# Systems of Sustenance

## A Re-imagining of Seattle's Food and Food Waste Infrastructure

Josh Carel

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Committee:

Brian McLaren

Sharon Sutton

Nina Franey

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## Abstract

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Josh Carel

Chair of the Supervisory Committee:
Associate Professor, Brian McLaren PH.D.
Lecturer, Nina Franey
Department of Architecture

Cities around the world are facing parallel challenges in addressing the resource needs of growing populations while simultaneously trying to decrease their environmental impact. This is especially true with food. In Seattle, a city expected to see 20% growth in the next 20 years, food accounts for roughly half of the average citizen's ecological footprint (Moore 2011). The responses of farmer's markets, food hubs and municipal compost, have thus far been ineffective at adequately addressing this challenge. Regional food only realizes a small portion of its potential percentage of the urban market, and municipal compost currently relies heavily on fossil-fuel transportation practices to inequitably distribute waste to surrounding communities. These shortcomings are results of inadequate relationships between the components of the regional food system and the city, and non-existent relationships between the components themselves.

This thesis posits that a reorganization of the programs through which resources are transferred between regional farms and the city is needed if the appropriate patterns of urban consumption are to be scaled-up in an environmentally-responsive, equitable way. The ensuing project seeks to indicate the new forms of urban infrastructure required to enable such a reorganization, and in doing so, design a new system that simplifies that interface between Seattle and Washington State's regional farms. In designing this system, three strategies were prioritized: understand and implement the appropriate scale of components as they relate to both the city and regional farms; formulate mutually-beneficial conglomerates of system components in order to realize efficiencies that are unattainable otherwise; and capitalize upon existing infrastructure and analogous circumstances within the city that can potentially catalyze the effective distribution of food and waste throughout the system.

The project proposes the implementation of a network that couples regional food/waste conglomerates with the stations of Seattle's Link Light Rail, allowing for the fluid transfer of resources within the city. The conglomerate program proposed for the University District Light Rail Station has been designed in detail in order to investigate the challenges and possibilities associated with inserting these new programs within the city. The project combines compost processing, food distribution, and market programs with the future light rail station.


Fig. 1: *Climber’s Dream*.

For

Adelle,
Kevin,
Donice,
Estee
and the rest of my family
for their continued support.

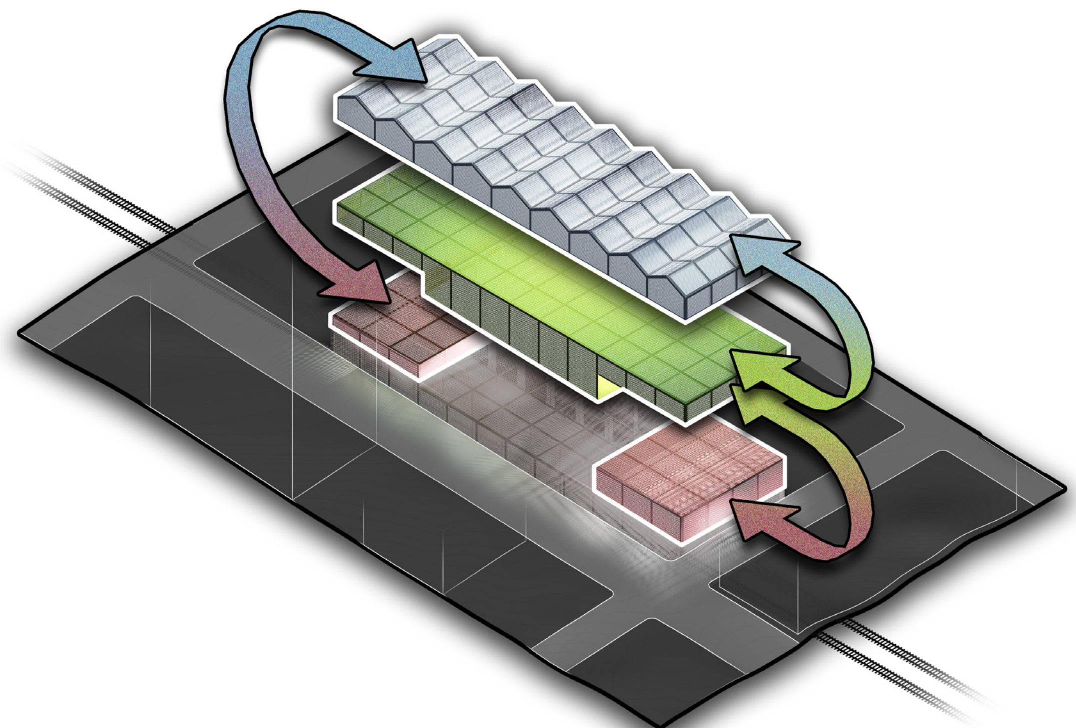

Fig. 2: *Conceptual Diagram*.

# Content

Fig. 3: *Market Scene*.

# the City

An apparition
seen on a mountain
by shepherd boys
founds a cathedral,
rectory and convent
a huddle of hovels
some whores and userers
seeking sanctuary.
A road, bridge, some houses
school, hospital, served by
pious rich ladies;
blacksmith, forge, farrier, some
day laborers at Whitsun
and Michelmas
A jester, goldsmith, coffin maker
chimney sweep, tavern
viaduct, amphitheater, cemetery, and more
set between field and forest,
urbs, civitas, polis, metropolis
megalopolis, necropolis.
A large consequence from an apparition
or was it a spectre?

-Ian McHarg

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Fig. 4. *Coronado Feeders*. Aerial image of a feedlot in Dalhart, Texas showing the effect the feedlot has the adjacent body of water.

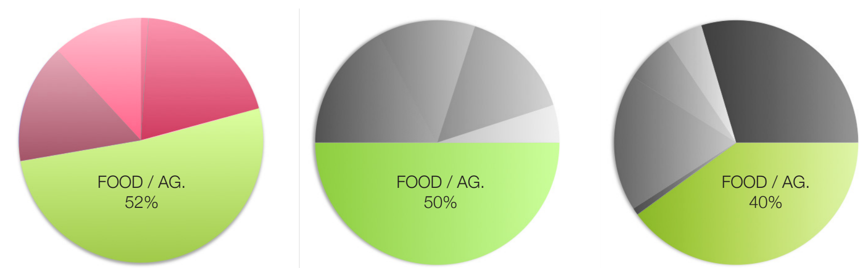
# 1: Introduction

Thesis Statement

As climate change has become an increasingly important challenge, it seems that architecture, as Rem Koolhaas has noted, has become the profession most responsible for addressing questions of the environment (Koolhaas 2011). Yet, thus far architecture's primary focus in terms of sustainability has been on the performance of individual buildings and the technologies required to increase their efficiency. This thesis asks the question: *How might architecture become more involved in sustainability beyond the design of individual buildings, into the sustainability of cities and regions?* The ensuing investigation focuses on the programmatic performance of future sustainable architecture as it relates to the broader territories of the city and region.

The challenge that this thesis focuses on is that of food. As cities around the world continue to grow, the demand for food in urban areas will also continue to rise. This situation runs parallel to the requirement that cities persistently decrease their environmental impact. The real challenge, therefore, is the coexistence of these two necessities: how to increase the flow of resources while decreasing the effect that their production, transportation, and discarding have on the natural world.

There are many metrics that indicate food as being a main contributor to humans' negative impact on the environment. Ecological footprints, carbon emissions and methane emissions are all greatly affected by the methods currently in place to supply




Ecological Footprint
Data shown is for Vancouver. Expected to be Similar for Seattle

Carbon Emissions
Culmination of agriculture and agricultural related activities.

Methane Emissions
Likely higher when including food waste.

Fig. 5: *Ecological Impacts of Food*.

food to consumers. This is especially true for Seattle. In a 2005 study that surveyed fifteen of the largest U.S. cities, it was found that the average Seattleite had the largest ecological footprint per capita (Moore 2011). As is the case with the national trend, food likely contributed to this statistic more than any other factor (Moore 2011). Seattle is expected to grow by roughly 20% over the course of the next 20 years (Langeler 2015)- that means adding nearly 120,000 people to a city of 600,000 (Langeler 2015). How might Seattle reverse the current shortcomings of its food system and welcome new citizens without significantly increasing its impact on the environment?

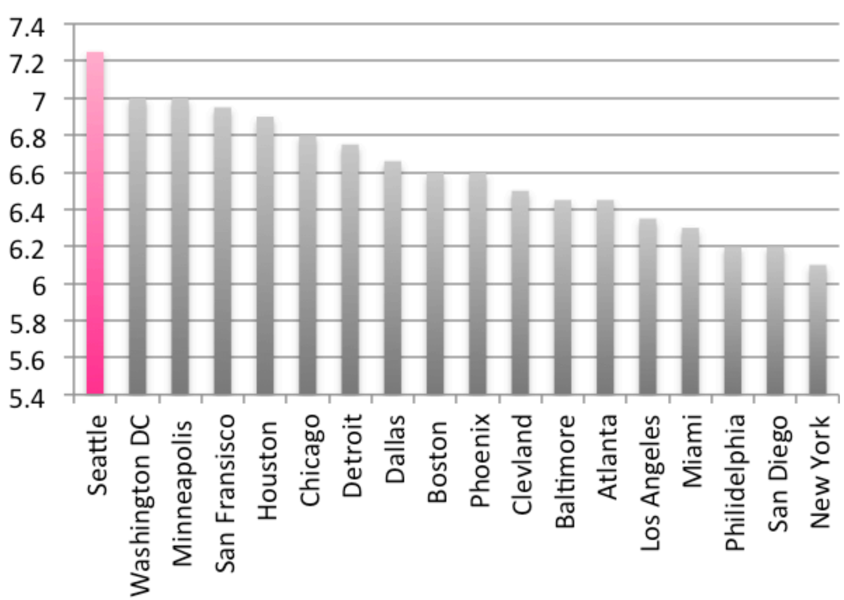



Fig. 6: *The Average Ecological Footprint of Residents of Various Cities in the United States*.

Given Washington State's suitability for agriculture, the negative impact of Seattle's food system on the environment is surprising. Washington State is the second highest producer in the United States for vegetables and third highest for fruits (Perez 2010, USDA 2012). Additionally, Washington State has a diverse, sparsely populated landscape which is suitable for growing a wide range of crops and supporting many different types of livestock. It would seem, based on these facts, that the average Seattleite could more easily support a regionally-based lifestyle than residents of densely populated or arid regions. Although it has been shown that eating regionally is not always better for the environment (Rogers 2012, Sexton 2011), it is understood that a regional diet is generally positive given that the land used for agriculture is naturally predisposed to support the crops or livestock being cultivated. Eating regionally lessens the amount of transportation-related carbon emissions associated with supplying food to local markets, lessens the amount of food that could be wasted in transit and storage required for long range trips, and also reduces the amount of infrastructure required between production and consumers. Given that Washington State's geography is highly suitable for a variety of different types of agriculture, this thesis

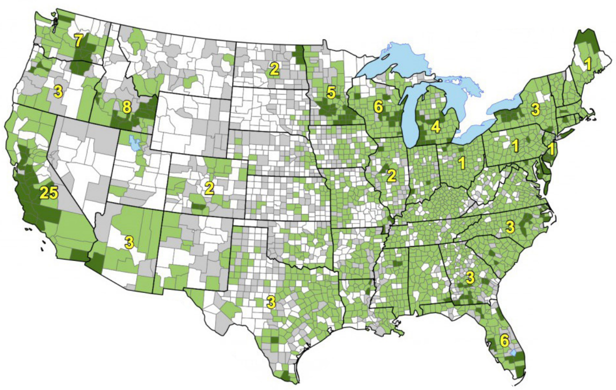


Fig. 7*: United States: Vegetables*. Map depicting the percentage of US vegetable production each state contributes. WA State contributes 7%.

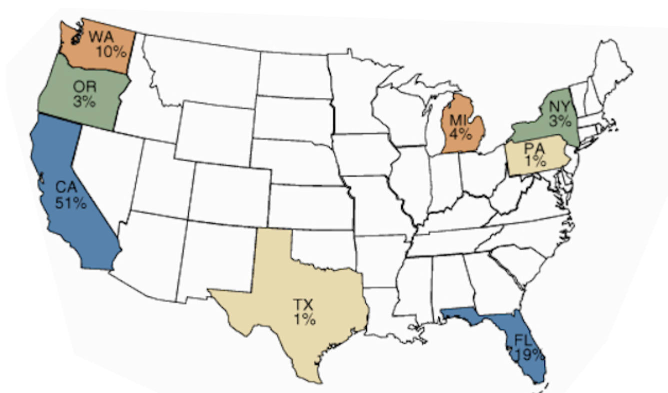



Fig. 8*: U.S. Fruit: Top Producing States, Based on 2010 Bearing Acreage*. Map depicting percentage of US fruit production each state contributes. WA State contributes 10%.

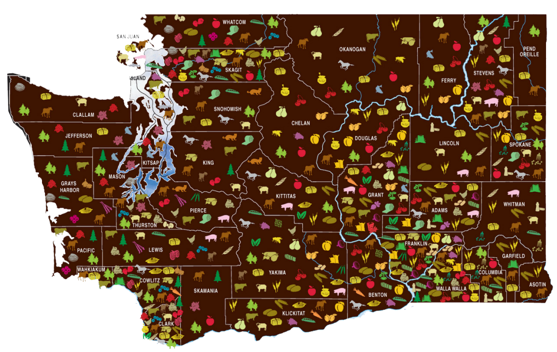


Fig. 9*: the Fresh Taste of Washington*. Map depicting various types of crops and livestock raised and cultivated in Washington State. Each color represents a different type.

views eating regionally as a key component in remedying the impact Seattle's food system has on the environment.

The high impact of Seattle's food system is also surprising given that Seattle has been a leader in municipal compost operations. Food waste has become a major problem in the United States with over 40% of the food produced thrown away (Gunders 2012). The destination for this waste has conventionally been landfills where it rots and produces methane, a greenhouse gas upwards of 25 times more potent than carbon dioxide (Gunders 2012). Seattle began its compost operations in 2004 and made them mandatory in 2015. Instead of food waste ending up in landfills, it is now processed and returned to regional farms in order to add nutrients to soil and supplant synthetic fertilizer.

Despite Seattle's ability to be a leader in both regional eating and food waste recycling, this thesis argues that the current infrastructure in place to support these activities is insufficient to realize their sustainable potential. The main components of the food system, the facilities for the distribution and sale of regional food and for the recycling of waste, are not currently poised to enable a sustainable relationship between Seattle and Washington State's regional farms. Likewise, each of these components is currently specialized, operating with no relationship to the other parts of the system. As will be discussed in further depth, the separation of these components results in redundancy that further detracts from their sustainable potential.

This thesis proposes a systems-based approach to the interrogation and re-imagining of the infrastructure of Seattle's regional food system in order to create a more efficient, equitable, and ultimately more sustainable connection between the city and Washington State's regional farms. The large scale components of distribution and composting will first be evaluated on an individual basis to understand the optimum forms they should take in a new infrastructural system. Next, their connection to each other, and their relationship to the city and to other components within the city, will be investigated in order to propose a system that can operate above and beyond the possibilities currently allowed by specialization.

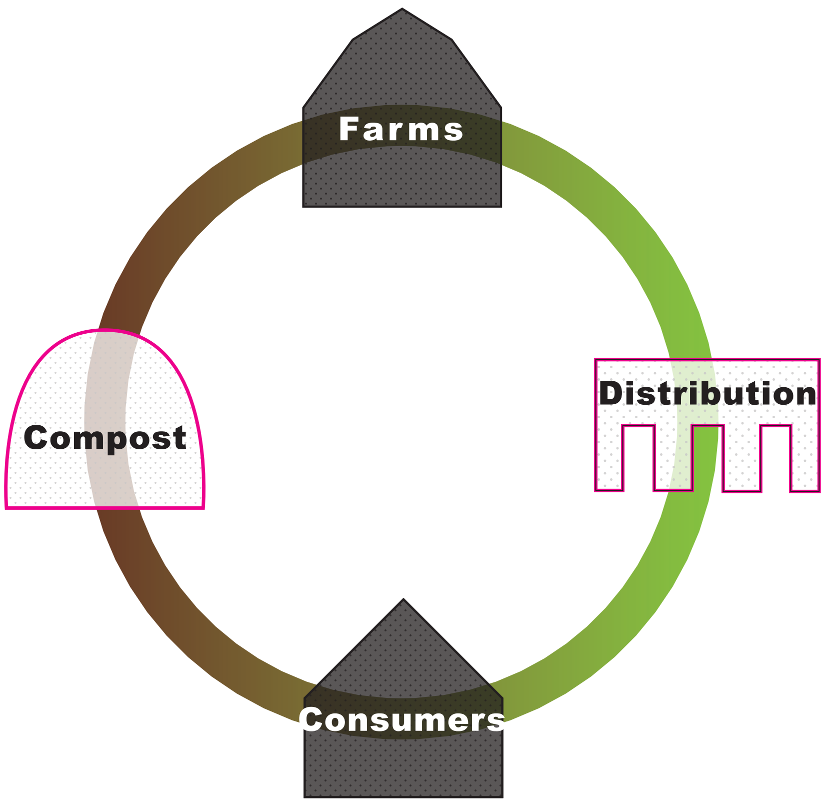



Fig. 10: *The Food Loop*.

In re-imagining a new food and waste infrastructure, there are three main goals:

1. Reduce the amount of transportation required for the movement of regional goods and waste throughout the state. This will be assessed on an individual level in researching components, as well as on a systems level in understanding components' relationships to each other and other infrastructures.
2. Prioritize the consumption of regionally produced food and encourage composting within the city. These activities are both aligned to overall intent of thesis and will be prioritized in the future infrastructure.

3. Support best practices in both food production and compost processing. This requires understanding the current activities conducted in Seattle and Washington State, and then determining the most sustainable and equitable forms of these activities that will be supported by a new food system infrastructure.

The theoretical framework of this thesis is divided into two chapters. Chapter Two looks at the specific components that exist between Seattle and regional farms with the purpose of indicating the failures currently exhibited by those components and proposes possible solutions. Chapter Three focuses on the system and how the components might be coupled and paired with other infrastructures. Chapter Four focuses in one of the facilities proposed by the theoretical framework and documents the challenges and possibilities in designing such a facility.

This is a speculative thesis. It attempts to push the idea of a sustainable food system as far as possible. The challenge of climate change requires the world, and especially the western world, to make significant changes in how "business as usual" is conducted. The responses necessary will not be conservative but will require fundamental alterations in aspects as small as everyday lives and as large as urban infrastructure. This thesis attempts to provide a comprehensive image of how such a change could both radically reinvent the way our food and waste resources are handled, and more importantly, how such a change could enhance the lives of urban citizens.

Fig. 11: *The Industrial Harvesting of Wheat*.

# Chapter 2: Re-imagining Components

## Introduction

Chapter Two will investigate many aspects of the two main components of the regional food system, the distribution center and the compost facility: the current models will be investigated and their shortcomings discussed. For each, there are emerging methods in which the services they provide can be conducted in a more sustainable, equitable fashion. This chapter seeks to indicate the optimum forms of these components and understand how they can be best deployed within Seattle. The goals laid out in chapter one will be relevant throughout the ensuing discussion.

## 2.A: Distribution

Distribution facilities are the infrastructural components that allows food to flow from farms to cities. They are nodes of collection where food from many farms is brought to one place for sorting and then for distribution to points of sale throughout cities and regions. In investigating new forms of distribution and in addition to the goals laid out in Chapter One, there are two specific objectives: First, in choosing an alternative, bear in mind the overall intention of this thesis is to enable the food system to increase its capacity in a sustainable manner. Therefore, the purposes here are not to indicate *any* alternative, but to envision one that could have widespread application and effect. Secondly, an alternative must reasonably be able to compete with the existing system on an economic level. The intent is to envision new systems that are more sustainable *and* more equitable, and therefore distribution alternatives seek to increase the availability of regional food to all demographics.

Goal three laid out in Chapter one is extremely important when considering new forms of food distribution. Supporting the best practices in farming may be the area of this thesis that would have most profound affect on the environment. Despite

Washington State being the second highest producer of vegetables and third highest of fruits, the Seattle region's food market is "overwhelmingly dominated by products sourced from outside the region" (NABC). As this section will argue, the condition is not as simple as having a supply in farms and a demand in the city. Rather, it is the infrastructure that exists between the supply and demand that is able to control many factors including the final destination for food produced in a certain region

Infrastructure is prejudice. The series of conditions that it creates will inevitably work in favor of certain activities over others. In the case of food, the distribution facility, which is in charge of controlling logistics and negotiating between suppliers and consumers, is key in determining what type of farming the food system is built to support. Therefore, in order to propose the correct, most sustainable infrastructure to put in place in Seattle, the conversation must begin with first understanding the type of farming that new infrastructure will advocate.

The size of farming operations is a good indicator of how land is managed, what methods are used for cultivation, and where the products and money go after sale. These factors all in turn affect the environmental impact of the operation. The appropriate farming size will be identified through an examining of the three main scales: large, small and medium.

## Large-scale Farming

The main type of farming currently conducted nationwide is large-scale or industrial farming. The typical industrial farm in the United States employs practices such as mono-culture, heavy pesticide use, and massive operations to achieve large-scale crop production. These practices are responsible for negative environmental effects such as decreases in biodiversity, polluted rivers and streams, and the depletion of nutrients in soil (Horrigan 2002). Industrial farming uses the resources of "fossil fuel, water, and topsoil at unsustainable rates" (Horrigan 2002), which when compared to smaller scale farms, results in less efficient operations. Industrial farming is responsible for using seventy percent of the world's agricultural resources but only producing thirty percent of the its food (Bittman 2013).

It is of additional concern that these practices have typically not been in the best interest of rural populations. By sending large amounts of profits to out-of-state corporate headquarters, rural communities have seen declines in quality of life and intangible heritage. A correlation between this phenomena and increases in the scale and productivity of farming can be seen as represented by the correspondence of these trends through the last several decades (Koolhaas 2012).

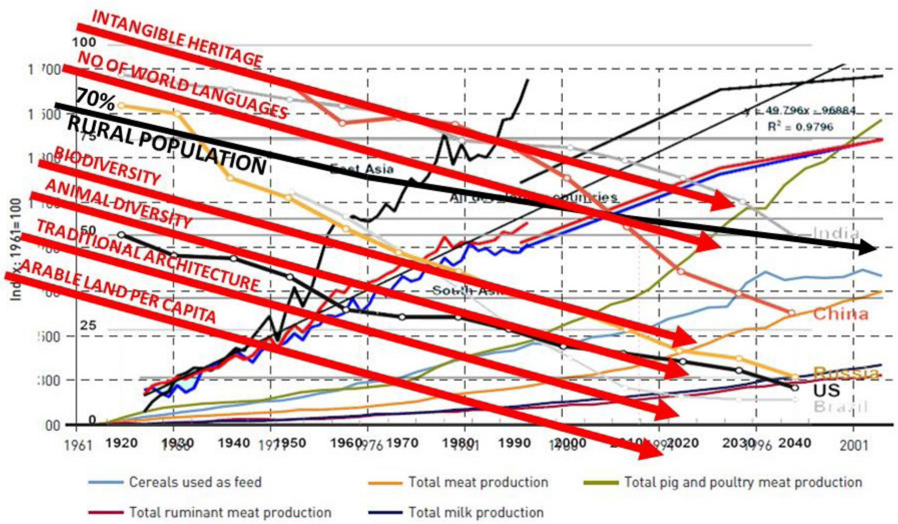



Fig. 12: *Intangible Heritage Loss*. Graphic showing corresponding relationship between loss of cultural characteristics and increases in farm productivity worldwide.

However, large-scale farming has its advantages. Despite its ecological flaws, since World War II the industrial food system has dominated the market in large part due to its ability to achieve economies of scale. By producing massive amounts of food, large-scale operations are able to overcome inefficiencies and bring products to market at low costs. This is a situation that any competing models will have to address if a suitable alternative is to be envisioned.

## Small-scale Farming

The heavily marketed alternative to industrial farming is small-scale farming. While the operations of small farms can often avoid the majority of the environmental problems associated with industrial agriculture, they have proven to not be an economically feasible option. In King County, which is comprised of mostly small-sized farming operations, farmer's expenses on average are $2,700 more dollars per year than their incomes (King County 2015). The same is true nationally. According to the USDA, small farms lose money and, until farms produce upwards of $350,000 of crop-generated profit per year, they able unable to attain incomes equal or more than the national average (USDA 2014).

Additionally, small-scale farming is time-intensive for farmers and costly for consumers, which both contribute to the difficulty in imagining this model supplying a significant portion of the increased demand for urban resources. Currently, small farms across the nation contribute only around 1-2% on average to the urban food market (Hauter 2012). This creates a paradox for farmers: either reach the income level of industrial farms, where economies of scale are reached and where food is less likely to be sold near the source; or stay small and seek other sources of income. This situation also plays out as either a positive or negative for the environment.

## Mid-size Farming

The alternative to large or small-scale farming is an in-between, medium-scale of operations. In her book *Foodopoly*, Wenonah Hauter explains how mid-size farms have the capability to avoid the environmentally damaging practices of large-scale farming while still capitalizing on economies of scale. They are able to function in sophisticated ways, while allowing for a more pixelated terrain that "provide wildlife habitats… diverse landscapes…(and) perennials that reduce greenhouse gases…" (Hauter 2012)

Yet, Hauter indicates that nationally, these farms are unable to survive due to lack of appropriate infrastructure for the transfer and sale of products (Hauter 2012). Mid-sized farms have been indicated as being too small to survive in today's commodity markets but also too large to participate in the farmer's markets or otherwise small local venues for sale (Fischer 2014). What is needed is an alternative system through which regional foods, produced at a medium-scale can be brought to Seattle's market in the most efficient way possible.

In order to conceive an infrastructure that can better support medium-sized farms, a basic understanding of how goods are transferred between Seattle and regional farms and the infrastructure in place to allow these transfers, must first be established. The two main methods for food transfer correlate to the type of farming conducted: the industrial and the small-scale.

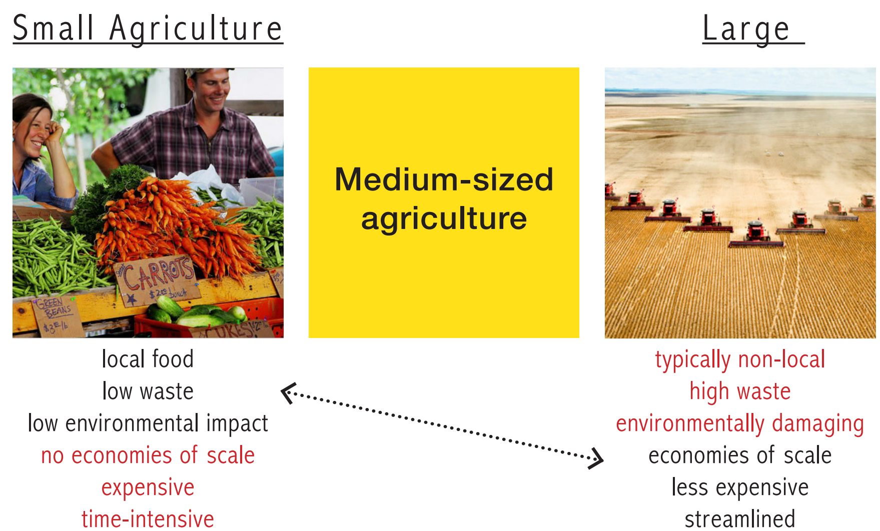



Fig. 13: *Medium Sized Farming*. Diagram depicting the basic advantages and disadvantages of small and large-scale farming and the possibility of medium farming capitalizing on the positives of both.

## Industrial Distribution

The industrial distribution system is comprised of large-scale components devised to move products nationally or even internationally. The main hub of this system is the distribution center: a single story, massive warehouse structure often sited in industrial areas. Typically owned by private entities, distribution centers are put in place to allow for the flow of goods to a specific, typically private, set of stores or clients.

The industrial food system is primarily focused on the economics of the products it delivers. This has lead to the centralization and consolidation of the food system into less and less parties (Hill 2008). Through the last several decades the food system has seen radical changes, where companies increasingly seek food supply sources outside their states in order to keep prices in grocery stores low (Hill 2008). As the middle man between farms and cities has become larger and more powerful, it has had a negative effect on farmers, resulting in 300,000 farmers in the US going out of business since 1979 (Hill 2008).

