ABSTRACT

Title of Document:	Yielding Architecture: A Manifesto for [Urban + Agri]culture
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The contemporary, monoculture-based agricultural model is failing, as evidenced by world-wide food shortages, environmental degradation, and mono-diets. Grassroots efforts to reanimate neglected urban space with food production foretell an impending farming revolution. Additionally, 20th century economic changes have left many American cities devoid of the industry around which they were founded, leaving behind vast swaths of uninhabited and often polluted sites. This thesis imagines reclaiming these post-industrial landscapes with institutional infrastructures constructed to support the burgeoning urban agriculture revolution.

Recasting what and how urban farming can *yield* will provide a new vision for both architecture and agriculture. A conceptual agenda that reinterprets *yield* as both value and potential suggests a high-performance architecture that exhibits the efficiency and sustainability found in natural systems. It also demands an evolutionary architecture that establishes a framework for potential forms, events, and output by *yielding* to external circumstances and inevitable future change.

Yielding Architecture: A Manifesto for [Urban + Agri]culture

by

Beret Dickson

Thesis submitted to the Faculty of the Graduate School of the
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This is dedicated to
KD and the Monster Squad.

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For love, support, and inspiration:
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“Nature in the 21st century will be a nature that we make.”

-Daniel Botkin[1]

INTRODUCTION

yield (v.)

. . . to give forth by a natural process

. . . to give over possession [control] of[2]

The contemporary, monoculture-based agricultural model is failing. Arable land is decreasing from sea level rise, over use, and water shortages. Simultaneously, yield per hectare efficiency ratios have become stagnant. When coupled with even the most conservative population projections, which predict a one-hundred percent increase by 2100[3], it is clear that the existing farm techniques are incapable of adequately meeting future food demands.

Additionally, government sponsored over-production has encouraged farmers to ignore time-tested strategies such as crop rotation, resulting in considerable decreases in soil fertility. In order to combat soil degradation while maintaining maximum productivity, a variety of petroleum-based fertilizers and pesticides are commonly applied to tired soils. While working to artificially boost the nutrient mix of farmland, more than half of these chemicals find

their way into above and underground water systems and, ultimately, into rivers, bays, oceans, and drinking water.

Many of these shortcomings can be traced to the emergence of mono-cropping – the intensive farming of a single plant species which. In the United States, that plant is corn. Corn dominates American diets. Arriving in empty calories from processed foods, artificial sweeteners, and corn-fed livestock, this single plant is directly responsible for over 57% of the average Americans daily caloric intake and indirectly for much more.[4]

The environmental consequences of these practices are severe. From eutrophication and siltation to erosion and desertification, the industrial agriculture complex has left an indelible mark upon the planet. Equally important is the impact the associated mono-diet has upon Americans themselves. Obesity, diabetes, and high cholesterol can all be traced back to the poor American diet.

Unfortunately, despite the palpability of the problem, government policy favors the industrial agriculture lobby. The Farm Bill, through direct subsidies to farmers, keeps corn prices arbitrarily low, providing food-processing companies with access to inexpensive corn. Not coincidentally, consumers are also presented with inexpensive and nutrient-devoid processed foods.

In response to these impending crises, individuals and community groups have reverted to the millennia-old tradition of urban agriculture. By reanimating the neglected spaces of America's cities with food production, urban dwellers are fostering a relationship with natural systems and promoting a sense of community, while simultaneously providing themselves with nutritious produce and, often, employment. The potential power of this movement becomes clear when one considers that current projections forecast up to 60% of Americans living in urban or suburban conditions by 2030 [80% globally].[5]

Baltimore Farm Works is an institutionalized infrastructure designed to support the burgeoning Urban Agriculture Revolution. Through its mission of the advancement and propagation of urban food production and distribution, Baltimore Farm Works seeks to empower individuals by providing them with the capability to grow their own food. Baltimore Farm Works utilizes a variety of farming techniques in a range of interior and exterior environments for research, education, and production.

The site chosen to test this conceptual program is a commonly found remnant of 20th century urban depopulation. As manufacturing and industry globalized or moved to exiurban peripheries, the raison d'etre of many American cities was replaced with vacant and often polluted sites. In many cases, as is the case for the site of Baltimore Farm Works, these drosscapes are on prominent and valuable land with access to important natural amenities such as rivers and harbors.

Baltimore Farm Works will reclaim one of these post-industrial landscapes, remediating its polluted soil while also repurposing it to yield new cultural, social, and productive value. While remediating the site and overcoming the ills of the past is an important symbolic statement, it is equally important to memorialize the scars of the past by exposing them. Thus, the site becomes a vehicle for revealing industry's grim past and simultaneously expressing the capability to instill it with a new yield.

Yield, as interpreted by this investigation, can be understood in two ways. The first, which can be translated as value, demands a highly efficient production process modeled on sustainable and cyclical natural mechanisms. The Calvin Cycle, for instance, combines the processes of photosynthesis in plants and respiration in animals to convert renewable solar energy into useable energy. Utilizing a linked series of low- and high-tech operations such as reverse osmosis for filtering water and anaero-

bic digestion for extracting biogas from plant waste, Baltimore Farm Works will have a cyclical and sustainable energy and water generation system equivalent to the natural Calvin Cycle.

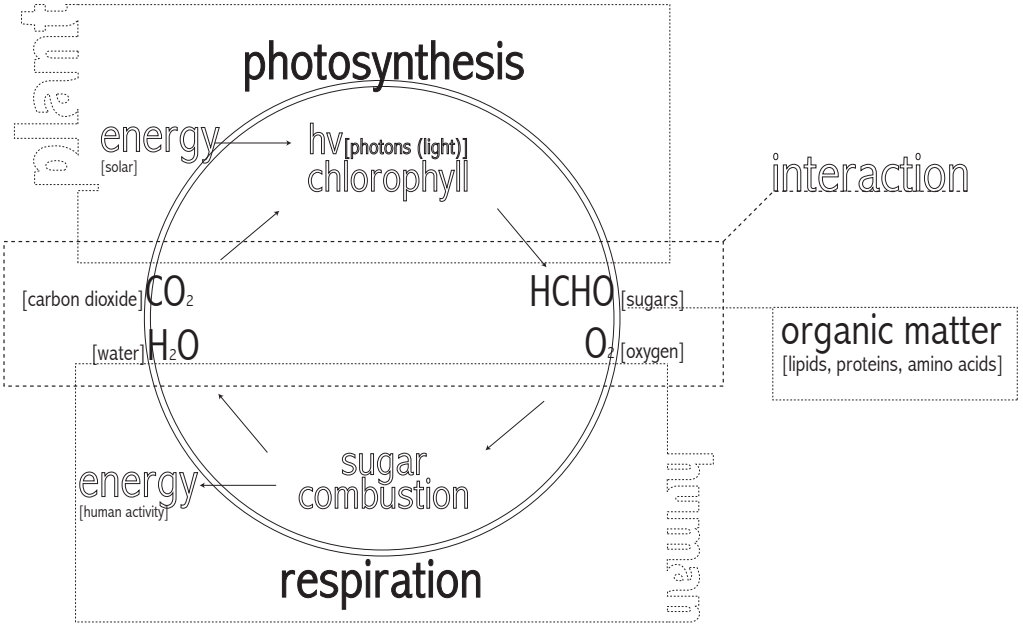


figure 1: The Calvin Cycle consists of the paired processes of photosynthesis [plants] and respiration [people], in which solar energy is converted into human activity.

The second definition of yield suggests an evolutionary architecture that establishes a framework for potential forms, events, and output by adapting to external circumstances and inevitable future change. This understanding of yield replaces value with potential. Much as natural ecosystems adapt to changing environmental circumstances, so to can architecture respond to economic, social, and political transformations. Further, architecture that is responsive to its environment can be used as a device for didactically expressing its operation. Baltimore Farm Works, as an infrastructural system, will provide a physical and conceptual scaffold for a wide range of potential operations, forms, and pedagogies.

Through a mutliplicity of yield types, Baltimore Farm Works challenges the conventional, one-dimensional understanding of yield as food production by also yielding energy, water, and, most importantly, knowledge. As an act of urban renewal and symbolic reclamation, it is also charged with yielding cultural and environmental value.

Finally, it is important to note the visionary nature of this investigation. Following in the footsteps of thinkers such as R. Buckminster Fuller, it extends the role of architecture beyond form and challenges the architect to engage in broad social and environmental problems through multidisciplinary action.

Further, while this thesis is without question visionary, it is also based upon existing technological capabilities. While it imagines new potentials and presents novel ways in which we can inhabit the planet, it is firmly rooted in the present.

“Wise though a man may be, it is no shame
To have an open mind and flexible.
Thou seest by the winter torrent’s side
The trees that bend go with their limbs un-scathed,
While those that bend not perish root and branch.
And so the sailor who keeps taut the sheet,
And stiffly battles with the tempest’s force,
Is apt thenceforth to float keel uppermost.
Bend, then, and give thy spirit room to change.”

-Sophocles[6]

PARADIGM

YIELDING ARCHITECTURE

An architecture that *yields* has two primary agendas: (1) a cyclical, sustainable, and efficient production process and (2) an indeterminate form that emerges from its use, need, and environmental circumstances. The first suggests a self-contained process in which a renewable external resource is converted from one form to another.

In a natural ecosystem, various plant species work together symbiotically to maintain each other and the environment they inhabit. Decomposing biomass from dead plants fertilizes the living, which produce flowers, fruits, seeds, and pollen which, in turn, support new plant and animal species. Varied root depths draw from different water levels and divergent nutrient needs result in shared resources. Large plants shade those with lower sunlight needs, while the smaller ones protect the soil from erosion. This system is simultaneously productive and sustainable.

The second characteristic of a yielding architecture, however, relates to external forces being applied to the system. As Sophocles eloquently describes, successful systems, whether natural or man-made, are able to adapt to changing conditions, whether economic, social, environmental, or other. In terms of architecture, space and form are at the service of fluctuating human need and cultural trends.

For instance, the form of a prairie in winter is radically different than in the summer. A simple 1-2 degree fluctuation in temperature, increased/decreased rainfall, or changing insect populations can result in the powerful emergence of a particular species – one that was potentially subdued in previous seasons. These subtle environmental shfits can have a profound impact upon the appearance of a field that one year may appear green, the next yellow, and the following purple.

Systems that are able to adapt to varied and unpredictable conditions not only survive, but also become more productive. A powerful example of a yielding, man-made system can be found in the United States Constitution, the genius of which is not in the organization of government or the distribution of power, but in the founders realization that what is right today may be wrong tomorrow. The Constitution sets out a rough framework within which the elected leaders, as the voice of the body politic, operate. A more rigid structure without amendments would be unable to evolve with the inevitable cultural change that accompanies any civilization.

A yielding architecture, then, in its most pure manifestation, is necessarily democratic, as it provides individuals with the power to determine the programmatic needs of the institution. Through the emergent collective voice of the body politic, each person's vote is recorded, responded to, and archived in the physical expression of the architecture itself.

Mutable/Productive Architecture

Since Le Corbusier's *Towards a New Architecture*, the inherent beauty found in the purely functional has fascinated the architectural community. Today, the pure forms found in smoke stacks, shot towers, and grain elevators, have become iconic and imageable symbols in our urban places.

Equally important as their symbolic power and aesthetic value is the ability of these industrial icons to be productive – to yield. Stan Allen, whose work attempts to create infrastructure rather than architecture, contends that form should be concerned "more with what it can do than for what it looks like"[7]. In a competition entry for *Logistical Activities Zone* in Barcelona, Allen imagined a superstructure into which a range of spaces could be located and onto which a variety of devices could be attached. His interest was less about actualities but potentials. Realizing his inability to predict the needs of all users, he created an infrastructural system with the flexibility to allow users to create their own space and fulfill their unpredictable programmatic needs.

Similar projects include Cedric Price's *Fun Palace* [London, 1960-61] and Renzo Piano/Richard Rogers' *Pompidou Center* [Paris, 1971-77]. Both of these large-scale infrastructures envision a flexible and modular scaffolding in which an endless variety of activity can take place. Scaffolding, here, is both a flexible architectonic system and a conceptual framework, providing for reconfigurable spatial environments and the engaged imaginations of its inhabitants.

Mason White of Lateral Architecture refers to this phenomenon as *Mutable Architecture*. His work includes series of responses that facilitate human action [*Cliffside Slips/Streetscape*], express natural systems [*Recording Memphis/Dock*], or respond to emergent urban patterns [*Playscape/Public Park*].

Finally, technology is beginning to construct new ways in which architecture can act as a responsive, cultural interface. From moving walls to expressive surfaces the potential for individuals to have a direct role in re-shaping their environment is just beginning to emerge.

Similarly, a greater awareness of natural mechanisms is providing a new medium for design. Landscape architects such as James Corner and Chris Reed of StossLU capitalize on the evolutionary properties of plant growth, water collection, and tidal patterns, amongst other natural systems, to define new relationships between man, nature and the built environment.

Sectional/Landscape Urbanism

The 20th century witnessed one of architecture's greatest visionaries, R. Buckminster Fuller, who taught us that man and nature are, in fact, part of the same system. His work, which was simultaneously technological and ecologically conscious, challenged a preconception that man-made, artificial systems were somehow distinct from natural ones.

The distinction between natural and artificial landscapes has become increasingly blurred during the last century. Agriculture, for example, uses natural systems [photosynthesis] and natural media [plants] to produce a commodity [food]. The process, however, is entirely manufactured. Genetically altered seeds, row-cropping, soil tilling and irrigation are all instances in which natural environments have been so heavily transformed by the hand of man that their "naturalness" becomes ambiguous. The inverse is equally true. Cities, for example, are entirely man-made structures. However, they are dependent upon and determined by natural systems such as hydrology, sunlight, and wind direction.

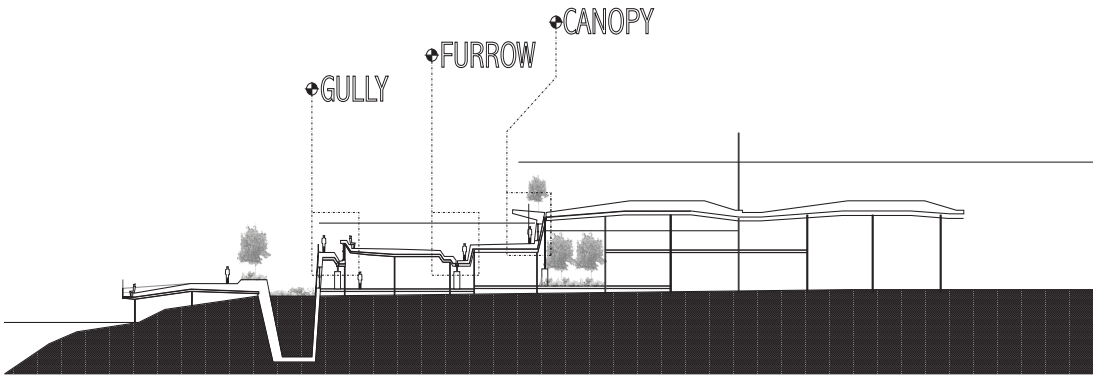


figure 2: conceptual section: a single, spatial surface also determines program through surface thickness.

Accepting the artificiality of urban landscapes provides opportunity to design cities and landscapes with multi-layered and performative sections by embedding performative and programmatic functions within the ground plane.

Implicit in this understanding of sectional urbanism is a similar understanding of landscape not as a solid upon which cities are built, but as a thickened surface. As a surface, it then has an above and a below, allowing for landscape to begin defining sectional relationships. Landscape surfaces, then, have the capability to become the primary generator of urban space.

This idea is also in line with the contemporary American, horizontal city. The ground plane has become the dominant space-making device throughout much of America. The opportunity presents itself, then, to challenge the horizontality of landscape, by bending, folding, twisting, lifting, and fragmenting it to accommodate the various programmatic needs of contemporary urbanism.

A wide range of contemporary projects have explored the new ways to imagine landscapes and to spatialize urban horizontal surfaces. Weiss/Manfredi's *Olympic Sculpture Park*, for instance, consists of a single folded and bent ground plane that accomodates vehicular circulation below and pedestrian traffic above as it mediates a 40' elevation difference between a dense urban condition and the waterfront. That same surface is ultimately separated from the ground, resulting in an interior, enclosed space.

The ambiguity between roof/ground and natural/artificial in Weiss/Manfredi's *Olympic Sculpture Park* can also be found in Field Operations/Diller, Scofidio, + Renfro's *High Line* in New York City. Repurposing a former elevated train line as a linear park required the infusion of natural vegetation into a highly man-made infrastructure. The resultant linear banding and bleeding of concrete vegetation, as well as subtle changes in ground plane create wonderful moments of interaction between not only the built and the natural, but also with and between people.

A final example, Lewis.Tsurumaki.Lewis's speculative *Park Tower* challenges the horizontality of landscape surfaces. A pair of spiralling horizontal surfaces, one housing automobile parking and the other a mixture of residential, commercial, and hospitality uses, rise vertically to form a tower. This radical approach to landscape and urbanism provides a new paradigm within which architects and landscape designers can began to define both space and program.

“Not only are we good at destroying the world,
we are also good at building the new.”

-Mao Zedong[8]

SITUATION

PRODUCTION

The gross productivity of an agricultural system is a product of the output efficiency and the cultivatable area.

O X A = GP
O = output per hectare
A = cultivated area
GP = gross productivity [9]

Efforts to maximize this simple equation are the root of all major technological and systemic changes in agricultural practice throughout world history.

Historically, in order to increase gross productivity, societies simply increased the amount of land cultivated *(A)*. Between 1928 and 1960, a fifty percent increase in global population was matched by a fifty-three percent increase in plowed land.[10]

Output per hectare *(O)* is primarily determined by the harvest index – the weight of edible grain compared to the total weight of the plant.[11] In the mid-twentieth century, when new arable land became increasingly scarce, a series of technological innovations spawned a dramatic increase in global harvest indexes and, consequently, output per hectare and gross productivity. These sweeping advances in efficiency constitute what is now known as the *Green Revolution.*[12]

The primary catalyst was the global adoption of hybrid seeds (dwarfs), which combined larger ears with shorter stalks capable of supporting them. Use of hybrid seeds was quickly and comprehensively embraced throughout the developed world. In 1933, only 1% of all seeds planted were hybrids. By 2000, dwarfs account for over 70% of all seeds planted. In 1900, the United States was averaging twenty bushels of corn per hectare. By 2000, that number had swelled to 120 bushels per hectare. Not coincidentally, global population more than doubled during the twentieth century.[13]

The emergence of dwarf seeds laid the foundation for

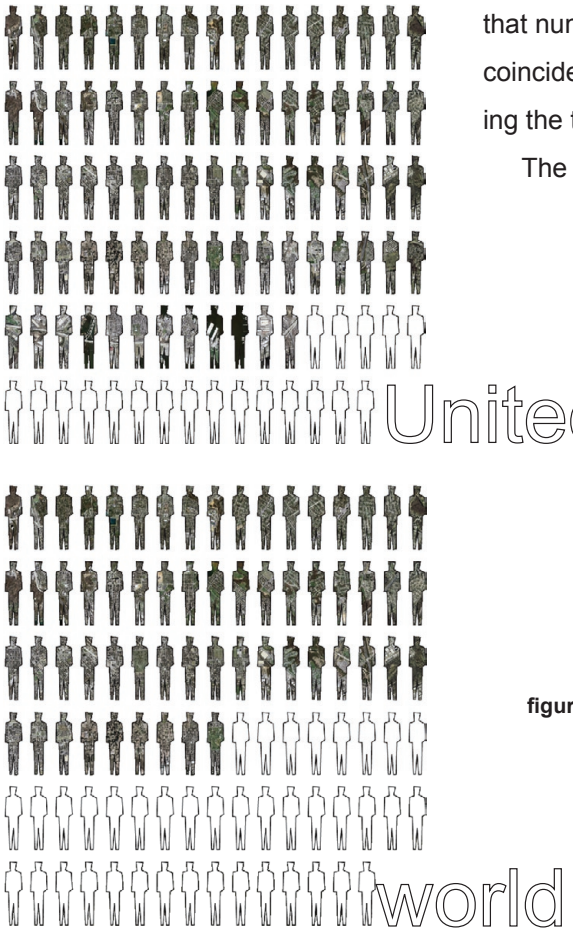


figure 3: World population is expected to at least double by 2100. In fact, if population increases at its current rate, world population will reach 12 billion by 2050. The majority of these increases will be occurring in cities. By 2030, 80% of the United States population and 60% of the world's population will live in [sub]urban environments.[14]

the current industrialized agricultural system. The quest for efficiency and the need to keep pace with the competition pushed farmers to abandon their older, more ecologically friendly methods of farming. Crop rotation, a diverse mix of plant species, and fertilizing with animal manure were replaced with mono-cropping - the intensive growth of a single species. The transition from sustainable farming techniques to monoculture has had far-reaching impacts upon food production and while mono-cropping may have been tremendously effective in the short term, its long term impacts have been incredibly detrimental.

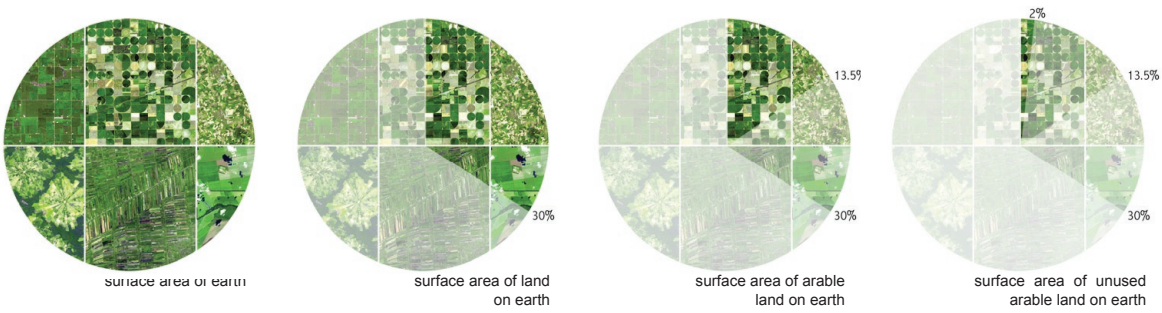


figure 4: Only 2% of the earth's arable surface remains. It is also important to note that the remaining 2% consists of the most marginal, least accessible land. Additionally, the land that is currently being utilized for agriculture is being depleted through unsustainable farming practices. Lastly, impending sea level rise and the accompanying salinization of coastal lands will significantly reduce the amount of land available for food production. [15]

Monoculture stands in direct contrast to a naturally existing polyculture environment, where a diverse plant types work symbiotically to maintain both their own health and the survival of the larger ecosystem. Varying plant heights and root depths choke out invasive weed species before they can grow and disallow exposure of topsoil to the elements, preventing erosion. Additionally, the different species absorb and return different nutrients, allowing the soil to maintain its nutrient content. Whereas monocropping consists of an annual cycle of growth and harvest heavily dependent upon intensive irrigation and artificial, petroleum-based fertilizers; polycultures are sustainable, close-loop systems independent of any outside energy or nutrient source.

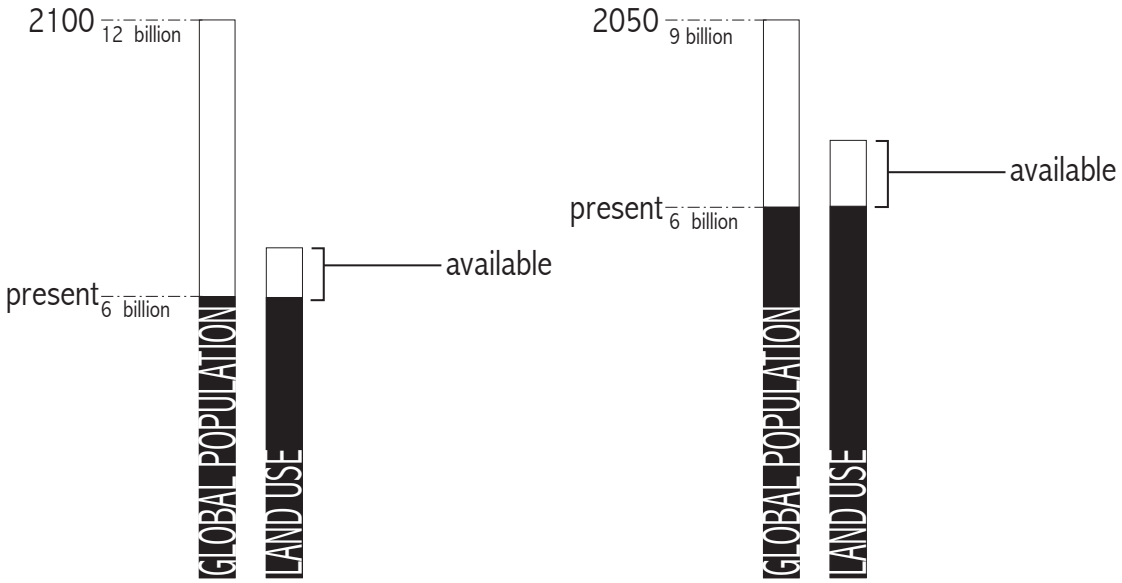


figure 5: A juxtoposition of expected populaiton increases and available arable land reveal a serious problem. Existing agricultural techniques are unable to support the world's growing population.

The net result of the widespread adoption of monocropping is evident throughout the agricultural world. 30% of the earth's topsoil has been lost due to erosion since 1960. Agriculture is responsible for 70% of global fresh water use, which is exacerbated by the fact that 40% of the world's population lives in regions competing for shared water resources.[16] Soil degradation and desertification are raging across the globe, resulting in even more fertilizer use.

In an ironic and telling example, increased use of pesticides [up 3,300% since 1945] has not increased their overall effectiveness - crop loss to pests has increased by 20%.[17] This startling statistic, a testament to the resilience and adaptability of natural systems, reveals a significant shortcoming of monoculture, as pests are able to easily work within a non-diverse plant environment.

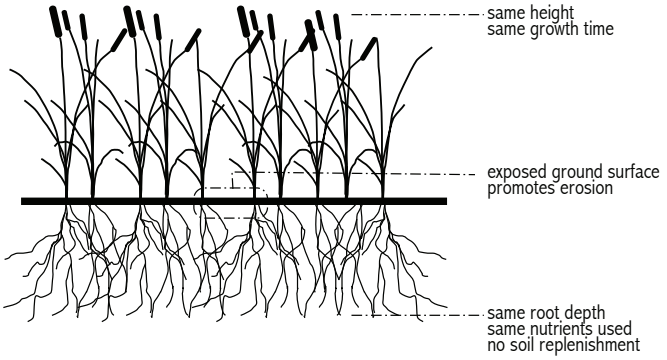


figure 6: typical monoculture environment

Twentieth century farming has become entirely dependent upon petroleum-based products. Whether they were forced to apply artificial fertilizers to prop up overused soil, lay down herbicides to prevent weeds, or spray pesticides to manage pest outbreaks, “suddenly, for the first time in ten thousand years of agriculture, farmers were beholden to the protection ring of petroleum and chemical companies, and were said to be growing their crops not so much in soil as in oil.”[18]

Much of the 20 million tons of fertilizer used annually,[19] as well as the millions of tons of pesticides and herbicides, in the United States finds its way into our streams, rivers, bays, oceans, and drinking water. Modern phenomena such as fish kills, red tides, acid rain, and the destruction of coral reefs are a direct result of modern agricultural practice. A particularly notorious example is the Gulf of Mexico’s infamous “Dead Zone,” a 20,000 square kilometer hypoxic zone at the mouth of the Mississippi River where marine life is virtually non-existent.[20]

Agriculture is the highest polluting industry in the United States. In addition to runoff into water systems, it is also responsible for loss of biodiversity, pesticide pollution, nitrogen pollution, soil depletion, erosion, siltation, eutrophication, desertification, and salinization.

