Living Laboratory:
A Circular Framework for North Seattle Community College

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Julie Johnson

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Abstract

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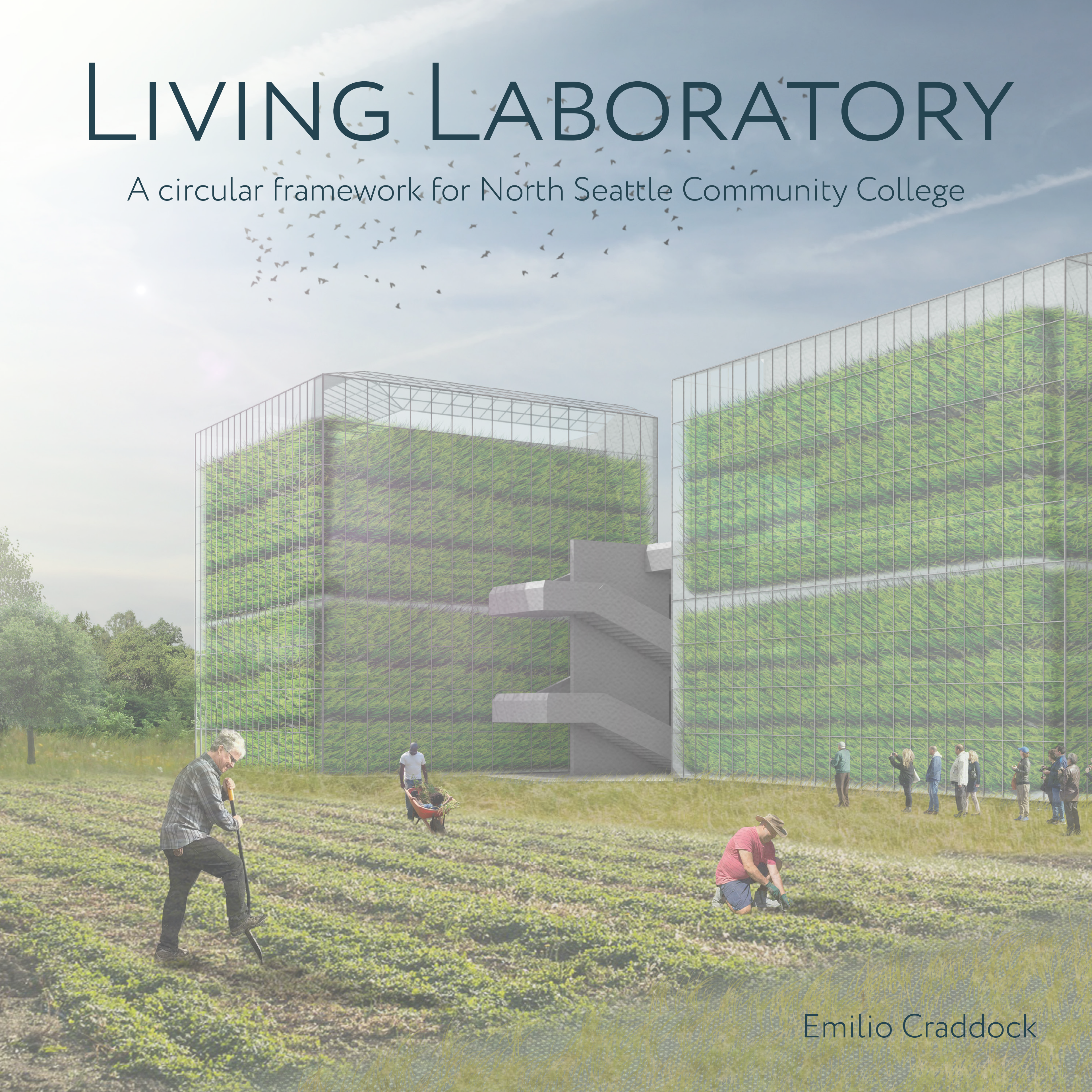
This thesis proposes North Seattle College as a living laboratory to explore the future of sustainable development at the district scale. As cities continue to increase in density and the problems caused by climate change continue to intensify, it is important for cities to become more sustainable and resilient. Holistic sustainable design, that prioritizes the health of ecological systems, lessens a city's ecological footprint and mitigates the negative impacts on the environment by designing efficient buildings, generating energy on site and closing resource loops. The future of urban living will rely on thinking holistically about the way buildings situate themselves within the urban fabric and the relationships these buildings have with the surrounding ecological systems. To maximize the impact of sustainable design, systems should be organized at the scale of city districts where resource flows become evident. Buildings should push their systems beyond the building and influence the surrounding environment on an ecological and social level. Incorporating principles of circular cities, regenerative design, and the Water-Food-Energy Nexus into the North Seattle College campus allows the school and its users to move beyond limiting their impacts and minimizing resource use; they will begin giving back to the earth. North Seattle College is a prime location to explore how integrating the flows of food, water, and energy into circular systems can allow a college campus to operate more sustainably and inter-dependently within the broader ecological context.

Living Laboratory

A circular framework for North Seattle Community College



Emilio Craddock

Abstract

This thesis proposes North Seattle College as a living laboratory to explore the future of sustainable development at the district scale. As cities continue to increase in density and the problems caused by climate change continue to intensify, it is important for cities to become more sustainable and resilient. Holistic sustainable design, that prioritizes the health of ecological systems, lessens a city's ecological footprint and mitigates the negative impacts on the environment by designing efficient buildings, generating energy on site and closing resource loops. The future of urban living will rely on thinking holistically about the way buildings situate themselves within the urban fabric and the relationships these buildings have with the surrounding ecological systems. To maximize the impact of sustainable design, systems should be organized at the scale of city districts where resource flows become evident. Buildings should push their systems beyond the building and influence the surrounding environment on an ecological and social level. Incorporating principles of circular cities, regenerative design, and the Water-Food-Energy Nexus into the North Seattle College campus allows the school and its users to move beyond limiting their impacts and minimizing resource use; they will begin giving back to the earth. North Seattle College is a prime location to explore how integrating the flows of food, water, and energy into circular systems can allow a college campus to operate more sustainably and inter-dependently within the broader ecological context.

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Chapter One

World View

Mentha arvensis at Prairie Creek Redwoods State Park, California, photo by Emilio Craddock

Fig 1.1
The Blue Marble taken by the crew of the Apollo 17 en route to the moon in 1972

Where We Are

The Earth's biosphere as a home for humanity is at risk. A myriad of problems including pollution, deforestation, overpopulation, and greenhouse gas (GHG) emissions are leading to a historic loss of biodiversity and the disastrous consequences of anthropogenic climate change.[1 2] The last 50 years have seen a dramatic rise in global temperatures, sea level, and severe weather events that are projected to continue well into the future.[3] Given current climate trends, the average global temperature increase is very likely to exceed 1.5°C leading to further sea level rise, heatwaves, heavy rainfall paired with increased periods of drought and "a change in the frequency, duration, and/or magnitude of extreme weather events."[4] The U.S. Global Climate Change Research Program has concluded that "it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century."[5] The Millennium Ecosystem Assessment (2005) estimates that 60% of global ecosystem services are degraded or are being managed unsustainably.[6] Solutions to complex problems, like climate change, require broad, multifaceted approaches composed of numerous actors working together across multiple scales. As humans, we have a responsibility to protect The Earth, our only home in the universe, and live sustainably and in harmony with our natural environment. Sustainable living attempts to integrate environmental health and social equity to create thriving, diverse and resilient communities for this generation and generations to come. This type of sustainability is not centered on humans and human health, but on holistic environmental wellbeing.

Built Environment

In 2007, for the first time in human history, more than half the world's population lived in urban areas. Since then, that number has continued to rise and is projected to be nearly 70% by 2050.[7] Urbanization continues to have a negative impact on climate change. New construction in 2018 represented 38% of global energy-related CO_2 emissions.[8] 75% of global natural resources and 80% of the global energy supply are consumed in cities. Additionally, cities and their inhabitants have been shown to be responsible for up to 80% of GHG emissions worldwide.[9] The cities we live in today are not only bad for the earth, but they are also often bad for humans as well.

In his book *Sustainable Urbanism* (2008), Douglas Farr makes the case that today's cities are bad for humans because they are polluted places that force people to stay sedentary and indoors, detached from nature. Babies born in the U.S. today will spend 87% of their life indoors.[10] Farr argues that we need to rethink how cities work and return to a time when cities were in tune with the world's natural systems.

Rethinking cities begins by assessing human relationships with natural resources and the environmental systems we live within. For the past century, the natural world has been treated as an infinite

Fig 1.2 Smog Over Tokyo, Japan

source of resources for humans to consume with no repercussions. Mountains are leveled, forests are cut, and ecosystems are demolished without a thought for the role these environments played and the larger impact that their destruction will have. To sustain the Earth for future generations, we will need to shift away from the perception of nature as a resource to nature as a delicate system that humans are only a small part of. This shift can occur in cities by allowing the built environment and nature to coexist. As Timothy Beatley asserts in his book *Biophilic Cities* (2011), it is essential to have nature in our cities. Direct and indirect exposure to nature has profound "social, psychological, and pedagogical" benefits for humans.[11] In their book *Ecological Deign* (2010) Nancy Rottle and Ken Yocom write that designing sustainable natural systems within the built environment not only connects people with nature, but it also makes it possible to "significantly reduce the human ecological footprint on the planet.[12] This type of design, coined ecological design, "aims to improve ecological functioning, preserve and generate resources for human use and foster a more resilient approach to the design and management of the built environment."[13]

Sustainable systems in cities should range across scales, from street design details to regional policies. While the integration of nature within the built environment should be an integral part of a city's sustainable framework plan, it is equally important to consider the many other resource streams that make urban life possible. City dwellers today rely on uninterrupted access to water, food, and energy. In our current development model, these three essential resources must be transported to cities across states, nations, and sometimes around the entire globe. This thesis argues that the most sustainable framework plan for urban built environments is one that integrates ecological design principles with a systematic circular approach to the production, consumption and reuse of water, food, and energy.

Fig 1.3 Deforestation in the Amazon rainforest

Fig 1.4 Canopy park connectors in Singapore

Endnotes

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Puget Sound, image from Google Earth

Chapter Two

Frameworks

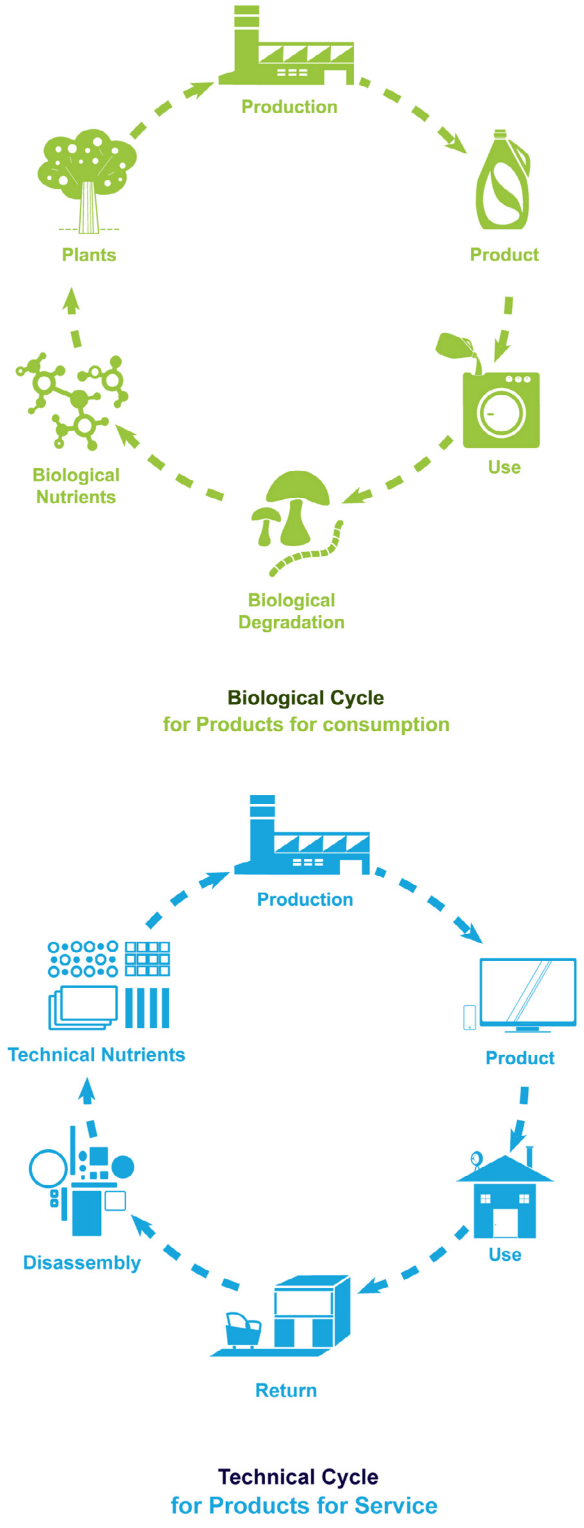

Fig 2.1 Cradle to Cradle framework by McDonough and Braungart

Sustainable Cities

To better understand what it could mean to design sustainably, it is helpful to investigate existing frameworks that operate across different scales. These frameworks clarify how complex systems work and emphasize connections and flows between inputs, outputs, and functions. While simple, these frameworks lay the groundwork for a systems-based, holistic approach to sustainable design and can get at the heart of how sustainable design can manifest within cities. Three frameworks that work together to provide a comprehensive view of sustainable design are Circular Cities, Regenerative Design, and the Food-Water-Energy Nexus.