## Farmers Markets and CSAs

The increasingly popular distribution methods opposed to that of the industrial system are local farmers markets and Community Supported Agriculture (CSAs). Farmers markets have seen an exceptional rise in popularity through the past few decades with over 2,000 opening in the United States since 1990 (USDA 2007). Yet, in Seattle the local food currently only accounts for three percent of the overall food market (King County 2014).

Fig. 14*: Safeway Distribution Center.* Auburn, WA.

The dynamic between the small, local system and the large, industrial system is similar for distribution as was discussed for farming. While the industrial system deals with very large amounts of food that is channeled through specified routes, the local system relies on individual farmers to make individual trips in order to bring their product to the urban market. While the cultivation methods of small and medium-sized farms is viewed as a much more sustainable alternative, the current practices for the distribution of these goods is far from optimum. Farmer's markets not only place farmers who sell through these venues at an economic disadvantage compared to their larger counterparts but also rely on customer's willingness to pay higher prices to account for the decreased efficiency of the system.

Another shortcoming of farmer's markets is their inability to scale up the amount of regionally-produced food in the Seattle market in an environmentally friendly way. In order to communicate why, a series of maps were produced depicting the current status of farmer's markets supply sources. Figure 15 is a survey of food products, bought at Seattle farmer's markets and brick and mortar markets, that were cultivated or produced in Washington State. Figure 16 takes those farms of production and displays their locations alongside data regarding Washington State's highest grossing, most productive farmland. When you overlay this information, a disparity becomes apparent. While the majority of Washington State's best farmland exists within the 100-200 mile radius from Seattle, only about a third of the regionally-produced food bought in the city came from these areas. Due to the distances required for the transfer of goods from the central and east parts of the state, most medium to small farmers in these areas cannot afford to invest the time and resources required to bring their products to Seattle farmer's markets and CSA venues. Therefore, the resulting situation is that most of the operations in these parts of the state have succumb to selling their products to the industrial system. This thesis advocates a new type of infrastructure is needed that allows the medium-sized farming operations to bring their products to the Seattle market at much larger quantities.

## Medium Sized Distribution

As with farming, this thesis advocates a type of distribution in between the industrial system and the small-scale farmer's market based system. The hope with this alternative is that, through a streamlined method for the sale of regional goods, the environmental disadvantages of out-of-state sourcing can be avoided while simultaneously achieving much higher economies of scale than currently afforded by regionally-based systems.

Food Hubs are an emerging model that are put in place

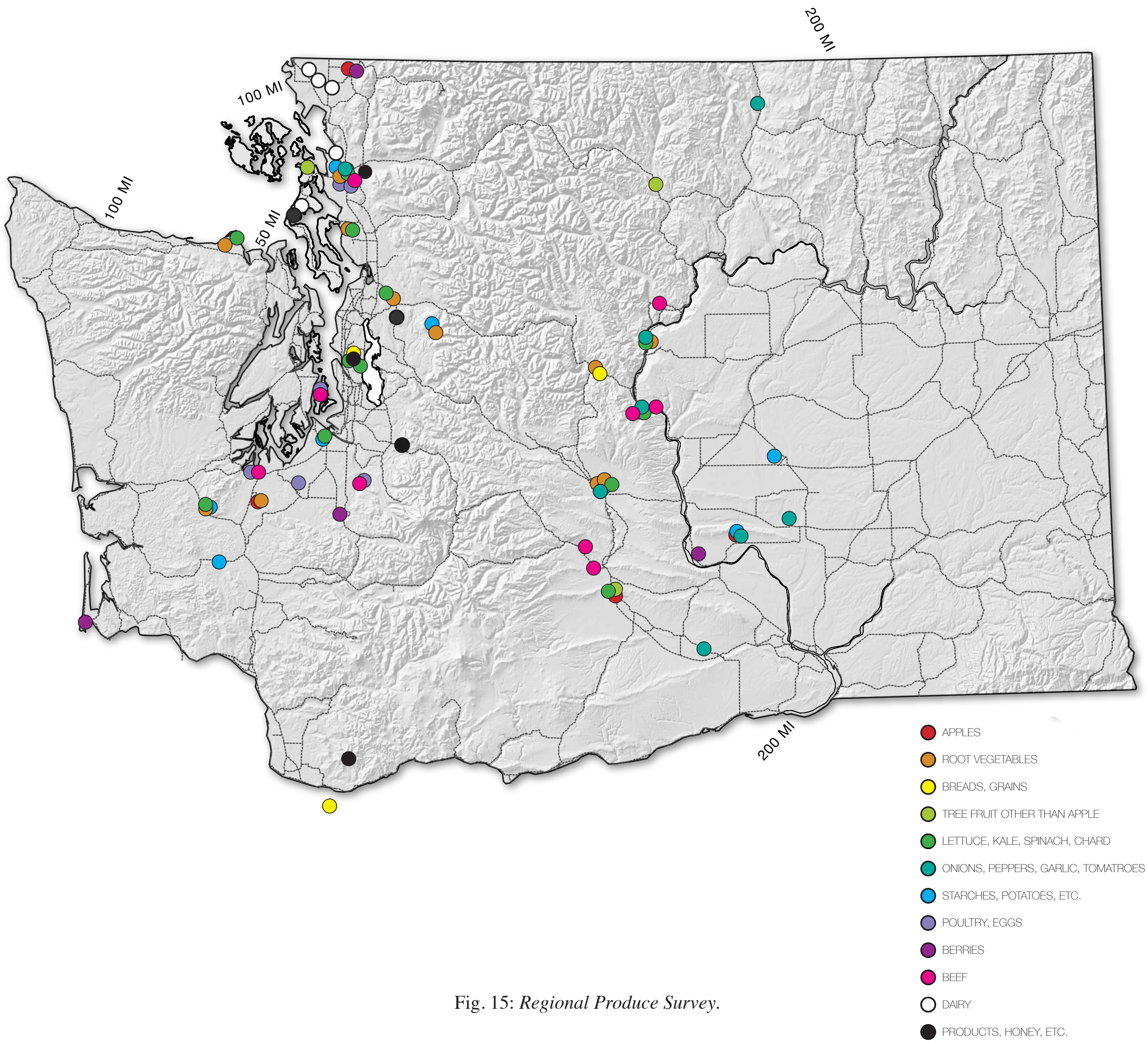



Fig. 15: *Regional Produce Survey.*

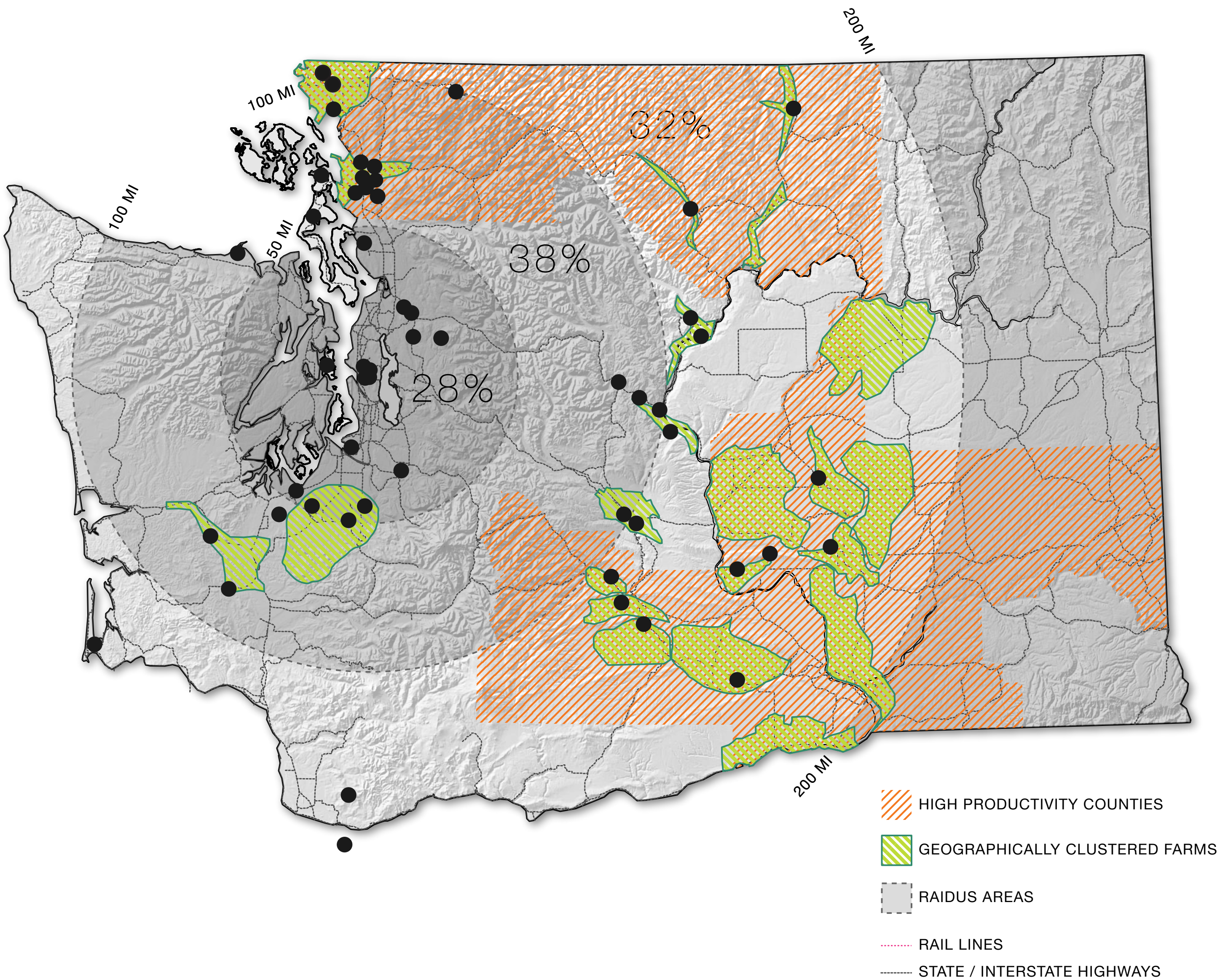



Fig. 16: *Regional Farm Overlay.*

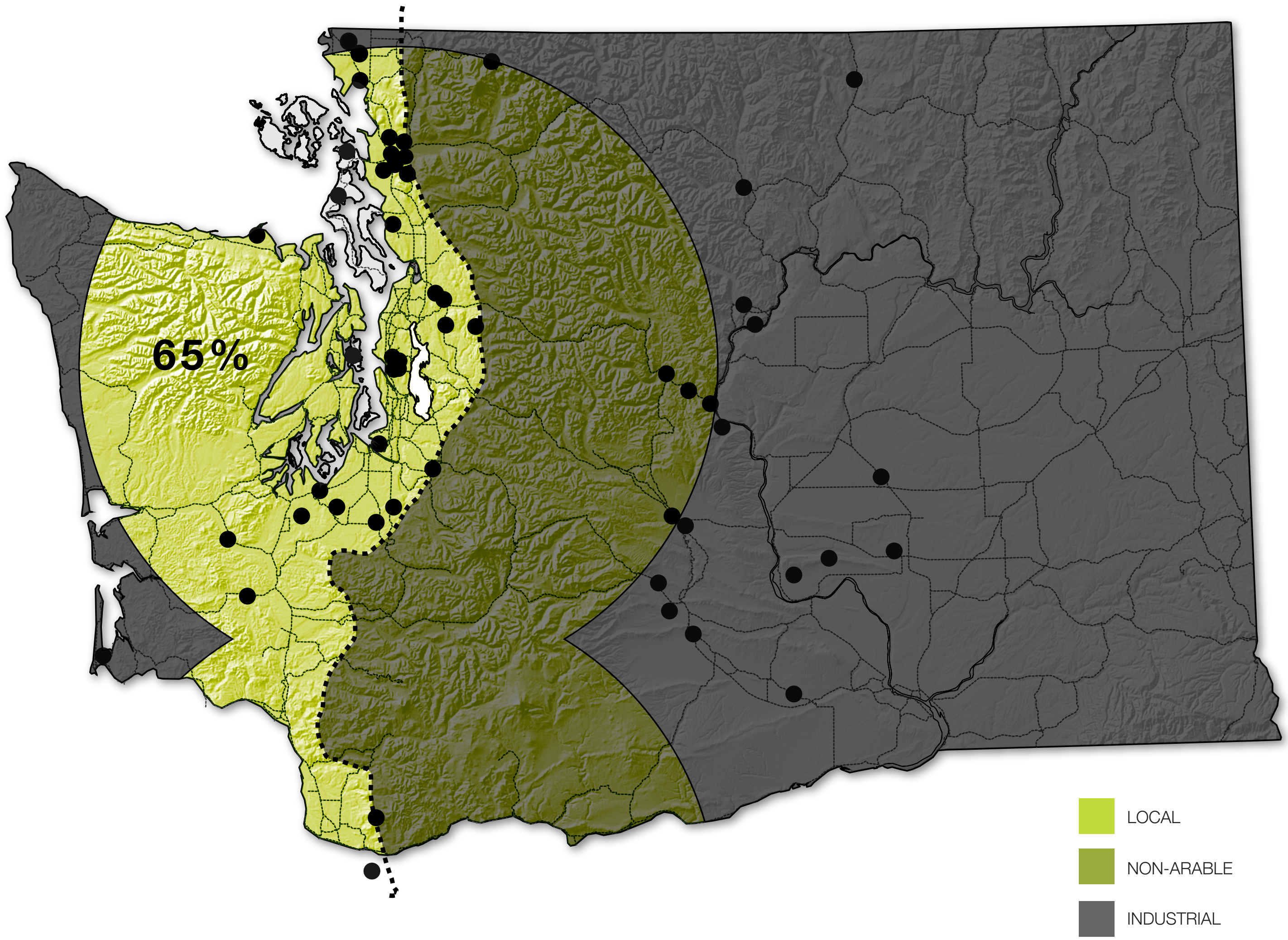



Fig. 17: *Local Versus Industrial*.

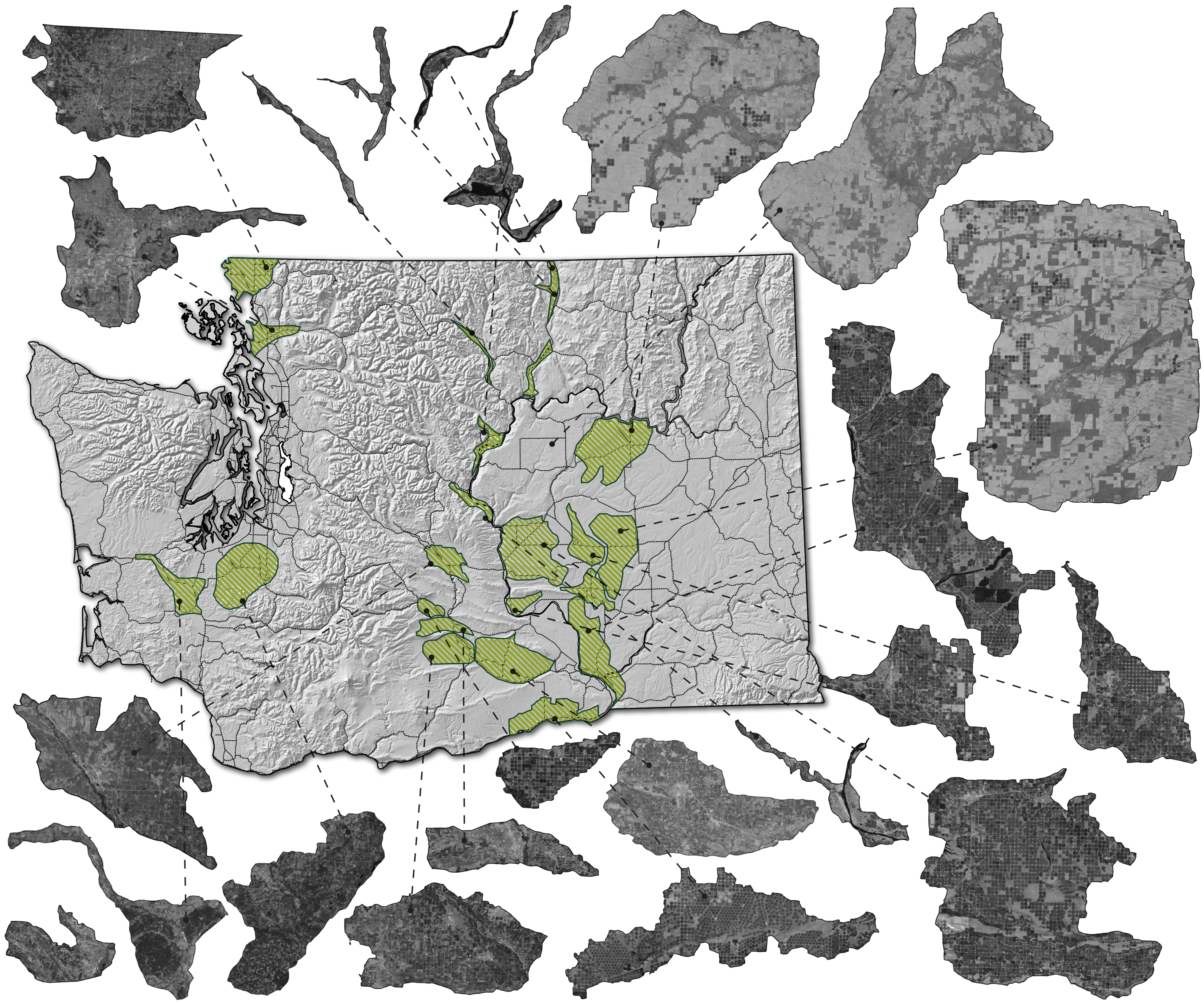
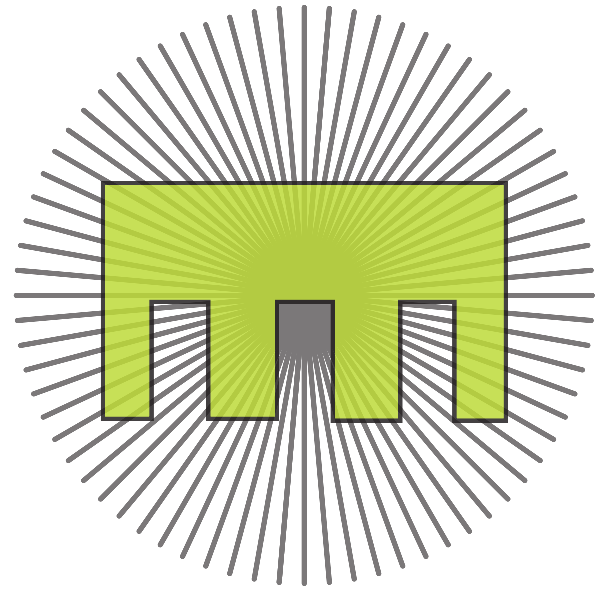


Fig. 18: *Farm Clusters*.

to serve the infrastructural needs of medium-sized farmers (Fischer 2013). Foods hubs are responsible for the aggregation and subsequent distribution of goods from regional farmers to consumers at whole-sale volumes (Fischer 2013). Additionally, food hubs typically support farms that operate using environmental conscious methods (Fischer 2013).

The food hub model is especially strategic for Washington State because it could allow medium-sized farmers in areas located at greater distances from Seattle to realize economies of scale. Instead of acting on individual bases, farmers would be able to group with other farms in their area to form geographically-intelligent farm clusters. In doing so, farmers within these groups could pool their resources and deliver large quantities of goods to Seattle at one time. Washington State's geography already lends itself to division in this way as a result of the mountains and rivers that have created distinct areas of cultivation. Figure 19 shows the macro-clusters that are easily indicated using aerial photography. It is envisioned that these large groups would be subdivided as necessary to create the optimum size of clusters.



## Localized Distribution

In urban areas food hubs seek to distribute regionally-produced food to a variety of sources such as markets, restaurants, and hospital cafeterias. In this sense, their intention is to enable regionally-produced food to permeate the urban market much more than farmer's markets or CSAs currently allow. Yet, many current examples of food hubs have mimicked their predecessors by locating themselves on the fringes of urban areas, neither capitalizing on efficient proximity to regional farm transportation conduits or integrating effectively into communities. Seattle

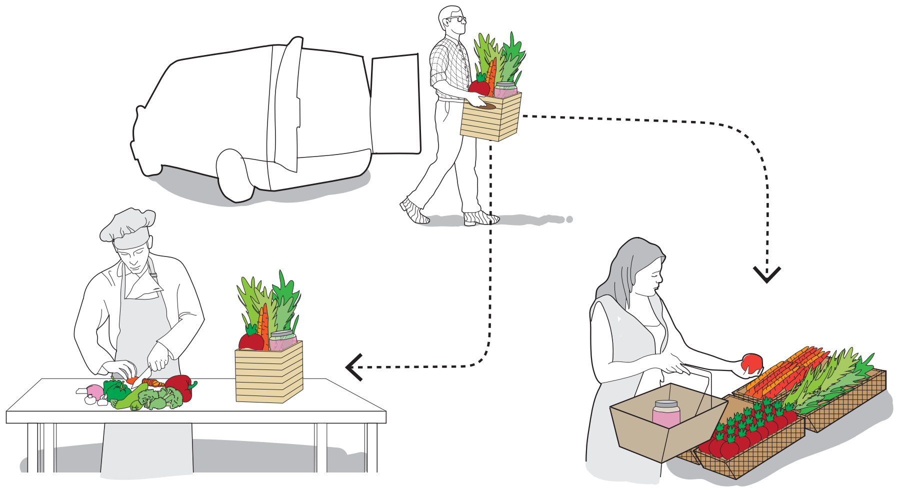


Fig. 19: *Localized Distribution*.


Fig. 20: *21 Acres Food Hub Location*.

currently has one major food hub, dubbed 21 Acres, located north of Redmond in Woodinville Washington. This location is not strategic for farmer deliveries or product distribution.

This thesis proposes that future food hubs within Seattle be localized within the city's various communities. In doing so, food hubs can capitalize on efficiencies in transferring goods shorter distances from distribution centers to final destinations. This will allow for the creation of a network for the distribution of regional food. Instead of Seattle embracing one large-scale facility, a plan should be devised to strategically implement a series of hubs that serve different parts of the city. Chapter Three and Four of this thesis investigate how such a network could be planned and potentially implemented in Seattle. Localized distribution centers should be designed to integrate with specific communities in which they are placed, and in doing so respond to conditions relevant to that specific area.

A good example of a food hub that has been well-planned for integration into a community is that of the West Louisville Food Port designed by OMA. The facility is meant to serve a specific community within the city that has been identified as a food desert. Instead of recreating the conventional isolated

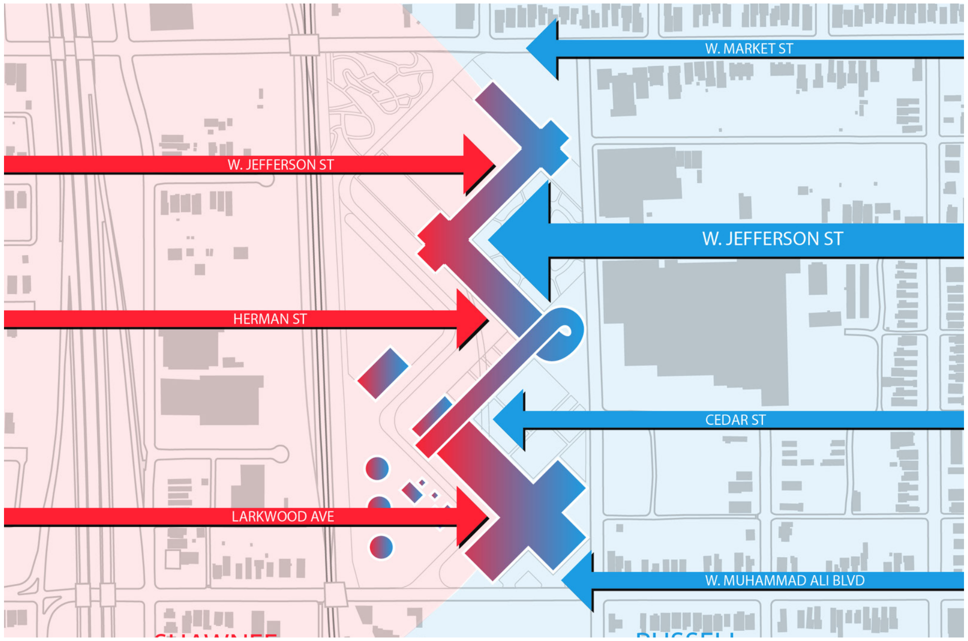



Fig. 21: *West Louisville Food Port*.


Fig. 22: *West Louisville Food Port*.

warehouse typology normative for these programs, the West Louisville Food Port literally uses the contextual pedestrian conditions to generate its form. Where the east and westbound routes meet the site boundaries, OMA has planned the project to feature public areas that foster different activities related to the facility. Through these public programs, the project acts as both an amenity to the community and a subtle educational element that reveals the benefits of such a facility.

This first part of Chapter Two indicated that medium scale farming and distribution operations will allow for the best combination of sustainability and economic feasibility for the supply of regional foods to Seattle. Further, the benefits of localizing future distribution centers in order to achieve local efficiencies and community involvement were embraced. The second part of Chapter Two investigates the inverse of this relationship will regional farms: compost operations.

Fig. 23: *Cedar Grove Everett, WA*.

## 2.B: Compost

The second component this thesis investigates is compost. Compost is an essential element in the future sustainability of the regional food system. Composting is a natural process that recycles nutrients from food waste, yard waste, and sewage back to venues of food production. In this sense, compost "closes the loop" between food consumption and agriculture. Its merit can be established by way of recycling, but also as opposed to the alternative. Food waste in landfills accounts for sixteen percent of American methane production, a greenhouse gas roughly twenty-five times as potent as carbon dioxide (Gunders 2012). When a biogas capture system is installed, compost facilities are capable of avoiding the majority of, or even completely eliminating, methane emissions (Brown 2009).

Seattle, along with a dozen other progressive US cities, has proposed a Zero Waste initiative. Seattle's current goal is to reduce the amount of waste that reaches its landfills to thirty percent of its overall waste stream by 2025, meaning seventy percent will be recycled (Seattle City Council 2010). A major portion of Seattle's landfill diversion will be in the form of food waste, which in 2012 was the number one component of the municipal solid waste stream that was landfilled, comprising over twenty-one percent (EPA 2012). Seattle began the process of diverting food waste to a third party compost facility in 2004, and made it illegal to dispose of organic wastes to a landfill in 2015.

### Waste Sites

The destination for Seattle's food and otherwise organic waste is one of three composting facilities, located in Stanwood, Everett and Maple Valley, Washington. The organic wastes are processed at these facilities, converted into usable compost, and then transported to various locations around the state for a variety of uses. But the process has been far from smooth.

A main issues with all waste in contemporary society is the notion of "away"; by simply throwing something out it is expected that it has been dealt with. In this new era of the anthropocene, societies are beginning to understand that there is no "away". Decades of traditional waste disposal have resulted in enormous landfills, littered water bodies, and, now, piles of the malodorous leftovers of massive metropolises dumped next to unassuming small towns.

As the philosopher Tim Morton writes, "…if we know that when we flush the toilet the waste goes somewhere there is no away" (Morton 2013), the same may be true for compost.

Seattle's compost facilities have each faced multiple lawsuits due to the odors they create. In 2013, both Cedar Grove locations, in Maple Valley and Everett, were sued by local residents claiming that the "composting facility emits a sickening odor that has devastated the quality of life of the residents living in the vicinity." (Heffter 2013). This has been a nationwide problem for composting facilities: one of New York City's main food waste destinations, the Peninsula Composting Plant, was shut down by authorities in October 2014, two years after the initiation of New York City's zero waste initiative (Eddings 2014). Resident's who lived near the facility testified that the facility produced "odors that were so awful they induced nausea and prevented children from playing outdoors." (Eddings 2014). Seattle's compost facilities could be destined for the same fate.

Hilary Brown, Principal of New Civic Works and author of *Next Generation Infrastructure*, asks the question "How much


Fig. 24: *Cedar Grove Everett, WA.*

risk – including intrusion, displacement, pollution, and disruption – may be assigned to any community while benefits accrue to a much wider public" (Brown 2014). Seattle, San Francisco, and Portland are not the cities that deal with the after-effects of food waste. The martyrs in Seattle's Zero Waste battle are the residents of the suburban towns where the compost facilities are located. In this sense, current compost operations can be considered ethically flawed; they do not exercise spatial justice as the benefits and the consequences of their operations are misaligned. The vast majority of citizens that appreciate the curbside convenience of compost pick-up do not experience the negative effects of large-scale processing.

