR $825
The Bingham
1BR $1090
2BR $1325
3BR $2100
Bridgeview Apartments
1BR $865
2BR $1250
3BR $1800
The Residence at Stonebridge
1BR $890
2BR $970


Attractions
Browns Stadium
Cleveland State University
Playhouse Square
Warehouse District (bars and restaurants)
East 4th Street
Tower City
Cavaliers, Indians, Sport Bars and Restaurants
Jacobs Pavilion
Ohio City: Westside Market, bars and restaurants

Micro Site Analysis






Parcels and Property Value
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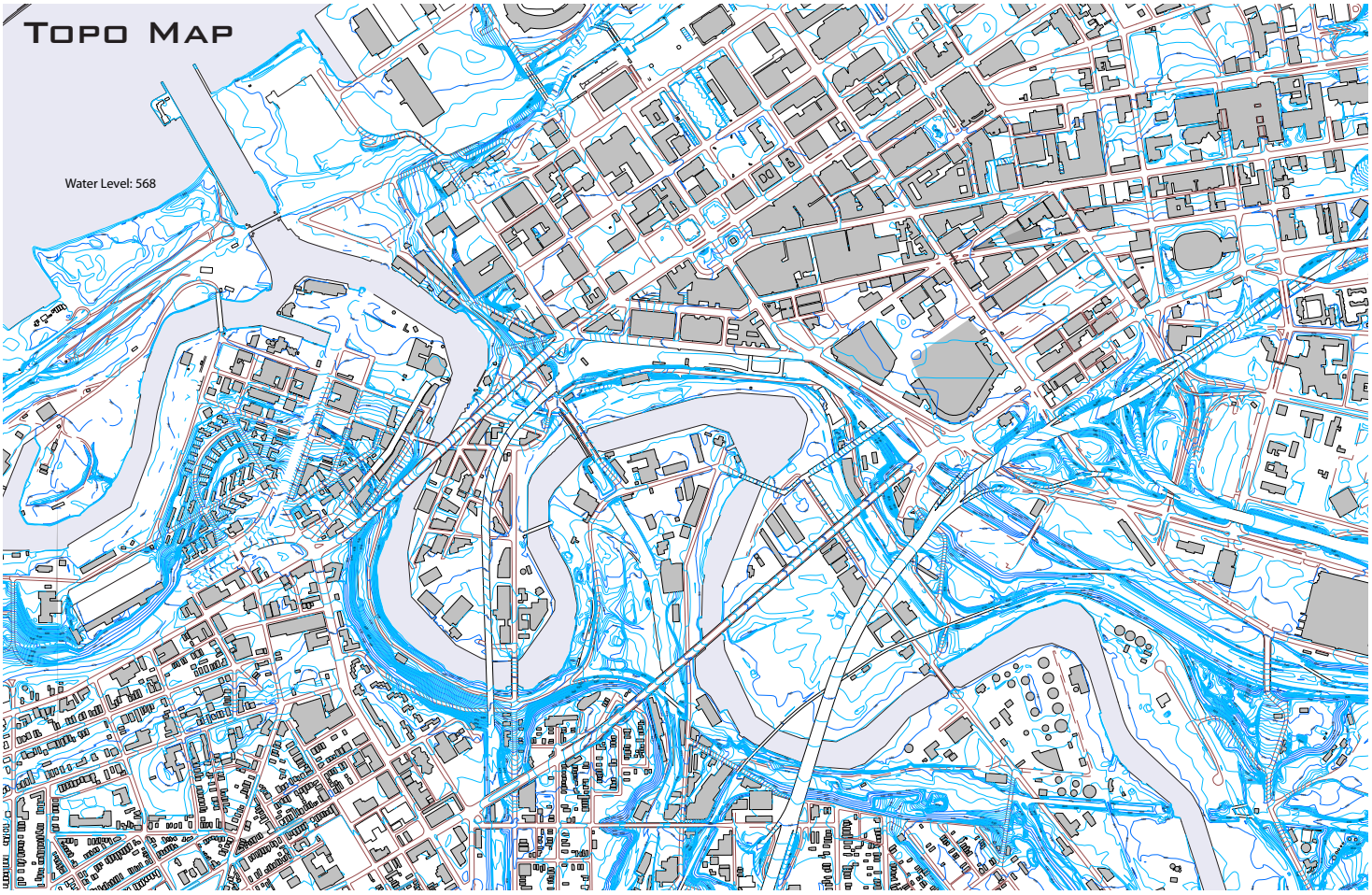
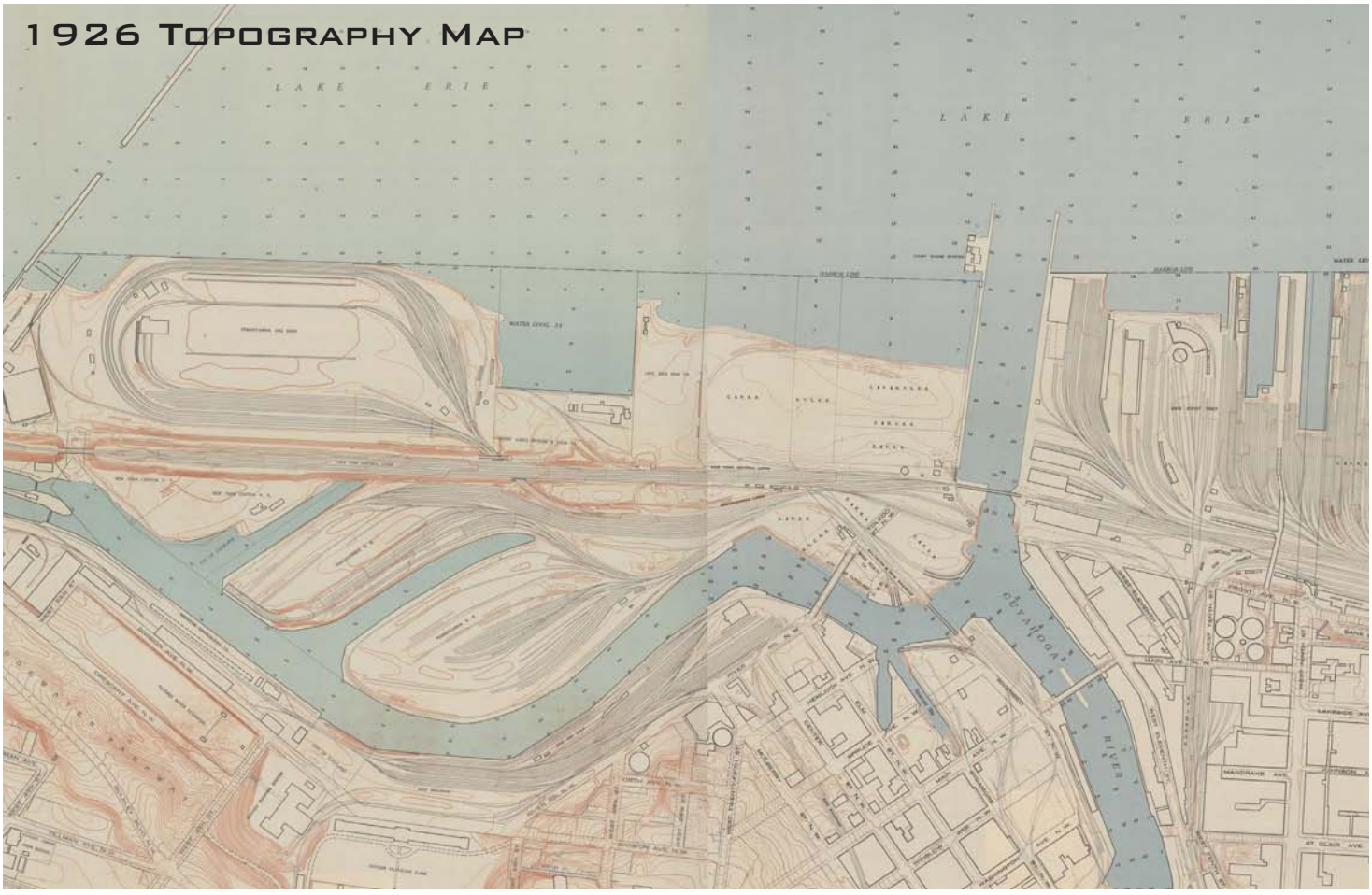
$915,000
003-17-013
$1,800,000
003-17-012
$2,142,100
003-19-015
$900,600
003-19-018
$98,800
003-19-011
$2,624,400
003-19-001
$353,100
003-19-017
$345,800
003-19-009
$1,290,900
003-19-016
$275,000
003-19-002
$1,250,000
003-18-004
$4,481,900
003-19-007
$415,600
003-18-005
$837,600
003-18-006
$343,323
Total Land Value
$17,971,580


Parks, Farms, & Trees
Parks
Farms
Trees

Topo Map



1926 Topography Map



Process

Master Planning



Scheme A



Scheme B



Scheme C



Scheme D



Scheme E



Scheme F



Scheme G

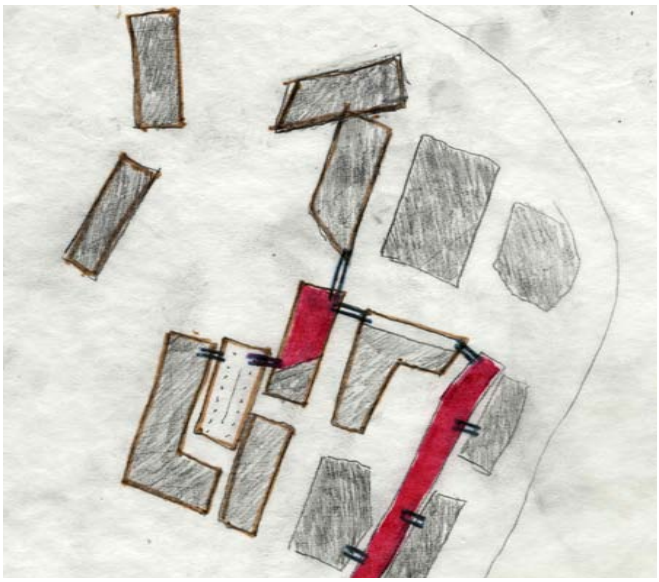


Scheme H

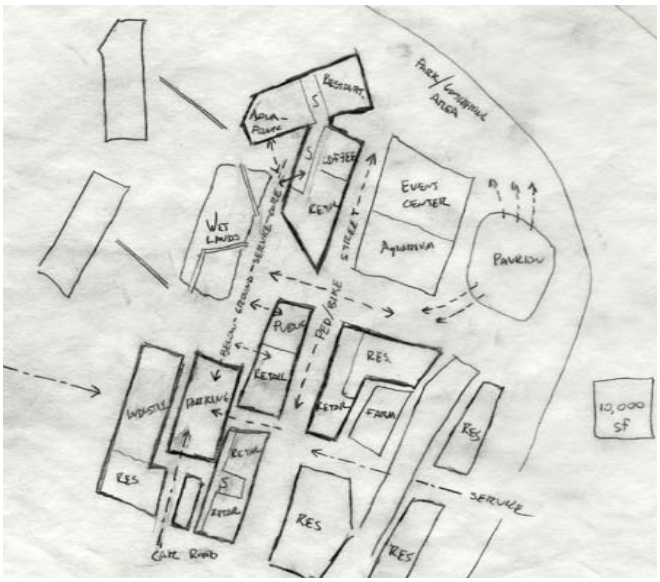
Master Planning



Scheme I

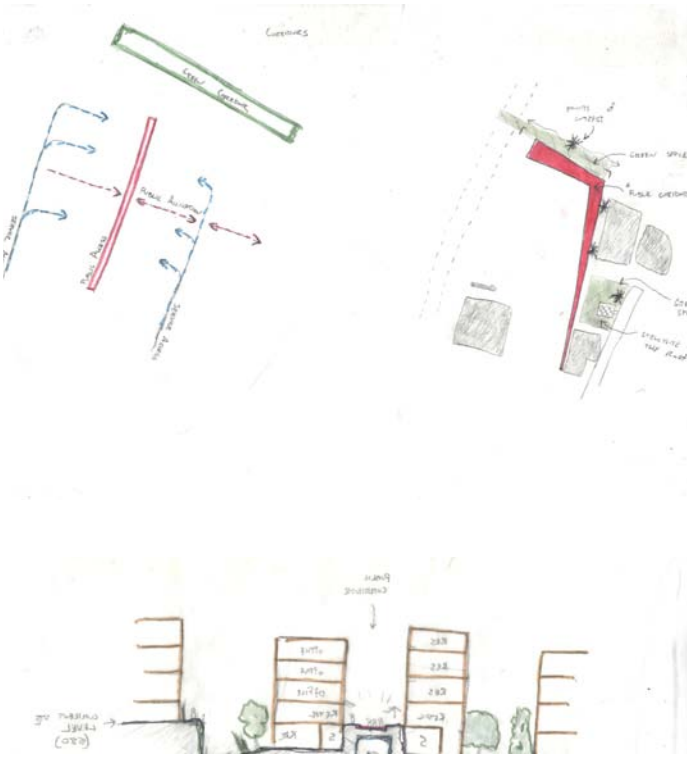


Scheme I - Upper Level Circulation



Scheme I - Gound Floor use

Key Ideas & Ground Floor Organization

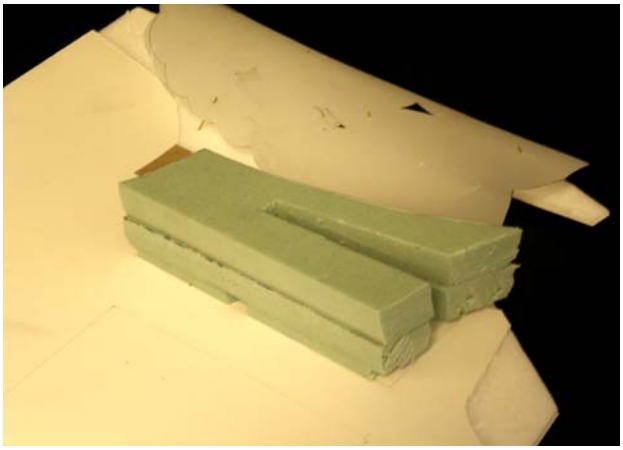


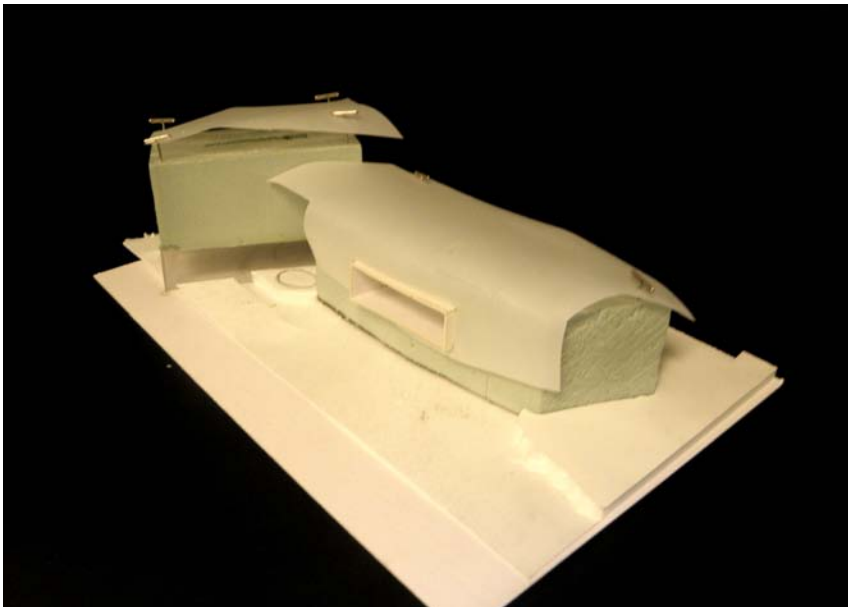


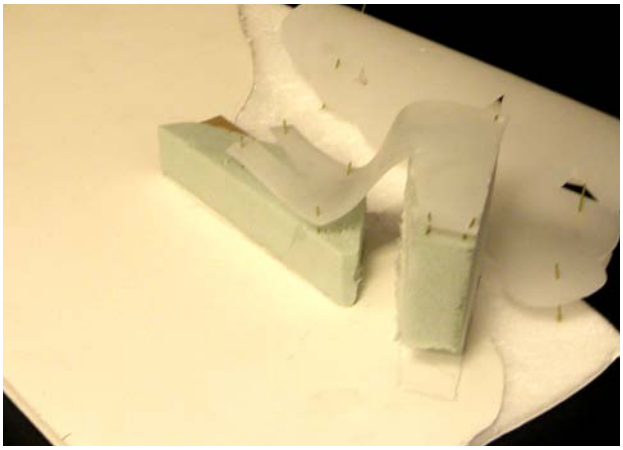


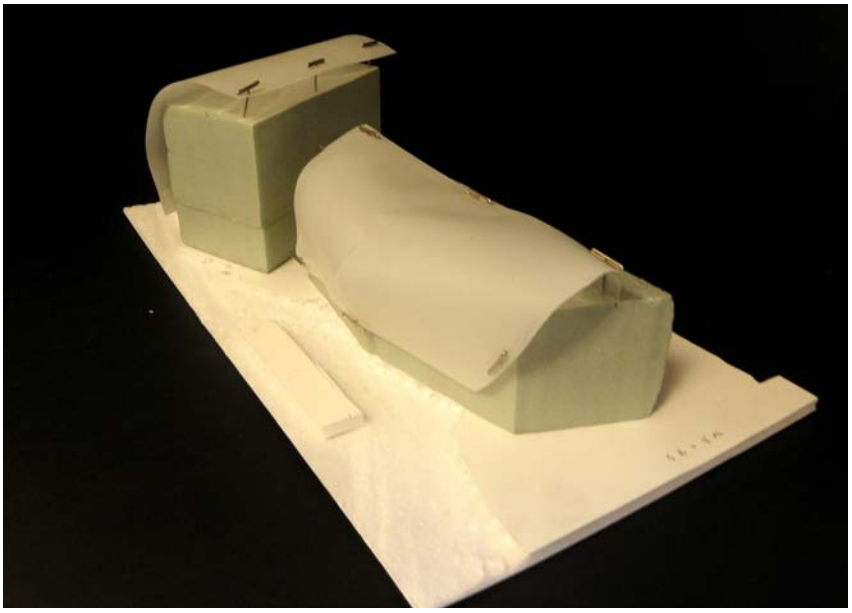


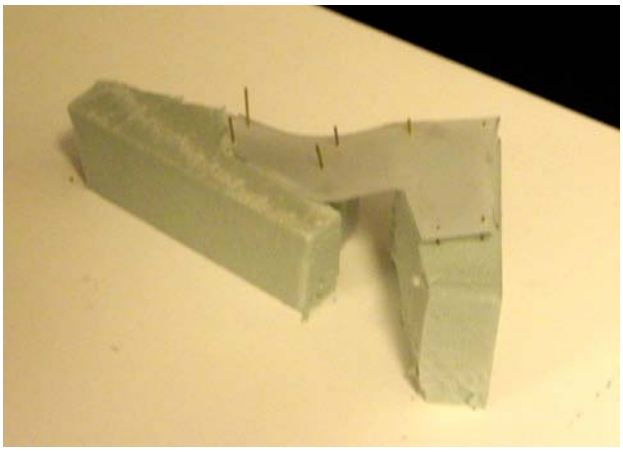
Study Models

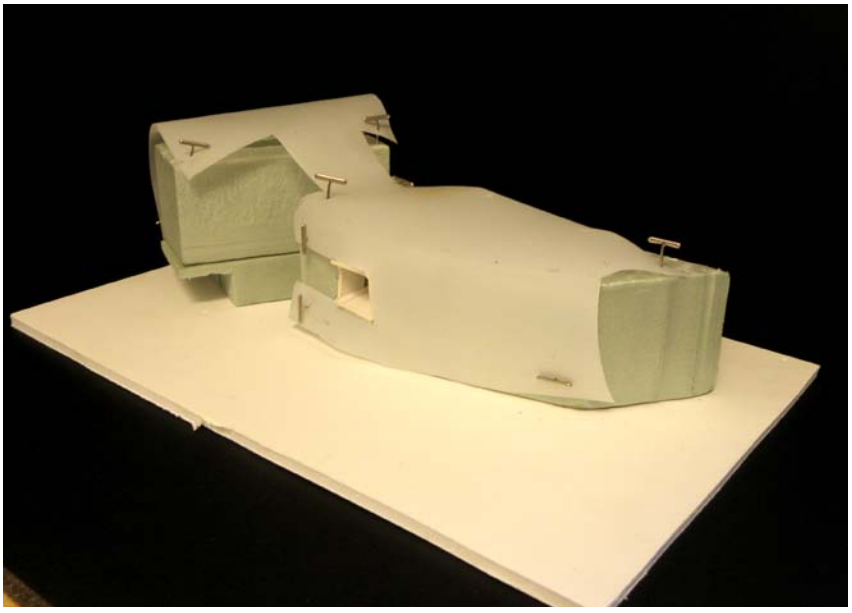


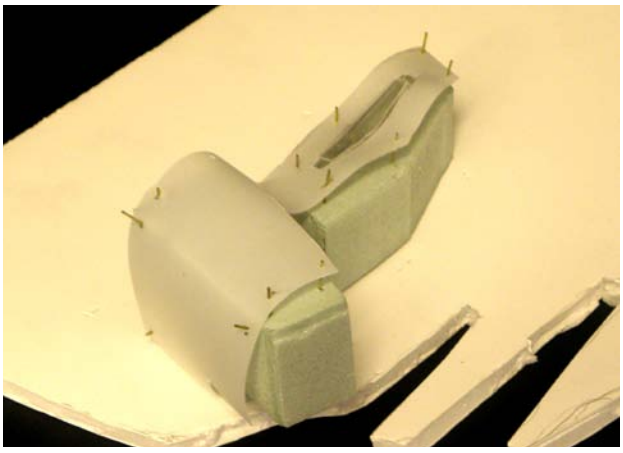








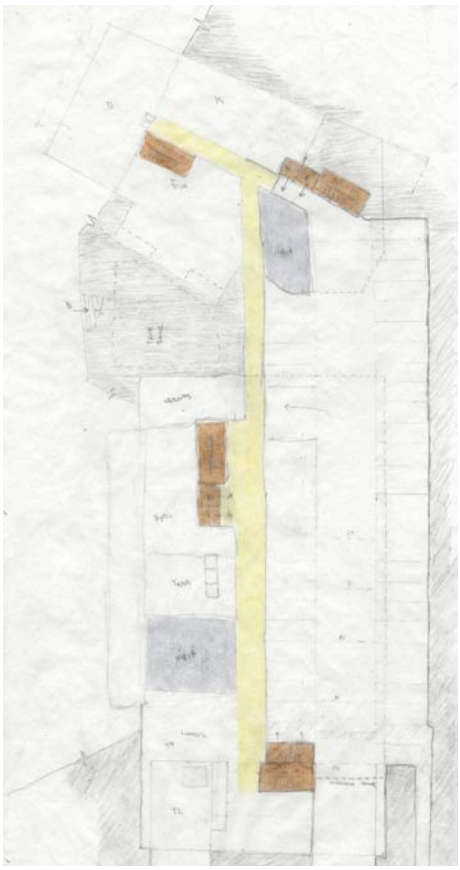




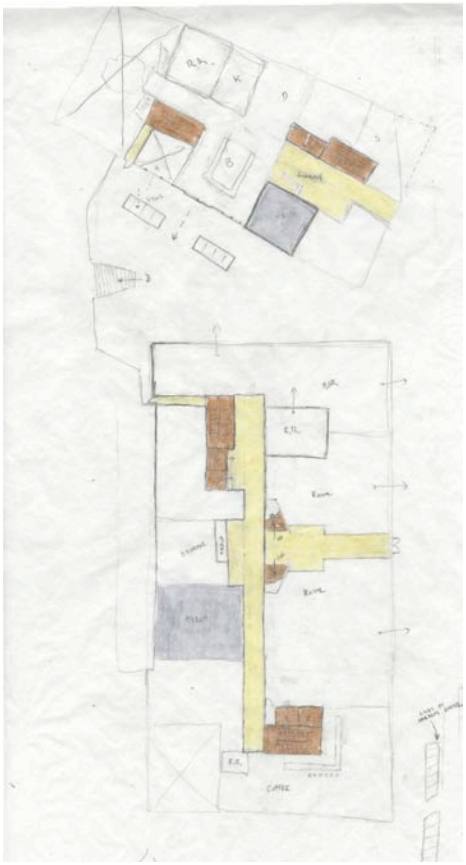
Site Development



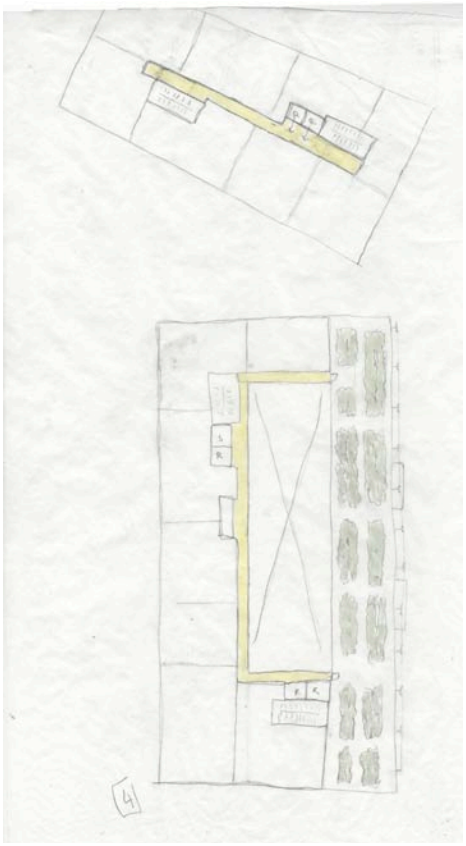
Plan Development



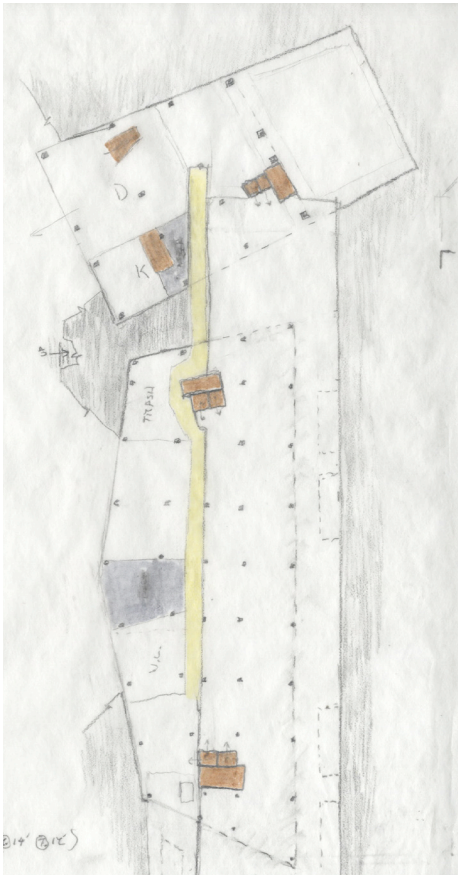
Level B



Level 1



Level 4



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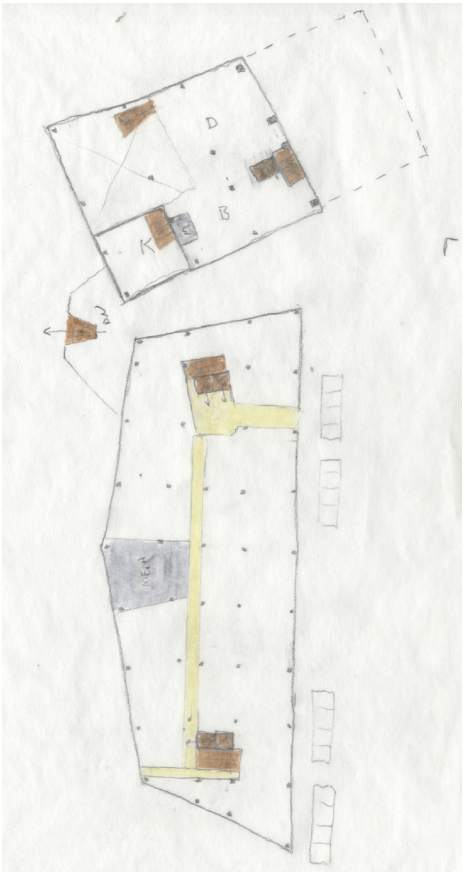
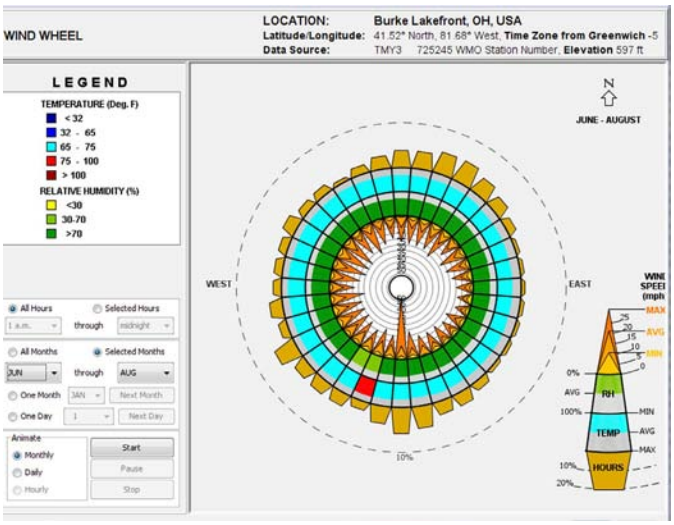