Distribution

There are two important preconditions for the rise of an agricultural society. The first is environmental catastrophe. The annual flooding of the Nile and the Mississippi or the fires of the southwest all created an environment in which man could begin to control what plants grew up from this *tabula rosa*. Eventually, mankind began simulating these environmental disasters. The flooding of rice fields in Asia Minor or the slash and burn agriculture in rain forests are smaller, controlled versions of naturally occurring disasters upon which early agricultural societies relied.

The second precondition is the existence of a local and easily domesticated plant species. Each geographic region developed such a species based on local climactic, hydrologic and geological conditions (rice in east Asia, maize in America, and wheat in Eurasia). While each climate zone chose different species upon which to build their surpluses, what is common throughout agricultural history is that each society became dependent upon a single crop, and always a grain.

The challenge with grain-based agricultural systems is that they require some degree of post-production to become edible. Whereas one could simply grow, pick, and eat a cucumber, wheat requires many intermediate steps, including milling, baking, and other processes. The result is a contemporary distribution system in which food processing companies control what food we get and how we get it. This is dangerous for many reasons.

First, the giant food processing companies, 5 of which are responsible for 75% of corn production and 4 of which produce 80% of the country's soybeans,[21] are geographically segregated from the consumers, resulting in an extended and gasoline dependent distribution system. It also gives these companies significant political power. It would make sense that the growers get the most profit from food sales, yet because of the Farm Bill's complex and convoluted subsidies system, the food processing companies are able to buy surpluses of grains for extremely cheap. The result is that food has become as much a political tool as a necessary means for human survival.

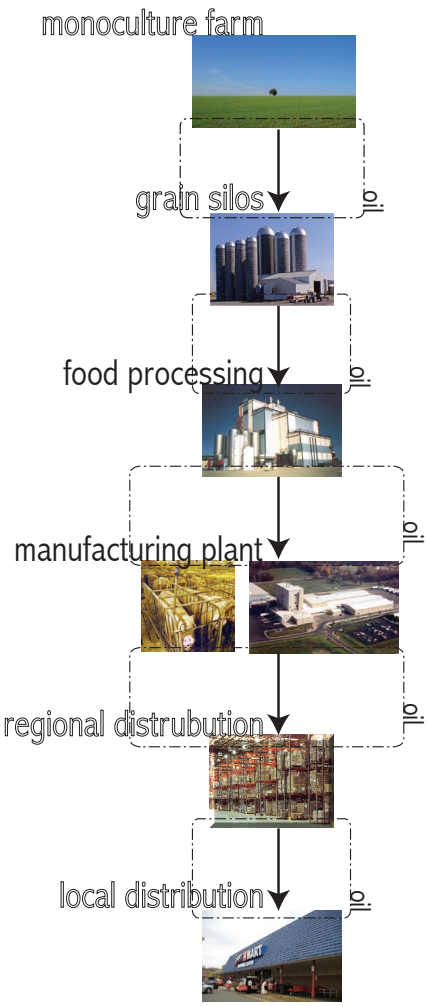


figure 7: The typical process of converting a single corn kernel into an accessible and edible food product consists of an assortment of energy intensive processes. This process takes 10 calories of fossil fuel to create 1 calorie of food energy.[22] Additionally, greater distances make the preservation and transportation of fresh produce more difficult and energy inefficient.

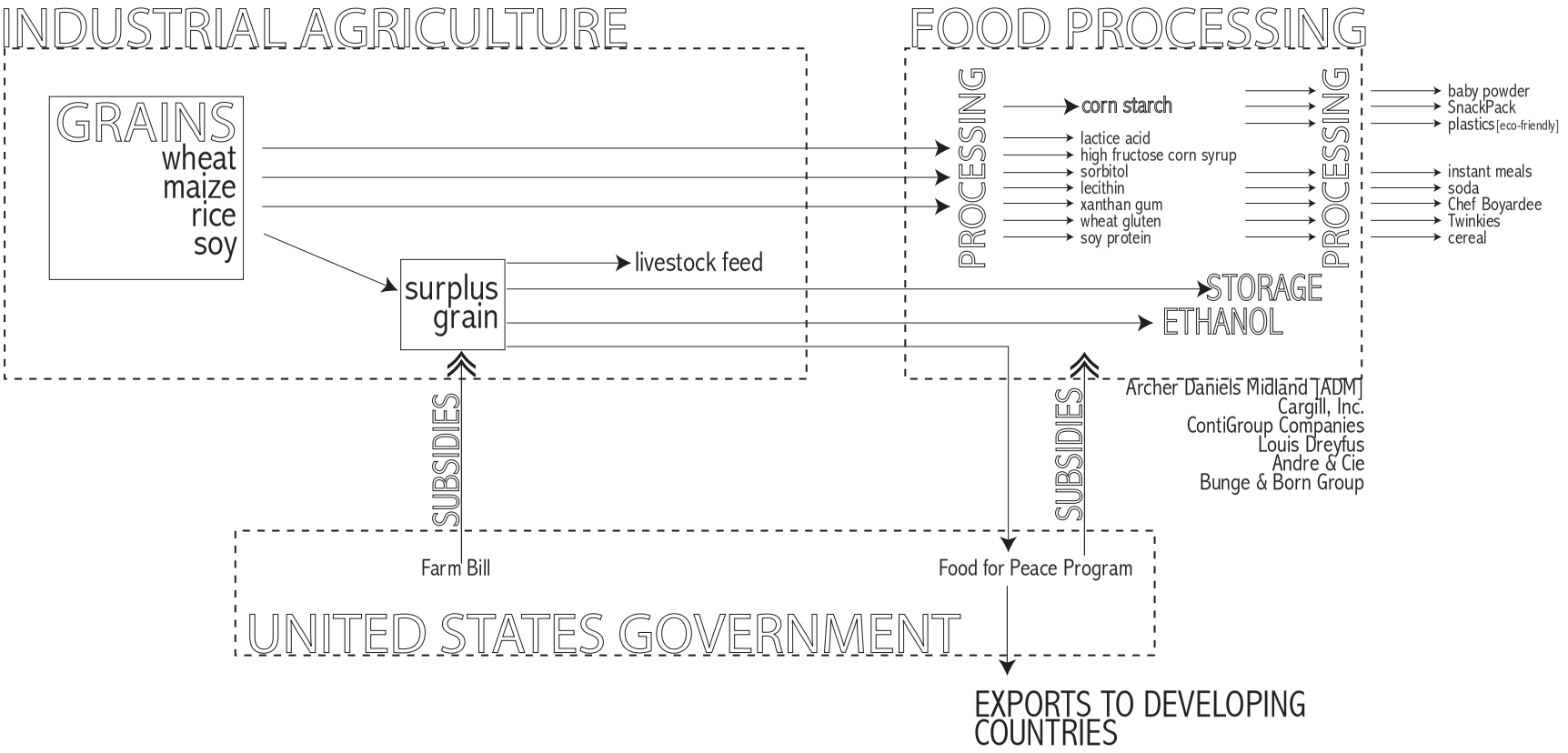


figure 8: The US goverment, through the Farm Bill, keeps corn prices arbitrarily low, resulting in cheap corn surpluses for food processing companies and, ultimately, cheap processed food for the general American consumer. Government owned surpluses are also used as political capital in foreign relations.

Of course, we are still capable of obtaining foods other than grains, but the source of these foods is rarely local. The average produce item travels 1,500 miles, costing one gallon of fossil fuel for every one-hundred pounds (if shipped by truck) In New York, 75% of apples are from the West Coast or overseas, even though the state produces more apples than city residents consume.[23] Benefits of eating locally produced food include freshness, taste, community cohesion, preserving open space, and, most importantly, reducing the agricultural industries dependence upon oil. As the oil age draws to a close and gas prices climb, the need to reduce “food miles” will become even more important.

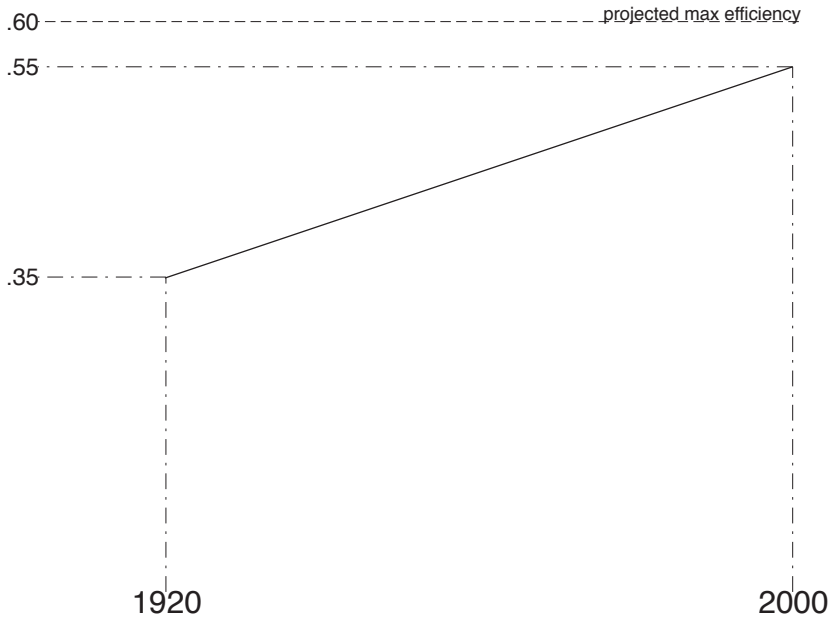


figure 9: The harvest index has nearly doubled since 1920 and is nearing its projected maximum. There are no forseeable technologies that will greaty increase yield per acre efficiency.[24]

Consumption

Equally important as the environmental and production deficiencies of monoculture is the resultant monodiet. Fifty seven percent of the average American's diet comes directly from corn in the form of inexpensive and convenient processed foods.

The extent to which Americans are dependent upon corn is even greater. The majority of the dairy and meat products that supplement our diets come from animals raised on corn, despite the fact that most animals are not genetically disposed to digest it and that meat from corn-fed animals has a much greater percentage of fat than grass-fed livestock.[25]

The American dependence upon low-cost, corn-based food is merely the contemporary manifestation of a trademark of any agricultural society – a division between rich and poor. Whether through feudal kingdoms or government endorsed corporate control, the poor in every agricultural society have been forced to subsist on the empty calories generated by a dominant grain. While the healthier fruits and vegetables have been cultivated throughout history, they have been the exclusive privilege of the wealthy.

A pivotal theme in Richard Manning's *Against the Grain* is that the search for food (and sex) is the fundamental task of humanity. Thus, throughout time, food became a defining characteristic of both culture and class. Food, as the definer of culture and self-preservation, is saddled with significant power and responsibility. Agriculture exploits this power by exaggerating class and cultural differences. Consequently, food is no longer the binding force of a hunter-gather society but the wedge between people in a cultivated civilization.

“We are called to be architects of the future, not its victims.”

-R. Buckminster Fuller[26]

Vision

Urban Agriculture Revolution

The world's population is growing, and the current, rural-based agricultural model is clearly unable to support a future urbanized world. There is however, a burgeoning, grassroots movement that has the potential to radically change the nature of food production.

> *There is a quiet revolution stirring in our food system. It is not happening so much on the distant farms that still provide us with the majority of our food; it is happening in cities, neighborhoods, and towns. It has evolved out of the basic need that every person has to know their food, and to have some sense of control over its safety and security. It is a revolution that is providing poor people with an important safety net where they can grow some nourishment and income for themselves and their families. And it is providing an oasis for the human spirit where urban people can gather, preserve something of their culture through native seeds and*

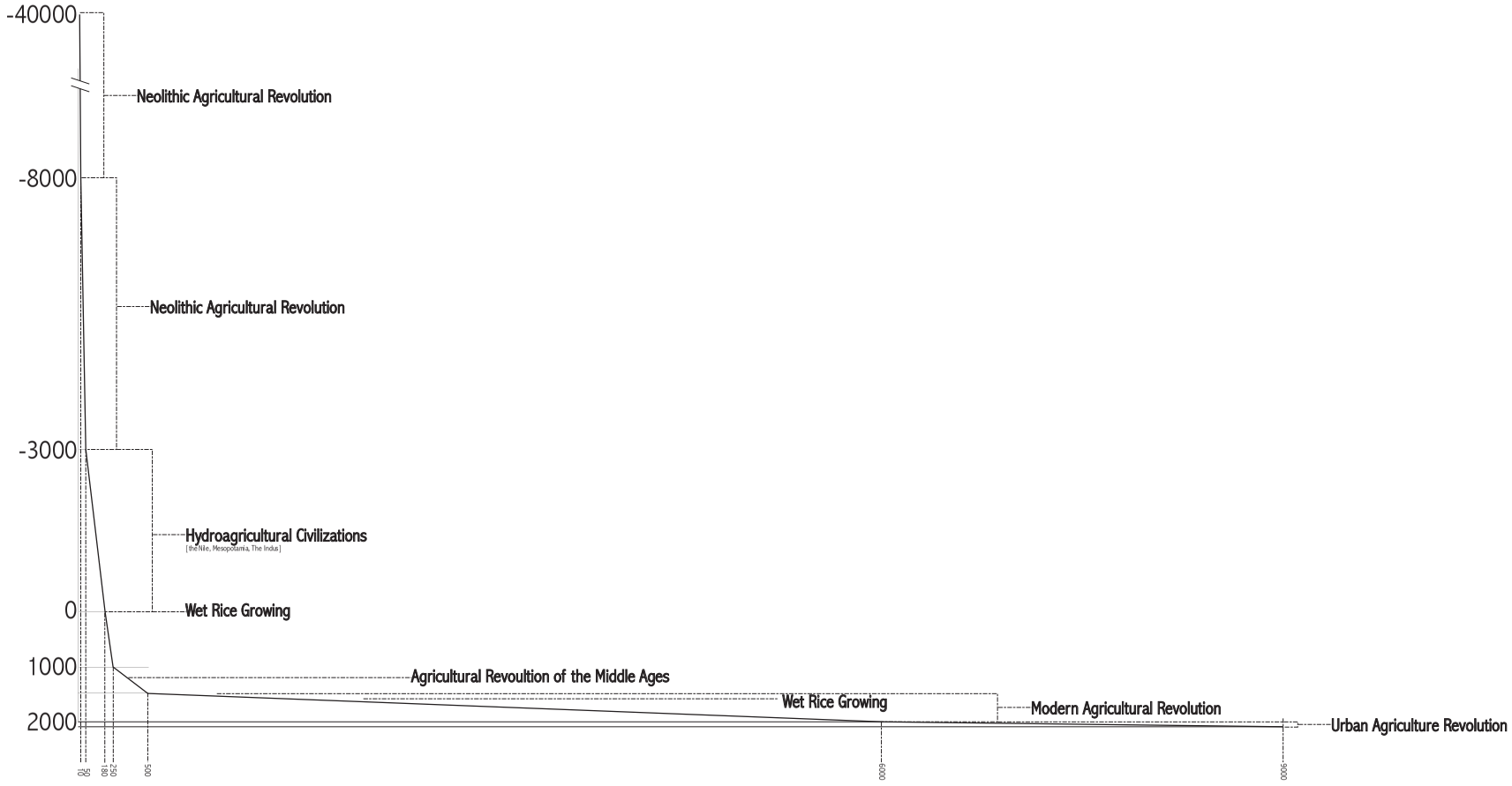
foods, and teach their children about food and the earth. The revolution is taking place in small gardens, under railroad tracks and power lines, on rooftops, at farmers' markets, and in the most unlikely of places. It is a movement that has the potential to address a multitude of issues: economic, environmental, personal health, and cultural.[26]

Worldwide, over 800 million people are engaged in some form of urban agriculture (UNDP 1996, FAO 1999), which provides solutions to many of the problems latent in the existing model of food production. By allowing individuals to feed themselves, eliminating transportation, and providing cheap and convenient fresh produce, urban agriculture has the potential to empower neglected city residents, eliminate food production's dependence on oil, and end the over-consumption of corn-based, empty calories.

In addition, the scientific and architectural communities have also become engaged in advancing the cause of urban agriculture. A host of technologies, including hydroponics, aeroponics and aquaponics, which allow for 24 hour, year-round, indoor farming, have dramatically changed the nature of food production. Previously controlled by environmental conditions such as sunlight, rainfall and soil nutrition, indoor farming is free from these limitations, allowing for radical new visions for how farming can inhabit cities.

In particular, Dr. Dickson Despommier, Professor of

figure 10: Population growth has occured in major spurts, each of which is created by a significant change in agricultural techniques and efficiencies. The Modern Agricultural Era is being replaced by an Urban Agriculture Revolution, which will allow for the continued growth of the human species.



Environmental Health Science, has been intensively researching the potential viability of vertical farms. His research proves that they can be both spatially efficient and self-powered. In concert with his students, he has proposed a 30-story tower capable of feeding 50,000 people.[28]

Yet, while organizations around the world, including the Food and Agricultural Organization of the United Nations, are actively supporting this emerging revolution, efforts thus far have focused on small scale, individual and community based farming.

This thesis asks the question, what would an institutional manifestation of urban agriculture look like? What if the US government became interested in investing in a new sustainable, urban infrastructure? What if infrastructure was used as a pedagogical tool in the service of yielding knowledge?

Yielding Knowledge

The fundamental difference between urban and rural conditions is not limited horizontal surface but an abundance of people. The proposal of this thesis, Baltimore Farm Works capitalizes on this unique opportunity by extending the traditional notions of farming to include not only food, but also energy, water, and most importantly, knowledge. In doing so, the institution defines yield not as soley food production, but as the creation of value.

In the case of Baltimore Farm Works, the social value of an empowered population capable of supporting themselves through urban farming far outweighs any productive efficiencies it could acheive. This broader understanding of yield obligates Baltimore Farm Works to simultaneously be a didactic and productive device and shapes the mission of the government funded, public institution. Baltimore Farm Works, is dedicated to the research and advancement of urban agriculture, as well as the discovery and dissemination of urban agricultural techniques.

The audience for Baltimore Farm Works is simultaneously widespread and local, as it consists of daily inhabitants, the occasional visitor, and the non-visitor. Local

neighborhood residents, faculty members [permanent and visiting], students [attending and visiting], farmers, and tourists will all play an active role in the sharing and distribution of knowledge.

Both a place of production and learning, Baltimore Farm Works is simultaneously a school and working farm. The academic curriculum, which will consist of apprenticeship programs as well as more formal academic and research environments, will utilize the actual production and distribution of food, energy, water, and knowledge as laboratories in the study of urban agriculture.

While the majority of learning will take place through the act of farming, educational research support spaces such as classrooms, labs, student services, administrative facilities, and a public lobby will also be included in the program. The internal program is designed to foster interaction between the various researchers. The traditional classroom model is eschewed in favor of a more open, flexible learning environment where multiple types of activities can be supported simultaneously. This includes spaces for individual study, small group study and large group study in addition to the requisite lecture halls and labs. The labs themselves are more compartmentalized in order to maintain control over lighting and air quality, but the open and flexible spaces will also support growing experimentation at a variety of scales, from windowsill gardens to interior courtyards.

It is in this flexibility that Baltimore Farm Works acheives the second goal of a yielding architecture. Adaptable and reconfigural spaces along with multi-use environments allow for the institution to evolve according to a changing spatial needs. Rooms can be combined, subdivided, or reprogrammed as the curriculum and pedagogy of the school transforms over time.

Baltimore Farm Works' experimentation will also include various methods of distributing food. A school-run grocery store, restaurants, farmer's markets, as well as other experimental and local distribution strategies will also be explored.

In addition to the farming of food, Baltimore Farm Works will also be employed in the practice of farming energy and water. The energy collection devices, which include photovoltaic devices and wind and water turbines, will be dispersed throughout the site allowing for temporal and typological flexibility. An additional energy source will be the non-edible biowaste that is produced by the farming activities of the Farm. This is a simple process with little spatial obligations, as it can take place in small and flexible containers. In addition to energy farming, reclaimed water will be used for irrigation and for non-potable human use. Along with water collected from within the site itself, adjacent water sources, including city wastewater can be utilized. The infrastructure of Baltimore Farm Works has been designed to reveal and express these processes of collecting, distributing, and reclaiming these water and energy resources in order to support its educational goals.

Engaging the public is as important to Baltimore Farm Work's mission and pedagogy as internal research and production. In addition to directed and supported community gardens, Baltimore Farm Works will also operate the Baltimore Agricultural Museum which, in addition to providing an educational resource, will also work with local communities to expand urban agricultural practices throughout the city.

The act of learning can take place at any time and in any situation. As such, in designing a place of learning, it is important to consider the various ways in which the site and the architecture can support the pedagogical goals of the institution and also act as didactic devices. Architectural systems can actively encourage individuals to reconsider their preconceived notions about farming and natural/artificial landscapes. Baltimore Farm Works uses its public space as instruments through which the general public can also be engaged with the educational agenda of the institution.

“This is the landscape that nobody wants. Its my cup of rejection . . .”

-Frederick Turner[29]

SIT[E]UATION

DROSSCAPE

"Drosscape is the creation of a new condition in which vast, wasted, or wasteful land surfaces are modeled in accordance with new programs or new sets of values that remove or replace real or perceived wasteful aspects of geographical space. Drosscaping, as a verb, is the placement upon the landscape of new social programs that transform waste (real or perceived) into more productive urbanized landscapes to some degree." [30]

During the last half-century, the industrial landscape of the United States has shifted from a Fordist economic model characterized by centralization in urban centers to a post-Fordist economy where industry is set about along the periphery of cities. The Fordist model is based on efficiencies produced by economies of scale, resulting in single, large complexes built around shared transportation systems. The post-Fordist model, on the other hand, relies on flexibility provided by multiple centers. smaller-scale infrastructure, as well as the smaller organizational hierarchy, allow for rapid change. Companies are then able to quickly respond to changing trends in consumption and demand.

The post-Fordist model is simultaneously a response to and cause of a dramatic 50 percent decrease in urban population density since 1950.[31] Fueled by inexpensive, convenient, and rapid transportation, as well as advances in communication technologies, the inefficiencies associated with spatial separation are now outweighed by the capability to be responsive and adaptable. Industrial de-urbanization has left more than 600,000 abandoned and contaminated sites have been identified within the United States since 1990.[32]

These waste landscapes, which Alan Berger calls "Drosscapes," are the contemporary worlds "in-between spaces," as they exist in "the wake of the socio- and spatio- economic processes of deindustrialization, post-Fordism, and technological innovation."[33] Such spaces exist at any scale, with various degrees of contamination, and in every city in the former industrialized world. Further, drosscapes are ideal opportunities for designers to creatively reintegrate both spatial and pollutant waste left by the economic and social processes of the last fifty years.

Additionally, the loss of community that the suburbanization of America's cities has created is a well-documented problem facing contemporary urbanism. Abandoned or brownfield sites provide unique opportunities to re-pop-

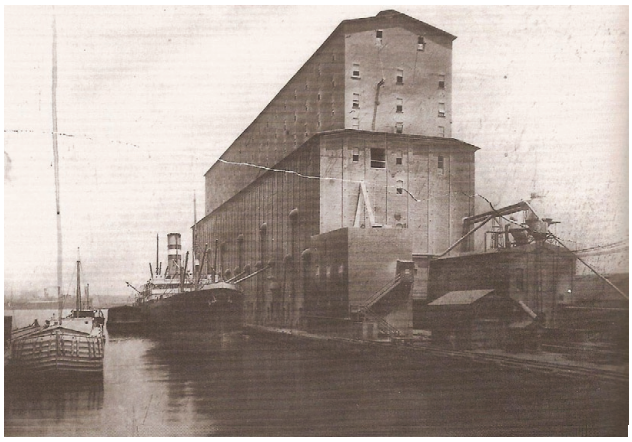


figure 11: The B&O warehouse was destroyed by a fire in 1922.

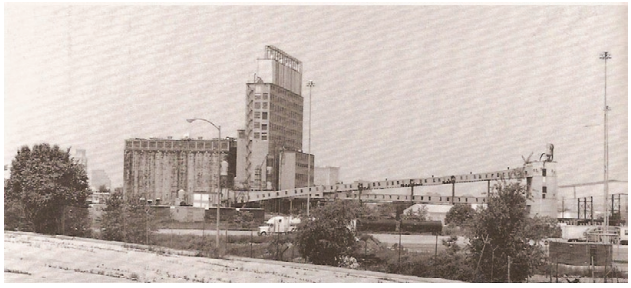


figure 12: The fomer ADM grain elevator and silos has been converted into residential condominiums and townhomes.

figure 13: The still active Domino Sugars Factory opened in 1922.

ulate American cities. Baltimore provides a strong test case, as its history follows the path of a typical American post-industrial city.

Baltimore's growth was dependent upon its port, and its port dependant upon the grain trade. Throughout the 18th century, Baltimore remained a relatively small town, whose economy was based on tobacco shipping. In 1750, however, John Stevenson experimentally arranged a shipment of flour from the city. This simple act kicked of an incredible growth spurt for Baltimore, which, due

figure 14: The 1901 sanborn map reveals a grid aligned to face the Inner Harbor to the northwest.

figure 15: This 1860's engraving highlights the former path of the Jones Falls, which is currently beneath the I-83 for much of its run.

to its proximity to the Pennsylvania and Maryland wheat fields, access to the sea, and fast moving rivers for powering mills, was ideally situated for flour export. The early 19th century creation of the Baltimore & Ohio Railroad, extended the reach of Baltimore's port, spurring even greater economic and physical expansion. In addition to flour, Baltimore also became the nationwide leader in shipbuilding and other industries, such as can manufacturing. The intensity of food industry had an impact upon the formal character of the city. Grain silos, warehouses, and elevators were and still remain iconic forms along the waterfront.[34]

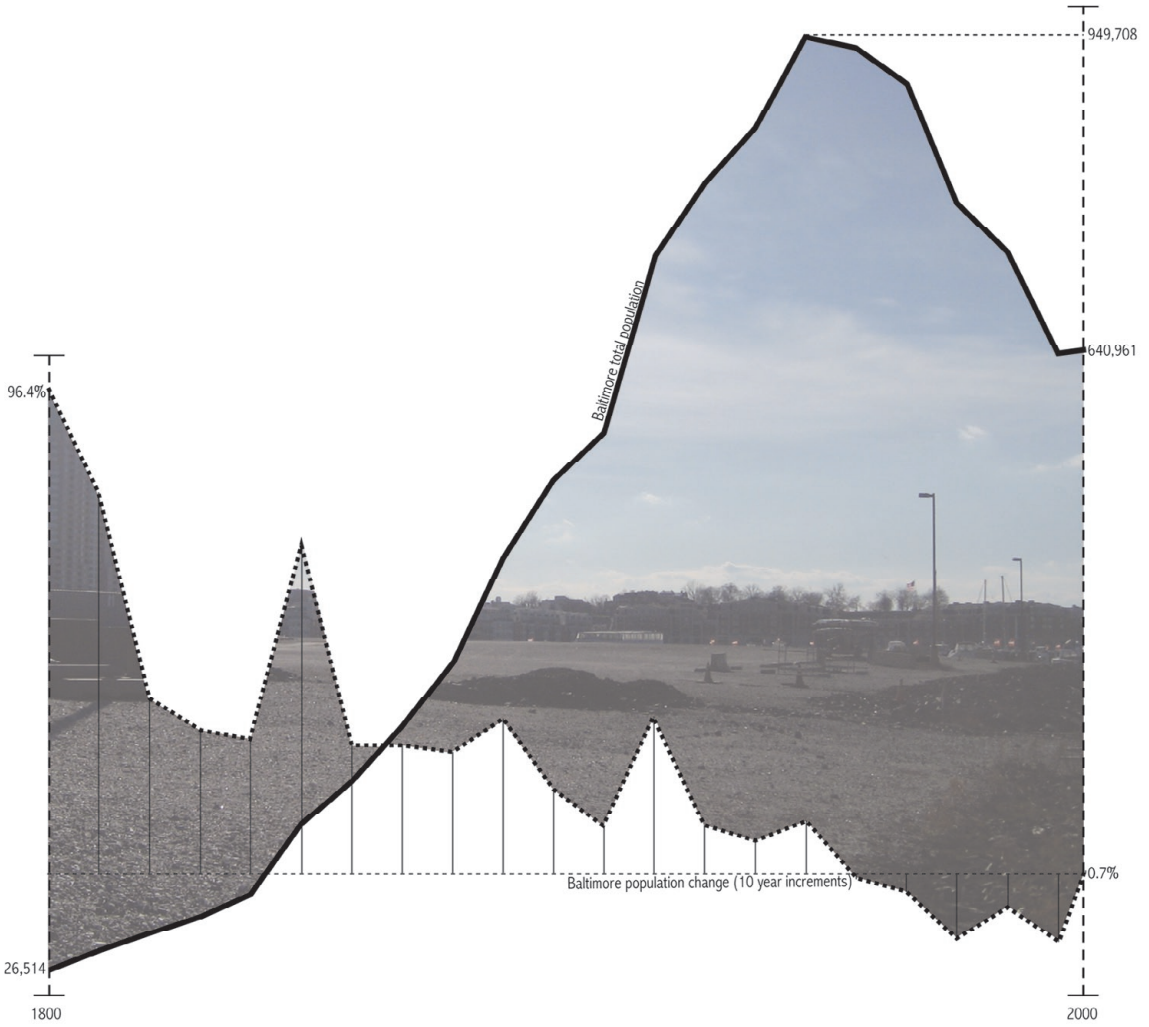


figure 16: The flight of industy and manufacturing from the city center conincided with a reciprocal drop in population.