The main concern related to this thesis is that composting operations, in their current form, threaten their own existence. When considering the ever-increasing amount and reliance on compostables, current practices seem unable to increase operations without further declining the livelihoods of adjacent residents. When proposing new compost infrastructure for Seattle, the system should seek out best practices in order to create an equitable solution so that the sustainable effects can continue to accrue.

A possible main cause of the odor problem, is the centralization of compost facilities. It seems the issue of odors becomes less and less manageable the larger the operations grow. The current facilities handle upwards of a million residents waste from Seattle and cities and towns around the Puget Sound area. Despite the extreme degree that has been taken to isolate these facilities, as seen in Figure 24, their size creates a problem that is extremely difficult to overcome. The Cedar Grove Everett facility is located in the Estuary of the Snohomish River, at least a mile from residents in all directions. Yet, it has still not evaded the aforementioned lawsuits.

## Transportation

Issues also arise from the transportation of food waste. An abbreviated description Seattle's "loop" is as follows: organic waste gets picked up from curbsides and is hauled by massive trucks to a transfer station. There, it gets put on even more massive trucks and hauled to the respective site of processing: each between 105 and 65 miles round trip from downtown. The waste is then processed and prepared for dispersal. Some amount of the waste is returned to the city and used by urban farmers, gardeners, and parks maintenance crews, but the majority is once again loaded

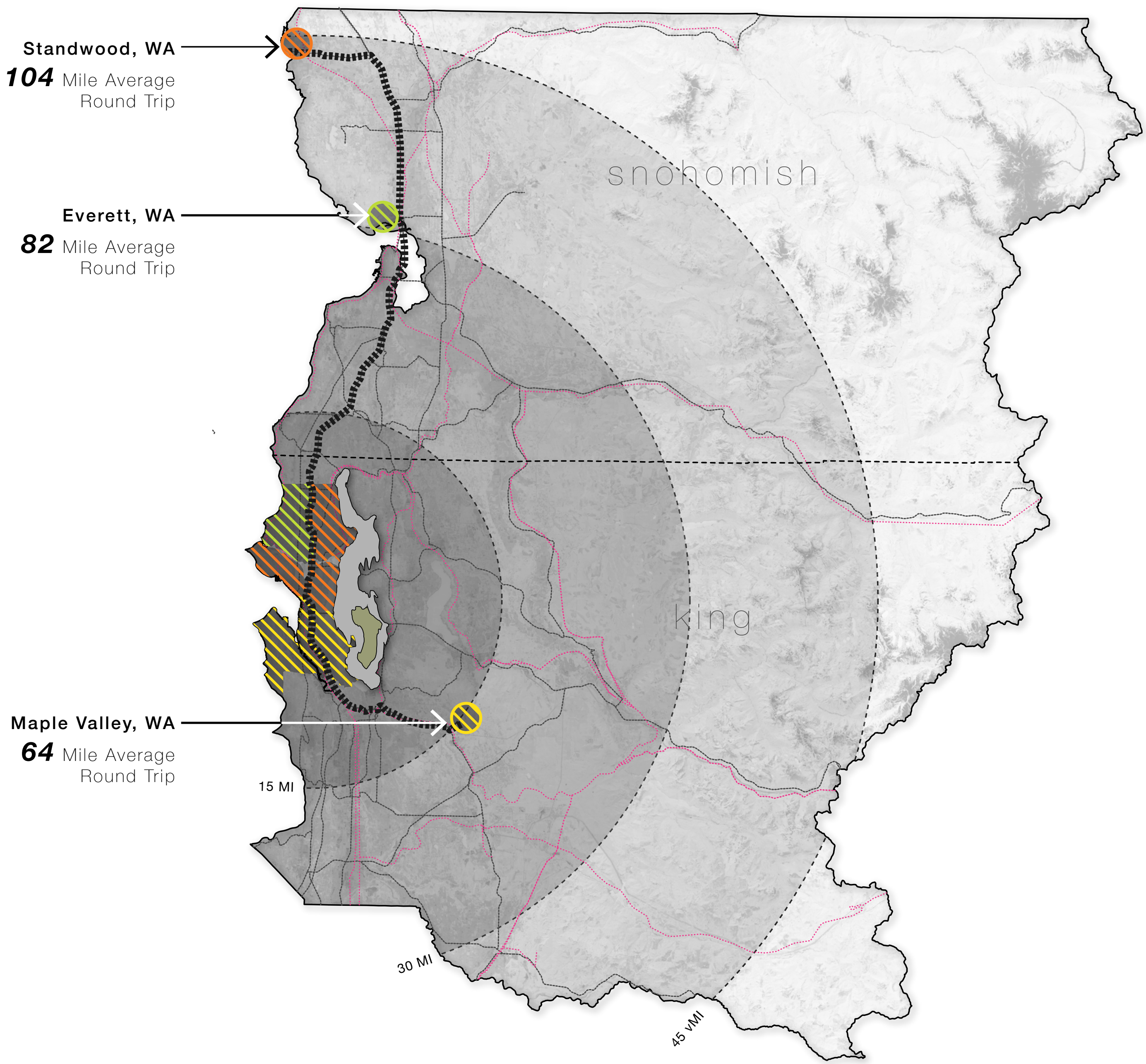



Fig. 25: *Seattle Compost Map*.

onto trucks and hauled to farms in Eastern Washington, the closest major cluster being around 150 miles from the compost facility. The last step in the process – the distribution to local farms and finally onto crops – undoubtedly includes ever more trucks and more fuel.

The fuel usage and greenhouse gases produced through "closing the loop" are absent from the current discussions regarding compost programs. As for the replenishing of soils, the current system is unable to realize the simplest of efficiencies, such as the transfer of food waste from an apartment building within the city to an urban farm. For compost operations to realize their sustainable potential, and become socially equitable, the composting sites require rethinking. Is the conventional practice of moving waste outside the city still the appropriate option? Or is there a smarter, more streamlined way in which Seattle can interface with Washington State's regional farms? This thesis seeks to indicate an alternative to the current centralized approach to compost processing. New infrastructure for compost should attempt to solve issues of both inequity and unnecessary transportation.

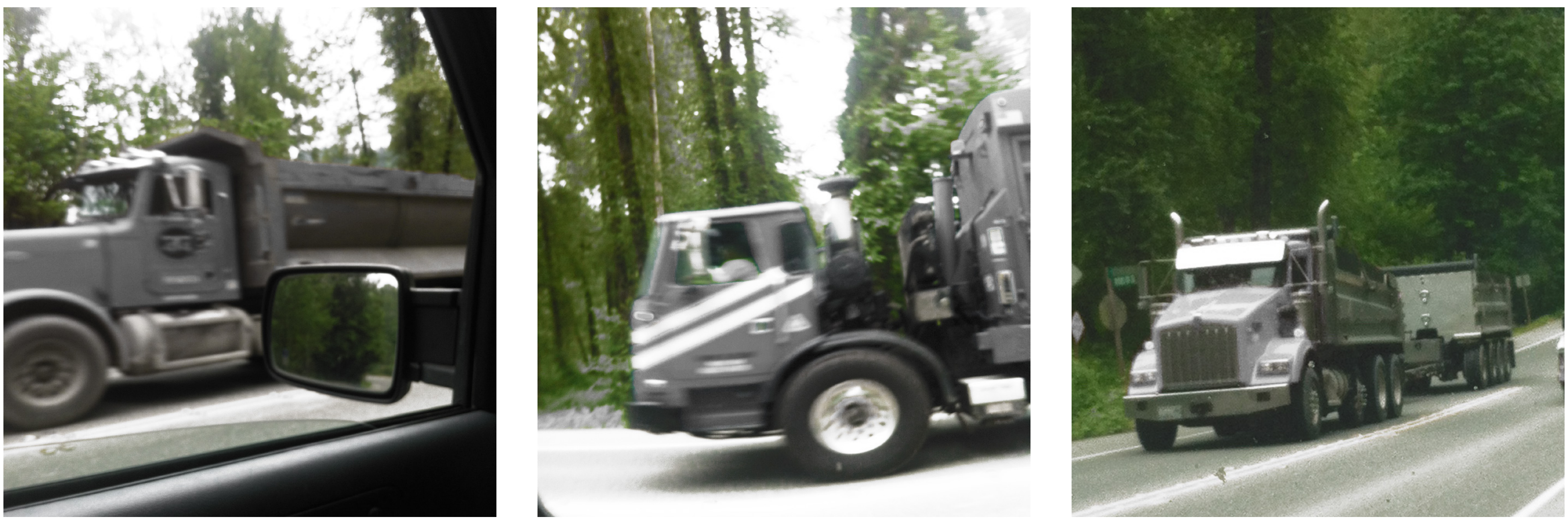
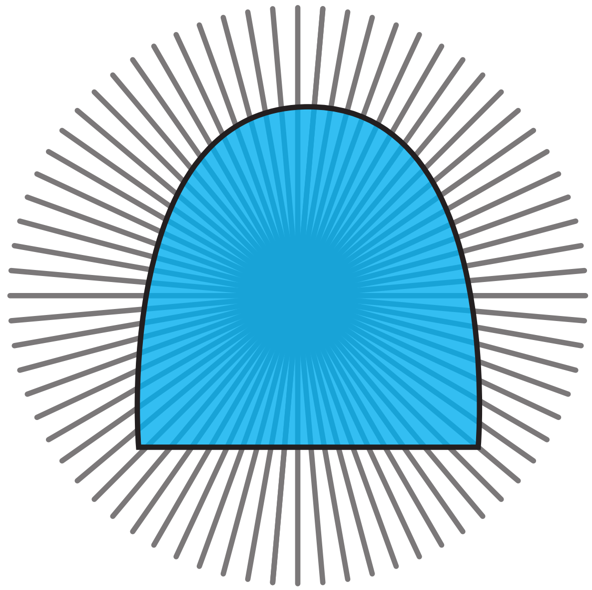


Fig. 26: *Trucks at Cedar Grove Maple Valley, WA.*



## Decentralized Compost Facilities

In moving forward, this thesis promotes the creation of compost facilities that operate in tandem with the proximity principle, which calls for “waste to be treated as closely as possible to where it is generated” (Brown 2014). This term is an alternative way of saying that waste treatment operations should emulate natural systems in the sense that excess energy for the movement of nutrients from waste back to consumption is minimized. In nature there is no transportation required; leaves fall from trees and decompose where they lay. The placement of compost facilities nearer the source will allow for in-city efficiencies. Neighborhood and community-scale facilities could provide compost for local gardens, farms, and landscaping operations, and in doing so, could reduce transportation requirements. In reaction to the recent closure of several compost facilities, Dr. Neil Seldman (Seldman 2014) wrote an essay advocating “locally based and diverse composting infrastructure” (Seldman 2014) . He indicated that decentralizing compost facilities “would create jobs, reduce private and public sector costs for managing waste, and better tie compost to healthy soils and local food production, thereby reinforcing a community culture of sustainability and engaged environmental stewardship.” (Seldman 2014). The decentralization of compost facilities offers many more benefits than their centralized predecessors, and are ultimately required if the ambitious goals of zero waste are to be achieved.

Yet, the problem of odors remains, which as previously noted, is foremost an issue of scale. If the waste-derived population decreases from the current centralized scale of upwards of a million people to a neighborhood population of ~80,000, significant decreases in odor production could be achieved. There are existing technologies that allow for the removal of odor in decentralized, urban facilities. The Chesapeake Compost Facility is located roughly four miles from downtown Baltimore and directly adjacent to the urban neighborhood of Curis Bay, Maryland: "Our aeration system pushes air through the compost piles and into a biofilter on a constant basis, actively filtering and eliminating odors. (Odors) are the greatest neighborhood concern and this system allows us to significantly eliminate that worry." (Briggs 2012).

There are also many odor control precedents in different waste-related sectors, especially in waste incineration. The aspirations of the Isséane Waste to Energy Plant in Paris, France

Fig. 27: *Chesapeake Compost Facility*. Located directly adjacent to the downtown of Curtis Bay, MD

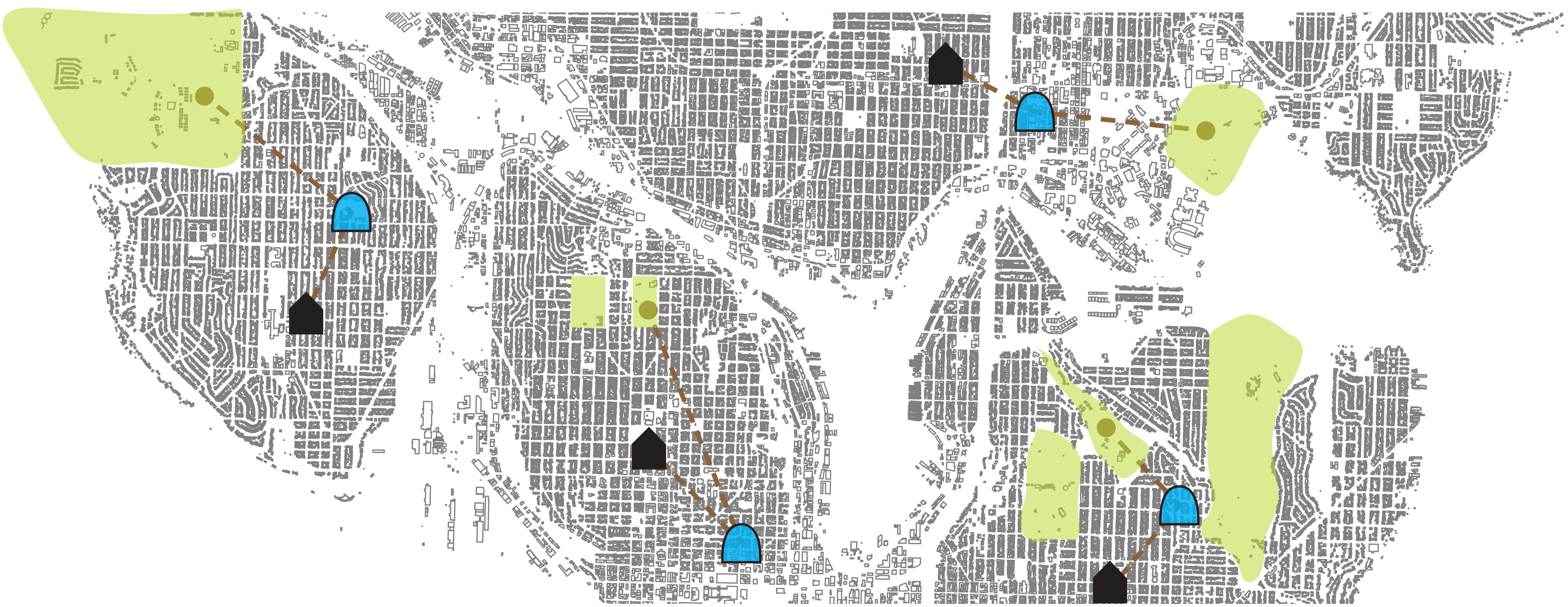


Fig. 28: *Decentralized Compost Facilities*.

are much the same as discussed here. Of the many environmental goals of the plant, a major motive in locating it in an urban area was to cut transportation costs and emissions (Burelle 2008). The plant is constructed in Paris' fifteenth arrondissement, on the banks of the Seine. The technology and design of the plant ensure an odorless environment, and a task force of community members was made responsible for informing the plant manager if any smells were perceived (Brown 2014). The plant brought local blue-collar jobs back to the community and created a system of compensating community members for participating in their programs (Brown 2014).

As Kevin Lynch has discerned from his extensive interviews regarding waste, there is considerable stigma regarding its presence. In order for compost facilities' location in urban areas to be accepted, these stigmas will have to be overcome. A major issue with the current system is that there is no way it conceivably enhances the lives of the citizens who contribute. The only interaction people currently have with compost systems is through waste receptacles and the buying of compost at the nursery. The participation in an act of composting can be considered an act of

Fig. 29: *Isséane Waste to Energy Plant*.

blind faith; contributors act according to the belief that their actions will result in such positives as "protecting the environment." This thesis argues that in order for compost systems to progress toward full participation they must move beyond the convictions of blind faith and become apparent components of a sustainable food system.

The Social Mirror is an art project by Mierle Laderman Ukeles in which mirrors were placed on the sides of a garbage truck in New York City. The project "force(d) direct confrontations between what is perceived to be the lowest of culture and the highest of art and between citizens and their waste services" (Engler 2004). Urban compost facilities have the potential to be social mirrors and reveal the actualities of the processes they conceal. Education programs could serve this function and instruct citizens on the direct connection between such actions as wasting food and climate change.


Fig. 30: *Social Mirror.*

In conclusion, the decentralization of compost facilities within Seattle allows for all of the goals in Chapter One to be addressed. First, the transportation of compost can be reduced by allowing for in-city efficiencies, where compost is used for activities such as urban agriculture. Additionally, the location of compost facilities in the city eliminates the possibility of unnecessary transport distances due to the current, nonstrategic location of processing. If realized, waste would be handled directly adjacent to consumers, and the most efficient link between regional farms and compost facilities can be achieved. Second, compost facilities can act as social mirrors and promote sustainable practices throughout the city. Third, and most importantly, with decentralization comes equity.

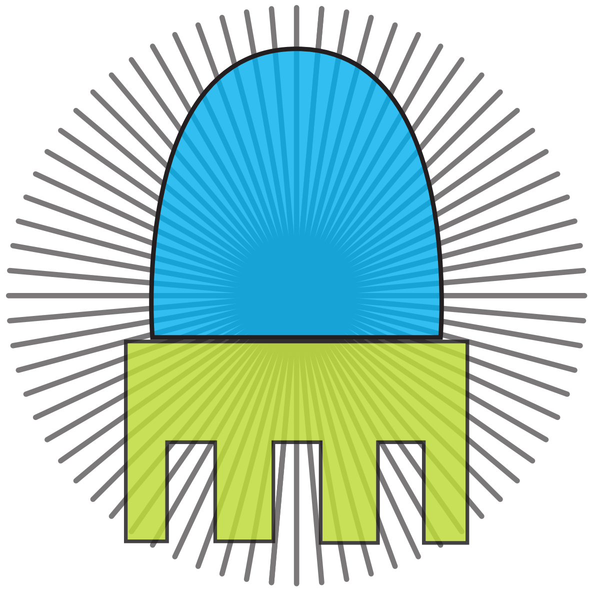
Fig. 31: *Zeekracht*. A project by OMA is a good example of coupled infrastructure. It couples wind-farming operations with habitat restoration activities.

# Chapter 3: Coupling

In her book *Next Generation Infrastructure*, Hilary Brown defines the *coupling* of projects as “those whose spatial proximity allows one system to make use of the productive or distributive functions of another, minimizing resources leaving the system” (Brown 2014). Coupling is the action of identifying and then creating mutually beneficial relationships between components in a system. Lateral Office is one of the foremost design practices investigating coupling in their work. They extend Brown’s definition of coupling beyond simply being a “combinatory exercise” to explain it as an investigation that seeks “opportunistic associations between economy, ecology, politics, and information” (Bhatia 2011).

Chapter Two identified the components currently needed for systemic change in Seattle’s regional food system. Chapter Three seeks to “couple” these components in order to realize efficiencies that are otherwise unattainable. There are three types of coupling that this thesis proposes. First is a coupling of the components of distribution and compost. The Second type couples these conglomerates with existing infrastructure to allow for a network between the various locations of components throughout the city. The third proposes the addition of markets to the system.

Gestalt theory posits that the whole should be, “more than the sum of its parts”. In terms of systems, this means that the overall system should be more efficient than was possible by the components of that system existing in isolation. This is the main goal of coupling: to create a food system for Seattle that works as a network to gain efficiencies through the connection of its various parts that would otherwise be unattainable if those components remained isolated.



## 3.A Coupled Compost and Distribution

Chapter Two proposed that distribution be localized within the city and compost be decentralized, also in urban areas. This thesis recognizes possible gains in efficiency in pairing these two programs. Buckminster Fuller's seminal work, *Operating Manual for Spaceship Earth*, is in many ways a manifesto against specialization. Fuller claims that "specialization precludes comprehensive thinking", and goes on to explain that many potential advantages are not realized due to various entities focusing on only one problem or subject (Fuller 1960).

Fuller coined the term *ephemeralization*, which essentially means "doing more with less" (Fuller 1938). Fuller's goal with ephemeralization was to present ways in which modernization could occur and life-enhancing technologies could be developed, but that these advancements would become increasingly efficient. Therefore, lifestyles would be permitted to be positively altered without the use of more resources (Fuller 1938). Ephemeralization is a goal of this thesis, and method used to achieve it is by attacking redundancies in the current system.

Compost operations and distribution facilities are currently both highly specialized entities. The vast majority of precedents for both programs deal solely with one resource. The supporting infrastructure for the processing, transport and storage of these resources are also only designed for specialized uses. A basic example would be that of the vehicles that now are used to move goods up and down the interstate system. Food is carried in fairly standard refrigerated semi trailers, while compost utilizes more specific "dump body" trailers. The trailers are not designed to adapt to the carrying of either product but can be used solely for their intended purpose.

In the current food system this specialization results in redundancy. Because the infrastructure is not designed to accommodate different resources, the system presently relies on one-way flows of goods. For instance, a truck carrying compost to a regional farm currently returns to the compost facility empty handed. The same goes for food; there is not a reciprocal trip for which the necessary travel home can be utilized due to the specialization of the infrastructure in place.

This redundancy in the system results in many excess miles in the transferring of resources between Seattle and Washington State's regional farms. This thesis proposes that the programs of compost and distribution be coupled in order to eliminate redundancy from the system. This move, of course, would necessitate a redesign of certain elements involved in both these

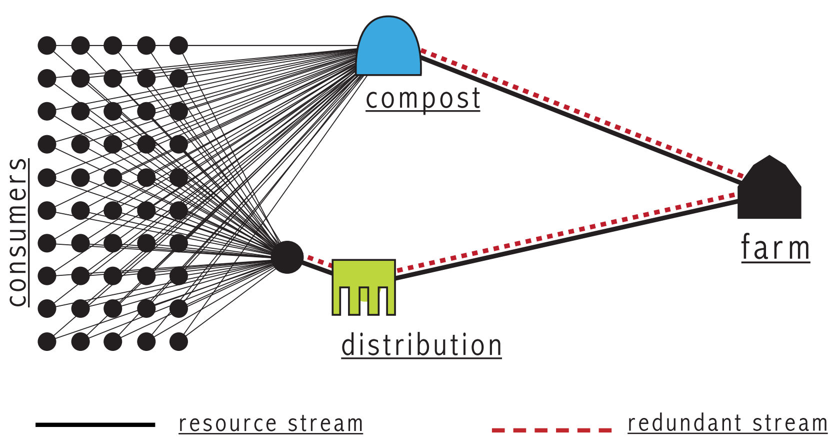



Fig. 32: *Redundancy Diagram.*

programs, such as the aforementioned trailers.

The combination of these programs would create two way flows between Seattle and regional farms. In the city, compost would be processed and exchanged for incoming food supplies. The opposite exchange would occur at nodes in the various farm clusters throughout the state; incoming compost would be unloaded and fresh food supplies would take its place. Figure 33 below depicts a basic illustration of how this would occur.

Fig. 33: *Resource Exchanges.*

It is helpful to plot out the foreseeable advantages that the coupling of these programs could offer. A hypothetical but highly probable circumstance would be the exchange of resources between Seattle and the rural community of Chelan, Washington: one of the closest farming communities located on the opposite side of the Cascade Mountains. In the current situation of one-way flow of resources, the distance required to transport compost to Chelan and back to Seattle, accounting for the current redundancy, results in 782 miles per resource exchange. If the programs of distribution and compost are brought into the city and coupled, the mileage for the two-way exchange of resources is reduced to 338- which is well under half what was previously required.

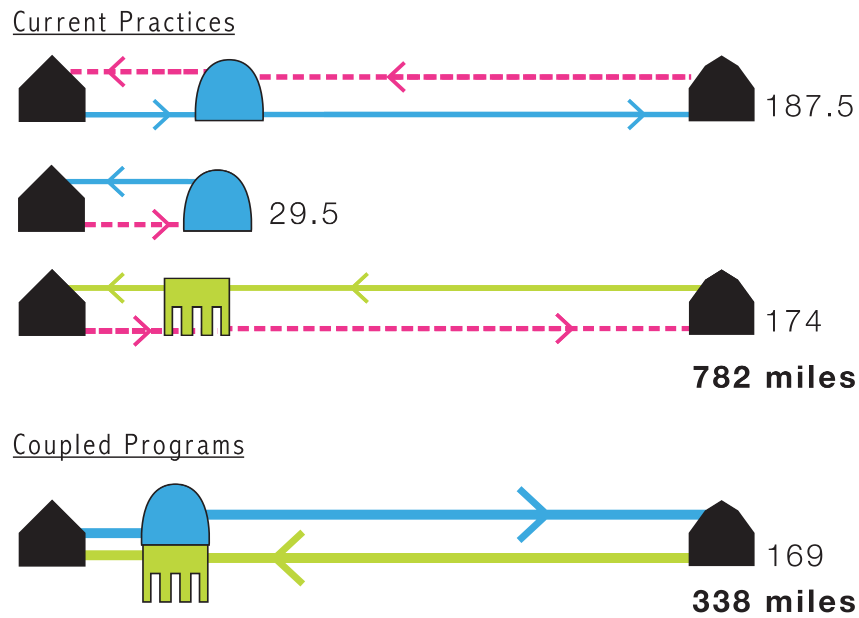



Fig. 34: *Specialized Versus Coupled Components*. Diagram showing current mileage required for the one-way exchange versus proposed two-way exchange of resources.

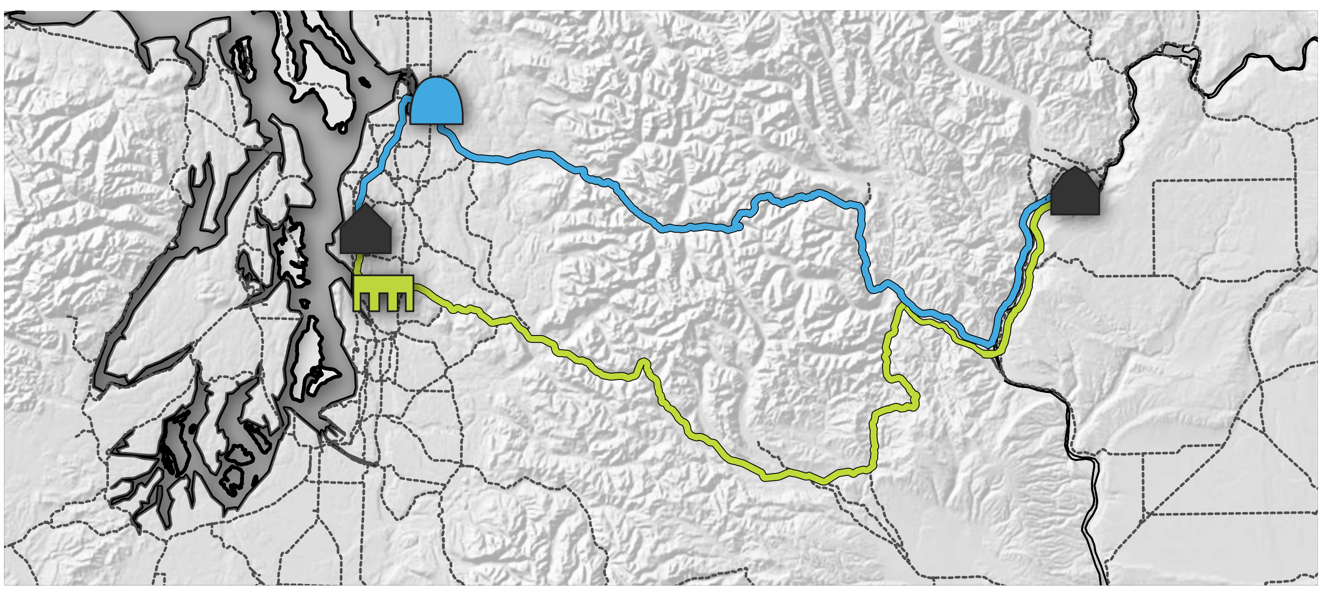
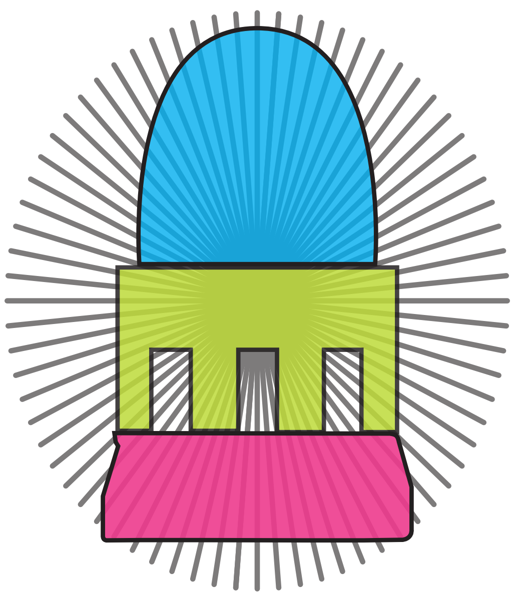


Fig. 35: *Seattle to Chelan Resource Flows*. Map showing relationship between Seattle and Chelan, WA and the resource trips required between the

Coupling, in this situation, offers the possibility of achieving a level of efficiency that would otherwise be unattainable if the programs were operating on an individual basis. The key element that this thesis proposes is a series of coupled compost and distribution facilities located throughout Seattle. The next portion of this chapter investigates possibilities in linking individual locations of these programs in a network throughout the city.