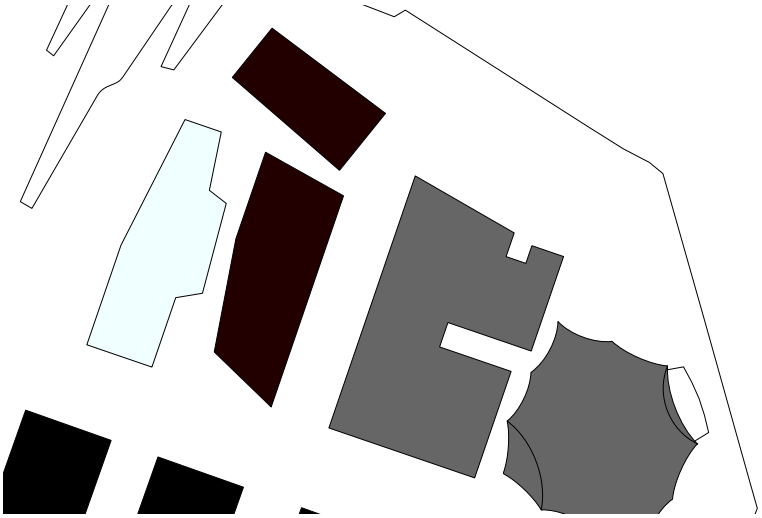
Level 1

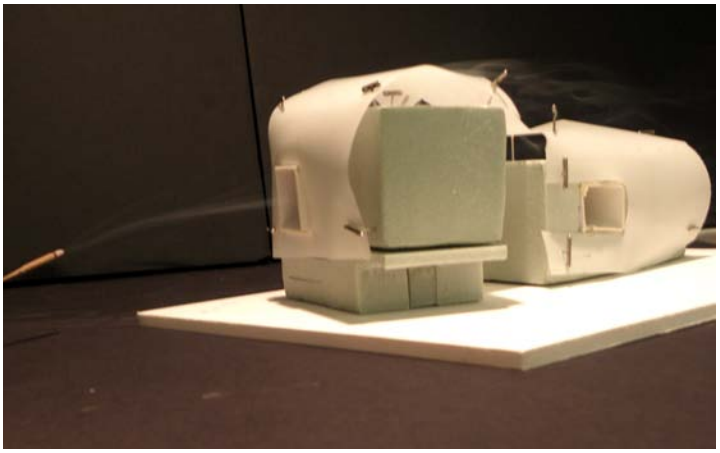


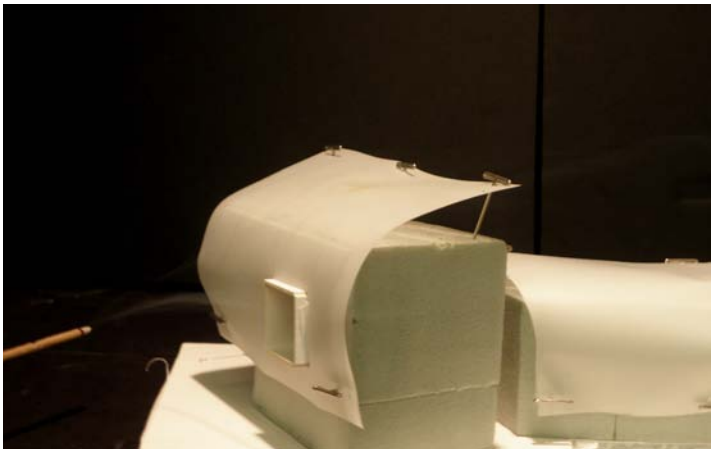
Level 4

Wind Studies



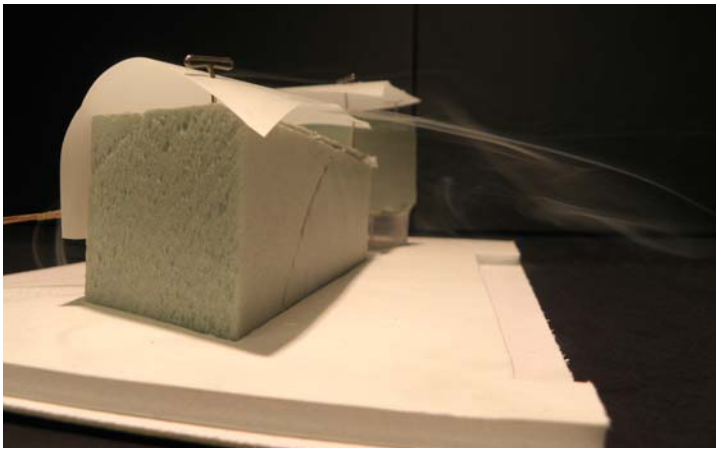


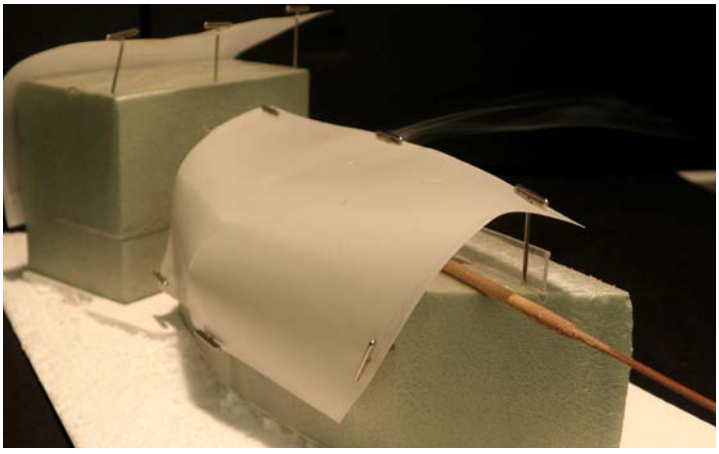




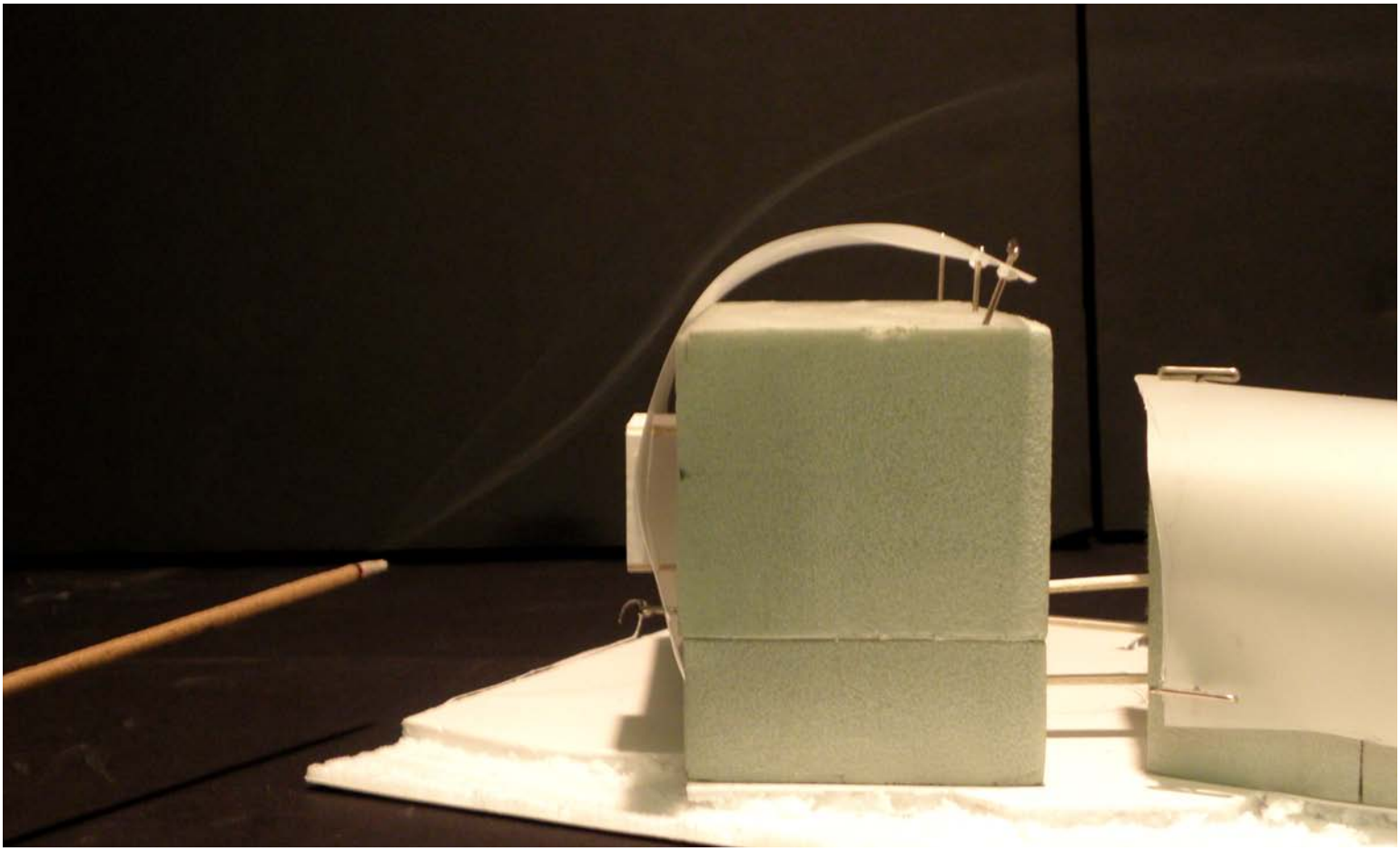


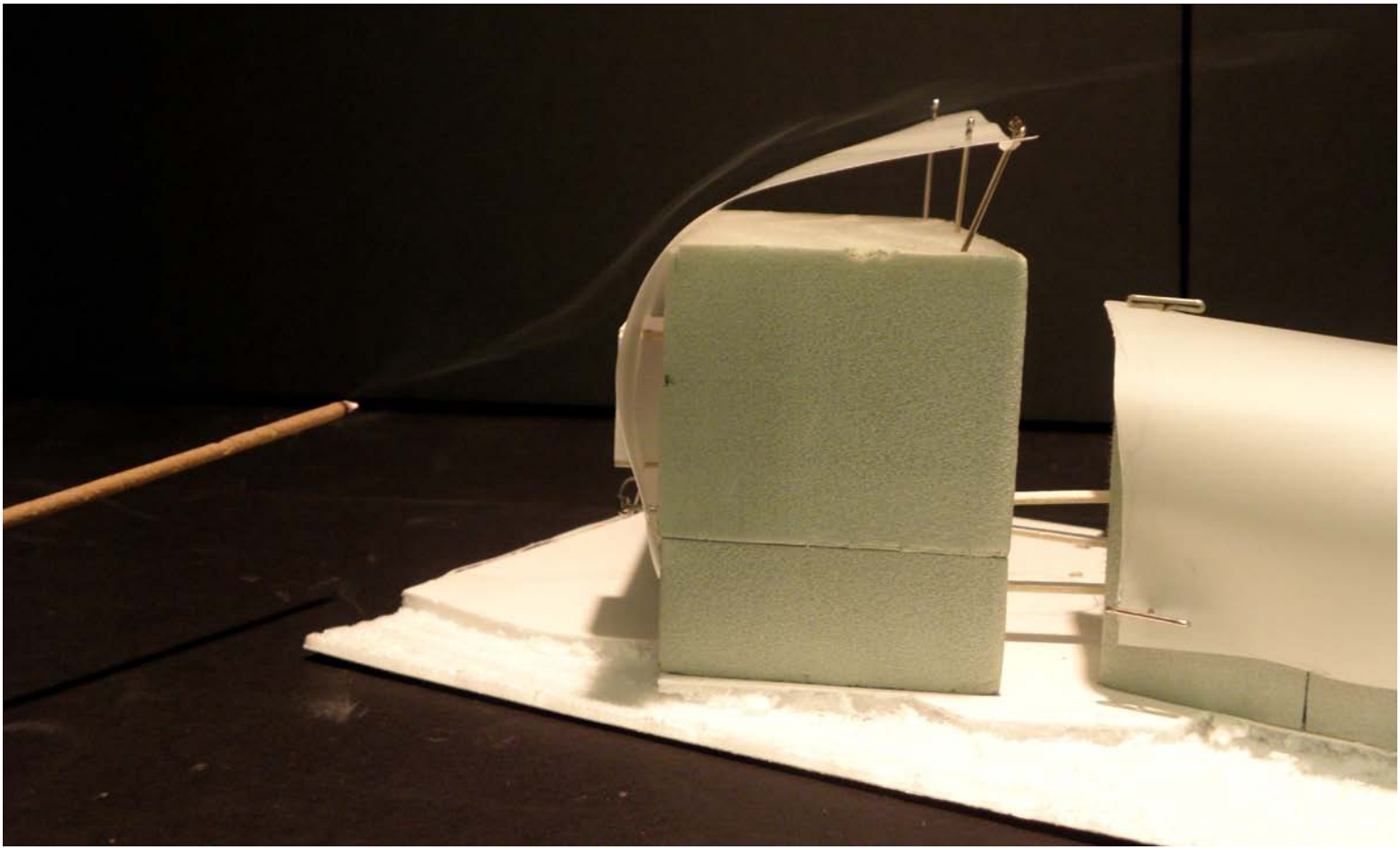




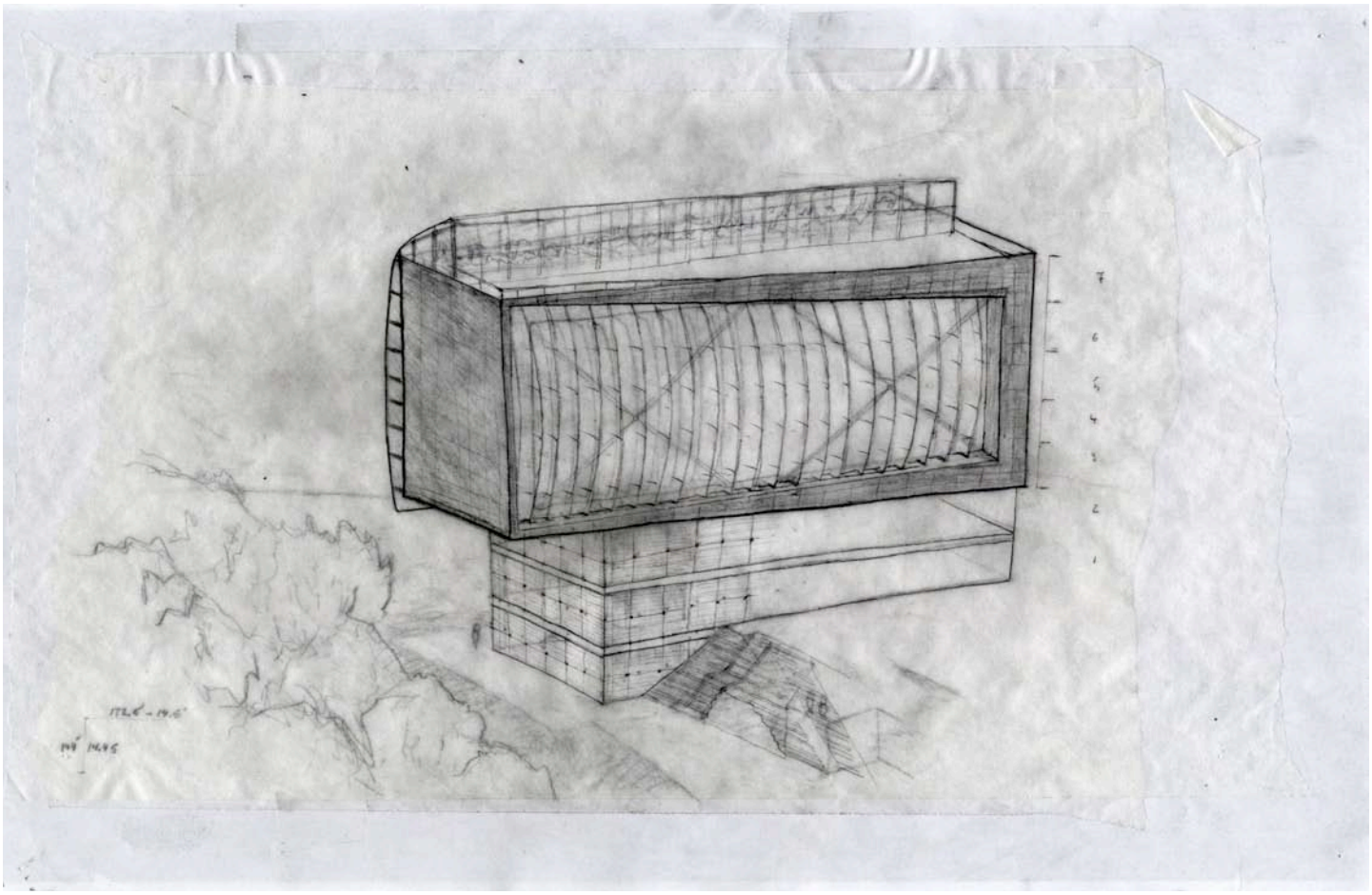


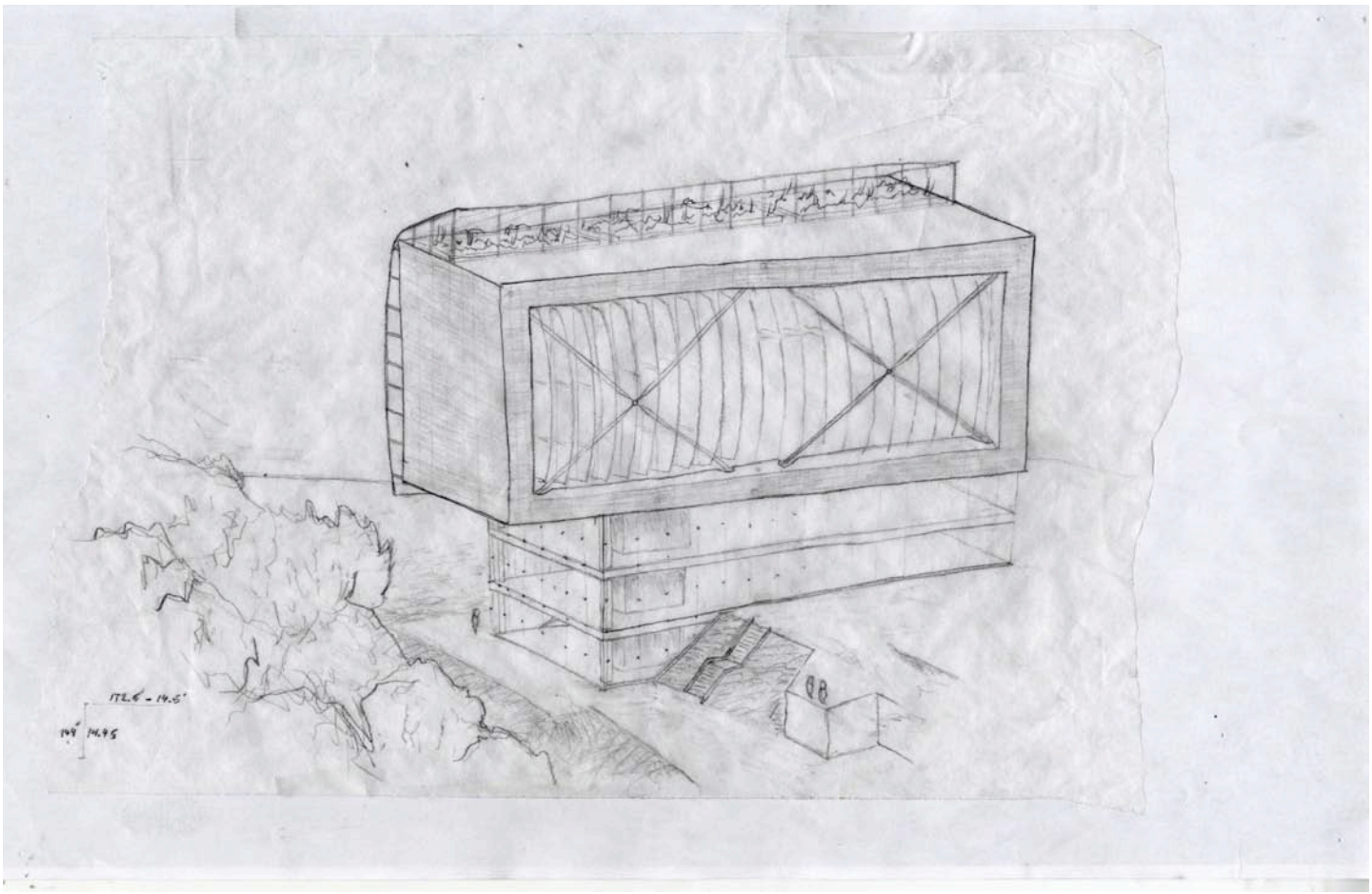
Wind Studies



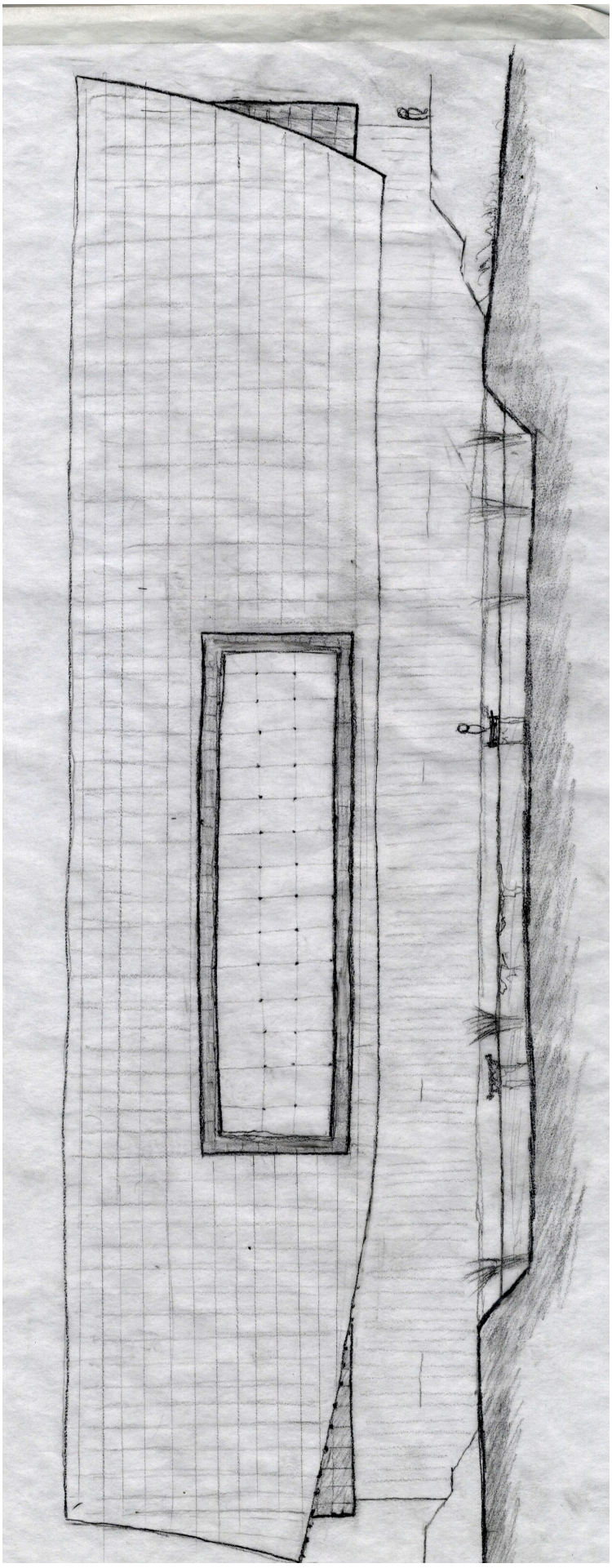


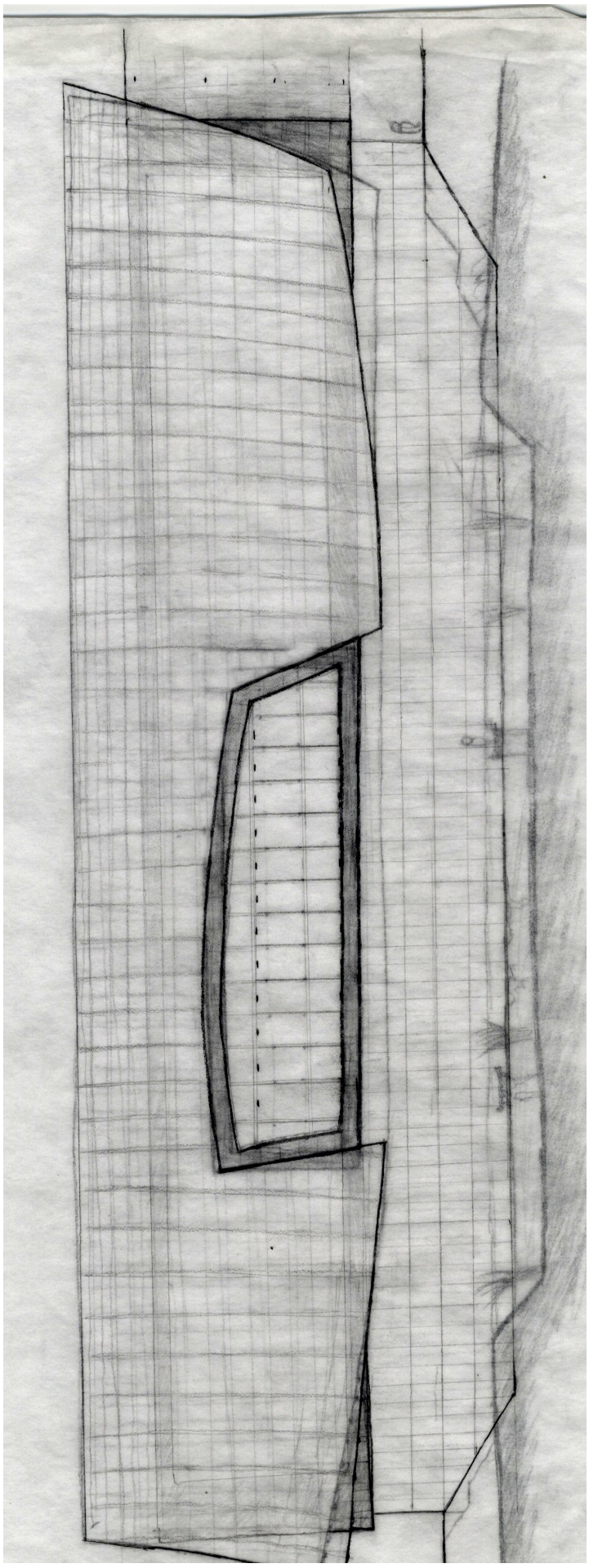
Facade Studies



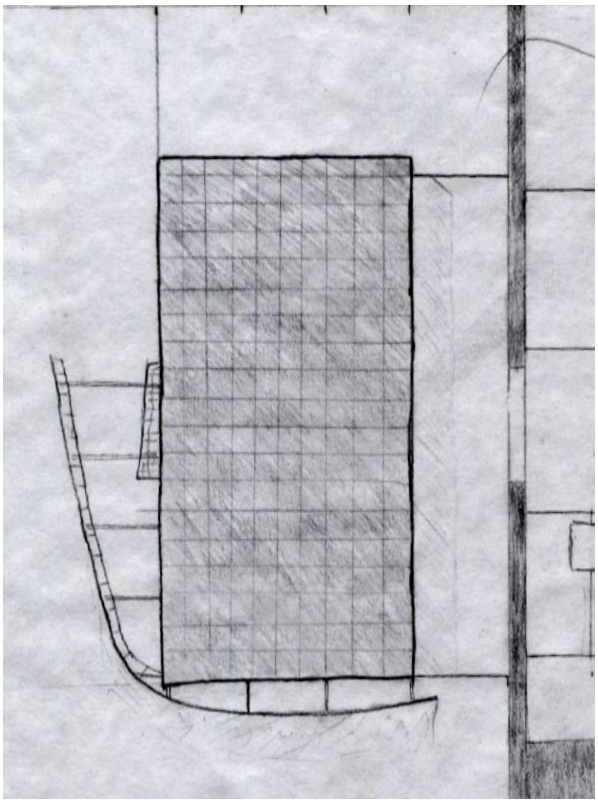


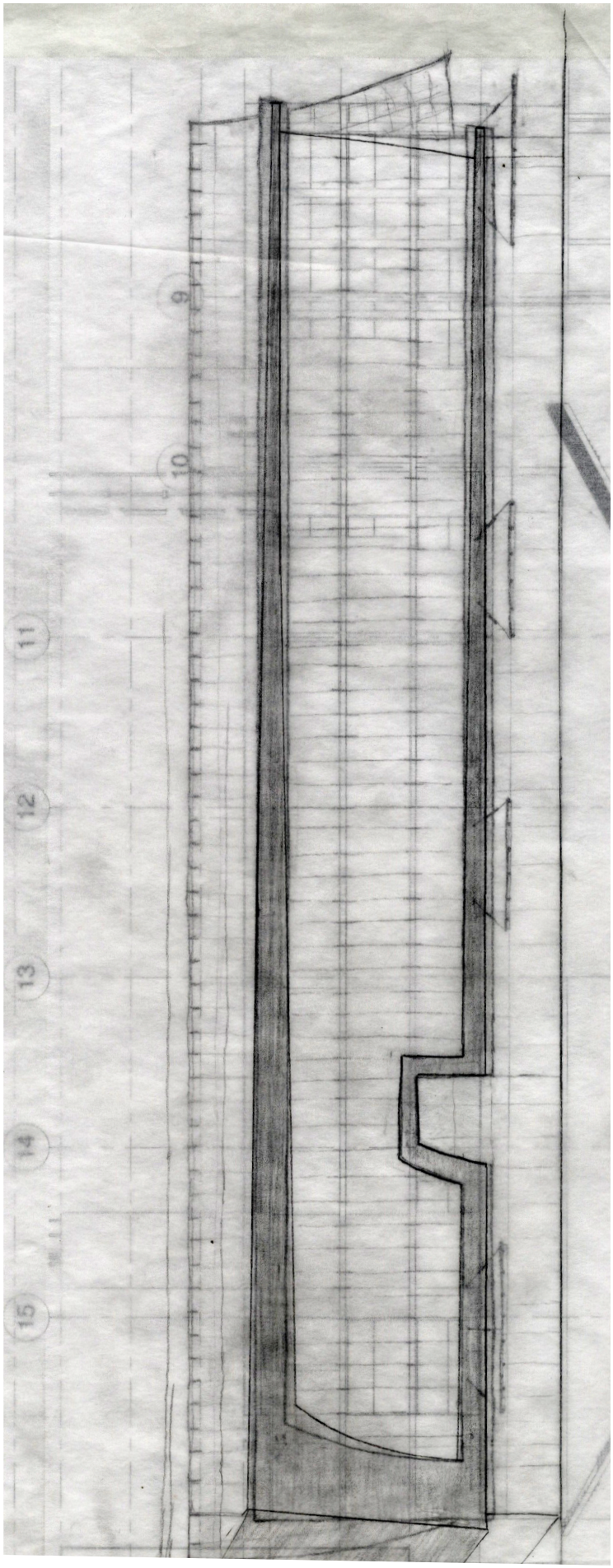
Facade Studies





Facade Studies





The Closed-loop Community

The closed-loop community was at the heart and was the focus of my investigations. After the written thesis was completed I set out to apply what I had learned in the case studies to my design project. The parameters of the community was to move away from a group of businesses and entities that consumed their resource in a linear fashion and towards a community that was able to reuse and absorbs some of its waste products. The goal was not to create a community that was completely independent. The community still relies on the greater city for resource. So the goal was to create a community that operated in between a closed-loop and a linear consumption pattern.

The design of the exchange connections came from several places. The connection were divided in to three catagories: materials, water, and energy. The material connections were primary inspired by the cases studies; by pulling ideas from them, combining and modifying them. The material flows connection was the first to be developed, and was also used to derive a large majority of the program for the building and the master plan. The water connection were inspired by my visit to the Living Machine at the Adam Joseph Lewis Center at Oberlin College. Visiting this project help me to learn about this water treatment process. After this visit I begun research on larger scale system to treat the water for the entire building and apart of the master plan. The energy connection was first designed to be a hybrid system of AC and DC electricity in order to make the building more energy efficient. Because large amounts of energy is lost when stepping DC power to AC for the grid and back for DC appliances, a hybrid systems was created to help the building use electricity more efficiently.

The material, water, and energy flows were a main component of the project that was overlaid over both the building and the master plan. While designing the systems of exchange I was able to make connections to component and what they could exchange. Although I figure what could be exchange, I could only calculate the quantity of what was being exchanged for some of the components. Quantifying all of the exchanges completely was sometimes out of my realm, but some of the more simpler exchanges were quantified in order to show how the system would work.

Material, water, and energy exchange

Material Exchange

Water Exchange

Energy Exchange

Program or building components

Produced items

Explanation

Detailed Note

Restaurant

7.) An average restaurant produces approximately 115lb of food waste per day.

Compost

Coffee House

7.) 16 cups of spent coffee grain per day

Spent Grain

Organic Grocery Store

Mushrooms

Baked Goods

Produced food

Resident's Gardens

For fertilizer.

Wormary

8.) 10,950sf has the ability to produce approximately 166 heads of lettuce per day or any other chosen crop.

Hydroponic Farming

Organic waste from fish production and farming.

Biomass

Water from fish tank fertilizes plants,while plants clean the water.

Biomass

8.) An average of 99.7 4-ounce fish fillets/day.

Fish Farm

Photovoltaic Cells

Anaerobic Generator

7.) Total food waste for residents is approximately 82lb of food waste per day.

3.) 81,667kWh/yr

Water to replace what the plants and fish consume in their production.

Building Battery

Methane

Gray water used for: washing clothes, and dishes. (Water won't be used for drinking because of extensive permitting, although it is still safe to drink.)

Residential Units & Building Visitors

Micro Turbine

Extra treated water that is not being utilized.

DC Electricity

Hot Water

Resident's Gardens

For irrigation

DC power will be used for USB outlets and all lights in the building.

Hot water is repurposed as it cools down in a cascading fashion, from very hot, to hot, to warm.

Stormwater

6.) The wetland can meet 137% - 274% of the building's waste water treatment needs depending on the time of year.

5.) Total building waste water = 12,375gpd

Storm water from the surrounding site is channeled to the estuary and reduces stress on existing storm water infrastructure.

Treated Water

The treated water exiting the wetland is clean enough to drink.

Constructed Wetlands

AC Electricity

2.) 153 units or households will be able to depend on electricity from the micro turbine.

Estuary/ Bio-corridor

1.) 176 units are able to be heated on a 0 degree day.

Black Water

Grid electricity

Warm water is only used to heat the existing water in the tank.

Water from toilets, dish washers, sinks, showers, washing machines, ext.

Storm water pollutants are filtered out of the water through the bio-corridor before it researchs the river.

Cuyahoga River

Detail explanation

1. **Heat/Hot Water:**
    - 200kw micro turbine (Capstone Turbine, Model: C200 HP)
        - Net heat rate for turbine = 10,300 btu/kWh,
        - So 200kW x 10,300 btu/kWh = 2,060,000btus/hr.
    - Btus needed for one unit 1200sf)
        - BTU load for 0 degrees Fahrenheit (an increase of 75 degrees) is 11,900 BTU/hr.
        - So 2,060,000 btus/hr from micro turbine / 11,900 btus/hr for one unit = 173 units
        - **176 units are able to be heated on a 0 degree day.**
    - Notes
        - This does account for heat loss during the time and distance that the hot water must travel from the micro turbine to the units.
        - The number 176 units is for the 0 degree day, so the hot water already being produced will be able to heat more than 176 units on warmer days.
    - Sources:
        - BTUs per house hold*: Calculator.net http://www.calculator.net/btu-calculator.html?roomwidth=30&roomwidthunit=feet&roomlength=30&roomlengthunit=feet&ceilingheight=10&ceilingheightunit=feet&insulation=normal&temperature=75&temperatureunit=f&calctype=heat&x=72&y=8*