Circular Cities

The concept of closed-loop systems and economies has been around since the 1960s and originally centered on developing economic policies. Over the past 50 years the concept has evolved from solely focusing on industrial and economic optimization to an emerging approach to sustainability.[1] In *Cradle to Cradle* (2002), Braungart and McDonough posit a circular system (Figure 2.1) in which "everything is a resource for something else."[2] In opposition to the cradle-to-grave mentality of use and discard, Cradle-to-Cradle supplies a framework for how to develop an economy that is built around the concept of reduce-reuse-recycle. Said economy should strive to design products with their end-of-life use planned from the onset.

However, applying the principles of circular economies to cities "is about a great deal more than creating a circular economy and circular business models within the urban context. It is about the regeneration and renewal of complex urban ecosystems."[3] The concept of the Circular City (Figure 2.2), which expands on the ideas of Cradle-to Cradle and evolved from frameworks set in place by the Ellen MacArthur Foundation, has three principal

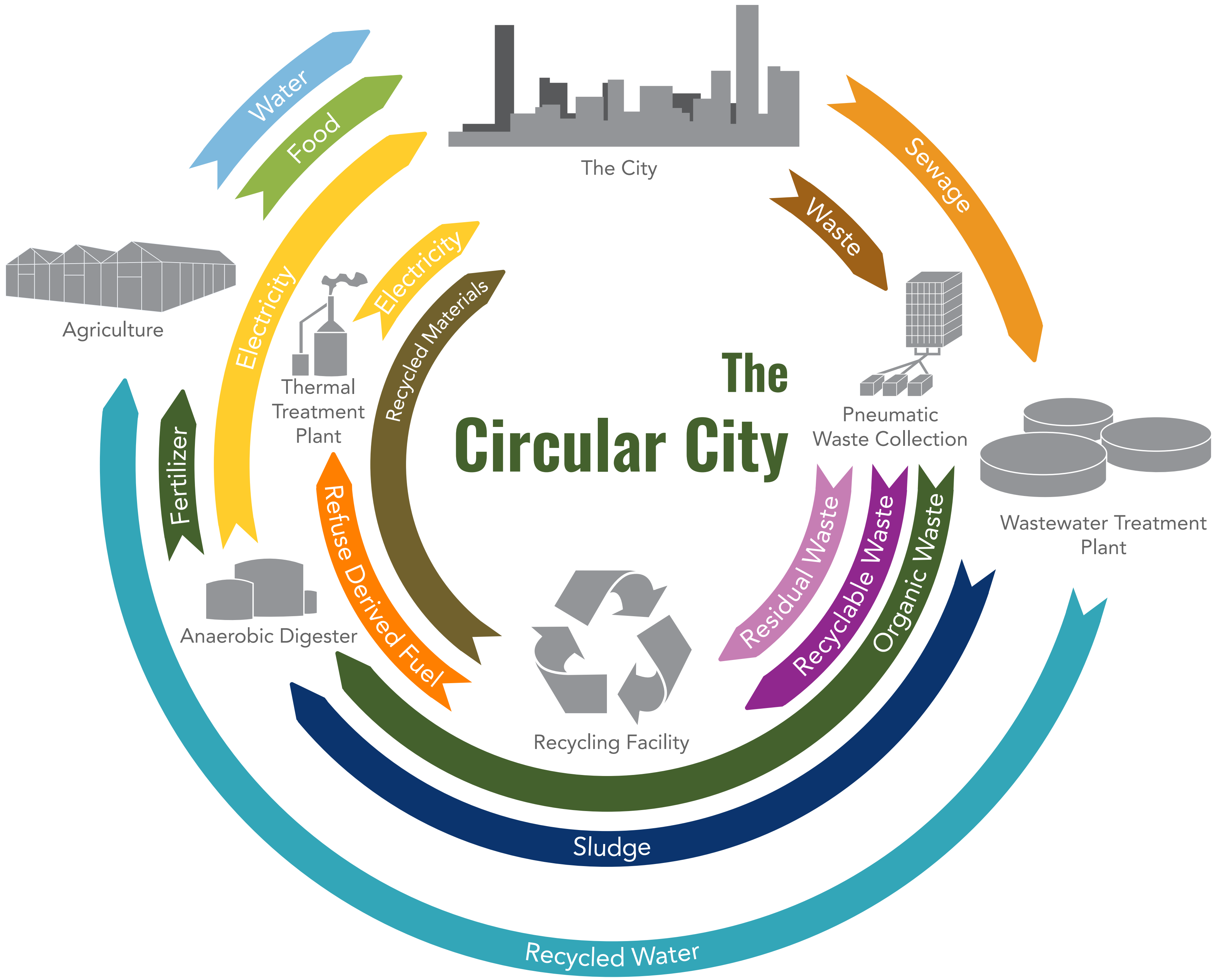

Fig 2.2 Resource flows in The Circular City

aims: “to reduce resource consumption and waste; preserve natural capital and ecosystem services; and design out negative externalities (economic, social, and environmental) associated with resource wastage and degradation of natural capital and ecosystem services in the city.”[4] The city should behave as a closed system in which resource input, waste, emissions and energy use are minimized by closing and narrowing material and energy loops.[5] Closing resource loops through recycling, re-use and energy recovery and restoring the urban ecosystem through regenerative green and blue infrastructure strategies leads to cities evolving into more sustainable ecosystems.[6]

Regenerative Design

While cities only cover 3 to 4 percent of the earth surface area, their ecological footprints affect most of the earth. Regenerative design stems from the need to foster a proactive relationship between humanity and the world’s ecosystems.[7] In her book *Regenerative Urban Design and Ecosystem Biomimicry* (2018), Maibritt Zari defines regenerative design as a concept that:

> “seeks to address the continued degradation of ecosystem services by designing and developing the built environment to restore the capacity of ecosystems to function at optimal health for the mutual benefit of both human and non-human life. Crucial to regenerative design is a systems-based approach. Buildings are not considered as individual objects but are designed to be parts of larger systems, and are considered as nodes in a system, much as organisms form part of an ecosystem.”[8]

Cities that develop regeneratively use cutting edge technologies and forward-looking urban design strategies to restore the “relationship between cities, the natural world and future life.”[9] Regenerative design strives to move beyond minimizing pollution and resource use and strives to contribute more than it consumes while simultaneously remediating past and current environmental damage.[10]

A keystone of regenerative design is the concept of environmental feedback loops (Figure 2.3). The existing loop today is a negative feedback loop where destructive human activity has detrimental effects on the earth’s delicate environmental systems and the climate. In turn, these effects amplify the impacts of climate change and negatively affect human life. The feedback loops in regenerative design aim to reverse these systems by increasing resilience and strengthening environmental systems that will