## 3.B Coupled Infrastructures

In theorizing possible locations for the siting of coupled compost and distribution conglomerates, this thesis recognizes that sites chosen simply for their proximity to density, or likewise, sites chosen for general characteristics such as land-use zoning, would not necessarily be in the best interest of the goals prescribed in Chapter One. Instead, this thesis sought to indicate sites that further contributed to the sustainable quality of the conglomerates in two ways. First, because this thesis proposes that the conglomerates be decentralized, there will be several throughout the city. How might their placement inform how these separate entities could act as a network? Second, how might specific sites enable a streamlined, and therefore an increasingly efficient interface with regional farms?



It was recognized in establishing these goals that they could be most efficiently achieved if the system of proposed conglomerates was able to couple with existing transportation infrastructure within the city. Research was conducted to identify underutilized infrastructure that could both support the activities being proposed and assist in attaining the goals herein. The infrastructural system that was identified as having the greatest beneficial potential is Seattle's Link Light Rail system.

The Link Light Rail system forms a north-to-south spline through Seattle. There are currently eleven stops in the central and south parts of the city and six more are planned to serve the northern portion. When completed, the light rail will be underground from its northernmost stop, through downtown, and currently emerges above grade just south of the central business district.

Placing the initial compost and distribution facilities within Seattle at, near or above the Link Light Rail Stations will create a fluid system for the exchange of resources throughout the city. In lieu of having trucks from regional farms travel to different locations, it is envisioned that there will be three interface points, at which the main resource exchanges will occur. These will be located at the logical locations of the southernmost and northernmost light rail stations, and at the SODO station, which is directly adjacent to the intersection of I-5 and I-90, well poised to interface with deliveries coming from the East. This additionally allows for the programs related to the loading and unloading of large trucks to exist in neighborhoods that have the available land to accommodate these functions. In that sense, distribution facilities in areas such as downtown and Capitol Hill, where density and existing surrounding built environments create a difficult condition for the continual movement of large vehicles, are now allowed to become much smaller.

Placing interface points at these locations simplifies the

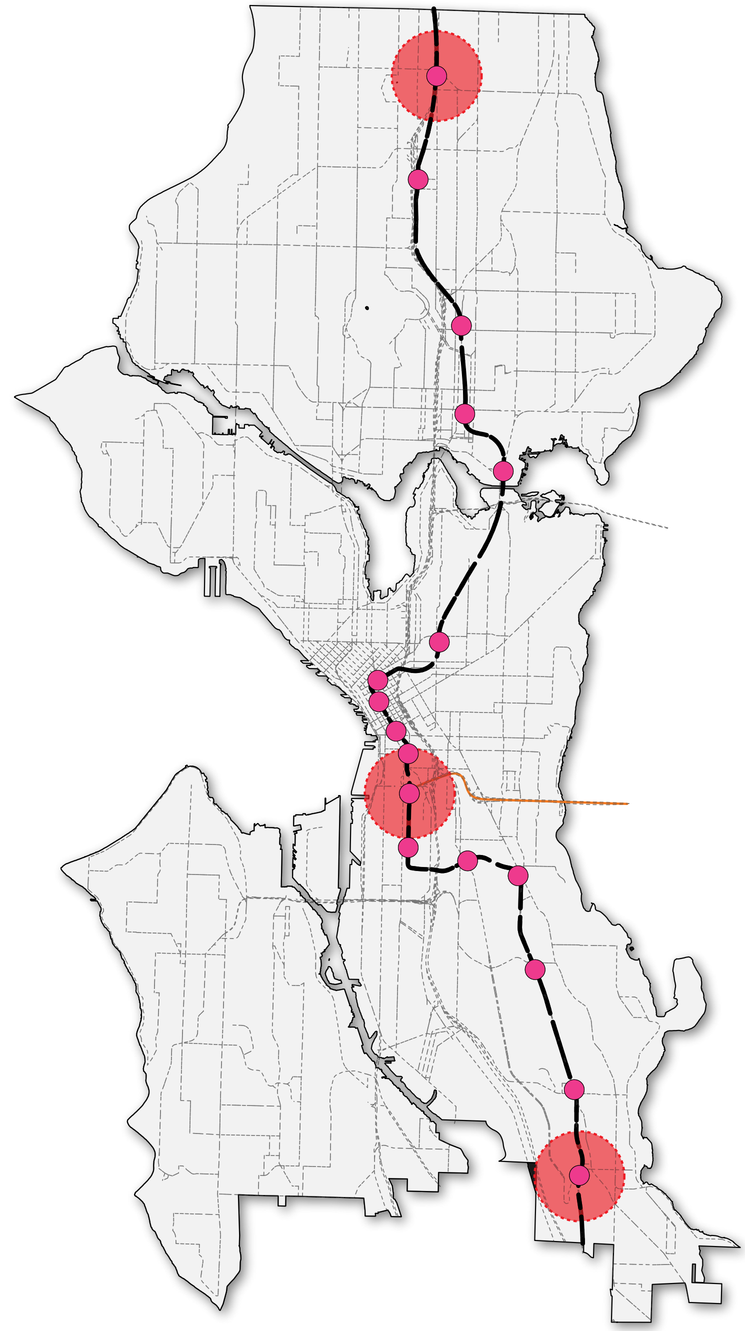


Fig. 36: *Link Light Rail and Interface Points*. Map of Link Light Rail stations, current and planned, indicated by pink circles. Three main interface points indicated by orange circles.

relationship between the city and regional farms. The new system within Seattle is able to mimic the ease with which resources are transfered to and from conventional distribution facilities. However, by continually transferring resources via the light rail to different locations within the system, the new infrastructure can remain small and integrated within communities. Moreover, by creating an autonomous network within the city, the flows between farm clusters and the interface points could likely reach high levels of efficiency. Focus can be placed on the simple repetition of trips between these locations without needing to interface with every facility in the city.

Another key advantage gained through this coupling is the ability it affords compost and distribution to benefit from the merger of their operations, but removes the necessity that they be physically paired on the same site. In other words, if the programs are linked by the network of the light rail, not every site must include both compost and distribution, they can be spread out as their respective resources will be aggregated at the interface points. Figures 37 and 38 show the different proposed locations for distribution and compost along the light rail spline.

For distribution specifically, this network would allow different types of food to enter the system at different interface points and be disseminated through the city to the various smaller distribution facilities (See Figure 37). For instance if vegetables came from the north, fruit from the east, and dairy from the south, the respective farmer clusters' trucks would drop their products off at the logical interface point, where these products would then be dispersed throughout the city. A similar situation can be imagined with compost. Each of the small compost facilities would process a portion of Seattle's population waste and the processed compost would then be collected at each of the interface points for exchange with farmers coming from various parts of the state (See Figure 38).

Due to the north-south orientation of the light rail line, it is envisioned that for the first phase of implementation the city would organize itself in a striated manner. Each light rail station would be responsible for the composting or distribution or composting/distribution for a different striation in the city, oriented primarily east to west. The size and quantity of striations responds to the location of the light rail stations but also to the optimum size for composting and distribution, which has been estimated at between 40,000 and 80,000 people (See Fig. 42).

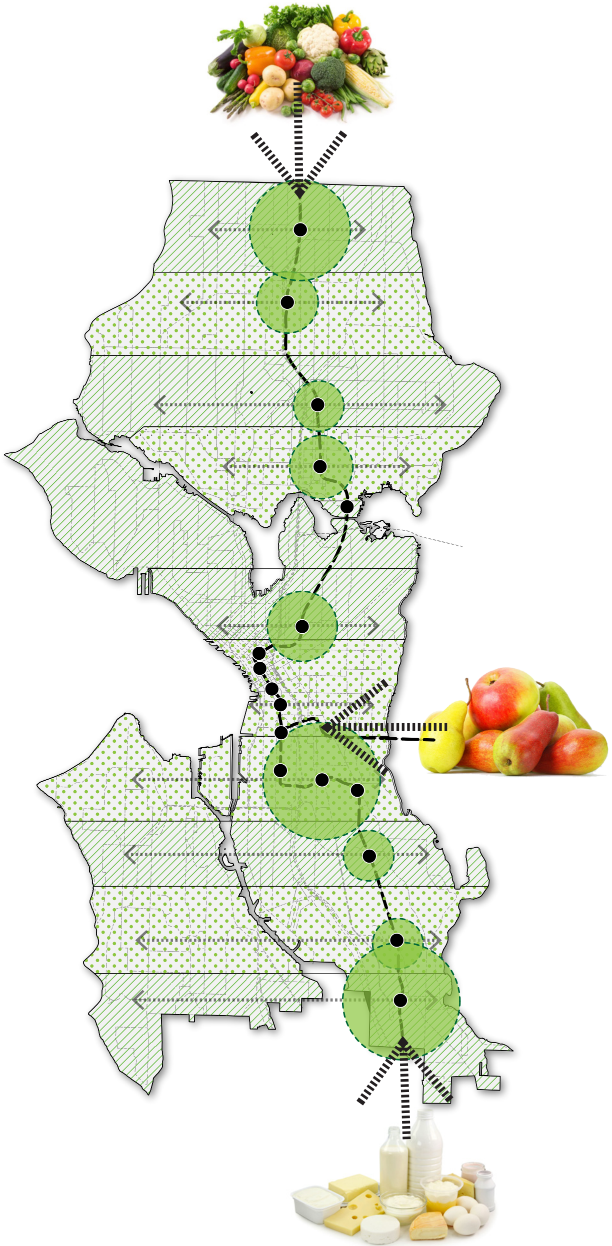


Fig. 37: *Proposed Distribution Facilities*. Size and location indicated by green circles. Also shows three interface points and hypothetical inputs of various types of food.

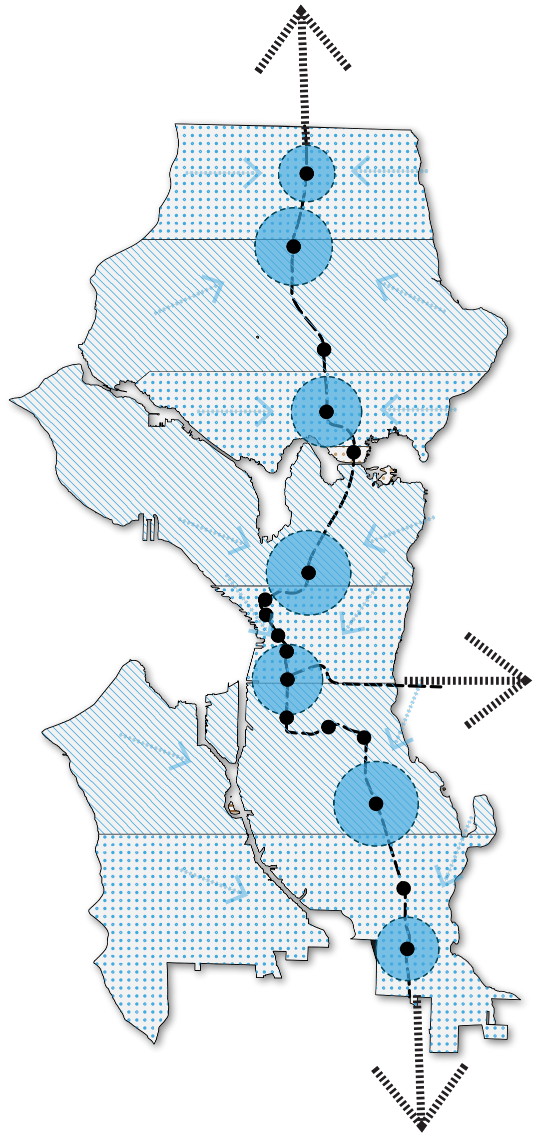


Fig. 38: *Proposed Compost Facilities*. Size and location indicated by blue circles. Also shows three interface points where compost would be exchanged for food.

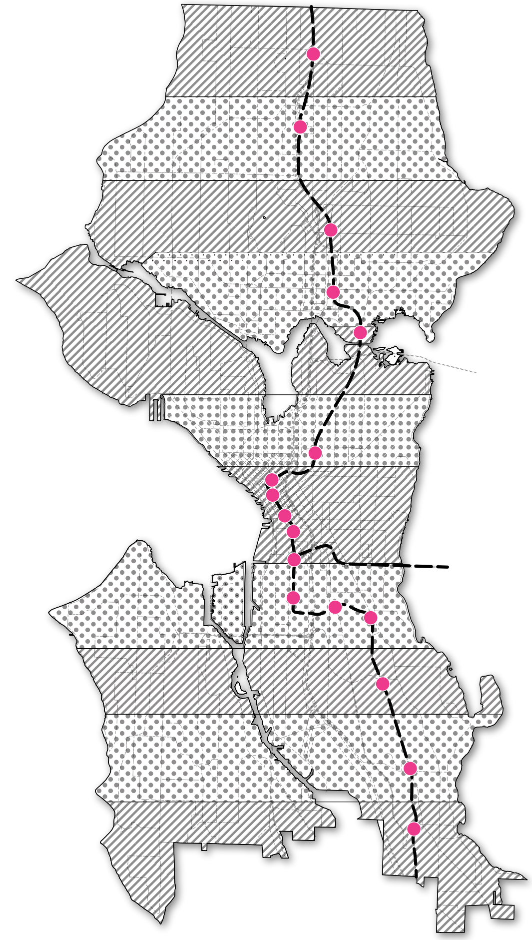


Fig. 39: *Proposed Initial Striations*. Striations indicated by different hatch patterns. Each striation is associated with a respective light rail station indicated by a pink circle.

The hope would be that the programs located along the Link Light Rail would only be the initial investment in this network. The transportation of goods by rail is over 200% more efficient than by truck. Transport by rail, "has an efficiency of 400 ton-miles per gallon whereas trucks currently hover around 130 ton-miles per gallon" (Stamas 2009). Washington State has an existing network of freight lines that extend to many the macro farm clusters previously identified, as shown in the map below.

Setting the precedent for resources being transported by rail within the city could open up the possibility of goods that utilize the statewide network to achieve incredible leaps in efficiency. There is also the hope that the network within the city would expand as density and population increase. There are plans in place to expand light rail and other forms of rail-oriented mass transit within Seattle. Future distribution and compost programming could expand within the city simultaneously to mass transit expansion.

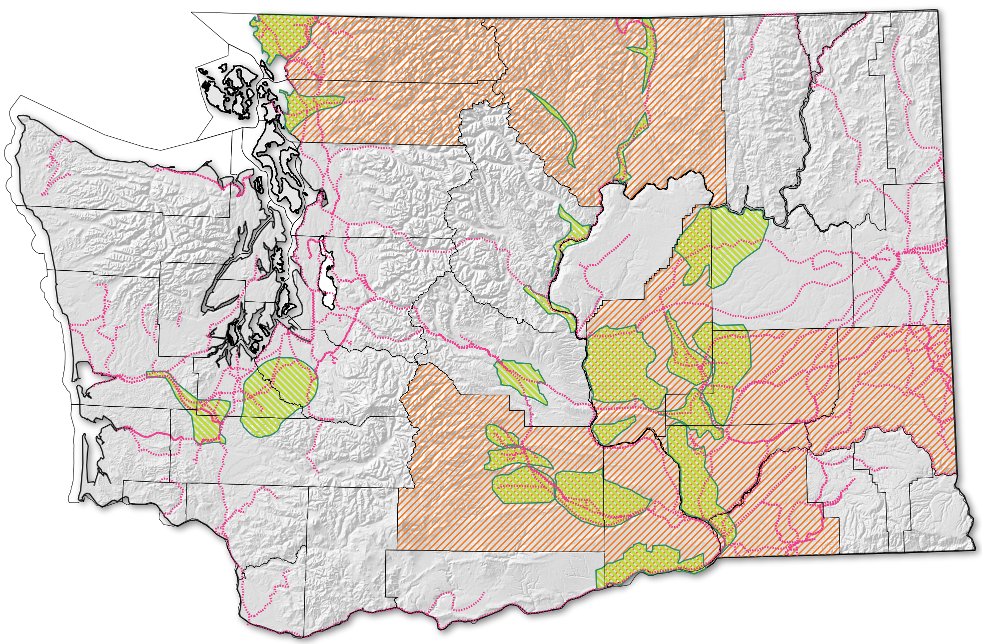


Fig. 40: *Washington State Rail System*. Statewide map showing existing freight system within Washington State. Freight lines indicated in Pink. Best counties for agriculture shaded in orange. Macro farm clusters shaded green.


Fig. 41: *Potential Future Seattle Rail*. Hypothetical map depicting current and future extensions of Seattle's rail system. Branches include creating commuter stops along the Sounder, and significantly increasing street car service throughout the city.

The coupling of food resource programming with the light rail system also acts as a critique of currently underutilized infrastructures within Seattle and other cities. As the curve below shows, there are certain times of the day in which very few to no people are using the system. By utilizing the rail for a different type of transport, the curve is able to be inverted so that the system is used more intensively throughout the day and night. The first leg of Seattle's light rail is 17.3 miles long and cost just shy of $2.4 Billion dollars to construct (Source Gutierrez 2011). This thesis advocates that infrastructures that take this type of massive resource and time consumption should be utilized to their maximum capacity; coupling allows for this.

In order to understand the strain that the proposed network of resource transfers would put on the existing light rail system, a series of calculations and graphics were produced to illustrate these facts. Using data regarding the pounds per cubic foot of both food and compost, and given that the average striation served is predicted to be populated by an average of roughly 80,000 people, the size and amount of resources related light rail cars needed was able to be calculated. As previously mentioned, the implementation of this system would require a redesign of many elements related to its function. The train cars and the containers in which resources are loaded shown in the adjacent diagrams are meant to simply act as a representation of what is possible. The next step in this process would be to more accurately envision all of these components.

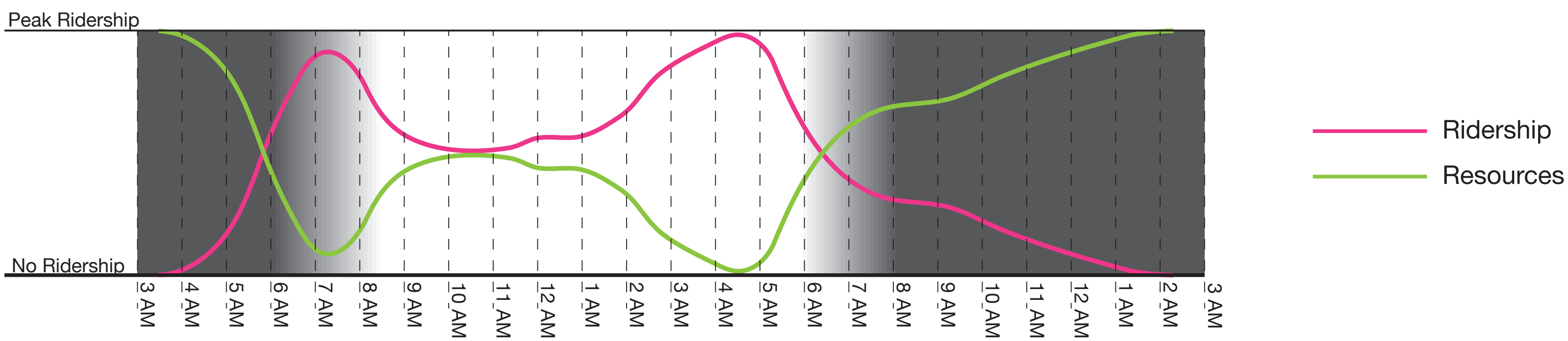



Fig. 42: *Rail Ridership and Resource Curves*. Diagram of mass transit ridership in the Minneapolis St. Paul Metroplex. The Ridership as compared to time of day is expected to be similar in Seattle. Current ridership of people represented by pink line. Proposed use for resources represented by green line.

## Food

80,000 people (Represents extreme scenario of system)
4 lbs per person per day = 320,000 lbs/day
(1.5) for wastages = 480,000 lbs/day
(.75) for regional portion = 360,000 lbs/day
90 tons per day
1 cu.yd. = roughly .5 tons
roughly 180 cu. yd per day
12 tons per rail car
Roughly 7.5 rail cars per day with 24 cu. yd. ea.
(4 of the trains shown to the right.)

Whole City

Roughly 56 rail cars per day with 24 cu. yd. ea.
(28 of the trains shown to the right)

## Compost

80,000 people (Represents extreme scenario of system)
.38 lbs per person per day = 30,400 lbs/day
(2) for additives = 60,800 lbs/day
(.75) for weight loss = 45, 600 lbs/day
22.8 tons per day
1 cu.yd. = roughly .9 tons
25 cu. yd per day
11.25 tons per rail car
Roughly 2 rail cars per day with 12.5 cu. yd. ea.
(1 of the trains shown to the right.)

Whole City

Roughly 56 rail cars per day with 24 cu. yd. ea.
(28 of the trains shown to the right)

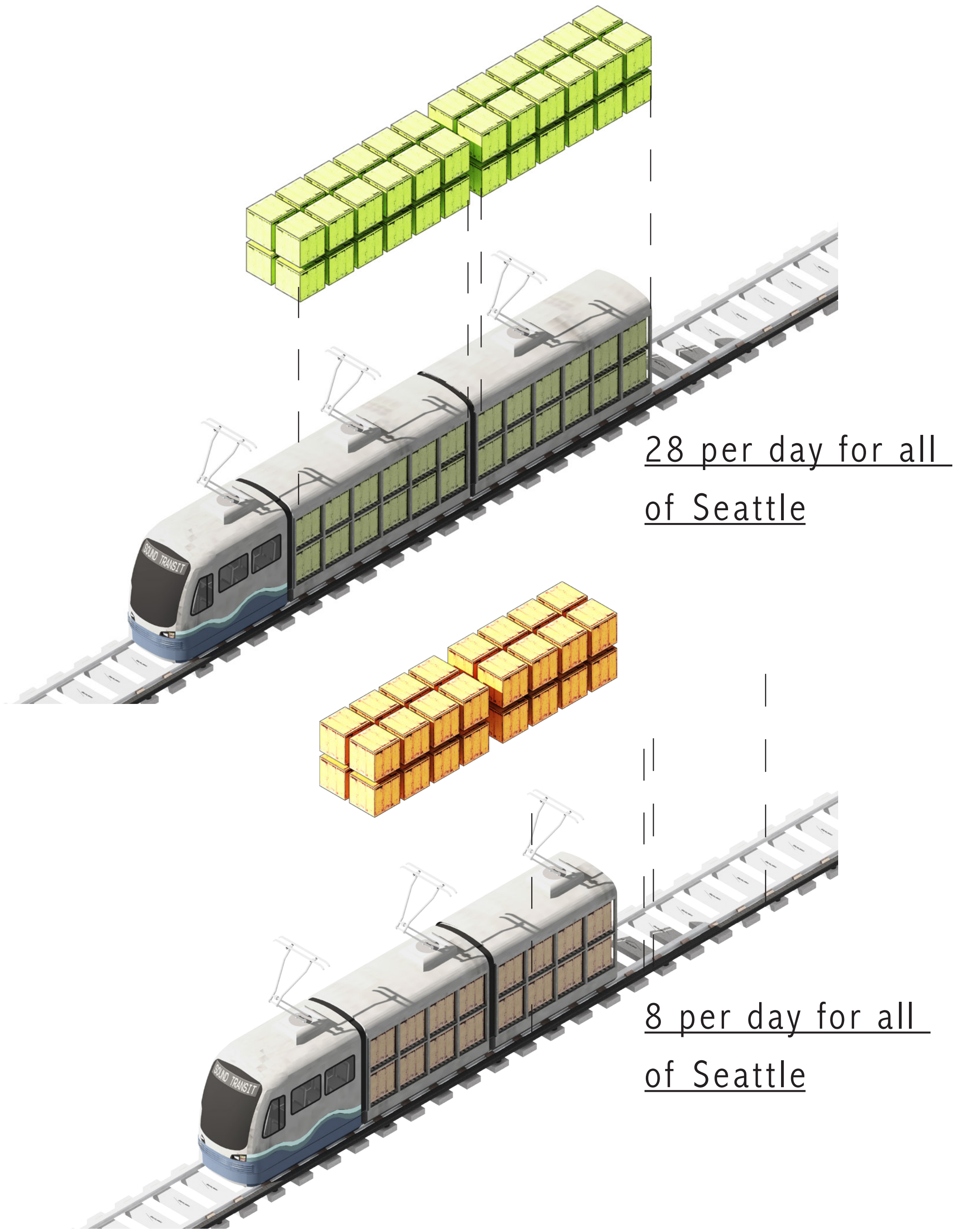



Fig 43: *Envisioning Food and Compost Rail Usage*.

## 3.C Coupled Markets

The last portion of Chapter Three, proposes an additional couplings of Seattle's new food network with a series of markets throughout the city. The first two sections of this chapter dealt primarily with how resources flow between farms and cities. This chapter examines possibilities the new system enables with how resources could flow differently within the city.

### Strategic Markets

Strategic markets are points of sale for regional produce that are purposefully placed to benefit from an existing set of conditions within the city. In this case, the primary condition is the density of people moving through the Link Light Rail Stations. In the same sense that the proposed system for resource exchange with regional farms capitalized on the downtimes of the light rail, strategic markets seek to capitalize on the high times.

The goal of these markets is to not only promote the sale of regionally-produced food, but also to decrease certain inefficiencies that result from the current trend of destination markets. Supermarkets currently rely on consumers taking individual trips to and from grocery stores. This results in heightened levels of carbon emissions due to the necessary dependence on fossil-fuel reliant transportation for many citizens to make these trips. Additionally, the lack of convenience inherent in destination markets creates a situation where citizens are prone to buying excess goods in order to avoid repetitive trips. This can

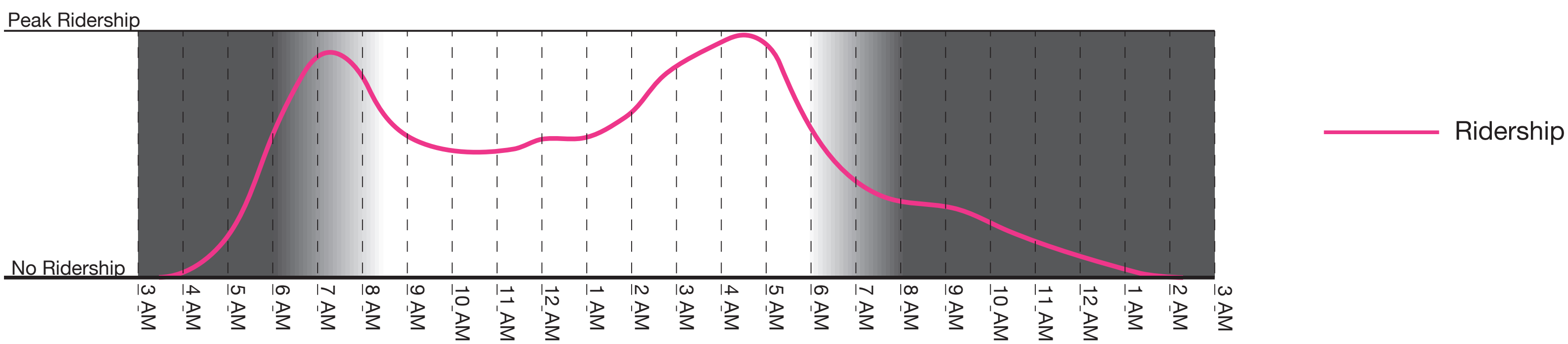



Fig. 44: *Rail Ridrship Curve*. Diagram of mass transit ridership in the Minneapolis St. Paul Metroplex. The Ridership as compared to time of day is expected to be similar in Seattle. Current ridership of people represented by pink line.

result in larger quantities of food being wasted.