        - Micro Turbine: *http://www.capstoneturbine.com/_docs/Product%20Catalog_ENGLISH_LR.pdf*
        - Btu calculator: *http://www.hearth.com/calc/btucalc.html*
2. **AC Electric:**
    - 200kw micro turbine (Capstone Turbine, Model: C200 HP)
        - 200kw/hr at 33% efficiency [Does this mean 33% of 200 is all the electrictity???].
        - Ohio's average house hold electric = 931kWh
        - 931 / (30d x 24h) = 1.3kWh average. (peak could be as much as 4kWh and on the low end as 0.2kWh)
        - So 200kWh from the turbine / 1.3kWh average for a unit = 153 units or households.
        - **153 units or households will be able to depend on electricity from the micro turbine for 75 degrees of heat.**
    - Notes:
        - The electric usage for the units will likely be much less because: 1. they are apartments and the 931 is an Ohio average including houses and apartments; 2. the load of the heating and lighting for the units is already accounting for (in atrium light, PV cell for other light, and hot water from the micro turbine.).
    - Sources:
        - Micro Turbine: *http://www.capstoneturbine.com/_docs/Product%20Catalog_ENGLISH_LR.pdf*
        - Average Ohio house hold electric use: *EIA spread sheet.*
        - Peak hours estimation: *Tony Ferraro.*
3. **DC Electric:**
    - PV cell:
        - Power produced: 3,266.7kWh / year, for 20 panels at 115W per panel,
        - Space required approximately 25' x 36' = 900sf,
    - Space available for PVs:

- Factory rooftop (the building across from mine): (38,100sf total) – (40% for stacks, walking room, HVAC units and skylights) = (22,860sf of available space for PV cells)
- My building's roof top = 2500sf

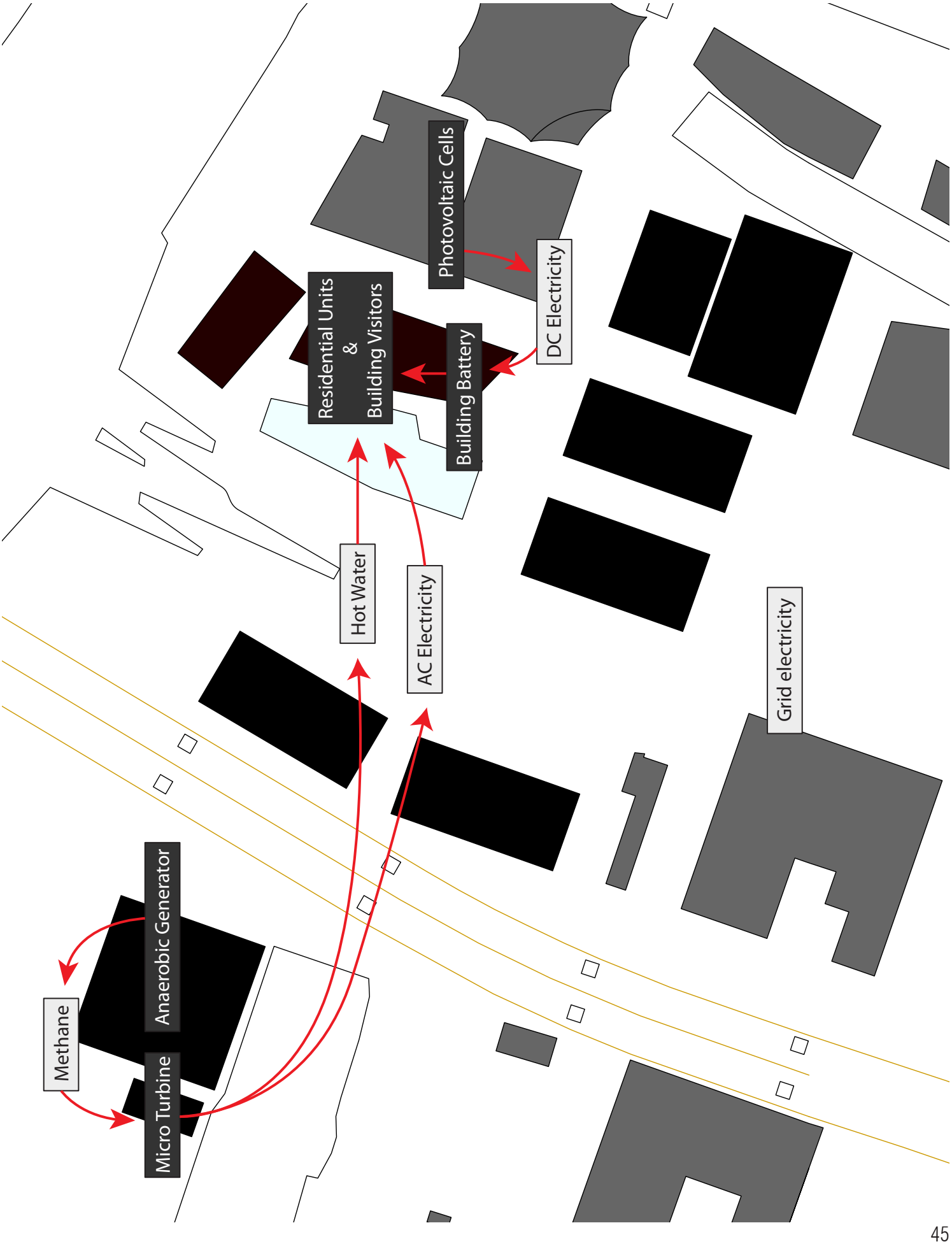
- DC power produced by the site:
  - (22,860sf roof + 2500sf roof) / (900sf panel) = (25 panels).
  - (25 paneled units) x (3,266kWh/yr) = **(81,667kWh/yr)**.
  - (81,667kWh/yr / [365d x 24h]) = (average of 9kWh for factory roof top.)
- Building Battery: Will store the electric during the day and will distribute power to the lights and USB outlets: Units will have outlets with standard AC plugs and USB plugs, in order to receive direct DC power.
- Sources:
  - PV panel performance: *http://teams.eas.muohio.edu/solarpower/data.html*

4. **Natural Gas:**
   - How much natural gas does the C200 HP Micro Turbine need? How much natural gas does the wetland and biomass produce?
5. **Waste Water**
   - Program's waste water:
     - Residents: (75 household) X (unit use 100gpd) = (residents use 7500gpd).
     - Restaurant: 4000sf = 125seats. 1seat = 35gpd. (125seats) x (35gpd) = (4375gpd)
     - Coffee House = 500gpd
   - Total building waste water = **12,375gpd**
   - Notes:
     - The Coffee House's waste water was estimated
     - Does not include the waste water produced by the rentable retail space.
   - Sources:
     - Residential: my water experiment, see thesis paper.
     - Restaurant: Water consumption worksheet, http://infohouse.p2ric.org/ref/42/41980.pdf.
6. **Treated Water** (Constructed wetlands cleaning process):
   - NSI Constructed Wetland
     - 0.5 - 1sf = 1g of treated water per day (depending on the time of year and the temperature).
     - 17,000sf wetland = 17,000-34,000gpd.
     - The building will produce 12,375 gallons of waste water per day.
     - **The wetland can meet 137% - 274% of the building's waste water treatment needs depending on the time of year.**
   - Sources:
     - Natural Systems International: constructed wetlands: http://www.natsys-inc.com/resources/about-constructed-wetlands/.
7. **Material Waste**
   - Coffee house waste:
     - Average of 230 cups per day grosses $250,000 annually.
     - 100 cup coffee maker will use 6-8 cups of coffee gain.
     - The average of a 1200sf coffee house will gross $200,000-$375,000 annually.
     - So 1200sf could average (230 cups of coffee = **16 cups of spent coffee grain per day**)
   - Restaurant food waste:
     - Source 1: 42,000lb per year or
     - **An average restaurant produces approximately 115lb of food waste per day.**

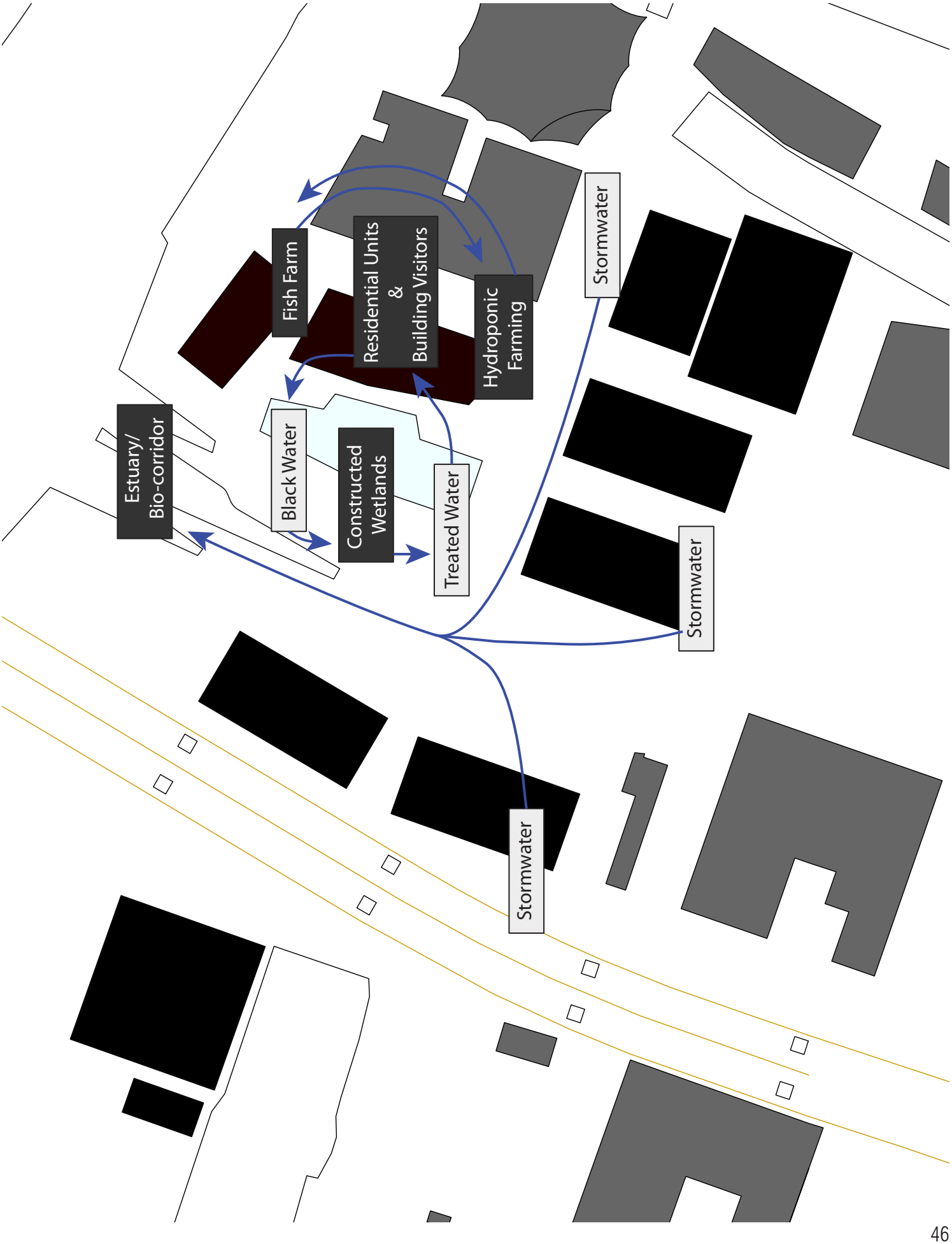
- Residential food waste:
  - Source 1: 197 pound per person annually
  - Source 2: 33lb per family per month. (33lb) X (12mo) = 396lb per family annually
  - (Average of 200lb per person per year) X (150 people) = (30,000lb of food waste annually).
  - (30,000lb) / (365days) = **(82lb per day)**
  - **Total food waste for residents is approximately 82lb of food waste per day.**
- **Total compostable material waste = 197lb of food waste and 16 cup of coffee gain.**
- Sources:
  - coffee house size: http://www.freshcup.com/featured-article.php?id=84.
  - Coffee grain per cup: http://answers.yahoo.com/question/index?qid=20071212154011AANMjFj.
  - Residential food waste 1: http://www.alternet.org/story/152429/americans_waste_enough_food_to_fill_a_90,000-seat_football_stadium_every_day_--_what_can_we_do_about_it
  - Residential food waste 2: http://www.csmonitor.com/The-Culture/Food/2012/0827/How-much-food-does-one-family-waste
  - Restaurant food waste: http://www.prewaste.eu/news-and-events/item/464-restaurants-produce-five-times-more-food-waste-than-uk-households.html

8. **Food Produced:**
   - Fish farm:
     - Fish tank: 1300sf of 4ft high tank = 5200cuft of tank space.
     - 1 cubic foot of water = about 7 gallons. 5200cuft X 7g=36,400g.
     - One fish needs 4 gallon of space
     - 36,400g/4g per fish=9,100fish.
     - 9,100 fish = 18,200 4-ounce fillets or 36,400 per year with 6 month grow time.
     - 36,400/365 = **An average of 99.7 4-ounce fish fillets/day.**
   - Hydroponic farm:
     - 1g of fish tank water is able to water and fertilize 1sf of garden space.
     - 36,400g=36,400sf of available garden space that can be fertilized by the fish.
     - the tank to garden square footage radio is about 1:25
     - The building has 10,950 of roof space dedicated to hydroponics farming.
     - *"10,800 square foot (930m) Portable Farms Aquaponics System, provides 60,000 heads of lettuce per year or other vegetables, (5,000 heads per month or 166 heads per day) on a year round basis"*
     - **10,950sf has the ability to produce approximately 166 heads of lettuce per day or any other chosen crop.**
   - Urban Farm and Gardens
   - Mushrooms
   - Baked Goods
   - Source:
     - Portable Farms Aquaponics System: *http://organic-fish-farms.escapeartist.com/faq/*