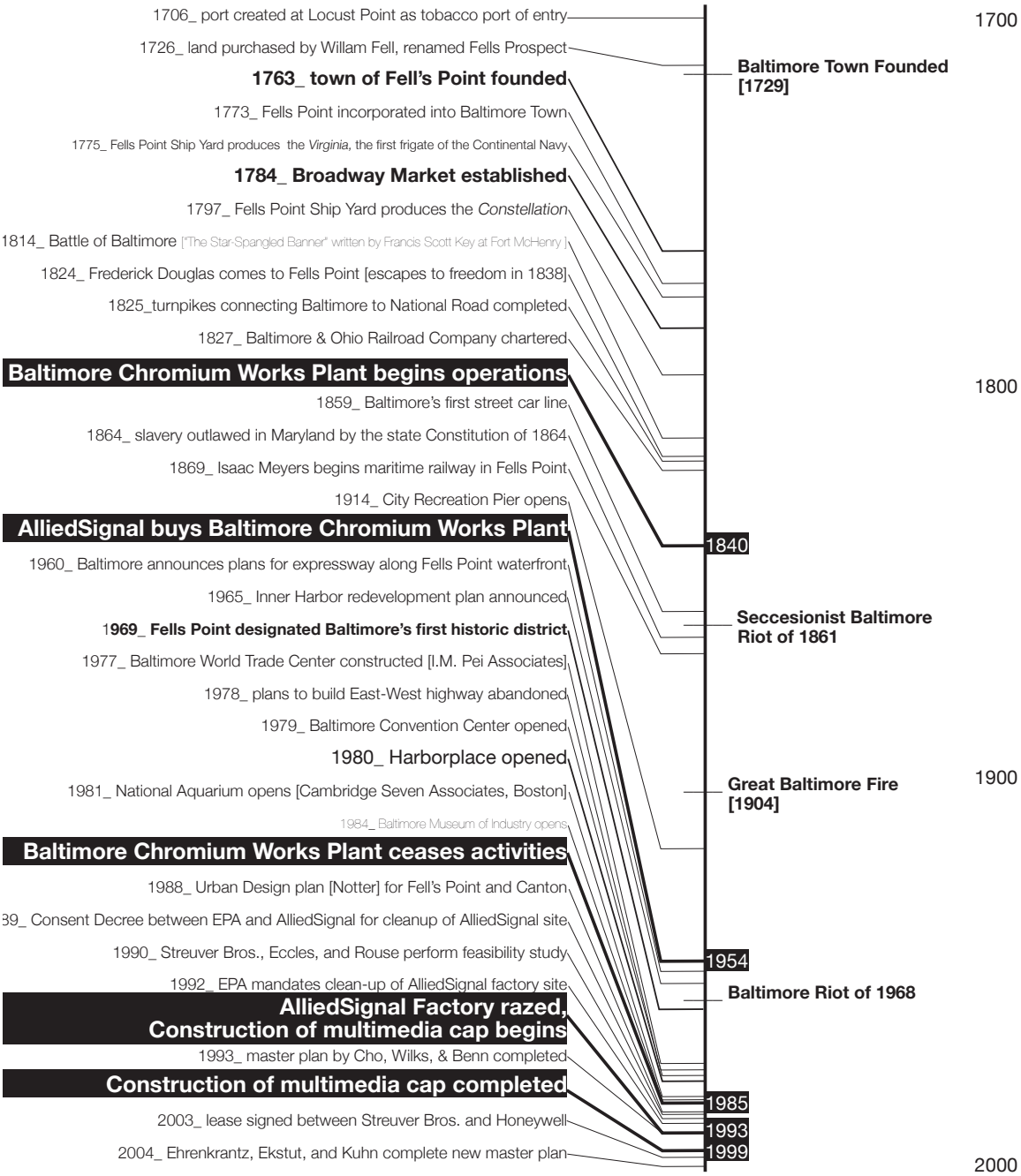


figure 17: timeline of Baltimore history

figure 18: An 1869 reveals Baltimore Harbor's active, industrial history.

figure 19: Baltimore Harbor in the 1960's, prior to redevelopment.

Baltimore's Inner Harbor existed as a working industrial center for most of the city's existence. As industry decentralized over the last half-century, the warehouses, lumber yards, docks, and cranes that occupied the many piers that dramatically protrude into the harbor have been replaced or refitted with museums, theatres, restaurants, hotels, retail, housing and various open spaces capable of supporting a wide range of activity.

This former drosscape is an ongoing experiment for the potential of former waste landscapes, particularly those situated along social amenities such as harbors and rivers. However, its successes, which include a publicly accessible waterfront and a re-enlivened downtown, are driven by commercial activity and tourism.

Baltimore Farm Works, on the other hand, is an act of urban renewal based upon a consumerism of need, rather than a consumerism of greed. Whereas the Inner Harbor's success depends on uncontrollable economic conditions, an infrastructure founded upon fundamental human needs has a much greater capability to withstand changing social and economic seasons. As opposed to houses for expensive shops and restaurants, these former industrial agglomerations can be transformed into symbolic, interactive, flexible, and productive public spaces. In short, these spaces have the potential and obligation to yield in ways unseen in America's cities.

Chromium Works

The particular site chosen for Baltimore Farm Works is that of the former Baltimore Chromium Works, from which the institution derives its name.

The site of the former Baltimore Chromium Works Plant was first obtained by English Quaker immigrant William Fell in 1726. Primarily a marshland consisting of cedar and oak, woods perfect for shipbuilding, the site rapidly grew in both economic significance and overall land mass. The Fells Point neighborhood, which was officially founded in 1763 and incorporated into Baltimore Town in 1773, quickly became the nations leading ship manufacturer. The invention of the steam ship drastically altered the economy of Fells Point, which then transitioned into manufacturing, while still maintaining it role as the primary merchant port in the Chesapeake Bay.[35]

Chromium manufacturing began at the site in 1845 when Isaac Tyson began producing potassium bichromate on the north side of the 1300 block of Block Street. The plant quickly grew in size, filling out the entire block and the narrow block to the south. The sites expansion continued following a 1908 acquisition by the Mutual Chemical Company and the final ownership transfer to Allied Chemical Corporation (later Allied Signal, Inc.) in 1945 until the entire peninsula consisted of various buildings in the service of chromium production.[36]

Work on the site ceased in 1985 when large amounts of chromium were detected seeping into the harbor waters. Since then, an elaborate cleanup and restoration process has transformed the site into what is today a field of asphalt. The site is still owned by Allied Signal, which changed its name to Honeywell, Inc., and is currently being developed by a team consisting of Streuver Bros., Eccles, & Rouse and H&S Properties Development Corporation under the terms of a long-term ground lease signed in 2003. The groundbreaking ceremony for the new 1.8 million square foot and $830 million Harbor Point development took place on January 22, 2008.[37]

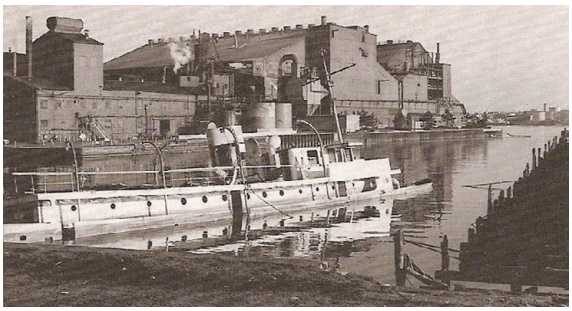


figure 20: Baltimore Chromium Works when in operation.

This current development project is the latest of several proposed schemes, beginning with the Notter, Finegold, and Alexander master plan in 1988, in which the entire peninsula was transformed into a recreational park. Subsequent proposals by Cho, Wilks, and Benn (1993) and Ehrenkrantz, Ekstut, and Kuhn (2003) provided a much smaller public open space on the southwest corner surrounded by a dense mixture of office, retail, and residential uses.

Whether creating a large-scale urban park or a new-urbanist, mixed-use master plan, none of the previous proposals re-imagine the site as a piece of public infrastructure, fulfilling a variety of physical, social, and political needs. Additionally, none of them capitalize on the site's incredible visibility in an effort to create a new, didactic and productive [yielding] icon for the city and its residents and visitors.

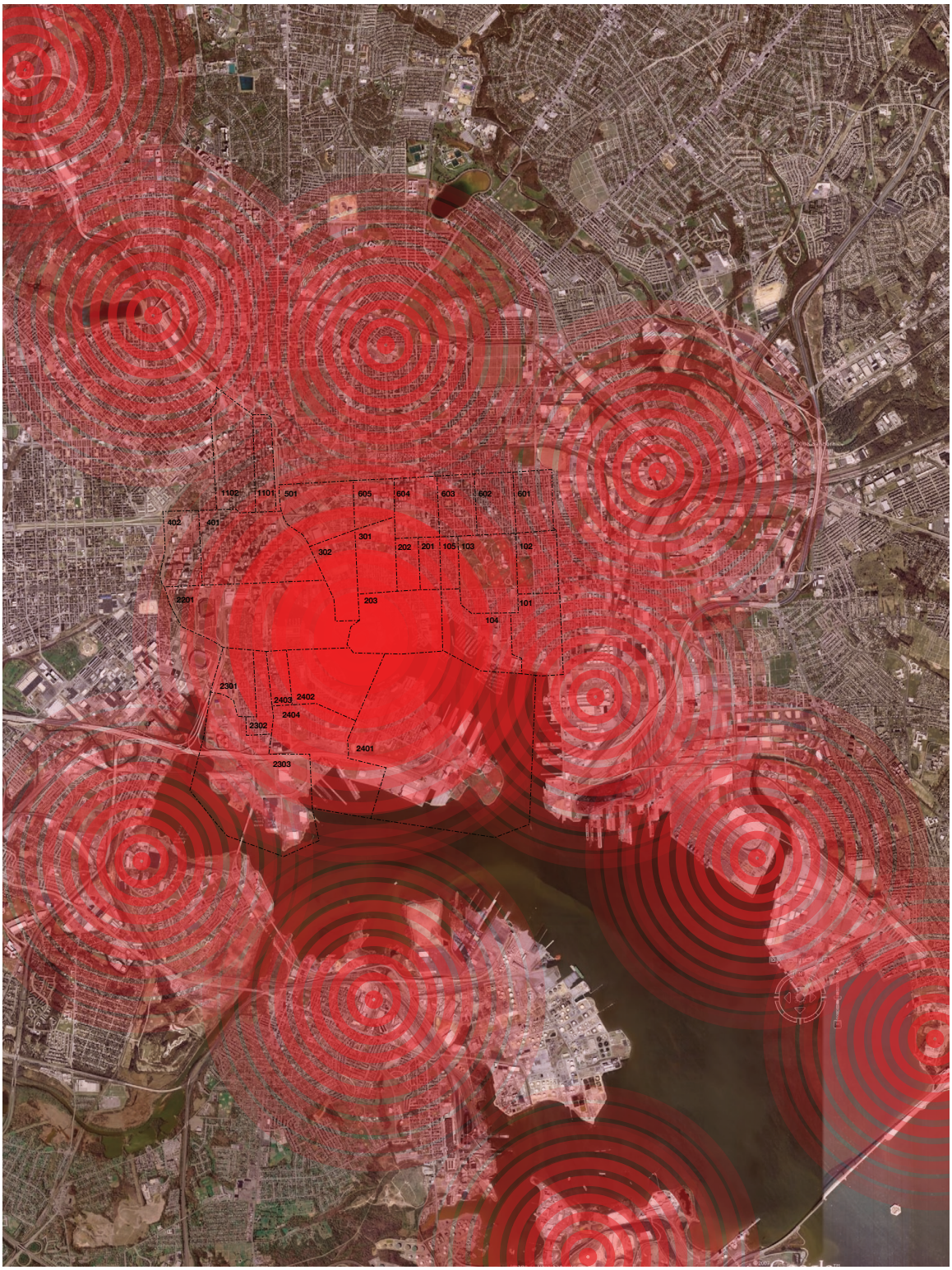


figure 21: Satellite image with census data. The potential expansion Farm Works facilities could mirror the spread of industry along the harbor and up the Jones Falls.

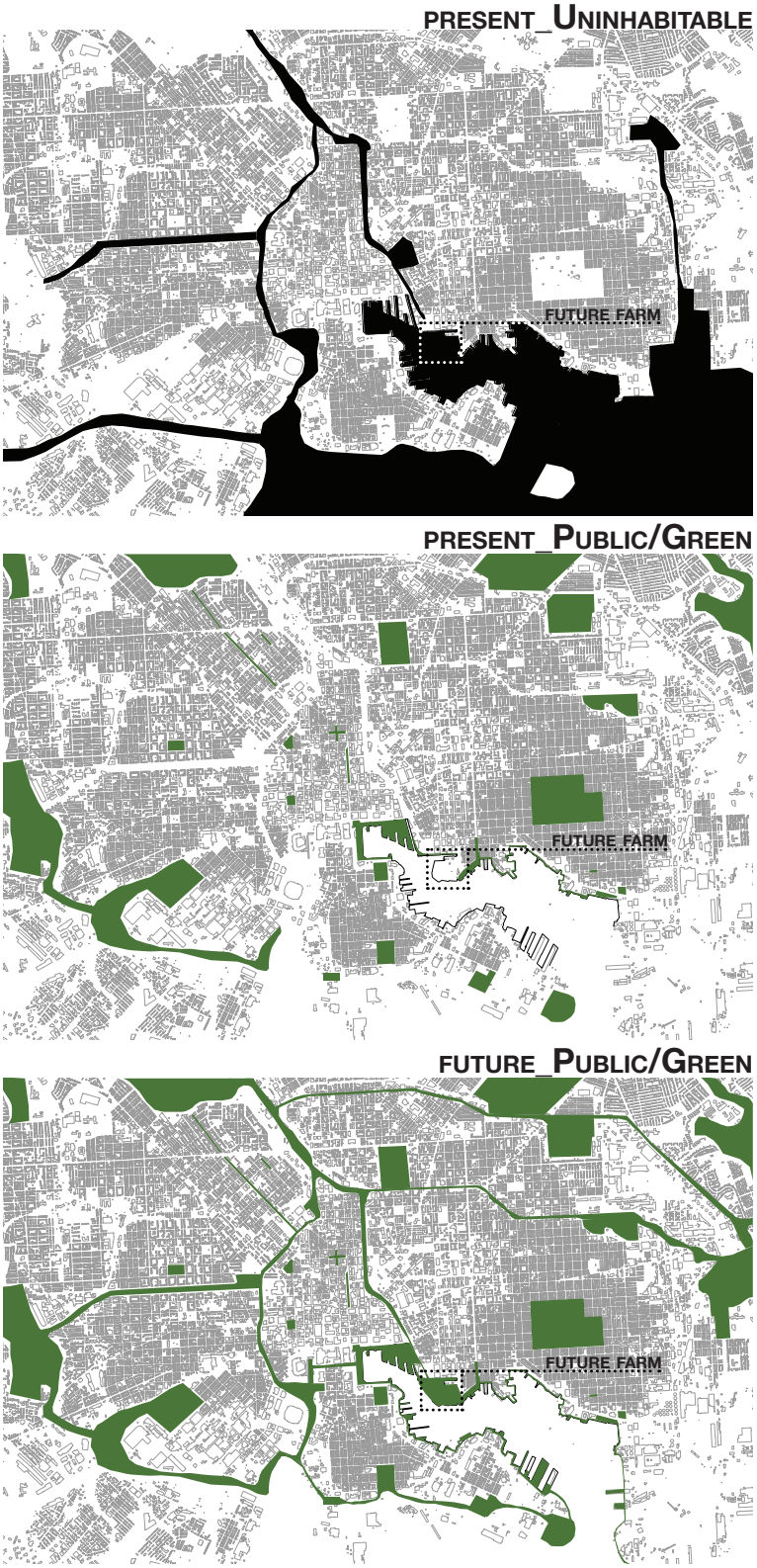


figure 22: future urban park network: *yielding* greenways replace highways and infiltrate medians, creating a series of public and productive connections.

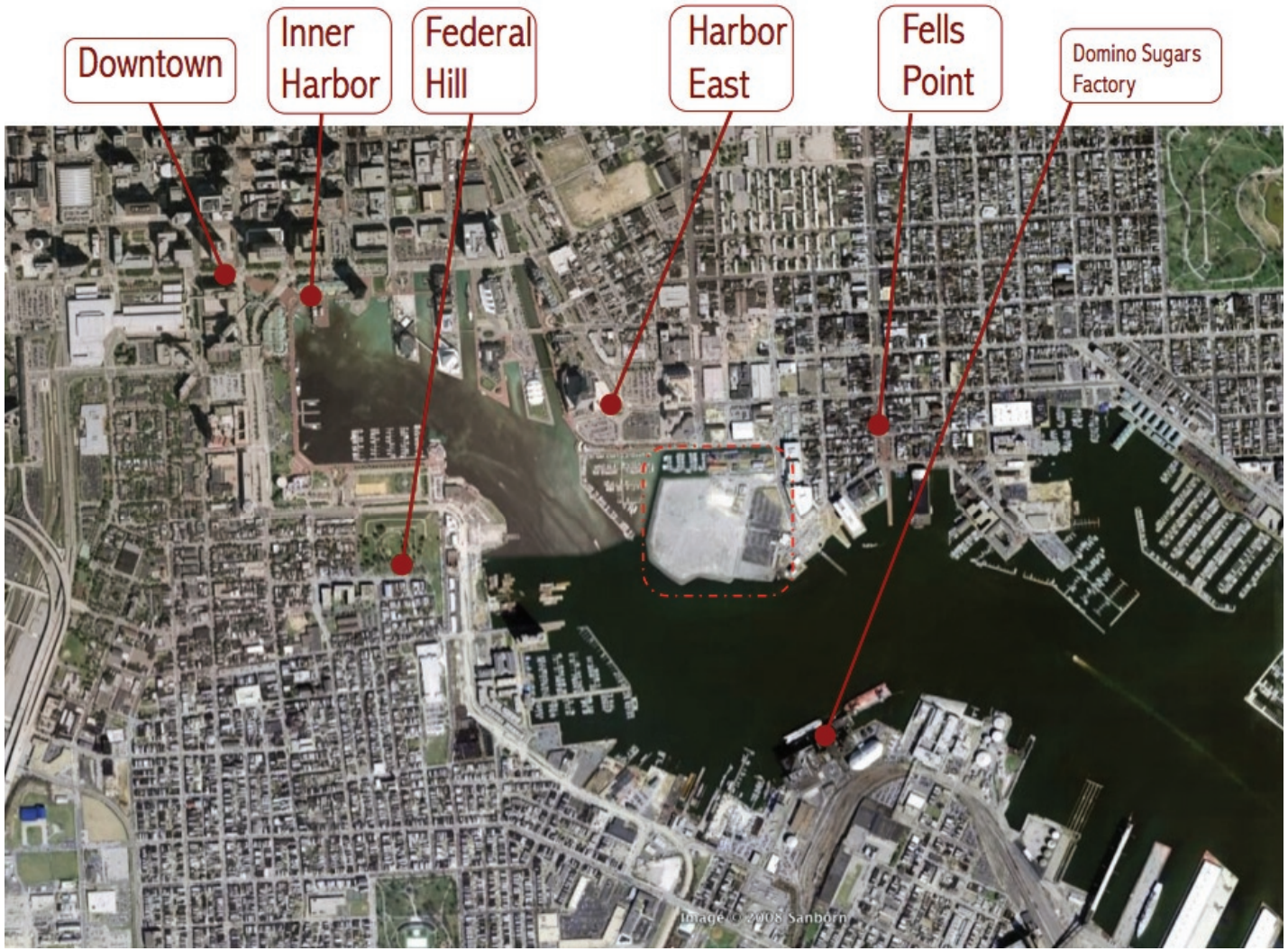


figure 23: context diagram locating adjacent neighborhoods.

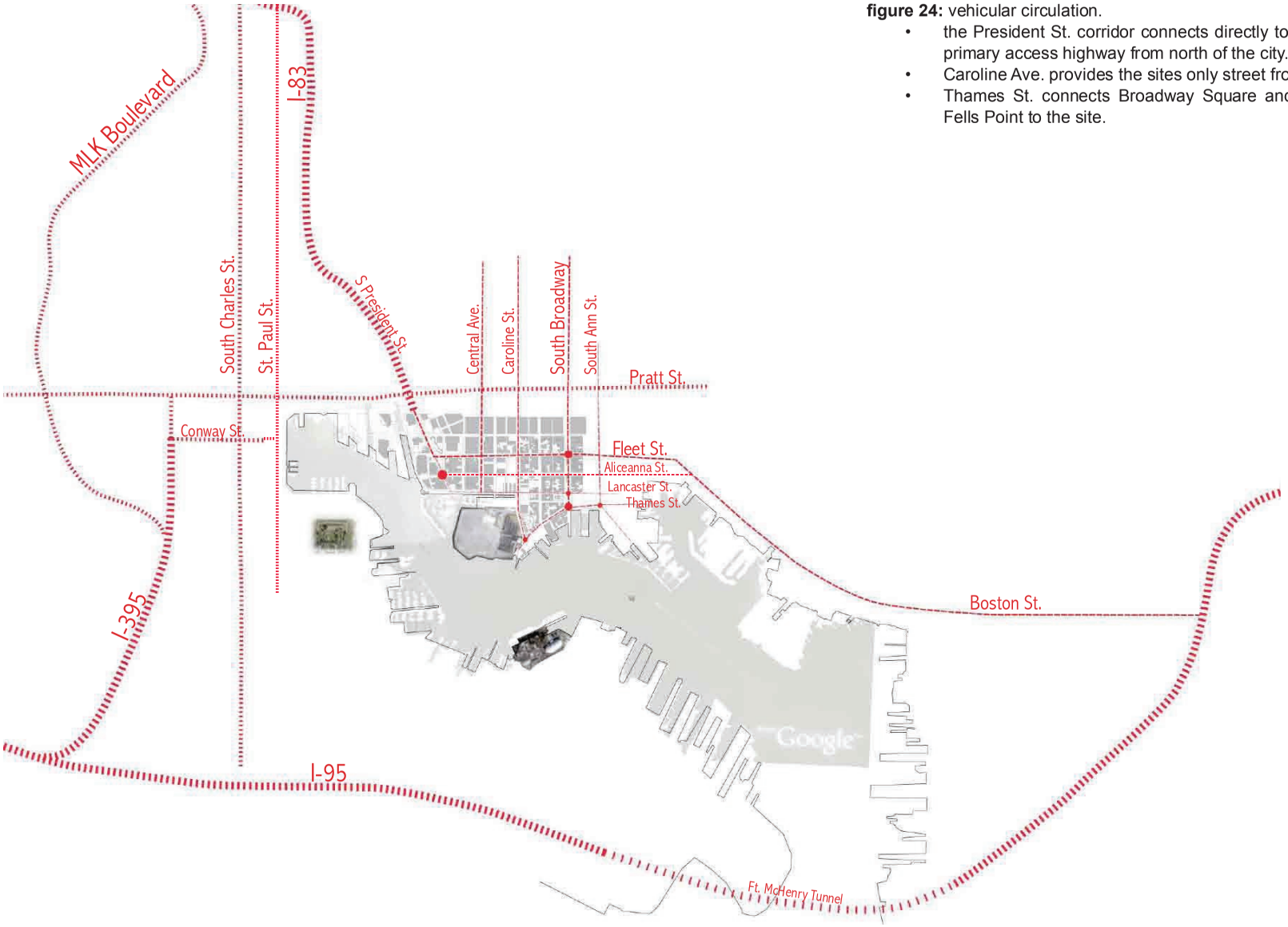


figure 24: vehicular circulation.

- the President St. corridor connects directly to I-83, an primary access highway from north of the city.
- Caroline Ave. provides the sites only street frontage.
- Thames St. connects Broadway Square and central Fells Point to the site.

figure 25: maritime transportation. A 50' deep shipping channel is maintained by the Army Corps of Engineers and extends to Domino Sugars Factory. The majority of boat traffic in the harbor is recreational, including water taxis, which skip over western Fells Point.