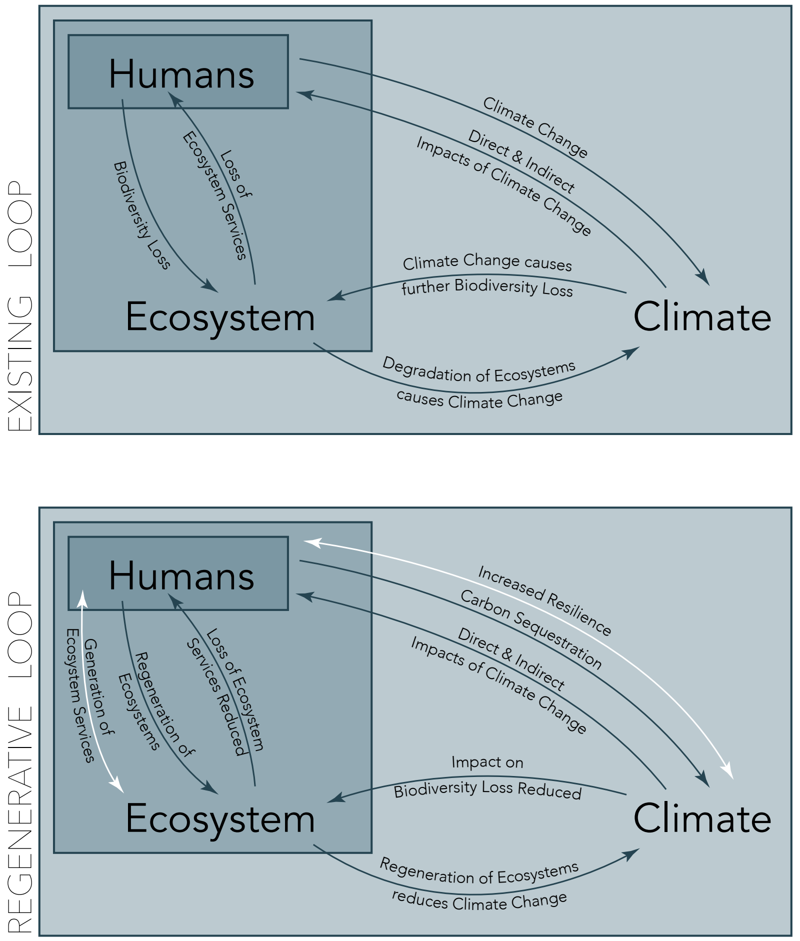

Fig 2.3 Regenerative Design feedback loop

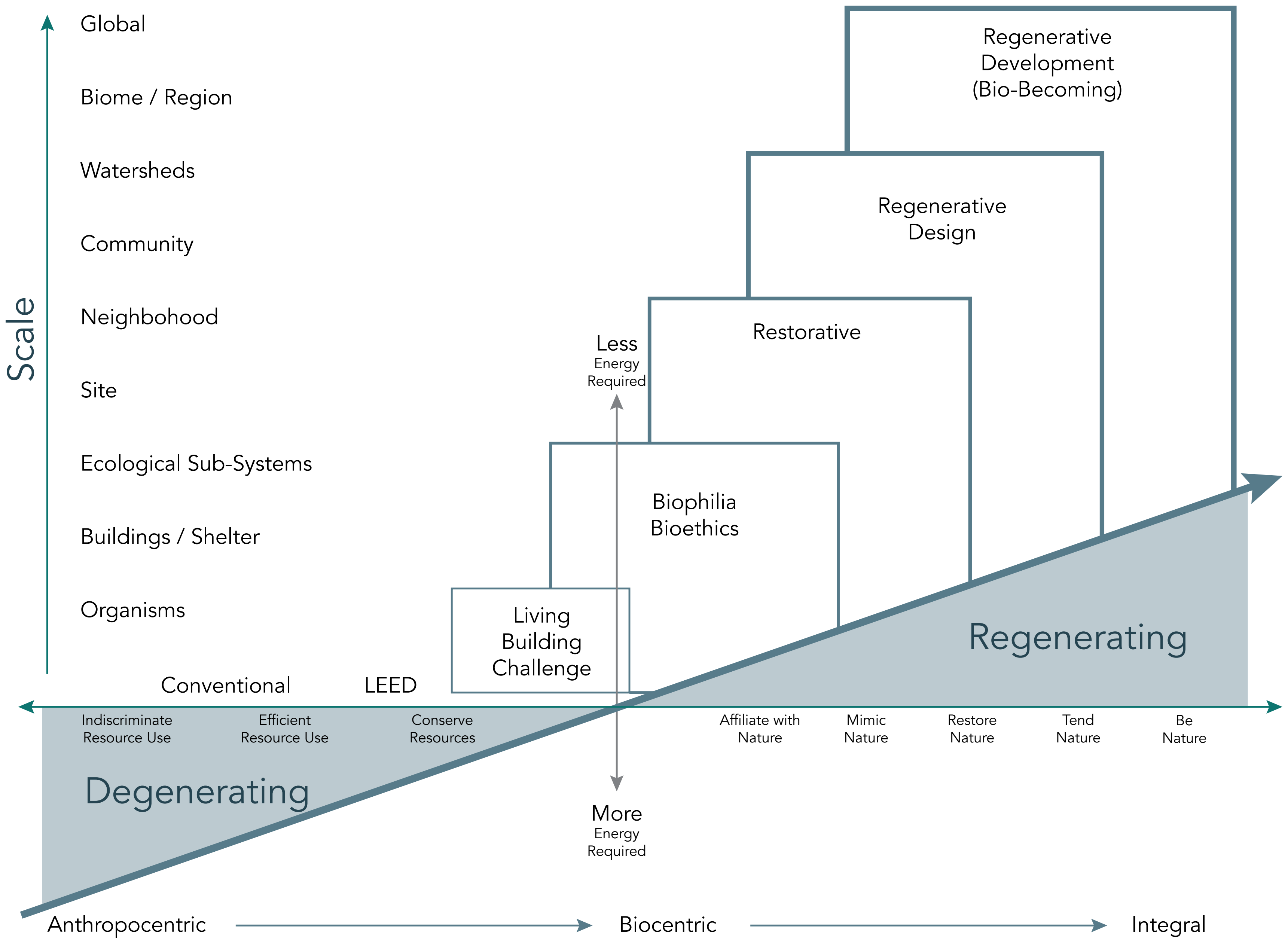

Fig 2.4 Sustainable design practice impact scale

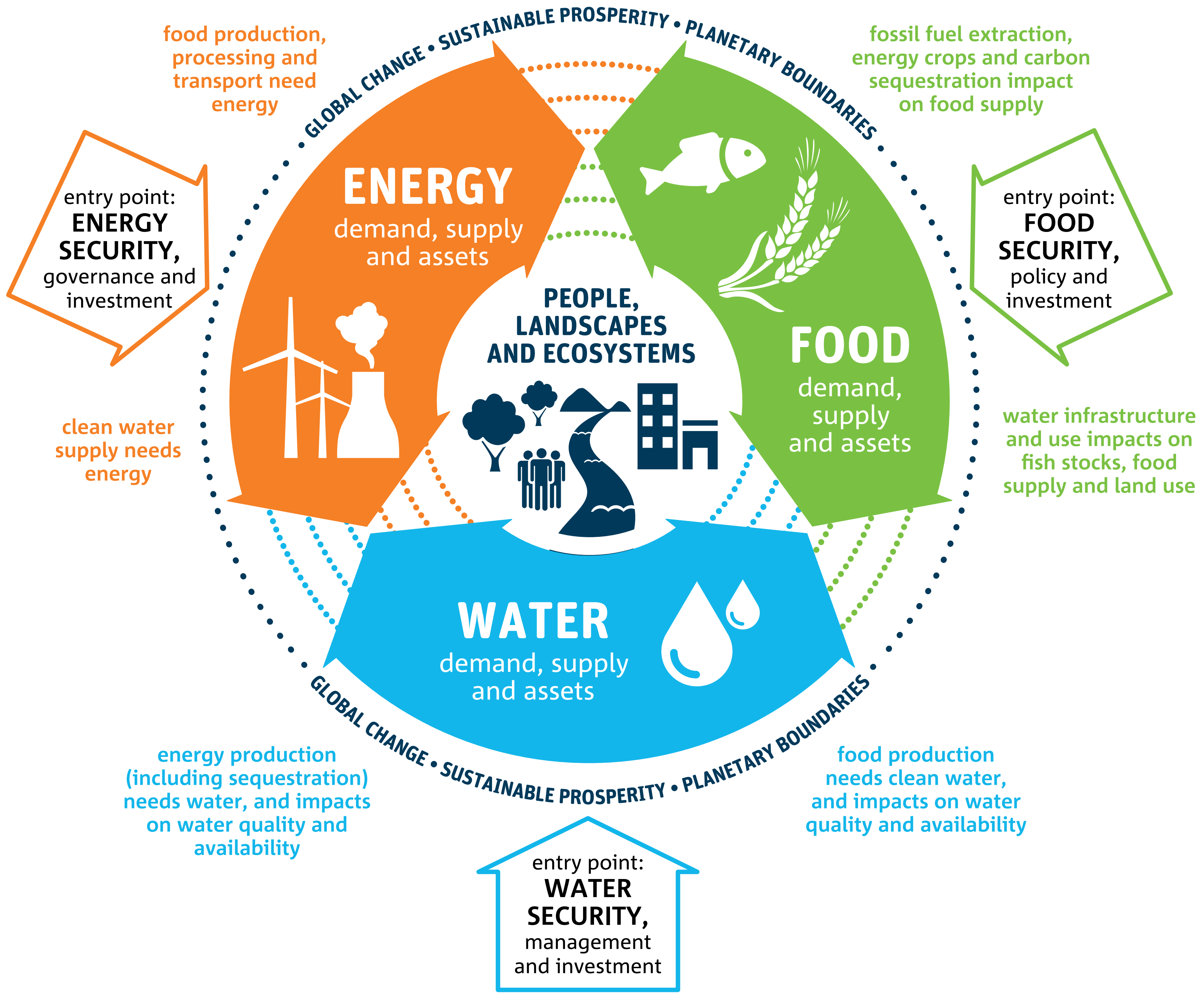

Fig 2.5 Water-Food-Energy Nexus

inevitably reduce climate change. These regenerative systems strive to push beyond conventional sustainable strategies that are used in the built environment today (Figure 2.4). Zari argues that sustainable frameworks such as LEED and the Living Building Challenge, while better than conventional design, do not push design far enough. To change how the built environment affects the Earth, design should "positively address both climate change and the loss of biodiversity at the same time."[11]

Food-Energy-Water Nexus

In 2015 the United Nations adopted *The 2030 Agenda for Sustainable Development*, an agreement between all UN member nations to implement 17 Sustainable Development Goals (SDGs) and 169 targets that "will stimulate action over the next fifteen years in areas of critical importance for humanity and the planet."[12] The SDGs focus on "achieving sustainable water use, energy use and agricultural practices, as well as promoting more inclusive economic development."[13] The Water-Energy-Food Nexus (WFE Nexus or Nexus) plays a central role in understanding the complex and interrelated nature of our global resource systems, on which we depend to achieve different social, economic and environmental goals.[14] The Nexus approach (Figure 2.5), which also began as an economic tool, was originally conceived "to promote the inseparable links between the use of resources to provide basic and universal rights to food, water and energy security" at a macro scale.[15] It can help to systematically analyze the interactions between the natural environment and human activities, and to work towards a more coordinated management and use of natural resources across sectors and scales.[16] The key purpose of the Nexus is to find areas of overlap between resource flows and use the relationship to design more sustainable systems. Analyzing water, energy, and food as one complex and inseparable network at the scale of a city or smaller can lead designers to focus on the synergies between them and develop sustainable approaches.

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Chapter Three

Case Studies

Solar Panels on the Bullitt Center in Seattle, WA, photo by Solar Panel Associates

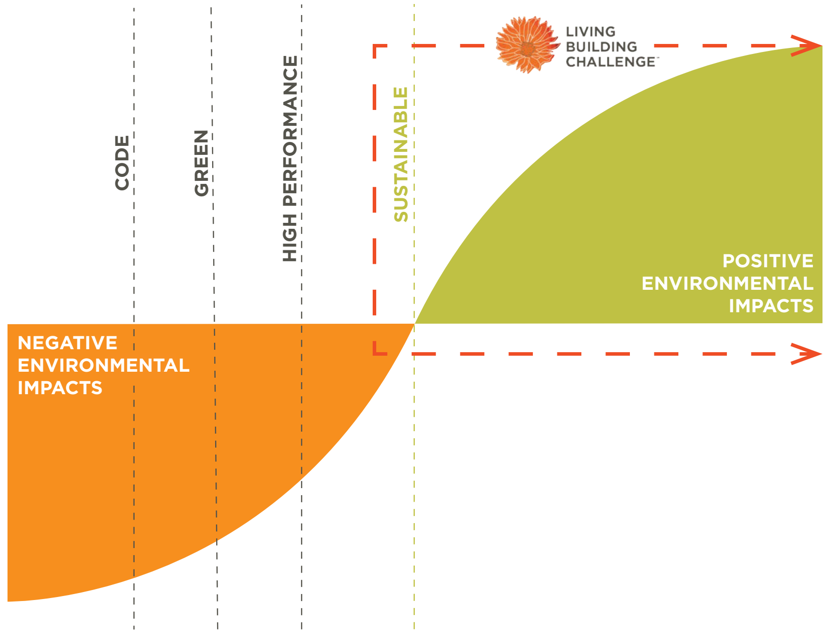

Fig 3.1 Living Building Challenge Impact Graph

Fig 3.2 Heavy timber in the Bullitt Center co-working space

In this chapter, four existing projects are unpacked, and their embedded sustainable interventions and internal organization are related to the sustainable frameworks described in Chapter Two. The projects are divided into two scales: the site scale and the district scale. They are arranged from the smallest site to the largest. The two projects at the site scale are high-performance buildings that meet the rigorous requirements of the Living Building Challenge, a sustainable building standard set by the International Living Future Institute. Resembling Regenerative Design, the Living Building Challenge is "an attempt to dramatically raise the bar from a paradigm of doing less harm to one in which we view our role as a steward and co-creator of a true Living Future." The goal is to move beyond solely offsetting the built environment's negative impacts but to actively design for positive environmental impacts (Figure 3.1). The two projects at the district scale encompass larger city zones and provide an example of how an integrated design process can lead to the development of integrated water, energy, and food systems.

Site Scale: The Bullitt Center

Constructed in 2013, The Bullitt Center is a six-story office building in downtown Seattle, WA that markets itself as the "most sustainable office building in the world" with a lifespan of 250 years.[1] The design intent behind the project was to create a building that had the same ecological footprint as a typical Douglas fir forest from the Pacific Northwest United States, the ecosystem originally on the site.[2] This is achieved by producing and collecting all the energy and water used within the building on site. Electricity and heat for the building are generated from the 14,000ft^2 photovoltaic array on the roof and the network of geothermal heat pumps bored 400ft into the ground below.[3] The building collects and stores rainwater

Fig 3.3 The Bullitt Center in Seattle, WA

Fig 3.4 Bullitt Center Basement Composters

Fig 3.5 Lagoon at the Phipps' Center for Sustainable Landscapes

that falls on the site in a 56,000-gallon tank in the basement. This water is purified and used throughout the building. Additionally, the bathrooms use composting toilets (Figure 3.4) which reduce water use and eliminate the need for a sewer connection. The circular water cycle throughout the building is an excellent example of how integrated systems reduce the environmental footprint of the built environment. The Bullitt Center is an example of a project that analyzed overlaps within the building's required systems and used those overlaps to develop efficiencies within the design. This thesis attempts to push the sustainability goals of the Bullitt Center and apply them on a larger scale.

Site Scale: Center for Sustainable Landscapes

The Center for Sustainable Landscapes (CSL), which opened in 2012, is an education and research building at the Phipps Conservatory and Botanical Garden in Pittsburgh, Pennsylvania. Occupying a 2.9 acre converted brownfield, the 24,0000-square-foot facility is designed as a net-zero facility and the project generates all its own energy and treats and reuses all water captured on site.[4] The new institution supports the Phipps Conservatory's 350,000 annual visitors and aims to maximize public interaction with sustainable technology.[5] The site is planted with over 100 native species and features a range of ecosystems and habitats. In addition to state-of-the-art sustainable design solutions on the interior of the building such as the geothermal well, the project combines building and site elements to achieve its sustainability goals. Figure 3.6 demonstrates the holistic site thinking. Water is collected, stored, and then reused in the building as well as on site for irrigation. The water flows are overlayed with the sites energy systems and then the opportunities for integration, such as the hot-water radiant floor, are highlighted for visitors to better understand the sustainable design features of the center. The systems thinking that guided the design for CSL is similar to the resource flow integration and analysis that is used in this thesis.

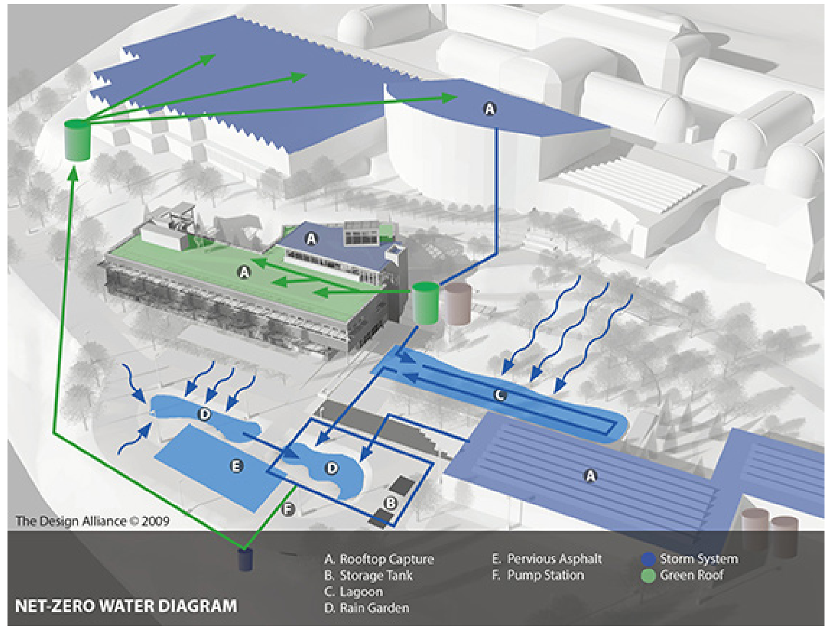

Fig 3.6 Net-Zero Water Diagram by The Design Alliance

Fig 3.7 Phipps' Center for Sustainable Landscapes

Fig 3.8 Aerial view of Bo01 in Malmö, Sweden

Fig 3.9 Bo01 stormwater biotopes

Fig 3.10 Downspout details in Bo01

District Scale: Bo01

Originally conceived as a City of Tomorrow international housing exhibition in 2001, Bo01 is a 54-acre mixed-use development in the Western Harbor of Malmö, Sweden. The project, completed in 2005, is a leading example of sustainable planning and building technologies that showcases socially supportive spaces and environmental values.[6] The development is comprised of a dense network of housing, office, retail, and community buildings. The population density of the district is much higher than the city average containing nearly 1500 dwelling units and housing over 2,300 individuals.[7] Bo01 is notable for its integrated energy, water, and waste systems. All of the energy used by the district is generated from renewable sources: wind turbines, solar tubes, and photovoltaic panels. Additional energy is produced from the solid waste management plant that collects waste from the district and uses an anaerobic digestion chamber to produce biogas. This gas is used to power public transportation as well as to generate heat and electricity. The district also has a sophisticated stormwater management system. Throughout the site, measures have been taken to reduce runoff and clean water before it enters Öresund, the near-by bay. Often these interventions are celebrated as unique design decisions (Figure 3.10). For this thesis, Bo01 represents the design opportunities at a district scale that appear when developments are created with the resource loops in mind. By designing the integration of all energy and waste systems from the onset, Bo01 was able to close resource loops and lessen the community's environmental footprint.