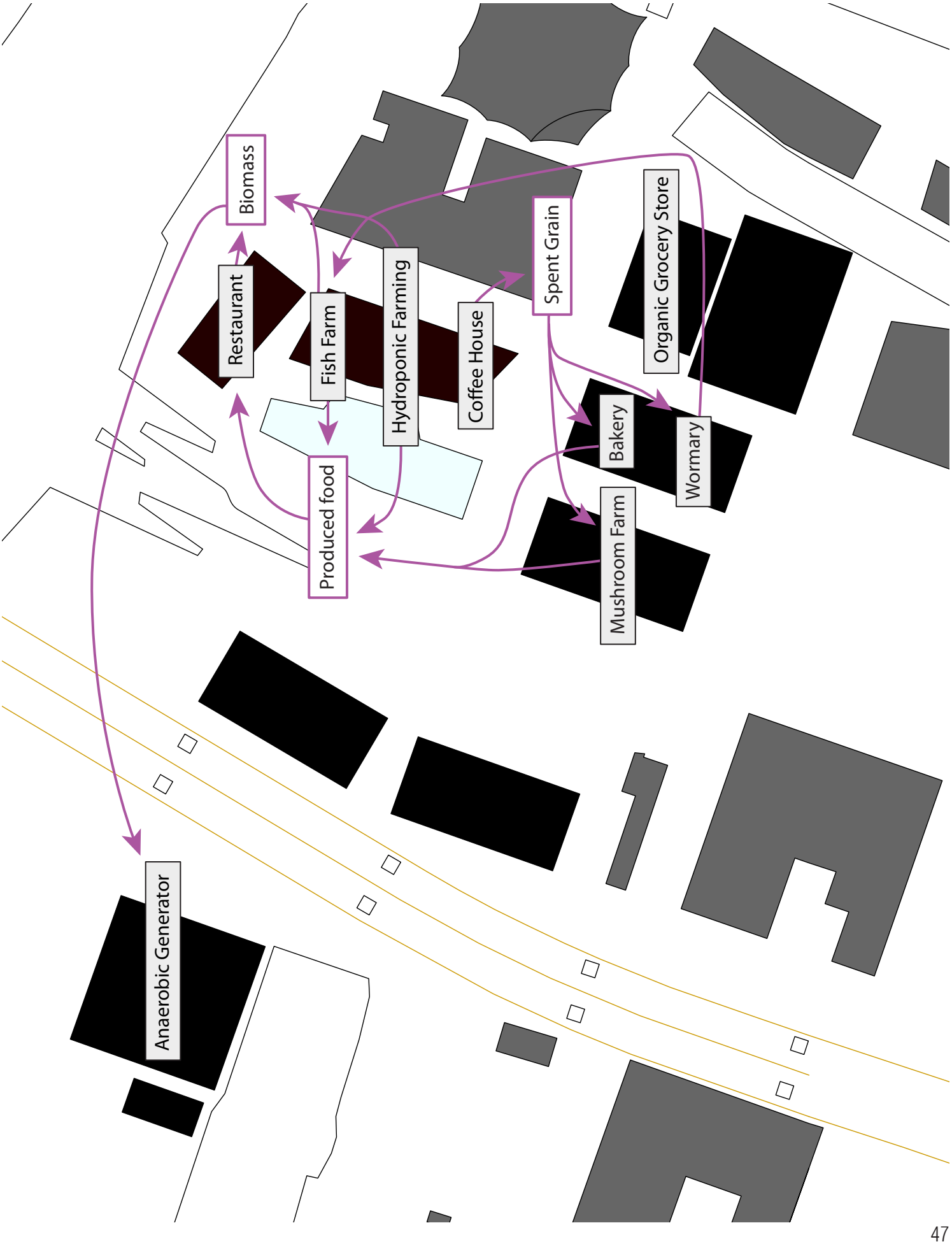
Closed-loop site map: Energy



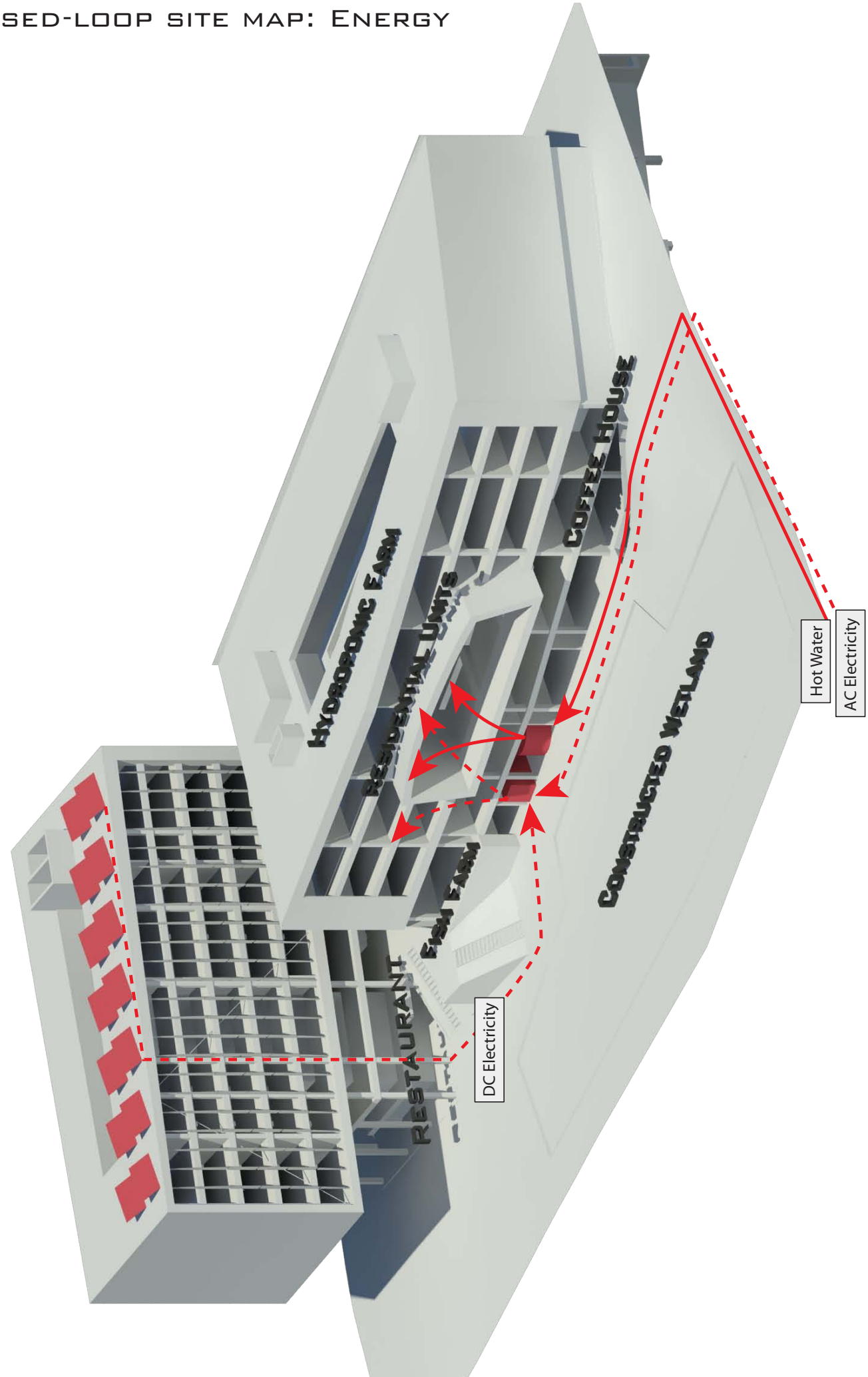
Closed-loop site map: Water



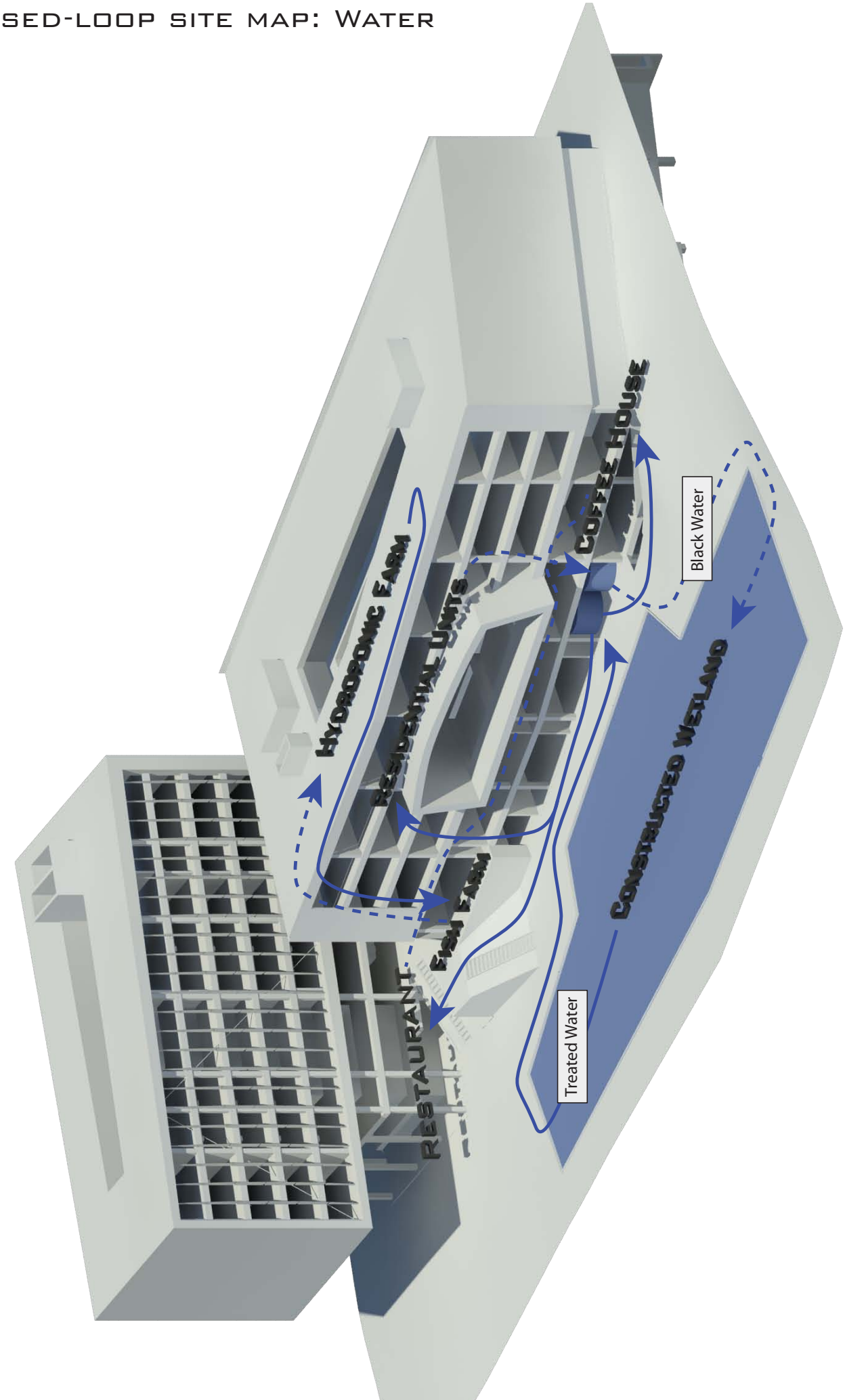
Closed-loop site map: Materials



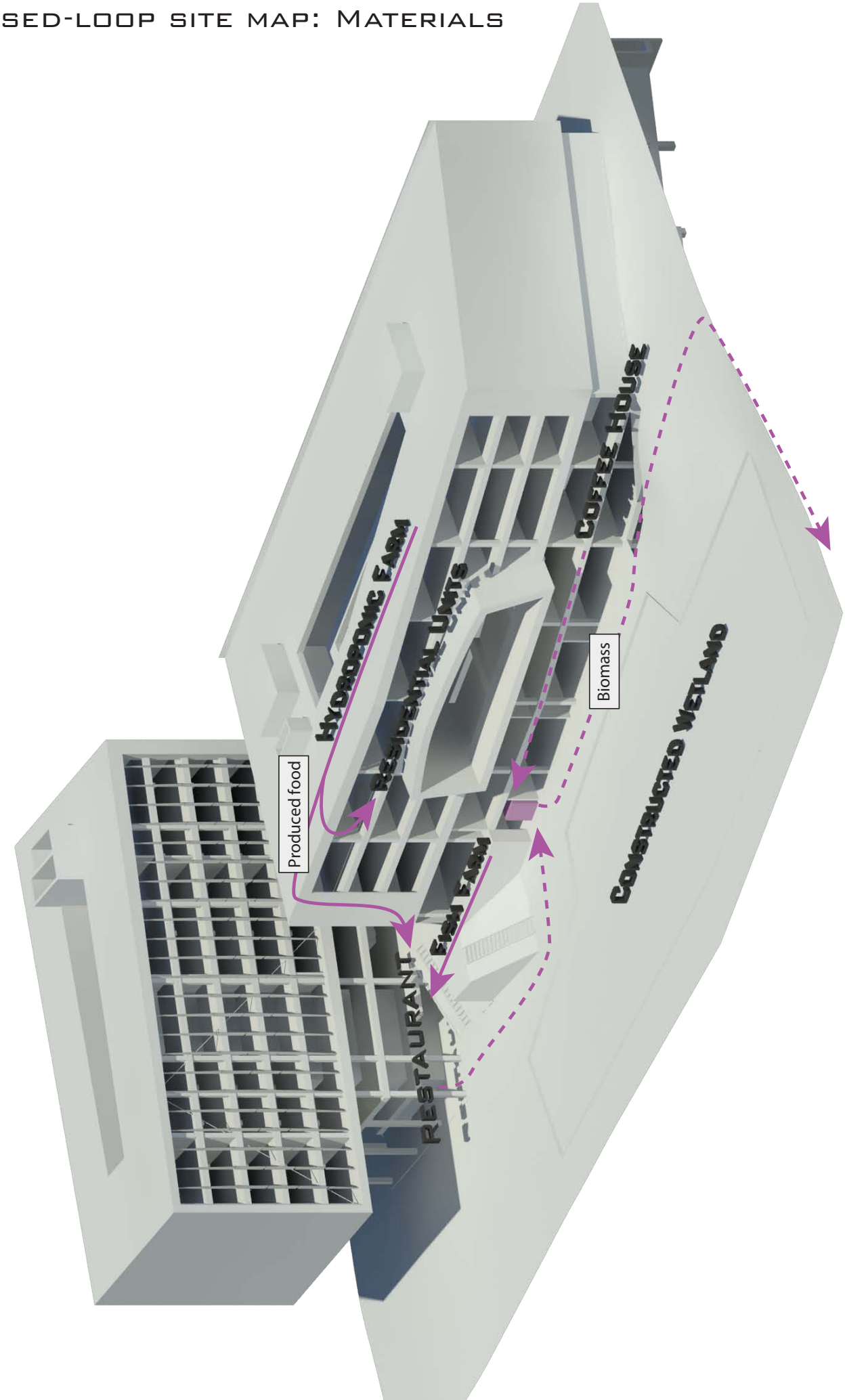
Closed-loop site map: Energy



Closed-loop site map: Water



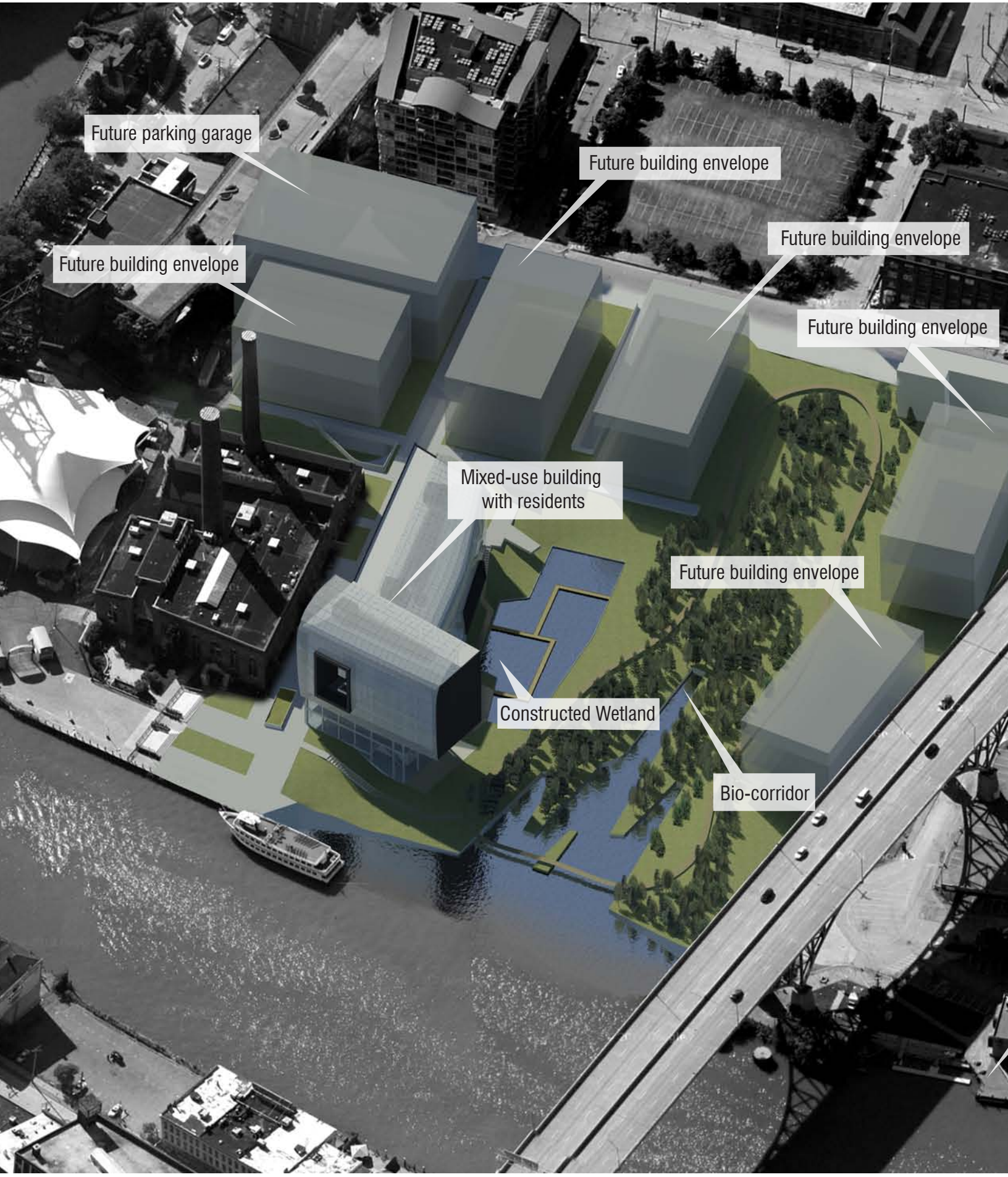
Closed-loop site map: Materials



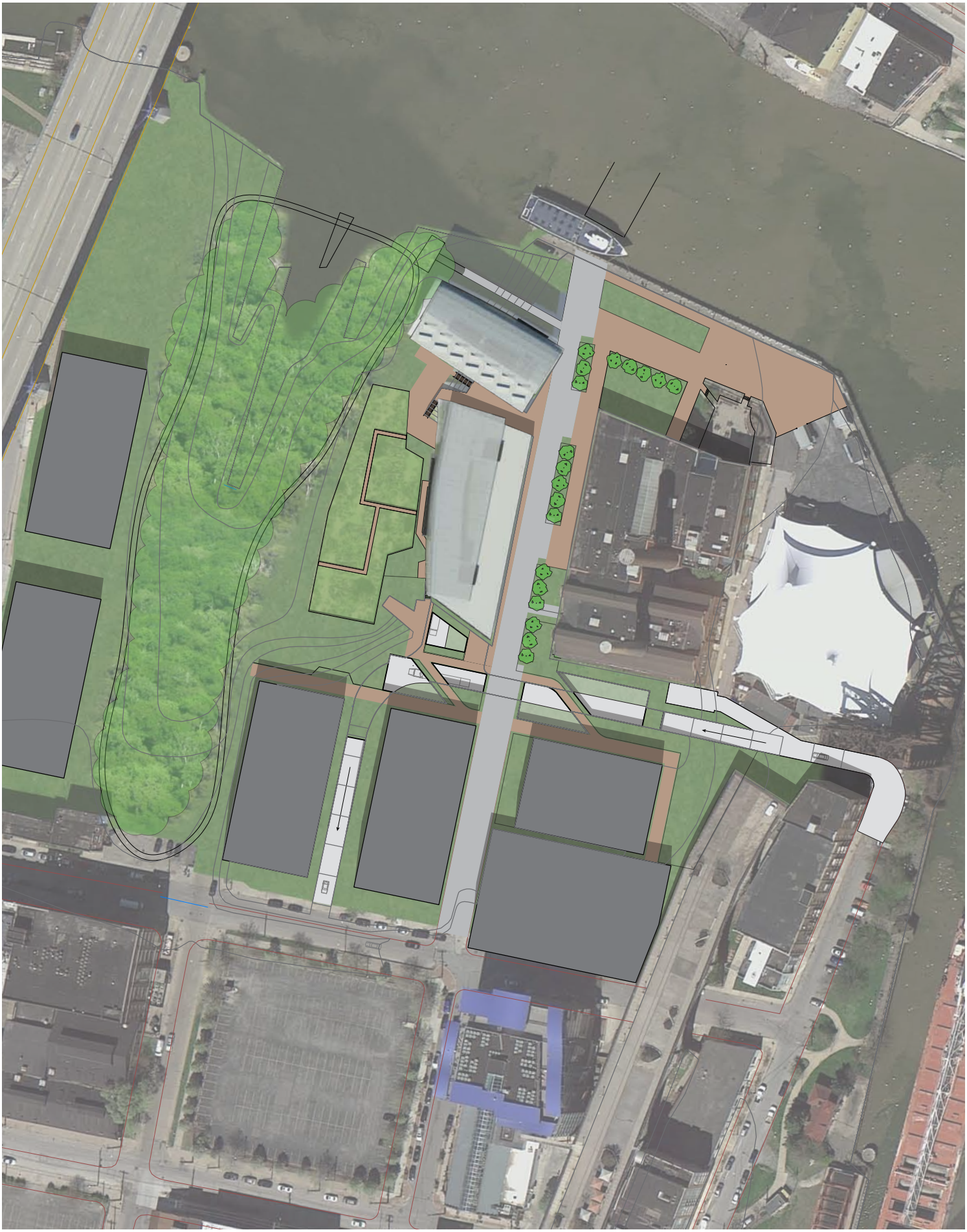
Final Thesis Work



3D Site Plan


Future parking garage
Future building envelope
Future building envelope
Future building envelope
Future building envelope
Mixed-use building with residents
Future building envelope
Constructed Wetland
Bio-corridor

Site Plan



Program

Restaurant Total: 6757sf
- Dining Room: 3288sf
- Kitchen/Support: 1443sf
- Bar Area: 1442sf
- Restroom: 584sf

Coffee House Total: 2462sf
- Seating Space: 1966sf
- Support: 496sf

Bar/Lounge:
- Seating Area: 2555sf
- Restroom: 273sf
- Support Space: 278sf

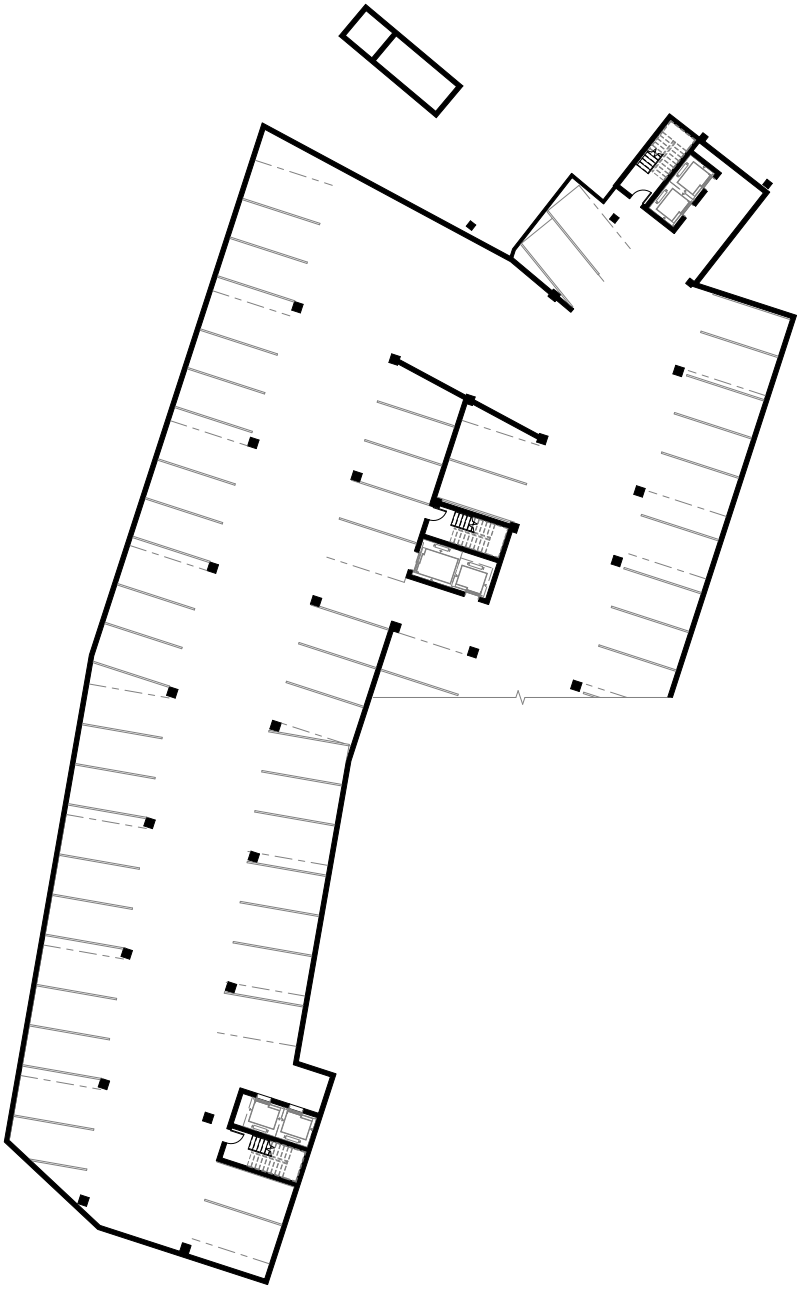
Rentable Retail Space 1: 3878sf
Rentable Retail Space 2: 2422sf
Office: 6191sf
Fish Farm: 2222sf
- Tank Size: 1127sf

