

FRIES ARE NOT A VEGETABLE
Urban Farm High School Grows Its Lunch and Its Curriculum

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Abstract

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Each school day, Seattle public school children are served a lunch that does not reflect the city's access to fresh food, its progressive attitudes on sustainability, nor its successful thriving industries. However, changing children's behavior toward their personal health and the health of the environment starts not only with a better lunch, but by actively involving them in their food supply system and its environmental impacts. This thesis proposes a new form of public school that integrates agriculture into both a hands-on curriculum and into the building itself. Using high-performance, high efficiency hydroponics in the building along with soil growing on the site, the facility becomes both an educational and a production facility. This "hyper local" model for food supply would eliminate the environmental costs of transporting fresh food, allow for waste, water, and energy efficiencies in the building, and engage both students and the surrounding community in the process. By growing, harvesting, and learning about sustainable technologies, teens would be vested in preserving the planet and in eating nutritiously, encouraging behaviors for better health and well-being throughout their lifetime.

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CHAPTER 1:

Introduction and Background

“There can be no keener revelation of a society's soul than the way in which it treats its children.” —Nelson Mandela (Mandela 1995)

A Need For Change

Health Crisis: What Are American Children Eating?

The most important resource in a developed society is the health and wellness of its people. Therefore, the health of the children in that society is a direct barometer of its future success. But over the past three decades, the health and nutrition of children in the United States has declined to a state of crisis. One in three American children are overweight or obese, putting them at risk for preventable diseases like diabetes and heart disease. This issue poses a public



fig. 01 Bad school lunch, Chicago Magazine, 2011

health crisis that threatens to lessen the well-being of the next generation and create trillions of dollars in future healthcare costs (Thompson & Carman 2015). The problem has received national attention, most notably through programs such as Michelle Obama's national *Let's Move!* campaign and the Edible Schoolyard Project in Berkeley, California (fig. 02). *Let's Move!* began in 2010, as Obama worked collaboratively with the corporate sector to reduce salt, sugar, and fat in commercial food production. Since children spend nearly two-thirds of their waking hours in school, she concentrated much of her efforts on public school lunch reform. *Let's Move!* updated the requirements for federally-funded school lunch programs, which provide free and reduced price meals to more than 21 million low-income children, to include more fruits, vegetables, whole grains, lean protein, and low-fat dairy products. Although the program has been successful in getting healthier foods into the lunchroom, it has not addressed the overall quality of the lunch, nor has it created lunches that children like and will eat. Student images on social media posted under *#thanksmichelleobama* show lunch trays with a "token apple" alongside a disturbingly unappetizing entree (fig. 03). Despite the good intentions of *Let's Move!*, lunchroom food in America remains notoriously unsavory. Compounding the problem is the fact that many children continue to be uninspired to choose fresh fruits and vegetables, even when they are offered (fig. 04). Designing an affordable, healthy, delicious school lunch and enticing children to eat it, not simply creating more food waste,



Thanks Michelle Obama, we now have lunchables for lunch.
pic.twitter.com/k9ZEj3uYAG

↩ Reply ↻ Retweet ★ Favorite ⋮ More



RETWEETS 4 FAVORITES 8

2:57 PM - 27 Aug 2014

Flag media

fig. 02 Michelle Obama's *Let's Move!* initiative, 2010

fig. 03 Student tweet to *#thanksmichelleobama*, 2014



has proven challenging. *Let's Move!* has rigorously focused on dietary nutrition requirements rather than more systemic change that would actively connect children with their food and nutrition. Thus, the behavior—what children reach for in the food line—remains the same in most school lunch programs.

Fifteen years before the *Let's Move* campaign, a more holistic model for school lunch reform program had begun. In 1995, Alice Waters, food activist and world-renowned chef of *Chez Panisse*, started the Edible Schoolyard Project (fig. 05). Waters was disturbed by a lack of wholesome nutritious food on the menu at Martin Luther King Jr. Middle School in her Berkeley, California, neighborhood. She also noticed an alarming disconnect between the food students were eating and the food cycle—the actual journey from farm to table. She met with the school principal to discuss the possibility of growing food on a blighted acre of land on the school grounds and from there, the Edible Schoolyard Project (ESY) was born. The project grew to include an organic garden, a kitchen classroom, and a staff comprised of a garden teacher, a professional chef, and a full-time director who work closely with the school's teachers and administrators. ESY and the *Chez Panisse* Foundation are now a nationwide effort that supports six Edible Schoolyards across the United States and inspires countless other national and international programs. Waters explains that her mission is to “bring a curriculum into every school that teaches children a set of values essential for our survival, most importantly, being stewards of the land” (BYUtv 2011). At MLK Middle

fig. 04 *Children's unhealthy choices*, 2014.

fig. 05 Alice Waters and students at King Middle School's Edible Schoolyard, 2010.

School, the children often arrive with little to no experience with gardening or cooking. ESY creates an environment where they feel safe to explore unfamiliar foods and discover that trying something new can be a fun and positive experience. The garden is the perfect tool to deliver experiential hands-on learning as students are taught how to prepare the soil for planting, composting, harvesting, transplanting, and propagation (fig. 06). They gain invaluable life skills like working on a team, respecting nature, and problem solving. The garden is incorporated into other aspects of the curriculum including math, earth science, energy flows, and cooking. In cooking class, they are taught to plan and prepare meals for themselves and their family and to shop for groceries, and are entrusted with quality tools such as sharp knives and kitchen appliances (fig. 07). They also gain the experience of sharing a meal—how to set the table, taking turns speaking in a group, passing food, and waiting until everyone is served to eat—dynamics that many students do not experience at home. Ultimately, work around food and in the garden builds knowledge, confidence, and life skills in a setting that children naturally enjoy, and this hands-on learning is much more lasting and profound than simply learning from a book (BYUtv 2011).

With regard to education, ESY is clearly a success; however, the ultimate vision of the ESY education was always to align the lessons of the kitchen and garden classrooms with the food served in the lunchroom. So in 2003 the Chez Panisse Foundation partnered with Berkeley Unified School District (BUSD) to



fig. 06 Outdoor classroom at King Middle School

fig. 07 Cooking classroom at King Middle School



fig. 08 Dining Commons and central kitchen at King Middle School in Berkeley, California.

transform their school lunch program. The partners constructed a central kitchen at the middle school to realize that vision (fig. 08):

The new Dining Commons at King Middle School now serves as the central kitchen for all 16 schools in the district, providing 10,000 meals per day, and made with wholesome, fresh, and mostly organic ingredients.... Featuring on-site composting and recycling stations, the Dining Commons presents a myriad of opportunities to connect garden, kitchen, classroom, and lunchroom experiences (Our Story, 2016).

Programs across the United States that have been successful with school lunch reform all share a common thread: they actively involve children in the process of growing, harvesting, and preparing food and often integrate the processes into the curriculum. This involvement shifts behavior, vesting children in their own health and the health of the environment, whereas simply offering more



fig. 09 South Central Los Angeles "Gansta Gardener," Ron Finley.



nutritious food does not. Ron Finley, self-titled "gangster gardener," also speaks to this behavioral change in children. Finley has created a local food revolution in South Central Los Angeles, an area formerly known as an urban "food desert," dotted with fast food and convenience stores, and void of supermarkets or any source of fresh food. He states, "If kids grow kale, they eat kale!" (fig.09). Merely placing an apple or a package of carrots on a tray does not necessarily motivate children to eat differently, especially if they have become accustomed to the tastes of high-fat, high-salt processed foods. But, as Finley claims, and as demonstrated by ESY, when children are closely connected to the growing and harvesting of the food, they are much more inclined to try new things

and voluntarily change their eating behavior. Systemic change, such as an immersive urban agriculture curriculum, would provide fresh food and inspire healthier eating in American children, and with equip them for a healthy life on many other levels, as well.

Ecological Crisis: The Current Food Supply System

Concurrent to school lunch reform, another food-related crisis is necessitating behavioral change in the United States. American's appetite for fast, cheap, easily available food has created a food supply juggernaut that is detrimental to both the environment and the food itself. The numerous steps currently required for getting food from farm to table consume an enormous amount of natural resources. Even perishable foods such as fruits and vegetables travel an average of 1500 "food miles" to reach urban consumers (fig. 10). This resource-intensive journey uses 10 percent of the total U.S. energy budget, 50 percent of U.S. land, and 80 percent of U.S. freshwater consumption (Gunders 2012). It also creates between 17 and 32 percent of the global greenhouse gas emissions (Bellarby et al 2008). And beyond growing the food, the current system requires processing, packaging, distributing, marketing, consuming, and disposing of it, activities that use 80 percent of the total energy consumed in the journey (Hill 2008). Food miles also increase traffic congestion and air pollution, thereby decreasing the overall quality of urban life and public health. With global populations predicted to exceed 9 billion by 2050 and 6.4 billion of that in urban



energy consumption



greenhouse gas emissions



water intensive



traffic congestion



food losses



weird food

fig. 10 Getting food from farm to fork is currently a resource-intensive process.

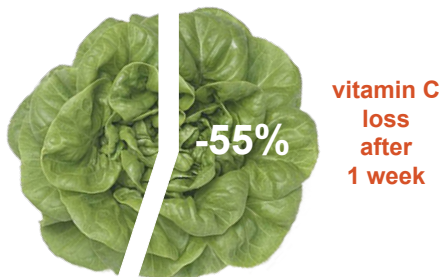
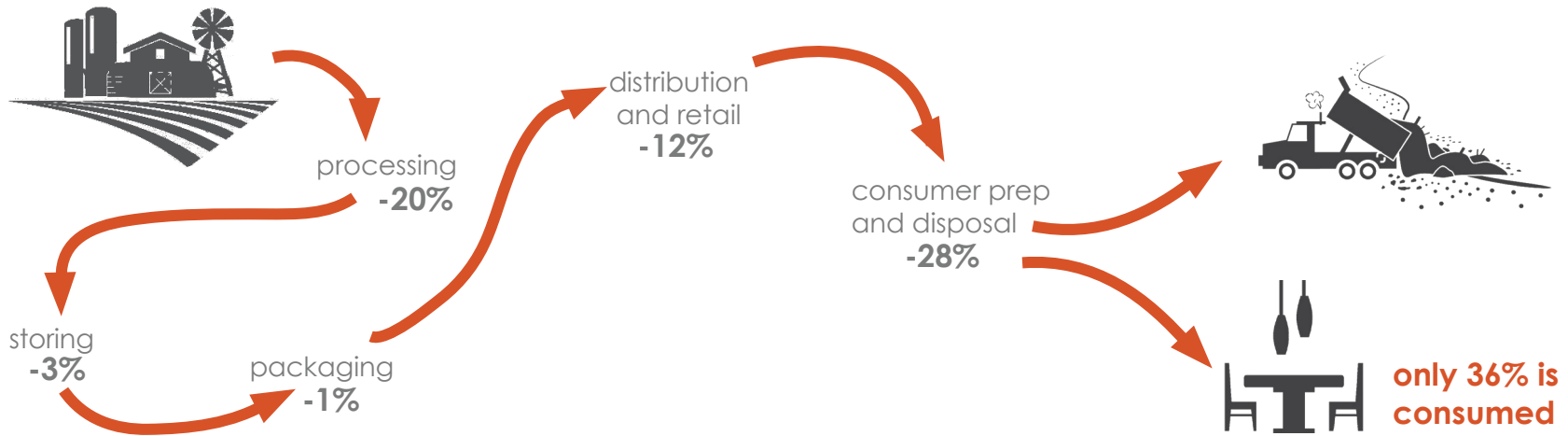


fig. 11 Food losses and inefficiencies.
fig. 12 Produce loses nutrition quickly after it is harvested.

centers, supplying Americans with food is creating an ecological crisis (Pirog & Benjamin 2003).

The current system also results in an enormous amount of waste. Fruits and vegetables are particularly vulnerable during each step of the process, with only 48 percent of commercially grown fruits and vegetables reaching the consumer and 36 percent actually consumed (fig. 11). Uneaten food is not only a waste of resources; it further contributes to methane gas emissions. If not composted, food that is not consumed ultimately ends up in municipal solid waste landfills as decaying organic matter. The food that does reach the consumer suffers losses in both flavor and nutrition the longer it travels from its source (Frith 2007). Once they are harvested and separated from the source of their nutrients, fruits and vegetables undergo higher rates of respiration, causing water loss and

nutrient degradation (Barrett 2007). One University of California study showed that most produce loses 30 percent of its nutrients three days after harvest and vegetables can lose up to 55 percent of vitamin C within a week (Eng, 2013) (fig. 12). Travel from farm to grocery store, shelf time, and storage at the final location often creates a significant amount of time between harvest and when foods are eaten. Depending on the season, it can be close to a month before fruits and vegetables reach the final point of consumption (Barrett 2007). Therefore, commercially farmed produce often favors qualities that lend to shipability rather than taste, nutrition, and diversity. Finally, beyond resource consumption, CO₂ emissions, food losses, and quality degradation, this abstract supply system leaves city dwellers completely disconnected from the source of their food.

These environmental and social issues have created a backlash known as the “local food” or locavore movement that recognizes the enormous advantages of growing food close to the consumer (fig. 13). The movement’s objective is to connect food consumers to food producers in their local area. The locavore diet focuses on foods grown close to consumption, typically within 100 miles. Eating locally aims to take advantage of seasonal varieties and use foods that can be prepared without the need for extra preservatives (Frith 2007). Farmers’ markets, home gardens, p-patches, community gardens, rooftop gardens, restaurant and hospital gardens, and even office gardens are all examples of locavore thinking (fig. 14). By reducing distance and growing



fig. 13 The Locavore Movement

food close to where it will be consumed, energy use is reduced by 80 percent and greenhouse gas emissions can be reduced to zero if food is grown on site. Reducing time from harvest to plate preserves the both the nutrition and the flavor of the food. Growing food locally also allows control over decisions like selecting varieties, choosing seasonally appropriate crops, and determining when the produce is picked—decisions that affect nutritional value and taste.

Across the country, urban dwellers have a renewed interest in local food. Growing food near the source of consumption can eliminate food miles and their associated environmental impact, while providing fresher, tastier, and more nutritious food. By bringing commercial agriculture, previously located only on rural farms, into the urban fabric, this growing movement encourages sustainable food security with less loss, better taste, and often at more affordable prices.



fig. 14 The Locavore Movement in Seattle: Ballard Farmers Market (t), Goat Hill Giving Garden run by King County employees (m), and Cascade P-Patch (b).

Thesis Rationale and Overview

This thesis posits that the potential solution to successfully changing the way American children eat lies in combining the logic of the locavore movement with the operation of a public school: growing fresh food in, on, and around a public school building to supply the produce for its lunch program. It further offers that incorporating such a program into a rich curriculum would physically, educationally, and visually connect children to their food source and get them excited about eating nutritiously. Finally, it suggests that designing urban agriculture into all aspects of the building program would create a myriad of additional benefits: a positive visual identity for public schools, engagement with the surrounding industry and community, reducing food miles, and achieving sustainable building performance through water, waste, and energy efficiencies. To accomplish these outcomes, this thesis proposes the integration of a high-efficiency, high-yield hydroponic farming system into school building design to grow the produce necessary for its school lunch program. Referred to as “building-integrated agriculture” (BIA), this new model for public school architecture would be a win-win for children, schools, and the environment (fig. 15, 16).

The proposed site for this demonstration project is Seattle, Washington. As a progressive-thinking city, Seattle could benefit by aligning its education standards with its reputation for excellence in other areas such as technology,



fig. 15 Building-integrated agriculture in retail commercial, Whole Foods, Brooklyn, New York

fig. 16 Building-integrated agriculture in housing, Forest House, The Bronx, New York

innovation, sustainability, and the arts. This proposal would allow Seattle to set a precedent for a new typology of public school building that addresses not only the quality of school lunch programs, but also the larger issue of connecting children to their food source and the natural environment. Consistently ranked among the top green cities in the United States, Seattle prides itself on its ability to provide a healthy environment, support a strong economy, and continually improve the well being of the whole community (Shaver 2014). At the heart of the Emerald City lies Pike Place Market, a mecca of beautiful local produce that is bustling year-round with locals and tourists (fig. 17, 18). However, this bounty is not accessible to all. On Earth Day 2016, Seattle Mayor Ed Murray's Office of Sustainability & Environment published its first Equity and Environment Agenda to address disparities in the living standards of Seattle's lowest-income residents (Coven 2016). This population often deals with higher levels of pollution and limited access to healthy foods and open space, and yet they benefit least from environmental progress. Consequently, the healthy living that Seattle boasts is enjoyed by its wealthier citizens, while its low-income residents, particularly children, are experiencing a health crisis similar to many depressed areas of the nation.

Efforts to lessen this inequality have included district programs to improve public school lunch. The school community, large and accessible, offers an ideal opportunity to provide fresh healthy food to this population. Almost 36 percent of



Seattle Public School children are currently enrolled in the free or reduced price lunch plan, making school breakfast and lunch the primary source of their daily nutrition (OSPI 2016) (fig. 19). Generating excitement, awareness, and interest in good eating would instill healthy habits in these children that would extend far past their school years.

To retrofit an existing school building and its systems for high-yield food production could prove prohibitively expensive. However, Seattle Public Schools (SPS) is currently seeking a downtown location to construct a new school that would address student capacity issues in the area. This thesis suggests that the new campus, designed as a magnet high school for urban agriculture, could

fig. 17 Pike Place Market

fig. 18 Fresh local produce at Pike Place Market



fig. 19 The state of Seattle children

support children in the downtown attendance area along with low-income children throughout the district that have an interest the program. This alternative high school would be a pilot project: a new school prototype that incorporates a high-volume growing facility into the building design to provide the produce needs of the cafeteria, as well as an educational platform for nutrition, ecology, and horticulture as an integral part of public education. Depending on yields, this new high school could supply food to additional schools in the district, or simply act as a catalyst for local food sourcing and on-site growing at other schools in the area. It would be both a production and an educational facility with an iconic form whose image promotes a new paradigm for health and sustainability in schools.

The thesis will begin by researching the present state of Seattle Public School's food service to determine children's behavior within the existing school lunch program and the food miles associated with the current food service. It will investigate the educational opportunities inherent in growing food on campus and the sustainability opportunities in the building design. By examining case studies across the nation, it will explore the strategies necessary to make this type of project successful. Based on these findings, a specific downtown site suitable for a design investigation will be determined. Finally, the thesis will consider the program needs and site characteristics, and incorporate BIA into the design of a new urban agriculture school model to be tested on the proposed site.

The State of Seattle Public School (SPS) Lunch

The Food and the Children

Despite living in one of America's greenest cities, the health statistics of Seattle's public school children are only marginally better than the national averages (fig. 20). The Healthy Youth Survey (HYS), a state-funded health survey taken every two years in grades 6, 8, 10, and 12 in Seattle Public Schools, shows both good and bad news. The good news is that the number of high school teens that reported being overweight or obese has declined 4 percent since 2010, but the overall percentage is still an unacceptable 17 percent (Seattle Public Schools HYS 2014). This is particularly disconcerting because obese children are likely to be obese as adults, putting them at higher risk for health issues including cardiovascular disease, diabetes, bone and joint problems, stroke, cancer, and osteoarthritis (CDC 2015). The HYS shows that the number of SPS high school students diagnosed with diabetes has remained somewhat steady over the last four years at about 3 percent. The survey also reported a decline of 5 to 6 percent in fruit and vegetable consumption at all grade levels since 2012.

The slight decline in obesity rates could be attributed to strong efforts by the district to improve nutrition, physical education, and health literacy. In 2005, SPS passed its first competitive foods policy, ending a five-year contract with Coca-Cola and removing all other junk food from school menus—cookies

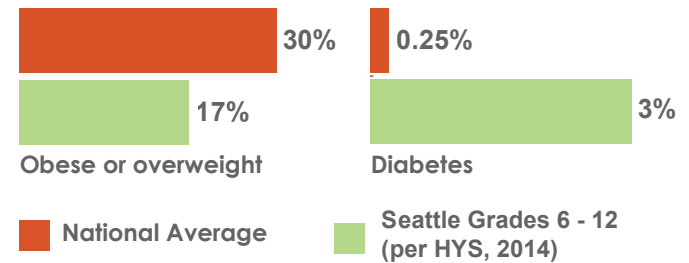


fig. 20 Healthy Youth Survey statistics for Seattle Public Schools

fig. 21 SPS competitive foods policy removed all junk foods and many vending machines, 2005

Food Rangers Marketing Campaign



	Total Enrollment	F/R %	Average Daily Participation	% of students participating in school lunch
Garfield HS	1645	37.6%	30 minutes	21.4%
Ingraham HS	1097	33.4%	50 minutes	18.1%
N. Hale HS	1146	30.0%	50 minutes	22.0%

Date source: Seattle Public Schools, 2013

fig. 22 Posters from SPS lunch reform programs

fig. 23 Seattle Public Schools lunch participation, 2014

and chips were replaced with carrot sticks and fig bars, and beverage dispensers were changed to offer only water or low sugar drinks (Blanchard 2005). Within the confines of budget and federal standards, SPS has made the best choices possible with regard to what it serves and how it supplies food service.

Interviews with SPS employees in Nutrition Services shed additional light on the current state of SPS school lunch. Teresa Fields, Program Lead for SPS Nutritional Services, provided details on the workings of lunch operations at a district level. According to Fields, SPS was serving whole wheat bread and offering fresh fruits and vegetables years before the federal government enacted the Healthy, Hunger-Free Kids Act of 2010, which raised nutrition standards at all federally supported school meal programs. She says that SPS has removed most vending machines and those that still exist must abide by the “Smart Snack” rules imposed by federal guidelines (fig. 21). The district has embraced continual improvement and been open to new ideas. Fields says that one elementary school in the district grew lettuce in their school garden and Nutrition Services allowed them to serve salad from the garden in the food service line. Programs such as the “Harvest of the Month” and “Food Rangers” also show earnest attempts to educate and excite children about healthy eating (fig. 22).

However, despite efforts to improve the SPS lunch program, health statistics continue to be troubling and participation remains low, especially in the paid lunch program as compared to that in free or reduced-price lunch (fig.

23). Debra Denby, head of the Garfield High School lunchroom staff for the last eleven years, says that on average, a mere 4 percent of Garfield's population purchases a full-price lunch on a typical day, and only 35 percent participate in the free or reduced-price lunch. She says that overall participation has declined in the last five years: before the changes in nutrition regulations, she served about 475 lunches and 250 breakfasts per day and today those numbers have fallen to about 250 lunches and 100 breakfasts. So why does paid lunch participation remain low and why are burgers, fries, and pizza still on the menu every day? Denby attributes much of the attrition to nutritional “upgrades” that include changes from all white to 60 percent whole-wheat flour, eliminating all fried items, and drastically reducing salt (which eliminated condiments like pickles and hot sauce). At Garfield, the busiest cafeteria days are when the menu includes nachos, barbecue chicken, spicy buffalo wings, or spaghetti—foods with the most flavor. Pizza and burgers are still offered every day (<http://seattleschools.nutrislice.com/>), creating a daily meal plan that is divided into 1/3 burger/fries, 1/3 pizza, and 1/3 other entree. Students can have baked fries with their burger because, despite their low nutritional content, fries are considered a vegetable. They are not allowed to have fries with pizza because the pizza sauce counts as the vegetable in that choice. Denby and the other lunchroom staff are charged with policing these regulations, such as telling students they cannot take an apple if they already have a juice, as the juice counts for their produce item. The



fig. 24 When juice counts as a fruit item, apples remain after lunchtime at Garfield High School cafeteria, May 2016.



fig. 25 Waste is still an issue despite improvements in the lunch program.

students have no voice in these rules, no knowledge of where the food comes from, and as they proceed through the Garfield lunch line, most of them reach for a chilled juice instead of an apple or pear from the bin (fig. 24).

Denby worked at Roosevelt High School when the school district meal prep was decentralized and says that students, teachers, and even contractors on site would pack into the lunchroom on soup and chicken tetrazzini days. She believes that part of the reason that the district changed to centralized meal preparation was to eliminate discrepancies in lunch quality between schools. Centralizing allowed for consistency, but overall, lunch programs became less desirable as home-style preparation and menu creativity was lost. Denby works very hard to make an appealing lunch within the current system, but would love to see the participation numbers increase. She says that because Garfield is an open campus, it is tough for her lunchroom to compete when teens can walk to the minimart across the street and buy two hot links on white bread at the same cost or less than her healthier food.

Like the challenges in the Let's Move campaign, the SPS problem is multidimensional. SPS lunch reform has made nutritional improvements to the food often at the sacrifice of flavor, so the food still lacks the necessary quality to attract children that can afford other alternatives. Additionally, teens who participate in the program, often low-income children that need the free or reduced price lunch, have more interest in familiar fast-food items than the

healthier fresh foods on the menu. Because these children have no connection to this food, their behavior remains much the same (fig. 25). The SPS Wellness Task Force, a group charged with continual improvement to nutrition, physical education, and health literacy procedures, provided an interesting observation in a 2014-15 report: “Student engagement is KEY with any changes to food in schools. Kids are the consumers of this food and allowing them to be part of the process—activities such as taste tests, developing recipes, and developing marketing campaigns—is critical to the success of a policy.” (Kramer 2015). Immersion in an urban agricultural school curriculum, centered on growing its produce on site, could not only supply tastier fresh food, but it would provide this critical tie between children and their food source, giving them an active voice and a vested interest in the food they eat.