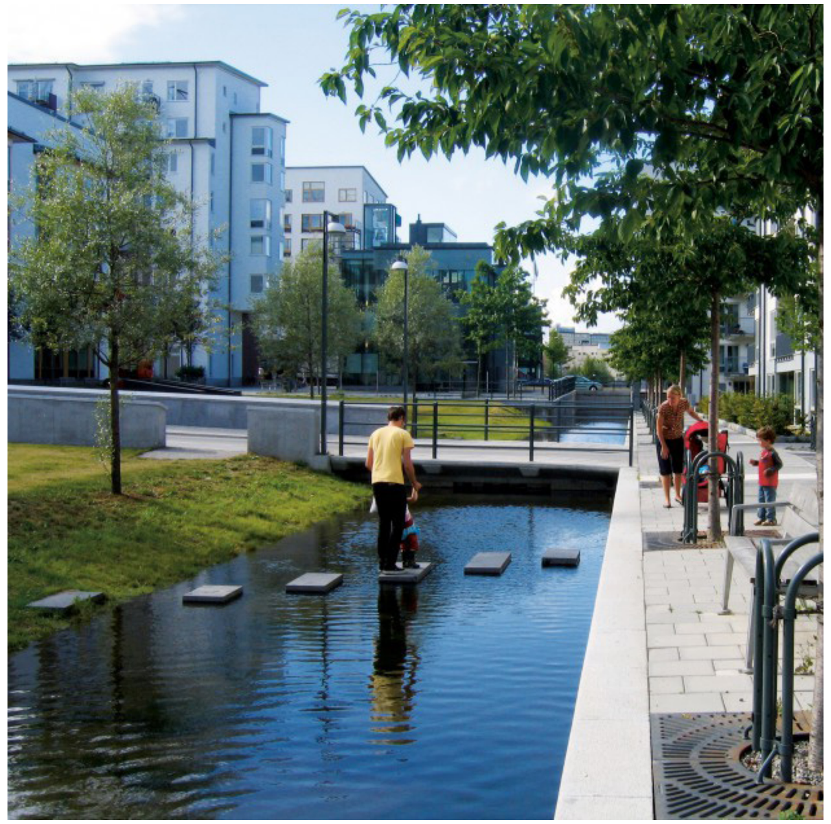

Fig 3.11 Stepping stones across channel in Hammarby Sjöstad

District Scale: Hammarby Sjöstad

Hammarby Sjöstad is a sustainable, 150-hectare urban district in downtown Stockholm, Sweden. The district occupies a brownfield waterfront zone that began redevelopment in the mid-1990s as a bid for the 2004 Olympic Games. When Stockholm was not selected for the bid, the city decided to brand the new district as a model for sustainable urban development. Today, Hammarby Sjöstad is home to nearly 25,000 people in approximately 11,000 residential units. An additional 10,000 people commute into the community to work.[8] From the outset, the design team set the goal for the new district to be twice as sustainable as a typical city district, in terms of environmental impact and energy use. The City of Stockholm developed "integrated environmental solutions" that became known as the Hammarby model (Figure 3.13), which uses technology to handle energy, waste, water and sewage in a holistic system that is integrated with the urban infrastructure.[9] The diagram for the Hammarby model breaks down how the district uses and recycles resources and shows how these resources flow between the different facilities on site. Comparable diagrams should be integral parts of the design process and this thesis attempts to develop a similar framework for North Seattle College. The integrated planning process that preceded Hammarby Sjöstad allowed the designers to implement large scale systems that address the resource flows of water, waste, and energy on site allowing the development to be more in tune with the existing ecosystem. In addition to integrating resource flows, the urban environment was designed to create an active social space for the inhabitants and visitors as well as allocating space for ecosystem services and native habitat.

Fig 3.12 Hammarby Sjöstad canal

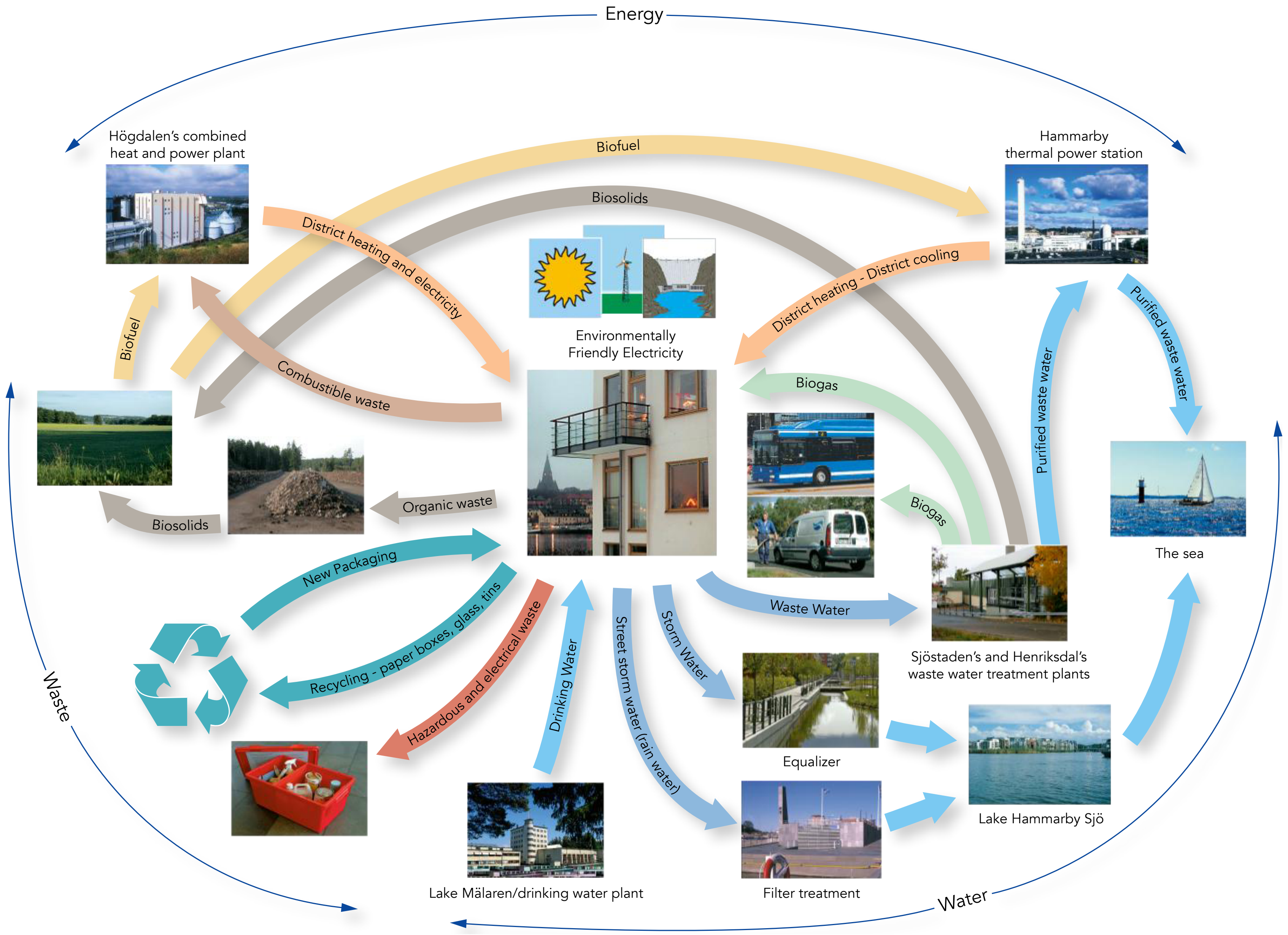

Fig 3.13 The Hammarby model of metabolic flows

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Aerial view of North Seattle College, image from Google Earth

Chapter Four

Site

Scales of Sustainability

Sustainable design solutions exist across a multitude of scales. On the smallest scale, individuals can choose to purchase low flow bathroom fixtures to conserve water and LED light bulbs to minimize energy use. These same individuals could then make the slightly larger investment to install photovoltaic panels on their roof or locate a geothermal heat-pump in the back yard to lower their carbon footprint. This type of design solution falls on the micro scale of sustainability. On the opposite, macro scale of sustainable design solutions are city and regional sustainability masterplans or even legislative decisions. Masterplans take large-scale environmental concerns and resource flows into consideration to make policy decisions that shape future development. On this micro to macro scale, design work falls into five broad spatial categories: site, block, district, city, and region (Figure 4.1).

The site includes the built structure and adjoining site. Buildings include many more minute scales of sustainability, however, they are not considered here. The block consists of a collection of sites. These sites can have built structures or not, however the sites work together to form a unit. Often the individual sites that comprise blocks operate independently of one another. However, if viewed as a single unit, the sites can take steps to become more efficient. Stepping up, a district comprises several blocks ranging in scale. The actual size of these districts can vary depending on socio-economic or geographic factors such as institutions, major road divisions and water bodies. Next is the scale of a city, composed of districts and connected by municipal rules and zoning regulations. These zoning regulations dictate what types of developments can occur where and can often specify sustainability requirements such as on-site water collection. The largest category with these spatial scales is that of the region. At the regional scale most decisions are policy based and while such decisions can have a large impact on the sustainable landscape, they often act as design typologies or guidelines.

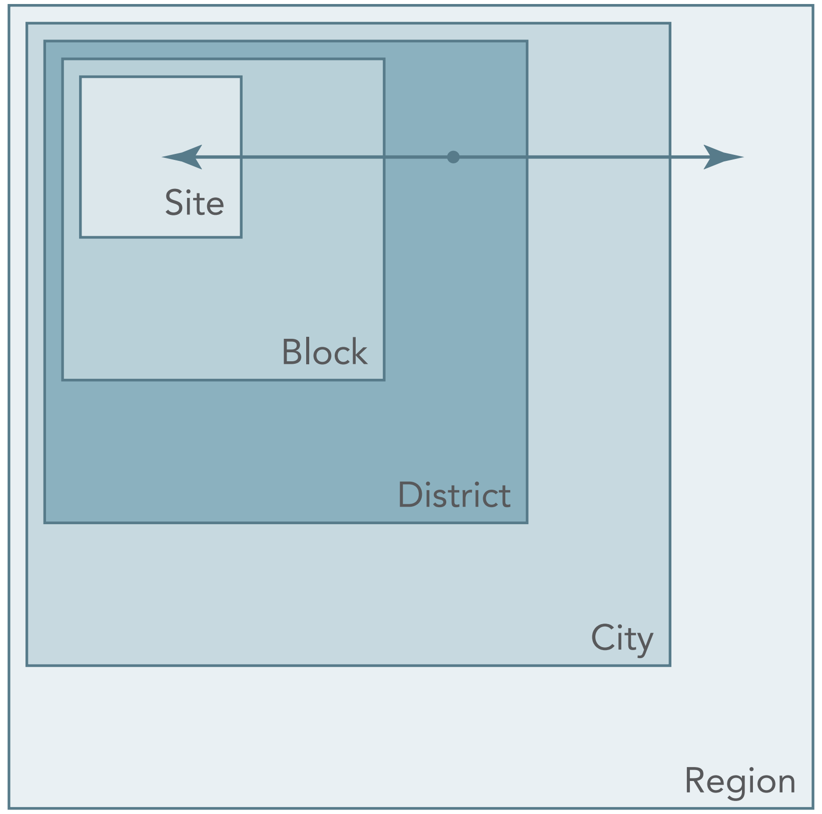


Fig 4.1 Diagram of overlapping design scales

District Scale

This thesis centers on design at the district scale. Design at the district level provides opportunities to engage with scales on both sides of the spectrum and combine ideas of building efficiency with large scale policy decisions. Improving a city's aging infrastructure to allow for an exchange of site generated energy and a city grid is just such an opportunity. Additionally, institutions of many kinds often operate at a district scale. These types of institutions, such as universities and hospitals, are in a unique position to guide a cohesive development process that can integrate water, energy, food, and social systems in ways that would otherwise not be possible. As opposed to development that occurs on single site, districts can combine the benefits and assets of diverse building types and functions to create a network that is more than the sum of its parts.