Hydroponic Farm Total: 11,597sf
- Farming Space: 10,673sf
- Support: 924sf

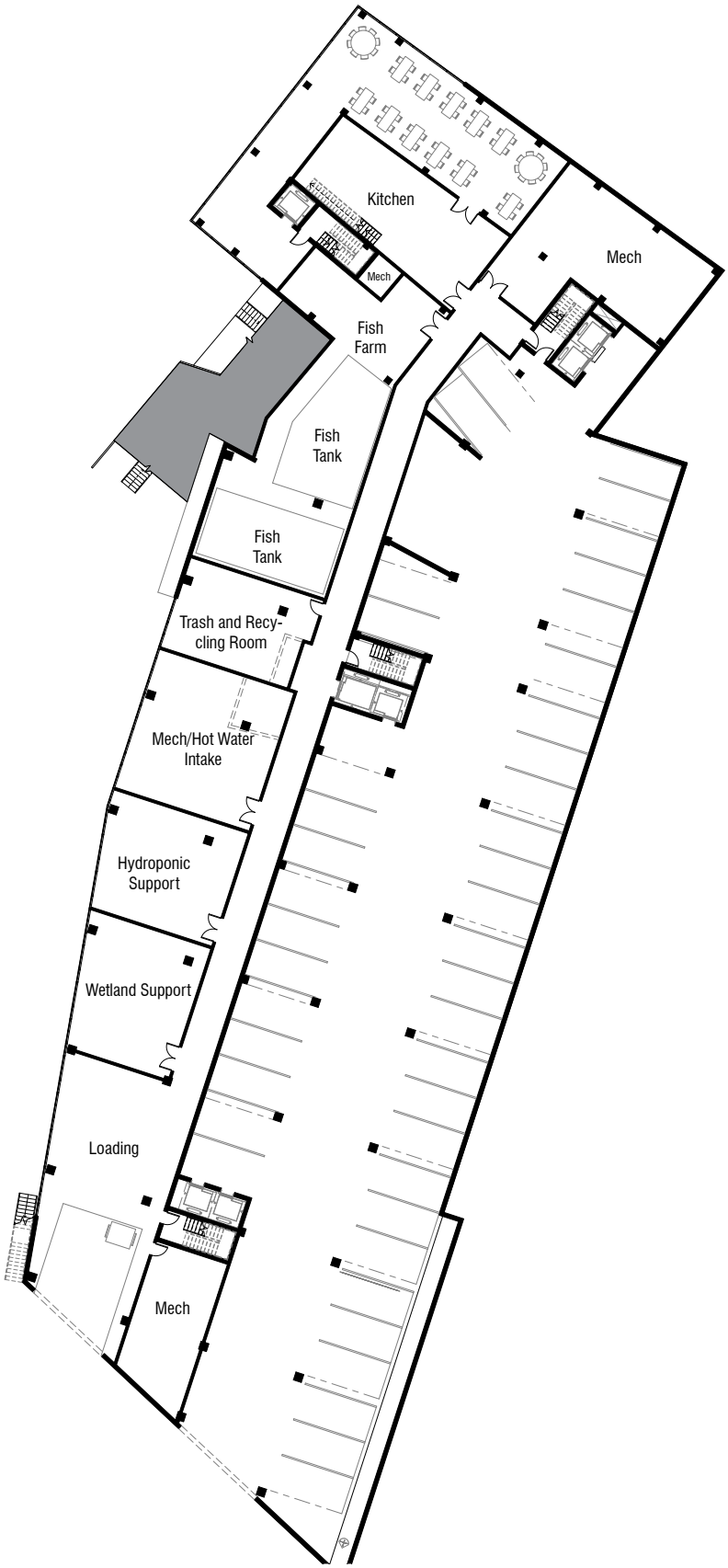
Residential: 75 units
- Studio apartments
- One bedroom apartments
- Two bedroom apartments
- Three bedroom apartments

Residential Leasing Office: 577sf
Bicycle Storage Room for Residents: 491sf
Resident's Workout Room: 779sf
Resident's Gardens: 6106sf (app. 80sf per unit.)
Wetland, NSI: Approximately: 17,468sf
Trash, recycling, and biomass collection: 739sf
PV Array
Mechanical and support space: Appx. 10%

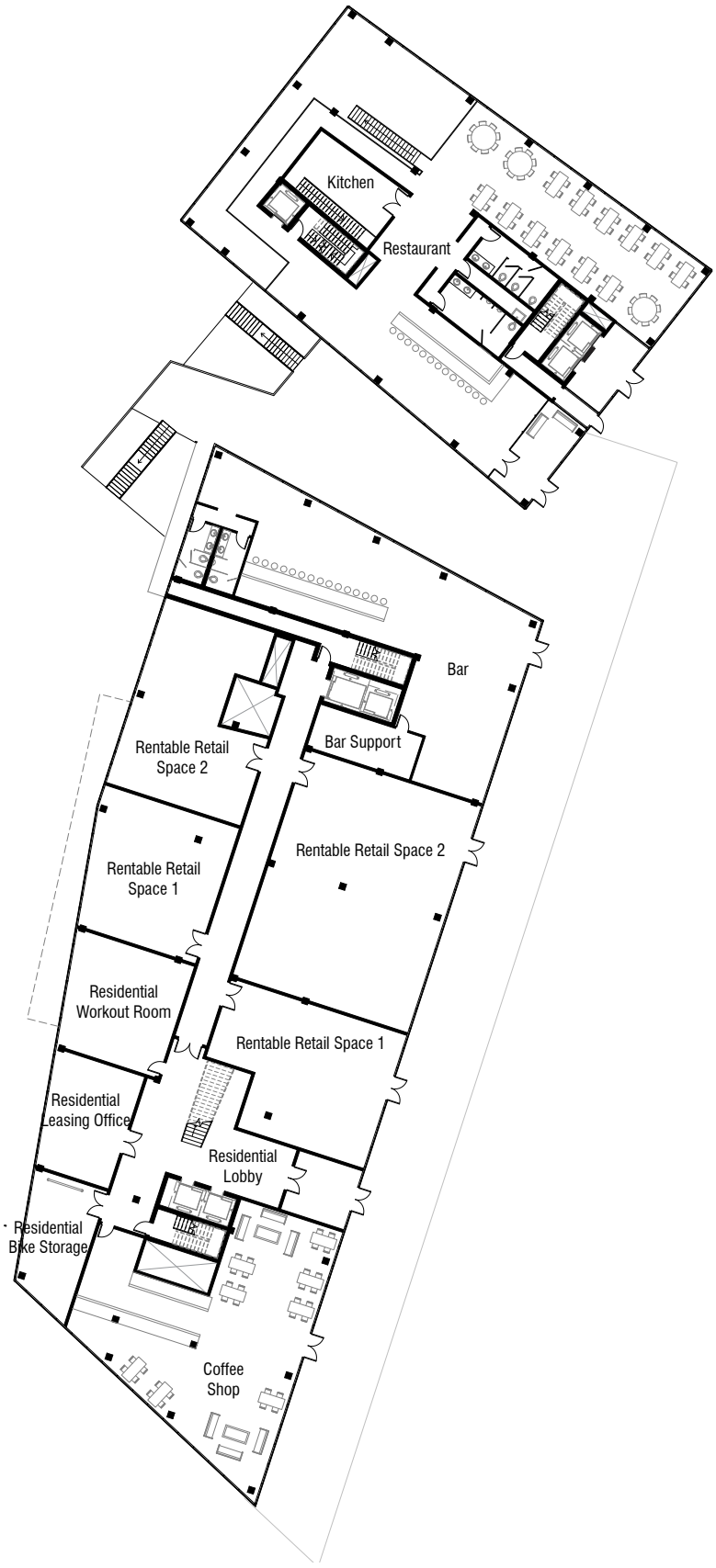
Level B2



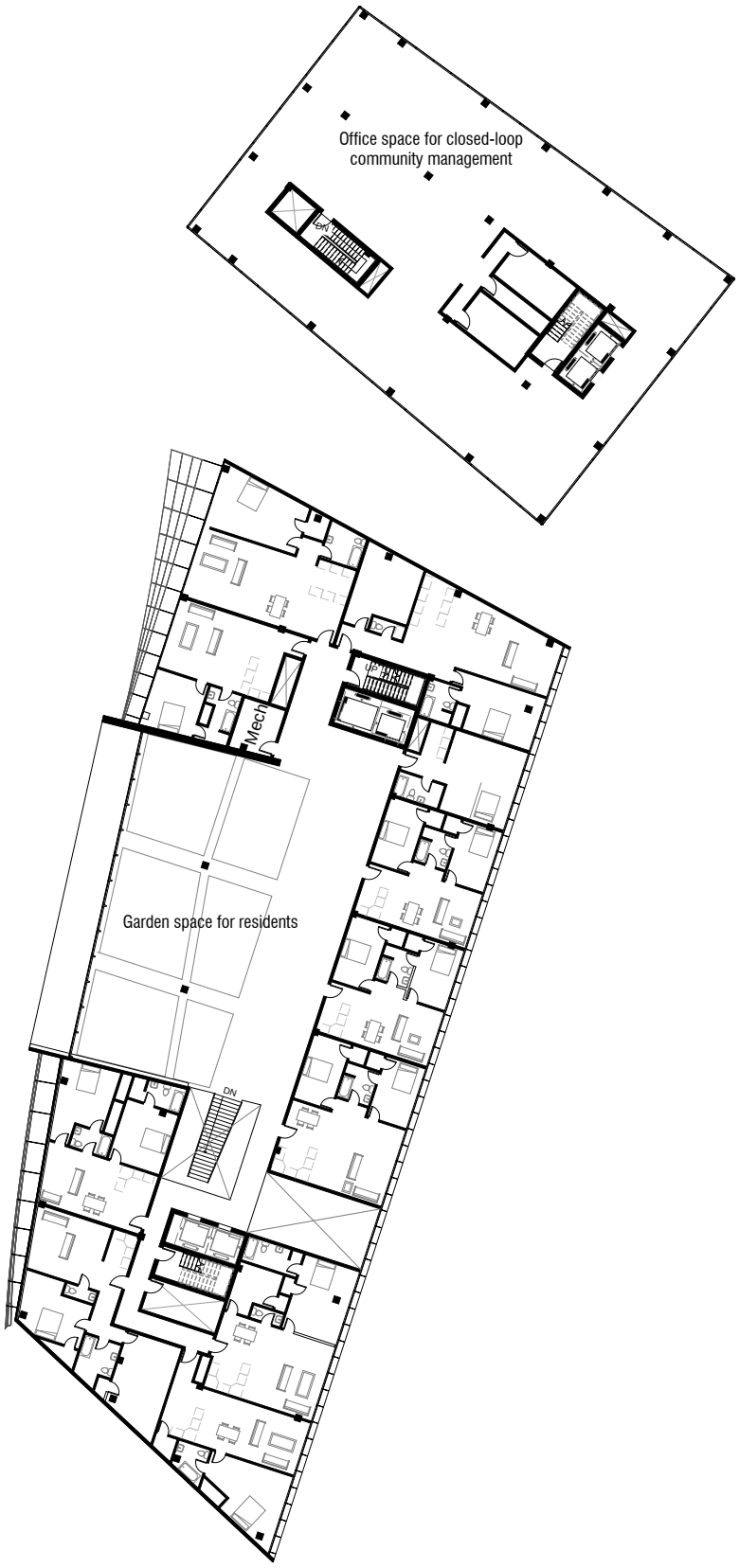
Level B1


Kitchen
Mech
Mech
Fish Farm
Fish Tank
Fish Tank
Trash and Recy-cling Room
Mech/Hot Water Intake
Hydroponic Support
Wetland Support
Loading
Mech

Level 1


Kitchen
Restaurant
Bar
Bar Support
Rentable Retail Space 2
Rentable Retail Space 1
Rentable Retail Space 2
Residential Workout Room
Rentable Retail Space 1
Residential Leasing Office
Residential Lobby
Residential Bike Storage
Coffee Shop

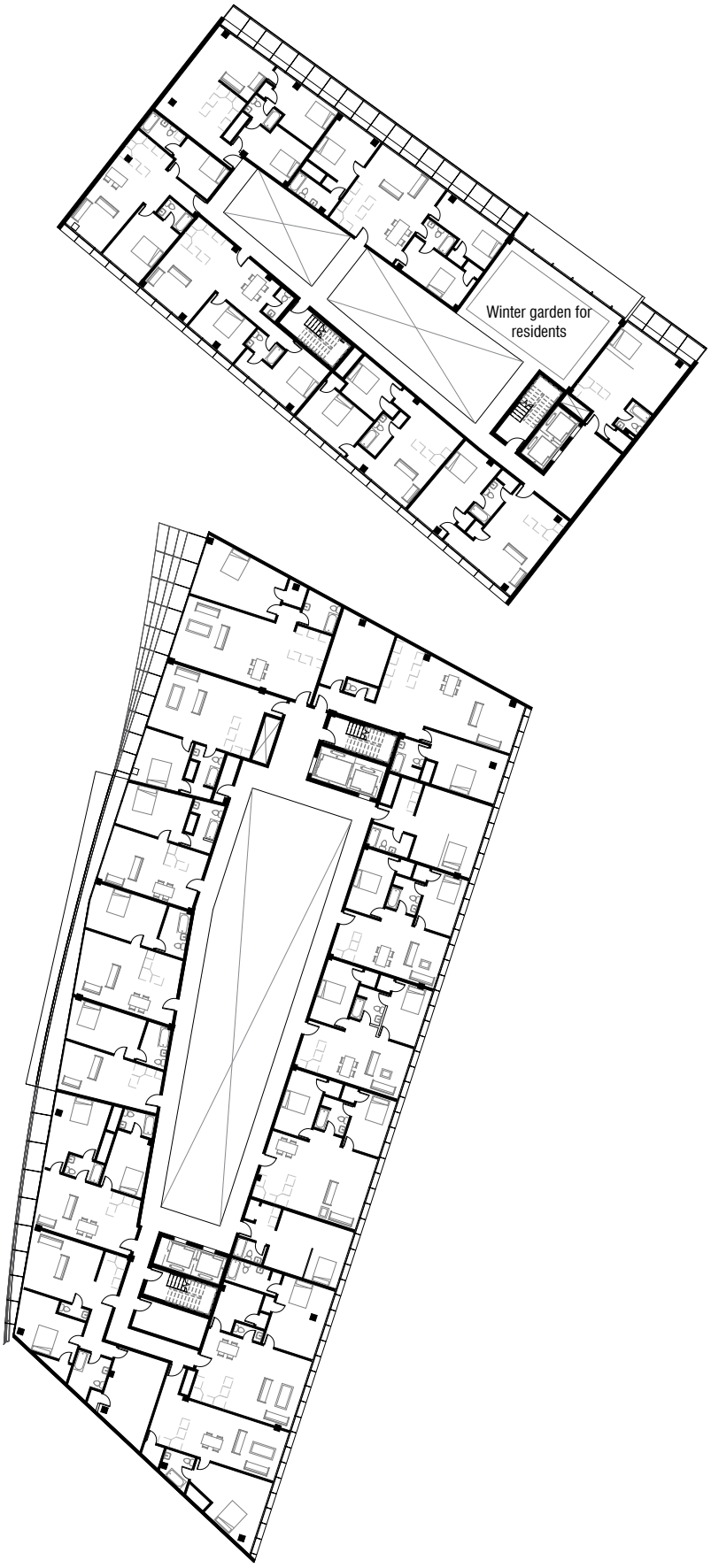
Level 2


Office space for closed-loop
community management
DN
Mech
Garden space for residents
DN