The Journey from Farm to School: SPS Food Miles

Currently, Seattle Public School feeds over 20,000 students per day and serves meals in 110 sites, including 95 schools—roughly 17,250 lunches and 6,400 breakfasts, with 39 percent of the students on the free or reduce price meal program within a surprisingly low budget. SPS spends about \$1.25 per student per meal, less than half the cost of a Starbucks latte, and it tries to keep the entrée portion under \$0.50. SPS Nutritional Services, based at the John Stanford Center south of downtown (SODO), does all of the ordering and a registered dietitian



*fig. 26 SPS John Stanford Center in SODO
fig. 27 Duck Delivery Produce Warehouse in
Portland, Oregon*

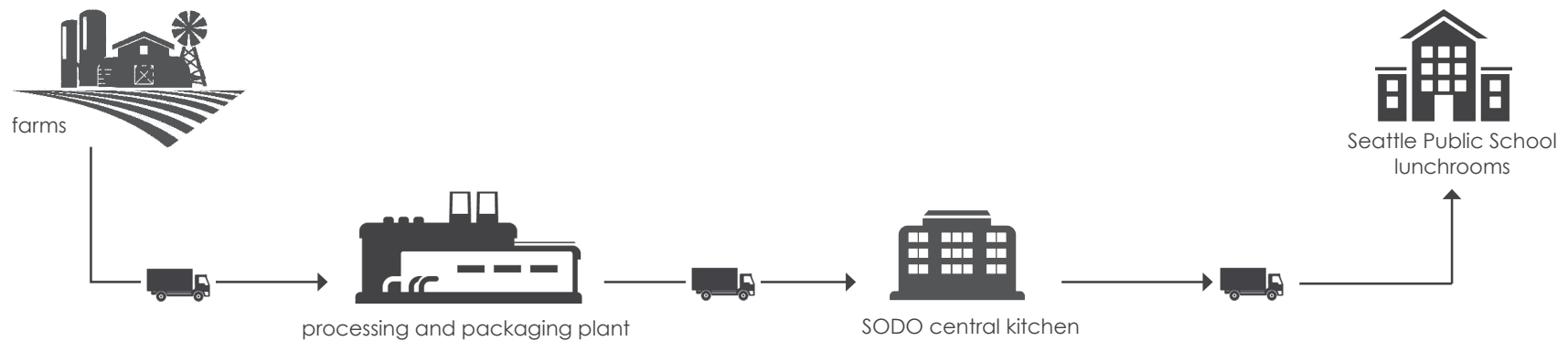


fig. 28 Current system of food supply in Seattle Public Schools

creates the menus (fig. 26). Teresa Fields says that SPS tries to be creative, but is often limited by the available commodities. SPS tries to purchase locally, and of Nutrition Services' four vendors—Duck Delivery (produce), Dairy Fresh Farm (dairy), Goody Man (bread), and Food Services of America (commodities)—the first three are based within the Pacific Northwest. Referring to these vendors as “local” can be somewhat misleading—these four companies are distributors, meaning they receive their product lines from various original vendors that are not necessarily located in the Pacific Northwest. Duck Delivery, based in Portland, Oregon, sources most of its produce from the Pacific Northwest, but food can travel from as far as Idaho (fig. 27). For example, lettuce might be grown in Washington; however, if it needs to be processed and packaged, it is transported to Duck in Oregon before its journey back to Seattle Public Schools.

Paul Gaskill, head of sales at Duck Delivery, says that very few schools purchase real leaf lettuce now. For ease of preparation and shipping, most use pre-cut five-pound bags of shredded lettuce. At the district's central kitchen at the John Stanford Center in SODO, the delivered items are transferred to refrigerators, referred to as "keepers," until the food is prepared. Once the meals are made, refrigerated trucks drive the meals to each school, along with ready-to-eat produce such as apples or pears. Some items, such as milk, bread, and whole produce are delivered directly to the high schools from the vendors. Thus, estimating the actual food miles can get quite complicated; however, a general map of the food journey is illustrated in figure 28.

Fields says that years ago SPS tried a direct farm-to-school supply, with thoughts such as "leaving the tops on the carrots so that children had more connection to how the food was grown." However, because the district is so large, local farms could not guarantee enough consistent volume. So for now, Duck Delivery handles the logistics and still provides somewhat local sourcing, as they make an effort to obtain Washington Grown produce when possible. Fields added, however, "a lot of things have changed since the earlier farm-to-school attempt and it might be worthwhile to try again."

Fields says that less than ten years ago, all SPS schools ran their own production kitchens before the district decided to centralize the cooking in SODO. These full kitchens, although no longer used for food production, still exist



fig. 29 Assembly line school food preparation in a centralized school lunch production facility in Boston's public schools

fig. 30 Fresh food prepared at a Boston school with a full-service on-site kitchen, like those in SPS schools

at each school. This is an enormous advantage within the concept of this thesis. Many schools across the country have kitchens with insufficient storage or refrigeration space, outdated plumbing, or in some cases, lacking basic cooking equipment like knives and cutting boards (Siegel 2016). These facilities are only suited for opening cans and reheating frozen foods (fig. 29). The capability at existing SPS schools to process fruits and vegetables that are grown on site or supplied to them from another school in the district could support a new SPS school lunch model that reduces these food miles and provides a better connection between the children and their food (fig. 30). According to Fields, SPS is currently considering a return to decentralized cooking, not as a cost savings, but to increase participation in meal programs. "Kids see and smell the food cooking during the day and become excited for lunch. It would help entice more of the children into food service," says Fields. And participation in the lunch program is key—more children in the lunch program equals more federal reimbursement, creating a system where good lunches get better, or conversely, bad lunches get worse, as funding fluctuates with the number of children that participate daily. Furthermore, combining tasty food with student buy-in minimizes food waste, with less food uneaten and more food consumed.

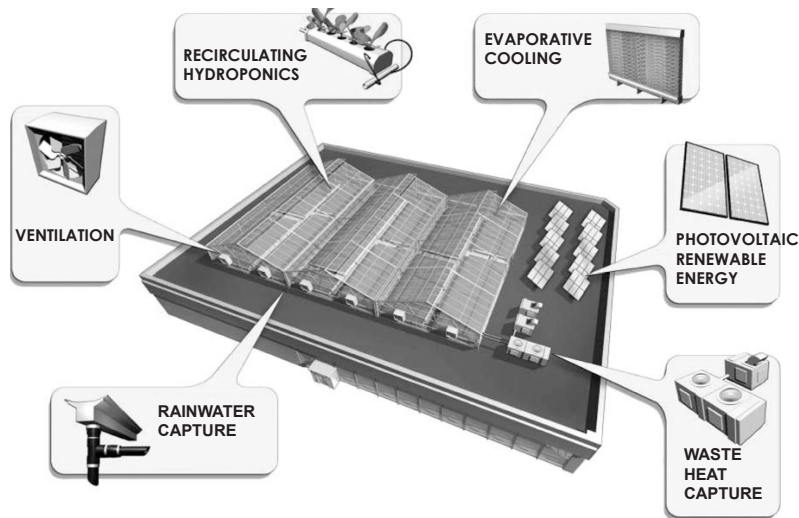
CHAPTER 2:

A Symbiotic Solution

"I believe that every child in this world needs to have a relationship with the land...to know how to nourish themselves...and to know how to connect with the community around them." —Alice Waters (BYUtv 2011)

Integrating Agriculture into the Building and the Curriculum

If the goals are to improve the quality of school lunch, to reduce food miles, and to motivate children to eat healthily by connecting them to their food source, a case could be made to simply hire a Seattle celebrity chef for meal planning, contract with local farmers for supply, and install school gardens for educational purposes. This thesis argues that by weaving the growing process into both the physical space of the school and into the curriculum, educational and ecological benefits can be achieved that would not occur if the food were grown off-site.



Building-integrated agriculture (BIA) takes this idea a step further, bringing agriculture into the school building, both literally and educationally, and maximizing the yield for the food service.

Building-integrated Agriculture (BIA)

Dr. Ted Caplow, a pioneer in the field of building-integrated agriculture, defines BIA as “a new approach to food production based on the idea of locating high-performance hydroponic farming systems on and in buildings, using renewable, local sources of energy and water.” (Gould & Caplow 2012) (fig. 31). Hydroponic farming is a system of growing plants in a nutrient-rich water solution, instead of soil, to deliver all necessary minerals to the roots. The most efficient hydroponic systems recirculate the nutrient solution and add more water and nutrients only when necessary. The advantages of hydroponics are numerous. Because hydroponics uses water rather than soil, most systems require less space than soil-based farming and reduce the structural loads to the building. Recirculating hydroponic systems also use substantially less water than conventional agriculture, and controlling the quality of the water eliminates the need for pesticides, avoiding the agriculture run-off of conventional farming (fig. 32). A 2015 study by the School of Sustainable Engineering



fig. 31 BIA rooftop farming system

fig. 32 Conventionally grown versus hydroponically grown lettuce

and the Built Environment at Arizona State University reported that the average difference in water consumption between hydroponic and conventional production of a head of lettuce was 10 to 15 times less (Barbosa et al. 2015).

The Millionaire Club Charity (MCC), a local organization that provides jobs and support services to homeless or unemployed individuals in Seattle, grows produce for its food service using hydroponics in the basement of its downtown location. In a relatively small raft system under the pink glow of LED lights, MCC has successfully grown several varieties of lettuce, bell peppers, bok choy, basil, and kale for use in the 300 meals per day it serves to its members (fig. 33). This allows MCC to grow vegetables cost effectively year-round to supplement its food donations that often lack fresh, leafy greens. Brent Herrmann, Director of Programs, and one assistant operate the three 900-gallon tanks, where they harvest roughly 90 heads of lettuce per week (fig. 34.) The system is fairly straightforward, but Herrmann says that it took about a year, and several mistakes, to streamline the process. Successful growing is dependent on water temperature, air temperature, nutrient mix, ventilation, light, humidity, pH, and knowing the specific requirements of each crop variety. For its efforts, MCC has a reliable fresh vegetable source in its basement, spends about half of store prices per head of lettuce, and provides the members of MCC with fresher, healthier food. One of the most valuable contributions of the system, however, has been an intangible benefit: Herrmann gives tours of the facility to local businessmen,



fig. 33 Hydroponics at the Millionaire Club Charity, downtown Seattle, 2016

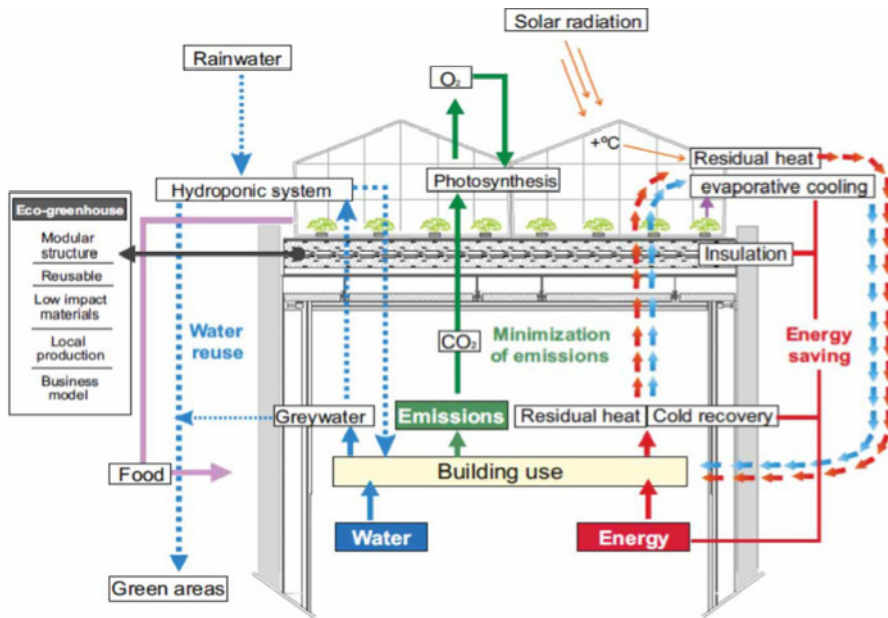


fig. 34 Hydroponic greenleaf lettuce at MCC

fig. 35 BIA diagram: Water, energy, and waste-stream efficiencies can occur when people and plants share the same building.

teachers, and students each month, attracting additional sources of funding to the organization.

The lack of availability and increasing cost of land in downtown Seattle suggests that with the best method for growing the bulk of the produce on site for school food service would be a BIA system, rather than soil-based farming. Hydroponic rooftop greenhouses would conserve indoor building space for school programming, allow optimal sun exposure, and accommodate year-round high-volume production. And as seen at MCC, hydroponic growing can also be a tool for attracting positive community relations, and therefore funding, to a cause like public school education.

Optimizing Water, Energy, and Waste Systems

MCC should be commended as one of the first and few examples of commercial hydroponics in Seattle, choosing to retrofit its 100-year old building with the system. However, if BIA can be incorporated into the original building design, substantial advantages in water management, energy use reduction, and waste mitigation can be gained (fig. 35). Considered separately, agriculture

and buildings each have enormous ecological impacts, so by integrating them, their aggregated impacts can be reduced and their parallel potential realized (Gould & Caplow 2012). In other words, there are several symbiotic relationships between humans and plants that can occur when they share the same building.

Rainwater harvesting, increased permeable surface area, and use of filtered gray irrigation for urban agriculture can greatly reduce the amount of water that the building requires from the city. This also reduces the amount of wastewater from the building that would normally contribute to pollutant runoff or combined sewer overflow (CSO). A Brooklyn watershed study estimated that covering 100 percent of suitable buildings in the area with green roofs would result in a 26 percent reduction in CSO volume (Ackerman 2012).

With regard to energy, BIA can reduce building energy consumption in three ways: alleviating the urban heat island contribution to global warming using green roofs, decreasing building energy use through rooftop agriculture, and reducing the amount of fossil fuels needed for food transport and storage (Ackerman 2012). Soil-based green roof gardens add significant thermal mass to a roof surface, thereby reducing heat loss and the amount of active heating and cooling needed inside the building. Similarly, rooftop greenhouses also provide an insulating layer to the building, and can further reduce fossil fuel consumption by making use of the waste heat and CO₂ from building HVAC systems. This waste heat is often difficult and expensive to recapture for building use, but it is

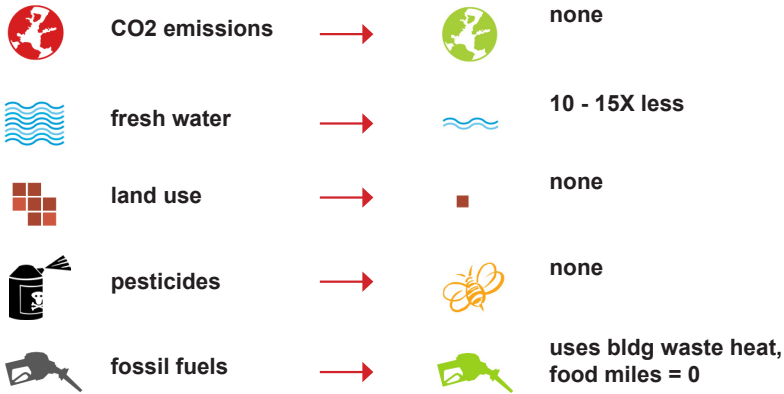


fig. 36 Resource and environmental impacts of a conventionally-grown versus a BIA-grown tomato

much easier to use as a source of heat and CO₂ for plants (Gould & Caplow 2012).

And lastly, BIA can reduce waste streams by making productive use of the large amounts of organic waste generated by building residents, not only through simple aerobic composting, but also with high-efficiency anaerobic digesters that capture the methane gas by-product of decomposition and use it as renewable energy. Even further efficiencies in water and waste streams can be captured if the use of filtered and treated wastewater from toilets, known as “blackwater,” is considered for plant irrigation and nutrition.

BIA has the potential to greatly reduce or reuse waste on all of these levels, which translates to savings in operational costs throughout the life of the building (fig. 36). With reduced water use, water run-off, waste streams, and energy demand, the building would be less of a burden on city infrastructure, a valuable benefit to Seattle municipalities as the demand on current systems continues to grow. The initial capital investment in a BIA-designed building could potentially be offset by water, energy, and waste credits, and the resulting lower operating costs could support the training and salaries of extra staff needed to “run the farm” at the school.

Urban Agriculture as an Integrated Curriculum

The greatest benefit of a public Urban Farm High School would be realized in the classroom. Beyond the tangible rewards of providing fresh and tasty food that children, teachers, and administrators want to eat, an urban agriculture high school has the potential for a rich, integrated curriculum (fig. 37, 38). Urban farming and its associated building systems would provide natural opportunities for project-based learning.

Project-based learning is an experiential, hands-on, student-directed pedagogy that fosters a deep knowledge of subjects because students have an active part in the process—"learning by doing." In contrast to textbook-based rote memorization, project-based learning requires inquiry, real-life investigation, and problem solving; the Edible Schoolyard is a successful example of project-based learning in practice. Early evidence of this concept can be seen in John Dewey's notion of the school as a 'social laboratory' in 1897, and as far back as the 4th century B.C.E. when Aristotle stated, "...using the language of knowledge is no proof that they possess it" (Calico et al. 2014). Indeed, current research indicates that children learn best when multiple teaching strategies are applied in the classroom. A 2014 study of 630 high school students points out that because today's youth are "digital natives," engaging them with technology that they are already inclined to use is also important. The study states:



fig. 37 Urban agriculture, project-based curriculum at Denver Green School

fig. 38 Urban agriculture, project-based curriculum in New York's public school system



Many researchers argue that education comes from experience; however, not all experiences are educative. Kolb (1984) proposed a theory of experiential learning that involved four principal stages: concrete experiences, reflective observation, abstract conceptualization, and active experimentation. These teaching methods allow students to reach application, analysis, synthesis, and evaluation, which are higher tiers in Bloom's Taxonomy of Learning (Calico et al. 2014).

Using these theories, the Urban Farm High School curriculum would incorporate experiential, project-based learning in a variety of ways. A highly effective health literacy education might



combine classes where students harvest seasonal food to prepare in a classroom kitchen with courses that teach issues such as food science, food security, and nutrition. The curriculum might include a horticulture and sustainability program, where students work in soil gardens and greenhouses then join classroom dialogue about environmental issues such as urban water management, food miles, sustainable farming methods, and global warming. The technology and science program could incorporate student operation of hydroponic greenhouses or measuring the heat generated in compost piles to learn science, biology, and chemistry lessons. The program could teach vocational skills such as farming and horticulture, and leadership and business skills could be fostered various student-managed programs such as bees (honey), chickens (eggs), mushrooms, vermiculture (worms), compost generation, and aquaponics (fish) (fig. 39).

Similar to the staff of SPS's John Stanford International School, who are trained in a language immersion curriculum, educators at the Urban Farm High School would be trained to teach through the lens of urban agriculture. Yet, "managing the farm" would be a shared responsibility of the entire school and provide students with the opportunity to connect with members of the surrounding community. Inherently, BIA would bring students close to the source of their food, and the corresponding curriculum would invest them in their own well-being and motivate them to be better earth citizens.



fig. 39 Students would have responsibility for managing school programs such as green markets, compost, and bees



Manuela Zamora,
Executive Director of
Education Programs, NYSW
photo credit: NYSW

"It is critical that kids are directly involved and see the connection between the growing and the food and the lunchroom, otherwise, they don't eat it and you are just creating more waste."

Manuela Zamora is the Executive Director of Education Programs at the nonprofit organization NY Sunworks (NYSW) in New York City. She was a co-founder of the Greenhouse Project in New York City, a NYSW program dedicated to improving K through 12th grade environmental science education in urban schools through a hands-on curriculum and professional development (NY Sun Works 2016). The program has built 36 school greenhouses across New York and New Jersey that accommodate a hydroponic urban farm and an environmental science lab, with a goal of "100 Labs by 2020.". In a phone interview, Zamora spoke to the success of the program. The Greenhouse Project has been very successful, but when asked about the connection between the greenhouses and the lunch program, Zamora explained that simply offering the site-grown vegetables in the lunch program was not a success—children did not eat the food and it often went to waste. Confirming the shortfalls seen in *Let's Move!*, Zamora stressed that the farm-to-lunchroom process must be clearly visible and children need to have a hand in the process in order for healthy behavioral change to occur.

Precedents for an Urban Agriculture High School

Partnerships

At the current time, the program proposed by this thesis—incorporating high-volume, hydroponic food production into a public school facility to supply the food service—does not exist. However, there are several organizations that have made notable improvements to school lunches using other types of innovation and partnerships.

In 2013, the San Francisco Unified School District (SFUSD) worked with the consulting firm IDEO to redesign its school food service system. Data collected from students, teachers, administrators, and parents determined that there were additional dimensions to the school lunch problem: crowded and unpleasant lunchrooms, large amounts of wasted food, prevalence of processed foods in vending machines, lack of international/cultural appeal, and ultimately, lunch food that was neither nutritious nor tasty (Wai 61). The study also found that feeding healthy, fresh, tasty food to children activates brain activity, improves socializing over food, makes them feel valued, and encourages them to eat more healthily outside of school, as well. The report concluded that the more students know about the food being served, the more likely they are to participate in school meals (Wai 162). Because of the findings, SFUSD instituted improvements to the physical space and operation of its cafeterias and now



fig. 40 *The New Lunchroom in the San Francisco Unified School District*



fig. 41 Growing Power's Will Allen

contracts with Revolution Foods to provide fresh, hand-prepared, more locally sourced food to the school lunch program (fig. 40).

The nonprofit organization Growing Power in Milwaukee, Wisconsin, uses innovative locavore thinking to provide high volumes of locally grown, high quality produce for public school lunches. Icon in the field of urban agriculture Will Allen founded the operation in 1993 with a clear purpose: to provide access to healthy, high-quality, safe, and affordable food for people in all communities and to offer hands-on training so that they can learn to create sustainable food systems (Growing Power 2014). Located in a low-income neighborhood of Milwaukee, the organization is strongly connected to the community and grows over a million pounds of food per year in greenhouses and farms in Wisconsin and Illinois (fig. 41). Its stated mission is: "To grow food, to grow minds, and to grow community." (Growing Power 2014). Educational outreach is a core mission. To this extent, Growing Power has worked to increase access to healthy, locally grown food for public school children. In 2014, Growing Power completed the largest farm-to-school procurement, sending 36,000 pounds of carrots to feed about 400,000 Chicago Public Schools students. Allen was able to achieve this using an unexpected, but creative partnership with Sysco, a U.S.-based North American multinational food distribution corporation. In 2011, Sysco donated 34 acres of land in Eastern Wisconsin to Growing Power for the purpose of growing food for schools. Using its two-acre flagship farm in urban

Milwaukee and the land from Sysco, Growing Power has been able to supply school districts in Chicago and Wisconsin with fresh local produce such as carrots, cherry tomatoes, peppers, zucchini, and yellow squash (Karst 2011). This alliance brought Sysco, a powerful industrial agriculture player, into the local, sustainable food revolution and at the same time, provided an entry point for a small local grower (fig. 41). The program does not stop at simply supplying the food. Since vitamin-packed kale is a vegetable easily grown year round, Allen wanted to supply a kale salad to Milwaukee Public Schools. However, taste tests revealed that children do not like pure kale. So Allen developed a kid-approved kale salad that included spinach, chard, pea and sunflower shoots, and beets and delivered it to the public school lunch program throughout the winter (Byczynski 2013).

Both of these precedents illustrate that successful lunch reform requires careful consideration of all aspects of the program and working closely with the children—growing, harvesting, and developing the menu—to foster buy-in and success. Natural light, fresh air, and proximity to growing spaces must all be considered to ensure pleasant spaces that reinforce positive student attitudes toward mealtimes and eating.

These successes also show that taking advantage of creative partnerships can bring the outside support needed to make a large project, like the school proposed in this thesis, feasible. Strategically locating near businesses and



fig. 42,43 Growing Power's partnership with Sysco



fig. 44 The Greenhouse at Henry Ford West Bloomfield Hospital
fig. 45 NFT tables in The Greenhouse

community could provide the visibility and access for educational outreach programs, financial support, community volunteers and a neighborhood population to participate in programs such as green markets and community supported agriculture (CSA) boxes.

To explore high-volume growing, this thesis will examine two groundbreaking projects that use growing in new visions for industrial food service and community health and education. The first precedent focuses on nutritional health and the second on ecological health. The Greenhouse at Henry Ford West Bloomfield Hospital outside of Detroit, Michigan, is a working example of a hydroponic greenhouse growing the food for institutional food service and The Vertical Farm project for Growing Power in Milwaukee, Wisconsin, is a speculative commercial building sustainably designed with high-tech, high-yield BIA incorporated with other building programming. These precedents showcase optimum agricultural systems, but also address the community health and culture issues that would be relevant to a public school food service application.