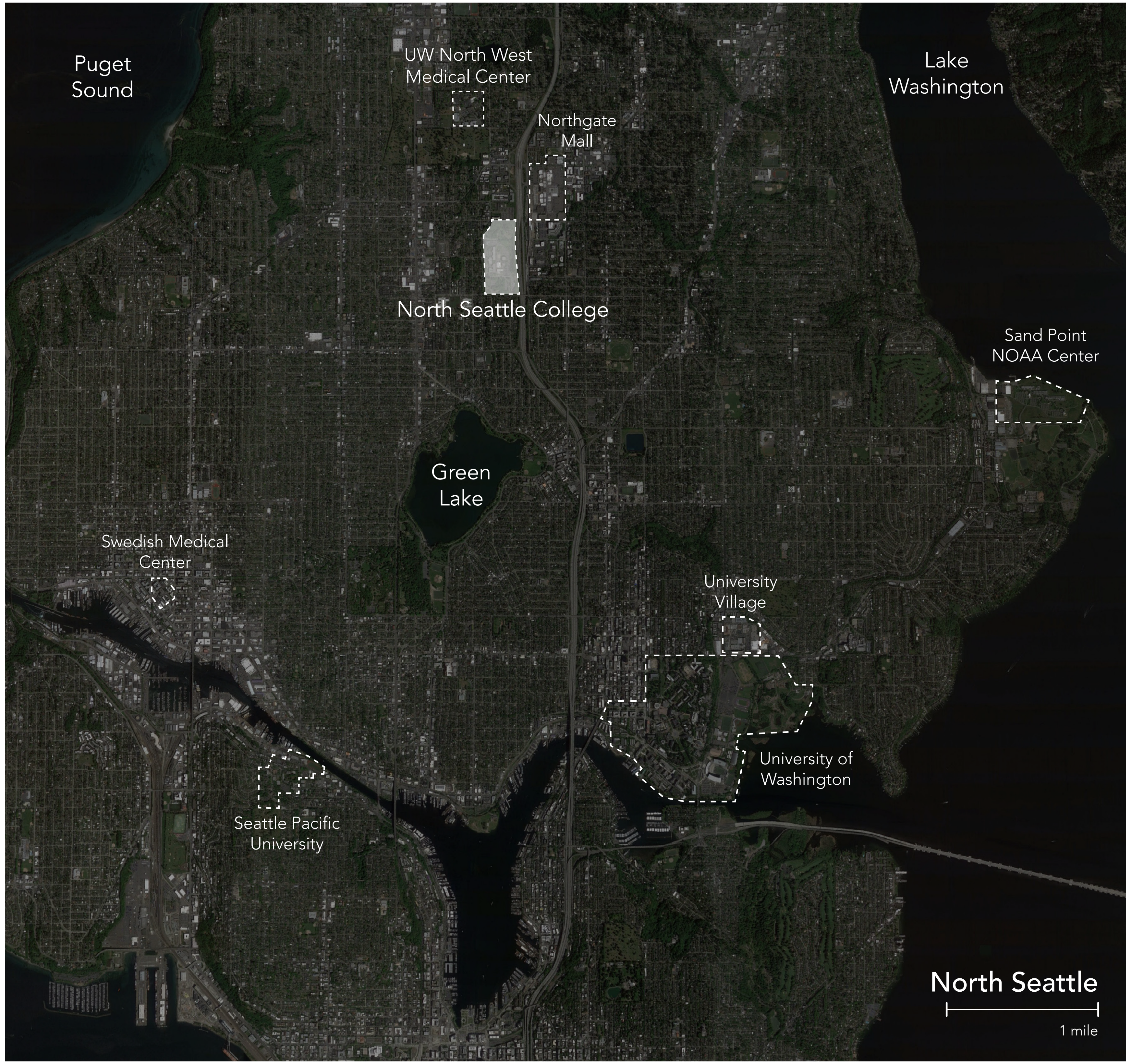


Fig 4.2 Examples of campus style districts in northern Seattle include universities, hospitals, malls, and government institutions

Seattle Districts

In Seattle there are many institutions that operate at the district scale (Figure 4.2). These institutions include hospitals, research facilities, malls, and many college campuses such as the University of Washington. The cohesive planning process that occurs at district-level institutions allows them to guide projects within the district so that they not only accomplish the individual goals of each project but addresses the goals of the larger district as well. Such districts can also have sway over neighboring developments and act as anchor institutions that spur sustainable development and positive change beyond their edges.

College and university campuses have particularly strong influence over the neighborhoods they inhabit. Built into the nature of higher education is the understanding that the institutions should strive to be the best they can be, and that can be reflected in the college's mission and in the physical buildings where the instruction is taking place. Another aspect that gives college campuses large sustainable influence is in the public life, learning, and experiences that occur there. Connecting and educating students and the local community is a critical part of becoming a more sustainable society. College campuses are able to engage with students and communities to provide sustainably conscious educational opportunities.

Community College Campus Typology

Community colleges are a unique campus typology found throughout the United States. Nearly all larger American cities are home to one or more semi-urban college campuses (Figure 4.3). Many of these colleges were built as commuter campuses in the mid 20th century and are generally composed of a sprawling network of buildings surrounded by large areas of surface parking lots. These car-centered campuses, which originally might have been on the periphery of their respective cities, are now fully enveloped by sprawling neighborhoods. As cities become denser and continue to grow around these spaces, the inefficiency and unproductive nature of these campus plans becomes clear. Roofs are flat and empty. Parking lots are treeless and exacerbate stormwater issues and the heat island effect. The structures of these aging campuses are reaching the end of their initial life span and are provide opportunities to reimage ways to bring these campuses into the 21st Century.

Academically, community colleges provide affordable education and vocational training for students who are interested in a flexible, higher education opportunity. Community colleges often allow individuals to pursue higher education who would not have the means to do so at a four-year university. A focus on integrating the educational and built environment aspects of community college districts can lead to a cohesive sustainable framework that showcases exciting wholistic design ideas, such as indoor aquaponic farming, while educating and training a broad spectrum of citizens in and about the importance and availability of jobs in the green economic sector. In Seattle, one college that is the epitome of this type of mid-century development is North Seattle Community College (NSC).

Fig 4.3 >
Four semi-urban community colleges from across the United States built in the 1960s

North Seattle Community College, Seattle, WA - 1970

Onondaga Community College, Syracuse, NY - 1961

Nashville State Community College, Nashville, TN - 1970

Florida State College, Jacksonville, FL - 1966

Geological History

NSC campus sits on land that was once Thornton Lake, a post-glacial lake left behind by the Puget Lobe Glacier approximately 14,000 years ago. The surrounding topography of the site today was carved by the immense weight of the nearly 3000-foot-thick ice sheet that once covered much of the Pacific Northwest.[1] The retreating glacier played an integral part in shaping the land and waterways throughout the region. Ice left behind formed glacial kettle lakes. The weight of these glacial remnants compressed the lakebed sediments creating deep basins. Over time these basins filled with silt and peat, forming the type of wetlands that are still visible on the site today.

Human History

After the final retreat of the Puget Lobe ice sheet, the Pacific Northwest was occupied by nomadic native peoples with the first permanent, modern Native American settlers arriving around 6,000 years ago. At the arrival of the first European settlers to the Puget Sound area in 1792, the Duwamish, People of the Inside, and the Xacuabš (pronounced hah-choo-AHBSH), People of the Large Lake, were the predominant tribes in the area and merged under the Duwamish name shortly after.[2] The Xacuabš had a settlement at the mouth of Thornton Creek on Lake Washington and visited the marshes on what is now NSC in fall "to collect cranberries from the marsh and other late-season foods."[3] [4] The marsh was home to permanent sweat lodges and was likely a spiritual place for generations. In the 1860s the US government began offering parcels for $1.25 an acre and the land that is now Seattle College was purchased by Arthur Denny. The Xacuabš people left their land in 1916 when the water level in Lake Washington was artificially lowered and the marsh ecosystem they inhabited dried up and was destroyed.[5] In the early 20th century, Denny's descendants began leasing the property to the Kumasaka Family, recent Japanese immigrants (Figure 4.4). The Kumasakas built a farmhouse and four greenhouses that would become "an enterprise they called Green Lake Gardens."[6] This nursery business acted as the foundation of a strong Japanese-American Community in North Seattle. In the 1960s, the development of Interstate-5 destroyed half of the existing community and shortly after the value of the land plummeted due to noise and pollution.[7] In 1966 the State of Washington purchased the property for the construction of a community college.

Fig 4.4 Kumasaka Family Farm, c.1920

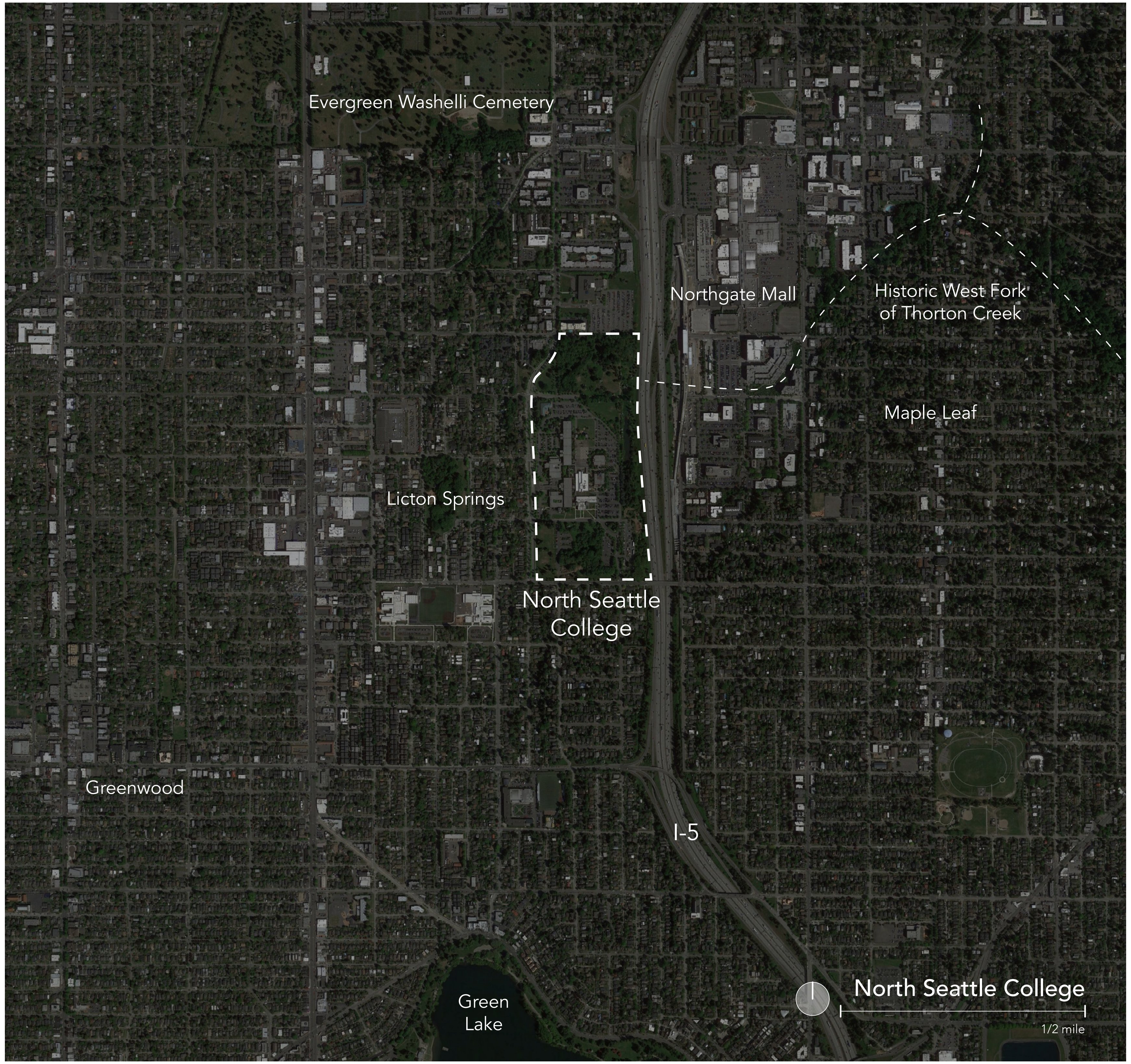


Fig 4.5 Location of NSC in North Seattle

Site Analysis

Today, the NSC campus is a 70-acre parcel of land in the Licton Springs Neighborhood of North Seattle. To the north, the campus is adjacent to a University of Washington medical clinic and the entire eastern edge of the parcel abuts I-5. The southern and western edges provide vehicular access to the site and are flanked by single-family neighborhood (Figure 4.5).

The original campus master plan, designed by Edward Mahlum and Associates in 1970, is comprised of a network of brutalist concrete buildings connected by sparsely planted plazas and corridors (Figure 4.7, 4.8 & 4.9). Beneath the built portion of the site is a web of underground parking. Since then, four significant additions have been built: a gymnasium, an education building, a public health facility and a childcare center. Despite these additions, the character of the campus is generally unchanged. Surrounding the expansive network of buildings at the center of the site is nearly 10 acres of surface parking.