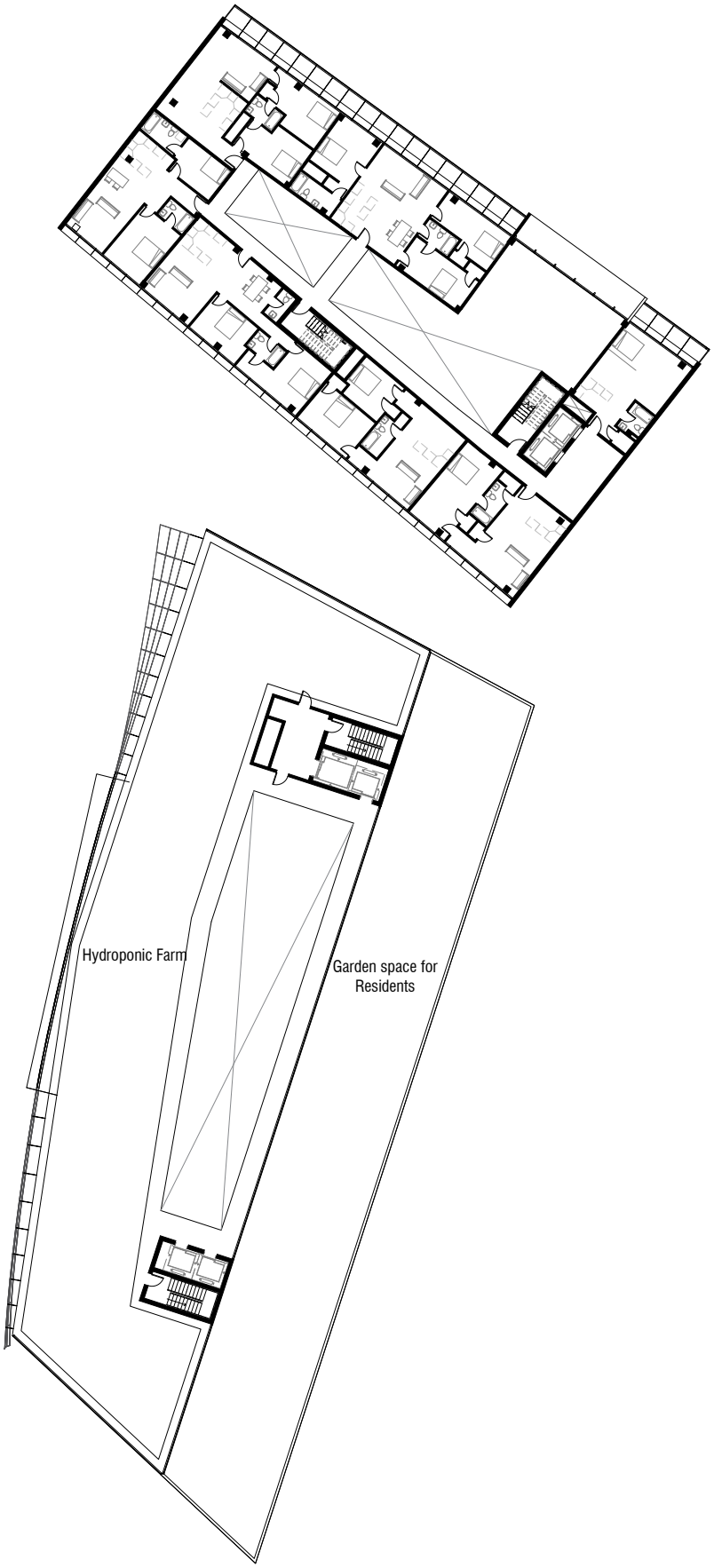
Level 3



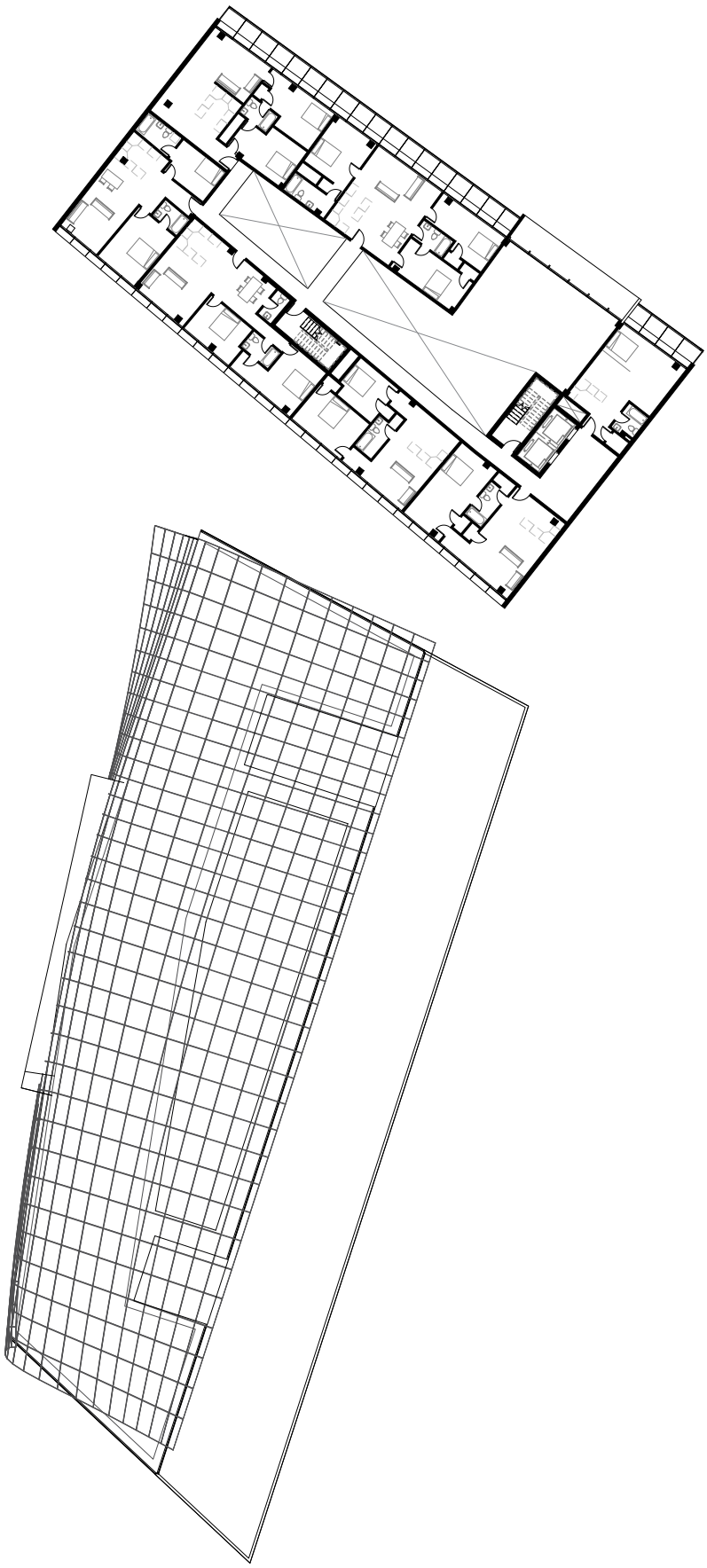
Level 4



Level 5

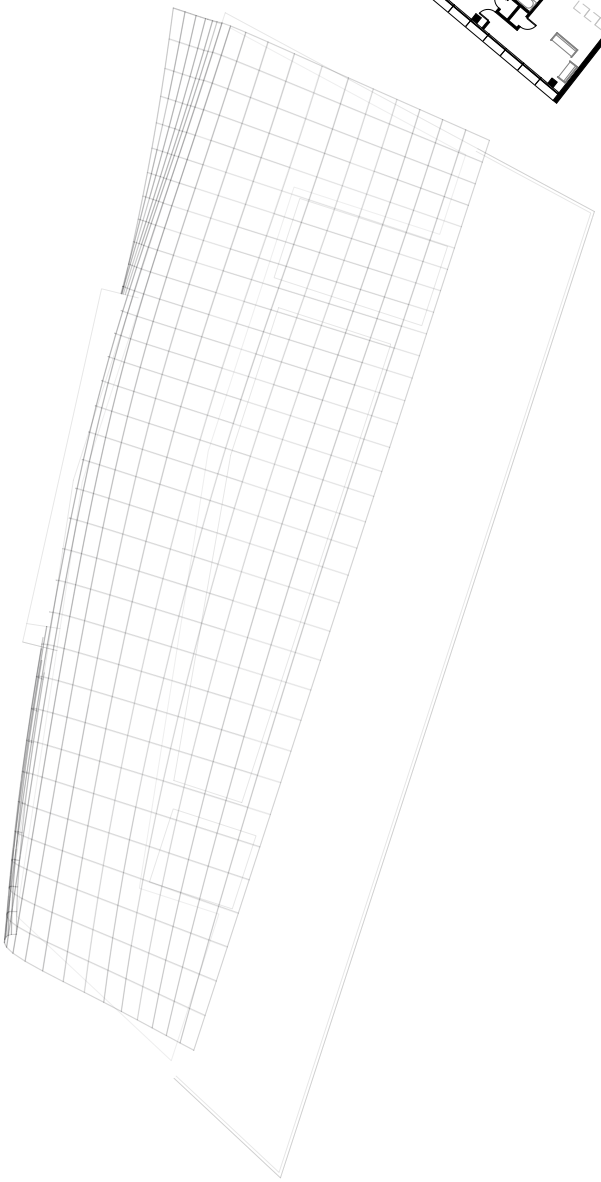


Level 6

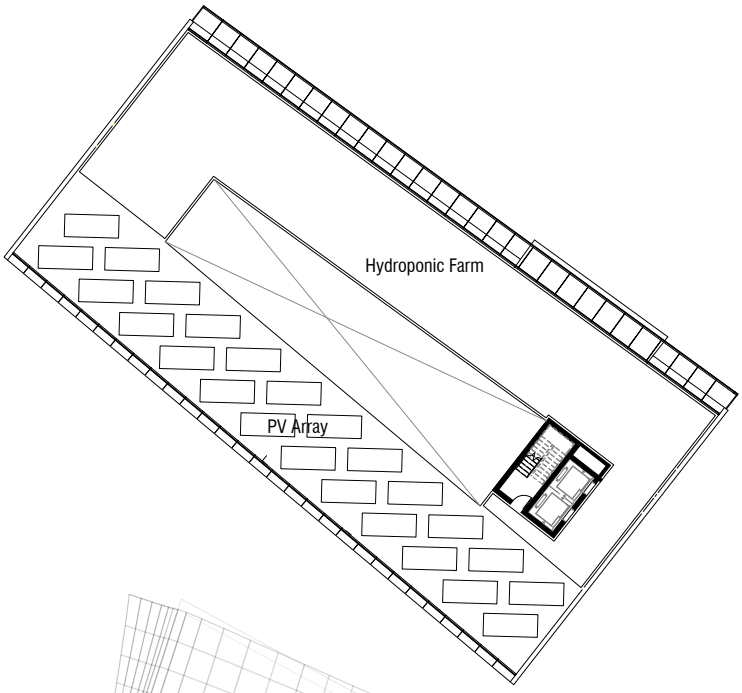


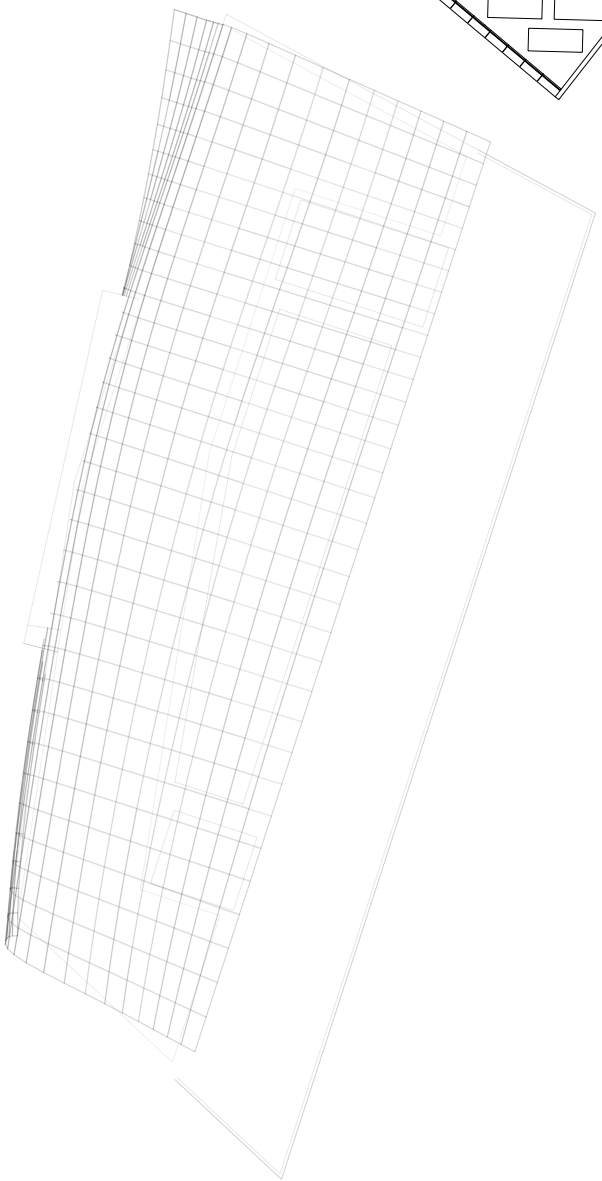
Level 7



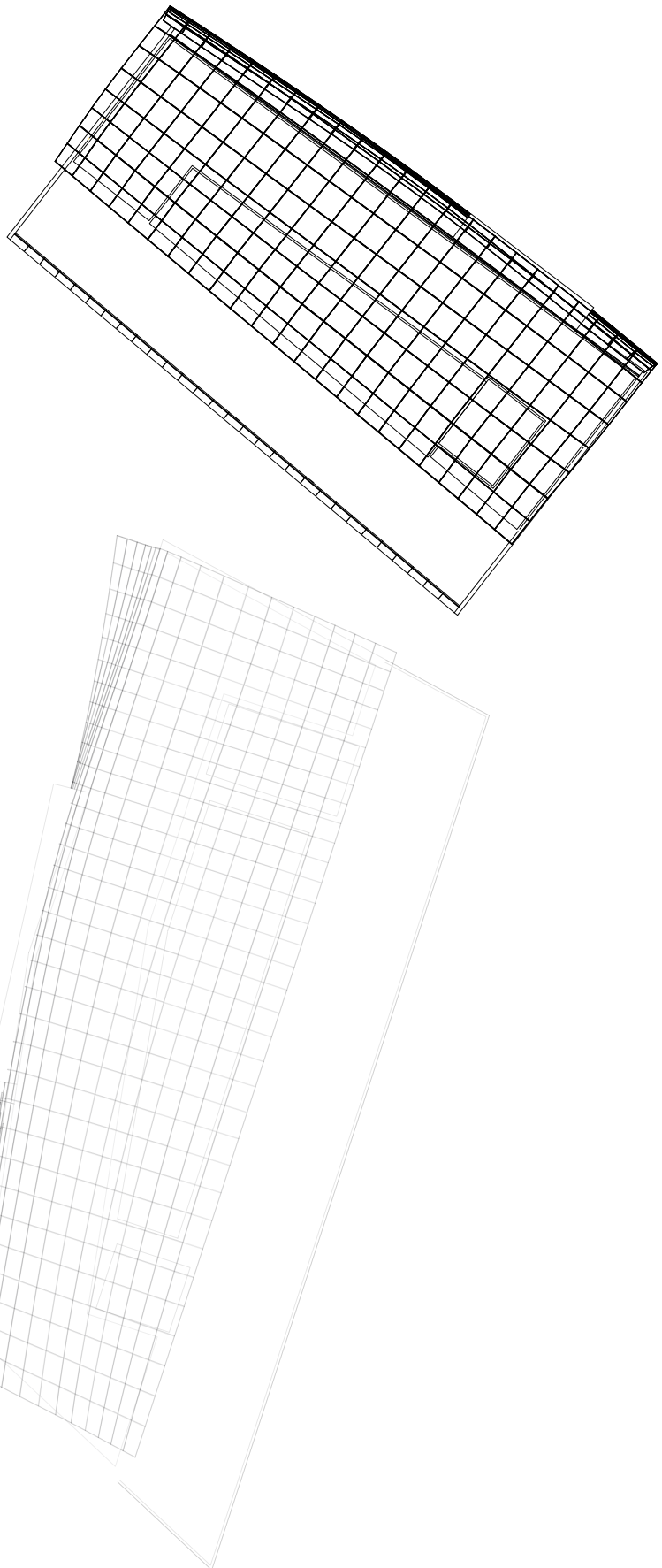


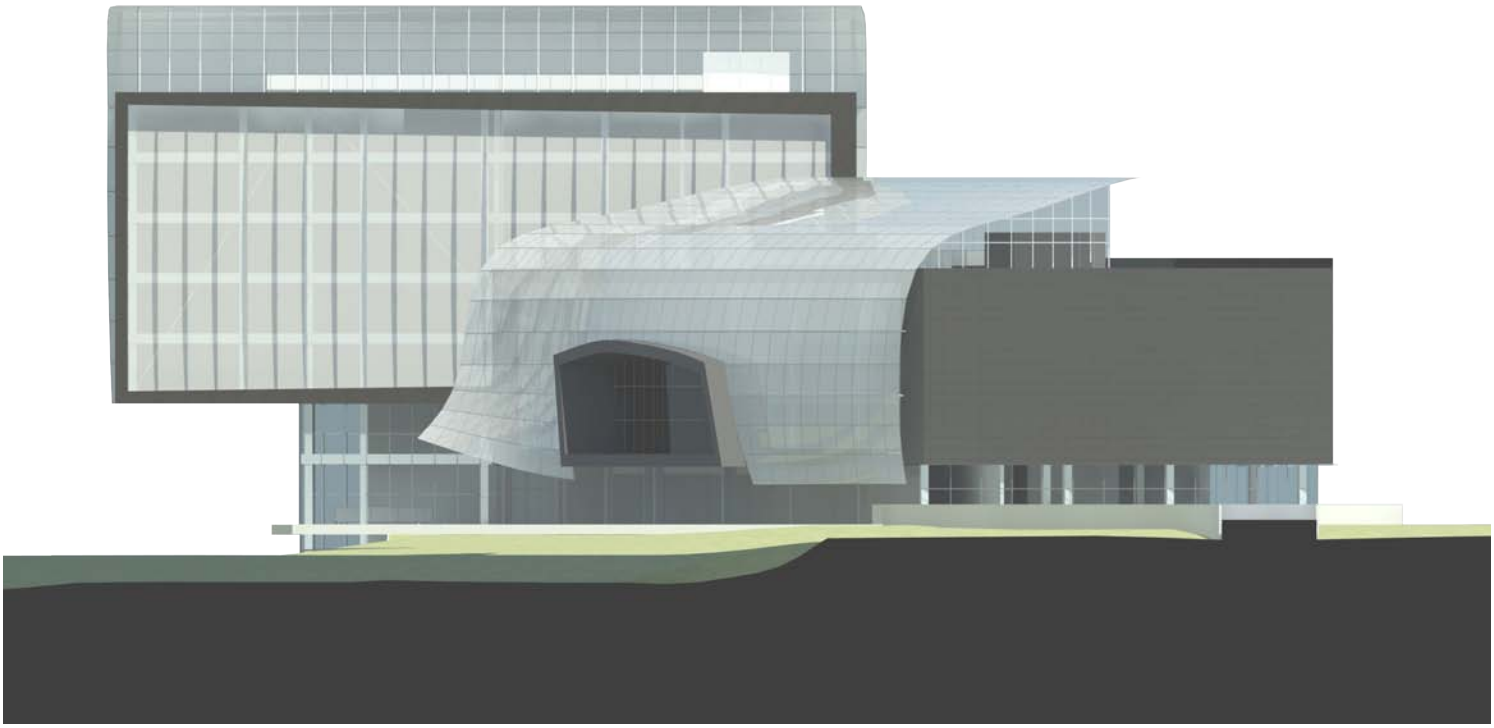
Level 8





Roof Plan

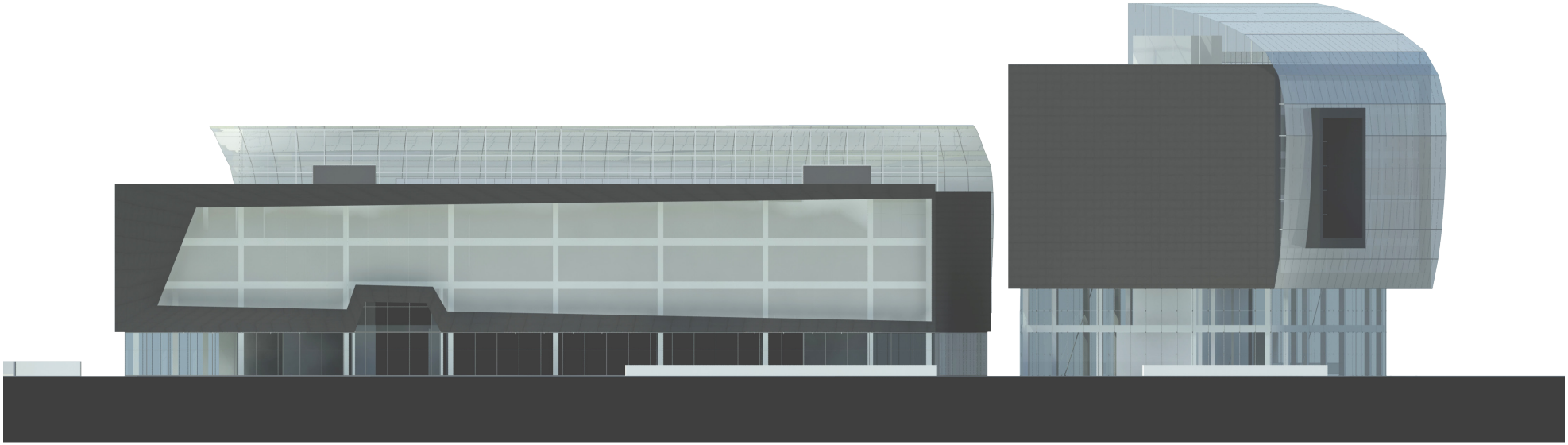




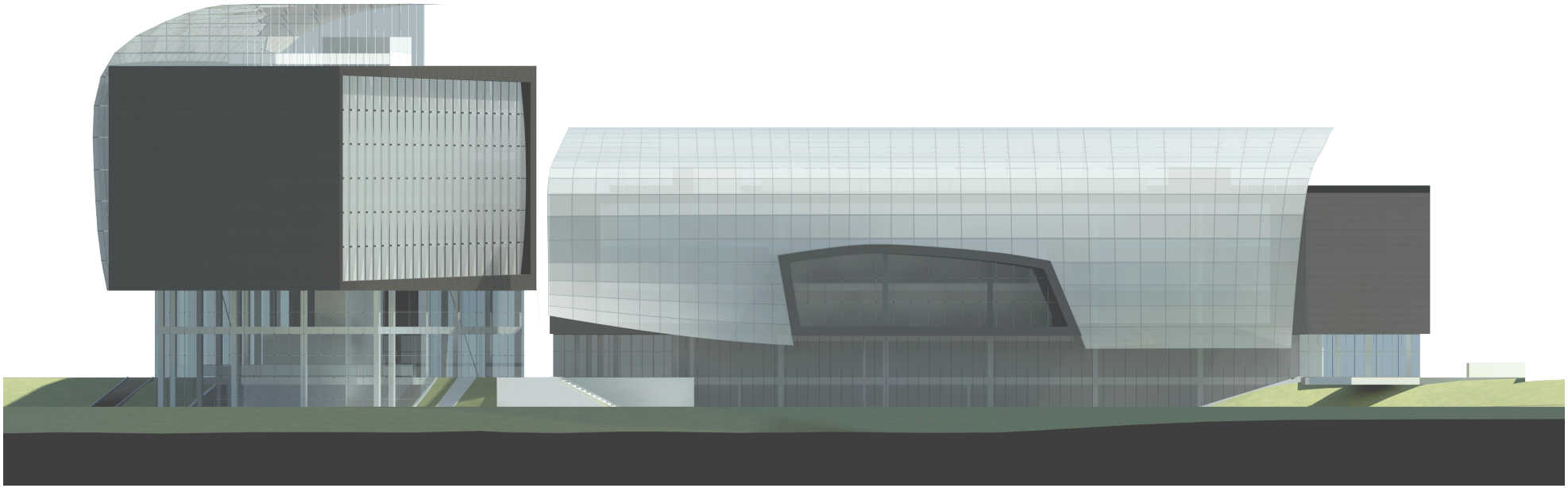
South Elevation



North Elevation

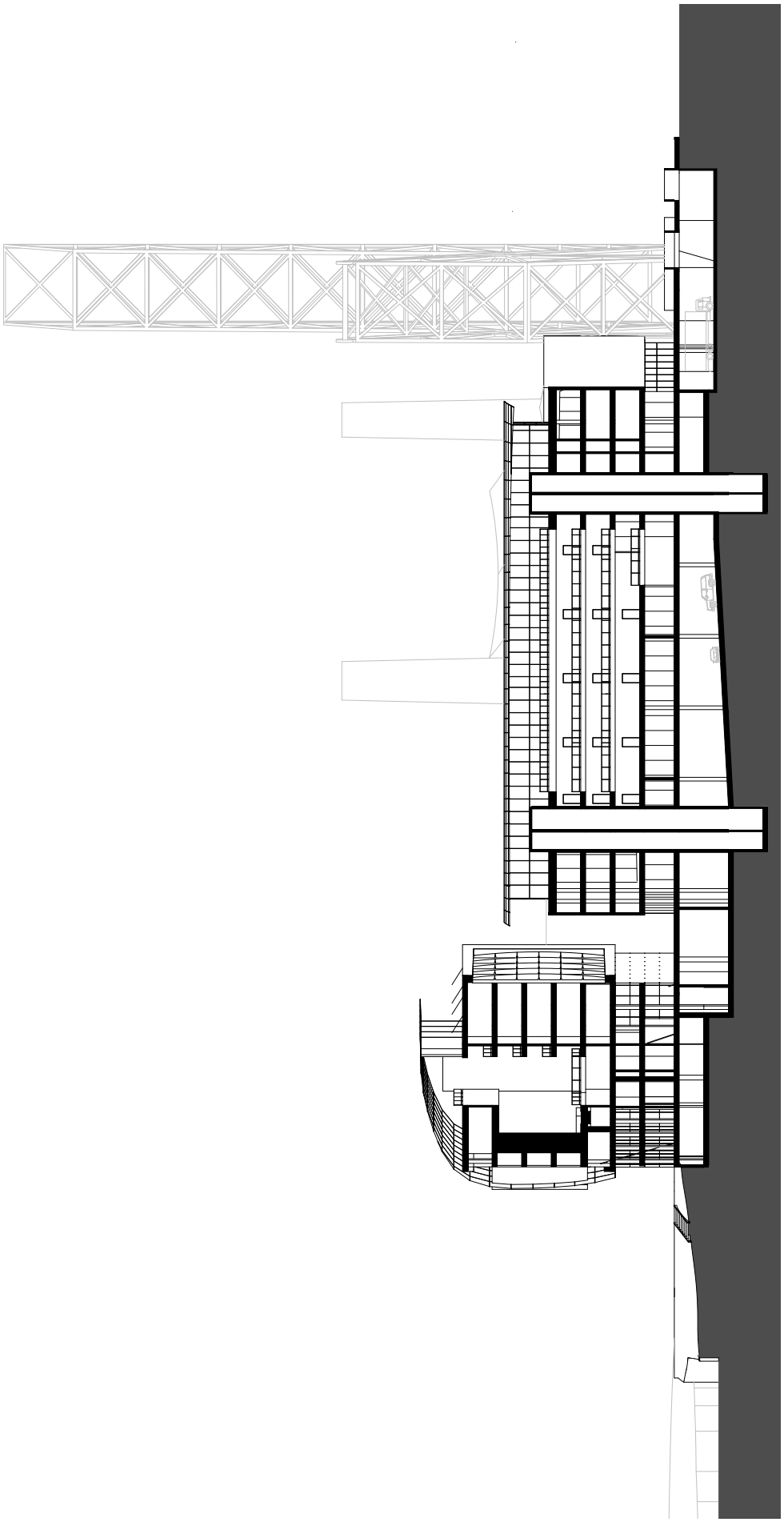


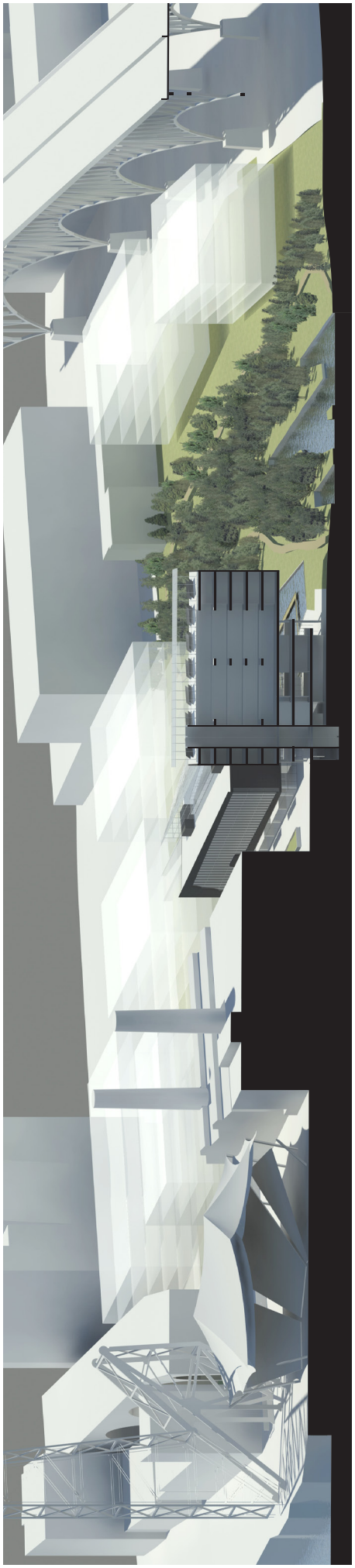
East Elevation



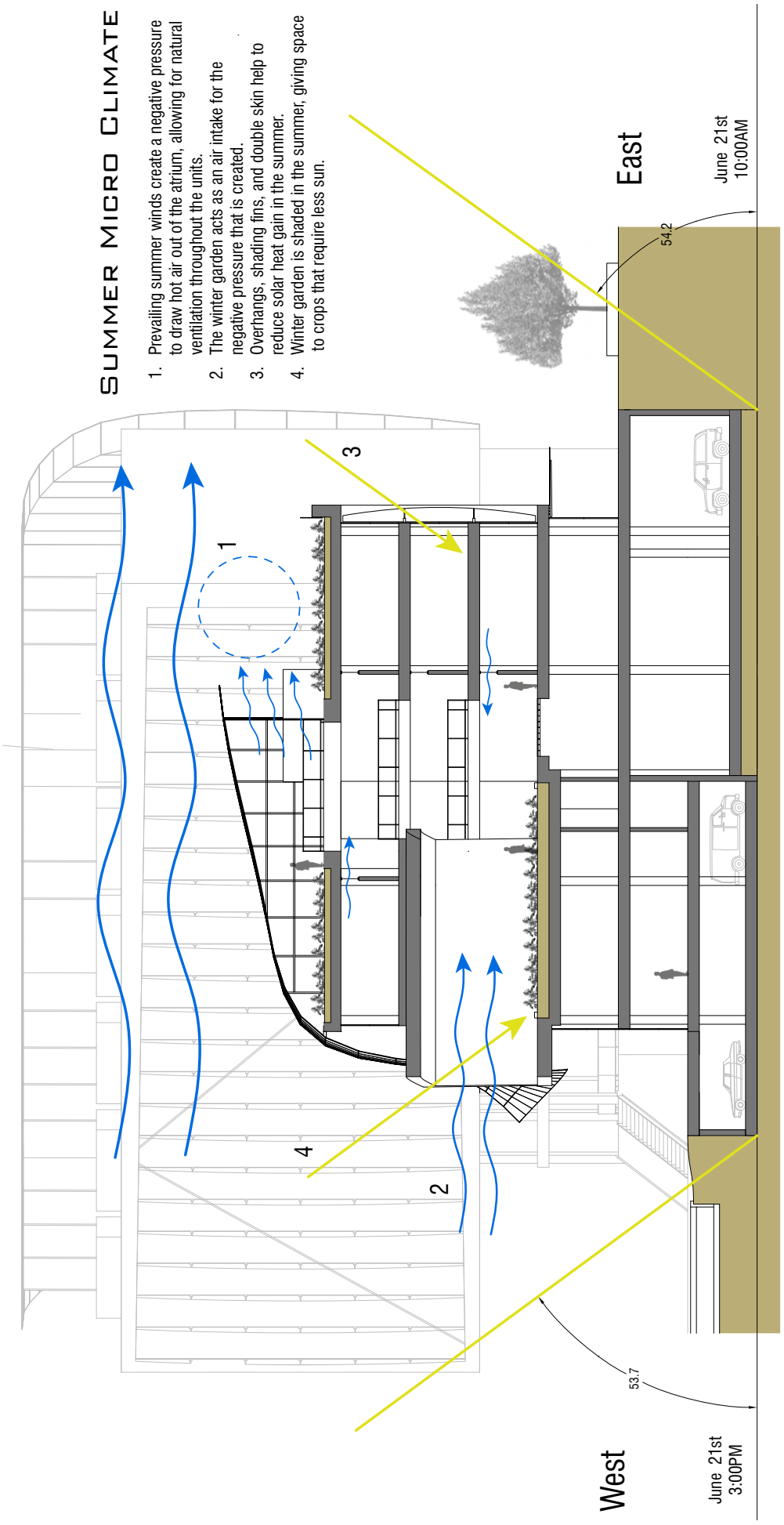
West Elevation

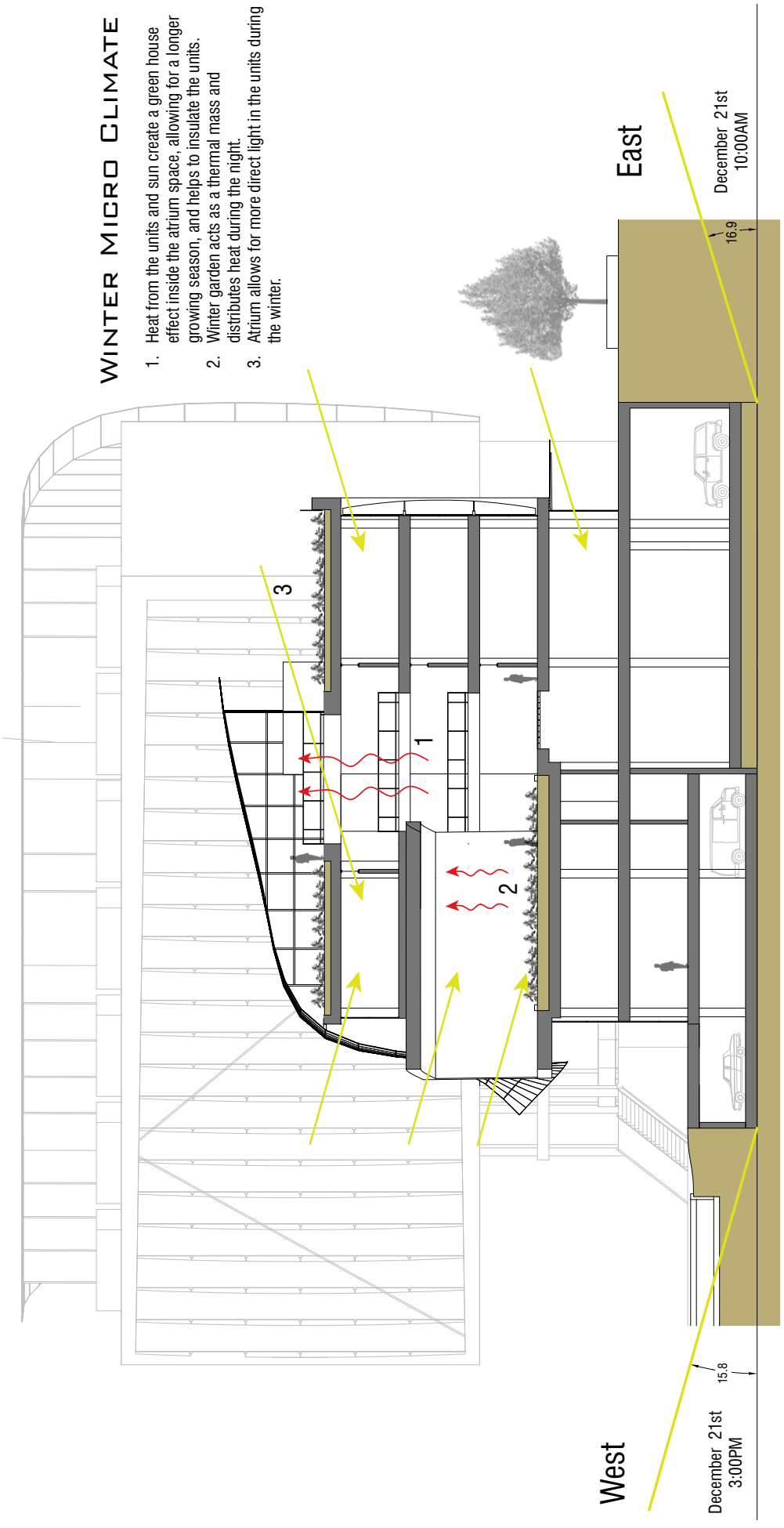
Sections



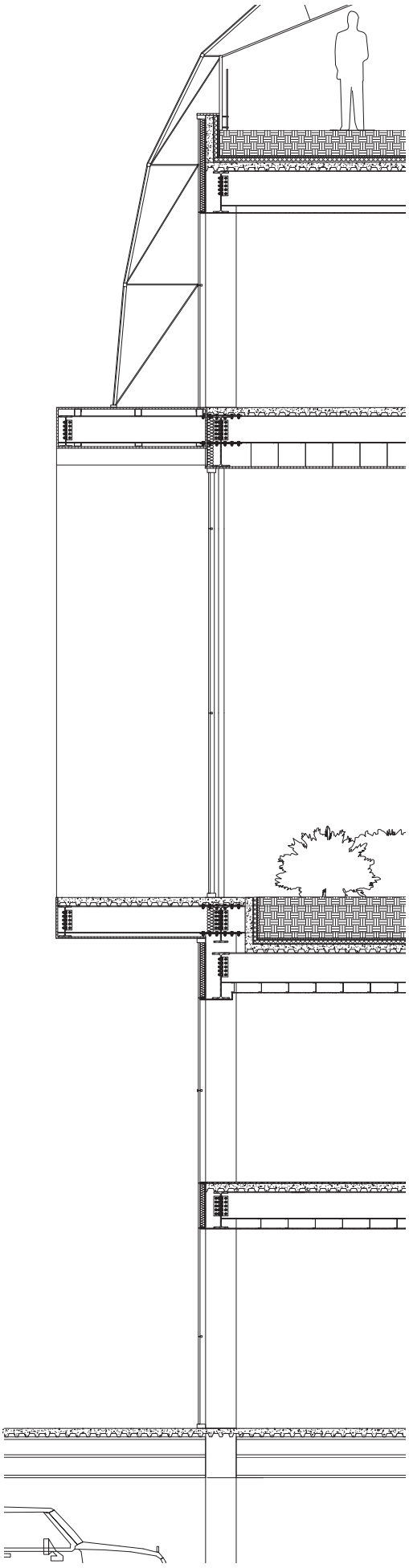


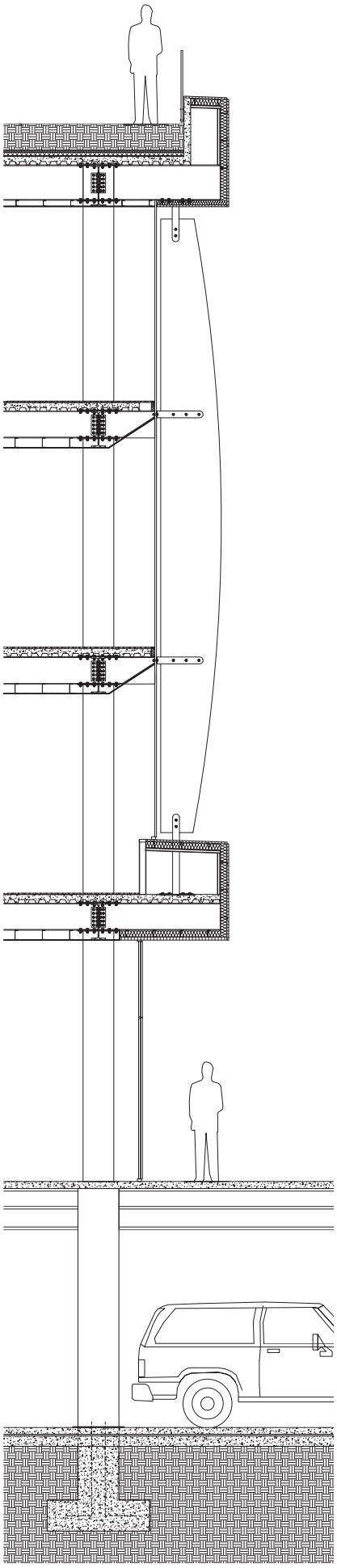
Summer Micro Climate



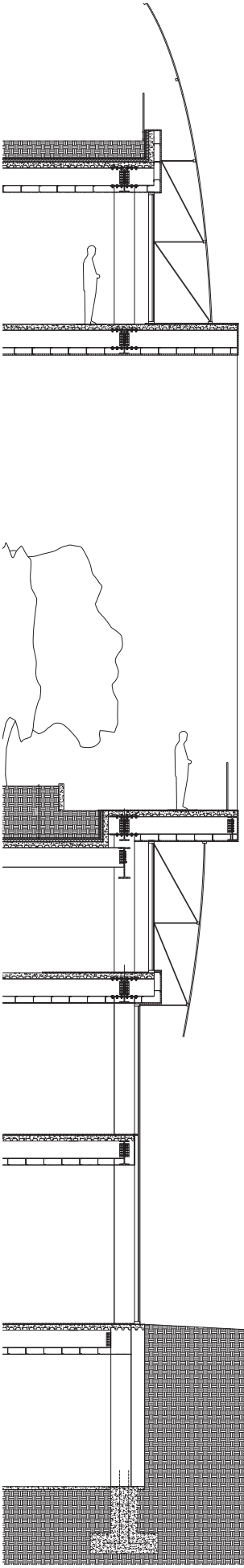

Winter Micro Climate
1. Heat from the units and sun create a green house effect inside the atrium space, allowing for a longer growing season, and helps to insulate the units.
2. Winter garden acts as a thermal mass and distributes heat during the night.
3. Atrium allows for more direct light in the units during the winter.
East
December 21st
10:00AM
16.9
West
December 21st
3:00PM
15.8
1
2
3