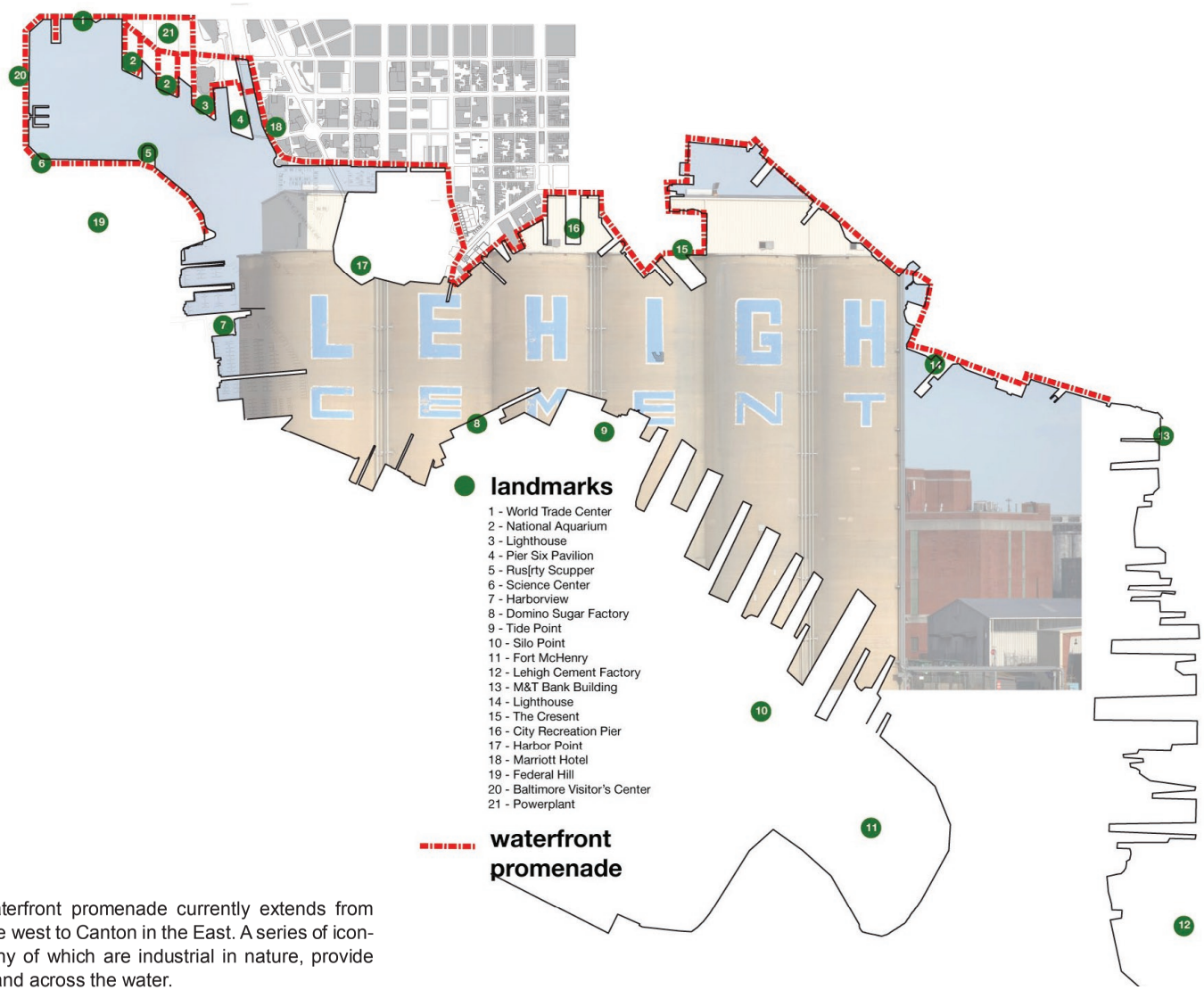


figure 26: Baltimore's waterfront promenade currently extends from Federal Hill in the west to Canton in the East. A series of iconic buildings, many of which are industrial in nature, provide visual foci from and across the water.

figure 27: coastal mophology. The outlet of the Jones Falls was formerly a large wetland.

figure 28: plan view of the existing site conditions. The 27.35-acre site measures approximately 1300 feet east to west and 1200 feet north to south The dashed line notes the extent of the bulkhead line.

Chromium Containment

During its 140 years of operation the Baltimore Chromium Works Plant produced 50,000 tons of chromium a year. Following the plants closure in 1985, it was found that chromium was still seeping into the harbor at a rate of 50 pounds per day. An additional 12 pounds per day was found entering the deep groundwater system.[40]

A 1989 consent decree sponsored a 10-year cleanup and prevention project, which isolated 15 of the site's 27 acres for containment. Overseen by the United States Environmental Protection Agency and the Maryland Department of the Environment, the total cost of the cleanup was nearly $100 million and fully funded by AlliedSignal, who remains perpetually responsible for maintenance of the site's monitoring and containment systems.[41]

The cleanup, which began in 1989, consisted of the razing of the AlliedSignal manufacturing buildings and the removal of soils with high concentrations of chromium (over 100 milligrams of chromium per 100 kilograms of soil). Concurrently, the prevention effort began in 1991 with the construction of a rock wall embankment around the perimeter of the site to support a failing bulkhead. In the mid-90's, a three-foot wide slurry wall was also constructed around the waterside perimeter of the site. Made up of a combination of soil and bentonite, the wall extends up to 75 feet down to bedrock. [42]

The containment area is completely contained by a multimedia cap, construction of which began in 1996 and was completed on April 14, 1999. The cap consists several layers: capillary break stone, a geosynthetic clay liner, a flexible membrane liner, geocomposite drainage, cover soil, stone, and asphalt. The cap is tied into the barrier wall, completing the containment structure. [43]

Finally, the "Head Maintenance System" monitors and controls the groundwater level within the site. 16 pairs of monitors (12 deep, 4 shallow), 16 pumping wells (12 deep, 4 shallow), 13 below ground maintenance vaults, and computerized control system ensure that the water level within the cap remains 0.01 feet below that outside of the containment structure. Any excess water is pumped to holding tanks in a two-story Honeywell building, the only building remaining on the site, which also contains the control system. A mandatory one-year verification period was completed in 2001. [44]

figure 29: The multimedia cap extents (hatch) covers only 2/3 of the site. the dashed, grey tone shows the sites original shape and size.

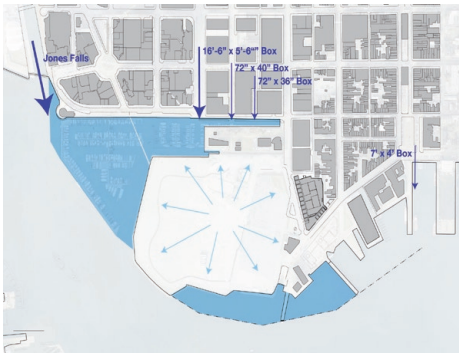


figure 30: site hydology. The site's topography results in drainage patterns in which all water is shed from the center and towards the edges. Three wastewater outlets empty into the canal north of the site. The Jones Falls re-emerges from under a highway and flows directly west of Harbor East.

Chromium, a naturally occurring heavy metal used to make chrome plating and pigments in paints, can exist in multiple forms. One of these, hexavalent chromium, is a particularly dangerous carcinogen. A 2000 study revealed that workers at the Baltimore Chromium Works Plant had double the normal rate of lung cancer, which was attributed to inhaling the hexavalent chromium dust. Over the years, however, as organisms and mineral interact with the buried and dangerous substance, it is chemically transformed into trivalent chromium, which both state and Honeywell officials agree is not dangerous to humans.[45]

Chemical and natural systems have been utilized throughout the world to stabilize soils and even remove dangerous heavy metals. A fool-proof method of removing chromium, however, has yet to be discovered. An additional obligation of Baltimore Farm Works will be the investigation of heavy metal remediation. Thus, an integral component of the institution's program will be controlled and safe environments for the study and experimentation of various remediation techniques.

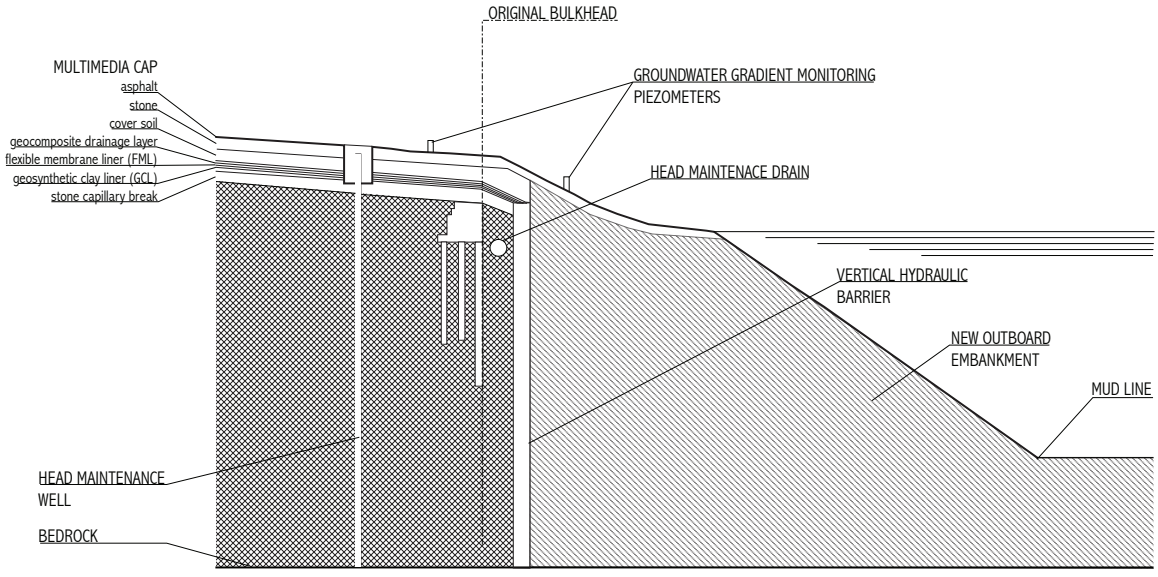


figure 31: existing cap edge section.

Edge Conditions

The site has five unique edge conditions which emerged as important parameters for programming the site. To the north and southeast are educational facilities run by the Living Classrooms Foundation. The northern facility occupies the entirety of the former Caroline St. pier and is home to the Crossroads School and the Milkuski Center for Workforce Development. The Crossroads School is a progressive charter school that draws students from several underperforming schools in eastern Baltimore.

The school's pedagogy is based on learning through doing and utilizes its adjacency to both natural and urban environments as learning opportunities. The facility contains docks, boats, a greenhouse, and a tower from which student can observe and experiment with natural systems. The goals of Baltimore Farm Works are directly in line with that of the Crossroads school. As such, an additional obligation for the institution will be augmenting the existing educational opportunities for the Crossroads School.

figure 32: Edge conditions.

The southeastern facility is the newly completed Frederick Douglass-Isaac Meyers Maritime Park. Named after two historically significant African American leaders with local ties to Fells Point, the institution consists of permanent and temporary galleries, interactive learning spaces, a boat building workshop, a digital arts center, an event space, and an extension of Baltimore's public promenade. The public nature of the museum, and its similarity to the public outreach and education aspirations of Baltimore Farm Works, creates a unique opportunity for shared resources, public space, and amenities.

Across a canal and to the north of the Crossroads School is the in-progress Harbor East development, which consists of 10-30+ story mixed-use buildings. Harbor East is the latest example of re-inhabiting the harbor edge and provides a significant population within walking distance of the site.

The immediate eastern edge of the site consists of modern, mixed used buildings. Beyond is the historic Fells Point neighborhood, which consists of a mix of residential, retail, commercial, and tourist uses. Historic architecture, quaint cobblestone streets, and vibrant public spaces such as Broadway Market and the waterfront promenade characterize Fells Point. Most buildings are 2-3 stories, however, several newer buildings on the neighborhood's northern and eastern edge reach up to 5-stories high.

To the south and the west lies Baltimore Harbor, which is primarily trafficked by recreational and historic ships, including the water taxis.

figure 33: Looking west from the Inner Harbor's World Trade Center reveals the incredible visibility of the site.

figure 34: View of steel boat launch adjacent to the Isaac Meyers-Frederick Douglas Maritime Park (right).

figure 35: View of pumping and maintenance station from Caroline St., the only remaining structure on the site.

figure 36: View of old pier and the Isaac Meyers-Frederick Douglas Maritime Park from Bond St. Wharf.. Domino Sugars Factory is in the distance to the left.

figure 37: View from the Ferndale Fence and Awning company up Caroline St. (left), up Thames St. (center) and towards the Isaac Meyers-Frederick Douglas Maritime Park (right).

figure 38: Looking east towards the Crossroads School from Harbor East. The capped site is visible to the right.

figure 39: Looking south across the site from the Crossroads School. The *Baltimore Ducks*, amphibious tourist vehicles, enter the harbor via the driveway in the bottom of this image.

“The past is our definition. We may strive, with good reason, to escape it, or to escape what is bad in it, but we will escape it only by adding something better to it.”

-Wendell Berry[46]

REALIZATION

OPPORTUNITIES

The merging of the program and site of Baltimore Farm Works create numerous and challenging opportunities for investigating what and how architecture can yield. It is precisely in the coincidence of seemingly disparate operations [farming & urbanism] that the most provocative and potential rich yields can occur.

First, a response to the sites toxic and capped soil condition resulted in a dramatic landscape gesture. Since the existing soil is incapable of supporting edible crops, a new ground surface is required in order to farm on the site. The separation of new ground surface from the old results in a residual plenum space in which a variety programs and farming types can be inserted.

In addition to the horizontal opportunities provided above and below the new ground surface, a vertical infrastructure is created to accomodate another group of farming types. The variety these two conditions provides create numerous opportunities and a simple, yet flexible framework within which the institution can operate.

Further, the two conditions multiply the symbolic power of the institution. The horizontal surface creates a place for public activity and interaction with the new, artificial surface. The vertical farming tower acts as a powerful brand for Baltimore Farm Works, similar to the industrial icons that litter the harbor. In this way, the site and landscape surfaces can act in concert with each other in reinforcing the pedagogical goals of the institution itself.

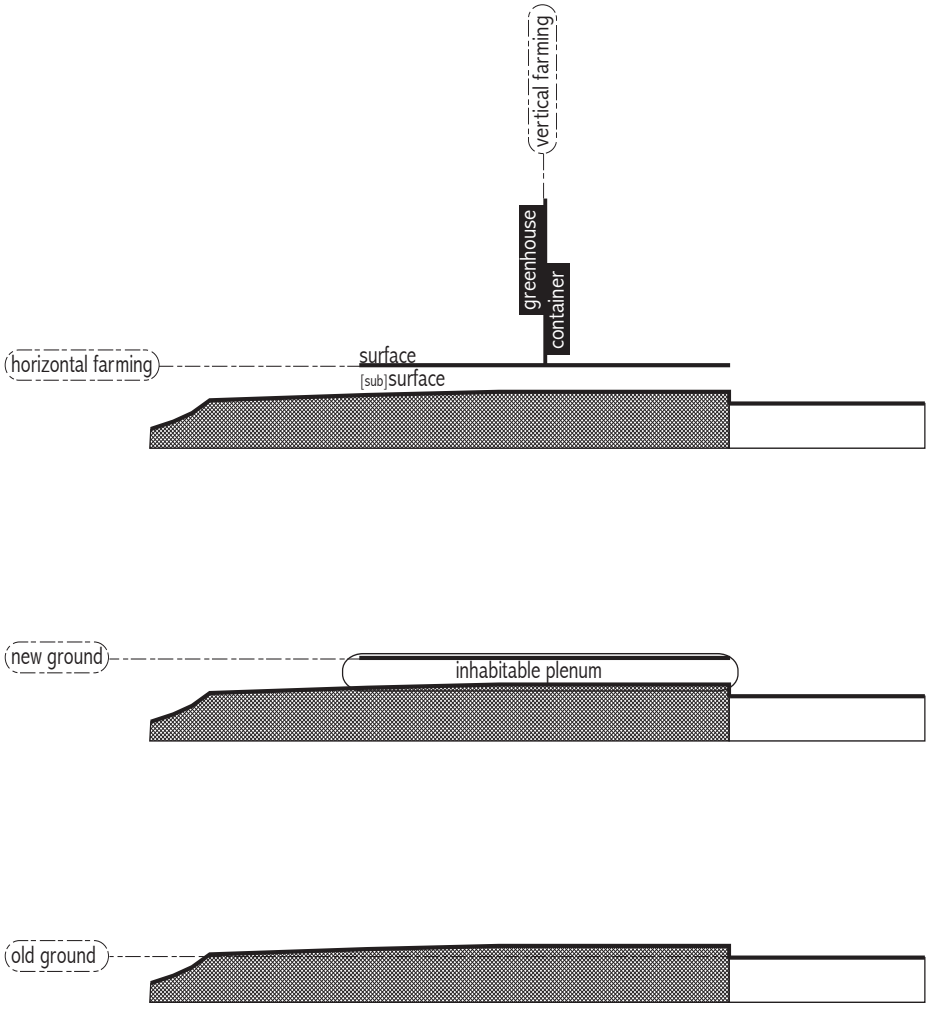


figure 40: conceptual site diagrams describing the primary response to the toxic soil condition.

Site Programming

The primary challenge in programming the site is the simultaneous occupancy of active public space and a working farm. While the public space has no access control, the farm needs to have tightly controlled and limited access points to maintain the integrity of the crops.

In order to maintain Baltimore's continuous waterfront promenade, the farm program is placed in center of the site and against the northern edge of the site and surrounded by public program. This siting provides opportunities for shared resources between Baltimore Farm Works and the Crossroads School. Placing the tower alongside the school's access road, which is also used by the Baltimore Ducks, exposes the workings of Baltimore Farm Works to an even larger audience. The public ground surfaces and the farming surfaces are held apart, with access occurring in three controllable points.

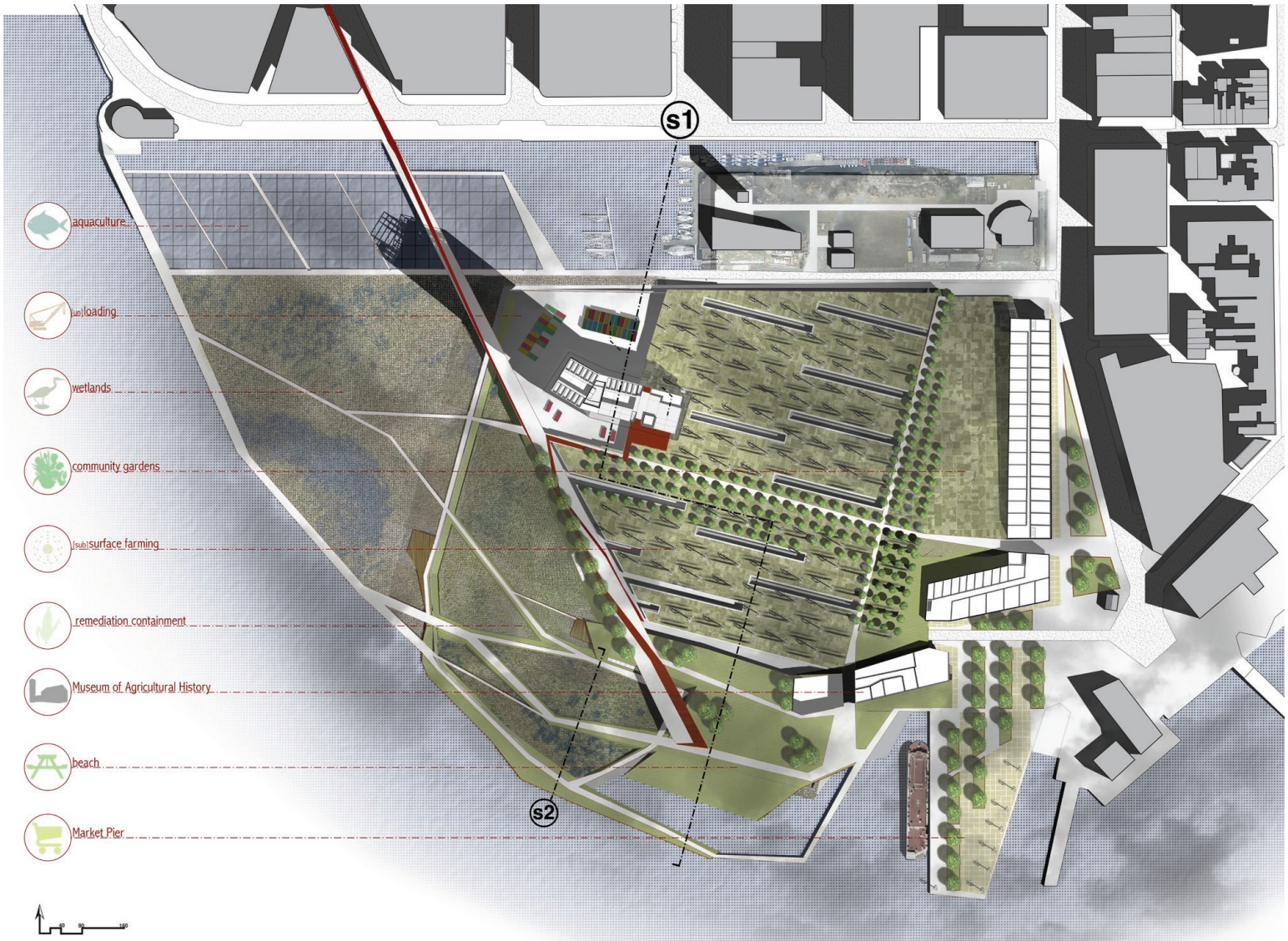


figure 41: Site plan

The eastern, urban edge of the site is a logical place for a pair mixed-use residential buildings. The upper floors are dwellings for students, faculty, visiting faculty, and workers. The bottom floor consists of farm-based retail and commercial programs such as restaurants, grocery stores, and farm supply stores. Many of these spaces will be owned and operated by Baltimore Farm Works, while others will be leased for private enterprise.

The southeast corner of the site, which is already inhabited by a public museum, is at the intersection of the two vehicular access routes and provides an opportunity for impressive views across the harbor to Domino Sugars Factory and down the harbor to Canton. Here, a new Market Pier is created. The Market Pier is a large, public space intended to accommodate a wide range of public events, including Farmer's Markets and festivals. The pier is also used as a loading zone for the Farm Works food barges, which transport produce from the farm to various neighborhoods along the harbor and operate as floating, daily produce markets.

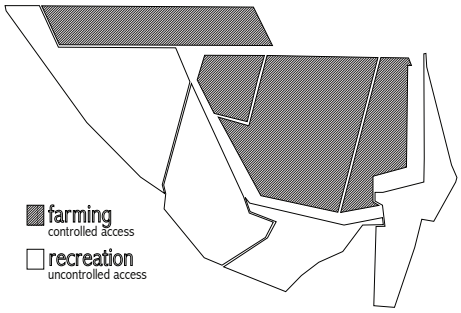


figure 42: site diagram designating the public and farm extents.

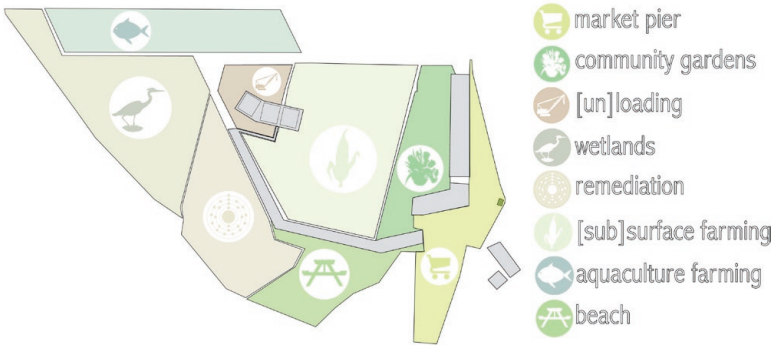


figure 43: site diagram locating the site programs

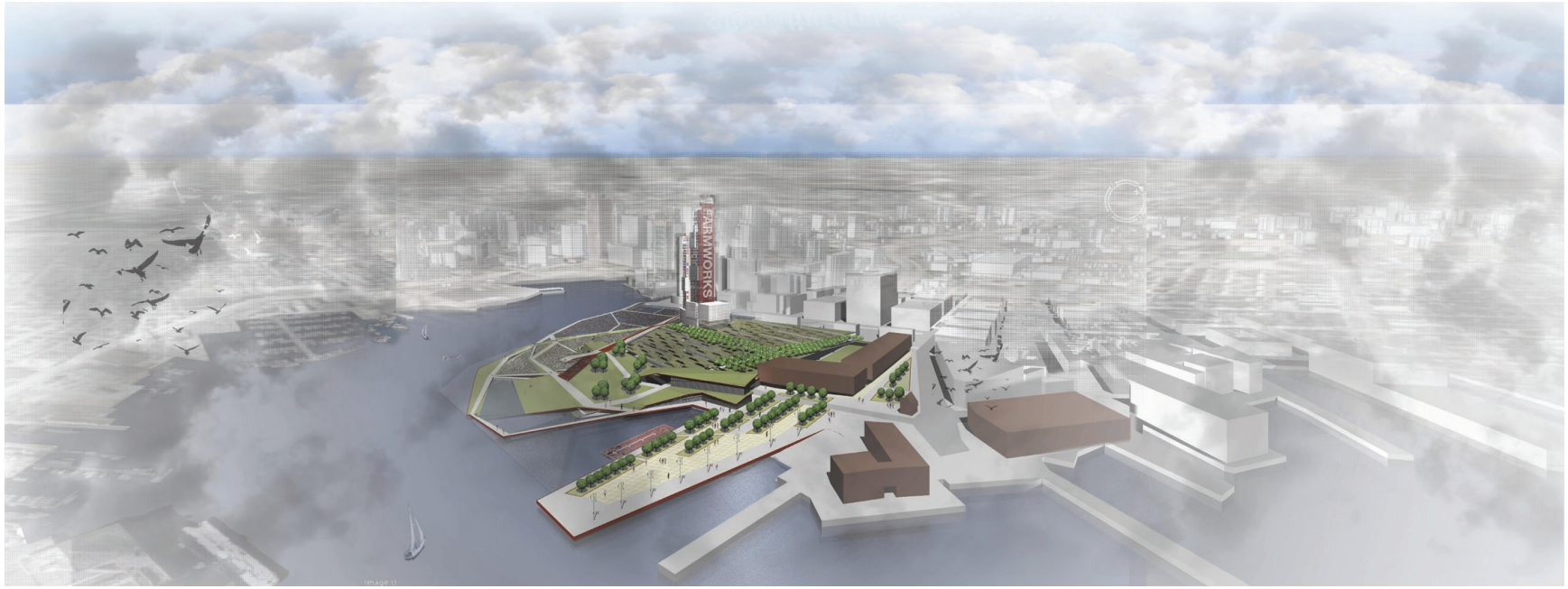


figure 44: Aerial Perspective looking northwest

figure 45: context diagram.

- The President St. corridor is extended with a pedestrian bridge. The physical axis is terminated at the interesection of the visual axis from Central Ave. in a monumental stair/elevated viewing platform. The visual axis continues to the Domino Sugars Factory.
- Caroline Ave. provides the sites only street frontage. The residential buildings are positioned to provide views down Caroline that terminate at the Domino Sugars Factory.
- Baltimore's waterfront promenade is extended via the floating pontoon bridges.
- The constructed wetlands and aquaculture fields will act as natural filters for the pollutants from the waste water box under Central Ave. [formerly Hartford Run] and the Jones Falls.
- Specific views are framed down, across, and up the harbor.
- A new water taxi stop on the Market Pier connects the site to the exising maritime transportation network.

Highlighting the Market Pier is the Baltimore Museum of Agricultural History. The museum is the primary access point to the farm itself. Two sequences from the museum lead to the tower. One is entirely outdoors and progresses through the surface fields. The other sequence leads through the museum galleries, from which one is also exposed to the [sub]surface farming.

In addition to the Market Pier, there are two other public access points. The first is an extension of the President St. axis via a pedestrian bridge. This bridge and path slips past the tower and ultimately terminates in an elevated viewing platform. A monumental staircase, which also doubles as an outdoor amphitheatre, connects the elevated path to the public surface below.

Finally, a network of floating pontoon paths connect the southwest corners of Harbor East and Baltimore Farm Works. These paths also contain the cellular constructed wetlands, which recall the historic marshes and also filter the many pollutants that emanate from the Jones Falls.

To the north of the wetlands and immediately to the west of the Crossroads School are a series of aquaculture fields, which also aid in cleaning the harbor water. Their location will utilize its adjacency with the Crossroads School, as students will be able to operate their own patches of the marine fields.