Institutional Precedent: West Bloomfield Hospital

In the United States, there are very few examples of institutions that have made the investment to grow food on site for their food service. The assumption is that to do so would be cost and space prohibitive. However, The Greenhouse at Henry Ford West Bloomfield Hospital outside of Detroit, Michigan, demonstrates

the ability of a 1,500-square-foot hydroponic greenhouse to grow the produce necessary to supply institutional food service (fig. 44). In September of 2012, the organization opened the first hospital-based, hydroponic, CFFO-certified organic greenhouse in the country. Simply named “The Greenhouse,” it grows nutritious food for patient meals, for the hospital café, and to sell at the hospital’s weekly on-site farmers’ market (fig. 46). The hospital recognized that 80 percent of chronic disease, including cardiovascular disease, diabetes, and cancer, can be prevented, or symptoms alleviated, through better diet and exercise (Greene 2012). The hospital’s vision was to be a national model for wellness education and reduce health care costs by providing people with resources to help them maintain optimal health (Henry Ford Health System 2016). Addressing Michigan’s high childhood obesity rate, the project includes an attached 1,500-square-foot education center with innovative programs geared toward children and the community. Educating and inspiring both patients and the public to make healthier food choices is in keeping with the hospital’s mission of promoting wellness as well as treating illness (Rector 2012).

The hospital aims to push the boundaries of typical hospital design by addressing sights, sounds, smells, and tastes, and breaking the negative paradigms of the hospital experience. The seasonal farmers’



fig. 46 “Henry’s Market on Main” at West Bloomfield Hospital



fig. 47 The resident farmer tends to the lettuce and tomatoes in The Greenhouse

fig. 48 Patient yoga classes at West Bloomfield Hospital

market, "Henry's Market on Main," is held weekly inside the hospital and is open to patients, guests, employees, and the community (fig. 46). Other programs include a resident farmer who oversees The Greenhouse and coordinates the educational programs, field trips, tours, and classes (fig. 47). Children's classes are offered on subjects such as understanding food labels, making healthy choices, pest control, and cooking. Patient workshops include international cooking in the demonstration kitchen, yoga, gardening as occupational and behavioral therapy, and fighting childhood disease through diet (fig. 48).

The Greenhouse uses a 12-by-20 foot (240 square feet) hydroponic nutrient film technique table to grow lettuce and specialty greens. Staff estimates the production to be 15,000 heads of lettuce per year with NFT hydroponics, reseeded weekly. Other produce is grown in three 26-foot rows of Dutch buckets, including 20 varieties of heirloom tomatoes, for an estimated production of 1000 pounds of organic produce per year (Henry Ford Health System 2016) (fig. 49). In addition to the lettuce and tomatoes, the relatively small space grows microgreens, five types of kale, hot and sweet peppers, eggplant, squash, cucumber, peas, beans, okra, edible nasturtiums, strawberries, Swiss chard, Chinese cabbage, specialty greens, and

various herbs. The café chefs work closely with the resident farmer so that they know what is being grown and when it will be harvested (fig. 50). The chefs can also request other varieties of fruits and vegetables to be grown. The system provides fresh greens from “farm” to plate in less than 24 hours. The greenhouse construction includes a glass roof for an overall project cost of about \$1 million, funded by an anonymous donor. The hospital estimates that on-site production will save more the \$20,000 each year (Greene 2016). The project has already inspired other hospitals, like Watertown Regional Medical Center in southeastern Wisconsin, to invest in gardens for growing food, providing therapy, and educating patients and the community about making healthier food choices. The Greenhouse does more than just provide healthy produce to its patients and the community. The Greenhouse has been a catalyst for holistic shifts in operation at the hospital. Similar systemic changes could be realized by incorporating urban agriculture production into an educational facility.

BIA Precedent: Growing Power Vertical Farm

In addition to championing food security for all socio-economic levels, Will Allen and his organization, Growing Power, are known for intensive cultivation techniques and sustainable practices both inside and outside the greenhouses (fig 51). In heated greenhouses, they raise fish and vegetables in an aquaponic system, a form of hydroponics that circulates wastewater from farmed fish to



*fig. 49 Tomatoes growing in the Dutch bucket system at West Bloomfield Hospital
fig. 50 West Bloomfield chef with a salad prepared from vegetables grown in The Greenhouse*

provide a nutrient-rich solution for irrigating plants. In turn, the plants use the nutrients and purify the water that then recirculates to the fish. Outside the greenhouses, the farm includes laying hens and ducks, goats, rabbits, turkeys, and beehives. Much of Growing Power's production is in low-cost, unheated hoop houses that grow greens all winter without the use of any fossil fuels. Compost piles are heaped on the outside of the hoop houses to provide heat. In addition to utilizing compost as renewable energy, the site also uses a 10.8-kW photovoltaic electric system to produce energy for the farm's indoor spaces and a solar water heating system. In the outdoor compost system, the facility composts 44 million pounds of organic waste per year, consisting of manure from their livestock, food and farm waste, and coffee grounds and spent grain from local coffee shops and breweries—waste that would otherwise become landfill. In a closed-loop cycle, Growing Power composts everything the staff and students do not eat or sell and then tills it back into the soil to fertilize more plants. In its current state, Growing Power is a highly successful operation. It has accomplished many of its goals using



fig. 51 Aerial view of Growing Power

modestly low-tech, high-yield, sustainable techniques to create a smartly coordinated web of farm food cycles (fig. 52).

Over the last two decades, however, Growing Power has expanded and Will Allen has been envisioning a new high-tech Vertical Farm to accommodate the need for additional production, classroom, meeting, preparation, warehouse, and growing spaces on the 2-acre site. In 2010, Allen worked with Kubala Washatko Architects to develop the design for a 5-story, state-of-the-art Vertical Farm on the current site. Analogous to the concept of high-yield food production in a public school, the 27,000-square-foot design uses BIA within a larger program that includes classrooms, offices, a staff locker room, a retail store, conference and volunteer spaces, demonstration kitchens, food processing and storage, freezers, and loading docks (fig. 53). Areas for staff and volunteers are purposefully



fig. 52 Existing systems at Growing Power create symbiotic farm food cycles

Building Integrated Urban Agriculture - Growing Power Vertical Farm

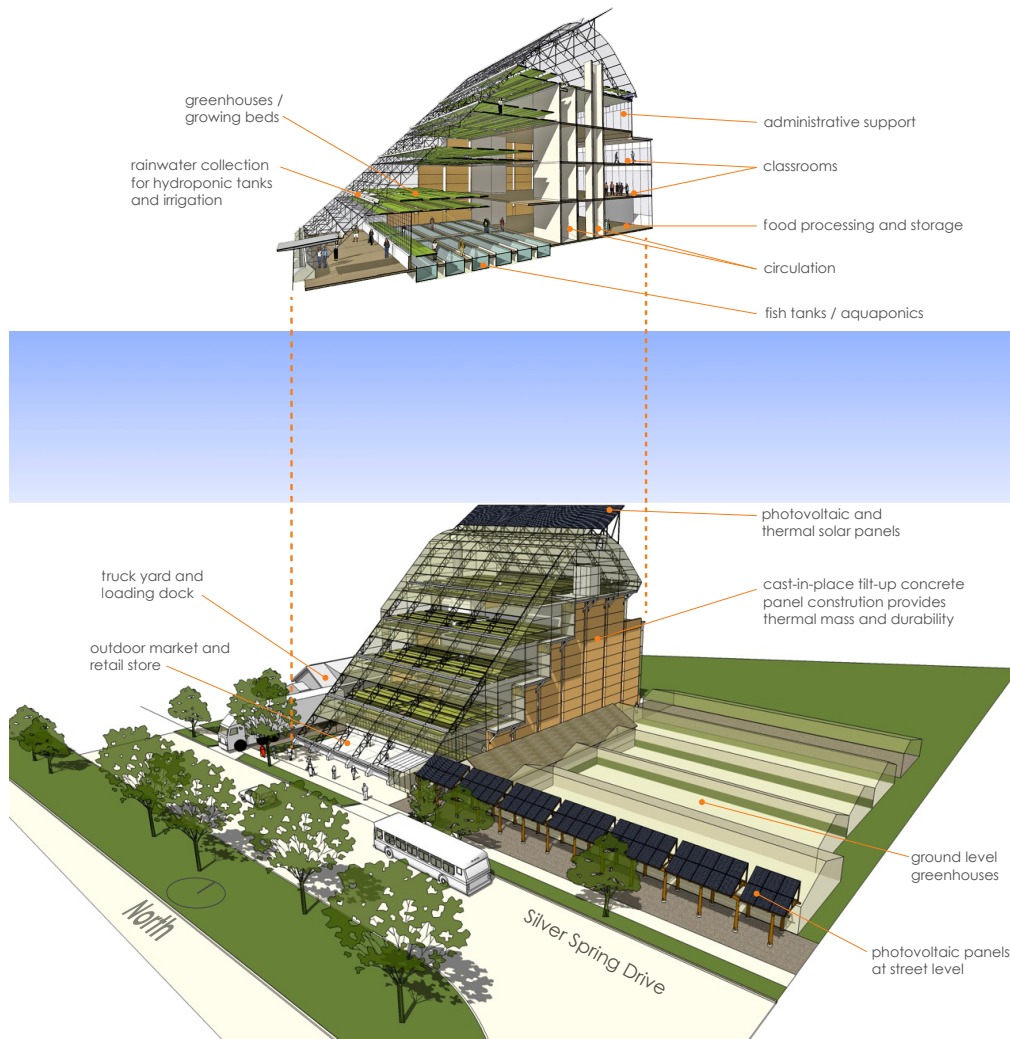


fig. 53 Building-integrated agriculture in Growing Power's proposed Vertical Farm

located near the greenhouse and educational areas to encourage active observation and participation in the growing. The program also includes a year-round indoor retail space and an outdoor market facing Silver Spring Drive that would serve as a gathering place for work, learning, and community social activities. The proposed form is dramatic in shape, with a stepped façade that faces south to the main entrance on Silver Spring Drive.

The Vertical Farm design translates the low-tech concepts of closed-loop, sustainable farm cycles that Growing Power currently practices into a high-tech, sustainable building. The proposed design offers greater efficiencies in space, energy, waste management, and particularly, water use. It utilizes recirculating hydroponics along with rainwater collection and storage to handle the operation's water needs. With regard to energy, the building is positioned on the site to absorb sunlight, with the greenhouses placed on

the southern façade to take advantage of natural lighting and the convective currents of passive solar heating. Geothermal heating would allow for solar heat to be captured by thermal solar panels on the roof, then stored in thermal mass in the ground under the building and used to warm the building in the winter. Lastly, roof-mounted photovoltaic arrays would generate a portion of the building's energy needs.

Along with the potential to produce high quantities of vegetables and fish, the Vertical Farm would serve as a model of sustainability and affordable healthy food production close to consumers (Herzog, 2010). The design was a winner in the 2013 Architizer A+ Architecture and Farming category, but the Vertical Farm is still a speculative project, as the capital campaign continues to raise funds for the \$10 million building. The architectural designs and permitting have been completed and the hope is that it will one day be built. It would be the first building of its kind in the United States, addressing the broader issues of food security and equal access, community outreach, sustainable development, green building design, and high density land use under one sustainable roof.

Summary

If most other sectors of the built environment are being constructed with sustainable, healthy, human-centered design, why should schools be any different? With anticipated growth in global populations and the consequent

food demand, the necessity for buildings to be multi-functional agricultural, energy, waste and water management systems will only increase. Both Growing Power and West Bloomfield Hospital have proven that with intensive farming methods and innovative programs and partnerships, high yields of produce can be achieved with very little space. With hydroponics, this yield increases even further, with fewer natural resources. And with BIA, synergistic energy exchanges occur between building and farm, between humans and plants, with the overall impact to the environment greatly reduced.

Furthermore, the urban agricultural programs at Growing Power and West Bloomfield Hospital have made tremendous intangible contributions to the surrounding communities in addition to the obvious health benefits—job creation, education, community outreach, food security, more sustainable living, and a better, more enjoyable quality of life. It seems only natural that BIA be used to extend these same gains to the place where America's children spend two-thirds of their day and consume a large percentage of their daily nutrition. While nourishing their bodies and minds with healthy, tasty fresh food grown in sustainable facilities, they'll simultaneously learn to be better inhabitants of the earth and paint a much better picture for America's future.

A BIA school could provide the vehicle for this connection. And by growing the food on school site, the processes could be incorporated into an effective, hands-on, project-based curriculum that children enjoy.

CHAPTER 3:


Programming and Methodology

Goals and Objectives

By aligning all aspects of the building and the site—light, space, structure, landscape, and systems—to support the high-volume growth of food and a corresponding curriculum, this design proposal will test the overall thesis goals. These goals and the four primary objectives that will be used to achieve them are summarized in Table 1. Integrating agriculture into the building design (BIA) is central to all four objectives (fig. 54). To further support these objectives, it is critical that the project be located on a site that maximizes both access and visibility.

Goal	Objective
Excite teens about their health and the health of the environment	Create spaces for a hands-on curriculum using educational opportunities inherent in growing process
Create a healthy, delicious, sustainable, well-attended lunch program	Grow 100 percent of the produce on site year-round
Engage local industry and community in the program	Choose a strategic location and a powerful visual identity for the project
Reduce ecological impact of the building	Equip building with sustainable systems to gain energy, water, and waste synergies between people and plants

Table 1

 **HANDS-ON CURRICULUM** THAT
EXCITES TEENS ABOUT THEIR
HEALTH AND THE ENVIRONMENT



 **GROW FOOD** YEAR-ROUND USING
SOIL GARDENS AND HYDROPONICS



 **ENGAGE** SURROUNDING
COMMUNITY IN THE PROGRAM



 **REDUCE** THE ECOLOGICAL IMPACT
OF THE BUILDING



fig. 54 Goals and Objectives

Site Selection and Analysis

Maximizing Access

The first step in determining the best site to address student needs and maximize access was mapping the Seattle public schools that currently serve the high school population. SPS has a total of fourteen high schools—ten Metro 3A division traditional high schools and four smaller high schools known as service or option schools (fig. 55). The service and option schools are smaller, with enrollments of less than 350 that draw students from all over the city. These schools have specialized service programs or an alternative focus to their curriculum, such as technology or the arts. This thesis proposes that the Urban Farm School be an SPS option school with a curriculum based on health, sustainability, and science, but with a larger enrollment of 1000 children.

In a central location with a larger capacity, the school could provide access to two populations: it could offer priority to students who qualify for free and reduced lunch both north and south of the city, in addition to addressing a currently under-served population in Downtown and South Lake Union attendance areas. Historically, Seattle schools were located outside of the city center and closer to residential neighborhoods. Unlike most metropolitan areas its size, the center of Seattle is virtually devoid of public schools (fig. 56). SPS enrollment has been steadily increasing for the last six years and downtown

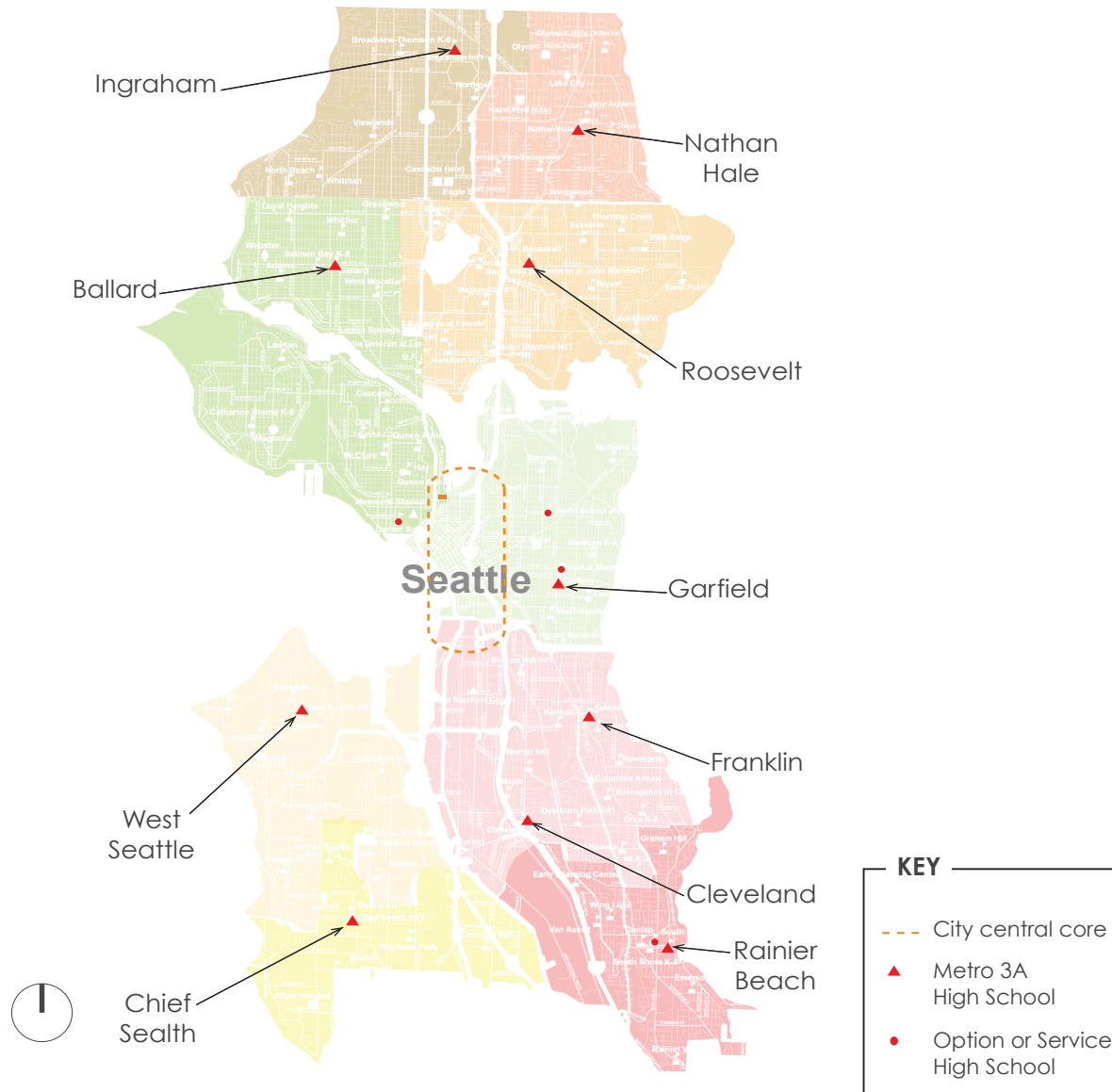


fig. 55 Existing SPS high schools

enrollment growth further exceeded that of the district by almost 20% in 2013 (fig. 58). SPS projections also show that the overall district enrollment will exceed the maximum capacity at its existing high schools by 1,839 children by 2022 (fig. 59). Given the growth of Seattle's student population, there is a clear need for a large, central high school that could ease capacity issues by supporting free and reduced lunch children throughout the district with an interest in the program. Additionally, it could serve the central attendance area, enriching downtown diversity by retaining families in the core of the city.

The site analysis also considered access to current food growing spaces within the city—urban farms, p-patches, and school gardens. There is a significant amount of interest and activity around urban agriculture throughout Seattle, but there is a lack of such activity in the central core (fig. 57). The largest projects, Beacon Hill Food Forest and Rainier Beach Urban Farm, are in south Seattle. Gretchen DeDecker, the point of contact within SPS for enrichment projects such as school gardens and greenhouses, provided insight into current school gardening activity. DeDecker says that about 80 percent of Seattle's public schools currently have school gardens and most have edibles, but many sites are incredibly small. She believes that there is a misconception that because the Rainier Valley area has a large low-income population, it is consequently lacking in school support. She explained that the northeast region of the city also has a large percentage of low-income residents and not nearly as much community

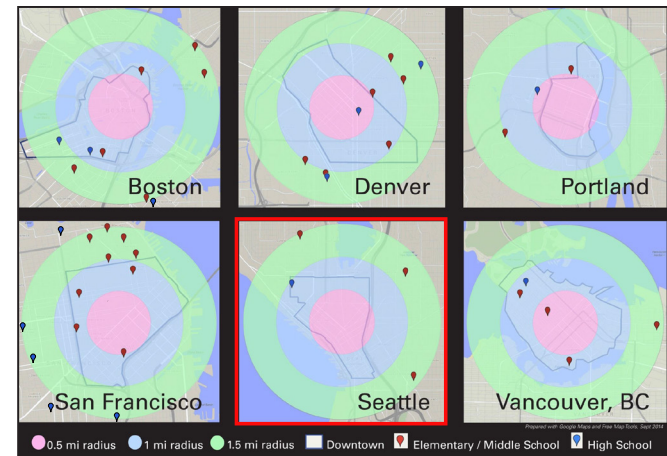


fig. 56 Major cities with downtown schools, photo credit: Bassetti Architects, 2014

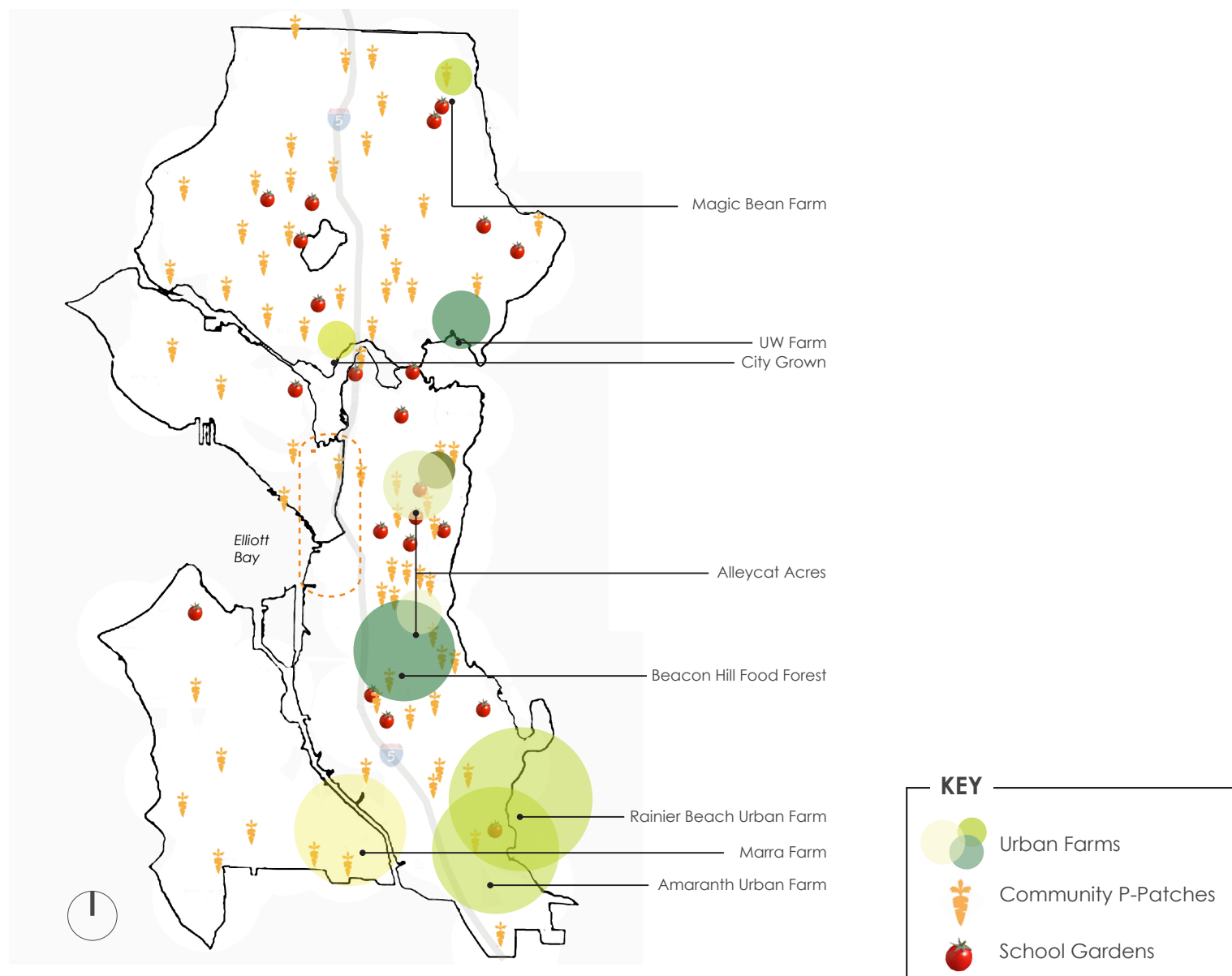
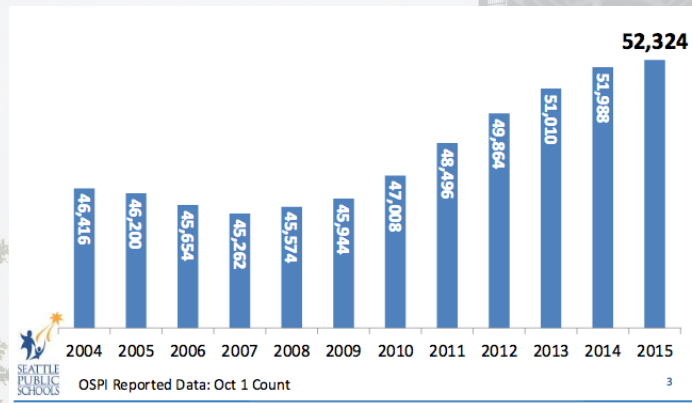


fig. 57 Existing food growing spaces

Seattle Public Schools Enrollment Trend

Data Source: Seattle Public Schools, OSPI



Change in K-12 Enrollment

Downtown SPS Enrollment vs. District-wide Enrollment
Data Source:

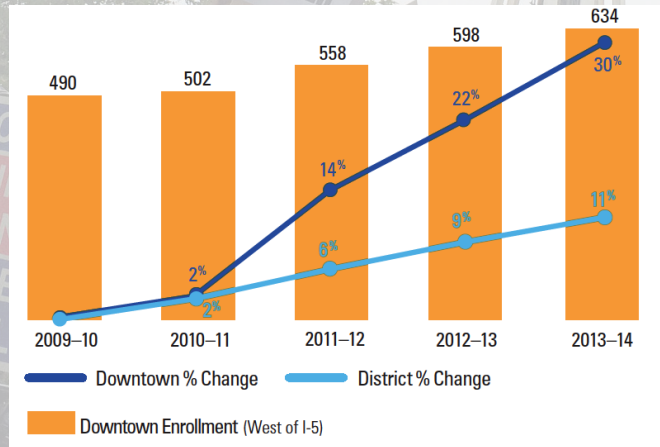


fig. 58

**2022
SPS Enrollment
Projections
Grades 9-12**
(Data Source: Seattle Public Schools)

High School	2022 Enrollment Projections	Capacity	Delta
Ballard	2365	1585	-780
Chief Sealth Int'l	1892	1257	-635
Franklin	2153	1385	-768
Garfield	2386	1593	-793
Ingraham Int'l	2489	1189	-1300
Nathan Hale	1484	1140	-344
Rainier Beach	1536	1150	-386
Roosevelt	2389	1707	-682
West Seattle HS	1195	1215	20
Totals	17,888	12,221	-5667
Center School		276	
Nova		510	
Cleveland		896	
South Lake		286	
World School 9-12		260	
Lincoln		1600	
GRAND TOTALS	17,888	16,049	-1839

→ TARGET CAPACITY FOR NEW SCHOOL = 1500 STUDENTS

fig. 59

involvement in large urban farming projects as the south. A centrally located urban agriculture high school could provide a unifying point of focus to this momentum that is occurring in varying degrees throughout the city.