Through the coupling of strategic markets with light rail stations, the convenience of buying regionally-produced food can be significantly increased. Now, instead of markets requiring individual consumers to seek out where to buy regionally-produced food, the food comes to them. 2014 was a record year for mass transit in the U.S., with more ridership than any year since 1950 (Seattle Times 2014). Seattle saw a 3% increase between 2013 and 2014 (Seattle Times 2014), and it is expected to continue to rise.

Due to the ever-increasing popularity of mass transit, and its even distribution throughout Seattle's neighborhoods of varying demographics, this coupling also has the potential to increase the equity of regionally-produced food throughout the city. Currently, a survey of farmers markets and brick and mortar markets that consistently sell regionally-produced food indicates that Seattle is under-served (See Figure 48). When the locations of those markets are overlaid with data regarding Seattle's neighborhoods where per capita income is $42,000 per year or less, it is clear that low in-come neighborhoods are disproportionately under-served. Therefore, another advantage of this coupling is its


Fig 45: *Strategic Markets*.

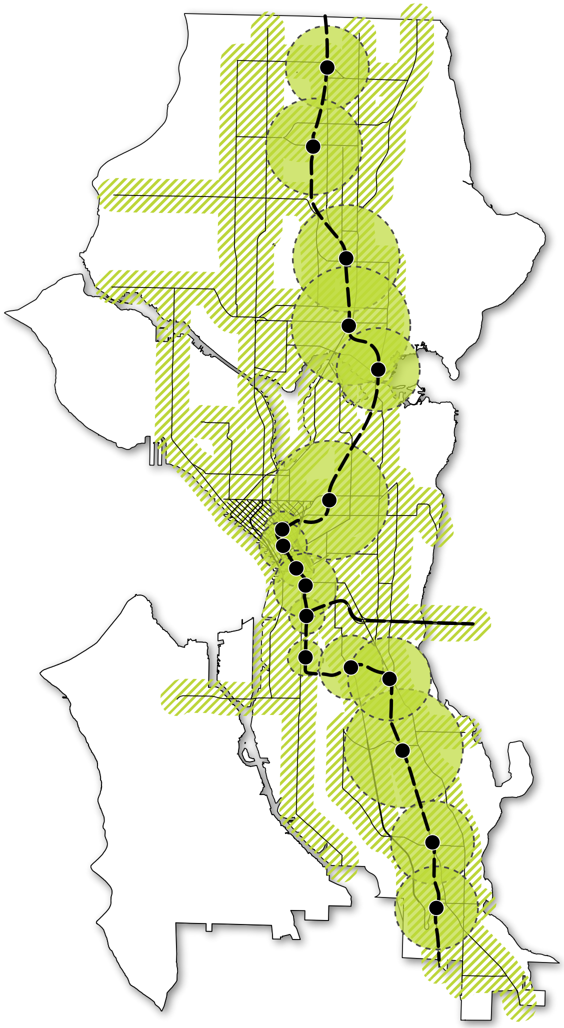


Fig. 46: *Proposed Primary Markets*. Map depicting proposed location of primary strategic markets. Markets would be paired with all Link Light Rail Stations. The green hatch emanating outward from the light rail indicates the areas of the city that are within a quarter mile walk and one transit stop away from a light rail station.

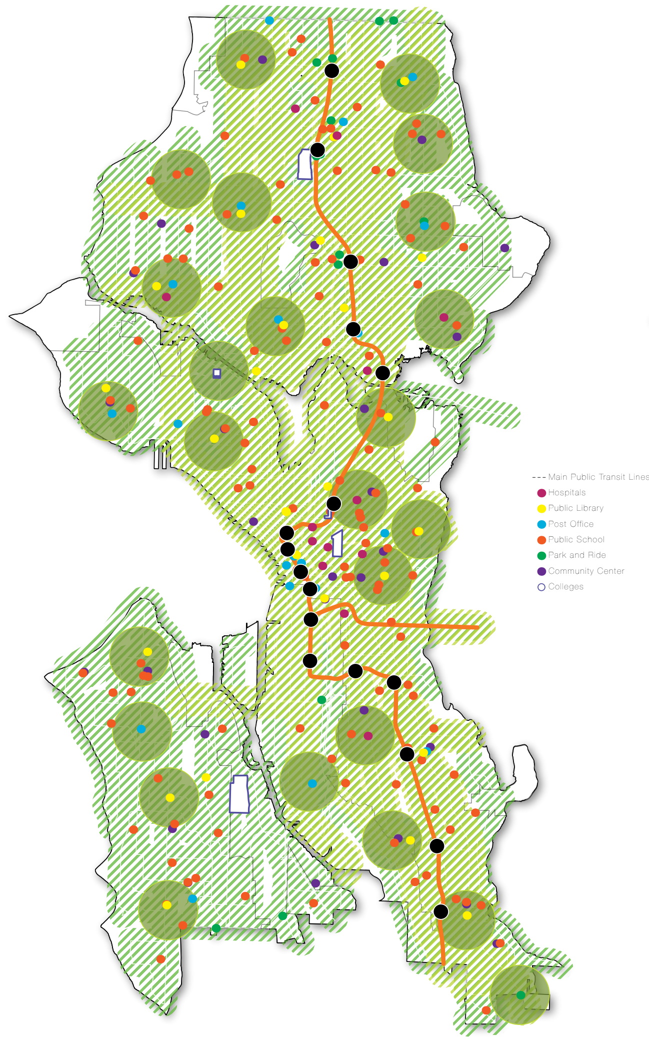



Fig. 47: *Proposed Secondary Markets*. Map depicting proposed location of secondary strategic markets. Markets would be paired with primary bus stops throughout the city that are near conglomerates of public amenities such as libraries, hospitals, and schools. Dark green hatch indicates areas that are within a quarter mile walk and one transit stop from these markets.

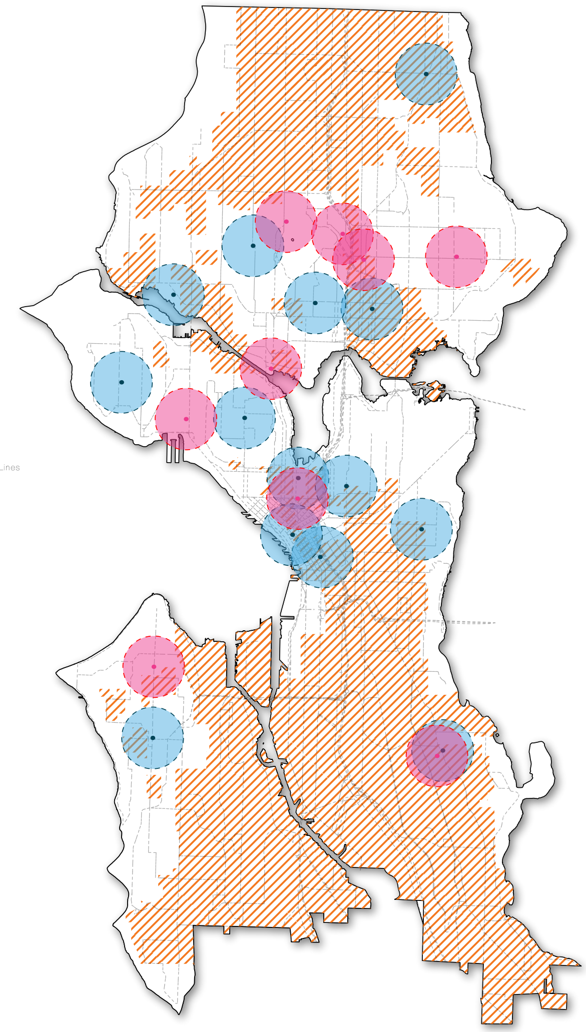


Fig. 48: *Current Regional Food Sources Compared to Low Incomes*. Map depicting current location of farmers markets in blue circles, and brick and mortar markets that consistently sell regionally-produced food in pink circles. Orange hatch represents areas of the city where the per capita income is $42,000 per year per household or less.

potential to reach many different types of citizens as compared to today's destination markets. Figures 46 and 47 show the proposed primary and secondary placement of strategic markets. Instead of walkability scores determining access to healthy food, the proposed system would rely on a new type of "one stop away" score, where portions of the population that live within one stop of a strategic market could be considered to have reasonable access to healthy food.

The last main advantage of strategic markets is that they could simulate the two-way flow of resources conducted at the regional level. Citizens could be incentivized to drop off their compost en-route to their daily commutes. Money saved by cutting transportation of goods throughout the system could be used to fund vouchers for the purchase of goods at the strategic markets based on the amount of compost delivered. This could reduce the amount of trucks and fuel required for traditional curbside compost pick-up.

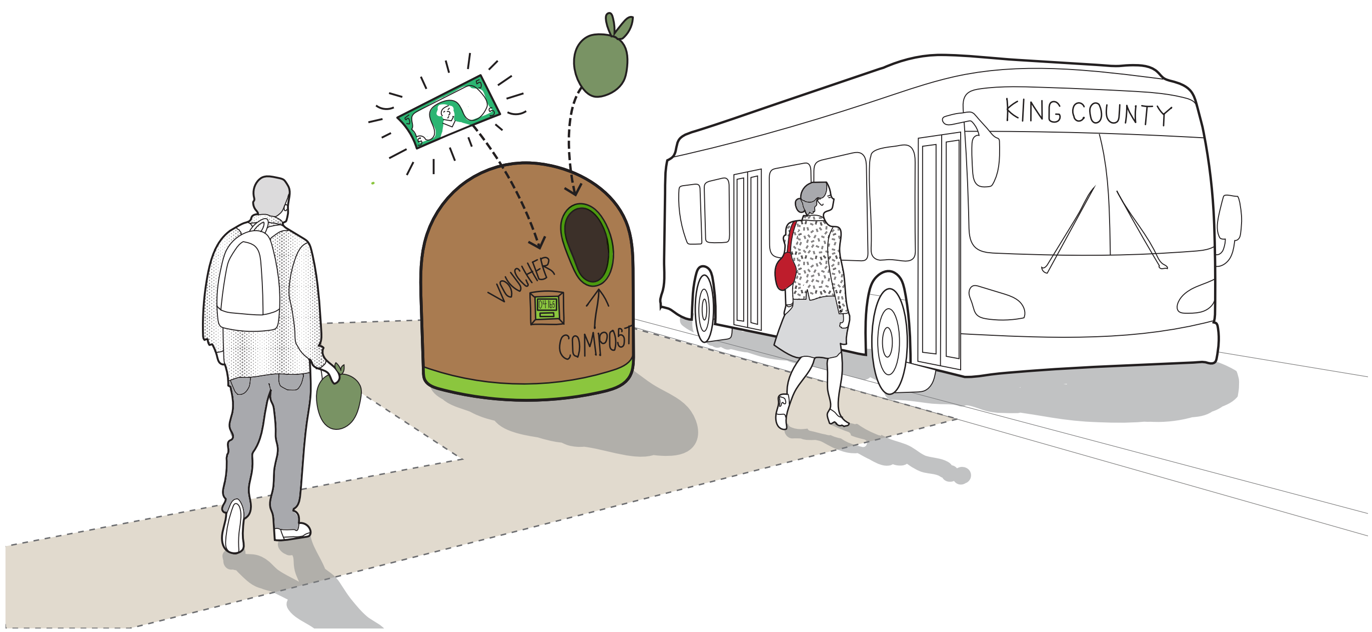



Fig 49: *Incentivized Compost*.

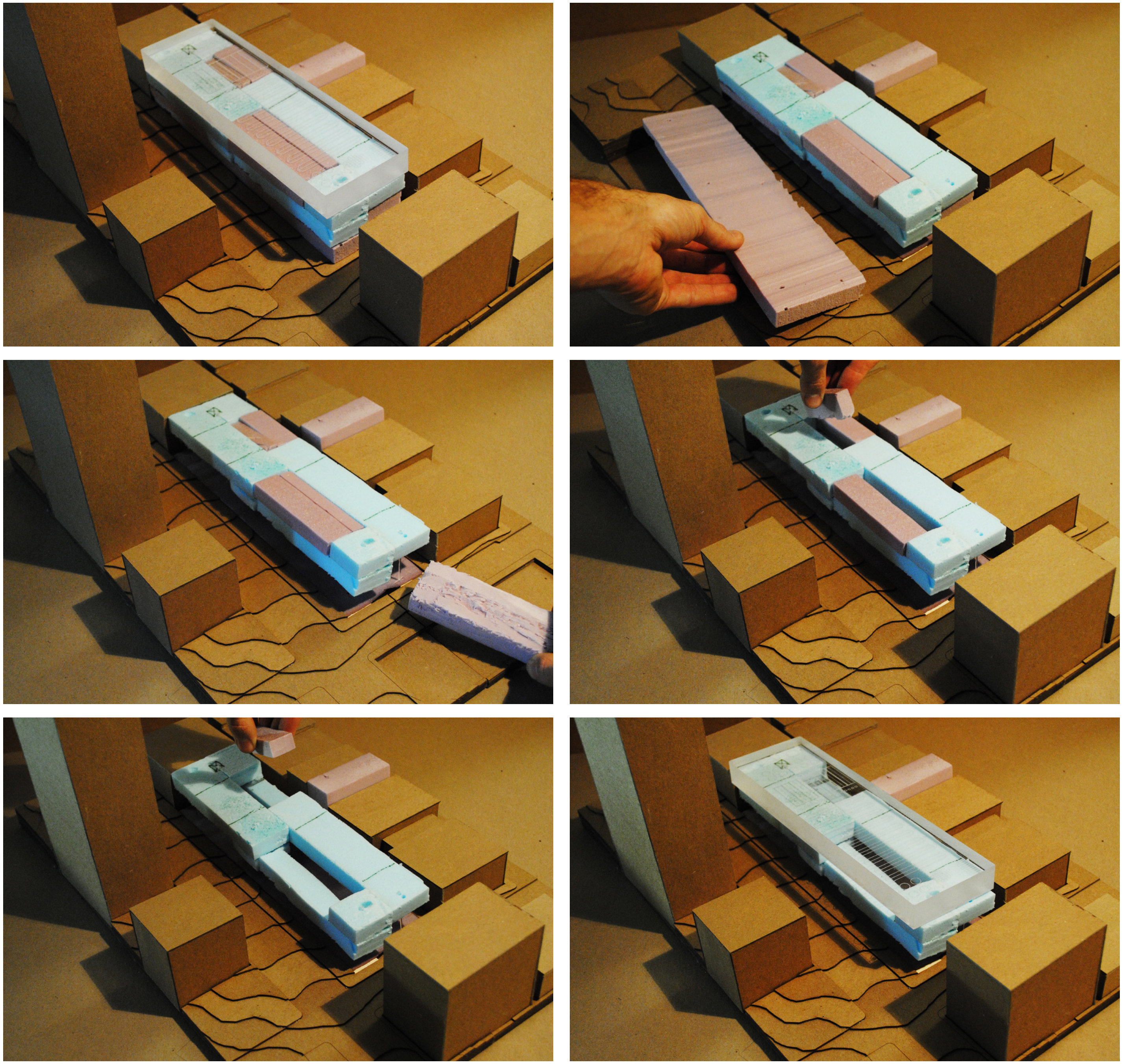
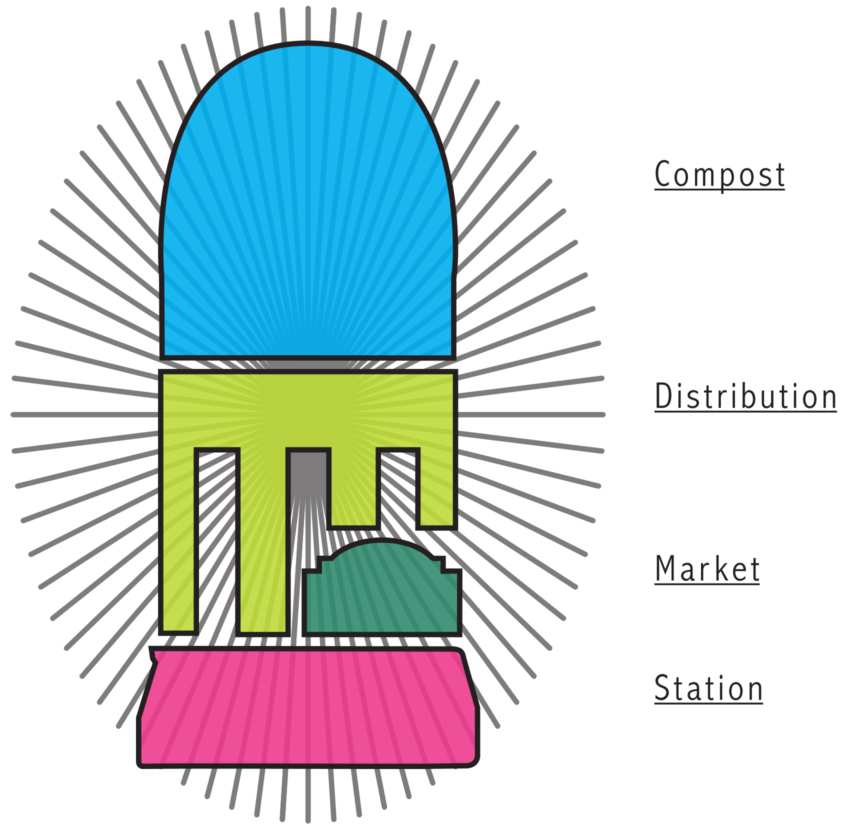


Fig 50*: Study Models*.

# Chapter 4: Design Proposal

Chapter Four investigates the challenges associated with deploying the program conglomerates proposed by subsequent chapters by designing one of the facilities a specific context and in detail. The chosen site exists above the University District Light Rail Station. This site was chosen due the complexity that arises from its urban condition, as well as the fact that it represents a satisfactory medium between facilities located on the northern and southern extremes of the light rail and those located downtown. The proposed facility for this station includes all of the programming elements discussed in the previous chapters: compost, distribution, market and light rail, all coupled on the same site.

The challenges associated with this type of facility are both logistical and contextual. How can these programs be combined and still allow them to perform their individual tasks as necessary? What design measures should to be taken to ensure that these programs are viewed as an asset to the communities in which they are placed and not a blight?



## 4.A Site Analysis

The University District Light Rail Station is located in the striation that includes the neighborhoods of Ballard, Fremont, Wallingford, the University District, Laurelhurst, and the southern portions of Greenlake and Ravenna (See Figure 52). This striation is home to roughly 80,000 people and, in terms of land use, is primarily comprised of single-family residential properties with some multifamily and commercial. The size of the striation was reverse-engineered to determine its extents based on how much compost the proposed site can process. When the site is viewed in context with the rest of the striation, it is interesting to note the minimal amount of land-use that is being proposed for the treatment and distribution of arguably our most important resources.

The future light rail station is currently under construction with expected completion in 2021 (Sound Transit). The site is located on the corner of Brooklyn Avenue Northeast and is between NE 45th and NE 43rd Streets. Brooklyn Avenue and 43rd Street are both collector arterials and 45th is a primary arterial The surrounding site context has a diverse mix of uses. The main portion of the University is to the southeast of the site with a few

Fig. 51: *Aerial of current site under construction.*

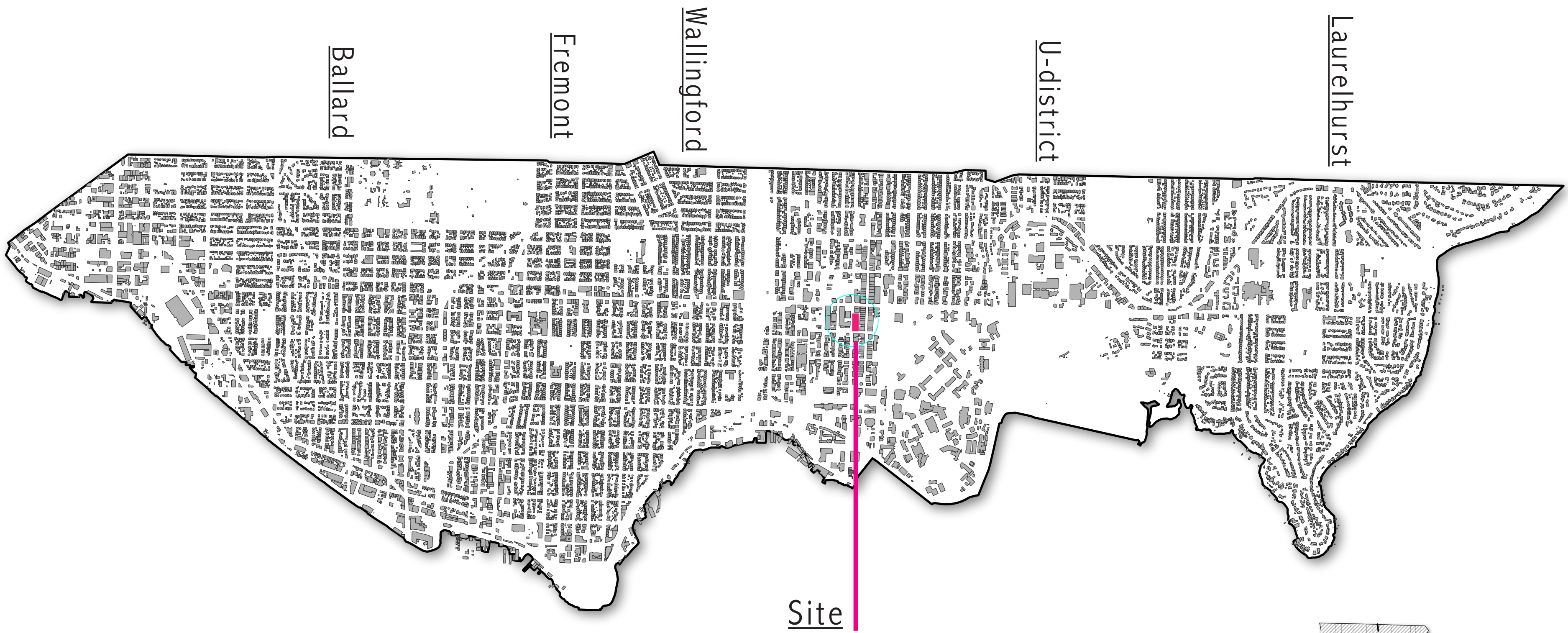



Fig 52: *U-district Striation*.

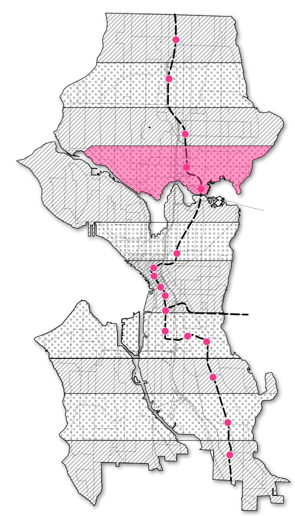



Fig 53: *Contextual Site Plan*.

ancillary buildings located in the immediate context, including the UW tower, directly to the west. University Way runs north-south and is one block to the east of Brooklyn Avenue. University Way is a heavily trafficked commercial street, which is home to a diversity of commercial uses, primarily restaurants and drinking establishments. The vast majority of the remaining context is comprised of residential properties, and is a mixture of both multi- and single-family.

The site has approximately a fifteen-foot drop in elevation from north to south toward Lake Union. The site directly abuts an alley to the east, which is currently used for back of house programming for the commercial properties located along University Way and accessed by municipal garbage collection. The buildings directly across the alley from the site to the east are home to a variety of shops and restaurants. The site can be accessed by pedestrians from any direction, however, the anticipated pedestrian flow is from the north on Brooklyn and the east on 43rd, with slightly less approaching from the south and west. There is great potential to re-utilize the alley as a pedestrian thoroughfare.

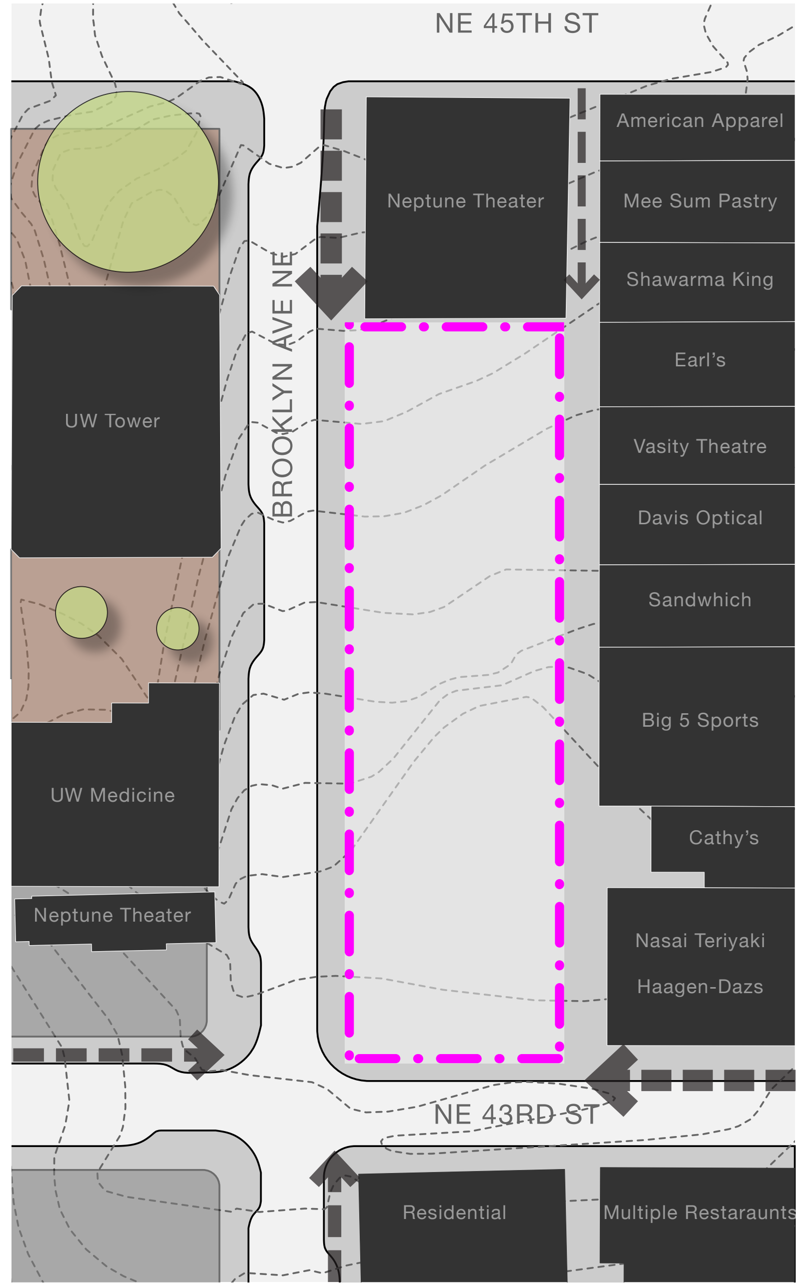



Fig 54: *Existing Site Plan*.

## 4.B Program Analysis

The program of this facility is complex due to both the intricacy of the individual components and the integration of the programs together on an urban site. The three programs of compost, distribution and market are broken down in this section for clarity according to the functions they serve and their relative sizes.

## Compost

The total size of the compost facility is based off waste from 80,000 residents:
(80,000 residents) x (.38 lbs waste per resident per day) x (365 days per year)
x (5500 Tons per year) x (2 for additives)
Total waste for year: 11,000 tons per year baseline waste
Ratio of required facility per ton of waste = 5000 sf / 3 ton per day
Required size of facility = 45,000 sf baseline size for all activities

### Unloading

For the unloading and initial internal transportation of waste
Space required at ground floor: 3,000 sf
Space required at main compost floor: 1,000 sf

### Initial Storage

Storage for pre-processed waste and admixtures.
30 tons per day at 1800 lbs for cubic yard
(30)(2000)/ 1800 = (33.3)(9)(2) = 600 sf material per day.
Storage space for three days for compost and admixtures: 3500 maximum
Space required at main compost floor: 3,500 sf

### Mixing

Area required for the mixing of compost and admixtures to achieve required composition.
Mixing one days worth of compost and admixtures = 600 x 2 + circulation.
Space required at main compost floor: 1,500 sf

### Composting

Earth flow heaving duty indoor composters have been identified as an appropriate solution for this application. Each composter handles 3 tons of compost per day at of size of 10'W x 50'L.
Space required at main compost floor: 5,000 sf (500sf per unit x 10 units)

### Curing

Area required to cure compost for 30 days. Must be large enough to hold 900 tons of compost.
One cubic yard of compost weighs approximately 1800 lbs (http://www.tuthillfarms.com/1/235/compost_test_results.asp)
Assuming average height of compost to be spread at 1.5 feet in height.
Required area= (900 tons)(2000) / [1800 lbs (weight of cubic yard)] = 1,000
1000 x [6'x3' (size of 1800 lbs, 1.5' tall pile)] = 18,000 sf
Space required at main compost floor: 18,000 sf

### Post Processing

Area for the storage of materials waiting to be removed from the site and delivered to customers.
Storage for two days worth of compost before removal.
Space required at main compost floor: 2,500 sf

### Loading

For the loading of materials.
Space required at main compost floor: 1,000 sf
Space required at ground floor: 3,000 sf

### Biofiltration

Filters required to remove odors from all activities relating to compost processing. The filtration system can exist on the roof of the compost facility.