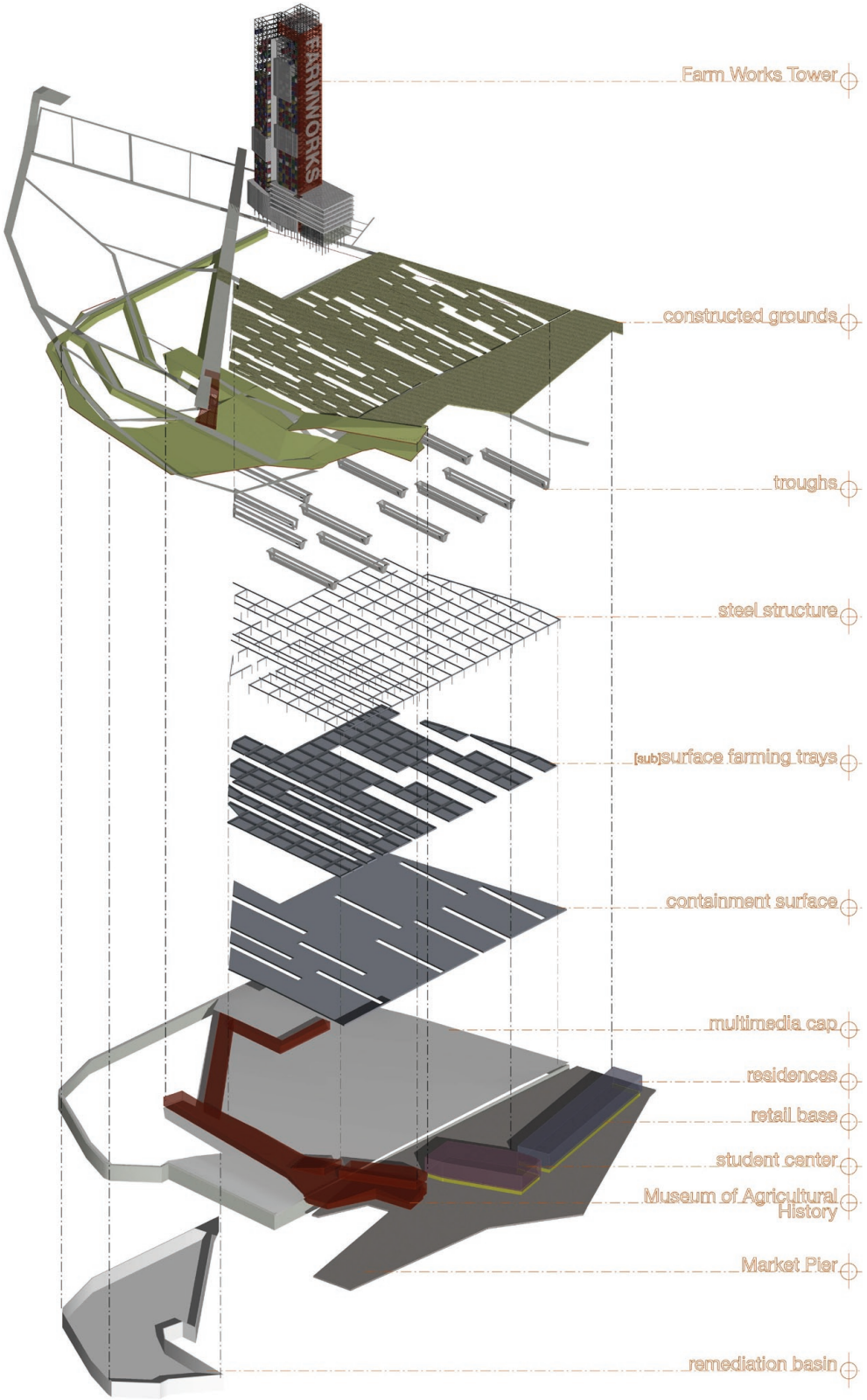


figure 46: exploded axonometric reveals the multiple infrastructural layers of the new ground surfaces.

figure 47: perspective from student center looking south through Market Pier. The Baltimore Museum of Agricultural History and the Isaac Meyers-Frederick Douglass Maritime Park frame views across the harbor towards the Domino Sugars Factory.

figure 48: perspective from within linear gallery of the Baltimore Museum of Agricultural History. The remediation containment zone, [sub]surface and surface fields, and the Farm Works tower are visible.

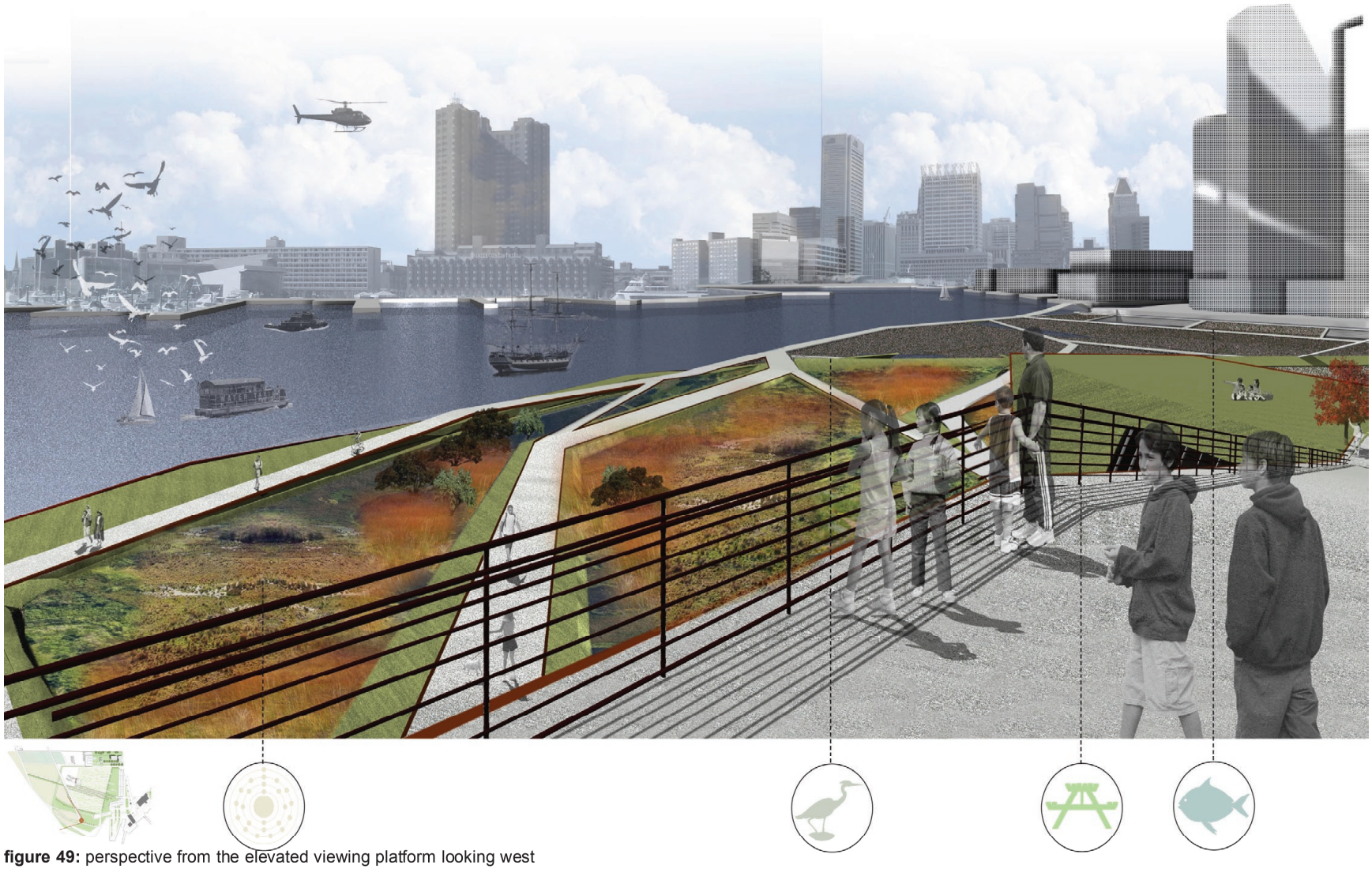


figure 49: perspective from the elevated viewing platform looking west over the remediation containment zones and constructed wetlands.

figure 50: perspective from pontoon path between constructed wetlands and aquaculture fields looking east towards the Farm Works tower.

figure 51: perspective from within surface field orchard looking west toward Farm Works tower.

figure 52: perspective from President St. pedestrian bridge looking south towards Domino Sugars factory. Constructed wetlands and the remediation containment zone are visible to the right and the [un]loading area is to the left.

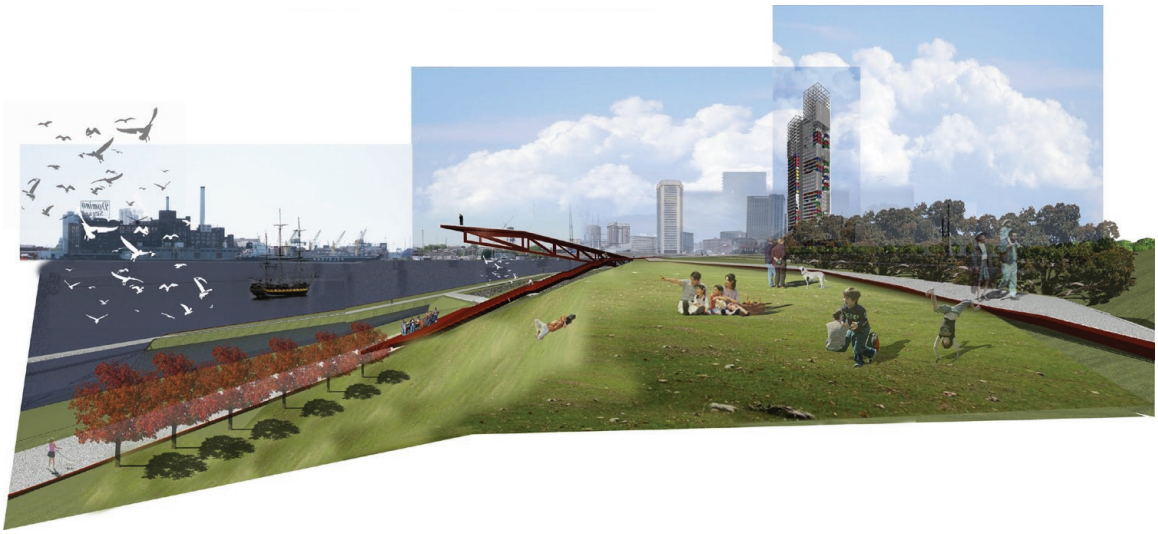


figure 53: perspective from on top of the Baltimore Museum of Agricultural History looking west towards bridge and Farm Works tower.

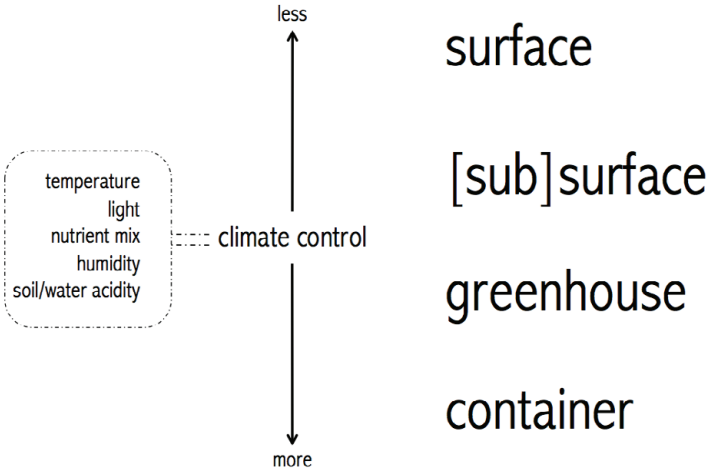


figure 54: diagram noting extent of environmental control in the farming types.

Farming Types

In keeping with the goals of yielding architecture and in order to create a broad range of production and research opportunities, several growing environments will be provided. Flexibility will be provided via the use of several farming types, each with a different amount of climate control capability. These range from being completely dependent upon external circumstances to complete independence and manufactured atmospheric conditions.

Located on top of the new ground are exterior surface gardens, which are dependent up on the local climate conditions. Thus, local species are grown using polycultural techniques in order to maintain the soil integrity and to reinforce the local farming culture.

Interior gardening will consist of three types. The first type exists beneath the new ground surface. These [sub] surface gardens utilize a combination of natural and artificial light and water sources collected in cuts [furrows] and folds [troughs] in the surface. The troughs and furrows are organized in linear patterns, similar to the forms of agricultural row cropping, and oriented towards the south for the greatest light exposure.

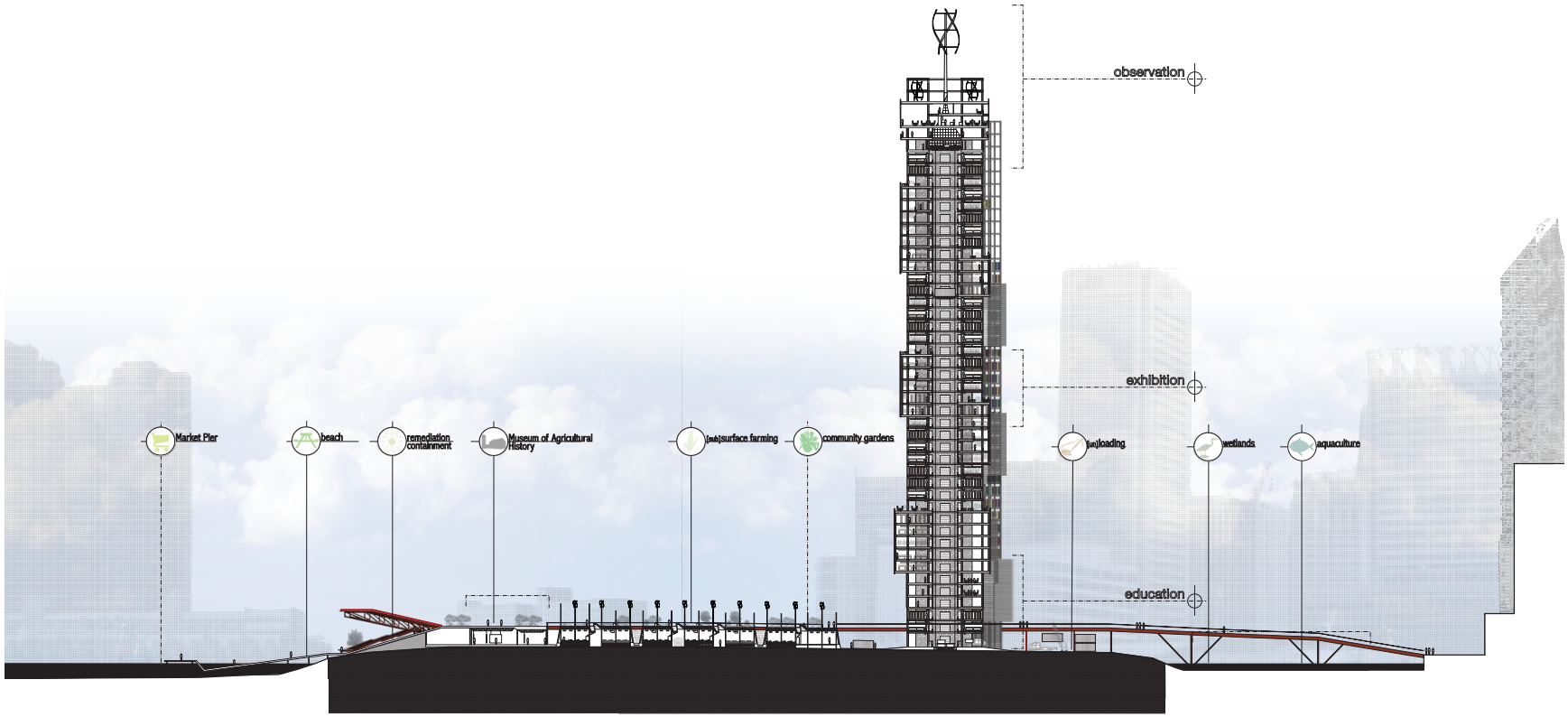


figure 55: site section S1

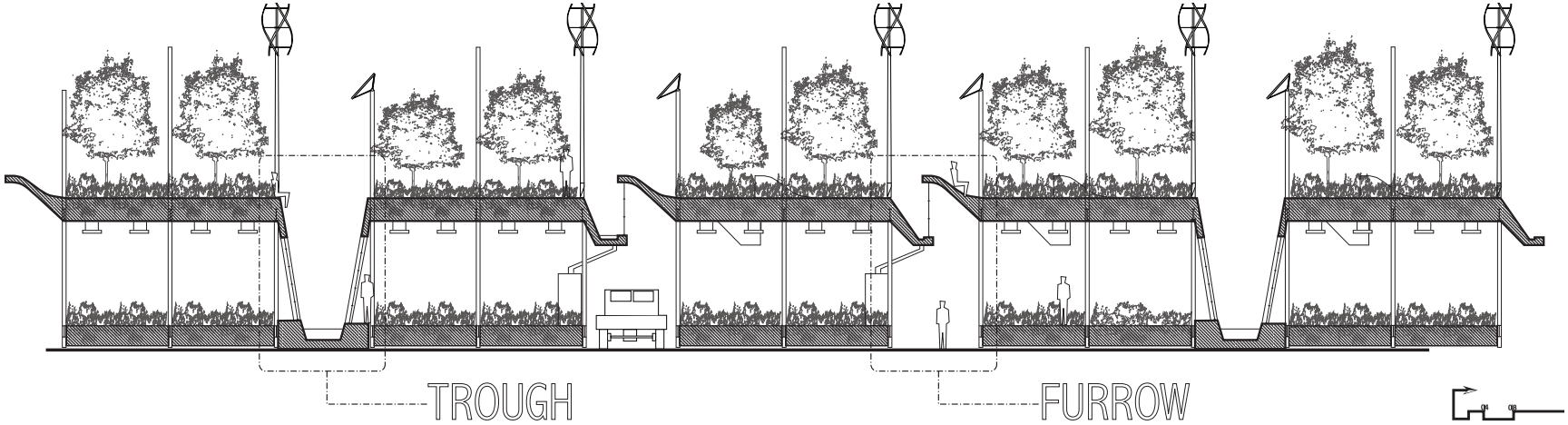


figure 56: detail section through [sub]surface fields. Linear cuts in the new ground surface are used to collect both light and water.

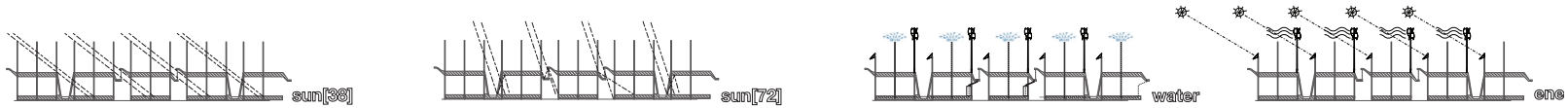


figure 57: [sub]surface diagrams

In addition to the horizontal surface and [sub]surface farming, there are two vertical and interior farming types - greenhouses and containers. The greenhouses are, like typical greenhouses, glass boxes. However, unlike entirely passive solar collection, performative skins will transfer solar and wind energy into artificial lighting and mechanical systems in order to create environmental conditions that mimic tropical, savannah, and Mediterranean climatic zones, amongst others. The greenhouses will provide Baltimore Farm Works with the ability to grow crops ill-suited to a mid-Atlantic climate.

The containers are re-fitted shipping containers optimized for growing a specific crop species. These modules, which will be controlled by a combination of natural and artificial lighting, heating, and air filtration systems will operate 24 hours a day, 365 days a year, regardless of season or weather. Further, the decreased growing time and modular nature of the devices will allow Baltimore Farm Works to be responsive to changing demands.

All of these farming environments employ a sustainable and cyclical processes that generates all of the farms energy, water, and food needs, without reaching out for external inputs beyond those naturally provided. The process farming of water, energy, and food creates byproducts that can be used in the production of the other two. Similar to the Calvin Cycle, in which the paired processes of photosynthesis [plants] and respiration [people] convert solar energy into human activity, solar and wind energy, along with water drawn from the harbor, the Jones Falls, and the wastewater outlets will generate all of the food, power, and water for Baltimore Farm Works.

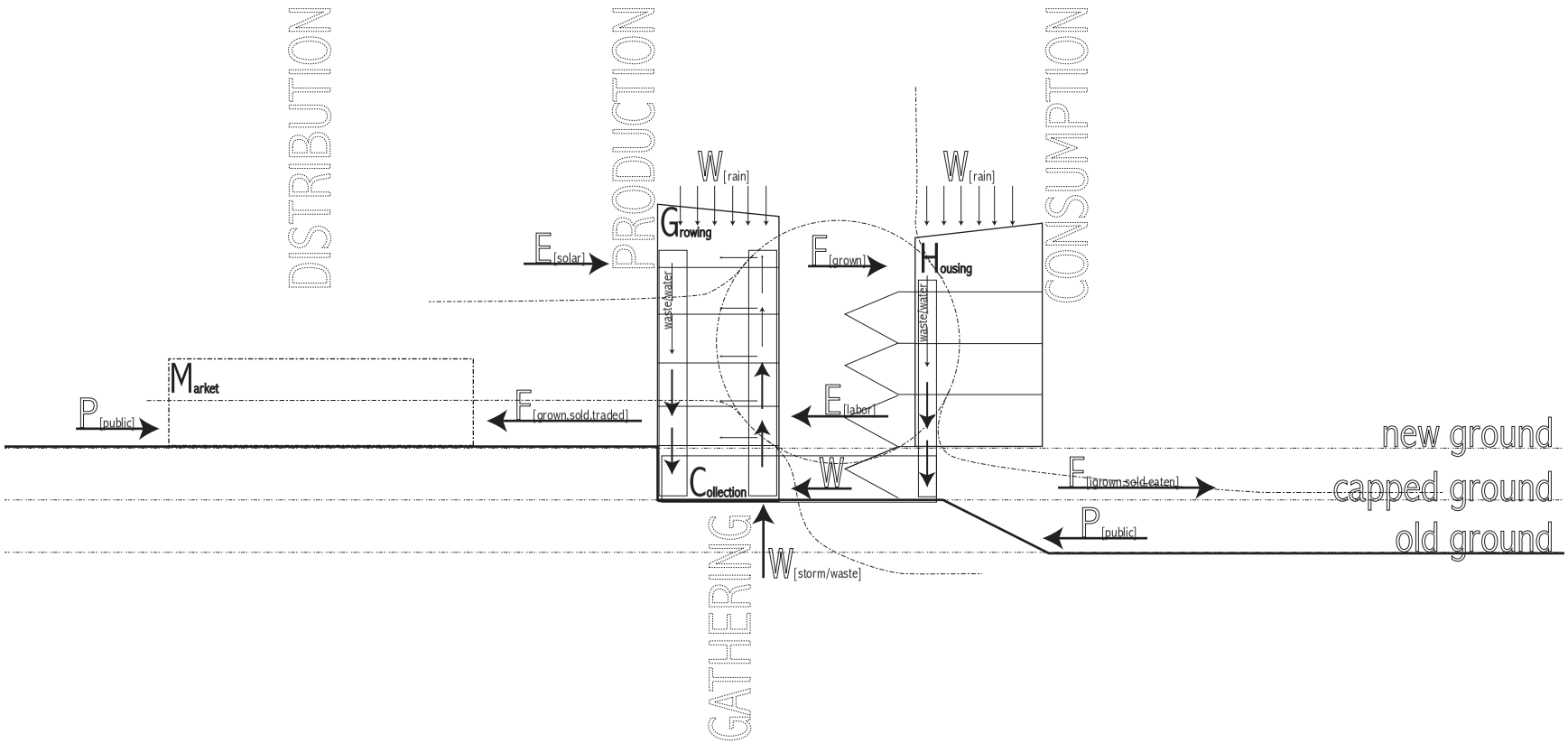


figure 58: A conceptual diagram documenting the intended relationships in a symbiotic system of food, water, and energy generation.

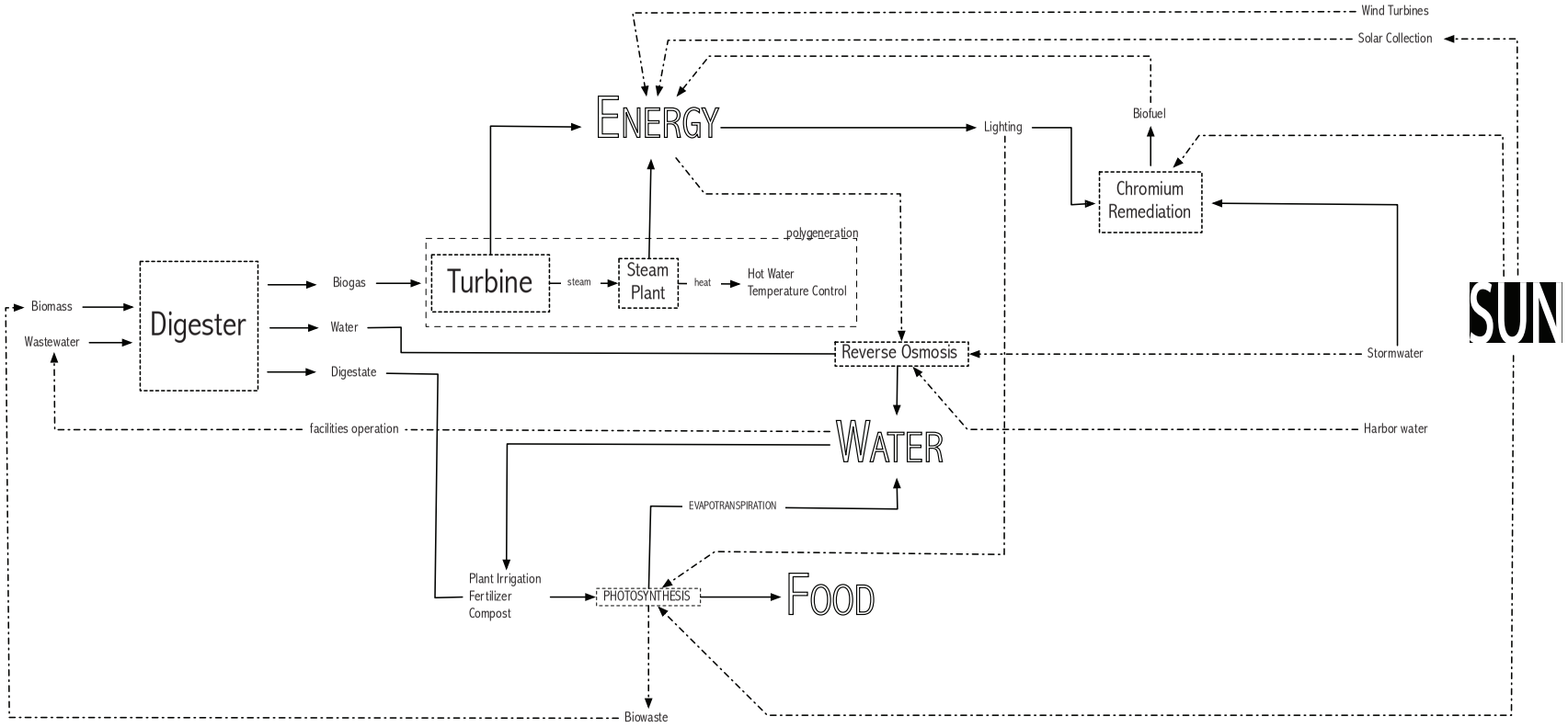


figure 59: A proposed system in which all water and energy needs are provided by the sun, wind, and exracted wastewater. An anerobic digester converts unsued biomass into biogass, water, and digestate. The biogas is used to begin a cogenerative energy process, while the water, after being purifyed through the energy intensive process of reverse osmotion, and the digestate are used to generate food.

The Edge

The desecration and subsequent cover up of the site presents a unique opportunity for didactically exposing the results of a century-and-a-half of environmental neglect. It is important, however, for Baltimore Farm Works to present an optimistic vision in which past indifference can be overcome by the same ambition and energy that created the problem in the first place. The cap edge, in particular, will become the occasion for simultaneously memorializing and dematerializing the cap edge.

In its existing condition, the cap creates an impenetrable cocoon. While it prevents leaching of toxic chromium into the harbor, it also prevents any attempts at remediating the site, whether through natural or chemical processes. Additionally, the perpetual and expensive maintenance required is evidence of a half-solution.