For several years, SPS has been searching for a possible location for a downtown school. In January 2015, it bid on an existing property in the downtown core, the Federal Reserve Building, to be adaptively reused for a school. Unfortunately, SPS lost the bid to a real estate developer who plans to build a 29-story apartment tower on top of the existing structure. As downtown land values continue to increase, it will be increasingly difficult for SPS to acquire a viable piece of downtown property for a new school; however, a city-owned property could provide an advantageous financial opportunity. With this in mind, a vacant “megablock” in South Lake Union, currently owned by the Seattle Department of Transportation, was chosen as the optimal site on which to test this proposal (fig. 60).

In addition to the economic advantage of being a city-owned property, the site is one of the few locations near downtown that possesses the second aspect of site access that was critical to a program focused on growing plants: solar access. The wide arterials, particularly Mercer Street on the south, allow for excellent sun exposure, even assuming maximum allowable zoning heights on the surrounding lots (fig. 61). In fact, because of the excellent sun exposure, minimizing glare and solar heat gain in classrooms would need to be necessary.

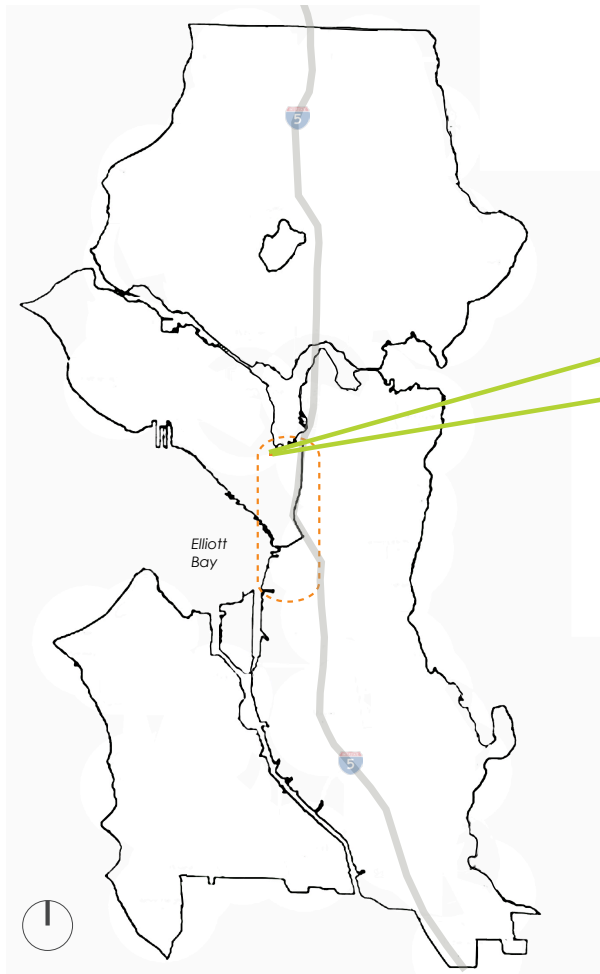


fig. 60 South Lake Union site

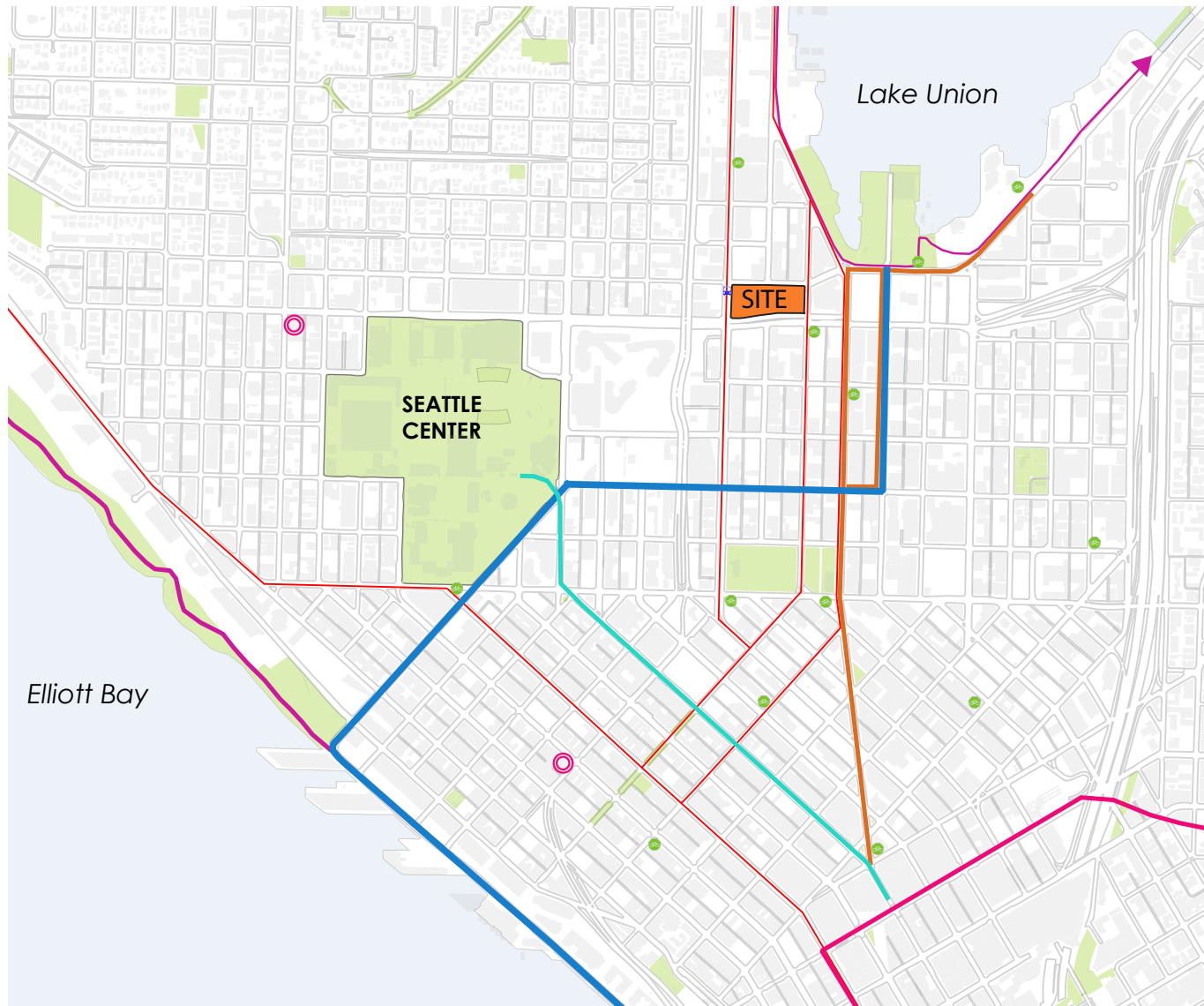


Lastly, it is assumed that most of the students would commute to campus using public transportation or bike, and the site has excellent access to public transportation routes (fig. 62). It is flanked by two frequent bus routes that run north-south and there are dedicated bike lanes on Dexter Avenue, 9th Avenue N., and Roy Street. It also has close proximity to the pedestrian-bike routes, Lake2Bay loop and Cheshiahud Lake Union path, allowing the students to easily connect with resources at the Seattle Center, downtown, and on South Lake Union. The South Lake Union streetcar, downtown monorail, and planned light rail stations are also nearby.

Capitalizing on Visibility

fig. 61 Sun paths on the South Lake Union site

fig. 62 Transportation access



KEY

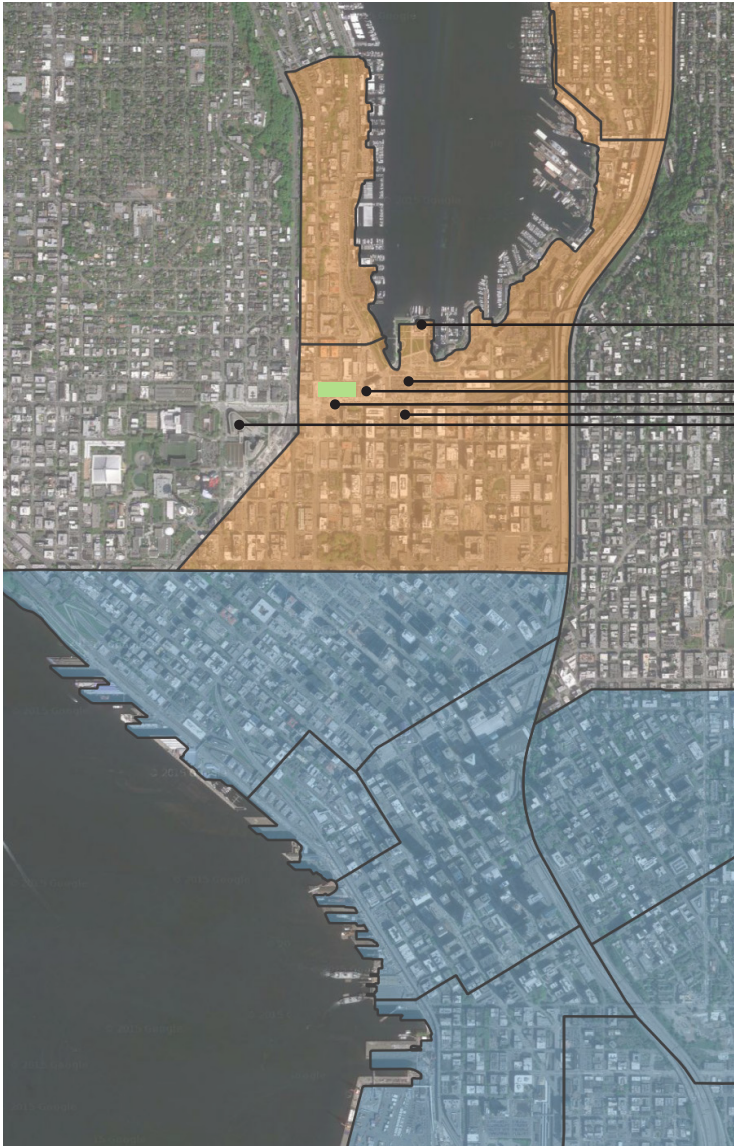
BIKE + PEDESTRIAN

- Lake2Bay Loop
- Cheshiahud Lake Union Path
- Pronto Bike Share Station

PUBLIC TRANSIT

- Frequent Bus Corridor
- Seattle Streetcar
- Monorail
- Sound Transit Link Light Rail
- Proposed Light Rail Stations

The South Lake Union location also offered another advantage that could contribute to the success of the program. The 137,040 square foot site is located near the recently developed corporate campuses of the Gates Foundation, Amazon, the Allen Institute for Brain Science, and UW Medicine, along with close proximity to the Seattle Center and the Museum of History and Industry (fig. 63). Google is also starting construction on a campus one block away in the first quarter of 2017 to open in 2019. As previously suggested, this strategic location could potentially provide the school with valuable resources of both educational outreach and financial support. The architectural form of this demonstration high school will be powerful marketing tool in itself; nearness to these thriving Seattle-based corporate neighbors might help to inspire civic-minded contributions to this state-of-the art urban agriculture public high school. Furthermore, the visual identity of a downtown Seattle Urban Farm School could be an inspirational icon for the Emerald City and a catalyst for broader changes at other schools in the district.



MOHAI
MUSEUM OF HISTORY & INDUSTRY

Google

ALLEN INSTITUTE *for*
BRAIN SCIENCE

UW Medicine

amazon

BILL & MELINDA
GATES *foundation*

fig. 63 Surrounding industry

Program Concept and Development

This architectural proposal is for a different type of school, one that contains some very nontraditional learning spaces, along with programming for several uses in addition to education—food production and processing, sustainable building systems, and food preparation and service. The building will contain traditional classroom spaces, but teaching would often occur in the nontraditional spaces. The manifestations of educational and noneducational program elements will overlap, but with the priority always being education. For example, the science program would utilize hydroponic greenhouses that would also serve for food production. Likewise, the anaerobic digester would be a programmatic element of zero-waste site sustainability, but could also be incorporated into the technology and science curriculum, teaching students about the biology of microorganisms and decay, chemistry, and co-generation systems. The core principle of this thesis is that involving teenagers in all steps of food production can inspire both personal and ecological health, therefore the building will allow for teaching opportunities throughout program.

At the center of these program elements is the Lunchroom Commons and Central Kitchen for food service. This would serve as the heart of the campus, like the kitchen is the heart of the home (fig. 64). A naturally lit space, well-connected to growing spaces, it would be a pleasant environment with flexible

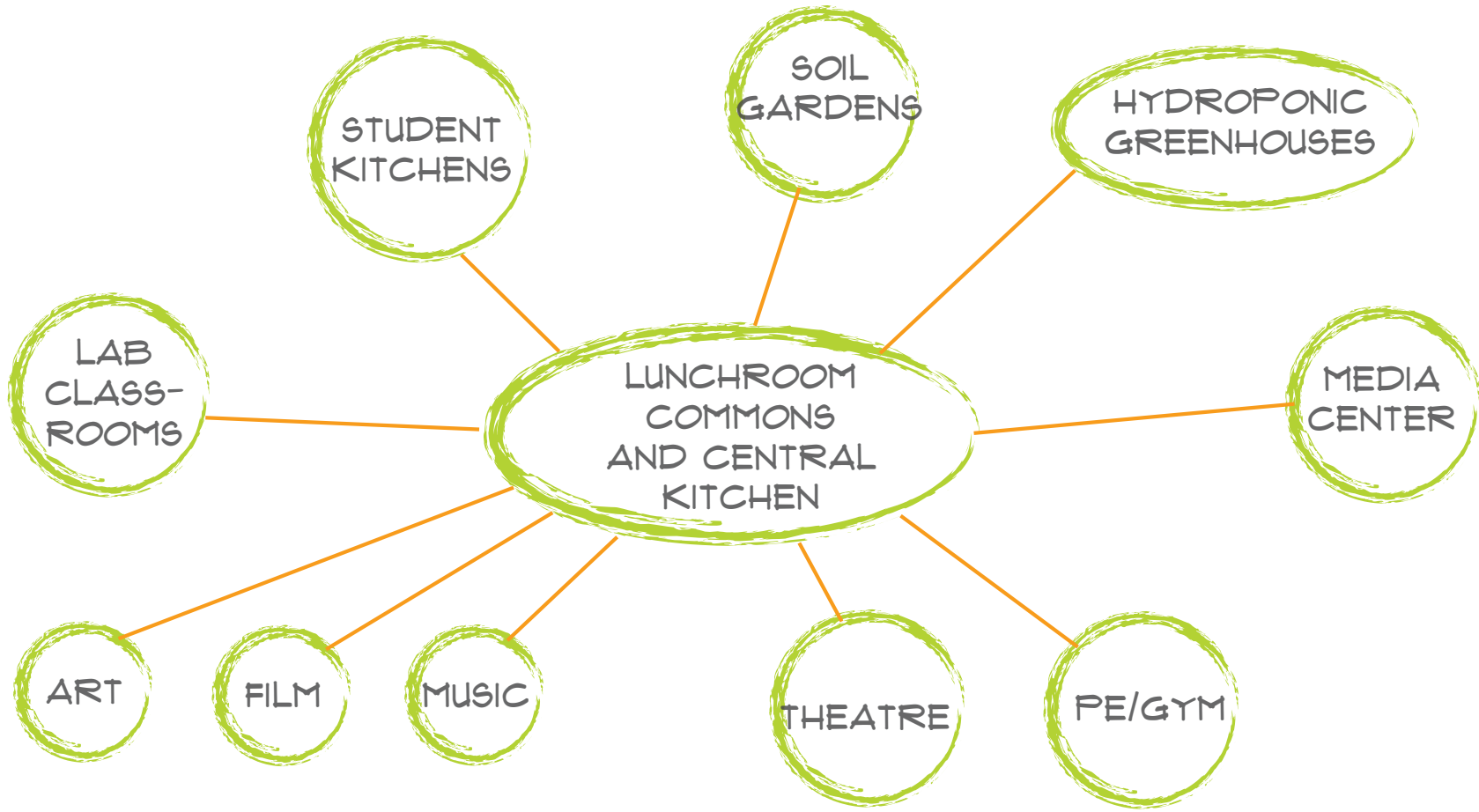


fig. 64 The program elements

spaces for eating comfortably alone or in groups, not cavernous and institutional like many traditional lunchroom spaces.

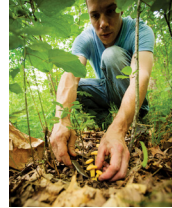
Additionally, rigor would be applied to every part of the curriculum so that it is taught through the lens of growing and preparing food and sustainable systems (fig. 65). For example, physical education classes might entail foraging for mushrooms or yoga on the fitness terrace overlooking the gardens. Projects in the kitchen classrooms might correspond to lessons in chemistry and history, or even translated to film or music in those classes. Art could involve food installations, interactive exhibits, or ceramics that could be used in the garden. These nontraditional spaces would enable stimulating, cohesive, project-based learning. The school will adhere to public school educational standards, but always through the lens of urban agriculture. Approximate space requirements for each part of the program are detailed in Tables 2 and 3.

Spaces for Education

Connection between classrooms and growing will be a primary concern in the school design; classrooms should be physically or visually proximate to an outdoor growing plot or a greenhouse whenever possible. The extra area necessary to support the growing will be gained by eliminating some of the facilities of a traditional high school. As a magnet school, no sports yards are required; therefore, the school will not have a track or a sports field. It will have a



STUDENT KITCHENS



GYM / PHYSICAL EDUCATION



LAB CLASSROOMS



HYDROPONIC GREENHOUSES



FILM



MUSIC



ART

fig. 65 Learning through the lens of urban agriculture



Education Spaces (estimated size of spaces needed)

School Capacity = 1000 FTE

Core academic classrooms	32,800 sqft
Art room	1,800 sqft
Music room	1,800 sqft
Horticulture lab	1,800 sqft
Nutrition lab	1,800 sqft
Kitchen Classrooms	2,000 sqft X 2
Hydroponic classroom greenhouses	15,000 sqft
Outdoor classrooms	1,500 sqft
Unisex toilets	3,000 sqft
Circulation 20%	39,200 sqft

Shared Facilities

Gymnasium	18,000 sqft
Black box theater	1,500 sqft
Media center (library)	5,000 sqft
Lunchroom commons	4,000 sqft
Central kitchen	4,000 sqft
Admin / faculty lounge / school nurse	3,000 sqft
Mechanical and storage	3,000 sqft
Circulation 20%	8,700 sqft
Parking	8,000 sqft
Covered bike racks / bike lockers	600 sqft

Total for Education Spaces

158,500 sqft

Table 2



Spaces for Food Production

Hydroponic production greenhouses	30,000 sqft
Outdoor garden plots	50,000 sqft
Offices for farming staff	1,000 sqft
Tool storage	1,200 sqft
Bee hives	500 sqft
Chicken coops	500 sqft
Greenhouse control room	1,000 sqft
Circulation (20%)	7,340 sqft
Total for food production	91,540 sqft



Food Processing and Building Sustainability Systems

Food washing facility	1,000 sqft
Packing room (CSA)	1,500 sqft
Refrigeration and storage	3,000 sqft
Anaerobic digester	5,700 sqft
Aerobic composting	2,000 sqft
Mechanical	3,500 sqft
Refrigeration and storage	2,000 sqft
Circulation (20%)	3,740 sqft
Total for food process and sustainable systems	22,440 sqft

Table 3

gym for student fitness, but like other option schools in the district, students who wish to participate in a school sport would catch the bus to play on the team of a nearby 3A high school such as Garfield. Similarly, the proposed school will not contain a large auditorium space. Instead, it will include a smaller, black box theater for performing arts classes. Parking and other low-intensity land uses will be minimized on the site in favor of food production and processing or educational programming.

The school aims to lessen SPS capacity issues with a targeted school enrollment of 1000 students; however, there is evidence that the hands-on project-based teaching of this program would be much more successful using some elements of the Small Schools Movement model. This movement, started in East Harlem in 1974 by Deborah Meier, advocated for schools with fewer than 400 children. Meier demonstrated that smaller class sizes encouraged independent thinking with real-world experiences (Meier 1995). The model stressed children's participation in school-directed work experiences, very applicable concepts for the program proposed in this thesis. Based on these findings, each class level in the school—freshman, sophomore, junior, and senior—will be given a curriculum focus and treated like a school within the school. The freshmen focus would be Health and Nutrition, sophomores would study Horticulture and Environment, juniors focus on Global Issues and Sustainability, and finally, the seniors on Technology and Science (fig. 66). Students would graduate



fig. 66 Curriculum focus by class



Photo Credit: American Hydroponics

Nutrient Film Technique (NFT)



Photo Credit: American Hydroponics

Deep Water Culture (DWC) or "Rafts"



Photo Credits: Hydrojournal (l) and Murray Hallam (r)

Media-Based

with a comprehensive understanding of food production, from horticulture to sustainable energy technologies. This science and critical thinking that could be applied to many careers, not just one in farming or horticulture.

Spaces for Food Production, Food Processing, and Sustainable Systems

The campus will include soil-based growing for both education and food production, but the primary high-volume growing will be in efficient BIA rooftop hydroponic greenhouses that extend throughout the building. There are three common types of hydroponic technologies to be considered for these production greenhouses: nutrient film technique (NFT), deep-water culture (DWC or 'rafts'), and media-based growing systems, such as the Dutch buckets used at West Bloomfield Hospital (fig. 67). NFT uses about 10 percent of the water needed for a raft system because

fig. 67 Common types of hydroponic growing systems

plants grow in long narrow channels rather than on rafts that float in deeper ponds; however NFT does not work well with plants such as tomatoes that have large root systems. NFT or media-based growing systems are often the choice for rooftop hydroponic greenhouses because they are lighter in weight. The heavier tanks of a raft system, like the ones used at the Millionaire Club Charity, are better suited on the lower levels of a building, and would require more extensive artificial lighting. In addition to these systems, vertical growing is a relatively new hydroponic technology that is becoming more popular. Modular hydroponic towers, such as Agrotech's Zipgrow, form scalable, flexible, space-efficient "farm walls" (fig. 68). These green walls are currently being used in some commercial farms and restaurants (<https://brightagrotech.com/farm-walls/>).