Total space required at main compost floor: 32,500 sf
Available space at main compost floor: 37,000 sf
Additional space for storage and expansion: 4,500 sf
Total space required at ground floor: 6,000 sf
Total space required at other locations: 13,000 sf

## Distribution Center

The size of the distribution center is also based on a population of 80,000 residents. The expected number of deliveries of food per day is five.

### Unloading

For the unloading and initial internal transportation of food.
Space required at ground floor: 3,000 sf
Space required at main distribution floor: 1,000 sf

### Sorting

Area for initial storage and sorting.
Enough space for the initial storage and movement of two days worth of resources.
Area required per day is roughly 2,500 sf
Space required at distribution floor: 5,000 sf

### Main storage

All resources are transient. Maximum predicted holding length is 5 days as most regional food resources are perishable. Area required per day is roughly 2,500 sf.
Space required at distribution floor: 12,500 sf

### Cold storage

All resources are transient. Maximum predicted holding length is 5 days as most regional food resources are perishable. Area required per day is roughly 1,000 sf.
Space required at distribution floor: 5,000 sf

### Loading

For the loading of materials.
Space required at main distribution floor: 1,000 sf
Space required at ground floor: 3,000 sf

| | |
|---|---|
| Total space required at main distribution floor: | 25,000 sf |
| Additional space for storage and expansion: | 2,000 sf |
| Total space required at ground floor: | 6,000 sf |

## Market

The sizing of the market is based off the size of the current u-district farmer's market. The total size of the current farmer's market at high time including all vehicle access and booths is roughly 70,000 square feet.

### Permanent free-form market

Area of sale indoors does not include vehicle access.
This area is for activities similar to those of farmer's markets where booths are erected for different vendors to sell goods.
Space required with overhead protection: 30,000 sf

### Permanent Market Booths

Area for the renting of individual booths that are provided with utilities and back of house space. It is envisioned that this space will rented to artisan for different types of food-production activities such as baking.
Space required with overhead protection: 5,000 sf

### Leaseable Market

A component of the market space that can be leased to a company to manage the sale of goods that are typically not sold on a regional basis such a cleaning products and processed foods.
Space required with overhead protection: 5,000 sf

### Vehicle access indoor market

Space required on ground floor: 6,000sf

### Outdoor spill over market

More market area that is allowed to spill over into adjacent NE 43rd Street during high times.
Space required: 30,000 sf.

## Education

Facility for the gathering of groups for tours, classes, etc. This space should be well located and have views of the processes taking place in the building if possible.

The basic diagram of the programmatic elements is depicted by the partis on the right. There are two basic types of programming that represent the general separation of uses: non-public and public. The curing process of compost requires natural sunlight and it is therefore necessary that at least the curing portion of the compost facility have sufficient roof exposure. The market is the main public program of the facility and it is therefore placed at grade to benefit from pedestrian engagement and ease of access. The light rail station is already determined as being below grade by existing plans. Lastly, the distribution portion of the facility has no specific requirements aside from sharing unloading and loading zones with compost. The simple culmination of these requirements is represented by the sectional diagram in Figure 55. The result is a building in which the constituent programs are highly disengaged from each other; a condition that does not promote public interaction with the entire building or community stewardship.

## 4.C Layering

Conceptually, the ensuing project seeks to maintain the programmatic performance displayed in the adjacent partis, but to do so in a way that literally "layers" the various components.

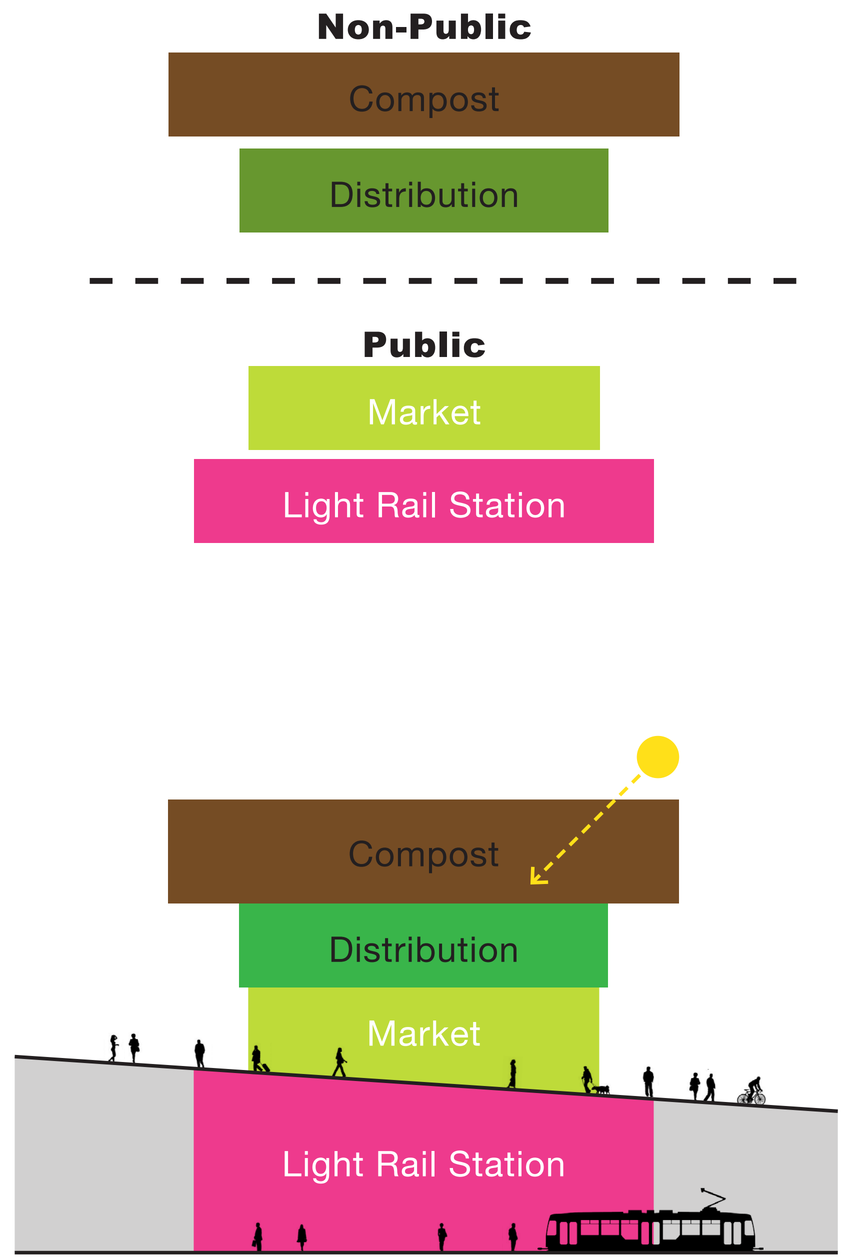



Fig. 55: *Parti Diagrams*.

The intent is that, through layering, the building can operate as a platform through which the general public can engage with the processes being performed inside. In doing so, the architecture allows for the creation of a subtle educational tool, highlighted at primary modes of vertical travel through the building's layers. Those who interact with the building frequently for use of the light rail or market will become aware of the essential tasks the building executes. In the public's understanding its role in the broader context of the city, Washington State, and the goals of sustainability, the architecture has the potential to both inspire acceptance and positively influence the behaviors of those move through it. Figures 56 and 57 depict early conceptual sketches of the experiential possibilities of layering. No longer is each space isolated, but views into other components create dynamic interior scenes and open up possibilities for educational episodes.

In order to understand how the building could be layered but maintain its functionality, the two non-public, performance-based components of compost and distribution needed to be interrogated on a detailed basis. These programs are conventionally organized in a very linear fashion, where each portion of the program is dependent upon the tasks completed by the preceding

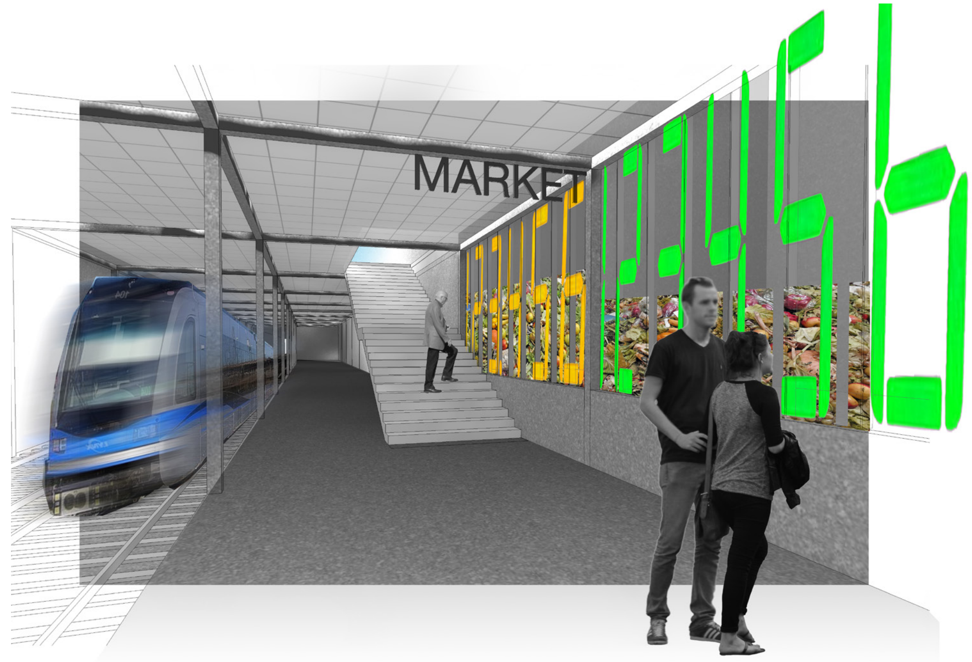


Fig 56: *Layering Conceptual Sketch*.

Fig 57: *Layering Conceptual Sketch*.

element. These programs typically exist at the fringes or well outside urban areas where land is plentiful, so they are typically permitted to have massive footprints that support a linear process. The image at the top of this page is a diagrammatic floor plan of the award winning Inland Empire Composting Facility. The diagram clearly shows the various activities from loading to unloading and the order in which they typically occur. To begin the investigation of understanding how the linear process might be reinterpreted, it was diagrammed for both compost and distribution at a detailed level. Figure 59 shows the elements of each program, their respective sizes and necessary adjacencies.

In producing this diagram, what became clear is that not all of the elements of these programs need to have direct horizontal relationships. Rather, as long as certain sub-programs have at least vertical adjacencies, they can exist within the building autonomously. This allows for the linear process to be broken into groups of sub-programs. Each group is comprised of elements that must maintain horizontal relationships to each other but not necessarily to the other groups of their respective program. The different sub-programs are indicated in Figure 60. An example of how this could work in the compost facility would be in

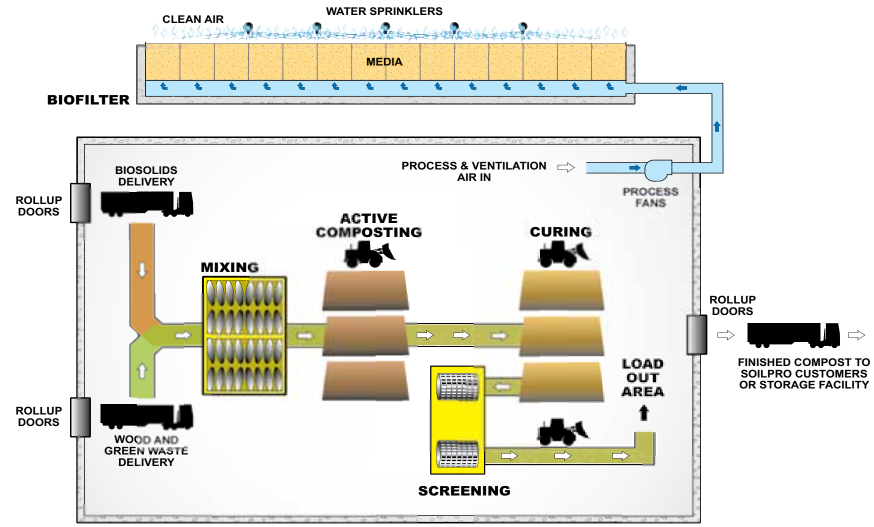



Fig. 58: *Inland Empire Compost Facility.*

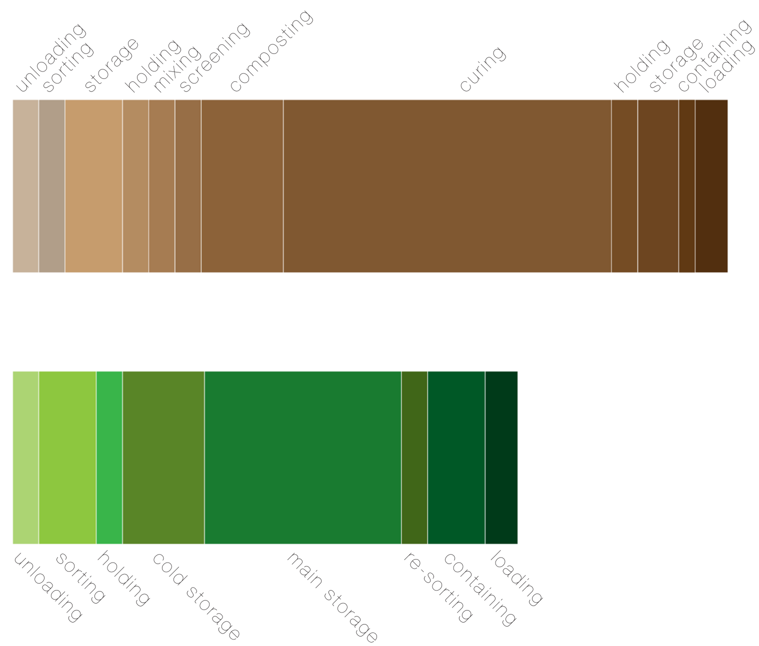



Fig. 59: *Linear Programming Diagram.*

relationship between the group of unloading and sorting as related to storage as related to the main compost floor. As raw food waste enters the site, it could initially be dealt with underground, sorted and conveyed to the main compost floor as necessary. The storage of additives could share the same vertical core as incoming compost but could act independently, moving goods vertically when required.

This diagram evolved into the final building parti as shown in Figure 61. The red rectangles represent the groups of programing that are proposed to have vertical connections to each other. Within each rectangle are the groups of sub-programs that require horizontal relationships to be maintained. The main portion of the compost floor that includes holding, mixing, screening, composting, curing and post-holding all exist on the top floor; the main portion of the distribution facility is comprised of holding, cold storage, main storage and re-sorting. It is also important to note that the orientation of these programs respective to one another is reversed as compared to the original diagrams. By having loading

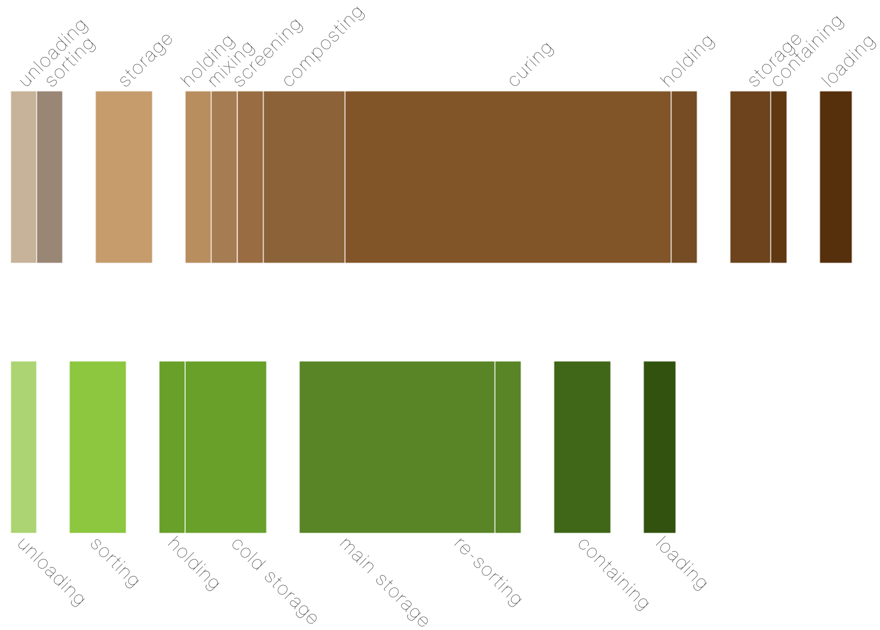


Fig. 60: *Autonomous Sub-programming Diagram.*

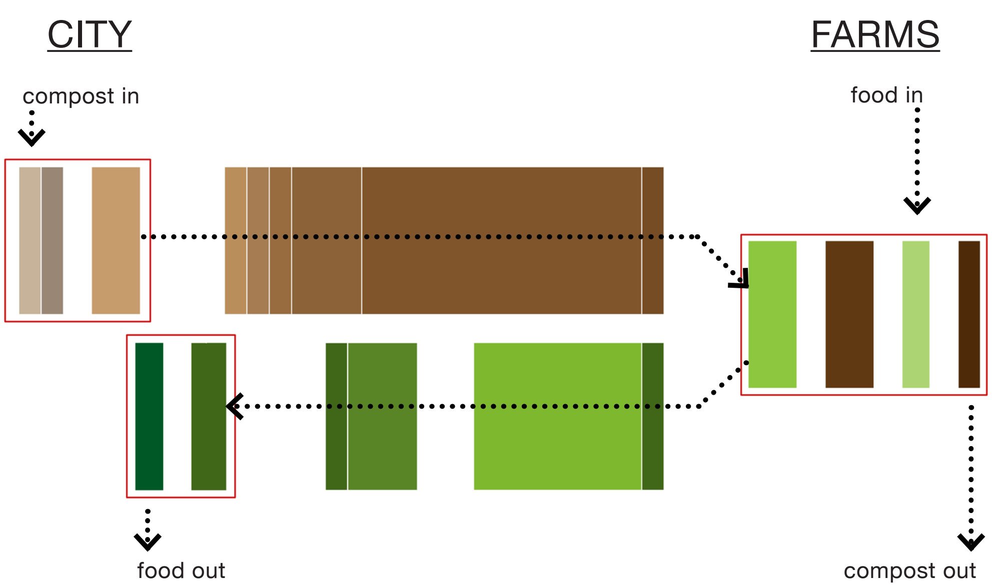


Fig. 61: *Final Programming Diagram.*

for compost on the same end of the building as unloading of food products, each end of the building is able to interface with a different territory: one brings waste in from the city and disperses food out, and the other vice versa for farms.  The farm end will have outlets for both local farms to exchange resources via pick-up and small box trucks as well as a portion underground that allows for the transfer of resources along the light rail.

Through understanding the necessary relationship between programmatic elements and their relative sizes to one another, these components could then be choreographed around the desired public experience. The physical model on the opposite page was built in order to investigate possible configurations. Each acrylic cube is representative of one program group. The result of this exercise is that the building parti can be morphed from the "layer cake" scheme to one as indicated at the top right of this page, where elements of the compost and distribution portions are mixed in with public programs when viewed in section. Compost and distribution program groups also exist underground and placed directly adjacent to the light rail escalators and will provide views into these spaces as users descend.

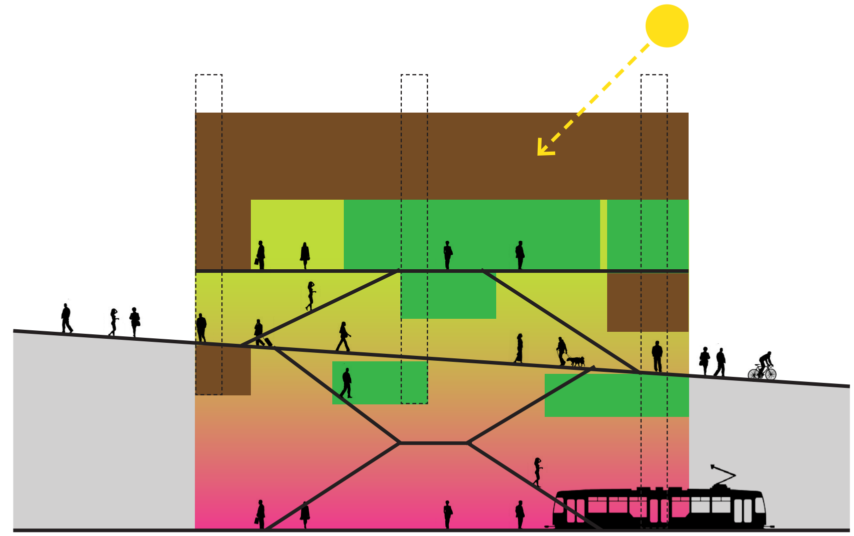


Fig. 62: *Layered Parti*: Sectional parti that results from the layering concept. The program between compost and light rail is now diverse.

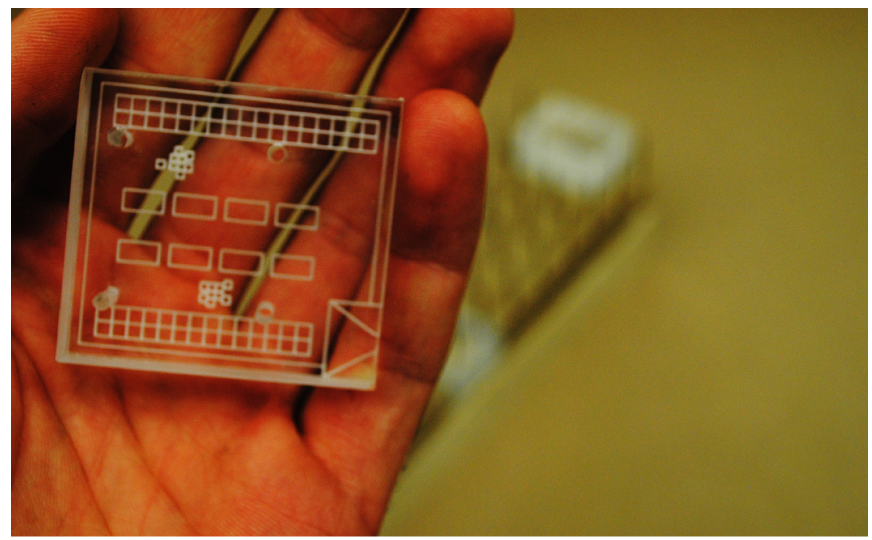


Fig. 63: *Program Group Model Component:* A program group etched on to acrylic and used in the model on the adjacent page.

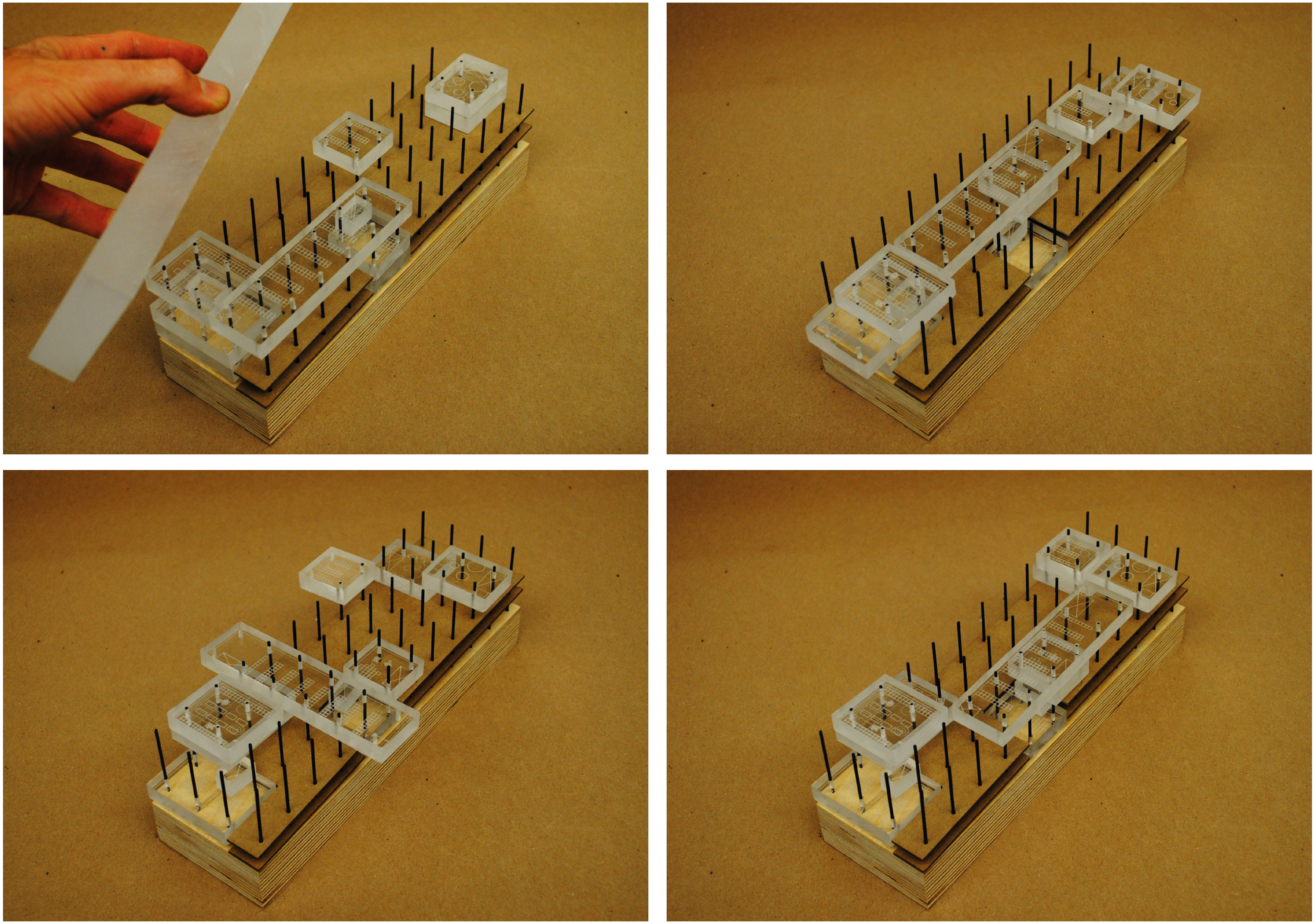


Fig 64: *Choreographing Model*.

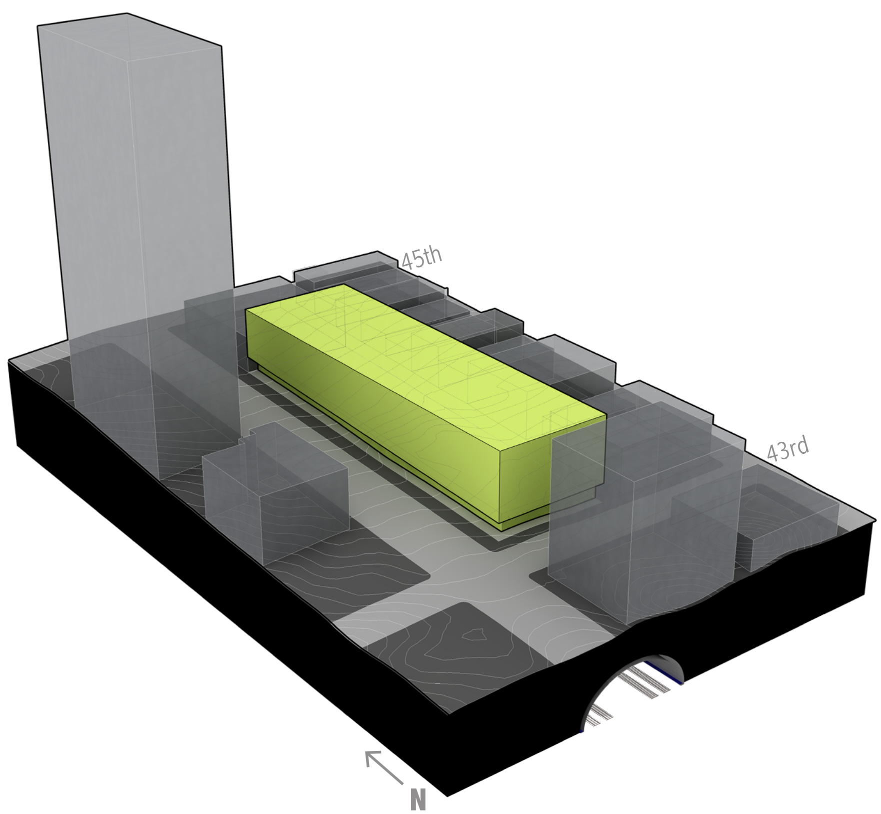
## 4.D: Building Diagrams

### 1: Massing

The diagram below represents the basic massing allowed by code. The site is located in an NC-65 zone, which sets the base height limit on the project at 65 feet. Exceptions within the code permit a max height of 69 feet, not including rooftop features. The ground floor has a 10 foot setback. There are FAR restrictions on the project, but these are easily satisfied by devoting major portions of the first and second floors to the open air market.