By “uncapping” the site and creating a sandbox condition, the soil can be exposed for remediation research. When natural remediation techniques are explored, the constructed wetlands and remediation containment zone create a vegetative frame around the cap edge, diminishing the strength of its former land/water and natural/ artificial border.

Additionally, the new ground surface is split to reveal the cap edge. Spotlights and quotes carved into the existing slurry wall memorialize the cap and provide an opportunity for residents and visitors to directly engage the mistakes of the past.

Four distinct edge conditions reveal or mask the edge and mediate the land/water boundary by creating a series of atypical person:water and person:cap relationships.

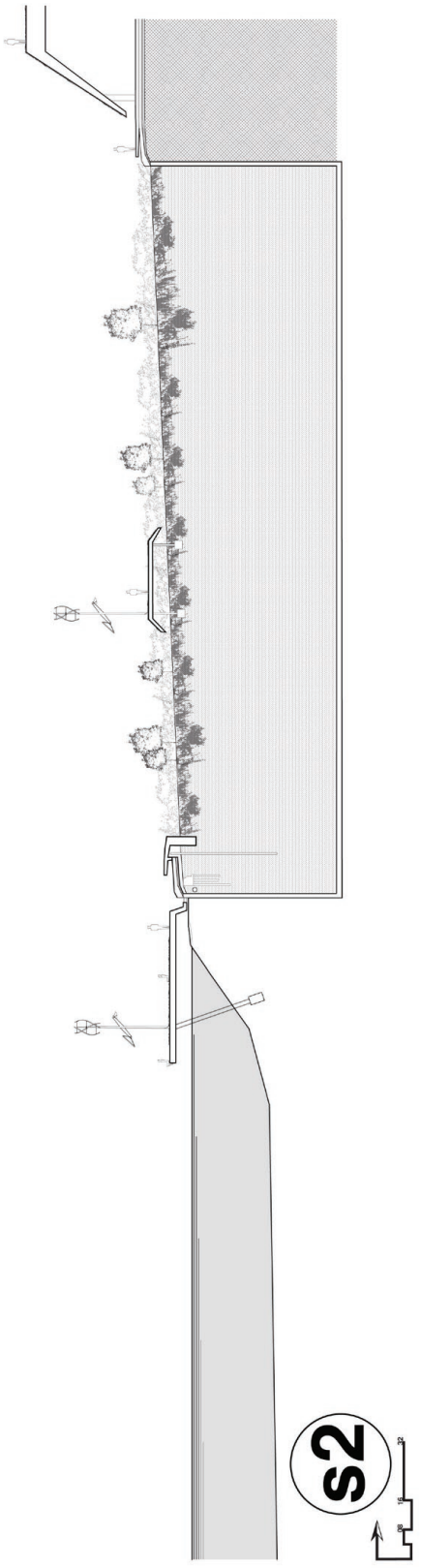
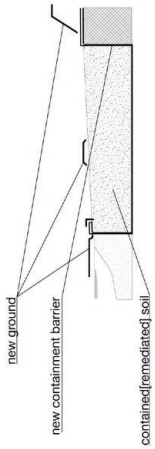


figure 60: section through remediation containment zone. The new ground surface floats above the contaminated soil.



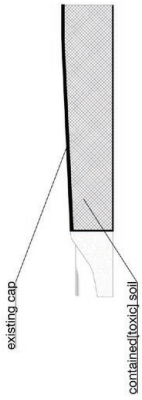
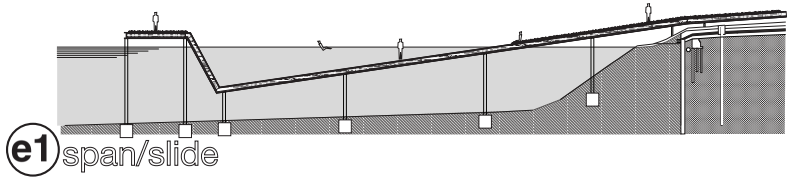


figure 61: remediation containment zone diagrams



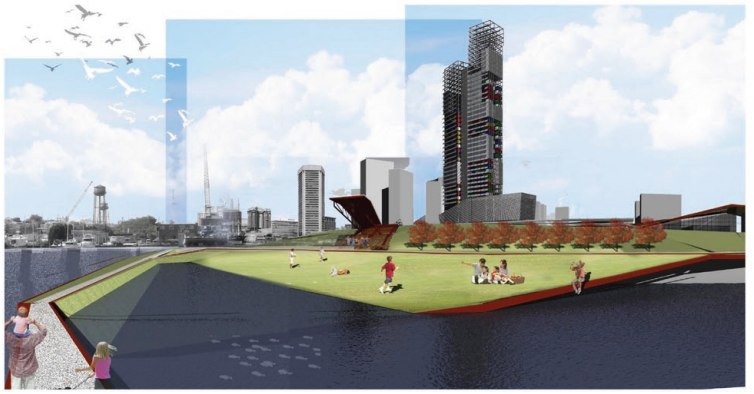
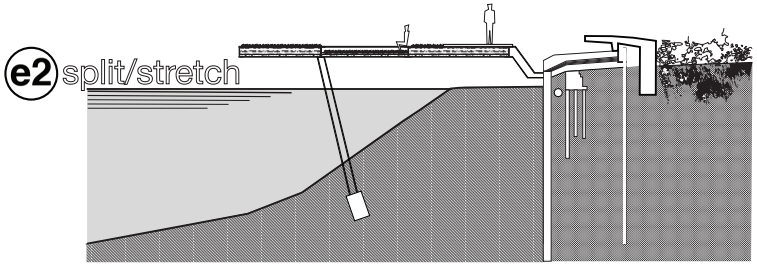


figure 62: *SPAN/SLIDE*. The only condition in which the cap is not exposed. The new ground slides into the water, creating a public beach and re-emerges to support a walking path.



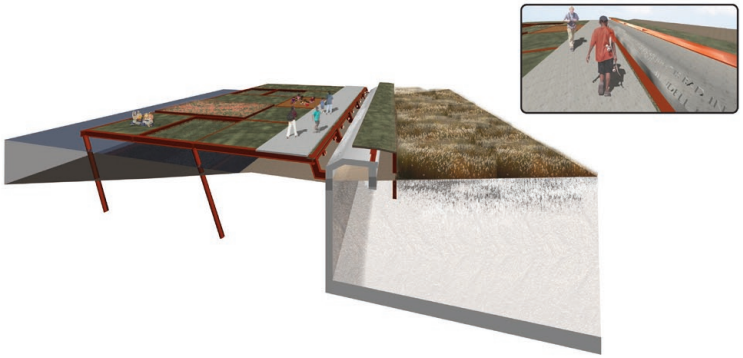
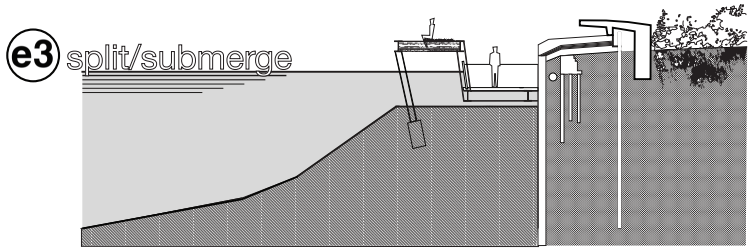


figure 63: *SPLIT/STRETCH*. The new ground, which reaches out over the water, is modulated by it steel super structure, providing opportunities for seating and various infills, such as sandboxes, flower beds, and voids.



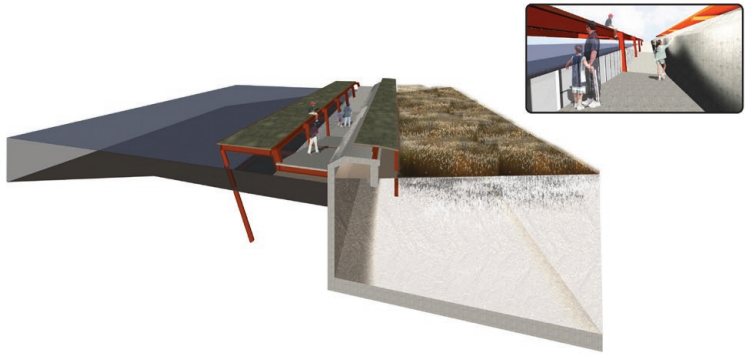
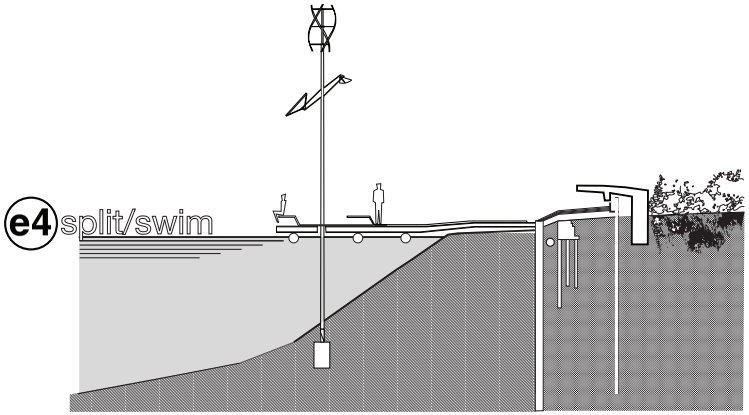


figure 64: *SPAN/SUBMERGE*. The path alongside the cape edge cuts below water level and the cap. A glass wall extends views into the harbor itself while the cap wall frames views of the sky.



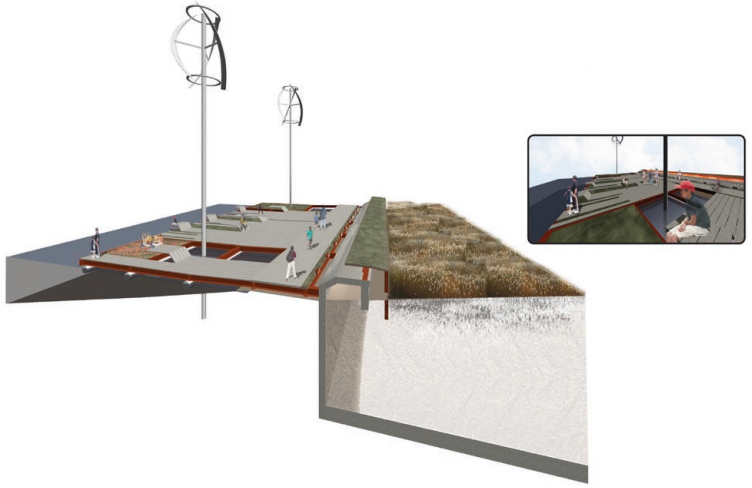


figure 65: *SPLIT/SWIM*. The new ground floats on pontoons, relfectng the changing tides and daily ebbs and flows of the harbor water. The vertical lights/solar collectors/wind turbines will be marked so that sea level can be easily recorded.

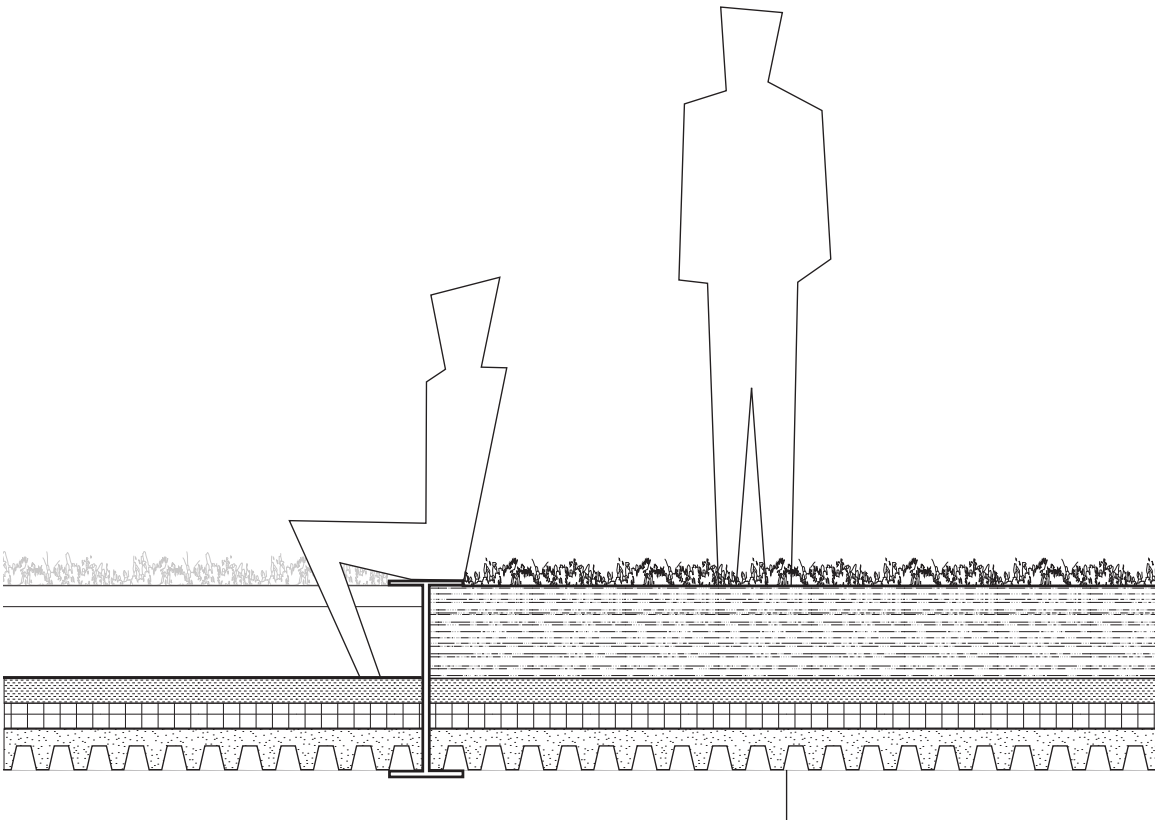


figure 66: detail section: revealing the *new ground* structure provides opportunities for engagement with the artificial surface.

Farm Works Tower

The design of the Farm Works tower looks to plants for organizational and system strategies. Further, the adaptability of plants provide exciting precedents for an architecture that has the capability to react and express changing contextual conditios. In order to maximize production, plants turn leaves toward the sun, extend roots to water or nutrient sources, and bend with the wind. These simple gestures are also very powerful and effective.

The structure of a typical plant consists of a internal core surrounded by a performative skin and productive modules [leaves/flowers]. The core is responsible for the distribution of food and nutrients. The structure, workings, and organization of the Farm Works Tower exhibit that of its natural counterpart. The tower is, at the most basic, a scaffolding into and onto which the containers and greenhouses are in inserted or attached. Automated cranes lift and lower the containers or harvested crops from the

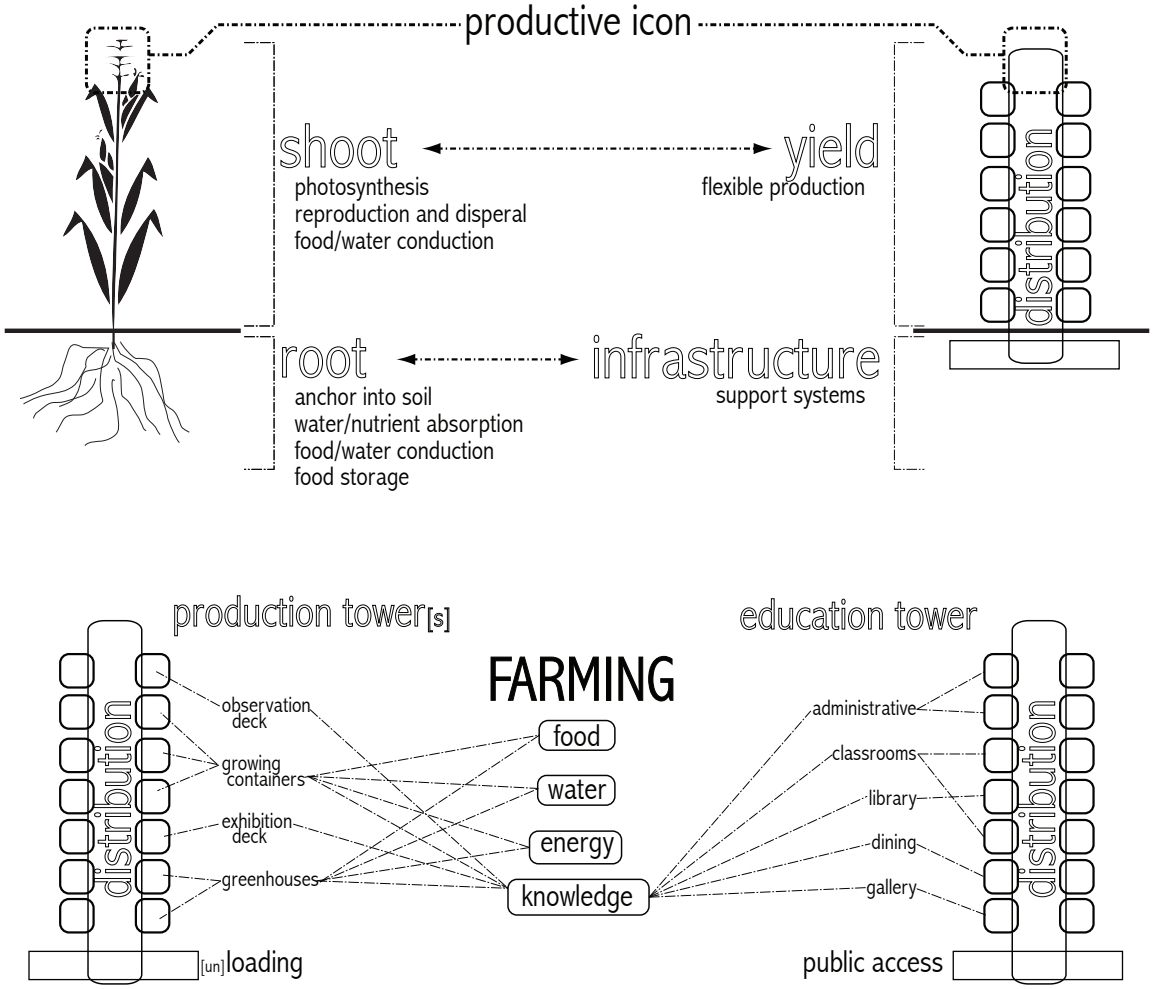


figure 67: diagrams showing the transformation of a simple plant diagram to that of a vertical farm tower.

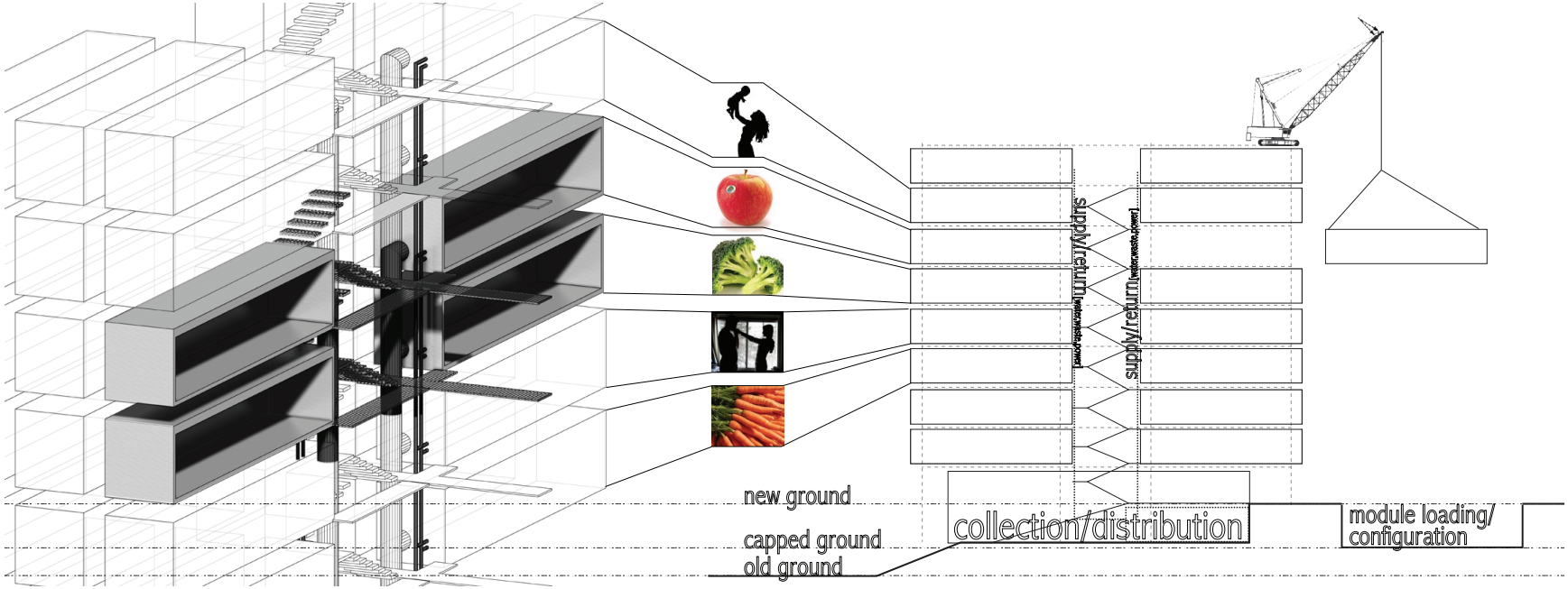


figure 68: conceptual diagram of the tower operation. Optimized farming modules will be placed in a structural scaffolding. Upon ripening, it will be lowered to the old ground to be unloaded and outfitted. Power, water, and circulation takes place in a central void.

greenhouses down to the ground level [un]loading zone, where they are unloaded and distributed. The containers would then be re-outfitted with another crop and, via crane, be hauled back up to grow.

The Farm Works tower is actually divided into three structural scaffolds. The two tallest are joined by a core that houses vertical circulation for humans and water. It also acts a lateral bracing for the towers. The second highest, which is also the farthest west, consists of exclusively research greenhouses and containers. The shortest of the three, the education tower, is wrapped by a performative skin, creating an interior volume that joins it to the middle tower.

In the educational tower's core, the distribution of food, energy, and water is replaced by the distribution of knowledge. Accessible to visitors, students, faculty, and workers, the central void is a place where knowledge can be disseminated by and to all of the farm's audience. The core is surrounded by galleries, classrooms, research labs, a library, a café, meeting spaces, and faculty offices, creating opportunities for shared experiences and chance encounters.

The middle and tallest tower, which, at 640' tall, will be the tallest building in Baltimore, is also accessible to the public. Attached to the eastern side of the tower is the Slow Elevator, a room-sized elevator platform from which tours can be led and whose name is inspired by the Slow Food Movement. Tour guides have the license to then stop at any level when something interesting is happening, which would necessarily include the permanent exhibition deck, where visitors can be exposed to various hydro/aeroponic farming techniques. The elevator extends to the uppermost levels, where an event space, a restaurant, and an observation deck capitalize on the views afforded by the tower's height.

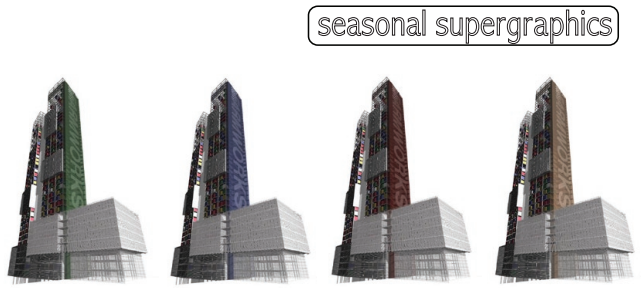


figure 69: diagram: seasonal changing supergraphics. LED's embedded in the vertical elevator skin will change color with the seasons or to mark specific events.

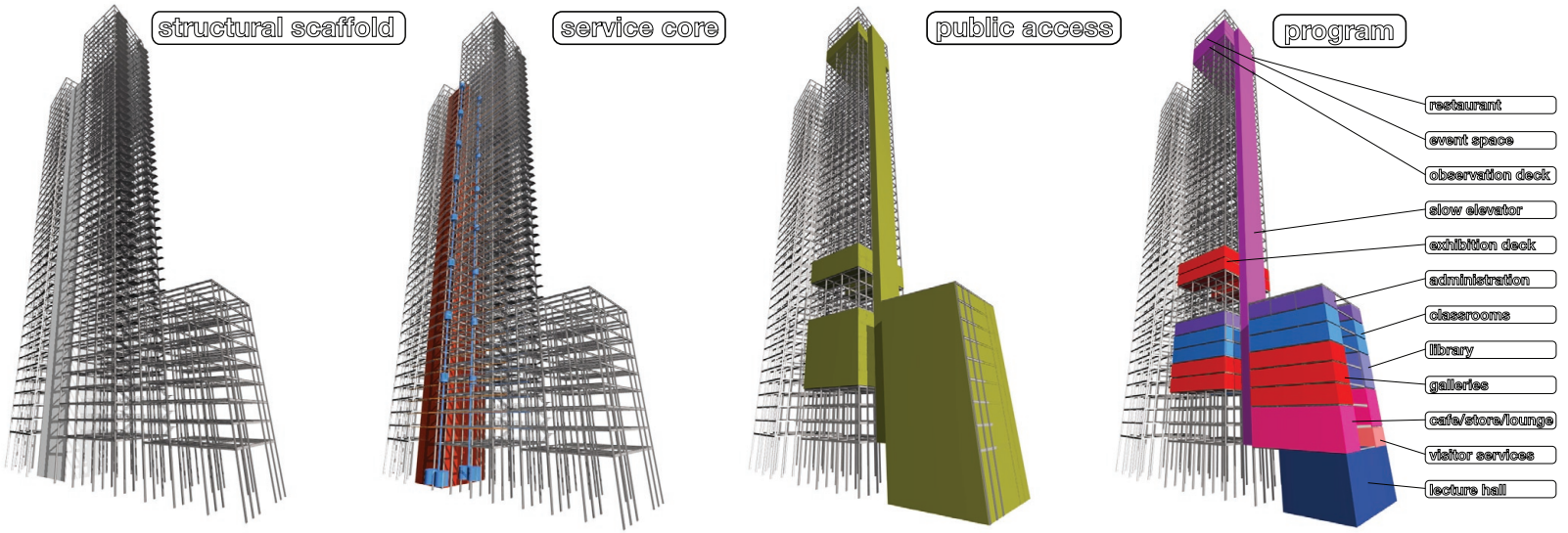


figure 70: tower diagrams

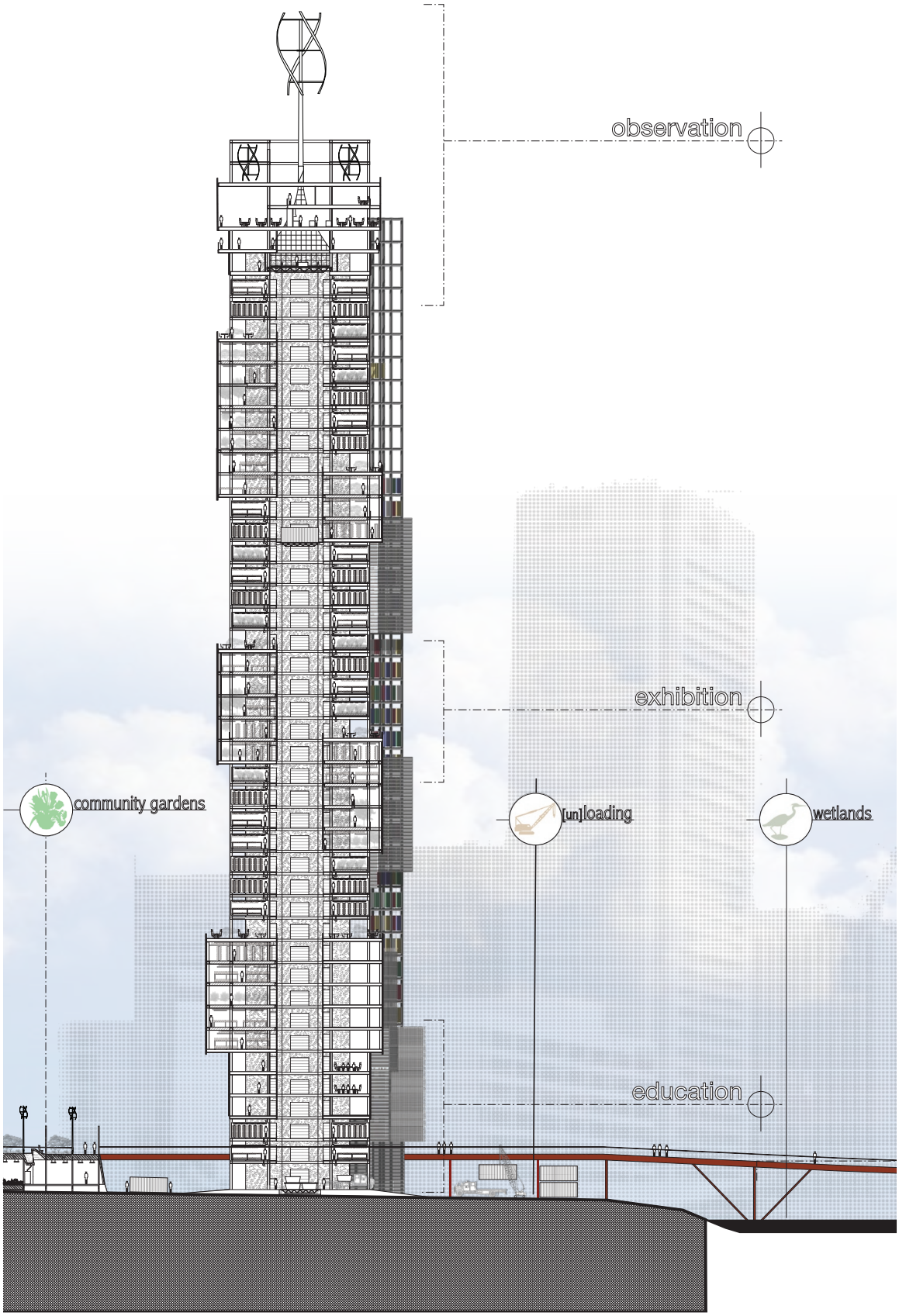


figure 71: tower section.