The south end of the site is largely unused. There are two additional overflow parking lots, a facilities storage area, mowed fields, and an undeveloped woodland area. Notably, on the far southern edge is the Licton Springs Community P-patch, a public space for neighbors to come together to plan, plant, and cultivate a garden while growing a sense community.

On the north end of the site is an area designated by NSC as the North Parcel, otherwise known as Barton Woods. The parcel consists of a network of rough foot trails that navigate overgrown woodland and wetland areas. These trails are used by students and nearby community members. In June of 2018, the NSC Department of Earth, Space and Environmental Sciences prepared a proposal to re-establish a portion of the North Parcel as Headwaters Park. This 4.5-acre park would highlight the seasonal wetlands and recuperate the woods as a teaching tool for the college. The proposal calls to re-establish native vegetation and restore the park as the natural headwaters for the West Fork of Thornton Creek.

In 2016, NSC published a forward-looking strategic and development plan for the college as well as the physical campus. The plan highlighted three core values that the college deemed most important: Advancing Student Success, Excelling in Teaching and Learning, and Building a Sustainable Community. As a sustainable community, the college wants to "increase the development of the college's efforts in resource utilization, curriculum, and campus culture."[8] A key catalyst for creating such a community is the college's wish to build affordable student housing on campus.[9] This type of development may allow for the college to begin a shift away from a commuter campus to a more integrated learning community.

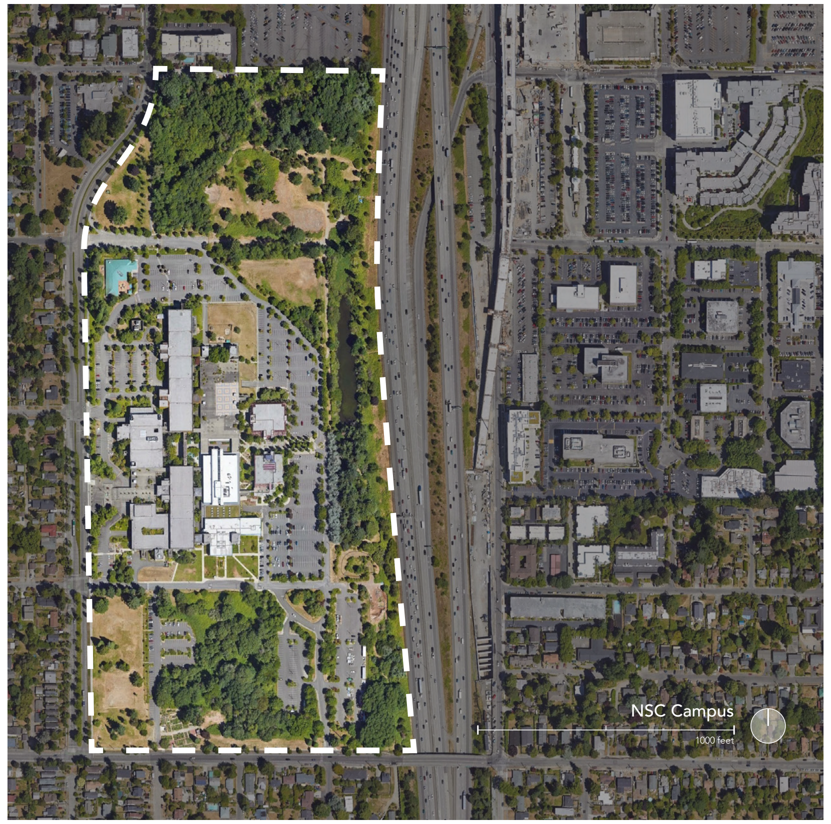


Fig 4.6 Aerial view of NSC Campus

Fig 4.7 NSC second story terrace, looking north

Fig 4.8 NSC northeast parking lot

Fig 4.9 Interior courtyard at NSC looking south toward the third floor bridge

Fig 4.10 Schematic analysis plan of NSC showing new light rail station and pedestrian bridge

Transportation

Today, students, faculty and staff commonly travel to campus by car or by one of the four King County Metro bus lines serving the site. While NSC encourages use of public transportation and commuting by bicycle, the proximity to an interstate interchange and a sea of parking lots still allows most users to arrive on campus by car. A future NSC however, will hopefully phase out single passenger automobiles in favor of more sustainable modes of transportation. The transition away from a commuter campus will be aided by the northward extension of Seattle's light rail rapid transit system, the Link. Across I-5 from NSC is a Link station at Northgate Mall that opened in 2021. The Link station is integrated with a 2,000' pedestrian and bicycle bridge that spans the interstate and lands on the northern end of the NSC campus. The bridge connects existing bicycle networks in the Licton Spring neighborhood across the interstate to the station and Northgate Mall. The Link extension and pedestrian bridge provide an opportunity for NSC to reimagine how student, faculty and visitors arrive on campus.

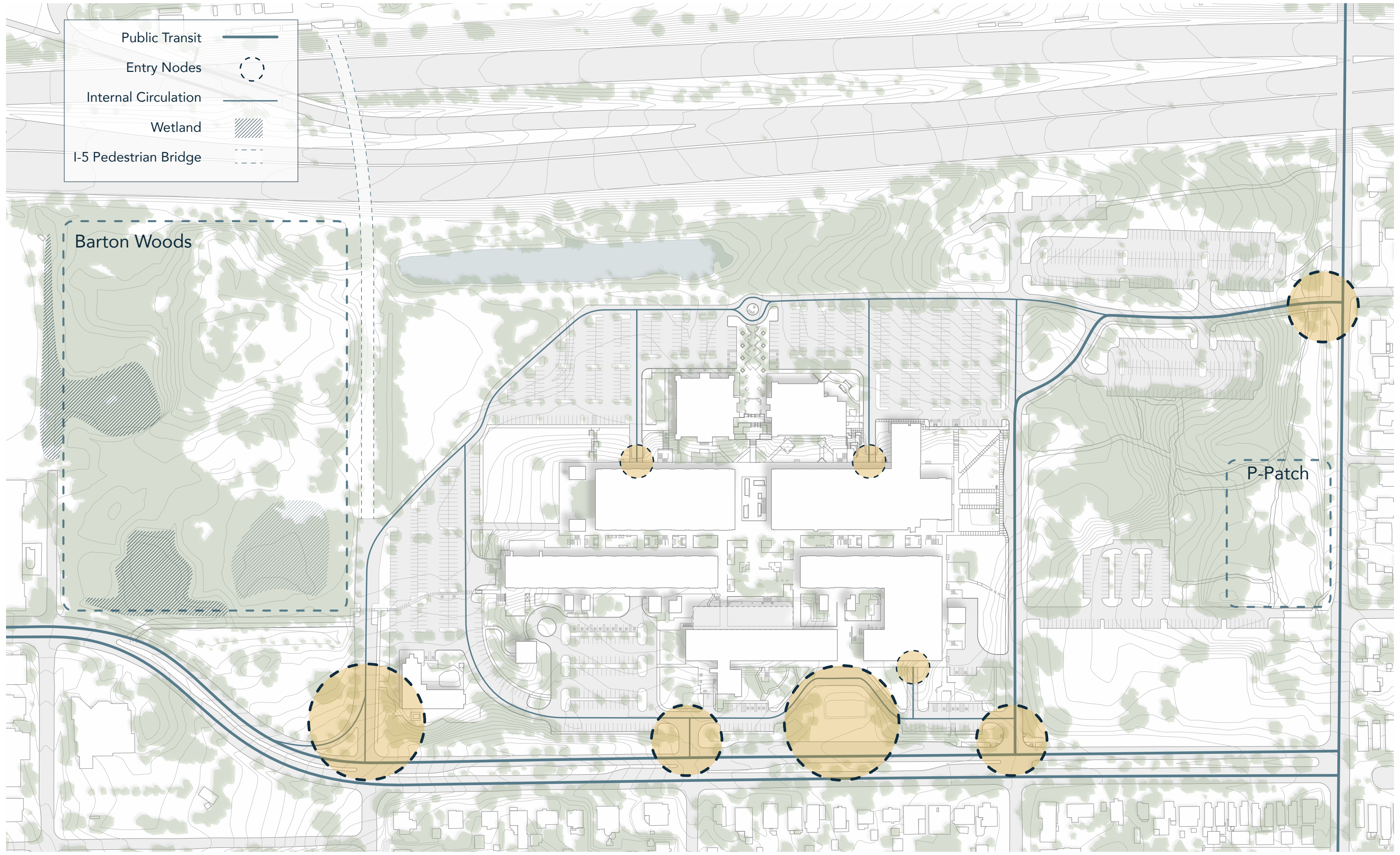


Fig 4.11 Schematic transportation and entry plan of NSC

Campus Life

Social capital is a fundamental element of facilitating a shift toward more sustainable urban environments. If the people living within cities all agree that climate change is an existential crisis affecting our generation, society can begin to take meaningful action to address the root causes. College and university campuses are excellent places to initiate such a shift. The overlap of technology, research, and a culture of learning and exploration means that students and faculty are excited by the opportunity to affect change. Community colleges are specifically positioned to provide both conceptual knowledge as well as hands-on, technical training for the sustainable goals of the future. As a Living Laboratory, North Seattle Community College can push the boundaries of sustainable design and technology as well as train the professionals that will put those technologies to work.

Oftentimes, colleges do not use the resources of their built environment efficiently. Classroom spaces and lecture halls are generally only utilized during teaching hours. On a seasonal cycle, building-use falls even more over the summer months when fewer classes are in session. This thesis argues for a system that extends the campus's productive hours on a daily as well as yearly timeline. By creating a college community that lives on-site and is integrated with the surrounding neighborhoods, public buildings can be used for longer hours and on weekends when classes are not scheduled. This neighborhood integration will invite nearby residents to see and interact with the campus instead of remaining bystanders on the outside. Hands-on technical training for green jobs will also allow the university to function year-round, as those types of industries do not follow educational school-year schedules.

Fig 4.12 The Quad at the University of Washington full of life

Endnotes

1 Thorson, Robert. 1980. "Ice-Sheet Glaciation of the Puget Lowland, Washington, during the Vashon Stade (Late Pleistocene)." *Quaternary Research* 13 (3): 303–21.

2 Edwards, Laurie J., ed. 2012. "Duwamish." In: *UXL Encyclopedia of Native American Tribes*, 3rd ed., 5:1851–66. Great Basin, Pacific Northwest, Arctic. Detroit, MI: UXL. Accessed June 11, 2021. http://link.gale.com/apps/doc/CX4019400132/GPS?sid=bookmark-GPS&xid=d8447d19.

3 Figge, John. 2015. *North Campus Parcel Report*. North Seattle College Sustainability Committee. P.4.

4 Thrush, Coll, and William Cronon. 2008. *Native Seattle: Histories from the Crossing-Over Place*. Seattle: University of Washington Press.

5 Thrush.

6 Figge. 2015.

7 Figge,

8 North Seattle College. 2016. *Strategic Plan*.

9 North Seattle College. 2016. *Building Development Plan*.

The University of Washington with downtown Seattle beyond, photo by Luke P., Pexels

Chapter Five

The Urban Nexus

Framework Integration

The term Urban Nexus is an approach developed by the United Nations and affiliated organizations to frame the Water-Food-Energy Nexus within the ideas of the circular economy and take steps to implement its principles within cities.[1] The Urban Nexus analyzes how the WFE Nexus can benefit five key sectors that, when taken together, promote social harmony, a green economy and environmental sustainability (Figure 5.1). In connection with the Urban Nexus, the International Council for Local Environmental Initiatives (ICLEI) has developed a similar tool with five complementary strategies which city governments can use to start working towards a more circular system. In the Circular City Action Framework, five strategies: Rethink, Regenerate, Reuse, Reduce, Recover, should be applied in parallel to all production, consumption, and waste management processes influenced by the city or its residents (Figure 5.2).[2] Building on the ideas of the Circular City Action Framework and expanding on the Urban Nexus' positions on urban planning, this thesis will try to develop a holistic understanding of a circular city at the scale of a district. The following schematic sections of North Seattle College aim to show how the overlaps between water, food, and energy at the district level can be used as opportunities to create sustainable, circular districts.