Based on this research, the most appropriate systems for the rooftop production greenhouses in the proposed high school would be recirculating NFT tables for smaller plants and Dutch bucket growing systems for larger plants, such as tomatoes, pole beans, and eggplant. The greenhouses would also support photovoltaic panels that would provide the energy for building lights in addition to the greenhouse power. These greenhouses are critical to the objectives of the thesis because they enable year-round growing on the site—100 percent of the school's produce needs 100 percent of the year.

Although growing food on site has the potential to increase nutritional value and flavor, several factors must be addressed to appreciate these advantages

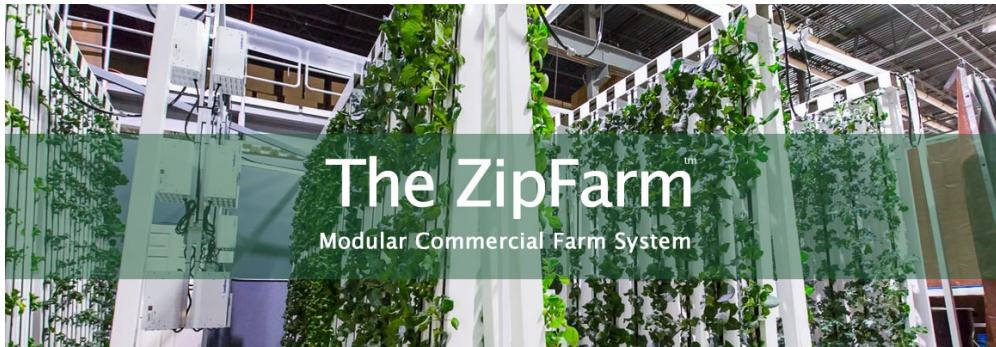


fig. 68 Zipgrow vertical hydroponic farming systems are modular and scalable

in an institutional, high-volume application. There need to be proper facilities for growing and storing, and efforts must be made in production, harvest, handling, and processing to ensure that taste and nutrients will be retained. For example, crop varieties with higher nutritional quality can be chosen at the initial planning stages of production. Fruits and vegetables can be allowed to mature to their full ripeness on the vine, which also provides the highest nutritional and flavor quality. If the produce is stored after harvest, proper temperature and humidity must be maintained to minimize nutrient degradation and further loss of texture, appearance, and flavor; the faster that produce can arrive on the plate after it has been processed, the more nutrient- and flavor-packed it will be. Therefore, a seamless, yet highly visible flow between growing spaces, storing spaces, and cooking spaces must be provided in the design. Adjacent to the gardens, the programming should include facilities for easy harvest and transfer to

temperature-controlled rooms for packaging, refrigerating, and storing excess yield. And to process the food safely and efficiently, spaces for washing the produce should be near to, but separated from the kitchen.

The relationship between solar access for plants and that for the students creates several layers of programmatic requirements with regard to food production. Figure 69B shows that there is a more limited variety of soil-grown food in the winter months, reinforcing the necessity of hydroponic growing to ensure year-round variety for the lunch program. Figure 69C illustrates that the most abundant soil-based harvest would occur during the summer months, when school is not in session. Therefore, the program should include space for a resident Urban Farmer and an assistant, such as a horticulturist or hydroponic expert. They would be full-time employees twelve months of the year and caretakers of the farm operation through these months. In addition to these employees, large-scale efforts to organize community volunteers would be necessary to make the program work. These positions would be comparable to artist- or historian-in-residence positions that currently exist in many SPS schools. Some SPS schools have used other creative ideas to help manage their farms during the summer season when school is not in session. In the past, Nathan Hale High School's Urban Farm has leased space to youth programs and enlists those students to help with the summer farm duties as a win-win for both parties. Other possibilities would be to allow apartment residents in the area to volunteer on the Urban

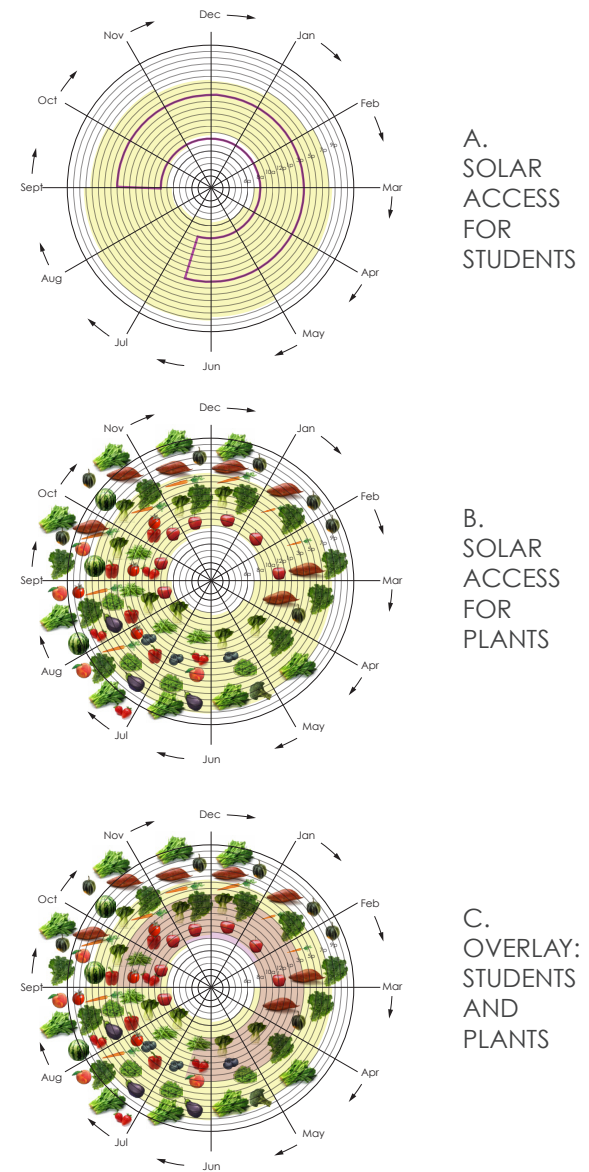


fig.69 Solar access for students and for plants



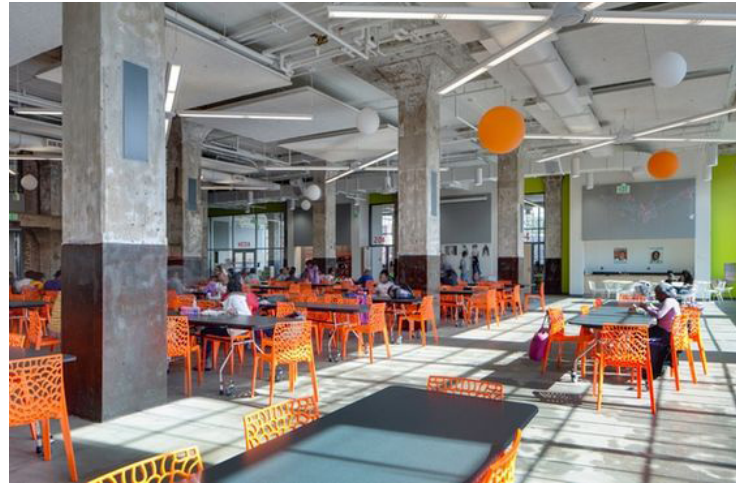
fig. 70 The Branson School cafeteria, Ross, California

fig. 71 Mercado Restaurant, Bratislava, Slovakia

School Farm during the summer in exchange for fresh produce. A large central garden would be a valuable asset to the community in the summer months, as the wait for many Seattle P-patches can be over a year. However, the most apparent way to manage the year-round food production would be with a year-round educational model, eliminating one long summer break and instead giving students longer breaks between each semester. This would also work well with the soil gardens that would be most productive during the summer months, when children would normally be on summer vacation. A year-round school model and a formal volunteer program could ensure that the facility run continuously, and potentially profitably, throughout the year.

Spaces for Food Service: The Lunchroom Commons

If the proposed school is thought of as a living organism, the educational spaces would be the brain of the campus, the gardens and greenhouses would be the lifeblood, but its heart will be in the Central Kitchen and Lunchroom Commons. As Esther Cook, professional chef and cooking teacher in the classroom kitchen at the Edible Schoolyard explains, "If you go to someone's house for a party, everyone is always crowded into the kitchen because it's where the excitement is, where people feel included, and where they are part of the pack." Since enticing all students into the lunchroom is critical for a lunch program to thrive, it is essential that the spaces for food service are warm and



inviting (fig. 70-75). They must be devoid of the intimidatingly long lunch tables, cavernous ceiling heights, poor artificial lighting, and institutional materials of traditional cafeterias. The environment must be vibrant, appealing, and visually connected to both the growing spaces and the kitchen. Restaurants across the country have embraced the transparency of an open kitchen, where fresh ingredients are openly displayed and chefs cook within view of the diners.

Restaurant owners know that bringing the sounds, sights, smells, and excitement of the kitchen into the dining room whets the appetites of diners, and this same strategy would be applied to this new lunchroom design. The lunchroom will offer opportunities to dine comfortably in a variety of circumstances, similar to a welcoming Seattle coffee shop—tables and spaces to accommodate large groups and places where a student can feel comfortable to eating alone. Like the employees' café at Microsoft in Redmond, Washington, the lunchroom will

fig. 72 Kent Denver High School dining hall

fig. 73 Baltimore Design School cafeteria



fig.74 The Dropbox cafeteria, San Francisco, California

fig.75 Nike staff cafeteria, Hilversum, the Netherlands

fig. 76 Microsoft employees cafeteria, Redmond, Washington

openly display hydroponic produce, either in towers or vertical walls, along with cases of microgreens to create a more pleasant environment and offer easy and immediate use by the kitchen staff (fig. 76). Natural light and ventilation will be as important to these plants as it will be to the students in the space. In addition, the Lunchroom Commons will have a strong connection to the natural environment, with places for outdoor dining and views of the school's soil gardens. Composting and recycling areas will be easy to use and close to, but separate from eating spaces to avoid unappetizing smells and sights. Because the school will not include an auditorium, the Lunchroom Commons would serve as an all-school gathering place during the school year, and during evenings and summer months this pleasant 3,000-square-foot open space could be rented for concerts and other local community events.

Delimits and Limits of the Investigation

There is no precedent that currently exists for growing high yields of produce in a public school setting for use in the school's food service. During the ten interviews that were conducted for this thesis research, there was universal enthusiasm for the idea; however, skepticism was consistently related to food safety and project costs. It is beyond the scope of this design proposal to address either of these aspects of the project, e.g., a cost-benefit analysis or investigation into specific food-handling regulations that might apply. This design proposal envisions a shift from the current paradigm, placing the health and well-being of children at all economic levels at the forefront of city and community priorities. In other places around the nation that have made healthy food and urban agriculture an integral part of education, the success has involved creative economic and operational partnerships, rethinking of rules, and countless volunteer hours. Furthermore, the precedents cited in this proposal prove that although these are issues that would need to be addressed, they are not insurmountable. The costs of this project would be significant, but this thesis argues that several aspects of the program could offset these costs, and furthermore, the rewards of healthy future generations and sustainable ecologies are worth the expense.



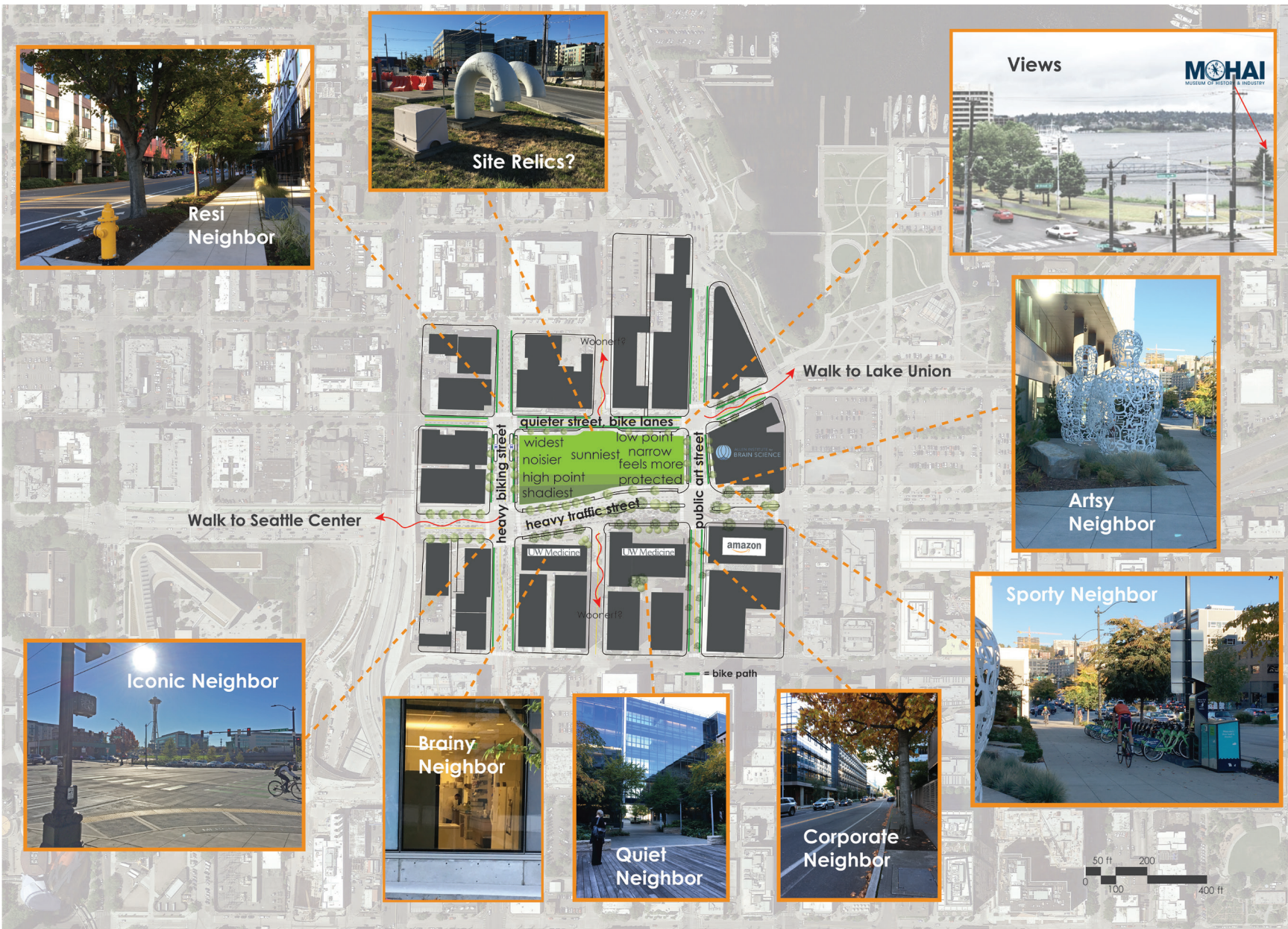
CHAPTER 4:

The Design: New Model for a Public School

Site Response and Plan

The final design for this project sought to strike a balance between optimally serving the program—growing food and education—and creating a building that responded appropriately to the thriving urban context. Referred to as the Seattle DOT “megablock,” the site runs lengthwise east-west for approximately two city blocks and has different conditions at each end and similarly varying conditions at each street edge (fig. 77). The western edge is noisier and more frenetic, with Dexter Avenue being a busy artery for bikes, buses, and four lanes of traffic. This western portion of the site is also about sixty feet wider and twenty-two feet higher than the eastern side. Because it is higher,

fig. 77 Synthesis of site conditions



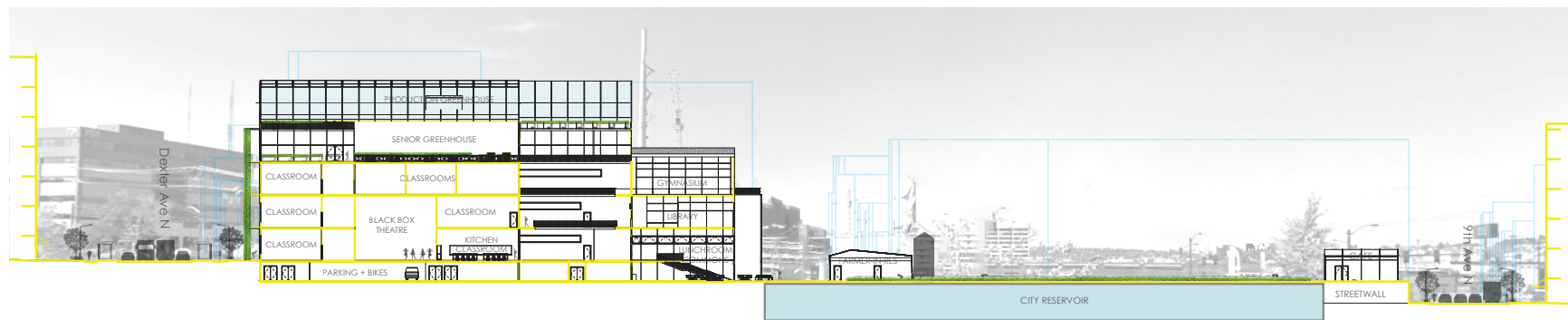
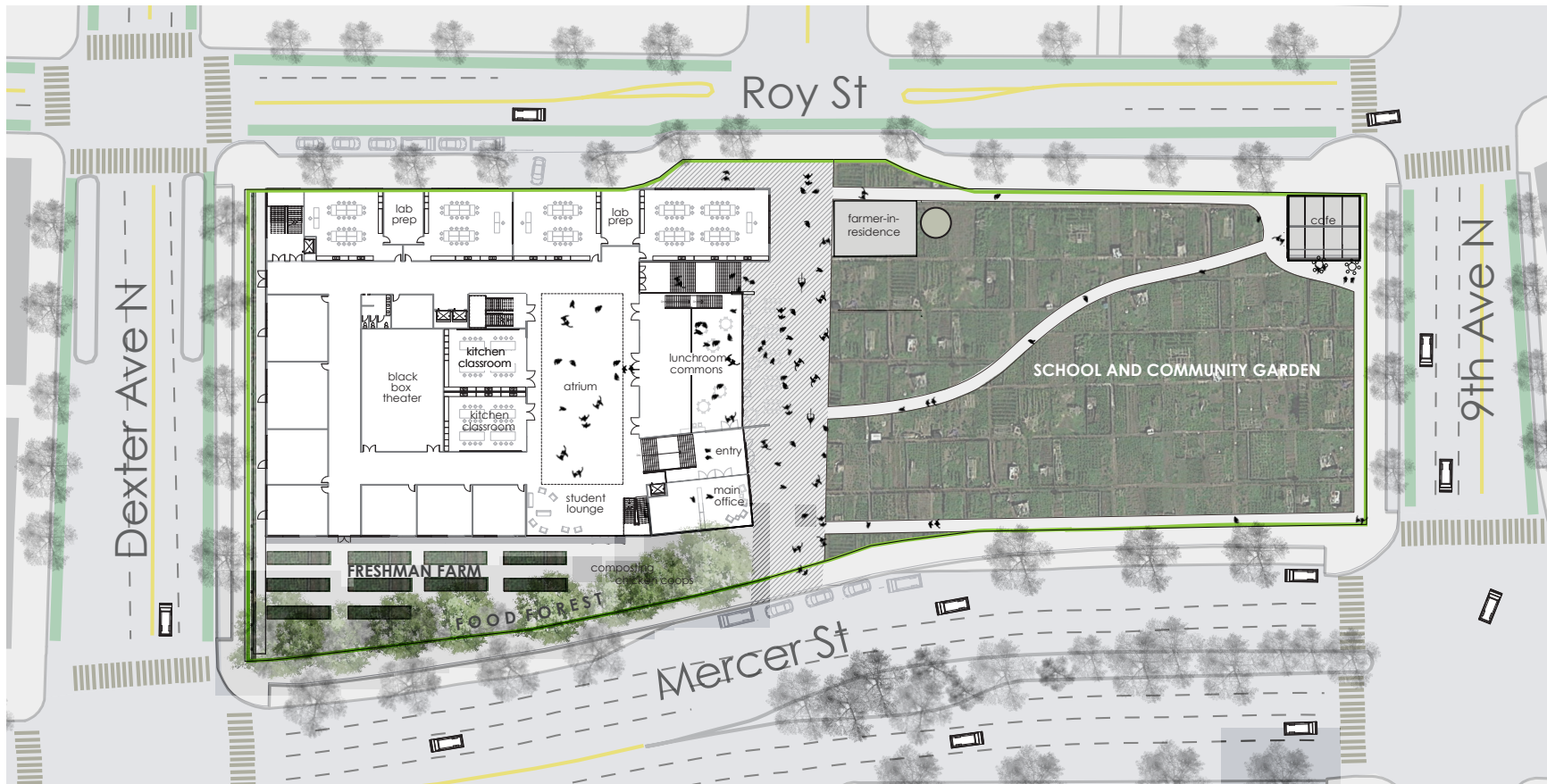




fig. 78 Site plan and longitudinal section

fig. 79 View of the school main entrance looking west. The shared school/community garden is in the foreground.

it is better positioned for views to both Lake Union and the Space Needle. For these reasons, this portion of the site was chosen for the building, leaving the lower, quieter half of the site for a large open soil garden, as shared community/school space for growing (fig. 78). This large shared garden contributes three things to the project: it preserves green space in the rapidly developing South Lake Union neighborhood, it generates food for the school and public needs, and it brings the surrounding community and industry onto the site, a central tenet of this thesis. A path draws the public around the perimeter of the garden

and a small cafe in the northeast corner provides a pleasant destination after a leisurely stroll or a run through the active garden space. The narrower portion of the site that houses the garden also receive unobstructed sunlight so it is optimal for soil growing. The six-lane Mercer Street edge on the south is the busiest, so the building is set back off of Mercer Street and buffered by the freshman growing plots and a permaculture food forest. A central axis on the site plan creates a pedestrian promenade that reflects where 8th Avenue North would be if it did not terminate temporarily on this block. This pedestrian promenade honors the shared-use pedestrian friendly designation for 8th Avenue in the overall South Lake Union Development Plan (citation). The main entry of the building, marked by a bold green canopy, is off of this pedestrian promenade (fig. 79). The promenade serves as a gathering space for both the community and the students, and provides a transition between the public space of the garden and the private school domain. The Lunchroom Commons, the heart of the campus, is also located on the seam of the pedestrian promenade. The lunchroom space can be isolated from the rest of the school building and used for meetings, dances, concerts, or outdoor markets when the school is not in session, further linking the school with its community and context.

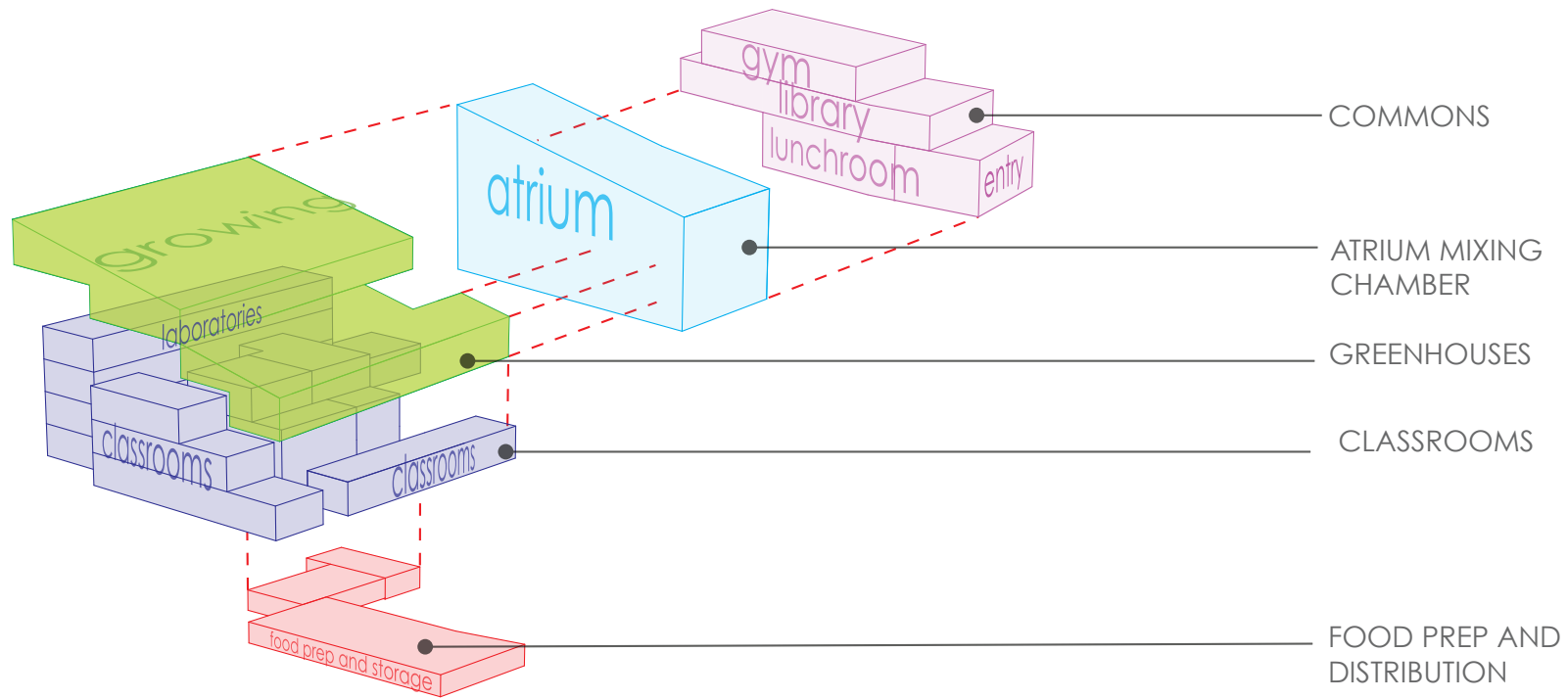


fig. 80 Spatial organization

Building Spatial Organization

The form of the building is organized into three zones (fig. 80). The eastern most zone contains the building commons, large shared facilities where all students in the school would interact. This area includes the main entry, the media center/library, the gymnasium and fitness terrace, and of course, the lunchroom commons. The central zone of the plan contains the atrium, a central mixing chamber that serves as both circulation and an open, active social center of the school. It works in tandem with its neighbor, the lunchroom commons. The third zone on the west side of the building contains the block of classrooms capped

with a “lid” of greenhouses. This arrangement allows the plants to capture the most sunlight and heat, and shields the classrooms from glare and solar heat gain. Lastly, the food preparation and distribution is tucked on the lowest floor of the building. All food produced in greenhouses and in the soil garden travels to this level to be processed, stored, and distributed or prepared.