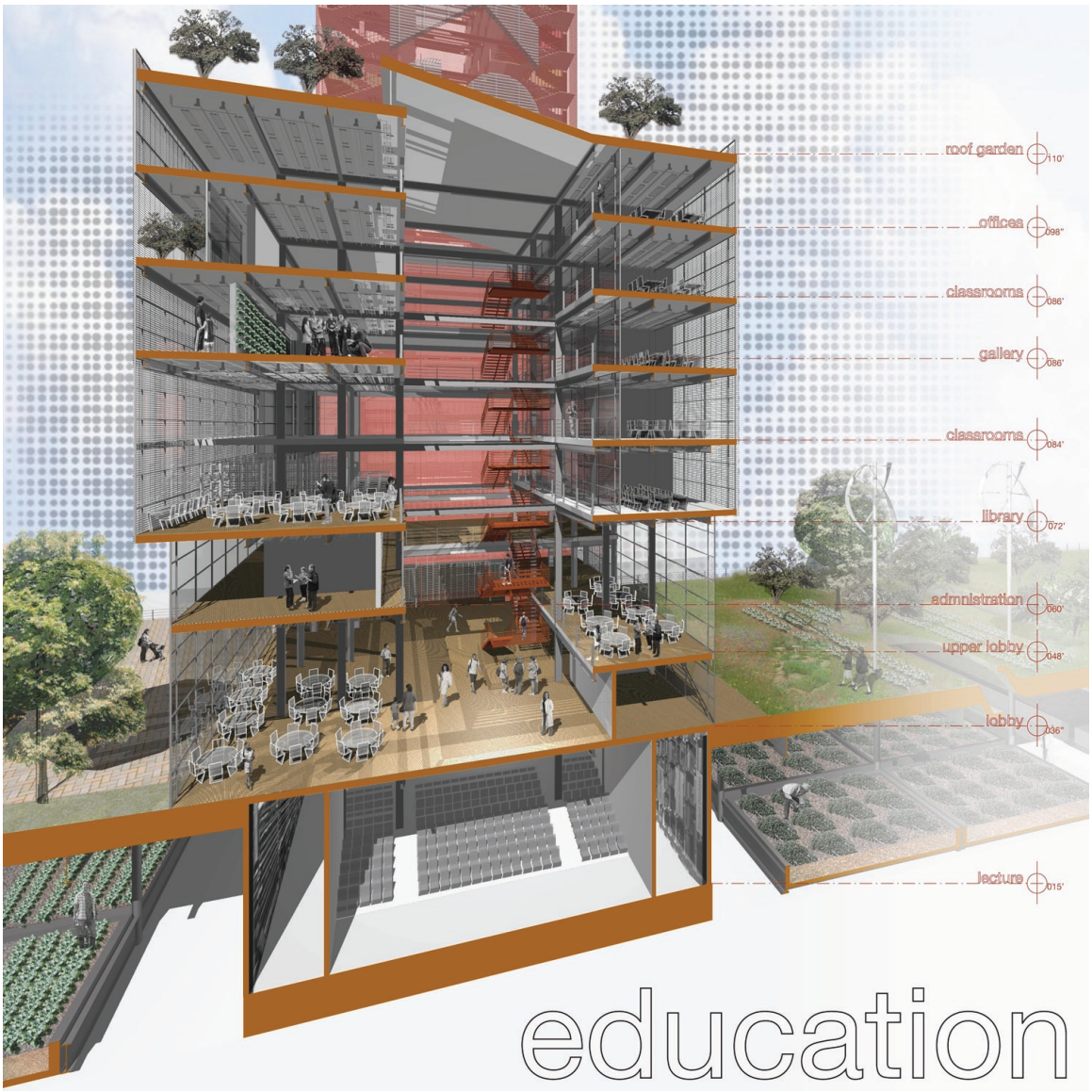


figure 72: section perspective through the education tower.

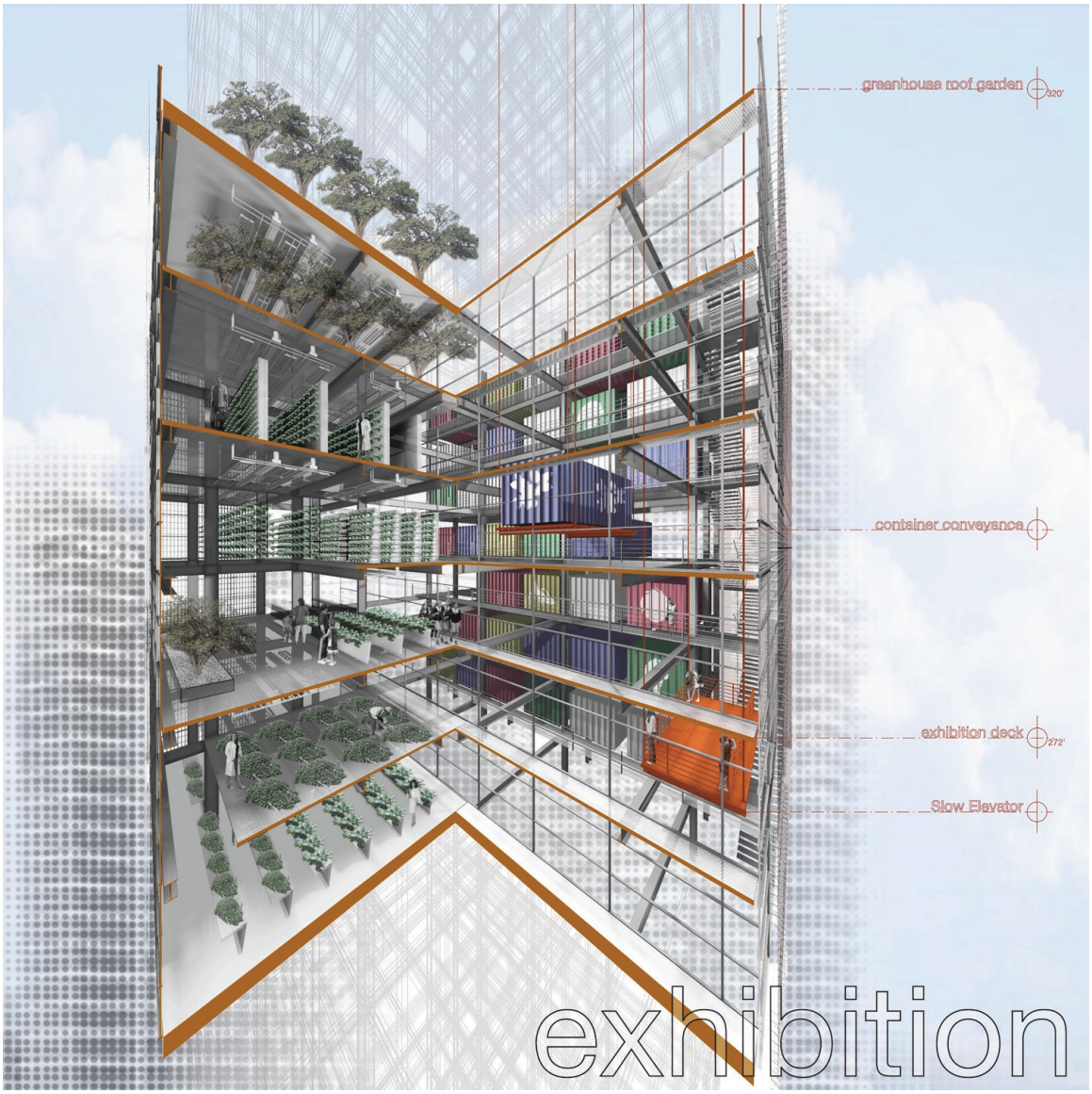


figure 73: section perspective through the exhibition greenhouse. The Slow Elevator, container elevator, farmers, tourists, students, and rooftop gardens are visible.

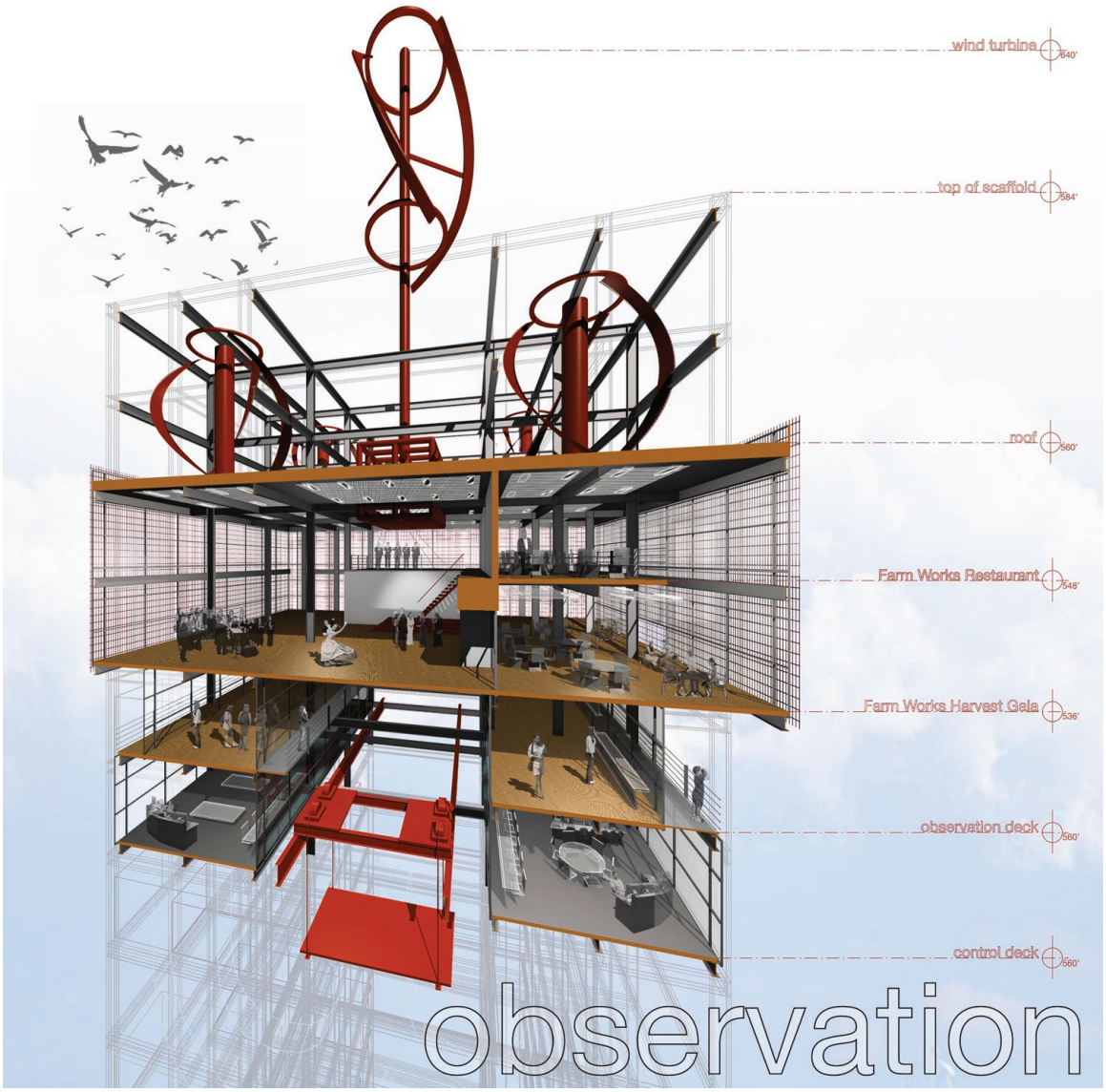


figure 74: section perspective of the top of the center tower. An event space, a restaurant, and an exhibition deck capitlize the views. The automated distribution crane is operated from within the control deck.

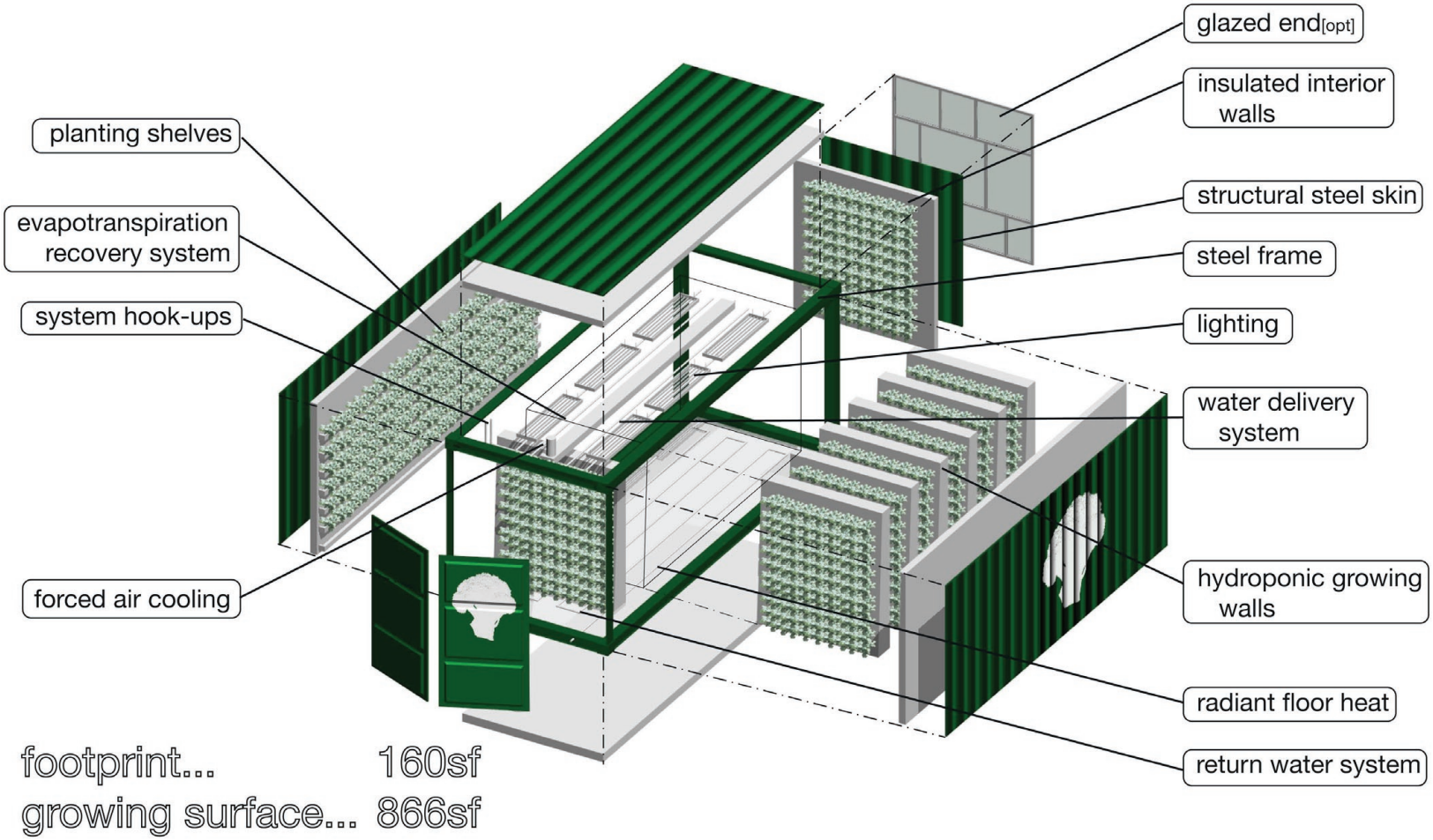


figure 75: container axonometric: environmental conditions withing re-fitted shipping containers will be optimized for particular crop species. Growing surface can be increased by up to 700% when using hydro/aeroponic walls. The container walls can be replaced with glazing or leased to private farmers.

figure 76: tower elevation studies. The containers and scaffolding reference the industrial history of Baltimore Harbor.

“Soft control can stimulate an urbanism that is motivated by the speculation that entities that do not change do not endure. All existing conditions are merely the initial conditions of agenda of change, from this moment outwards.”

-Michael Hensel & Tom Verebes[47]

Conclusions

The Value of *Yielding*

Beyond the social, economic, and cultural value that an institutionalization of Urban Agriculture provides, the architectural importance of this thesis investigation lies in the use of yield as a framework for architecture, landscape, and urban design. A *yielding architecture* manufactures form and space that responds to and expresses its context while simultaneously creating value.

It is also important to remember that value is not strictly limited to the economic concerns that have been the primary motivator of American urbanism in the 20th century. Social, ecological, and cultural value are equally significant and, not coincidentally, often promote a reciprocal increase in economic value.

Urban design, in which a series of infrastructural systems provide a framework within which individuals then invent ephemeral and contextually relevant forms, provides a model for how a *yielding architecture* can be manifest. This thesis presents several ways in which the emergent systems found in urban patterns be implemented at a smaller scale, both physically and temporally. In particular, scaffolding as a flexible and modular structural system is, essentially, the vertical extrusion of a city grid. The Farm Works Tower, which is inhabited by growing containers and greenhouses, could just as likely be infilled with modular housing or retail. The structure and distributed mechanical systems provide the resources for a wide range of potential formal and spatial configurations.

The constructed landscape of Baltimore Farm Works operates in a similar way. The infrastructure in this case is water and soil. The form and spaces are dependent upon the crops species, seasonal variations, and other human/environmentally controlled parameters.

However, the issue of scale still remains. The Farm Works Tower and surrounding landscape exist at a middle scale, somewhere between a city and a dwelling. While this investigation was by no means intended to be a comprehensive catalogue of the how architecture can yield [a very ambitious and most likely endless task], it does leave the smaller scale largely unaddressed. Of course, the conceptual program of Baltimore Farm Works did not necessarily lend itself to small-scale investigations. Future investigations using different programmatic vehicles will be required in order to further test the potential of yielding architecture as a design methodology.

The Value of *Values*

A multiplicity of value types is inherent in an architecture that yields. It is up to the designer, then, to determine what will be the primary yield of the architecture. However, if one is truly invested in the goals of a yielding architecture it is not the designer, but situation that decides. The role of the designer, then, is not to instill his/her own values upon a project, but let the goals emerge from a collective voice, from the genus loci. The architect has to *yield* to the demands of program and site.

In the case of Baltimore Farm Works, the primary goal is education. Farming knowledge emerged as the most relevant type of value to produce. While the containers could have been stacked more densely and operated in more efficiently [orientation to the sun, energy cogeneration, etc.] in order to increase food output, the goal of the project led to and abandonment of super-efficiency as the primary parameter, although it certainly remained as an important criteria for evaluation.

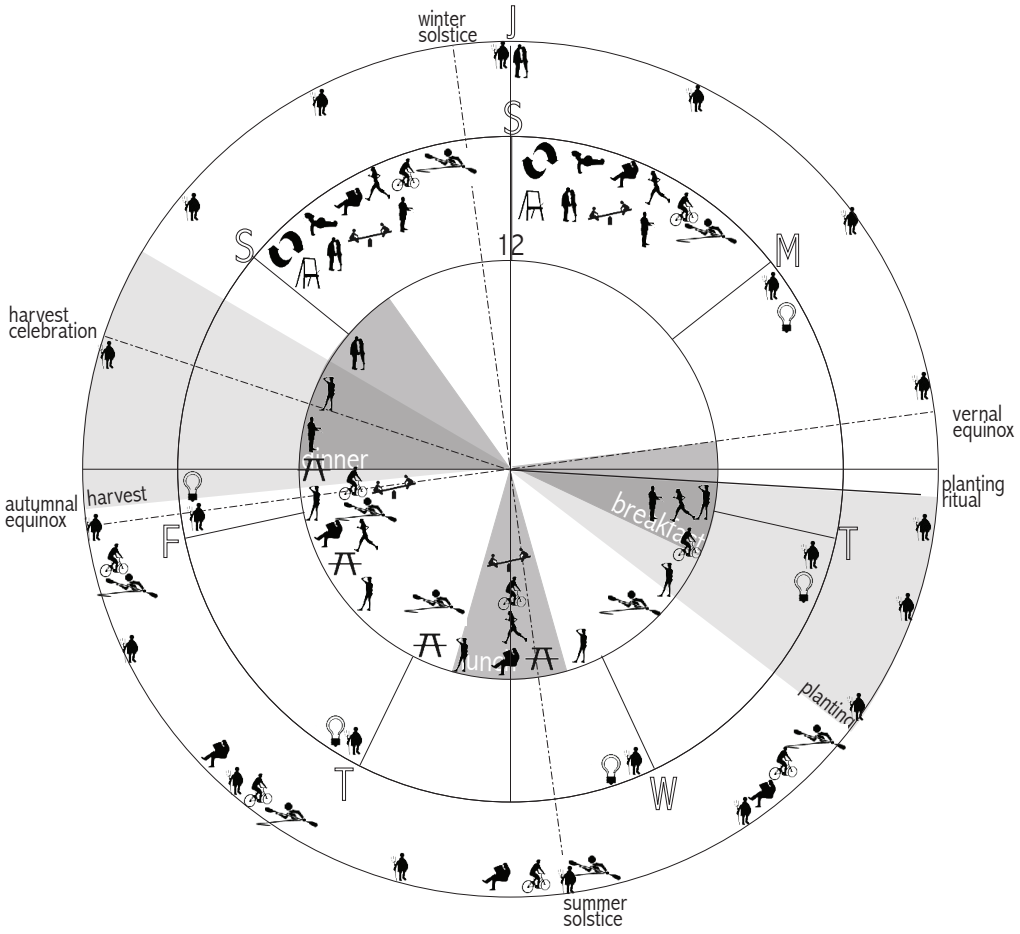


figure 77: A study of seasonal and daily cycles in relationship to human activity. These relationships emerged as less important to the conceptual program, although they did remain as a secondary layer of design consideration.

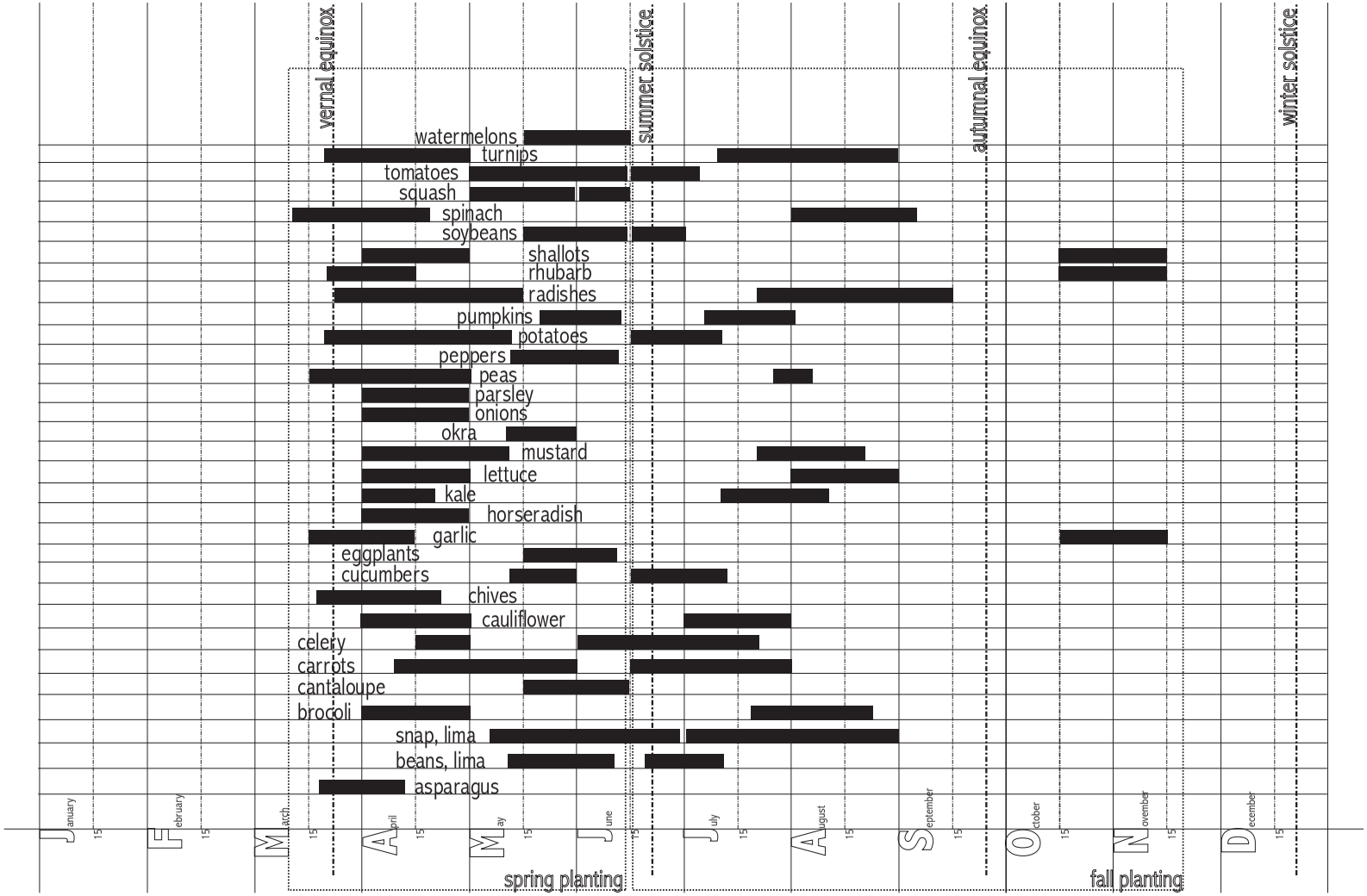


figure 78: A study of planting schedules for locally grown crops. This information would ultimately reveal itself in the form and colors of the surface fields.