Nexus Opportunities

Figures 5.4, 5.5, and 5.6 are schematic sections that analyze potential opportunities of the WFE Nexus within North Seattle College. Figure 5.4 is a simplified flow diagram detailing the existing resource inputs and waste outputs of the campus. Today, the campus relies entirely on conventional sources of water, energy, and food. Water and energy come from the municipal energy supply and food is grown and processed offsite. By rethinking its approach to

Fig 5.1 Urban Nexus Wheel

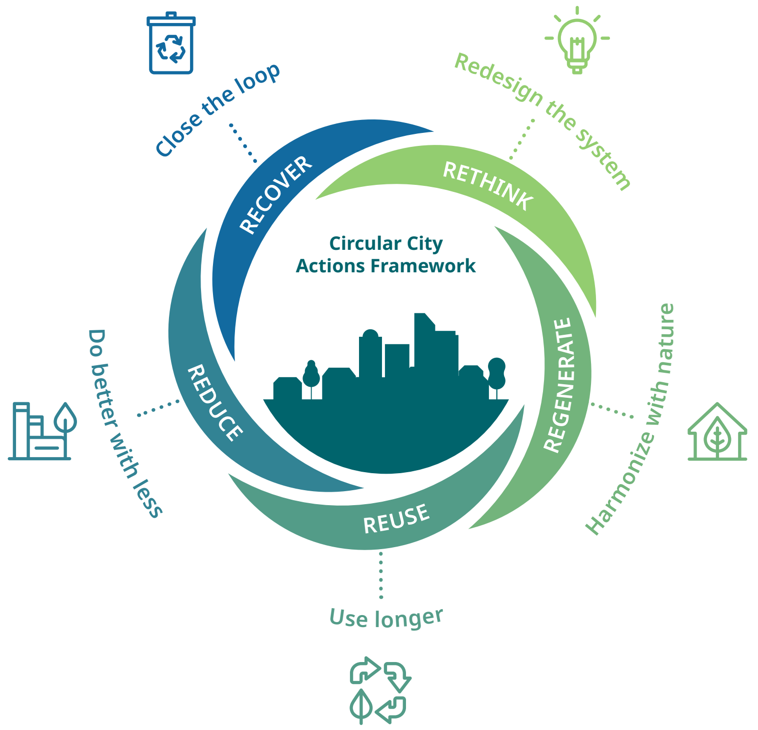


Fig 5.2 Circular City Action Framework

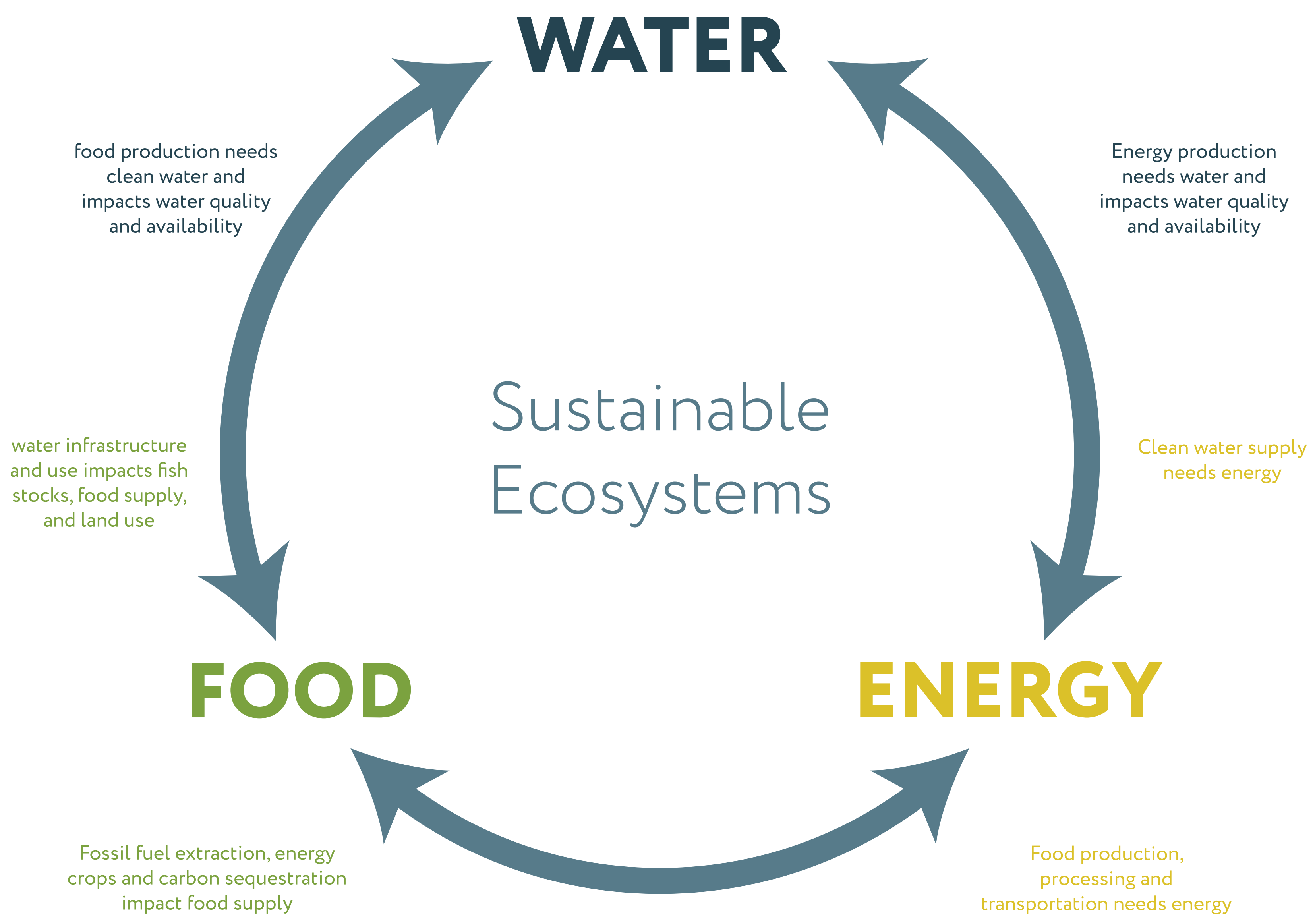


Fig 5.3 Overlaps in the WFE Nexus lead to sustainable ecosystems

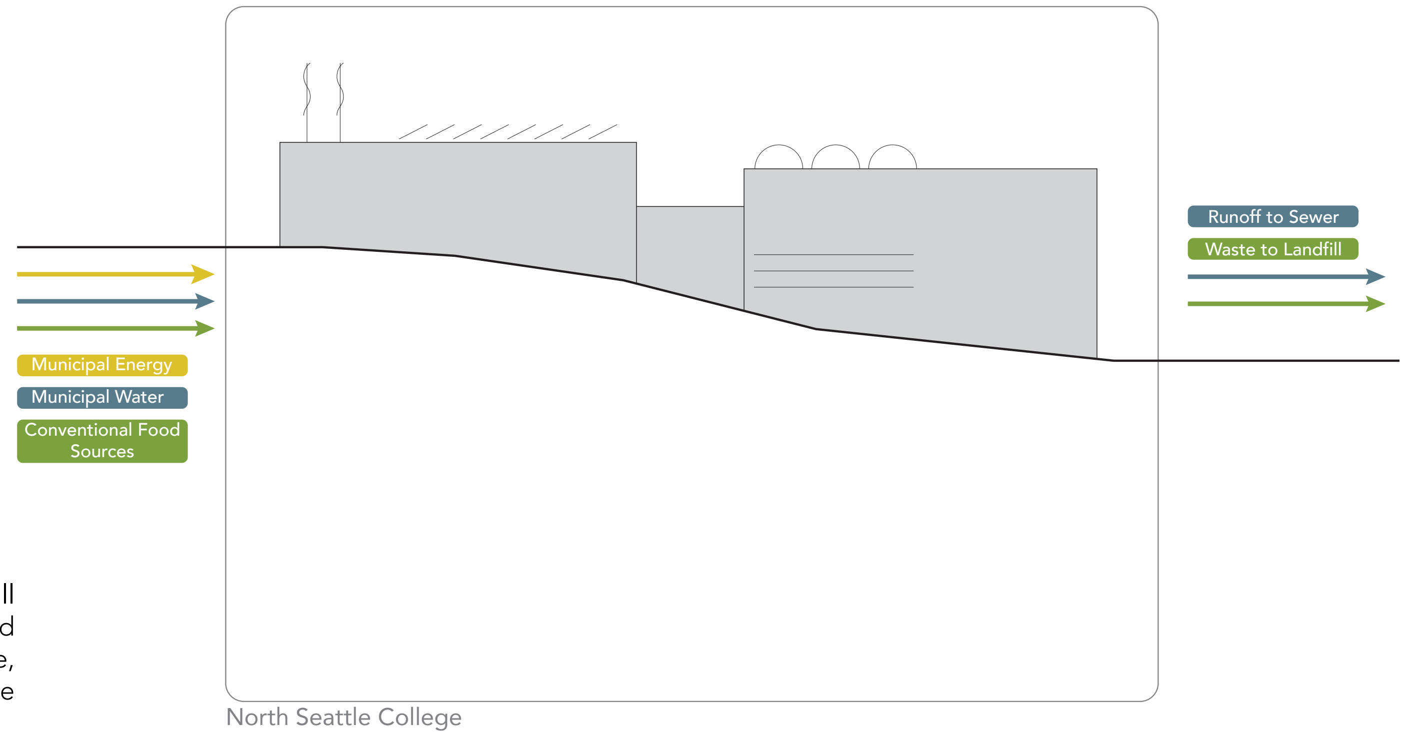


Fig 5.4
NSC Base Condition: all water, energy, and food resources originate off site, all waste is removed from the site

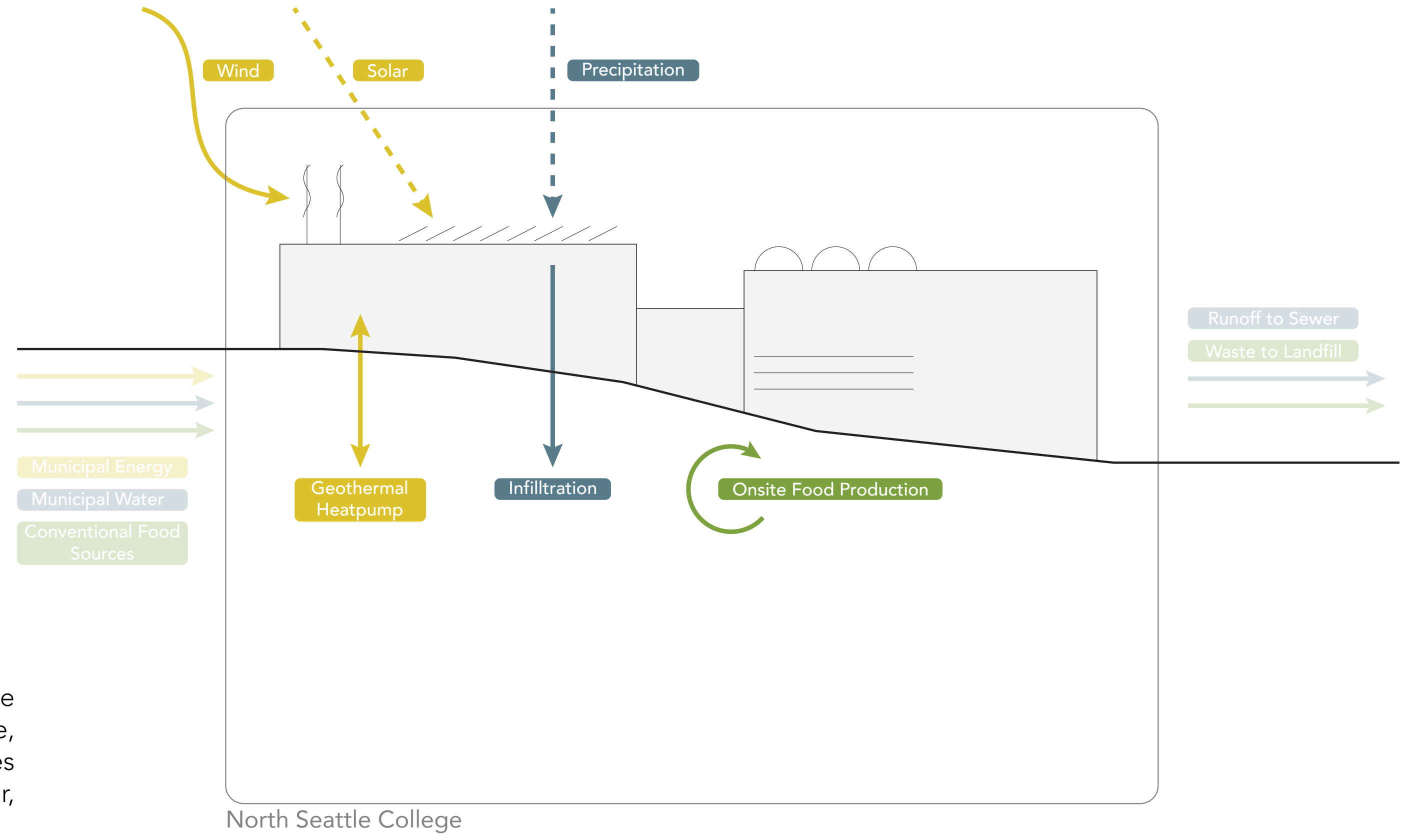


Fig 5.5
NSC Opportunities: minimize conventional resource use, locate alternative sources and disposal for water, energy, and food