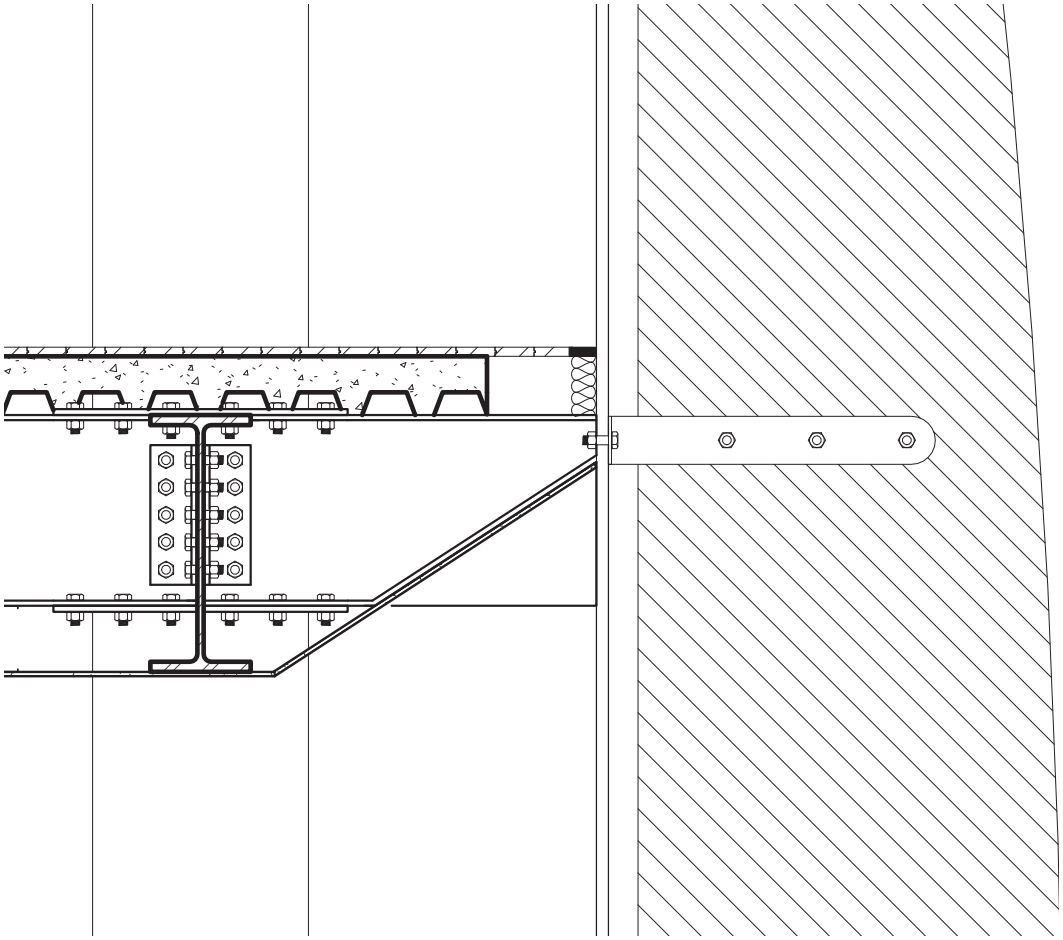
Wall Sections

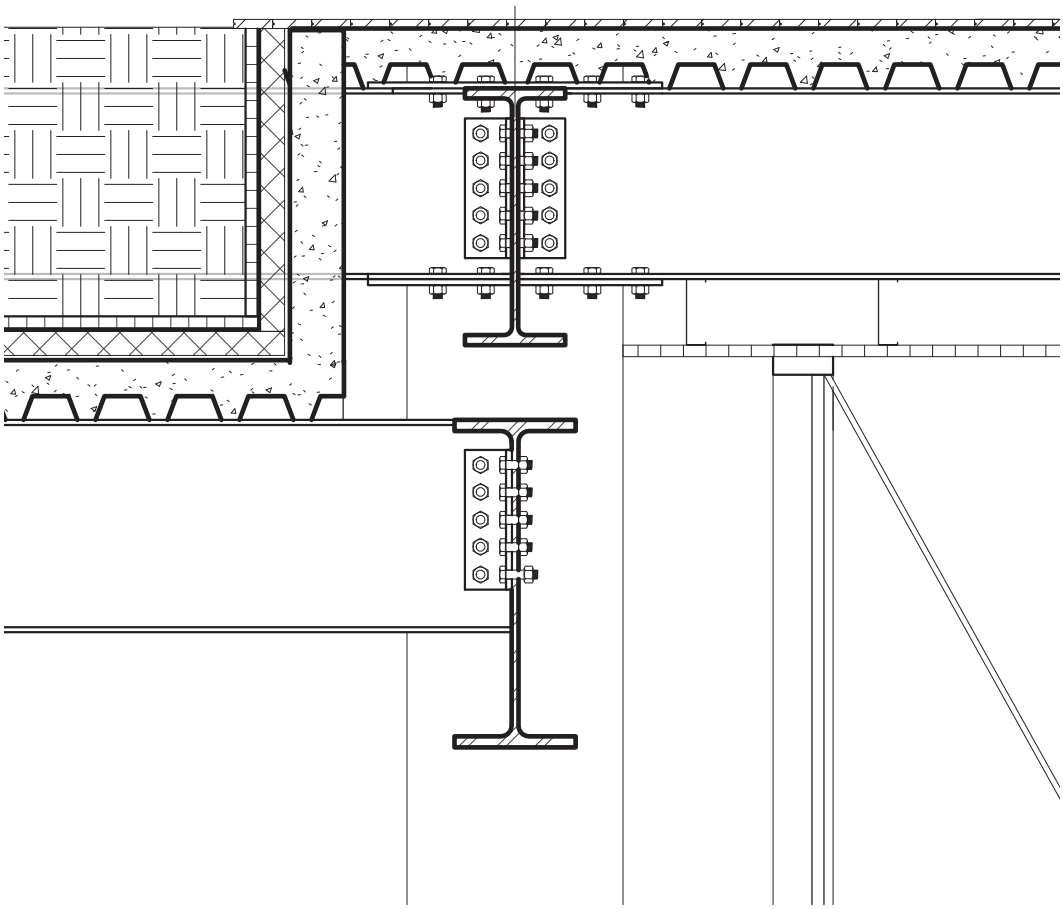




Wall Sections







Materials





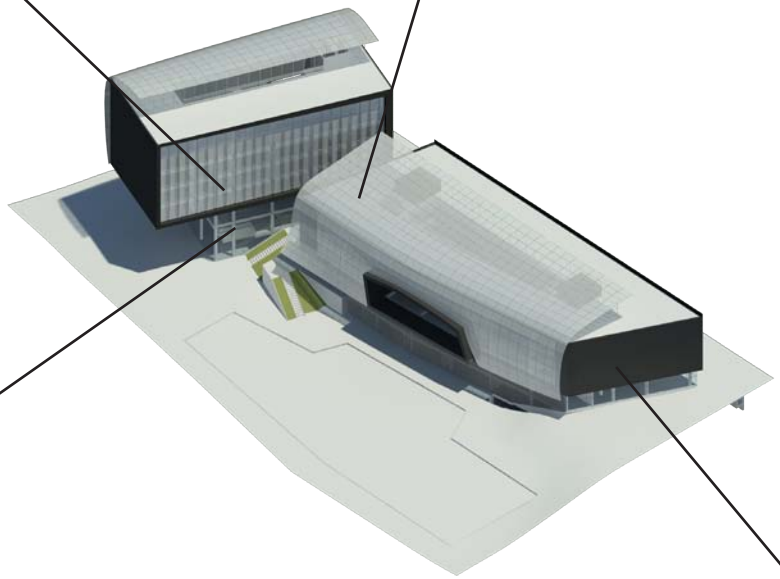
Frosted glass finns



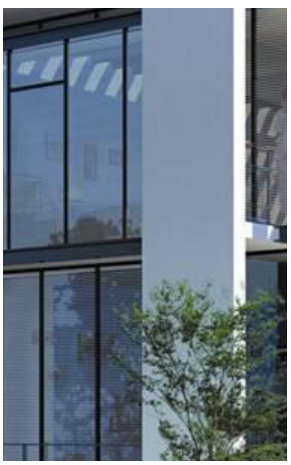
ETFE

Advantages:

Transmits more light
Insulates better
Costs 24% to 70% less to install
Is only 1/100 the weight
is strong enough to bear 400 times its own weight
has a nonstick surface that resists dirt
is expected to last as long as 50 years.



Glass with blinds

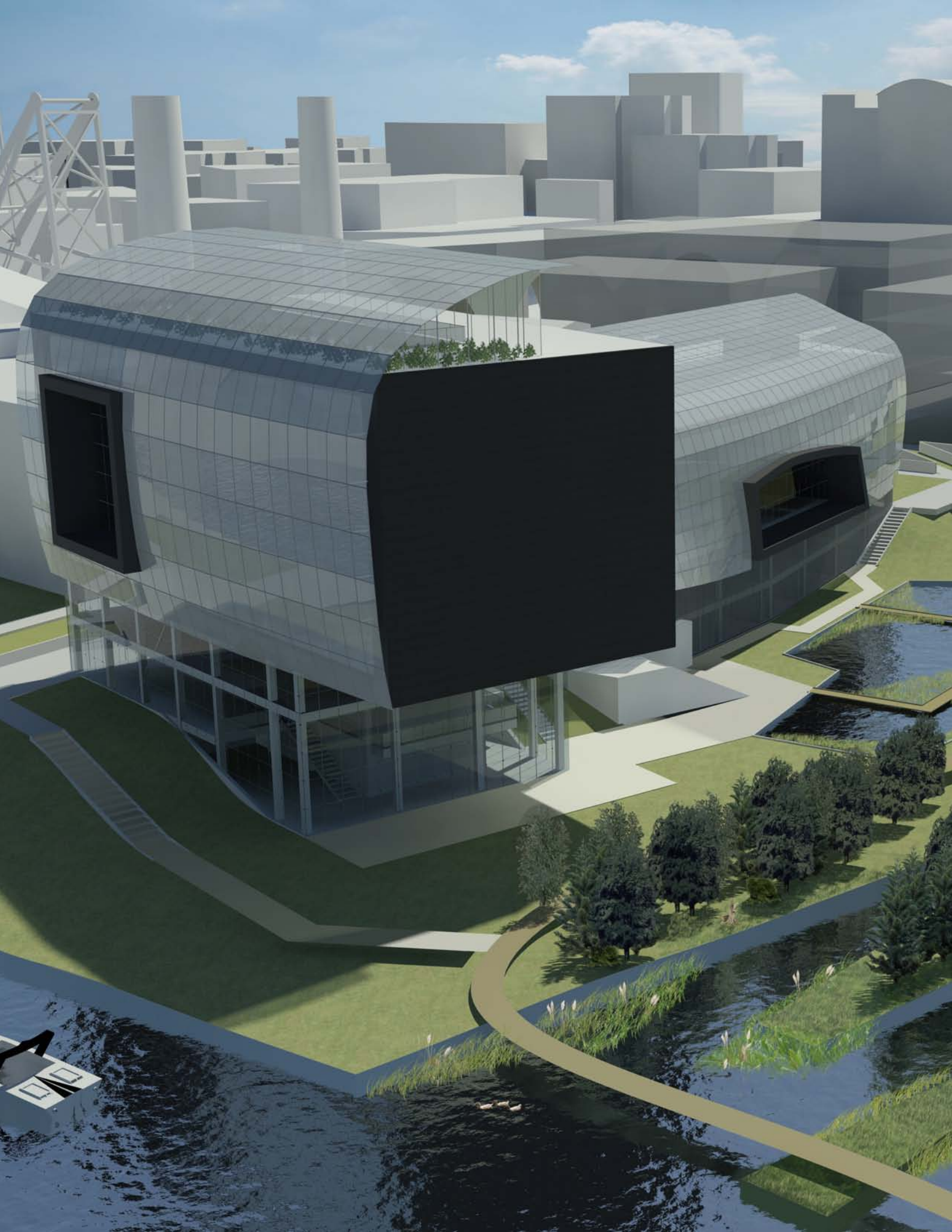




Aluminum Panel

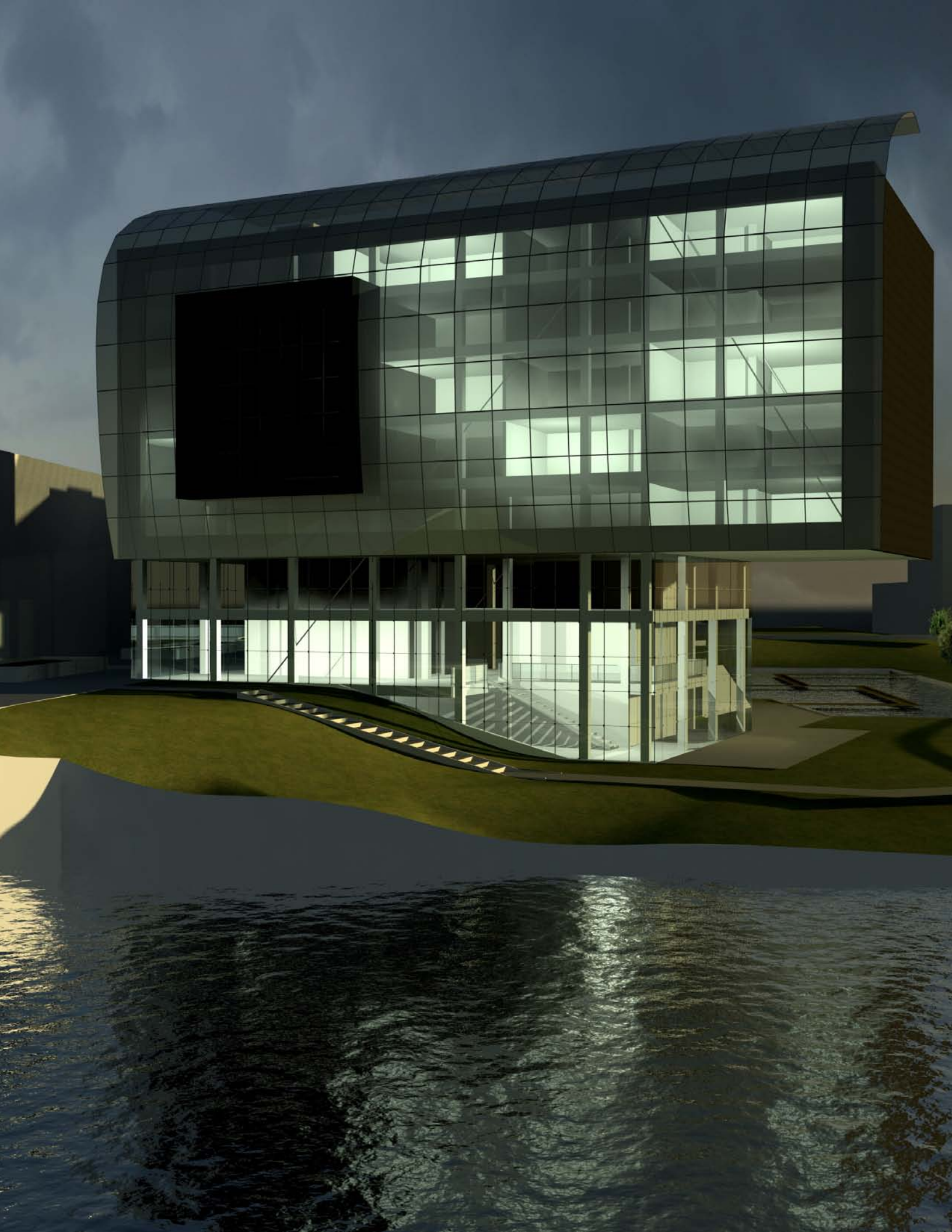








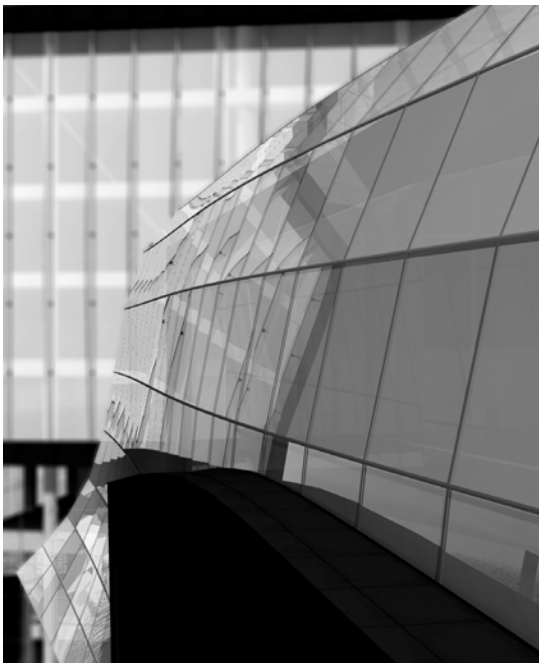


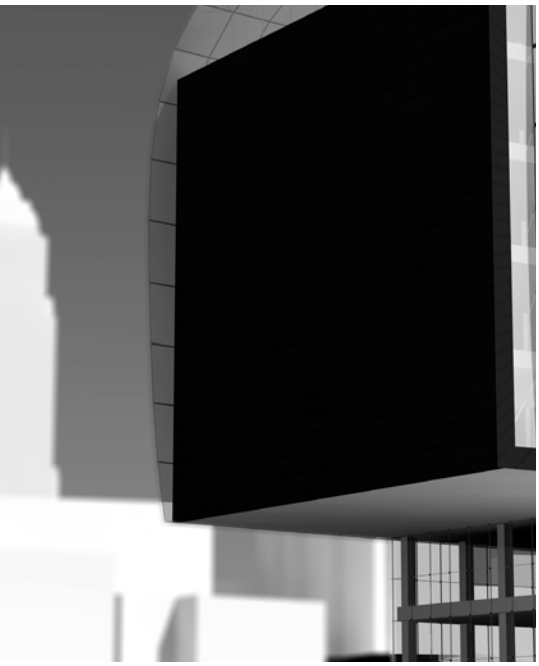
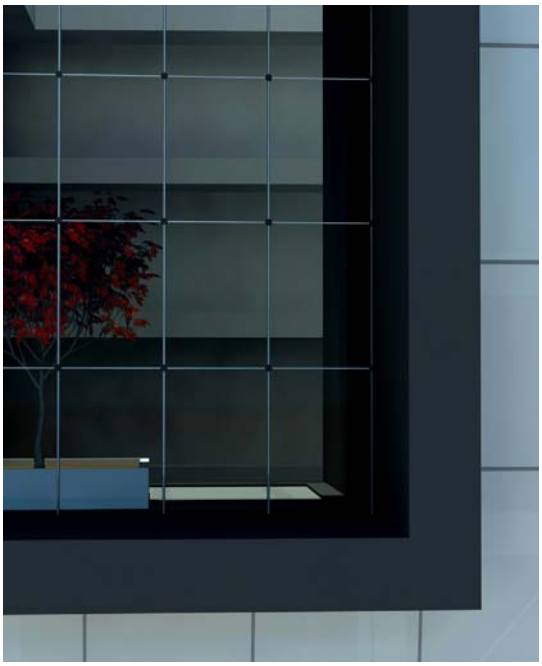
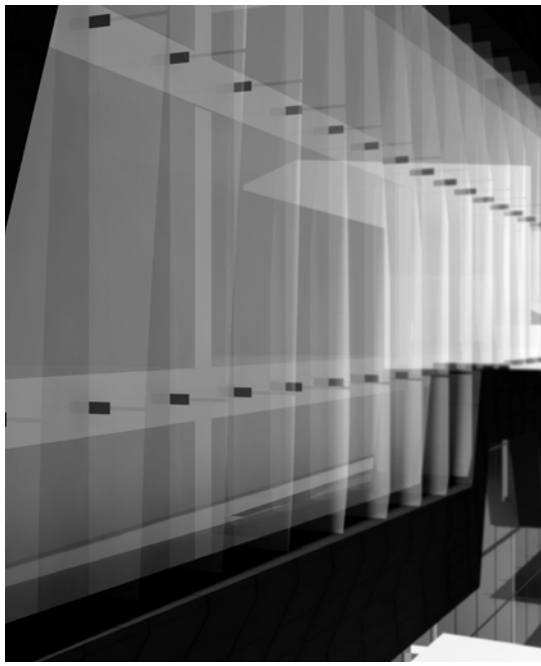