### 2: Compost

The compost facility maximizes the extents of the site at the top floor. The population that the facility could serve was reversed engineered based on the site conditions (zoning, lot area, setbacks, etc.). Accordingly, it is irresponsible to remove any large portions of the compost facility given that a major percentage of the building's square footage is already devoted to public programming. Therefore, the building's rectangular shape is determined by the main portion of the compost facility which comprises all of the third floor of the building, as represented in blue in the diagram below.



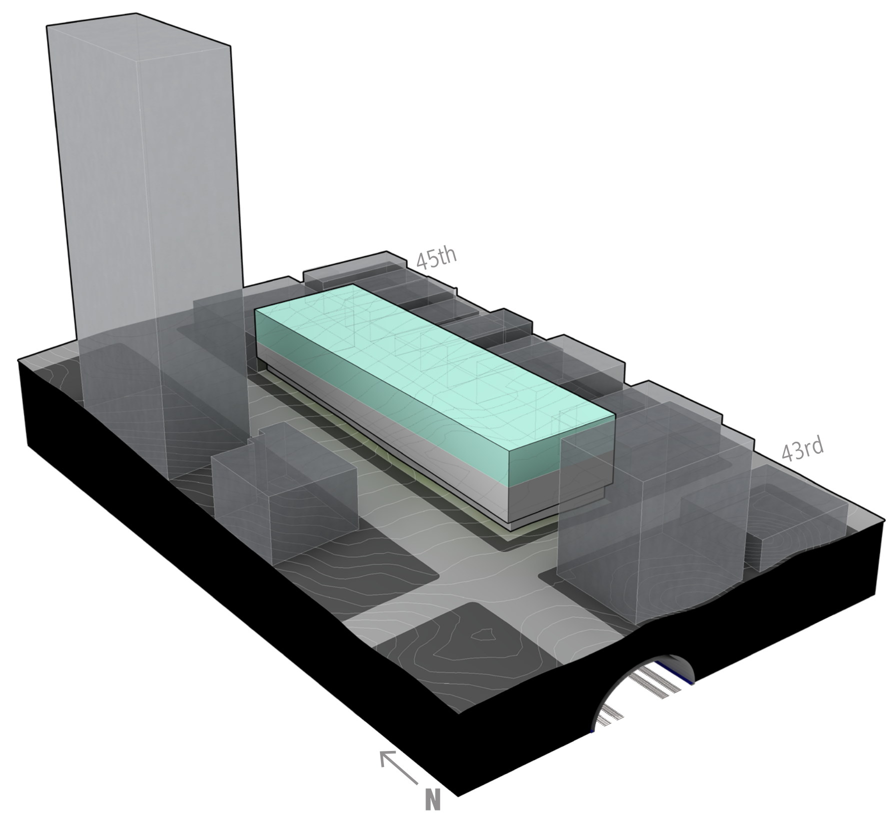



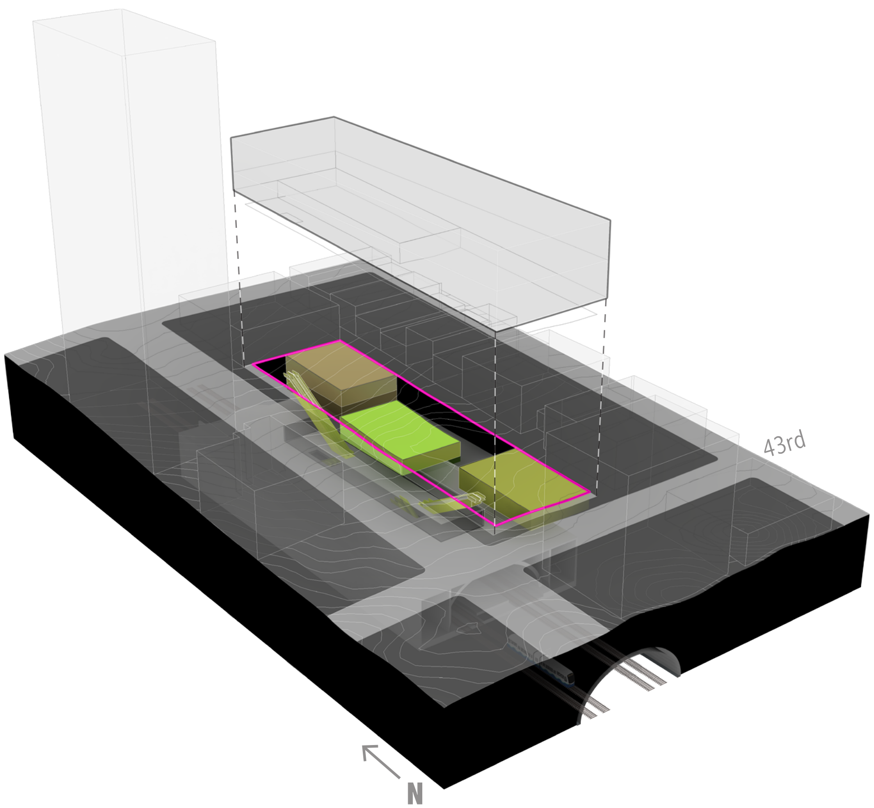

Fig. 65: *Massing Diagram*.
Fig. 66: *Compost Diagram*.

## 3: Underground

The program elements related to the unloading and loading of resources are buried underground. The primary reason for this is to limit the amount of disturbance to the pedestrian experience. The underground elements are located as required by relationship to the main building cores and elements above. As previously mentioned, these programs exist directly adjacent to the light rail escalators and are capable of allowing views into the processes. Portions of the compost program that produce exceptionally noxious odors are all buried. These may include the activities of sorting and storage that deal with unprocessed food waste.

## 4: Grade Plane

As a result of burying programs, there are only a few compost and distribution related elements that are required to be located on the grade plane. These include ramps down to the programs below and surface parking primarily for market vendors. This leaves the remaining roughly three-quarters of the grade plane free to be devoted to the open air market. The result is a pedestrian street frontage that is completely unobstructed and extremely permeable to the public.



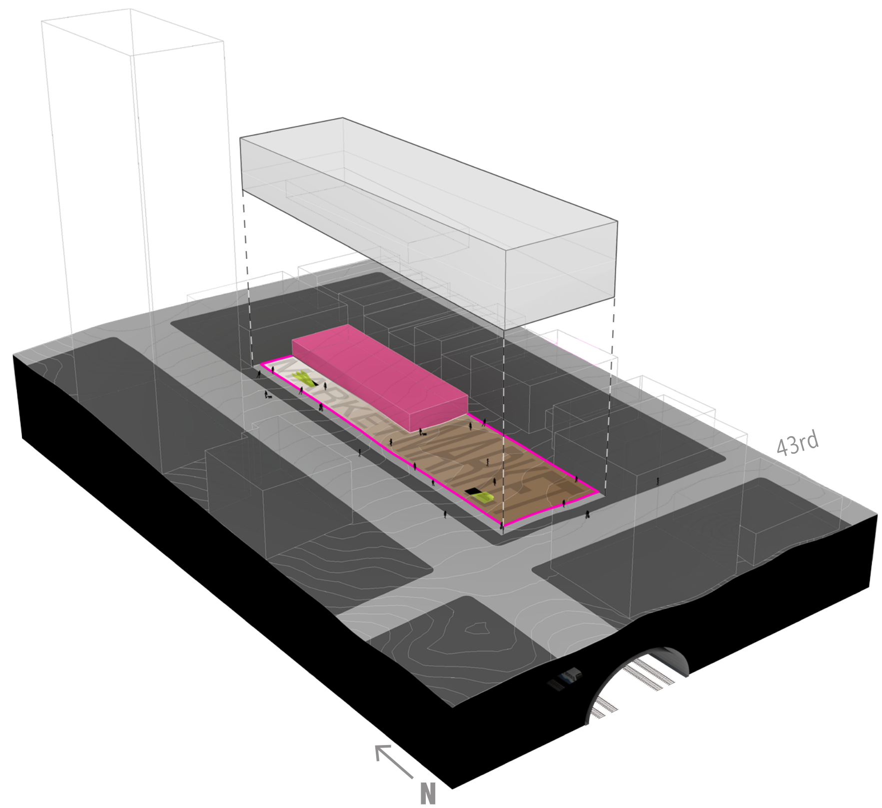



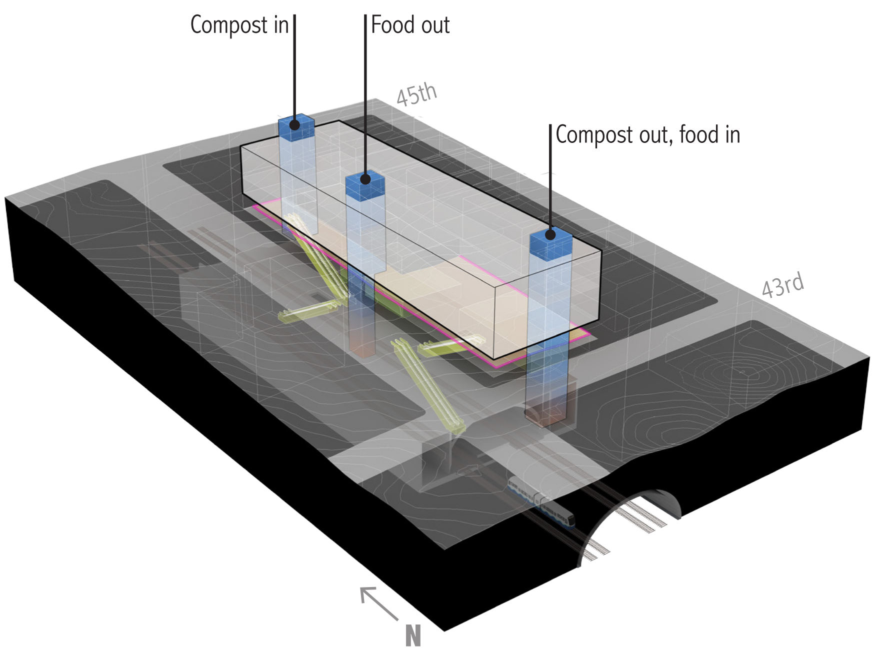

Fig. 67: *Underground Diagram*.
Fig. 68: *Ground Plane Diagram*.

## 5: Cores

There are three main cores that comprise the vertical circulation of goods and people throughout the building. The range of each core varies depending on what resources they are responsible for moving. There is a core devoted solely for the vertical movement of incoming compost due to its need to be isolated when in a pre-processed form. The core for outgoing food is located near the center and building and the core for compost out and food in is located on the south side of the building. As shown in Figures 78-82, the cores are also essential to the building's structure. Due to their relatively even spacing along the building's long axis they are used to support a super structure that allows the building to cantilever in the east and west directions, further reinforcing the permeability of the public street frontage.

## 6: Entries

The drop in grade from the north to the south side of the site creates the opportunity for a series of particularly special spatial experiences. First is the carving away of the building at is northwest corner to reveal a double height entry for those approaching from 45th Street. Second is the carving of a varying double to triple height space along the alley. The result is an "outdoor room" that is intended to be the main venue for the market. This area could be utilized as an interface between the underused backsides of the buildings located along University Way. As shown in Figure 80 and 82, the product could enliven of the current dead alleyway. Additionally, the location of this area creates the ability for the main market to spill out onto 43rd Street during times of peak use.



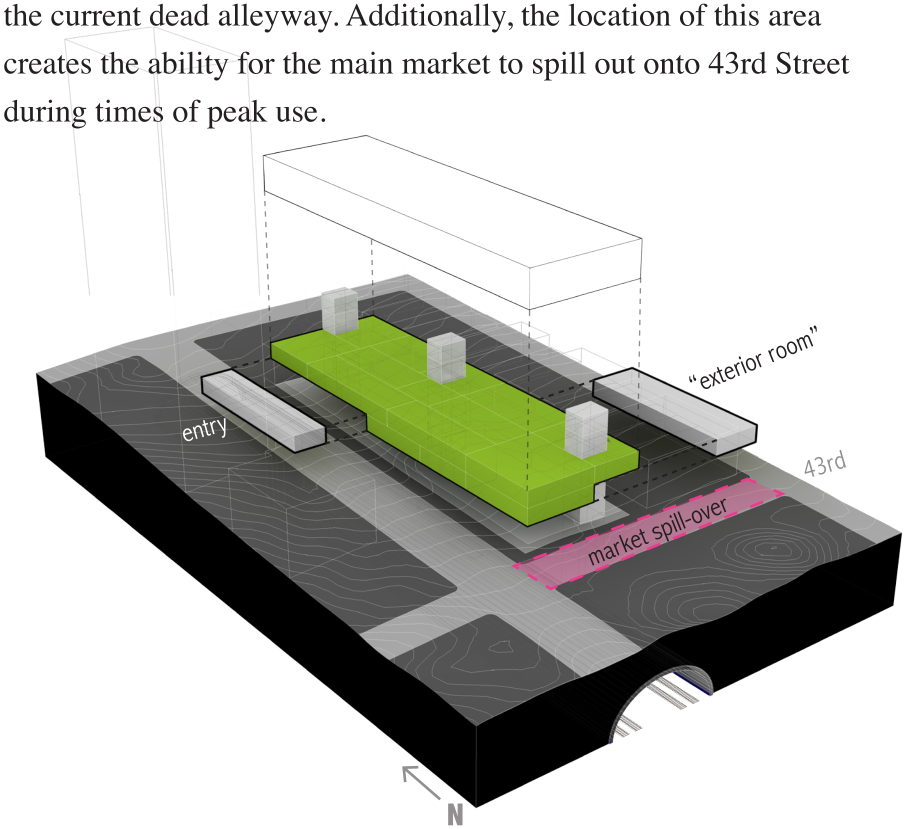



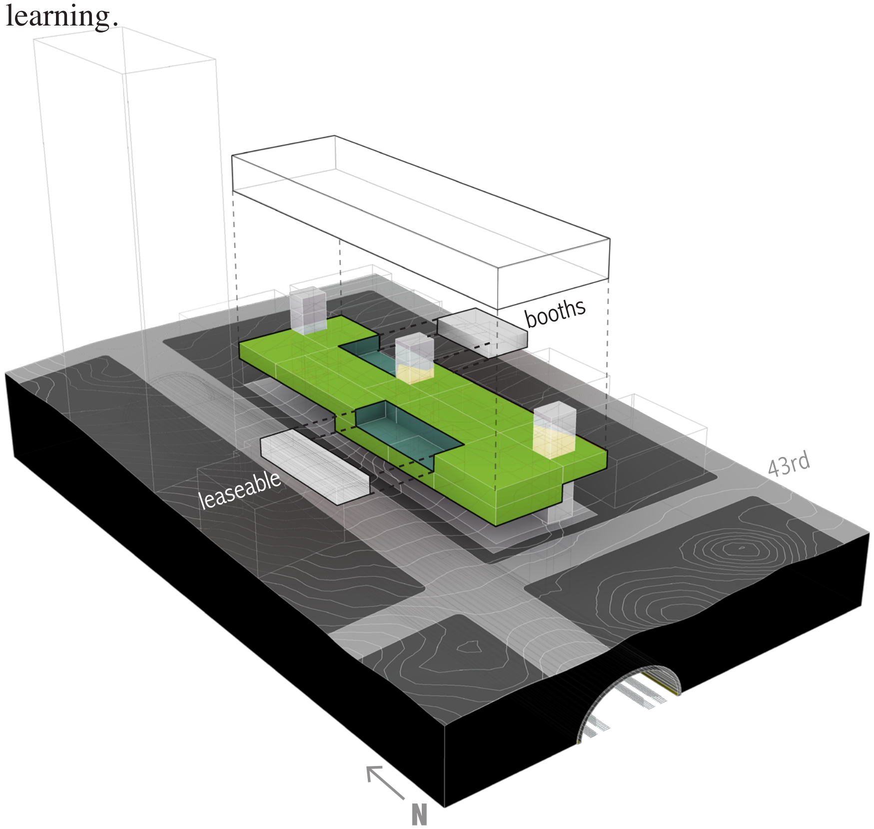

Fig. 69: *Cores Diagram*.
Fig. 70: *Entries Diagram*.

## 7: Markets

Two portions of floor directly below compost (second or third floor depending on location in building) are removed to create dedicated spaces for the portions of the market that need secure areas: the permanent market booths and the leaseable market. These spaces have a direct balancing relationship with the voids carved out of the mass for the entries. The goal with these spaces is to create vertical integration of the market with the other programs. The public is encouraged to explore these areas via a series of programmed staircases that will appear in forthcoming images. This vertical circulation is the primary canvas for community learning.

## 8: Atrium

The final massing step is the removal of an atrium from the center of the building. The atrium acts as the main vertical circulation element and unifies the interior spaces, giving users many different vantage points when moving through this area. The atrium places the focus on the interior portion of the building and creates a condition in which visual interaction with the various processes of the building is possible from all floors. The resulting form, as seen in green below, is a loop in which the non-public programs exist, allowing the general public to be above, below, and beside different processes as they move through the space.



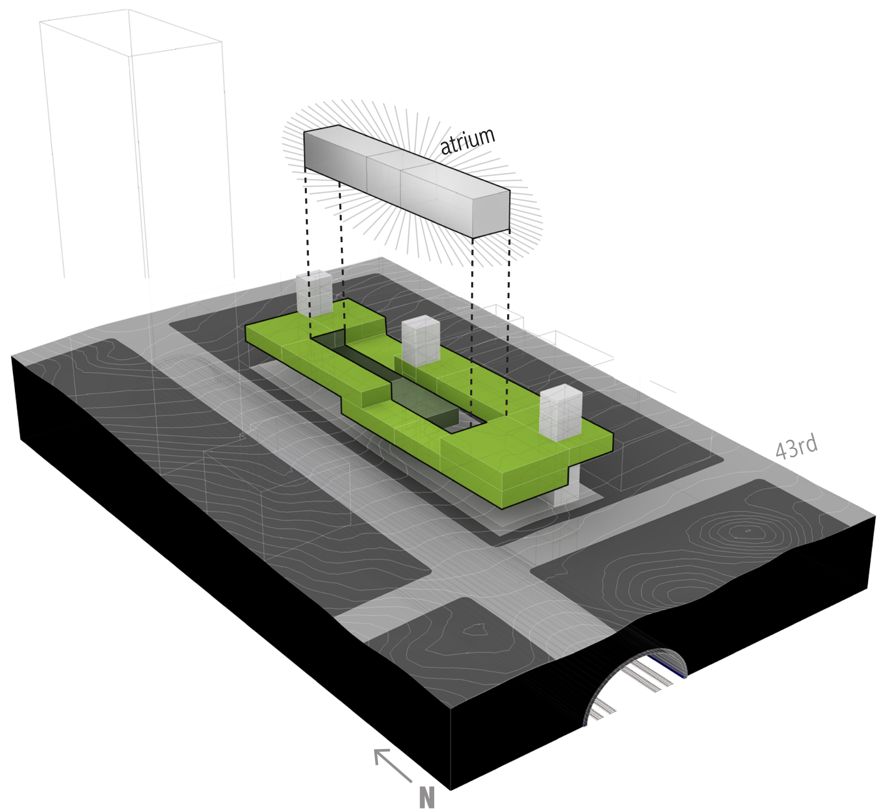



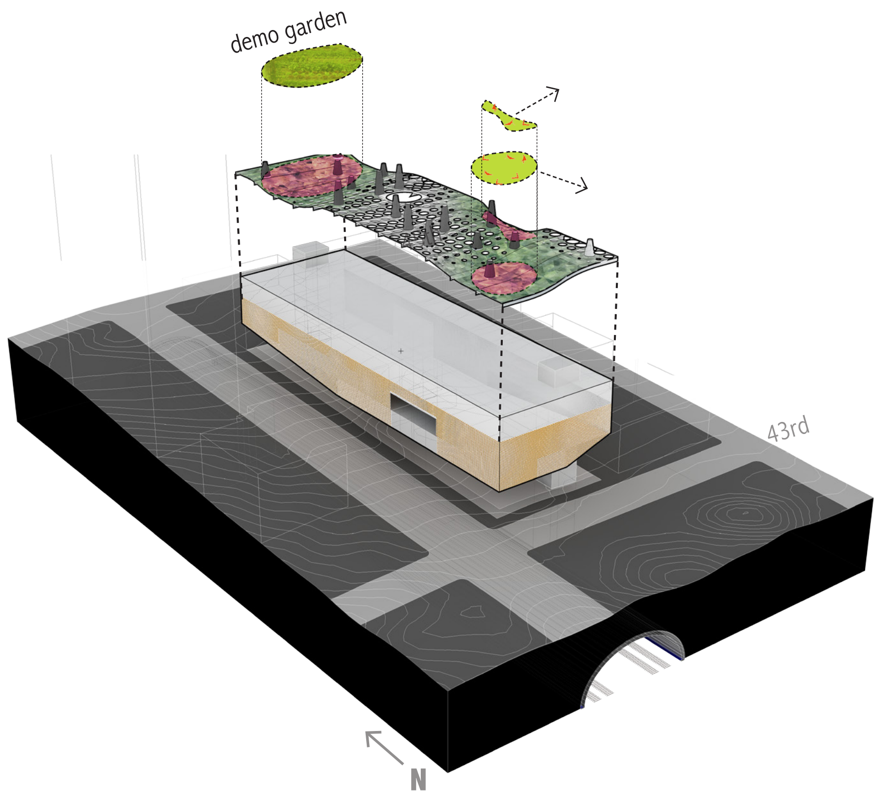

Fig. 71: *Markets Diagram*.
Fig. 72: *Atrium Diagram*.

## 9: Roof

It is necessary that a good deal of the roof be comprised of biofiltration vents and skylights. The vents counteract noxious odors emitting from the compost curing process, and the skylights allow light to permeate the composting floor. However, there are a few areas where these elements are not required that can be opened up for public use. On the north end there is a demonstration garden, where the entire closed loop from food production to composting can be achieved on site at a small-scale level. Additionally, there are two areas that are designed to be viewing platforms for the public to enjoy the scenery of the Cascades and the University to the east and Mount Rainier and Lake Union to the south.

## 10: Skin

In lieu of using conventional materials for the skin of the building it is proposed that the building be clad in a screen composed of mushroom bricks; building blocks grown using food waste and mushrooms. This material allows the processes that take place in the building to contribute in the construction of the building and allow the concept of rethinking conventionally used systems to permeate to the very skin of the building. The screen is envisioned to let light and views in at times but not others, creating a dynamic experience between the interior and exterior, in which much of the building's purpose remains mysterious until it is entered, explored, and experienced first hand. Figure 76 shows the screen in detail and explains how the bricks were scripted across the facade.



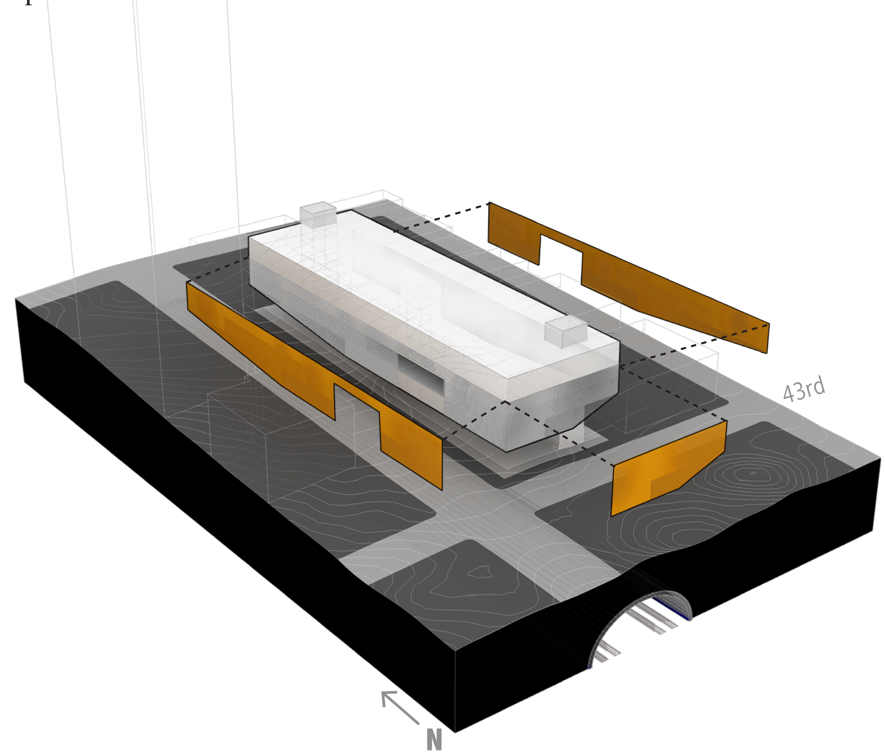
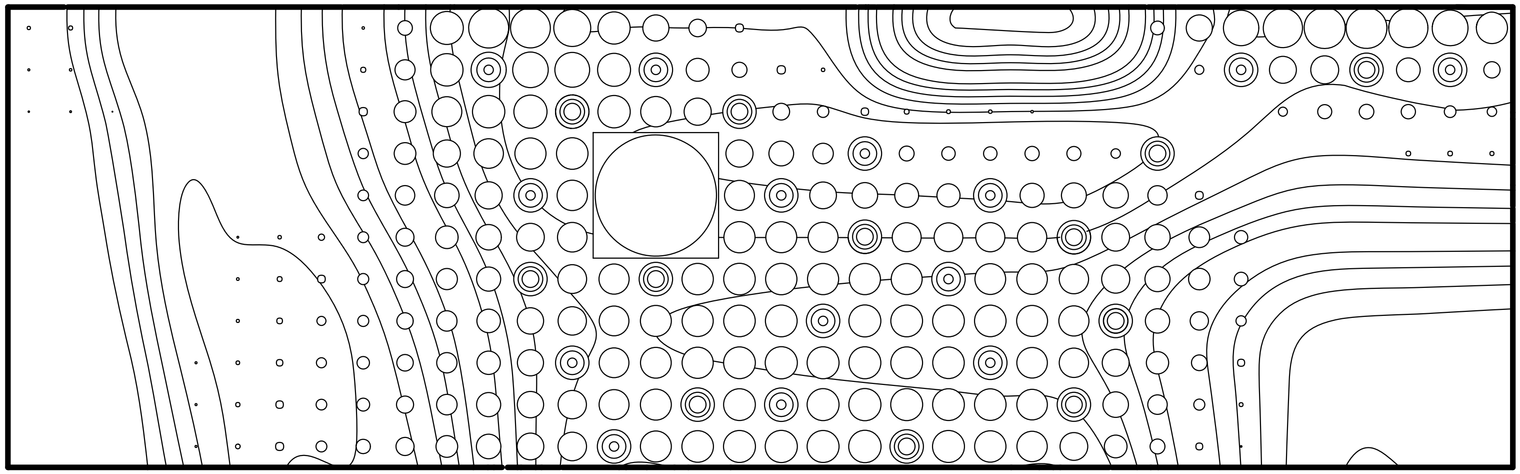




Fig. 73: *Roof Diagram*.
Fig. 74: *Skin Diagram*.