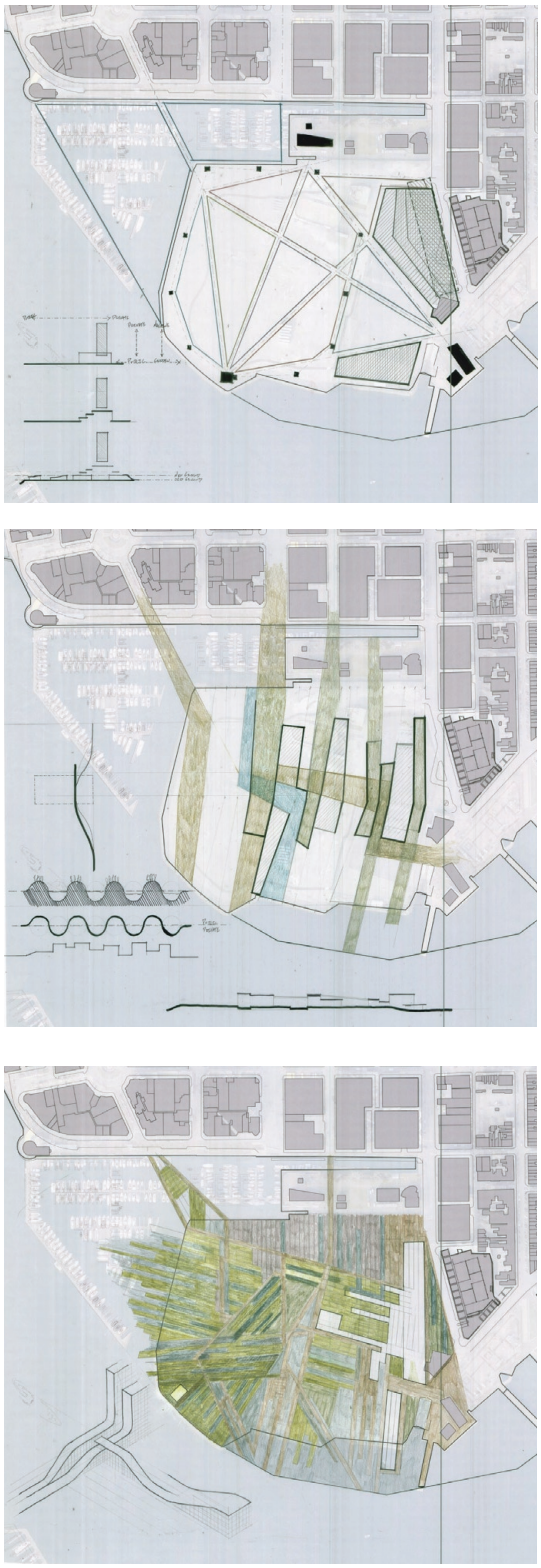


figure 79: Process site schemes in which various site and formal strategies are studied. These explorations were used to determine the primary site-driven parameters.

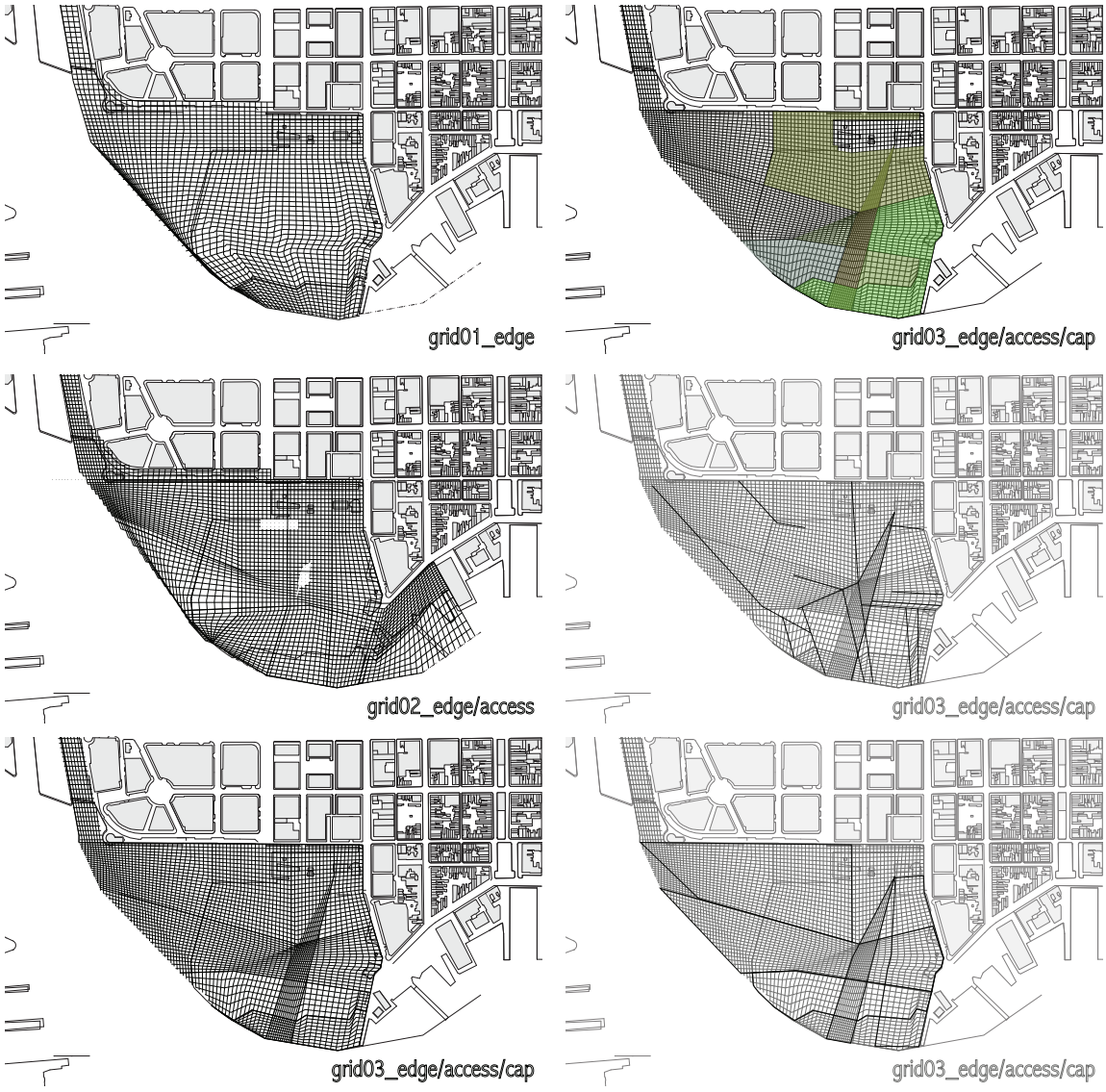


figure 80: Process site studies focusing on potential geometries for an infrastructural grid. These studies, in which edges are denied by continuous gradients, were abondoned in favor of more rigid geometrical patterns that expressed edge conditions and geometrical collisions.

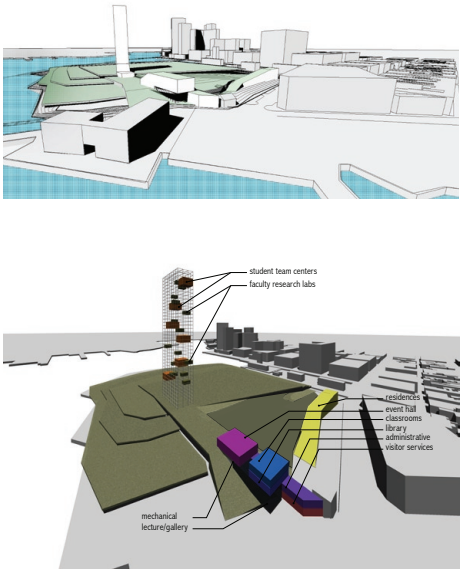


figure 81: Process massing strategies in which multiple terraces where considered. Ultimately, a single, continuous surface was used.

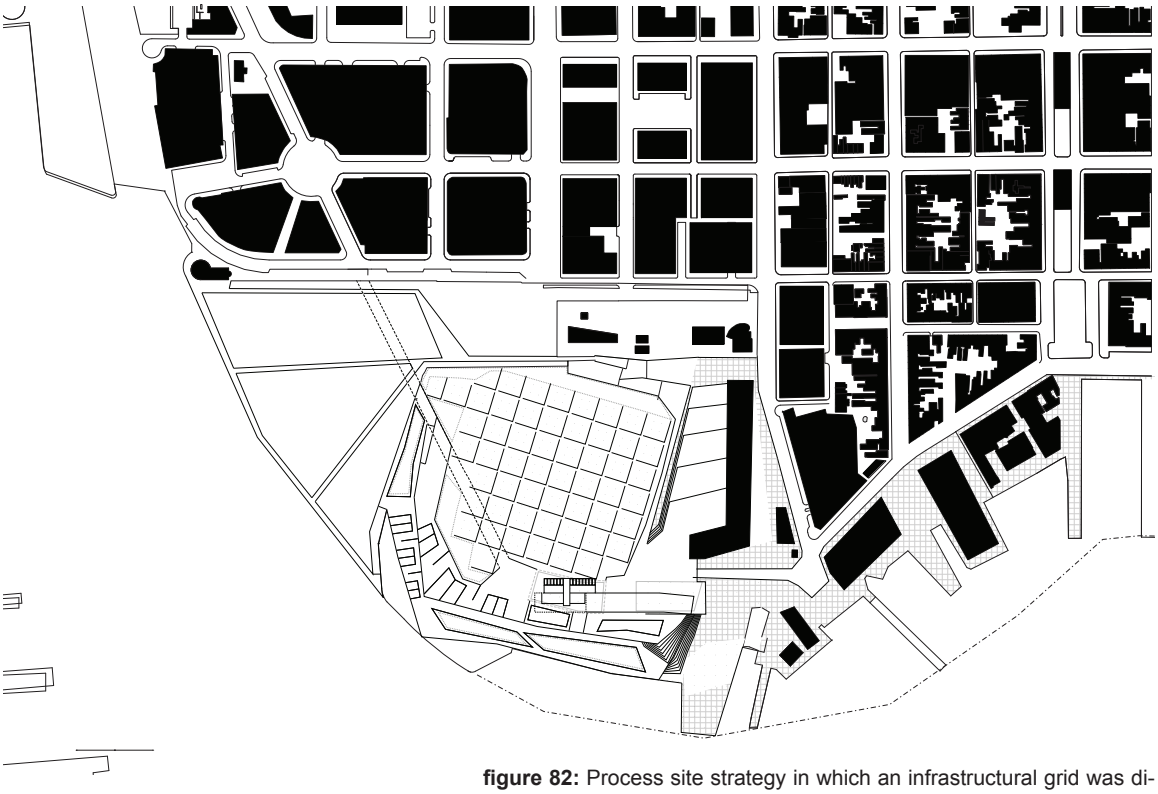


figure 82: Process site strategy in which an infrastructural grid was directly expressed upon the new ground surface. Later strategies would employ troughs and furrows in a linear pattern, suppressing the grid.

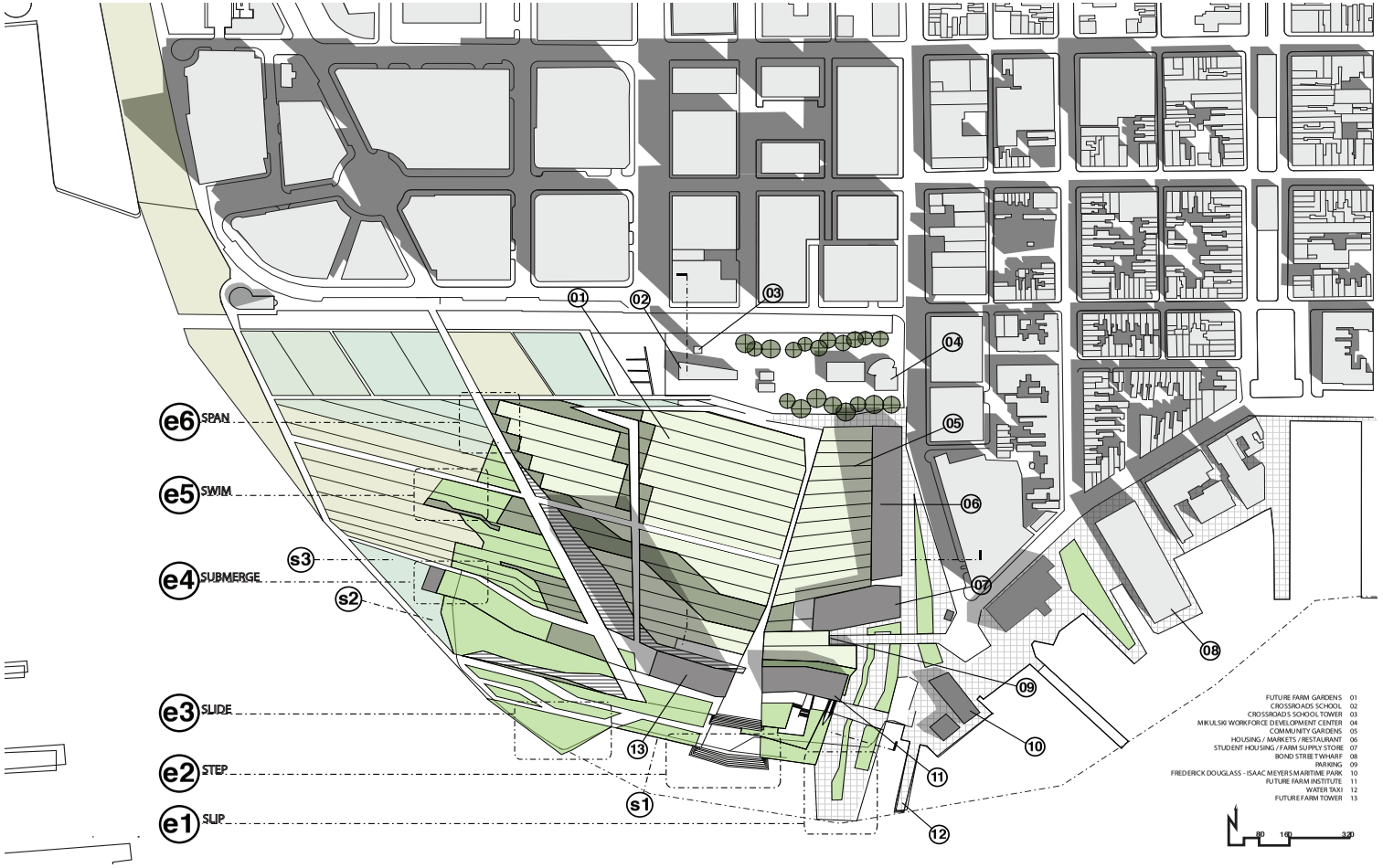


figure 83: Process site schemes in which the tower remained on the southern edge of the site. Here, visibility and spatial control of the public green space was more important than sequence to the tower and solar access for the fields.

Program_Future Farm

The Future Farming Center will be a public institution dedicated to the advancement of urban farming. The role of the institution will include
. . . . high yield food production/distribution [research/education]
. . . . energy generation [research/education]
. . . . water reclamation [research/education]
. . . . public outreach

Future Farm Museum

Main Lobby
Reception 200
Coat Room 200
Rest Rooms [2 x 200] 400
Flexible Display Space 200
Lobby [informal gathering] 1000
2400

Student Services
Cafe [kitchen/prep] 1500
Locker Rooms [2 x 500] 1000
Lounge 1000
3500

Educational Facilities
Main Lecture Hall [100 people] 3000
Minor Lecture Classrooms [4 x 600] . . 2400
Library [offices] 2000
Collaboration Rooms [2 x 500] 1000
Computer Lab 1000
Storage 500
Restroom [2 x 200] 400
8300

Research Facilities
Main Labs [4 x 1000] 4000
Research offices [15 x 400] 6000
8000

Farm Facilities
Interior growing modules . . . . . ?????
Exterior gardens . . . . . .?????
Aquaculture ponds . . . . . .?????
?????

Administration
Reception 200
Waiting Room 150
Director Suite 1000
Staff Offices 1500
Restroom [2 x 200] 400
3250

Services
Janitorial 200
Loading Dock 1000
Mechanical (15%)
Circulation (30%)
1200

Public Programming

public open space
farmer's market
festival/public art
public promenade
informal lawn
outdoor activities [kayak, canoe, fish, exercise]
community gardens

Distribution Facilities
Restaurant
Vestibule 100
Wating Room 200
Bar 500
Dining 1500
Kitchen 250
Prep 200
Office 200
Janitorial. 100
Employee Lockers 100
Food Storage 100
Cold Food Storage 100
Frozen Food Storage 100
General Storage 200
Restroom [2 x 200] 400
4250

Grocery Store
Vestiule 100
Registers [3]. 300
Display Space 8000
Deli 200
Staff Offices 1000
Loading 1000
Food Storage 2000
Restroom [2x100] 100
?????

Infrastructural Facilities

Powerplant
battery storage for solar/wind generated energy facilities for conversion of bio-waste into fuel pellets into energy
Employee Services
lounge/cafe
lockers
Administration
offices
Service
loading dock
storage

Water purification
water drawn from Harbor, waste water systems, storm water systems is filtered for use in plant irrigation/building needs
Employee Services
lounge/cafe
lockers
Administration
offices
Service
loading dock
storage

Lobby
Entry Vestibule 200
Main Lobby [flexible display] . . .2000
Museum Shop 500
Rest Rooms [2 x 500] 1000
Coat Check 200
Reception Desk 200
Security 200
3800

Galleries
Historical [permanent]
food 2000
energy 1000
water 1000
flexible exhibit space 2000
Rest Rooms [2 x 200] 400
6400

Visitor Services
Event Space 2000
Lecture Hall 1500
classrooms [2 x 500] 1000
Storage 2000
Cafe [kitchen/prep] 1500
Rest Rooms [2 x 300] 600
8600

Administration
Director Suite 500
Curator Suite 500
Staff Offices 1250
Conference Room 500
Reception 200
Rest Rooms [2 x 200] 400
3350

Outdoor Space
Event Space 2000
Observation Tower 500
Garden Exhibits 2000
Energy Exhibits 800
Water Exhibit 500
5800

Services
Janitorial 200
Loading Dock 1000
Mechanical (15%)
Circulation (30%)
1200

figure 84: mid-project tabulated program. The program grew, shrank, and was reconfigured as the goals and primary values of the thesis project evolved.

Future Farm Program_

The Future Farming Center will be a public institution dedicated to the advancement of urban farming.
The role of the institution will include:

- *. . . . high yield food production [research/education]*
- *. . . . energy generation [research/education]*
- *. . . . water reclamation [research/education]*
- *. . . . public outreach*

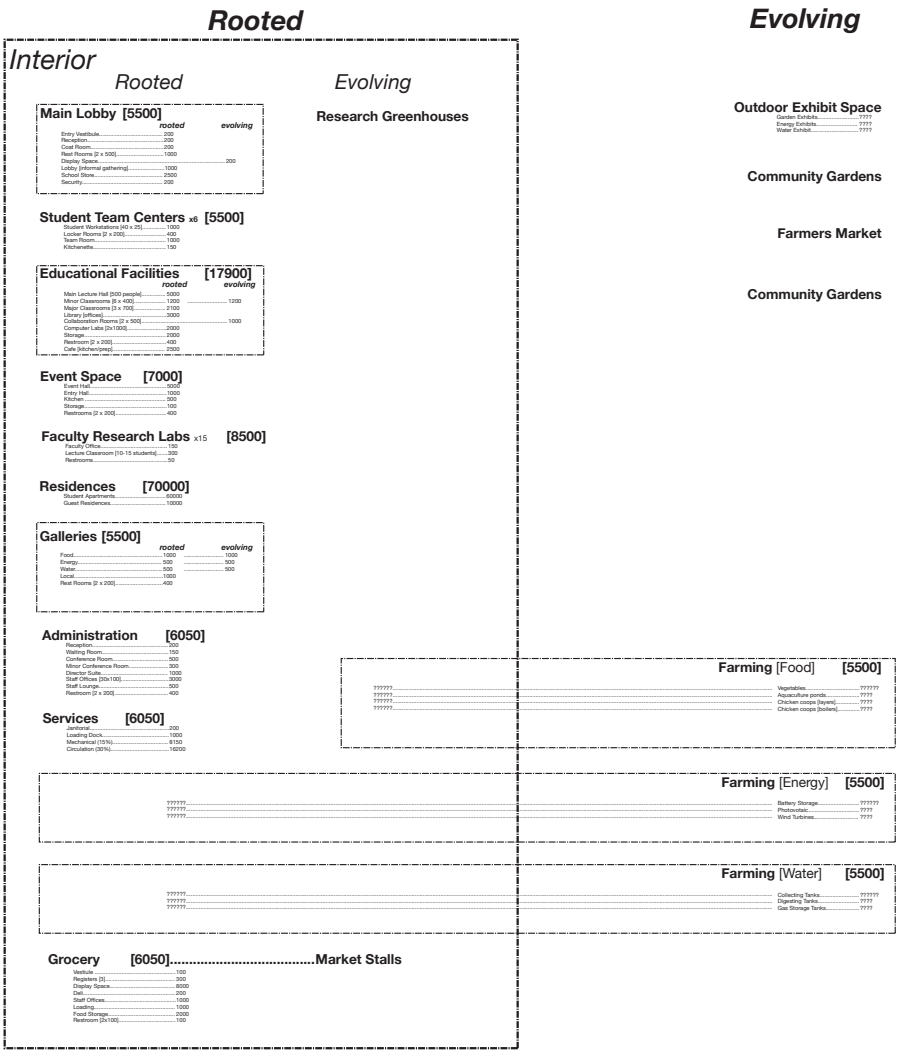


figure 85: penultimate program. Here program is divided into those activities that are unpredictable [evolving] and those that can be explicity designed for [rooted].

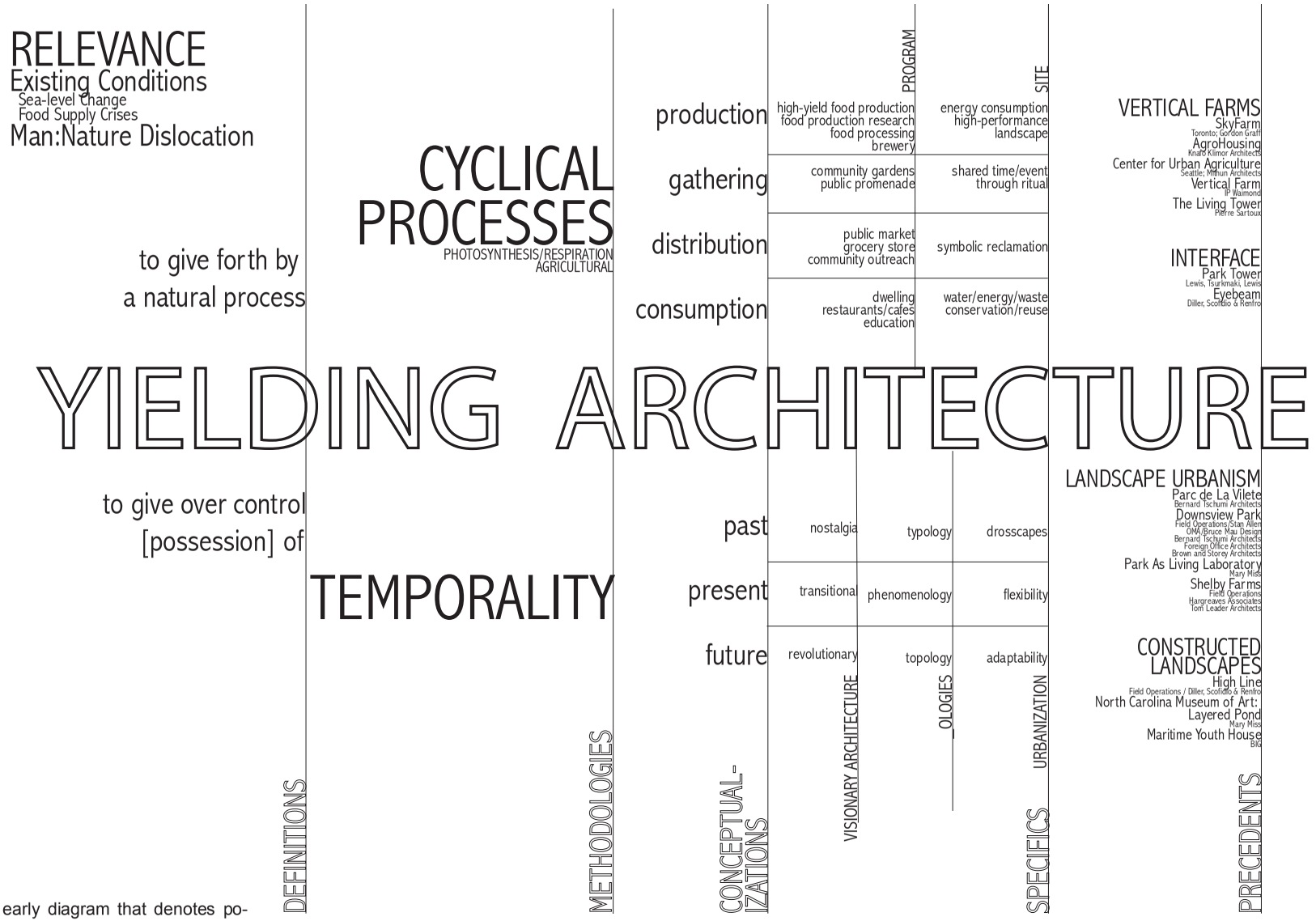


figure 86: early diagram that denotes potential avenues of investigation.

The Value of *Data*

The impact of Baltimore Farm Works could be widespread. As a new paradigm for urban design, a prototype farming tower, a symbolic act of reclamation and part of a solution to an impending food supply crisis, this thesis creates value in multiple ways. An important next step, however, would be to find a means of quantifying that value.

While cultural and symbolic yield cannot be measured directly, food output, economic viability, and energy generation are quantifiable entities. An investigation into the specific amounts that Baltimore Farm Works could yield would present further design challenges that would augment the value of the thesis investigation itself.

It is often said that we live in the Information Age, in which data has become the most valuable commodity. Others have suggested that, given the ubiquity of information in contemporary culture, we are now in a Creative Age where it is not the accumulation of information that is important, but its creative use. Much in the same way that Kieran Timberlake describe the architect as a compiler of chunks designed by specialized manufacturers, the talented designer is one who is able to sift through the endless amounts of information available and discern the extent patterns and appropriate solutions. In other words, while it is necessary to yield information, it is equally and perhaps more important to yield to what that information reveals.

The Value of the *Architect*

Architects are trained to imagine the creative application of or solution to a set of synthesized data. This thesis suggests a new use for these talents model in which architects are leaders of multi-disciplinary teams interested in solving large-scale problems. This challenges a paradigm in which architects are used strictly for formal and spatial design.

The architect, then, is charged with not only creating visions for the future of our species, but also directing and inspiring a wide range of experts form across multiple disciplines toward solutions of our most pressing problems. Food supply is one of many growing concerns resultant from increased pressure applied by population growth. This project is a call to arms for not only architects, but for all designers, to re-engage other disciplines. It is only through cooperative efforts that we can achieve the integrated and comprehensive strategies of adaptation and invention necessary for the advancement of our species and the planet.

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12. *Manning*, 90.

13. *Manning*, 90.

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15. *Despommier*, 65.

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