The Educational Model: Up and Out

Envisioning a clear educational model was essential to organizing the school and determining how the students would use the spaces as they progressed through the program. As mentioned in the previous chapter, each class—freshmen, sophomore, junior, senior—would have a specific curricular focus, based on their development as a young person as well as progressively learning the processes of agriculture and sustainable systems.

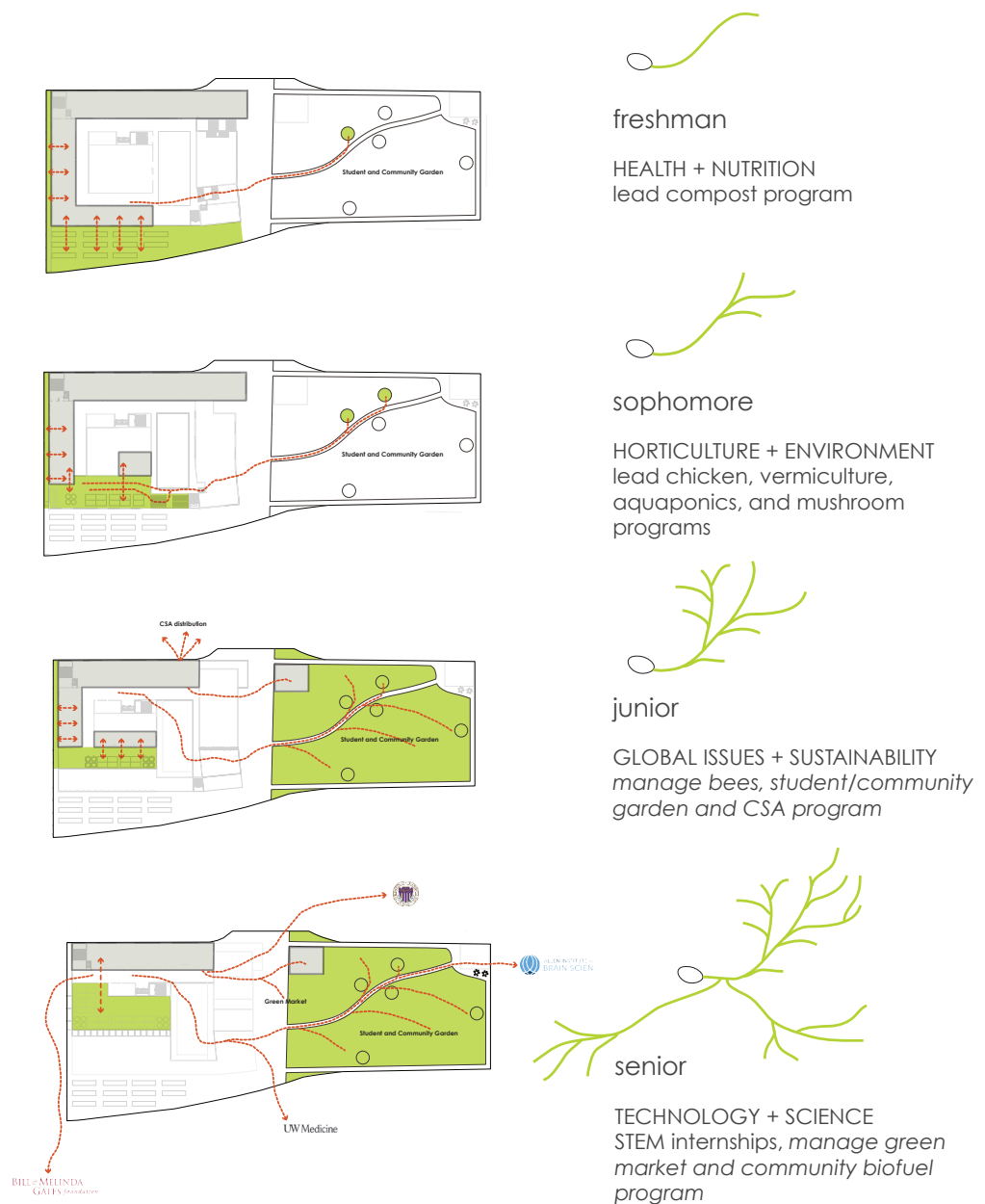
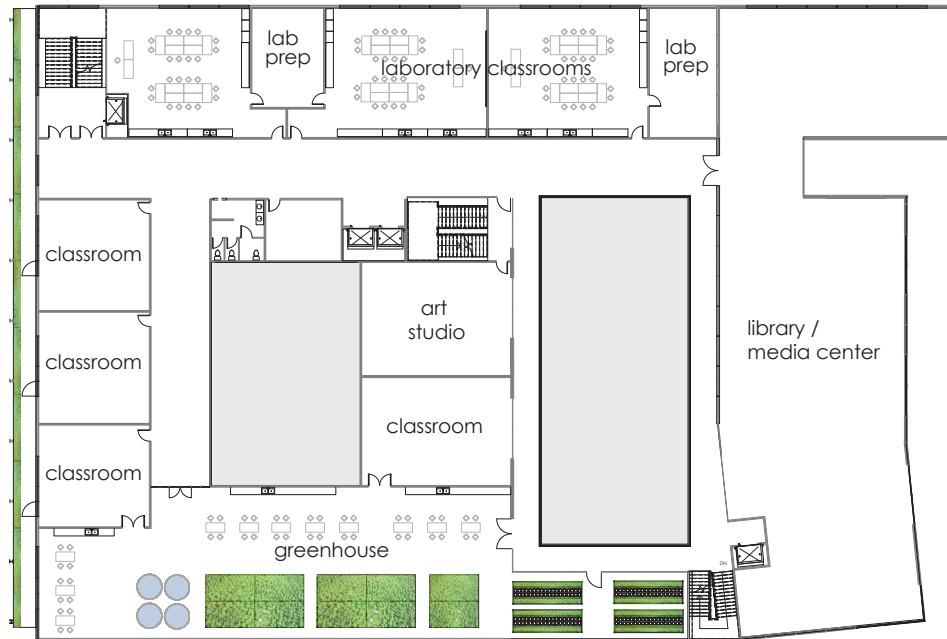
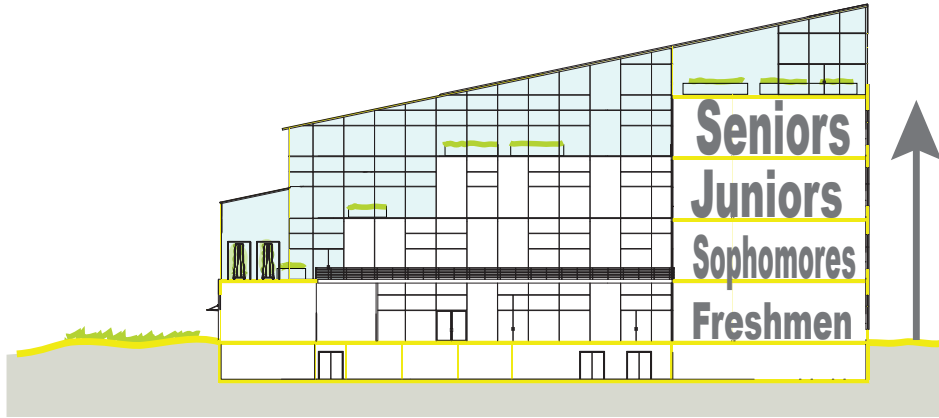


fig. 81 Educational Model: Progress OUT



LEVEL THREE PLAN (SOPHOMORES)



This educational model is reflected spatially in the architecture, both in plan and in section (fig. 81,82). As freshman, the students begin in the lowest level of the school, with a very hands-on curriculum focused on health and nutrition. They have no exposure to the greenhouses, but have lots of “hands in the dirt” time, adjacent to the Freshman Farm soil growing space that also serves to buffer the school from Mercer Street. They spend most of their days on this lower level of the school, also taking cooking and nutrition classes in the laboratories and kitchen classrooms on this floor. They have limited time in the outdoor classrooms of the student/community garden and they are responsible for the all-school composting program, also located in the Freshman Farm.

In the second year of the program, the sophomores progress up a level in sectionally in the building, gaining their first exposure to the

fig. 82 Educational Model: Progress UP
fig. 83 Sophomore Level Plan

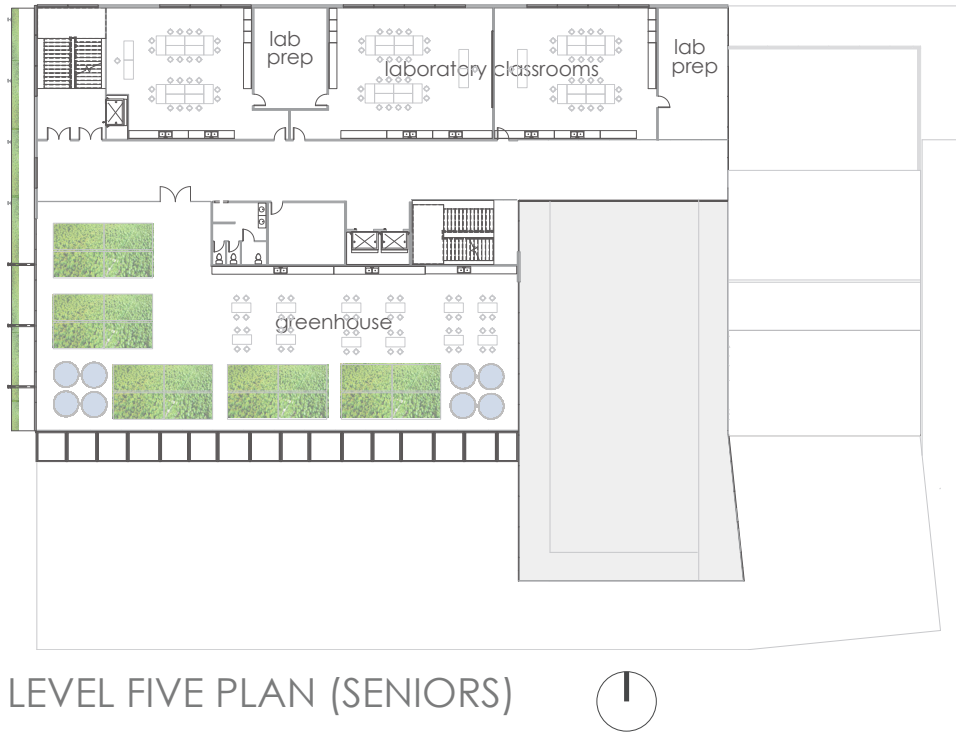
greenhouse classrooms (fig 83). Their curriculum focuses on horticulture and the environment and they have responsibility for the school's chickens, along with the vermiculture (worms), aquaponic, and mushroom programs. In plan, this takes them into the outdoor classrooms of the shared garden more than in their first year.

As juniors, the students focus on global issues and sustainability, with responsibility for managing the student/community garden along with the Community Supported Agriculture (CSA) program. These programs take them further out into the campus garden in plan, and sectionally, they move up a level in the school to a larger, more technical greenhouse classroom (fig. 84). Managing the exterior programs— CSA and the garden—also gives them their first experience of dealing with the public concerning school programs. They are branching further out from the main building into the garden and further into the community.



LEVEL FOUR PLAN (JUNIORS) 

fig. 76 Junior Level Plan



LEVEL FIVE PLAN (SENIORS)



Finally, the seniors occupy the top levels of the building, adjacent to the largest greenhouse and closest to the top production greenhouse and control rooms (fig. 85). Because they are developmentally ready, their program focuses on technology and science, with time spent in laboratories and greenhouses, but still with a strong connection to the soil growing. They manage the weekly green market, in conjunction with community garden members, and they are responsible for the community biofuel program, which collects food waste from local coffee shops and restaurants for the on site anaerobic digester. These activities give them opportunities to be active participants in the community. In addition to this, they engage in STEM internships with nearby industry such as the Gates Foundation, UW Medicine, and the Allen Institute for Brain Science. This allows them to apply many of the skills they have learned in the program and extend their knowledge even further from the site.

fig. 77 Senior Level Plan

A Walk Through of the Building

Arrival

On arrival to the building, a student would enter either the main entry in the southeast corner of the building or either of the other two secondary entrances to the building on the northwest or northeast (fig. 86). In keeping with the school's focus on sustainability, there is limited parking in the lowest level of the building to encourage the use of bike or public transportation and bike lockers are also located in the lower level. The main entrance is at the community garden level and the green canopy creates a compressed experience to enhance the expansion into the center atrium at the top of the entry staircase (fig. 87). The student might stop to check in at the main office on the left or grab a healthy breakfast in the lunchroom on the right.

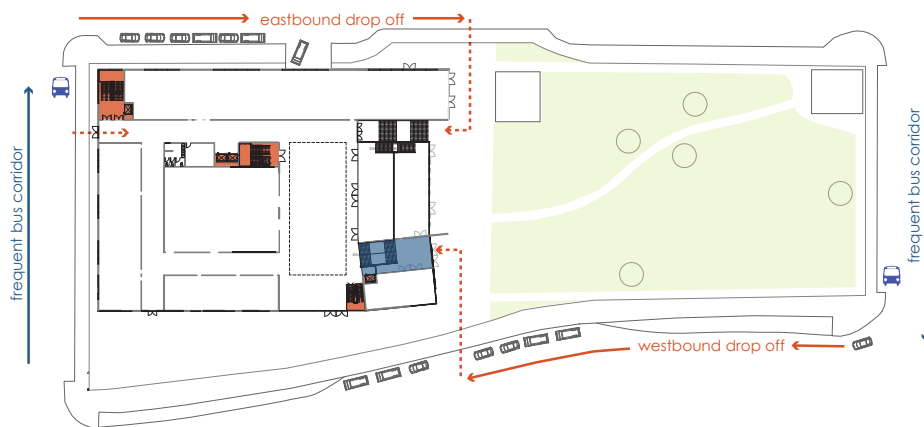


fig. 86 Circulation diagram. The building has three vertical circulation columns that contain both stairs and freight elevators (orange). The blue shaded area indicates the location of the rendering on opposite page.

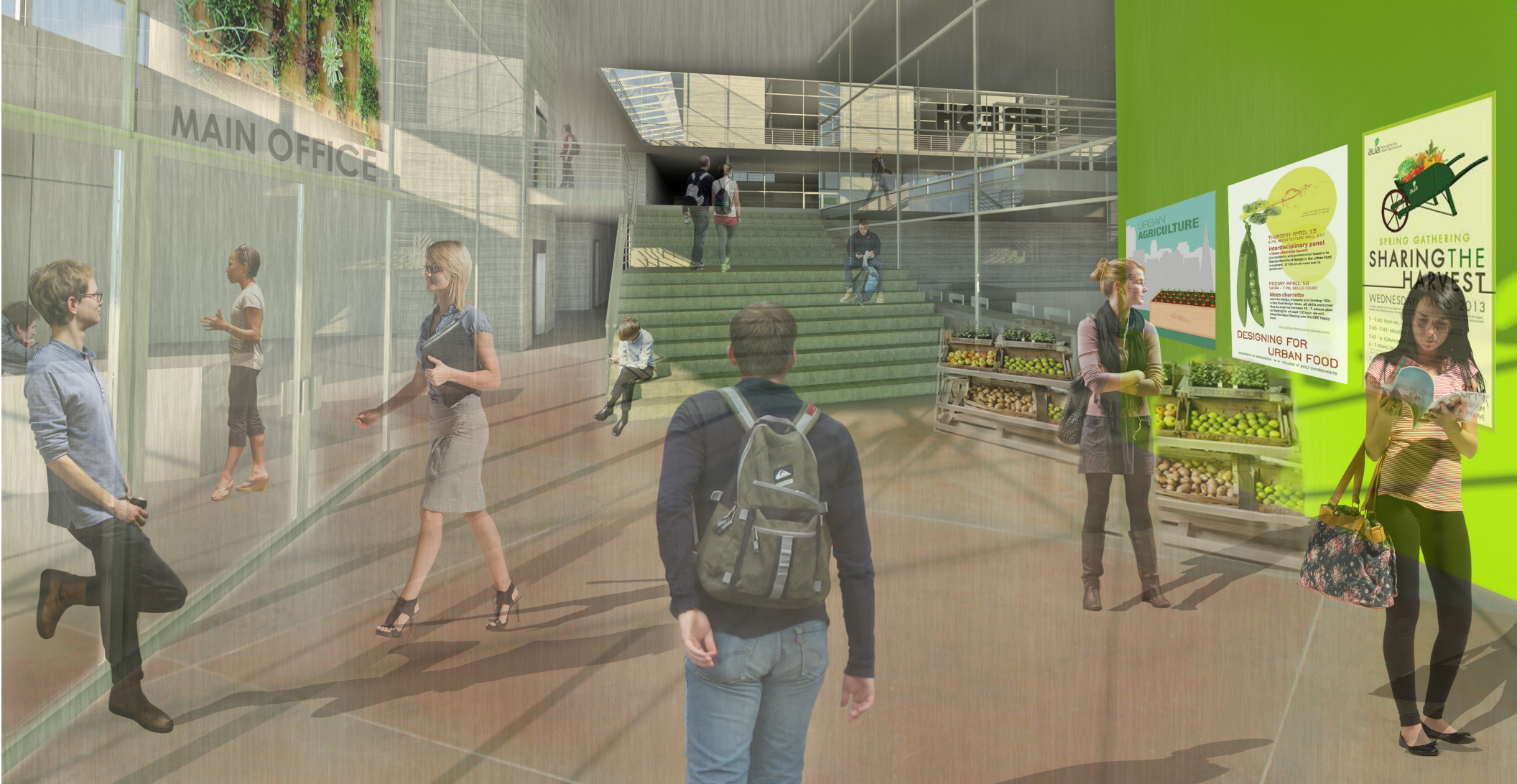


fig. 87 Experiential view of student entering the school. The center atrium is located at top of the stairs.

The Atrium

The center atrium is envisioned as an lively, social space where students meet to study, eat, talk, exchange ideas, and observe growing, harvesting, cooking, and eating in a glance (fig. 88,89). On the east side of the atrium is the entrance to the upper level of the Lunchroom Commons. On the west side, students can observe what is cooking in the classroom kitchens. On the south side of the atrium is the student lounge, which looks out into the Freshman Farm and the food forest. On the second level, occupants of the atrium can have a view to the vertical growing in the sophomore greenhouses. Natural materials, natural light, and the sights of both soil and hydroponic growing make this space representative of the spirit of the school.

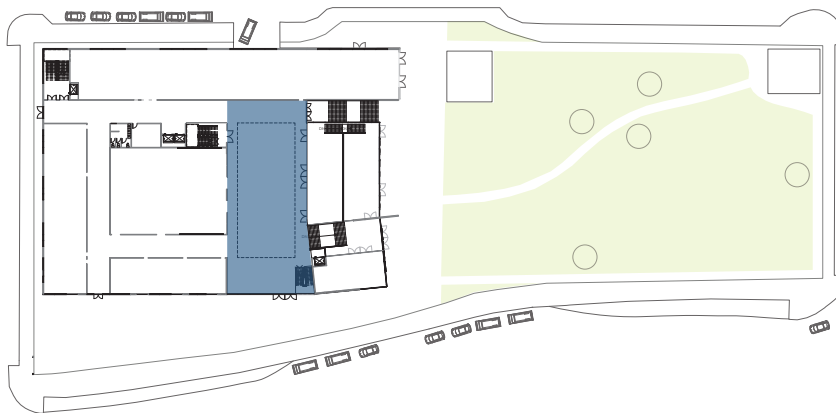


fig. 88 The blue shaded area indicates the location of the rendering on opposite page.

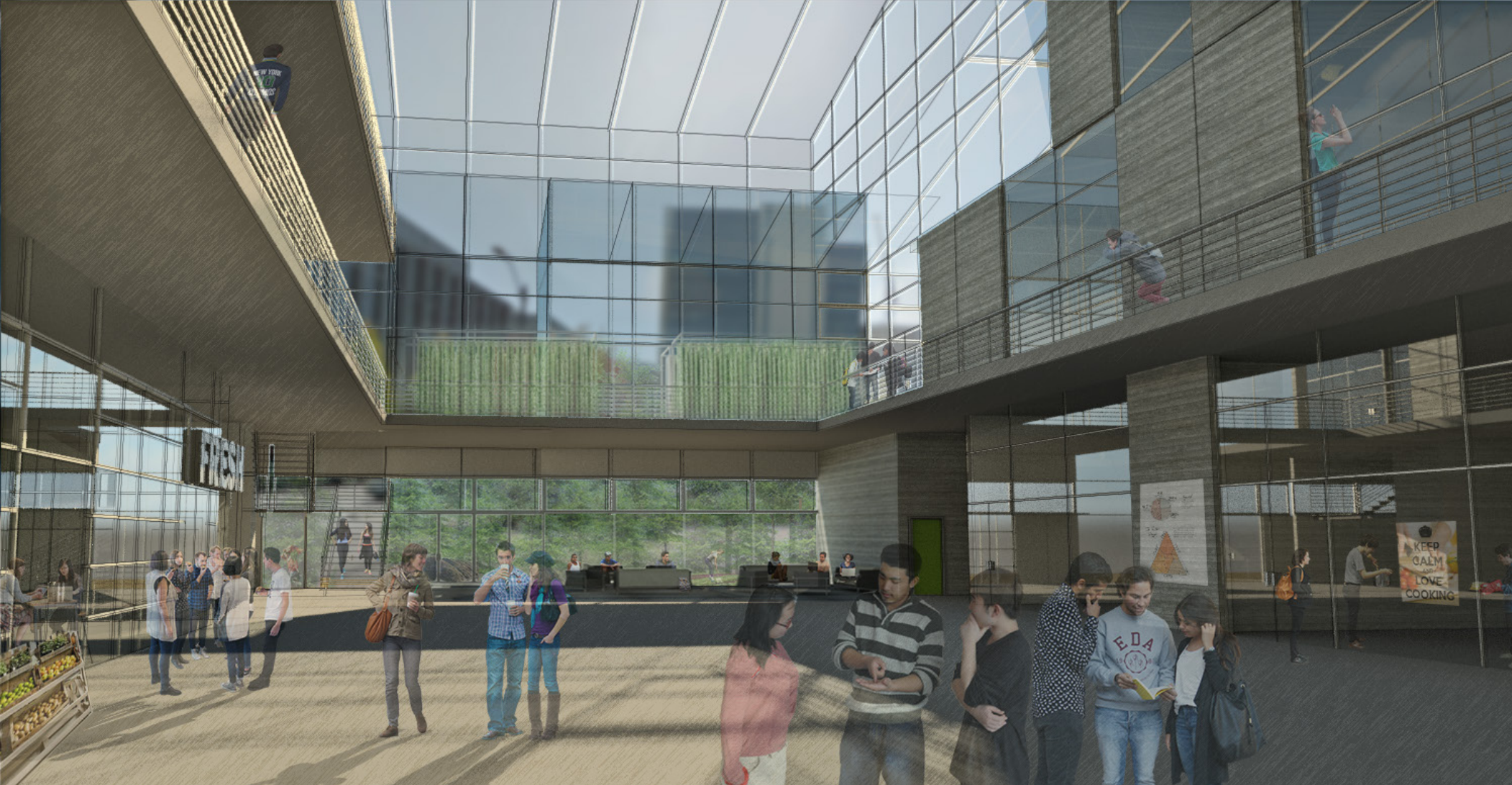


fig. 89 Experiential view of the atrium. Lunchroom Commons upper level is on the left, classroom kitchens on the right, and student lounge looks out to the Freshman Farm in the background. UW Medicine campus is across Mercer Street in the distance.