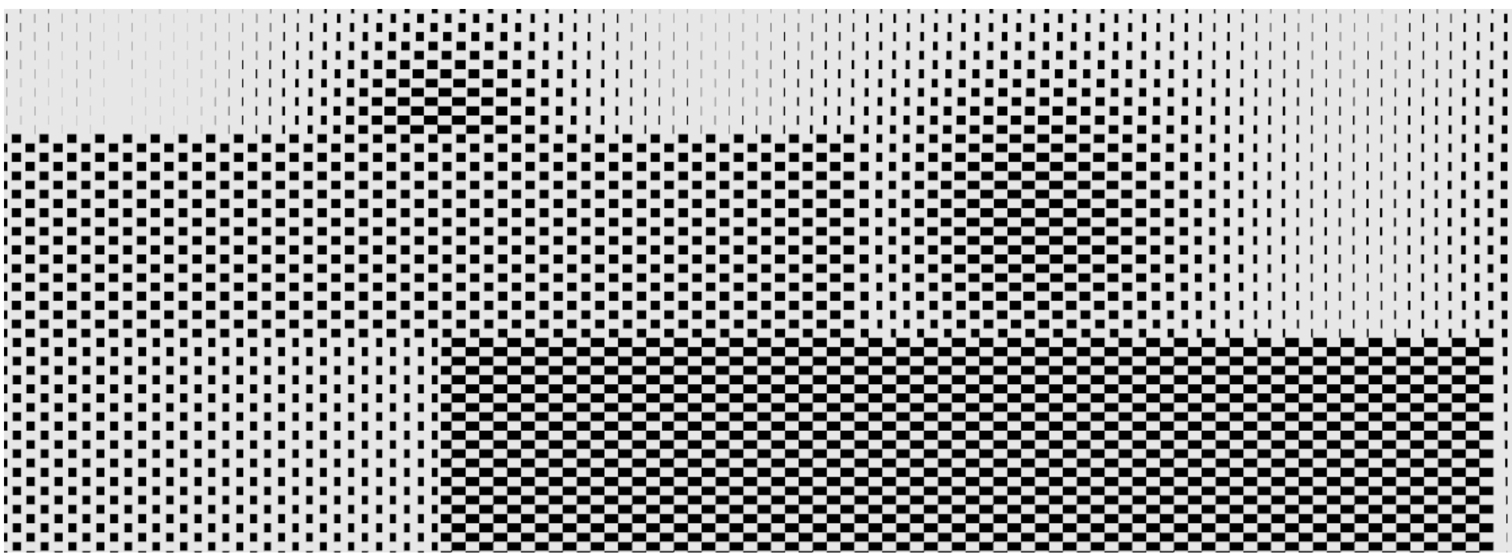


Fig 75: *Roof Plan*.
Fig. 76: *Skin Detail*.

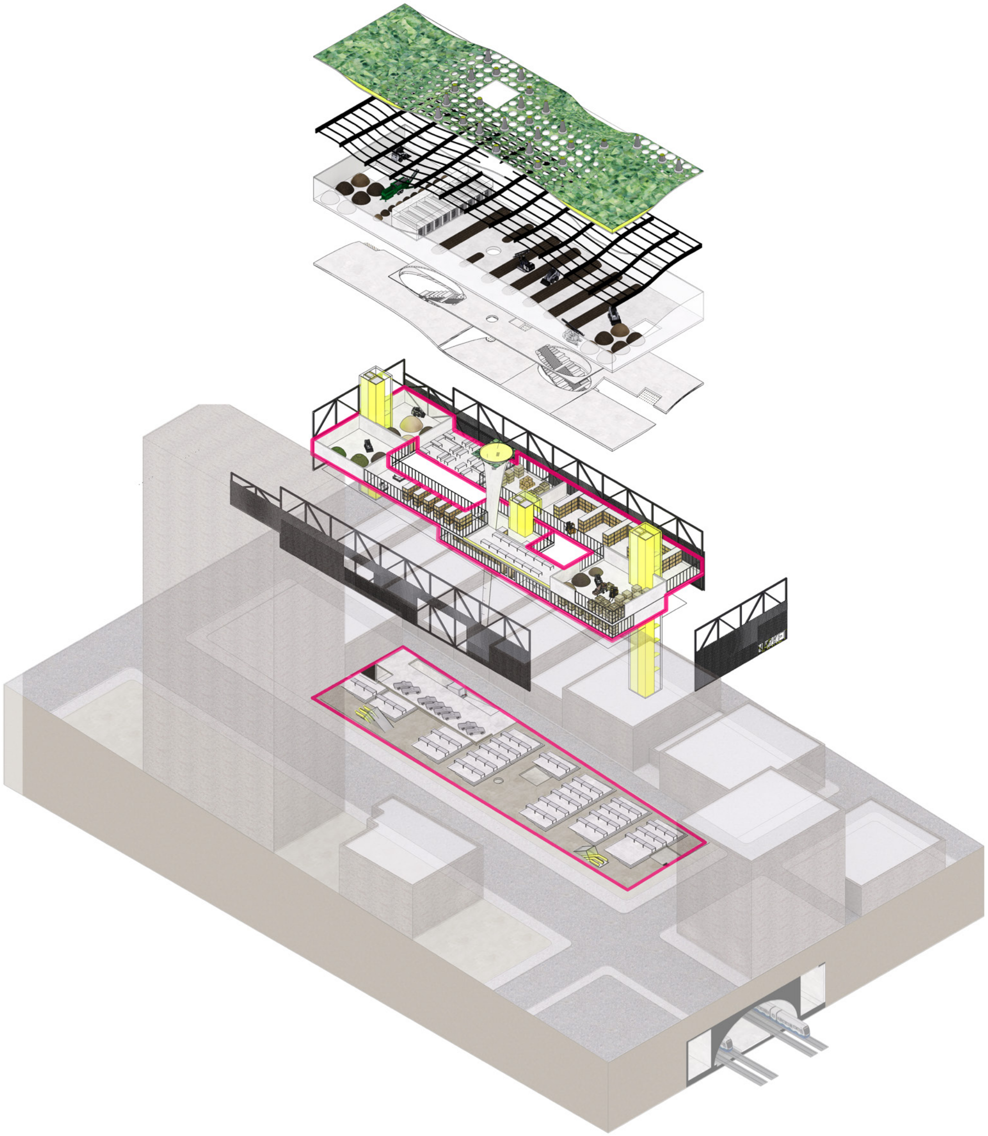


Fig. 77: *Exploded Diagram.*

## 4.E: Final Proposal

The final proposed exterior perspective is shown in Figure 78. As previously mentioned, the main mass of the building is cantilevered off the cores to create the most porous pedestrian street frontage possible. The ground floor is occupied by the open air market, which is envisioned as a permanent version of the current U-district farmer's market. This type of programming does not have security requirements and therefore no exterior cladding is required at the building's base.

The mushroom brick skin wraps the three sides of the building that are exposed. The north end shares a party wall with Neptune Theatre. The skin stops five feet above the compost floor slab, exposing a translucent glass box that allows light to permeate the composting space. At night the composting portion will be lit and will act as a beacon in the neighborhood as people move to and from the light rail station. The brick skin is removed at places where public programming exists behind it, such as the leaseable market space seen in the adjacent render. Otherwise the skin reveals only partial views inside, adding a level of intrigue, inviting the public to explore.


Fig 78: *Exterior Perspective*.

The longitudinal section is helpful in understanding how the cores relate to the different spaces. The southern most core, left in the image below, is designated for food in, compost out. It therefore runs the full height of the building from compost to light rail. The middle core is solely for food in and needs only to connect distribution to the below grade loading spaces. Far right is the compost core linking unloading to the main compost floor. The long section also shows the light well element, which allows light to penetrate from the roof down to the light rail platform where it terminates into a rain garden. The light well is used as way-finding element throughout the building, and is a constant element on all floors.

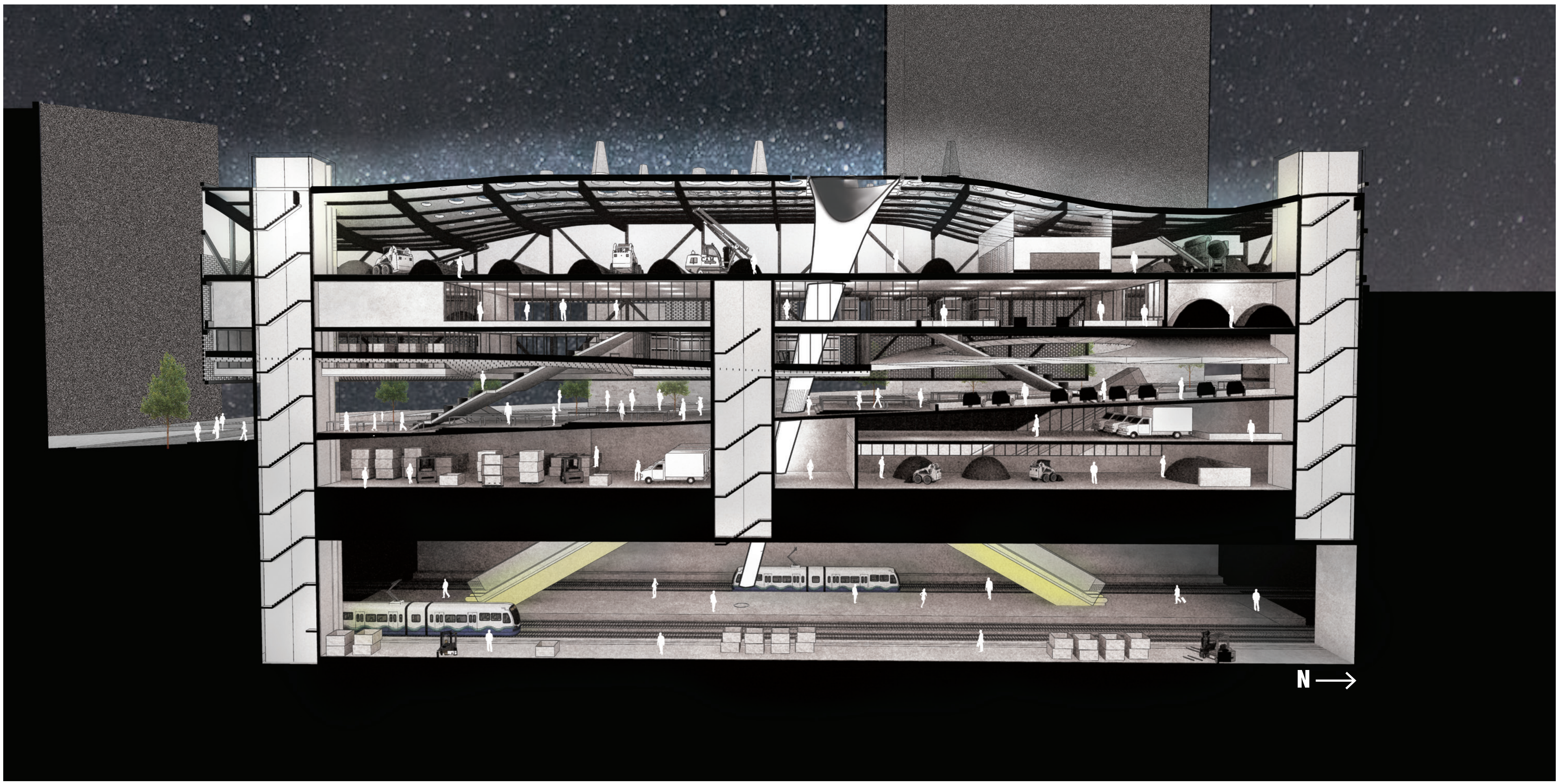



Fig. 79: *Long Section.*

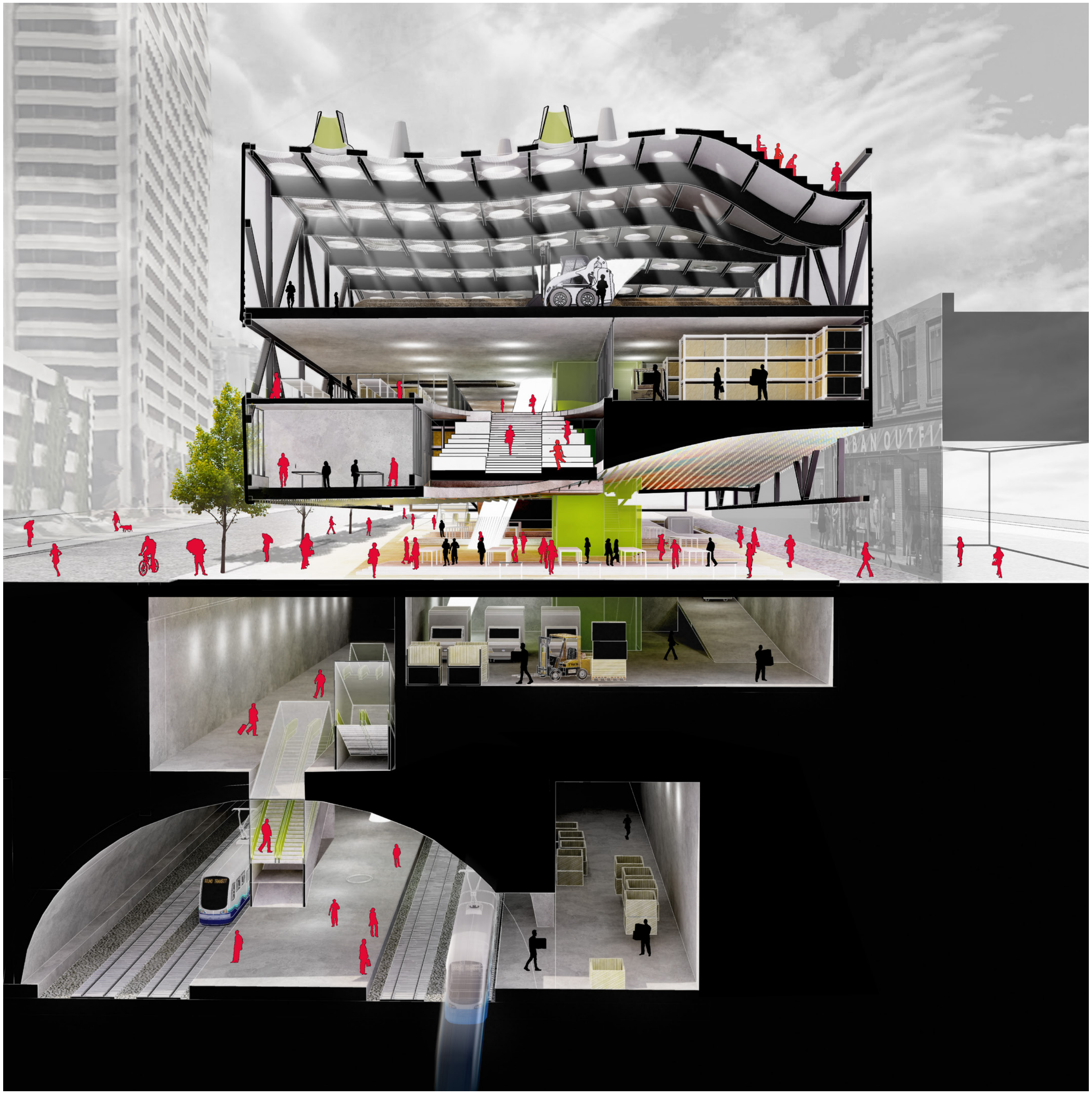
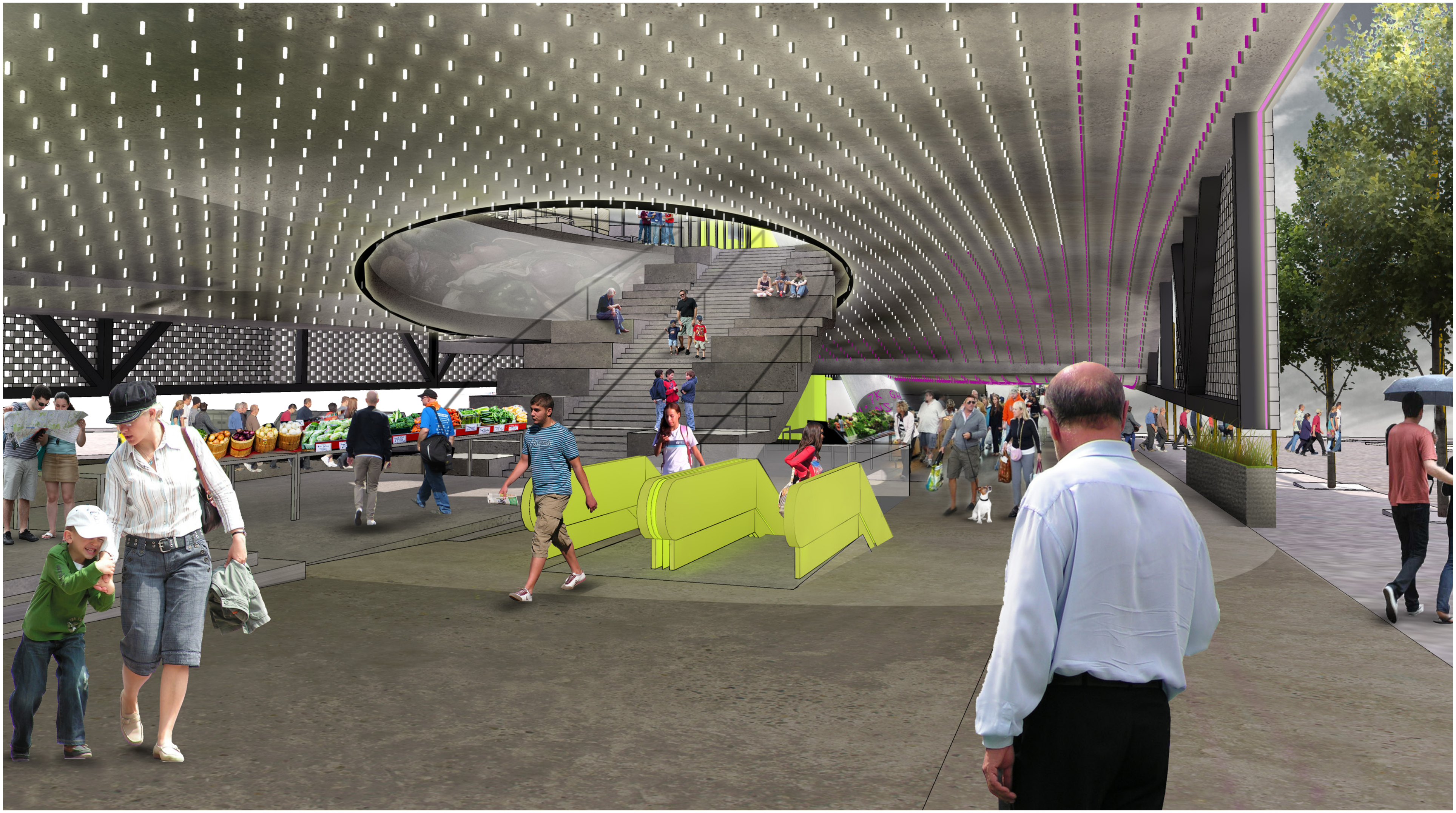


Fig 80: *Transverse Section.*

In the transverse section, the red figures represent the general public, while black represent employees of the various programs. Here, the concept of layering is evident. The general public is able to occupy all floors of the facility save for the main compost floor. The "exterior room" is visible on the right side of the image, as well the enlivened alleyway that is activated by the backside of the existing University Way shops and restaurants.



The entries into the light rail stations are designed to promote the sale of regionally-produced food sold in the markets. As users enter the space, they are surrounded by vendors. The activated stair shown in the image above is designed to draw users up and into the market spaces on the second and third floors. The ceiling of the ground floor market space is occupied with an art installation that uses LED lighting to display metrics regarding community's sustainability performance.

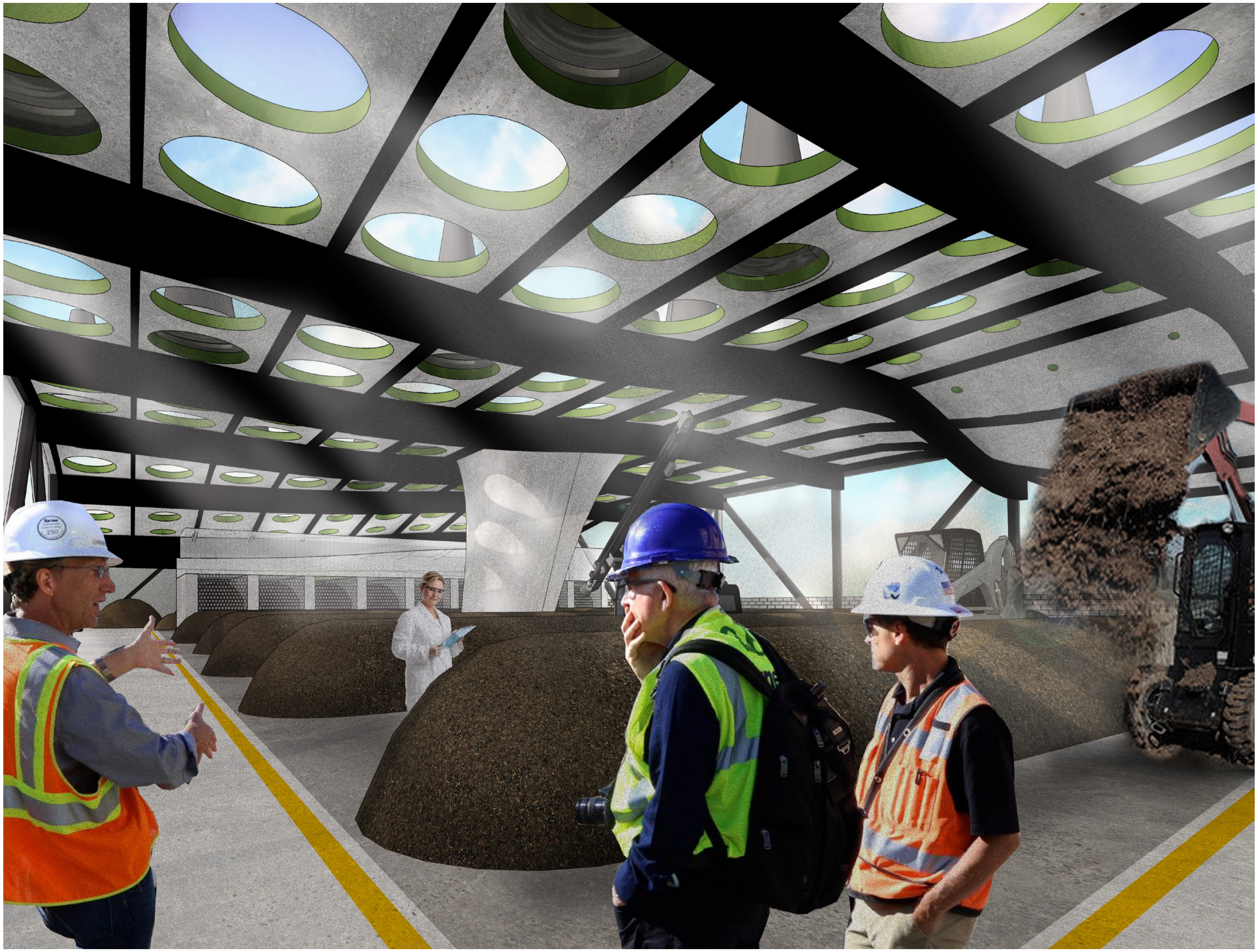
Fig. 81: *Light Rail Entry Perspective*.

As shown in the perspective below, during times of high yield, the market space is designed to overflow onto 43rd Street. In approaching the site from University Way, the building prioritizes the urban condition created through the dynamic of the exterior market, the alley, and the existing adjacent shops.


Fig 82: *Market Entry Perspective*.

The atrium is where all the programs collide. As users move vertically through the building, they are presented with views into the various component programs. As seen below, the ancillary market spaces exist direct adjacent to spaces used for compost and distribution oriented activities. The processes performed within the building become the backdrop for the very activities they allow. This central void in the building allows for small teaching moments, unique places to sit and eat, or areas for indoor gardens.

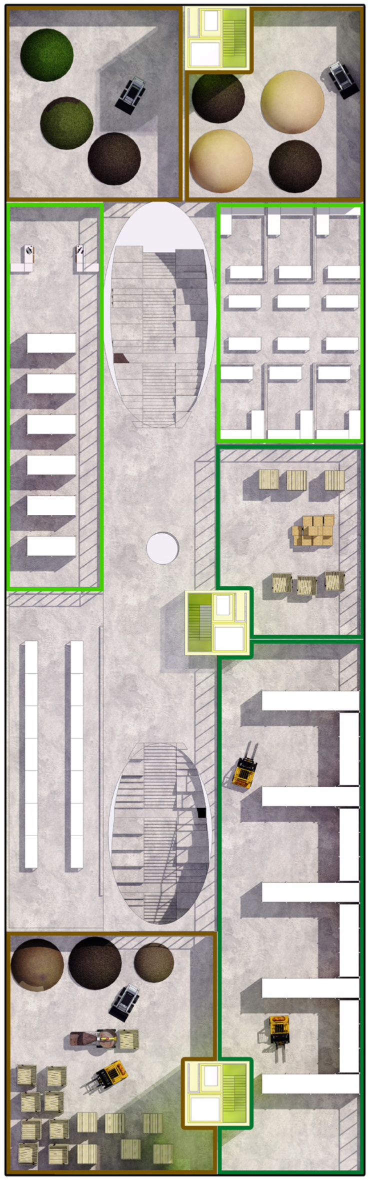

Fig. 83: *Atrium Perspective*.



The building has the potential to be an excellent tool for the education of the public. Members of the community could be invited to take tours, and in doing so, further understand why the building is in their neighborhood and positive effects it allows.

Fig 84: *Compost Perspective*.


Fig. 85: *Floor plans*.



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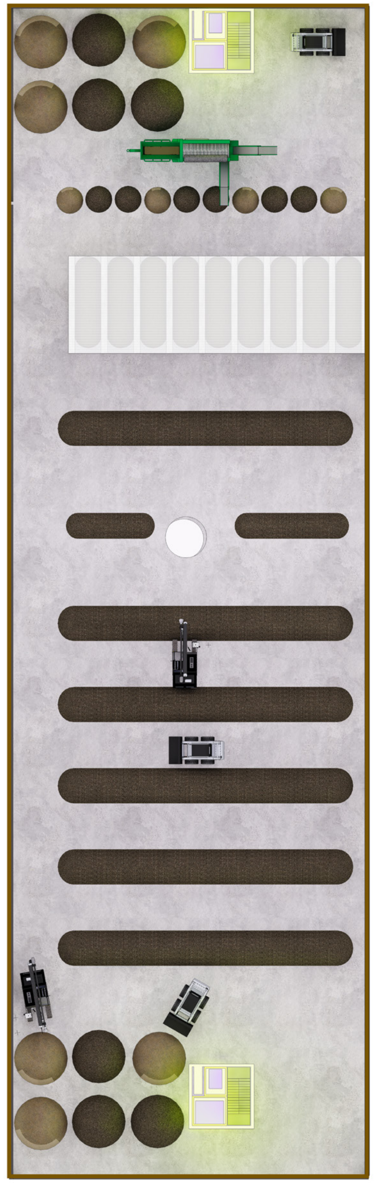

Compost

Fig. 85: *Floor plans*.

# Chapter 5: Conclusion

My purpose in this thesis was not to propose a project in which the full extent could be realized tomorrow. Rather, I sought to radically re-imagine one particular urban system, with the hope that the resulting project could open up new possibilities in my thinking about sustainability. I feel that the ambition of the project is its biggest success. Through pushing the initial ideas as far as possible, the resulting project became an increasingly complex but coherent example new potentials in architecture interfacing with territories of the city and region.

Buckminster Fuller was likely the biggest influence on this thesis. I am surprised that his ambitious ideas of efficiency and systems thinking have faded so far from the mainstream discussion. Inspired by many of his writings, this thesis became a critique on how architecture is currently considering its role in sustainability: as primarily an issue of building systems and materials. The project herein, is a very different type of sustainable architecture. It is interesting to think of the building as a kind of platform, where a series of exchanges and activities are able to take place that cannot occur anywhere else in the city. In this sense, the project was never really about the design of a building, but about a collection of ideas as to how architecture can push the limits of what is currently understood to be sustainable.

The "hyper-program" was continually the biggest challenge of this project. Questioning whether the site could accommodate all the proposed activities was a constant source of self-consciousness. In the end, the decision to pursue the most daring of conglomerations was a result of my continued surprise at the secondary and tertiary benefits accrued through the programmatic couplings that could be arranged. I am interested in further pursuing this type of investigation in other systems and at other scales. I feel that sustainable infrastructure is the most exciting new field for architects to imagine.

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