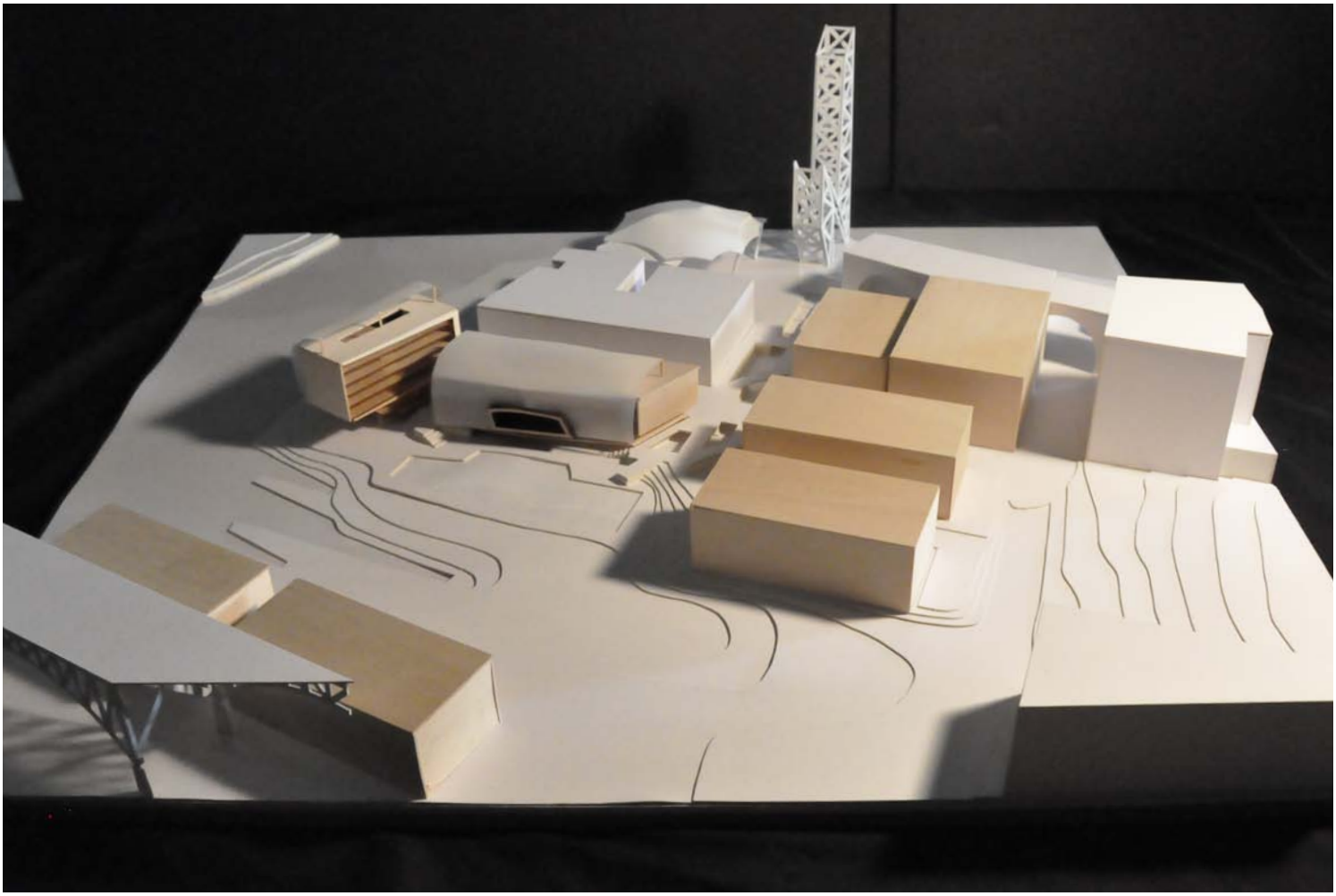


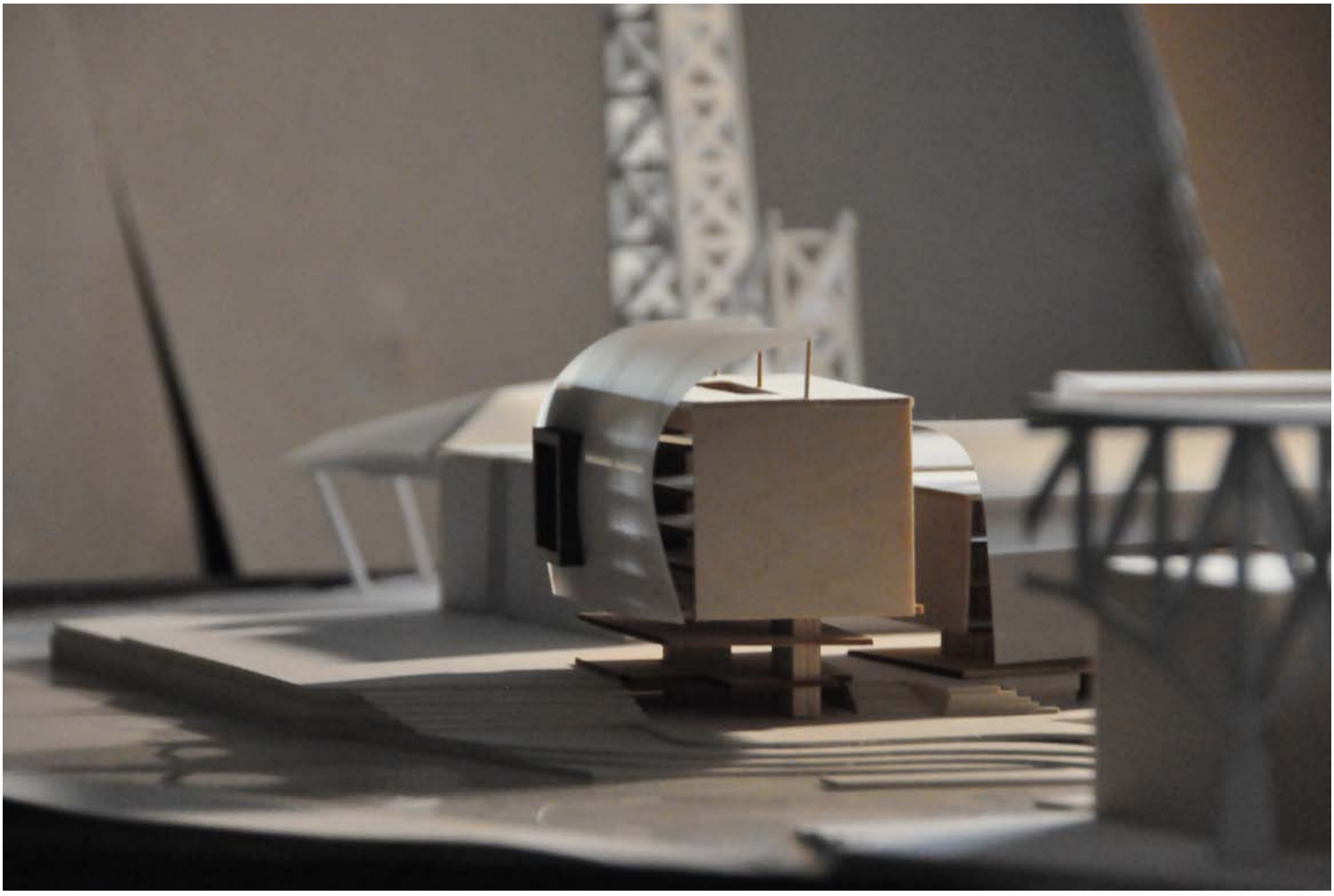


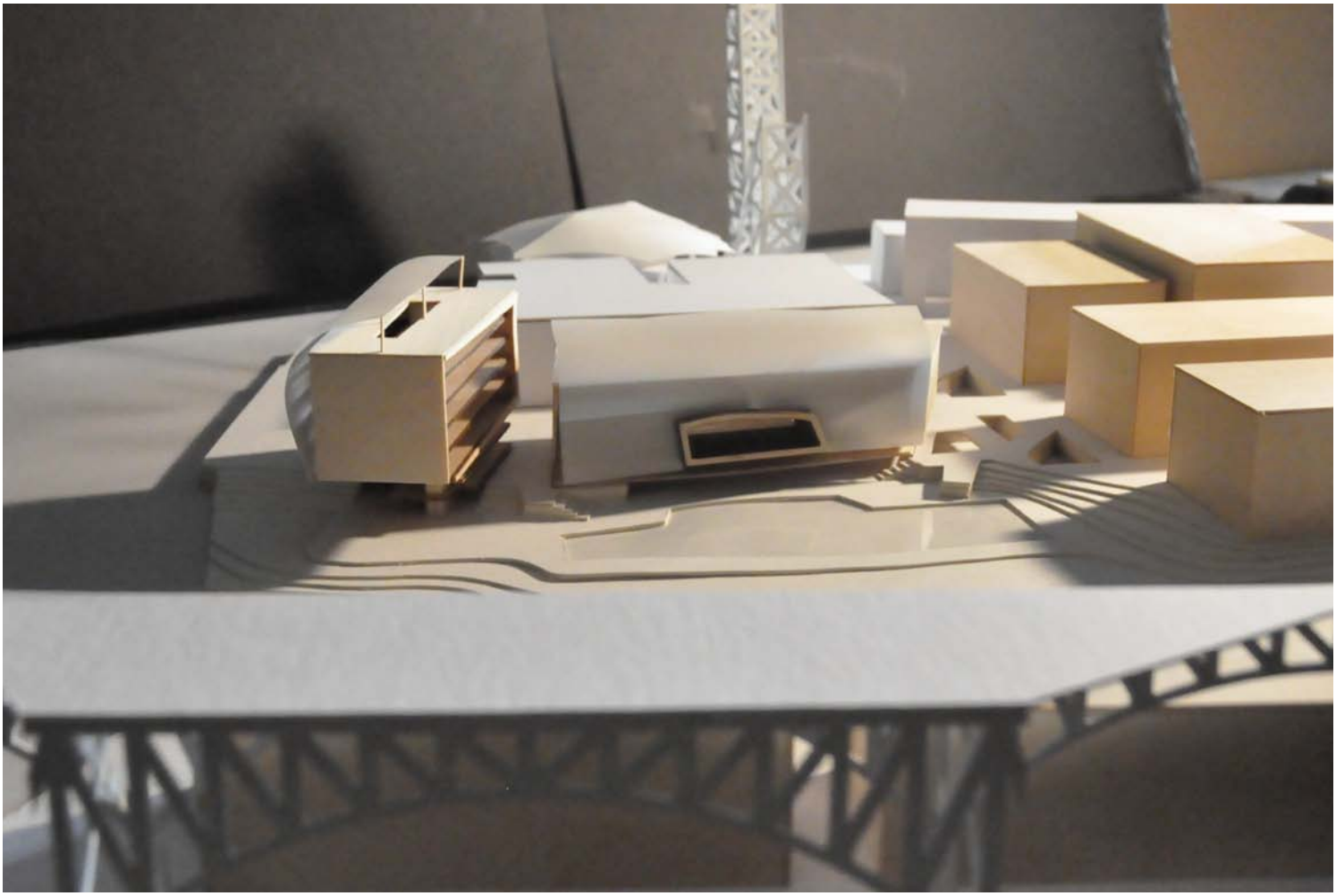


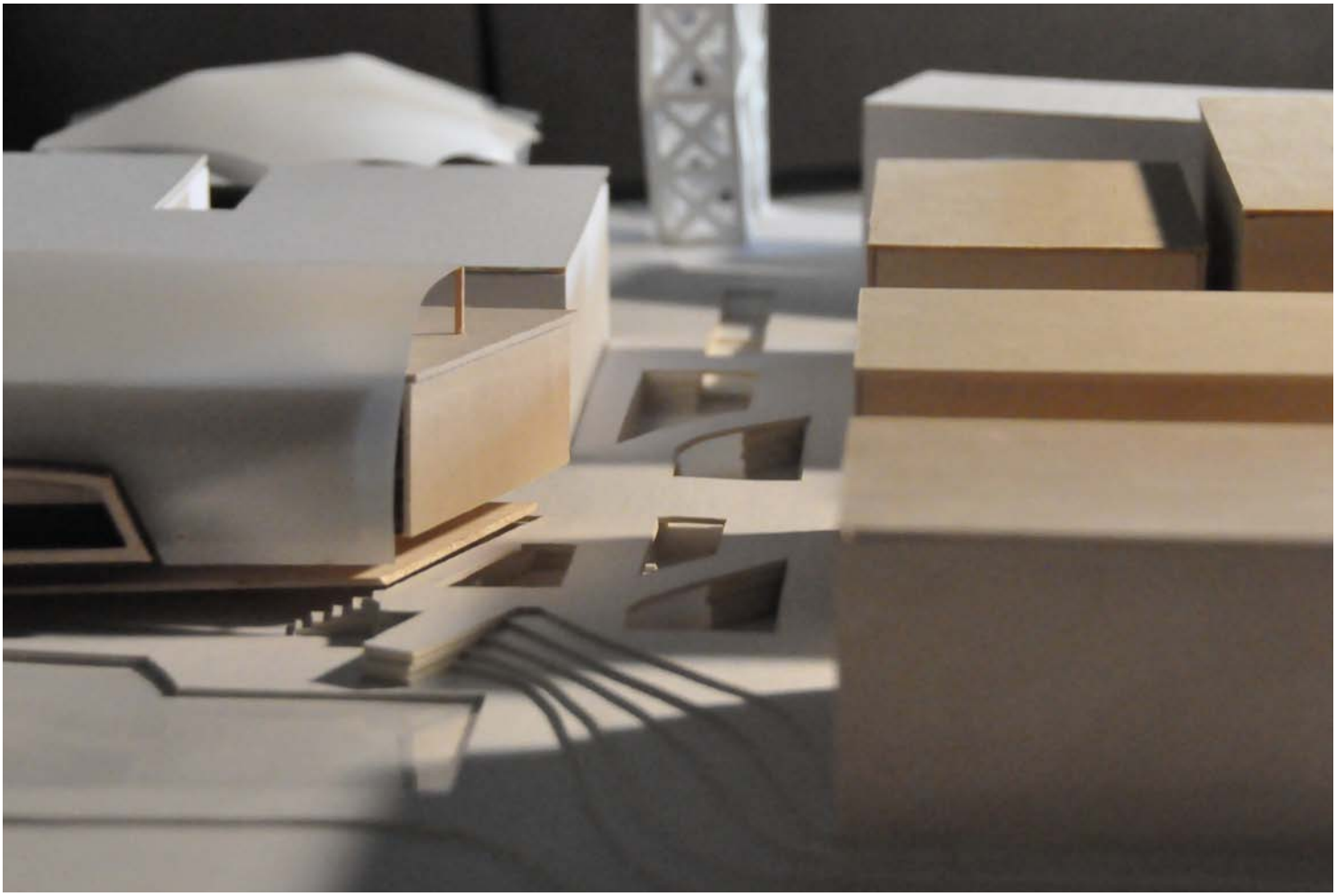


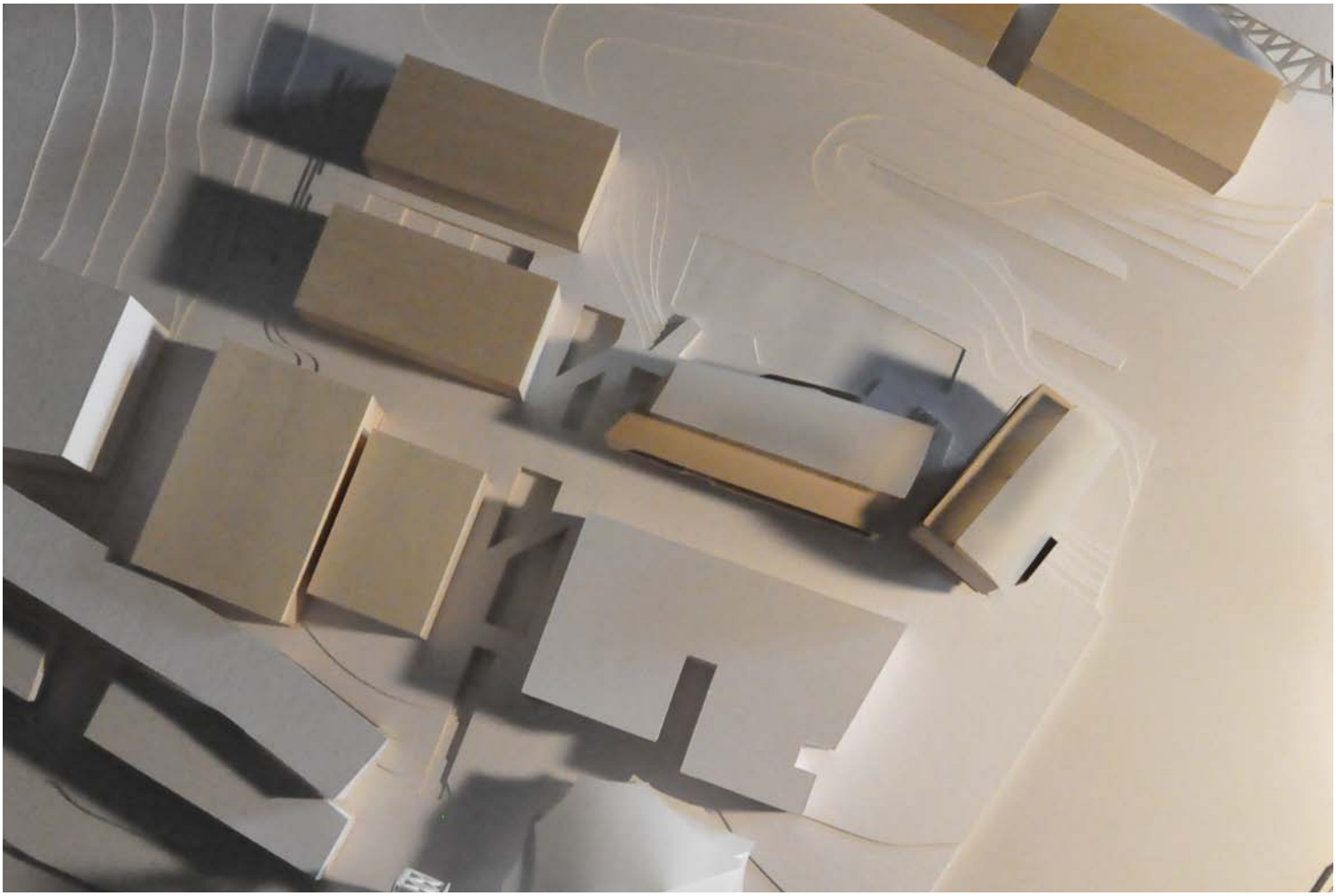




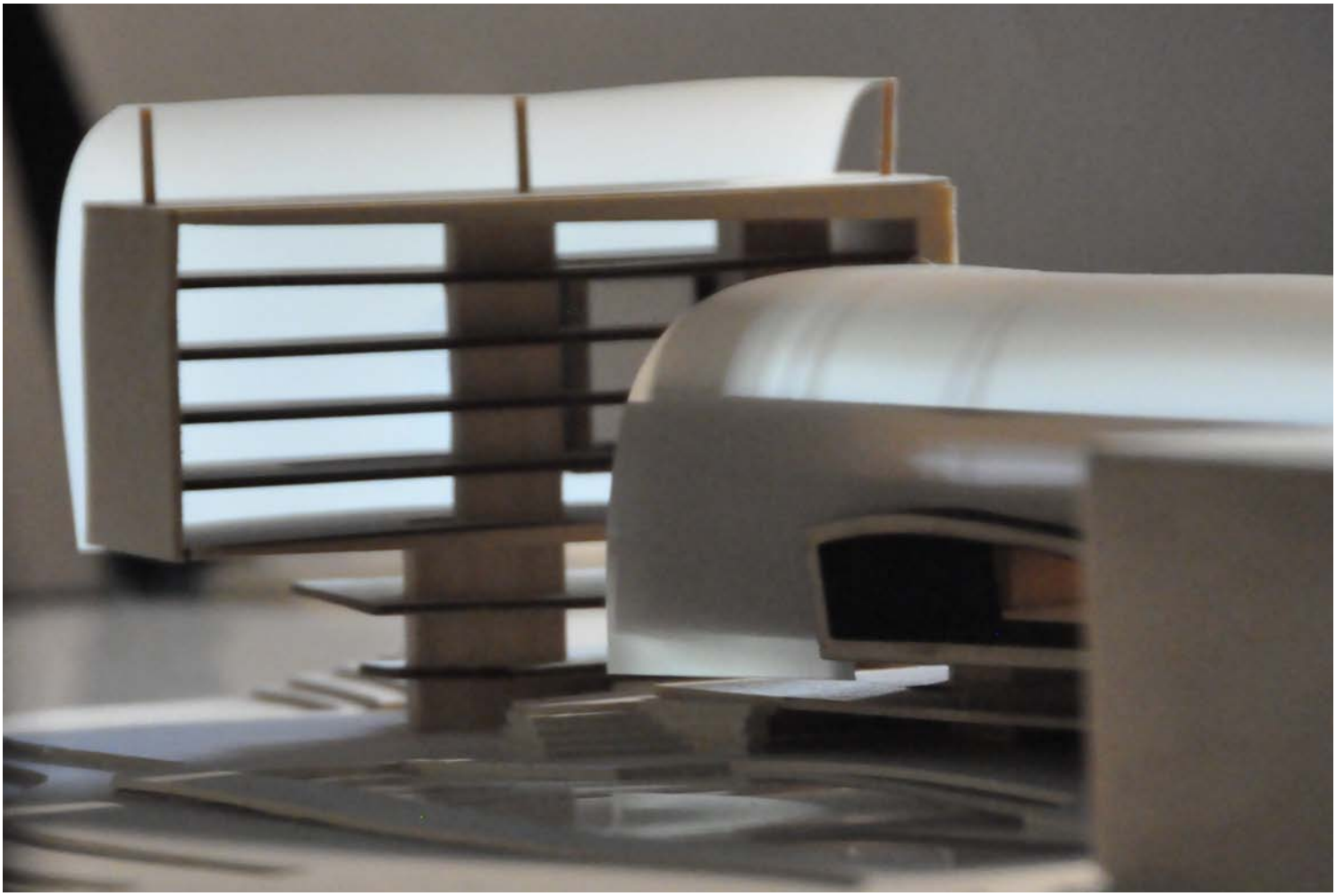


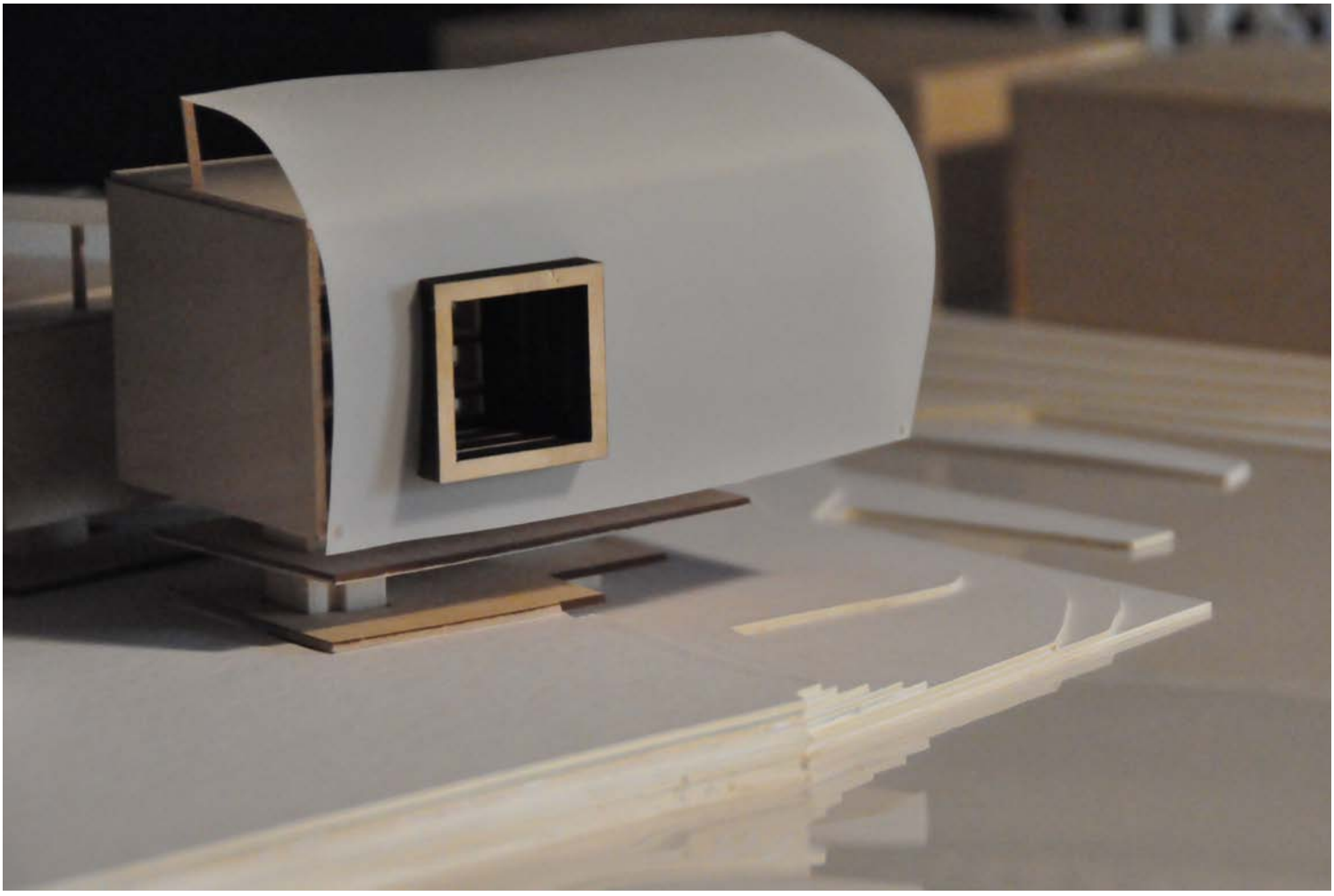


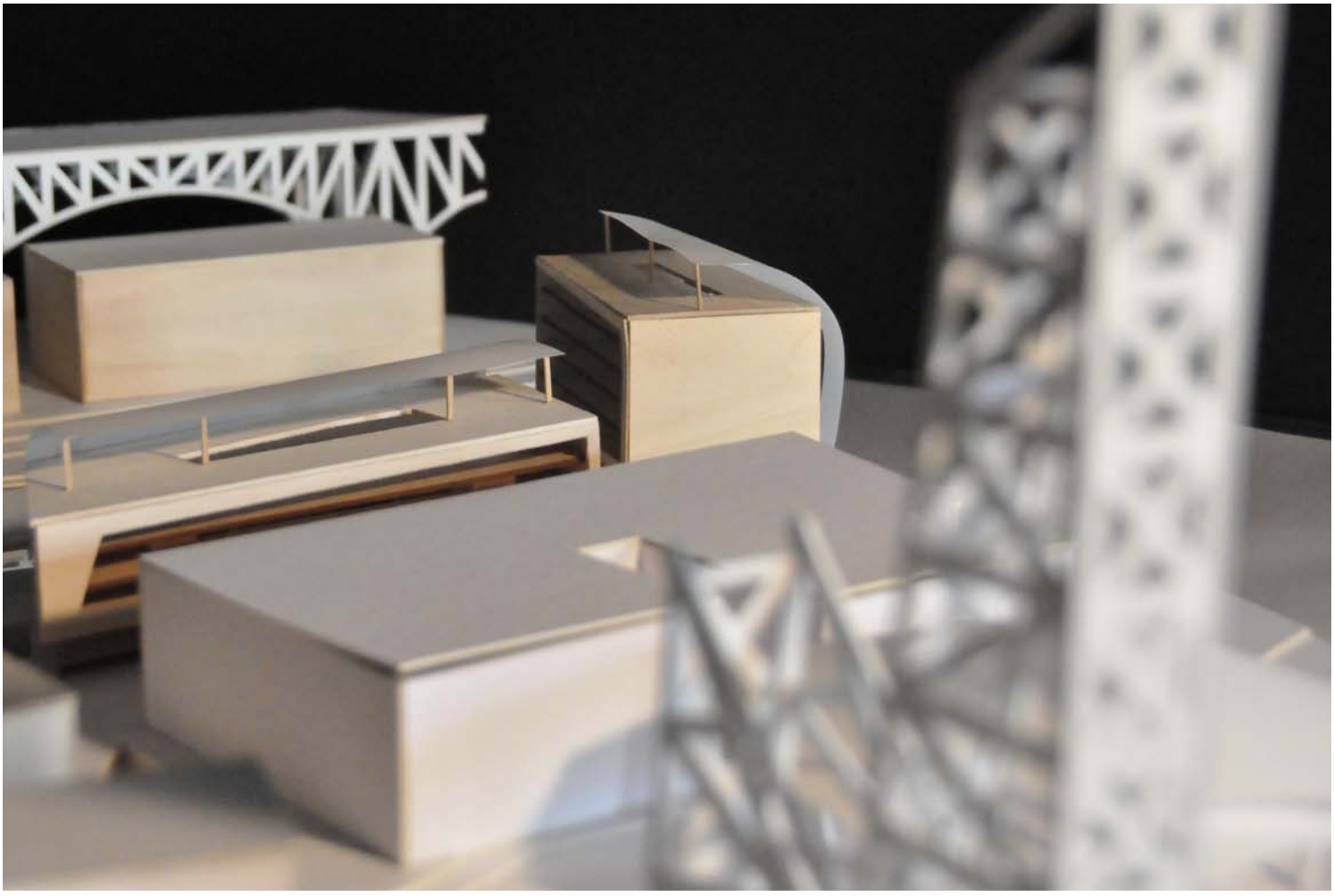












Presentation