The Lunchroom Commons

The lunchroom is a double-height space with views onto the school/community garden (fig. 91). Like the atrium, students can see both hydroponic and soil growing from the space. The open kitchen and displays of live greens and microgreens make it a new vision for high school cafeteria dining. In the warmer months, two large overhead doors can open onto the pedestrian promenade and allow for outdoor eating and ventilation. Countertop seating, tables, and lounge seating on the upper level would give students a variety of options if they would prefer to eat alone or with a group. This level also represents the final stop for the circulation of the food (fig. 90). Harvested in the greenhouses or in the outdoor soil gardening spaces, the food would travel via cart and freight elevator to level one for preparation, packaging, and storage. It would then be distributed to the CSA boxes, the green market, or the lunchroom, where it is finally eaten.

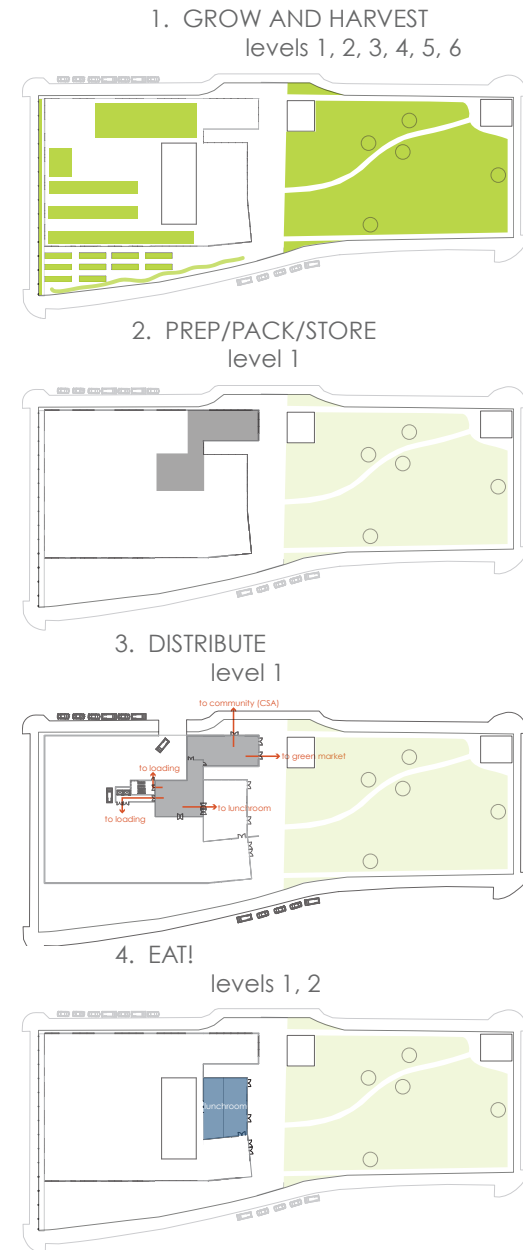


fig. 90 Circulation of food



fig. 91 Experiential view of the Lunchroom Commons lower level. The space looks out to the pedestrian promenade and the student/community garden.

Kitchen Classroom

Located off of the atrium, the kitchen classroom would be another lively space in the school (fig. 92, 93). The classes could easily access the Freshman Farm, on the same level, to forage for ingredients to be incorporated into the cooking lessons. The glazed walls between classroom and the atrium space allow for lots of natural light and enable students that are passing by to observe the cooking. Cooking classes could set up tables in the atrium for tastings and dinners, another way to entice children into trying new foods and expanding their tastes. The close proximity to the common space also enables appetizing smells to drift into the common area.

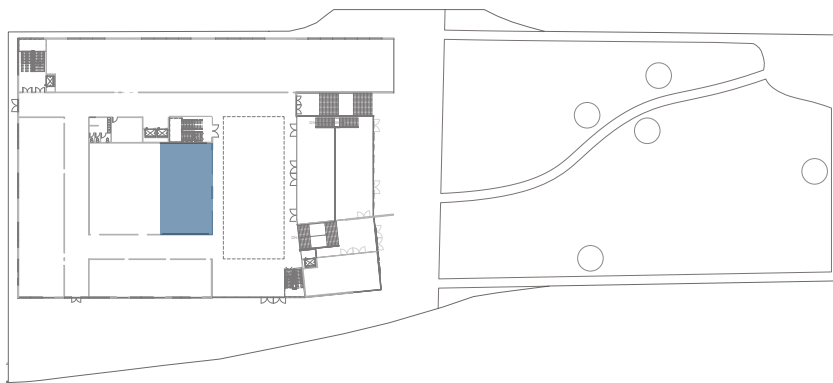


fig. 92 The blue shaded area indicates the location of the rendering on opposite page.



fig. 93 Experiential view of the kitchen classroom.

The Greenhouse Classroom

The sophomore greenhouse is located on the third level of the school and overlooks the Freshman Farm below. This is a double-height space, open above to the larger, junior level greenhouse (fig. 94, 95). Traditional classroom spaces are adjacent to the greenhouse to allow for testing and more traditional instruction on occasion. The space is very open and accessible, with students encouraged to study, explore, harvest, and learn in the space.



fig. 94 The blue shaded area indicates the location of the rendering on opposite page.

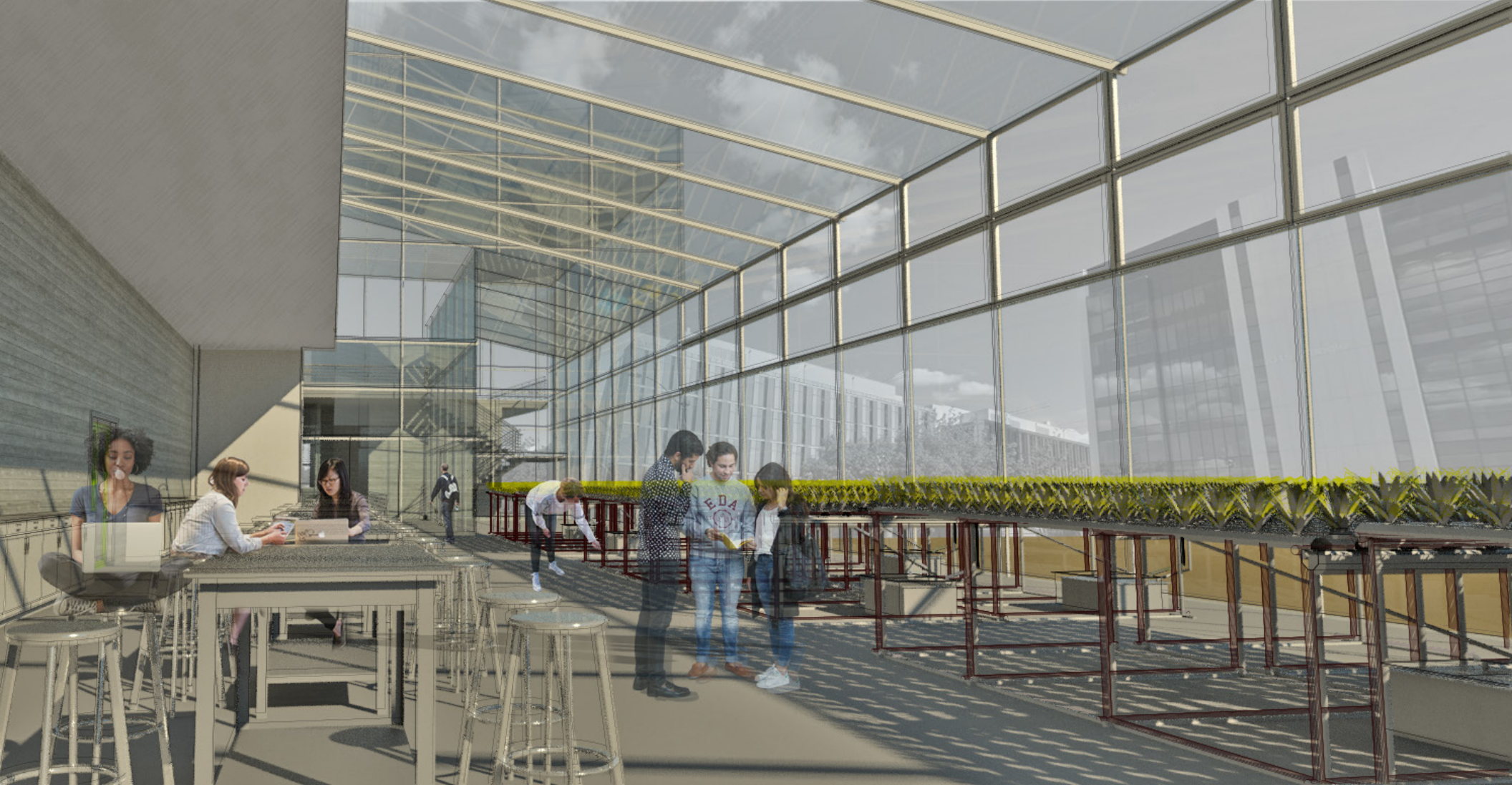
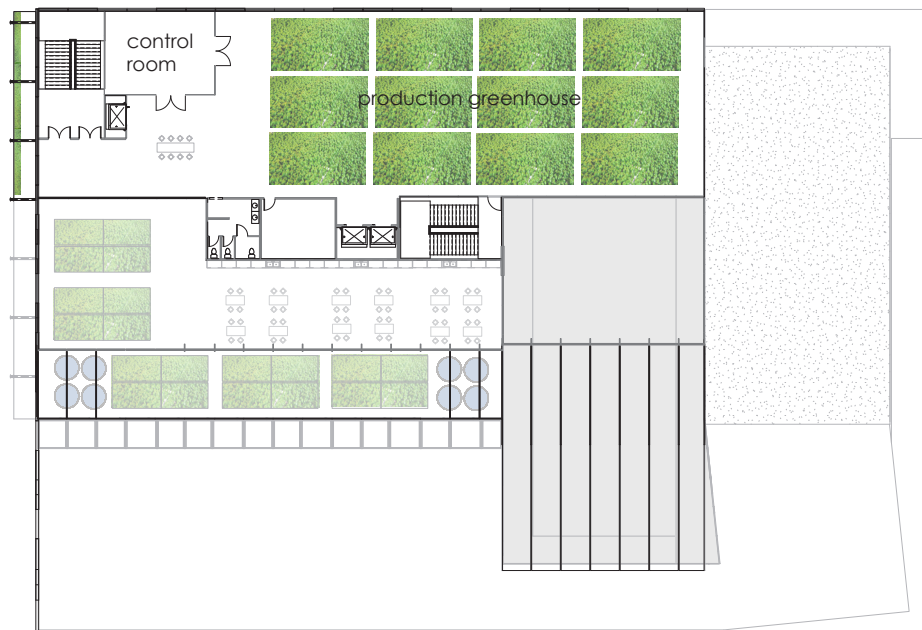


fig. 95 Experiential view of the sophomore greenhouse classroom.

The Production Greenhouse

This is the largest production greenhouse space located on the top floor of the building (fig 96, 97). This level also contains the control room for the greenhouses that is operated by the senior students and the staff. Like the sophomore greenhouse, it is a double-height space to allow for air flows and active viewing and interaction with the growing space below. Freight elevators in the vertical circulation core transport harvested food to level one.



LEVEL SIX PLAN (PRODUCTION GREENHOUSE) ①

fig. 96 *Production Greenhouse plan*

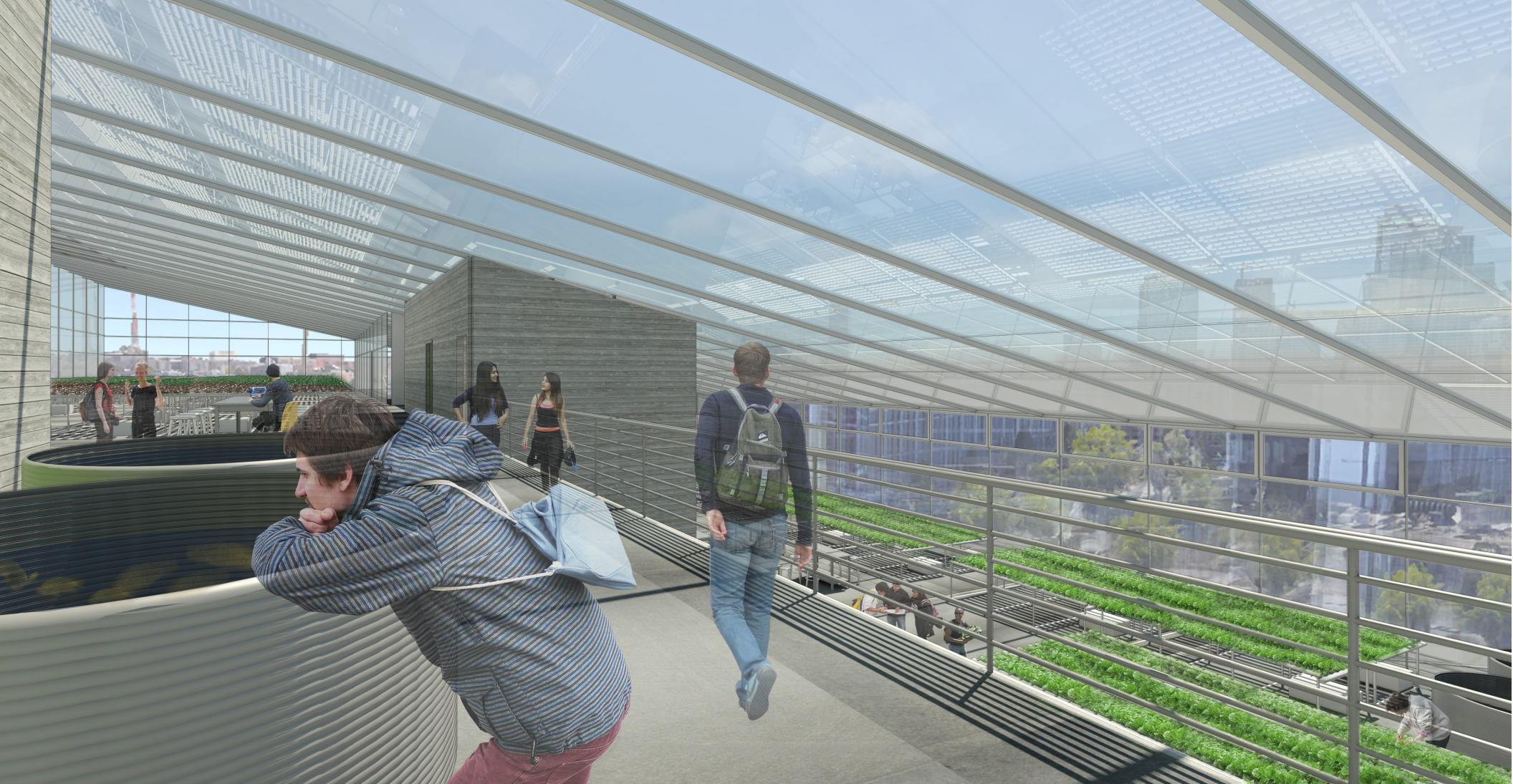
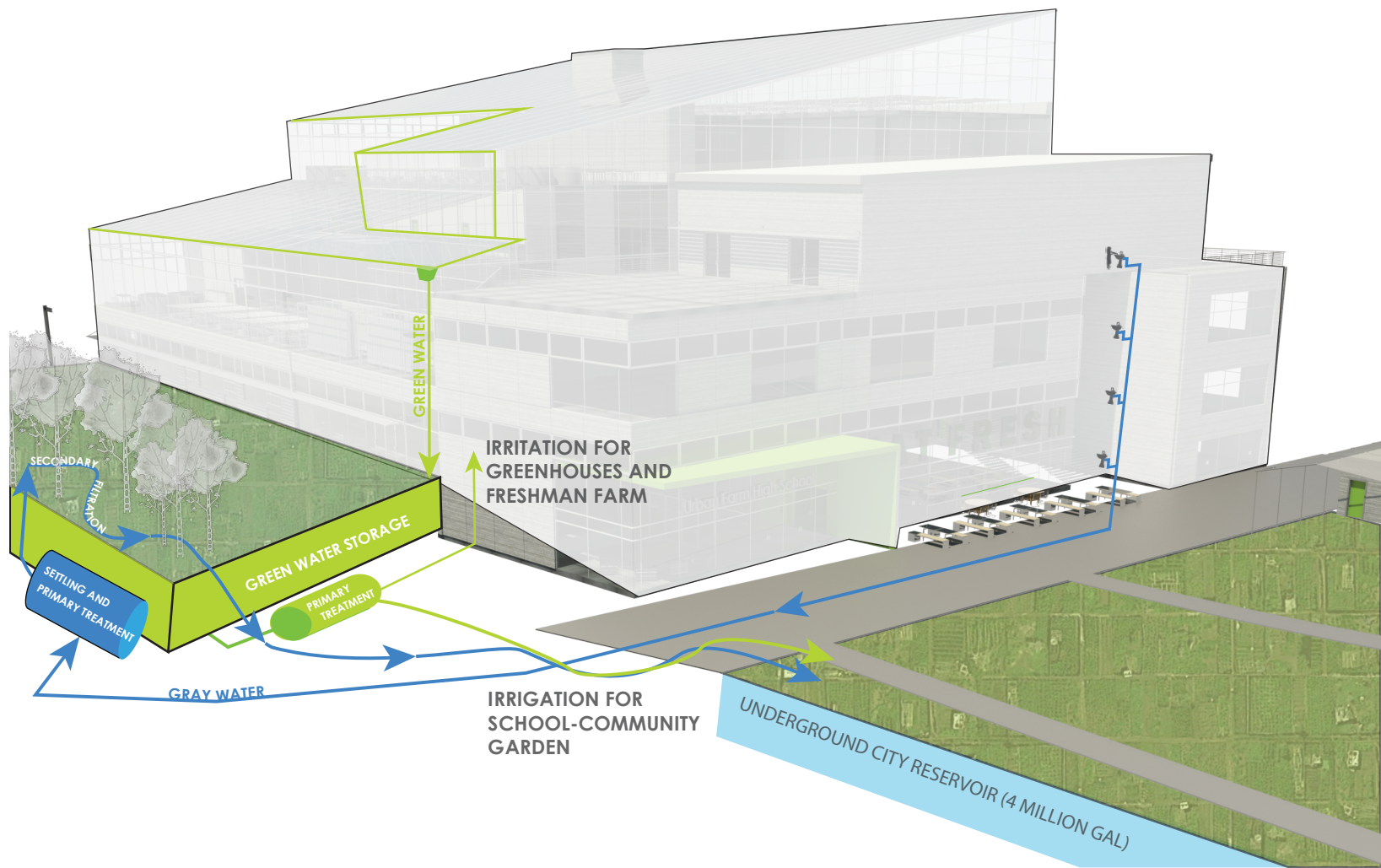


fig. 97 Experiential view of the production greenhouse. Aquaponic tanks for tilapia are in the foreground, the vertical circulation core is in the background, and the double-height space looks down into the senior greenhouse NFT tables.



human scale:
wastewater



building scale:
stormwater



site scale:
city reservoir



Sustainable Systems

Water Management

A program base on high-volume growing would require a large amount water, and a key part of the efficiency in the building-integrated agriculture model is to use recirculating hydroponics, along with water from the building for irrigation. Therefore, the water management at the high school would occur on three levels: the human, building, and site scale (fig. 98). On the human scale, gray water from the building occupants would be reclaimed, treated, and stored on site for irrigating the large school/community garden. This waste water would first enter a primary treatment tank on site, it would travel through secondary filtration in the food forest area, then be ready for irrigation. On the building scale, stormwater would be recaptured off of the large roof and stored in baffles under the Freshman Farm for additional irrigation. Finally, this thesis proposes that water management occur on a site level, as well, with a city reservoir under the school/community garden (fig. 99). Currently, Seattle has a total of ten reservoirs.

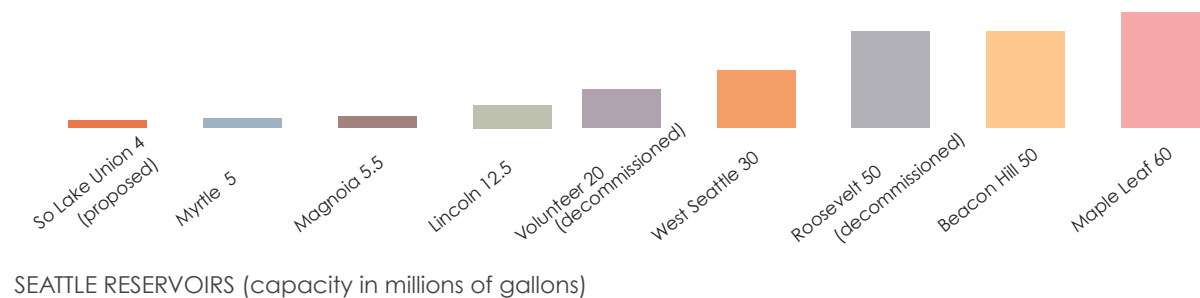


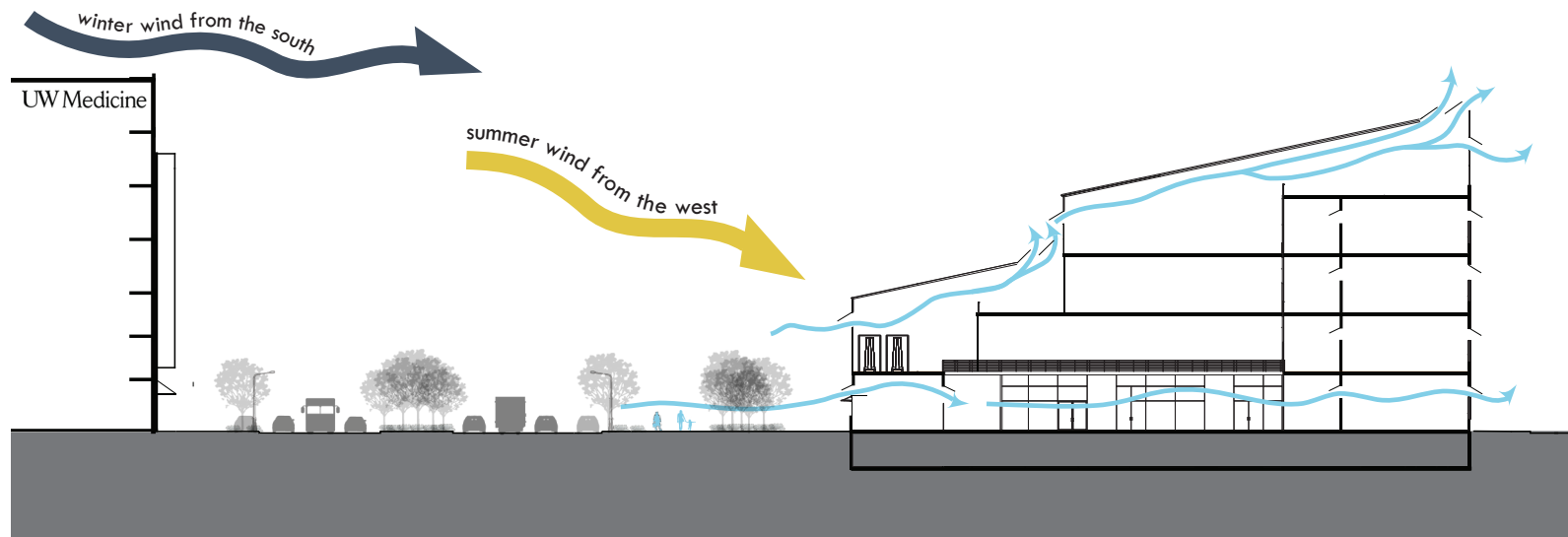
fig. 98 Water management system

fig. 99 Seattle reservoir capacities

However, two of them, Volunteer Park and Roosevelt, have been temporarily, and possibly permanently, decommissioned because they are uncovered. This site presents a perfect opportunity for a four million gallon city reservoir to replace some of the capacity lost from Volunteer Park and Roosevelt and serve the downtown area. The city reservoir would add another layer of water management and reflect the spirit of the project.

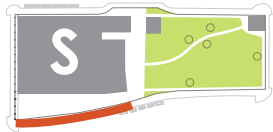
Light and Air

Light and air were also considerations in the design of the building, for both students and plants. The double-height greenhouse spaces and automated awning windows on the north and south facades promote cross-ventilation and passive cooling in the warmer months (fig. 100).





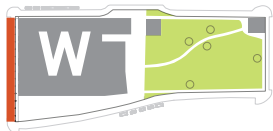
ROY ST: LABORATORY CLASSROOMS TO USE NORTH DAYLIGHT, SERVICE ENTRANCE



MERCER ST: GREENHOUSES, FOOD FOREST BUFFER, HORIZONTAL FINNS, LIGHT SHELVES



9TH AVE: FULL SUN ON GARDEN WITH RETAIL STREET WALL BELOW



DEXTER AVE: GREEN WALL TRELLIS FOR VINE PRODUCE AND SOLAR/ NOISE SCREEN

Light influenced how each edge of the site was treated and the design approach was to use plants to buffer people from harsh sunlight and noise whenever possible (fig. 101). The large laboratory classrooms were located on the north side of the building to take advantage of north light on that facade. The Freshman Farm and Food Forest create a light and noise buffer on the southern side, along with horizontal fins and classroom light shelves on the first level; the upper levels are all capped with the greenhouse structure on the south facade. The eastern edge contains the community/ student garden to capture full sun on the site. And finally, the western facade of the building, on the busy Dexter Avenue edge of the site, accommodates a trellis structure to support vine produce and act as a noise and solar screen for the western sun (fig. 102).



fig. 100 Air flows and the building

fig. 101 Treatments along each site edge

fig. 102 Green wall trellis on western facade

CHAPTER 5:

Conclusion

This thesis contends that the current method for feeding America's school children is unacceptable. It argues that the problems associated with bad school lunch and a children's health crisis are parallel to a broader problem in U.S. culture that relies on a resource-intensive food system, leaving its citizens—and future citizens—disconnected from their own health and the health of the environment. This proposed model for public high school suggests a different vision for educating children, using personal and environmental well-being as the focus and growing food as the tool. By bringing the processes of sustainable agriculture into children's own hands, the building and the curriculum would equip them with skills to be responsible leaders and successful world citizens in the next century.



fig. 103 *The way school lunch should be*

With this model in mind, the thesis could have been investigated from a number of angles. In fact, the most difficult part of the exploration was imposing limits on its breadth so that chosen aspects could be covered more thoroughly in the time allowed. Ultimately, the formative factors in the design were: successful spatial and educational collaboration between growing and students, applying building-integrated agriculture to optimize daylight conditions for plants and students, and utilizing the site and its relationship to the urban community to most effectively support the program. There are, however, three particular areas that would be interesting to explore further.

The literature review consistently revealed that a large part of the school lunch problem is that it disproportionately affects low-income children. The chosen site is not in a low-income area, but rather in a thriving, high-rent section of downtown. Unlike cities such as Detroit, Baltimore, or Philadelphia, Seattle does not have a impoverished residential area within its urban center; low-income children generally reside in

outlying neighborhoods due to the high cost of in-city housing. The idea was that a central location could serve these students best as a whole. It would be interesting to test this model, in a similar, but scaled-down form, in a low-income neighborhood of a city in economic distress, like Detroit. Could it stimulate jobs and change behavior like Growing Power did in Milwaukee? The small-footprint, high-yield rooftop greenhouses of BIA could allow high-density efficient use of urban space, and the benefits of fresh food would have a larger impact in these urban "food deserts," often limited to convenience stores and fast food. Perhaps a repeatable, small-school model could be developed to help children in these neighborhoods.

Secondly, the sustainable systems in this project are more suggestive than instructive. It was originally envisioned that the equipment necessary for sustainable processes such as harvesting rainwater, waste-heat capture, evaporative cooling, anaerobic compost and biogas production, and interactive kiosks that displayed cistern data and building performance would be part of the program. More attention could be given to these systems, potentially incorporating them more effectively into the design and operation of the school. Similar to the approach with food production and processing, these systems could be visible and accessible to maximize their educational potential.

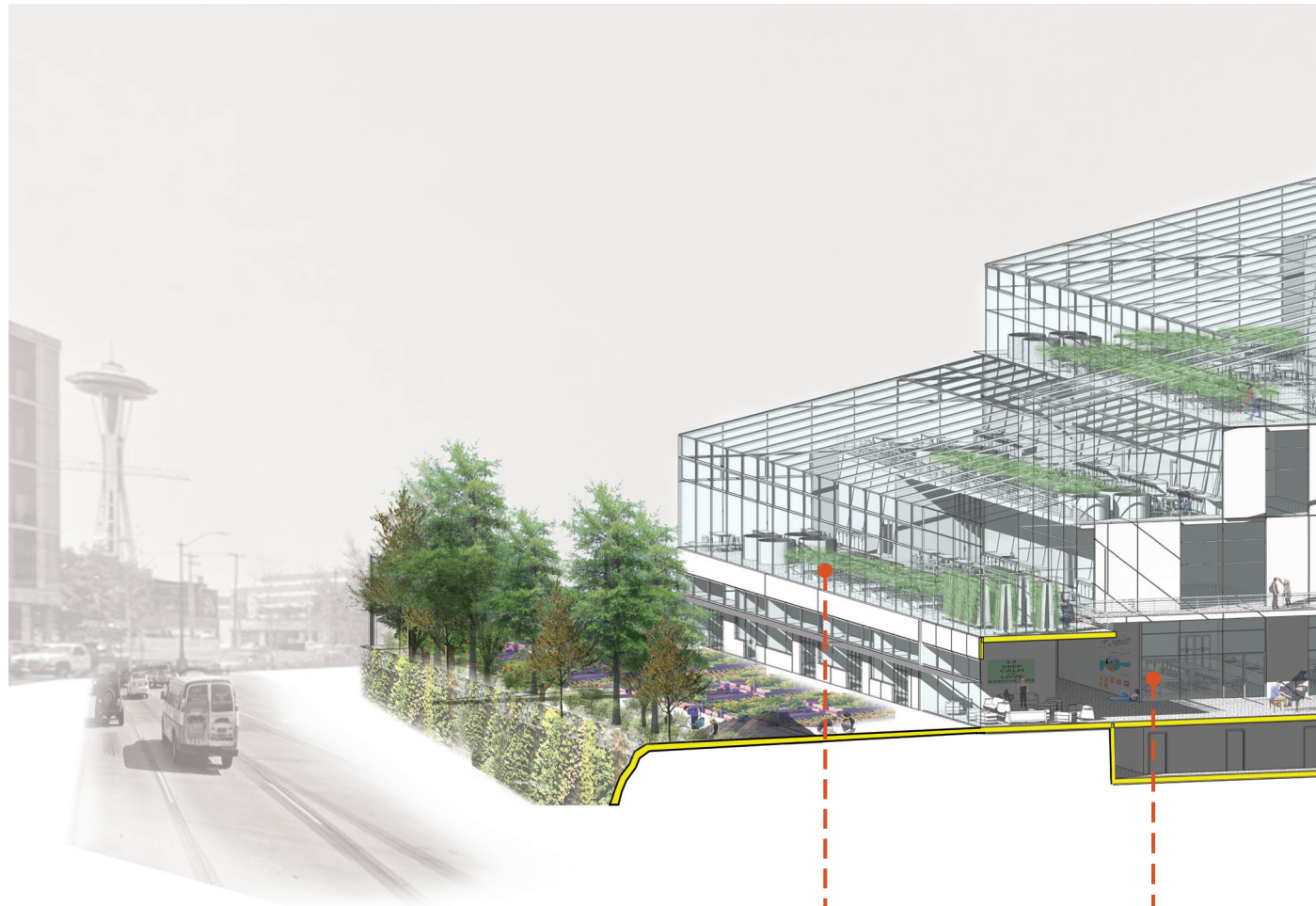
A final aspect that merits further investigation would be a cost-benefit analysis of this model. This thesis generated several ideas in both program and



design that could offset the high initial construction costs of this school. The same sustainable building systems that would enrich the program could also provide local and federal water and energy credits, along with ongoing operational savings in water, energy, and waste. Other economic considerations might be the school's ability to realize profits from not only produce, but secondary products like specialized jams, honey, eggs, mushrooms, and even compost. Would these ideas, along with volunteer and financial support from community and industry, enable this model to work in a variety of locations? Could existing schools be retrofitted with smaller BIA "packages" that enhanced existing lunchrooms and curriculum? Would success require untraditional partnerships, like Growing Power's alliance with Sysco or the one between Gotham Greens and Method eco-cleaning products that places the world's largest rooftop greenhouse on a new factory building for a BIA win-win? (Chow 2016) (fig. 104)

Although these areas were not explored, the section in figure 105 captures the spirit that this project hopes to convey—that a strong connection between food-growing spaces and experiential learning would support a hands-on curriculum that would excite teens about their health and sustainability. Along with this mission, the hope is that the iconic form and strategic location would motivate nearby corporate campuses to give back to Seattle's youth and public schools, and inspire a new attitude on how children are fed and educated. Certainly, Seattle's future leaders deserve no less.

fig. 104 Collaboration between Method Plant and Gotham Greens in Chicago, 2016

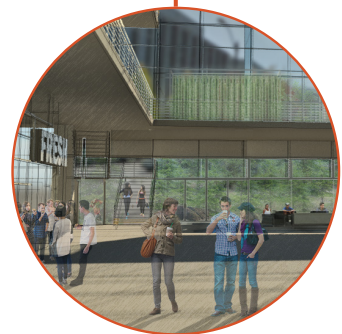
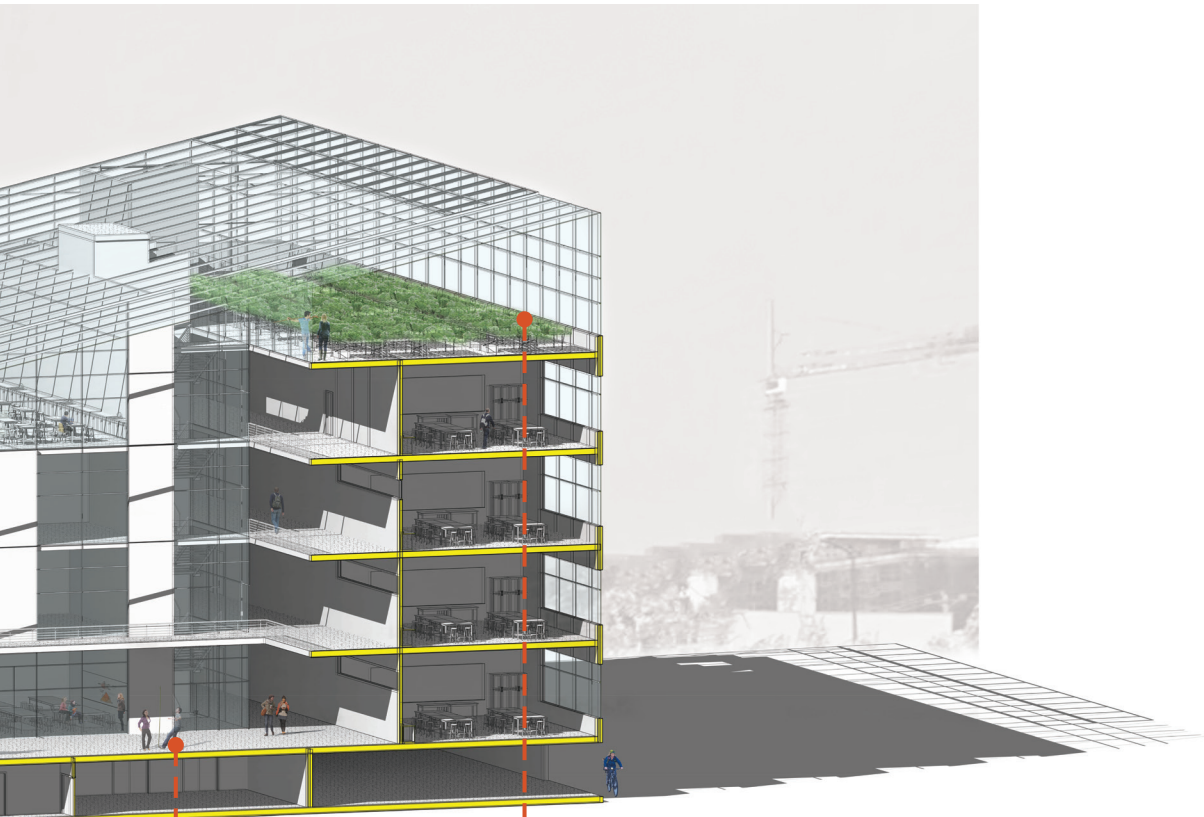


SOPHOMORE
GREENHOUSE
CLASSROOM

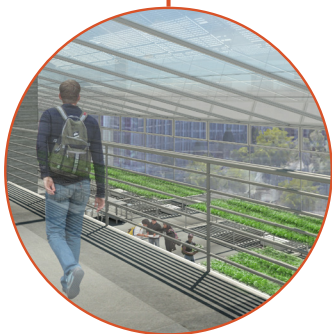


KITCHEN
CLASSROOM

fig. 105 Sectional perspective looking west



THE ATRIUM



SENIOR
PRODUCTION
GREENHOUSE

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Appendix

**There are a few examples in the United States of schools that grow high volumes of food for their lunch program. Denver Green School, a small public elementary school in Denver, Colorado, is a rare example of a public school that grows substantial quantities of produce for its school lunch (Figure 15). The garden supplies enough produce for the cooked meals and the cafeteria salad bar seven out of nine months of the school year. On a previously abandoned one-acre field behind the school, 70 varieties of vegetables and herbs are grown for a total of over 100 pounds of food per week. To make the project work financially, the farm is owned, managed, and operated by an urban agriculture nonprofit, Sprout City, then sold back to the school cafeteria at a loss. The plan works, however, with grants, private donations, and countless volunteer hours.

**Growing Power's farm-to-school efforts in the Chicago Public Schools District also inspired changes in the sourcing and planning of the other food items on the menu. After the carrot procurement, an advisory group of parents and educators formed to bring scratch-cooked, hormone-free, Amish-raised chicken drumsticks to the menu (Healthy Schools Campaign 2014). The group also organized a healthy cooking contest for high school culinary students. Reconnecting students with the source of their food was a catalyst for high participation and a broader change.



Sprout City runs the farm at Denver Green School, a public elementary in Denver, Colorado.

PROJECT:		A New Seattle Public High School (Building-Integrated Agriculture to supply its cafeteria)						LOCATION:		Seattle, WA (near downtown)			
ANNUAL OCCUPANCY:		1,200 students / September through June								47.45°N, 122.3°W			
NOON SUN ANGLES:		June: 66°		Sept/Mar: 43°		Dec: 19°		Annual Cloudcover: 72%		Primary Design Sky Condition: overcast			
PROGRAM ELEMENT	Occupancy Time + Duration	Is Daylight Important?	Views to the Exterior Important?	Direct Sunlight Control Needed?	Glare Control Needed?	Glare Control Crucial?	Space Darkening Required?	Design Illumination?	Ideal Daylight Aperture Strategy?	Ideal Solar Orientation?	Organization on Site?	Electric Lighting Controls?	Notes
Classrooms	7:30am - 3pm	VERY	YES	YES	YES	YES	SOME	45 fc	Side, possibly Top Lit	North, South, Maybe West	Top Floors (Under roof)	Continuous dimming? Blinds?	close/view to greenhouses
Cafeteria	7:30am - 3pm	SOMEWHAT (atmosphere)	SOMEWHAT (atmosphere)	SOME	NO	NO	NO	45 fc	Side, possibly Top Lit	North, South, Maybe West	building perimeter	Zoning?	close/view to greenhouses
Auditorium	7:30am - 3pm (intermittant)	NO	NO	NO	NO	NO	YES	30 fc	none	Doesn't matter	Bottom floor (building interior)	Dimming, specialty lighting	
Gymnasium	7:30am - 3pm	VERY	NO	YES	YES	YES	NO	45 fc	Top lit	Doesn't matter	Top Floors (Under roof)	Continuous dimming?	
Library	7:30am - 4pm	SOMEWHAT (atmosphere)	SOMEWHAT (atmosphere)	YES	YES	NO	NO	45 fc	Side-lit for desks, Top-lit for stacks	North, South, Maybe West	building perimeter	Continuous dimming?	
Offices	7:30am - 4pm	VERY	YES	YES	YES	YES	SOME	45 fc	Side Lit	North, South, Maybe West	building perimeter	Continuous dimming? Blinds?	
Commons	7:30am - 3pm	SOMEWHAT (atmosphere)	YES	NO	NO	NO	NO	30 fc	Side Lit	Doesn't matter	building perimeter	photo-responsive?	
Restrooms	7:30am - 4pm	NO	NO	NO	NO	NO	NO	15 fc	indirect (clarestory) or side lit	Doesn't matter	Doesn't matter	photo-responsive?	
Corridors / Circulation	7:30am - 4pm	SOMEWHAT	NO	NO	NO	NO	NO	15 fc	indirect (clarestory) or side lit	Doesn't matter	Doesn't matter	photo-responsive?	
Greenhouses	7:30am - 4pm	VERY	NO	YES	NO	NO	SOME	700 - 5000 fc	Top and Side-Lit	South	Roof	Switching / zoning	

Daylighting criteria and considerations for a high school located in Seattle

RELEVANT CASE STUDY PROFILES - USING URBAN AGRICULTURE TO SUPPLY FOOD SERVICE									
GARDENS FOR TEACHING/EDUCATION									
Organization	Key Concepts	Location	Leader(s)	Operation	Growing Systems/Other Technologies	Growing Area	Annual Yield	Distribution	Description of Project
The Edible Schoolyard (ESY)	Soil-based, school gardens, kitchen classrooms, garden classrooms	Berkeley, New Orleans, San Francisco, Los Angeles, New York City, Lake Placid.	Alice Waters	Teaching Institution--about educations/classrooms, not school lunch per se.	Guiding Principles are: PARTICIPATORY, INTEGRATED, SHARED, DELICIOUS, BEAUTIFUL, but connection to school lunch is through the Berkely Unified School District School Lunch Initiative. "The fully realized vision of edible education has always been to mirror the lessons of the kitchen and garden classroom at ESY Berkeley with real food served in the lunchroom."	N/A	N/A	N/A	Started in 1995 as a 1-acre garden at MLK Jr Middle School in Berkeley. Now teaching institution for promoting integration of organic gardening into school's curriculum, culture, and food program. Aims to involve students in growing, harvesting, preparing, and sharing food, learning about food and food systems, and improving food choices.
The Science Barge	Hydroponics, net zero energy, net zero waste stream, building integrated agriculture	New York, New York	Ted Caplow, New York Sun Works	Prototype of floating sustainable urban farm	Recirculating hydroponics powered by solar, wind, and biofuel. Zero net carbon, zero chemical pesticides, zero runoff. Water from desalinization that converts brackish water of Hudson River to fresh water and rainwater catchment. Barge also has aquaponic capacity.	1200 sqft aluminum greenhouse with glass walls and polycarbonate roof.	N/A, however, provides research and training for Get Fresh Yonkers Food Co-op, Farmers Market, and CSA	N/A	Sustainable, floating urban farm designed and built by New York Sun Works, environmental non-profit, in 2007. Mission is to stimulate development in sustainable food production and building-integrated agriculture.
Watchung Public School	Hydroponic lab, soil-based gardens	Montclair, New Jersey	Amy Armstrong (science teacher) + PTA	Public K-5	Hydroponic Lab: NFT system for spinach, kale, swiss chard, collard greens, herbs) + vine crop (Dutch Bucket) system for tomatoes, squash, cucumbers, eggplant, and peppers. School also has an outdoor soil garden. All for teaching purposes, no large production. Will add aquaponics in the future.	School greenhouse was converted to hydroponic lab	Science curriculum use only right now, but hope to eventually supply to cafeteria and sell herbs/produce at local farmer's mkt or food pantry.	N/A	Converted school greenhouse to hydroponic lab run by science teacher, total cost \$21,000 (from PTA). New York Sun Works designed layout, construction, teaching curriculum, and provides on-going support.
Kitchen Garden Project	Lunch Reform, local, organic, sustainable	Sheffield, UK	Jamie Oliver						more about menu/food quality reform and food education rather than growing food onsite for the food service.
GARDENS FOR FOOD SERVICE, WORKPLACES									
Organization	Key Concepts	Location	Leader(s)	Operation	Growing Systems/Other Technologies	Growing Area	Annual Yield	Distribution	Description of Project
Plantronics, Inc (employees cafeteria)	micro hydroponic farms, supplies employee cafeteria	Santa Cruz, California	Ken Kannappan, CEO	Consumer Audio equipment	Small, modular, hydroponic, computer-automated micro farms, designed and installed by company. Cityblooms (also in Santa Cruz). Farm units grow all the microgreen needs of the employee cafeteria.	1,500 sqft produced 750 lbs of produce to the onsite café in 2 months	10 cultivation units (400sqft) can grow 50-60 lbs of fresh greens/week. 16 units can grow 5 tons of lettuce/year.	Harvest the bins, load on a bike trailer, and bike them 200 yards to the kitchen.	Producing the greens onsite prevents them from losing nutrition in storage and transit, save 10,000 gallons of water annually, no fertilizer run off, measure farm-to-fork distance in yards rather than miles. Also eliminates the financial and environmental costs with food waste and food transportation.

GARDENS FOR FOOD SERVICE, PUBLIC K-12									
Organization	Key Concepts	Location	Leader(s)	Operation	Growing Systems/Other Technologies	Growing Area	Annual Yield	Distribution	Description of Project
The Berkely School Lunch Initiative (BSLI)	School Lunch Reform, local, organic, sustainable food, National School Lunch Program	Berkeley, California	Carina Wong, Executive Director Chez Panisse Foundation, Ann Powers, Director of Nutrition Services at Berkeley	Started in 2004, 2008 white paper details ground breaking program in lunch reform	Lured children back into cafeterias with delicious, seasonal, sustainable, local fresh food. Locally grown or sourced, soil-based.	N/A	N/A	All produce regionally sourced (from California or Washington to Berkeley)	This report contains information on existing food service costs, funding sources, the National School Lunch Program (NSLP), and details on how food service programs are currently structured, paid, supplied. Very successful program, but details political, logistical, and economic barriers.
Denver Green School	Soil-based garden on campus to supply cafeteria, partnerships	Denver, Colorado	Allen Potter, teacher, Chad Hagedorn, Sprout City Manager	K-8 Public School (alternative)	Traditional soil farm on previously abandoned 1-acre field behind the school. Owned/Managed by Sprout City Farms, urban agriculture non-profit. Food is grown by Sprout City and sold back to the school cafeteria. Farm produces over 70 varieties of vegetables and herbs (kale, chard, spinach, cauliflower, tomatoes, cucumbers, squash...)	1-acre (about a football field) right behind the playground!	Farm provides produce for salad bar and cooked meals 7 out of 9 months per year. Grows >100 lbs of food/week. Also provides food to neighborhood and community.	on-site production, hand-carried to cafeteria	Arrangement took 18 mos to negotiate with the school district. Broke ground March, 2011. Total project cost less than \$20K. Sprout City matches school district wholesale rates--same as they would get from Sysco industrial ag. Produce is organically grown. They lose money for selling at the low rate, but make up for it with fundraising, community, and volunteer support (they are a non-profit).
Maize High School	Hydroponic, vertical farming, supply to cafeteria	Maize, Kansas	Jay Super, science teacher	Public High School	Zipgrow, hydroponic or aquaponic vertical farming towers in the school hallways. Zipgrow towers can grow lettuce, kale, collard greens, chard, bok choy, mustard greens, radicchio, herbs, strawberries, cucumbers, bell peppers, chili peppers. Towers are lightweight, scalable, mobile.	many vertical towers (3'x5') lining the hallways	8 towers = enough salad for one lunch period in 4 weeks	on-site production, hand-carried to cafeteria	With the help of a Kansas Department of Agriculture Farm to School sub-grant, students are learning about hydroponics and growing produce for the school cafeteria.
GARDENS FOR FOOD SERVICE, UNIVERSITIES									
Organization	Key Concepts	Location	Leader(s)	Operation	Growing Systems/Other Technologies	Growing Area	Annual Yield	Distribution	Description of Project
Duke University	Soil based, CSA, high-yield	Durham, North Carolina	Saskia Cornes, Farm Manager	Campus Farm	Working (Soil-based) Farm started in 2010, provides produce to campus dining halls and CSA members. Grows 124 varieties of crops.	1-acre soil farm, one greenhouse, 1 hoop house, seedling production using heated high tunnel.	7,500+ lbs food/year	Sold \$6,760 worth of food to Duke Dining in summer, 2015. Also provides CSA to local members.	Farm has 3 objectives: make Duke a leading food educator, strengthen and connect disparate food issue efforts, and INCREASE ACCESS TO AND CONSUMPTIONS OF LOCAL, SUSTAINABLE, STUDENT-GROWN FOOD ON CAMPUS.
Green Mountain College (Farm and Food Project)	Soil-based, supplies cafeteria	Poultney, Vermont	Paul J. Fonteyn	Private College	Soil-based agriculture, greenhouses, animal husbandry, built 2 high tunnels (root-zone solar hot-water heating) in 2010, studying mobile flash-freezing for 3 growing seasons for institutional and food pantry use.	2-acres for veggies, 15-acres for pastures	14% of college's total food purchases are site-or locally-sourced,	Farm provides produce to campus, as well as to CSA members and to local farmer's markets.	student-motivated campus farm. Mission of environmental and personal stewardship, civic engagement, food justice, and global understanding. Dining hall composting creates a closed loop local food system.