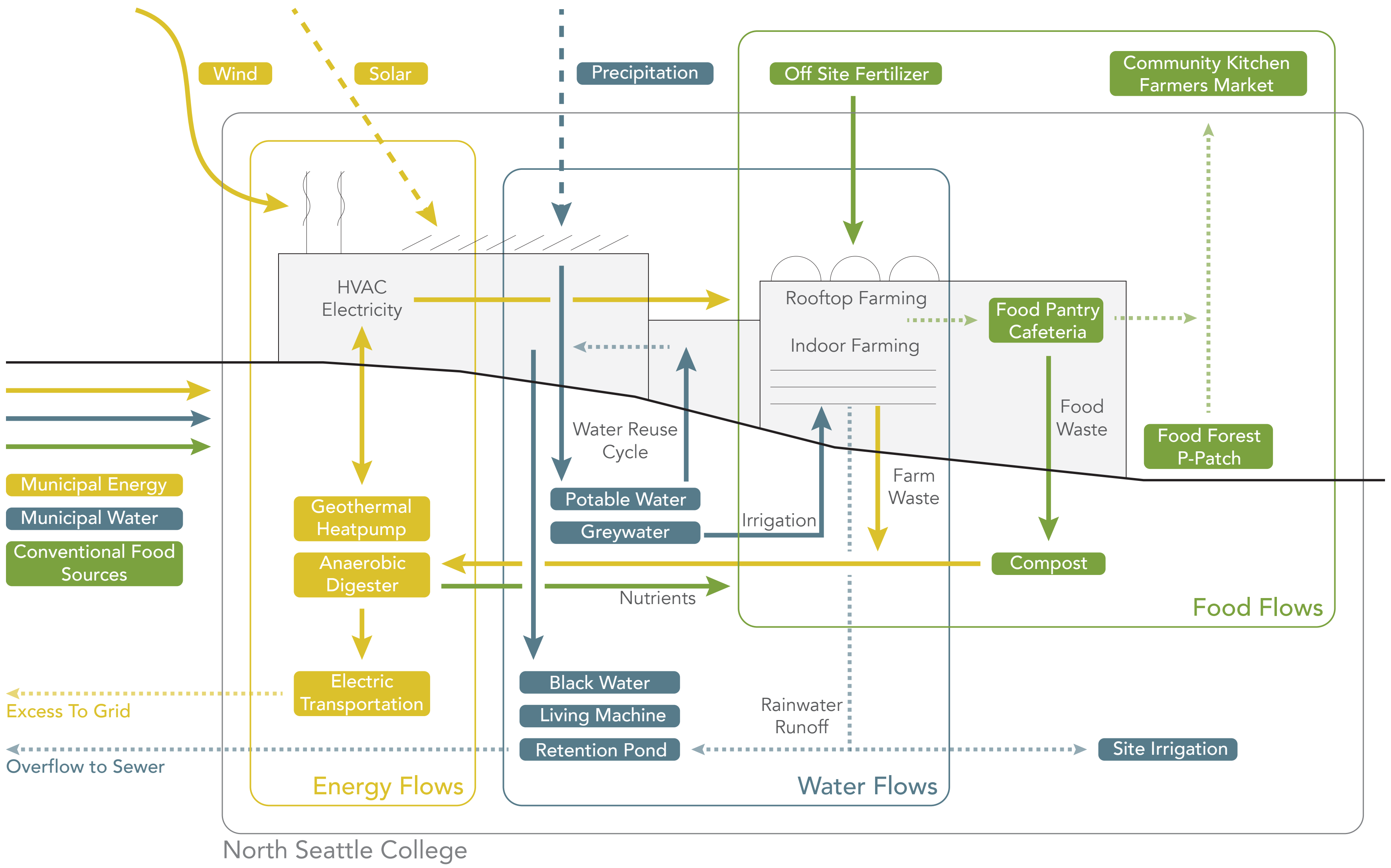


Fig 5.6
NSC Circular Resource Flows: water, energy and food systems become interconnected, reduce environmental impact and create opportunities for innovative design solutions

	Location	Spatial Intervention	Function
Building	Roof	Photovoltaic Panels Windmills Green Roofs Greenhouses	Solar Energy Wind Energy Lower Heat Absorption Water Detention Ecosystem Services Food Production Building Services
Building	Terraces	Green Roofs Greenhouses	Public Space Exterior Classrooms Habitat Food Production Education
Building	Facade	Vertical Growing Passive Solar Solutions	Food Production Shading Thermal Improvements
Building	Corridor	Living Machine Habitat Improvements	Waste Disposal Education Increase Biodiversity
Building	Interior	Modernized Fixtures	Improved Resource Use
Building	Underground	Indoor Farming Anaerobic Digester Geothermal Pumps	Food Production Education Energy Production Biowaste Disposal Energy Production
Connections	Walkways	Signage Swales & Bioretention	Education Stormwater Mitigation
Connections	Parking Lots	New Construction Removal Electric Charging	Housing Expanding Classrooms Living Building Return to 'Nature' Stormwater Mitigation Improve Infiltration Sustainable Transportation
Connections	Roadways	Porous Paving Removal	Stormwater Mitigation Improve Infiltration
Site	Open	Composting Living Machine Detention Pond Open Fields	Waste Disposal Nutrient Production Water / Waste Purification Education Stormwater Mitigation Habitat Social / Active Space
Site	Woodlands & Wetlands	Maintain	Education Habitat

Fig 5.7 Opportunity Matrix

resource use, the college can begin to reduce its reliance on off-site services (Figure 5.5). Energy can be produced on site from renewable sources such as wind, solar or geothermal. Water can be collected from roofs and parking lots to be stored and used in the building. Collecting or allowing rainfall to infiltrate on site also lessens the stress on the municipal sewage system during large stormwater events. Food can be grown on rooftop farms, indoor farms or students farms on the surrounding site. Once the opportunities are identified, the system can be refined and the overlaps of resource flows become evident (Figure 5.6). Looking at resource flows collectively gives rise to intriguing design opportunities and novel ways to reduce a district's environmental impact.

As overlaps in the resource flows began to emerge, an opportunity matrix was developed to contextualize how the opportunities could manifest as design interventions on site (Figure 5.7). The interventions were spatially divided into three overarching categories: building, connections, and site. These areas were then further subdivided into specific zones within the campus. For each zone, various interventions and their functions were conceptually placed on site. This method helped identify overlaps in functionality and areas where interventions would be able to connect to at least two of the resource flows within the Water-Food-Energy Nexus.

To further ground the nexus opportunities on site, the opportunities at six key locations were quantified (Figure 5.9, 5.10, 5.11, 5.12). These calculations show the potential that certain interventions might have to offset the college's existing environmental footprint. However, an in-depth analysis of the quantities and volumes of resources was not the focus of this thesis.

Fig 5.8 Typology of possible intervention locations at NSC

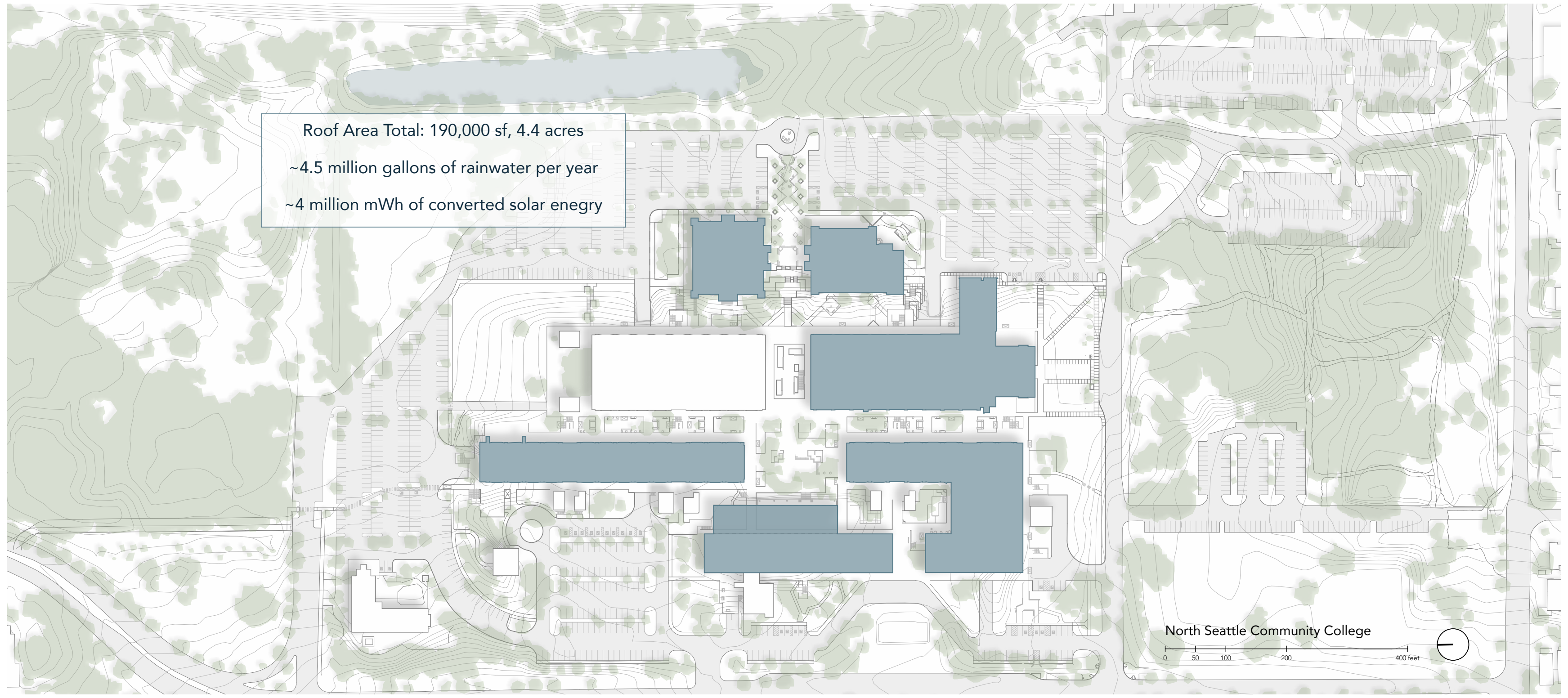


Fig 5.9 Roof opportunities

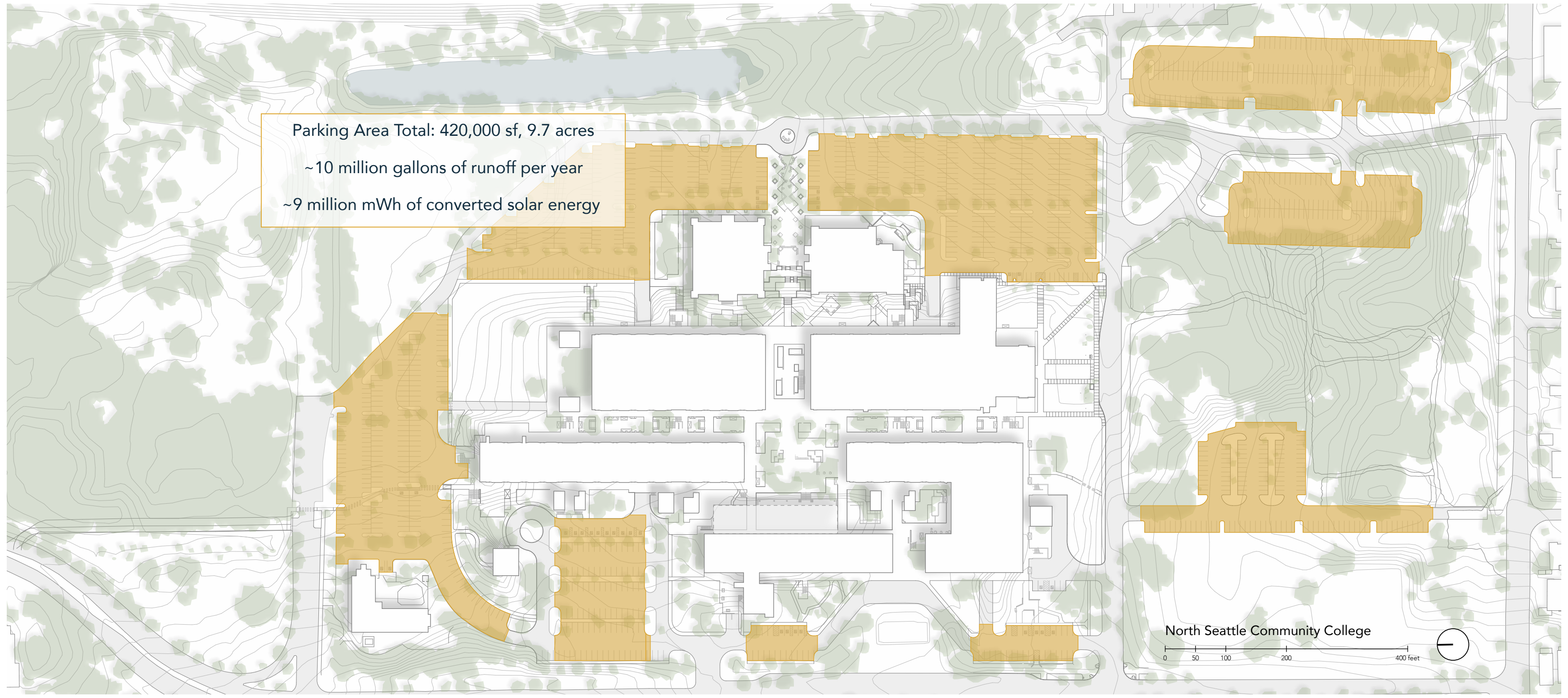


Fig 5.10 Surface parking lot opportunities

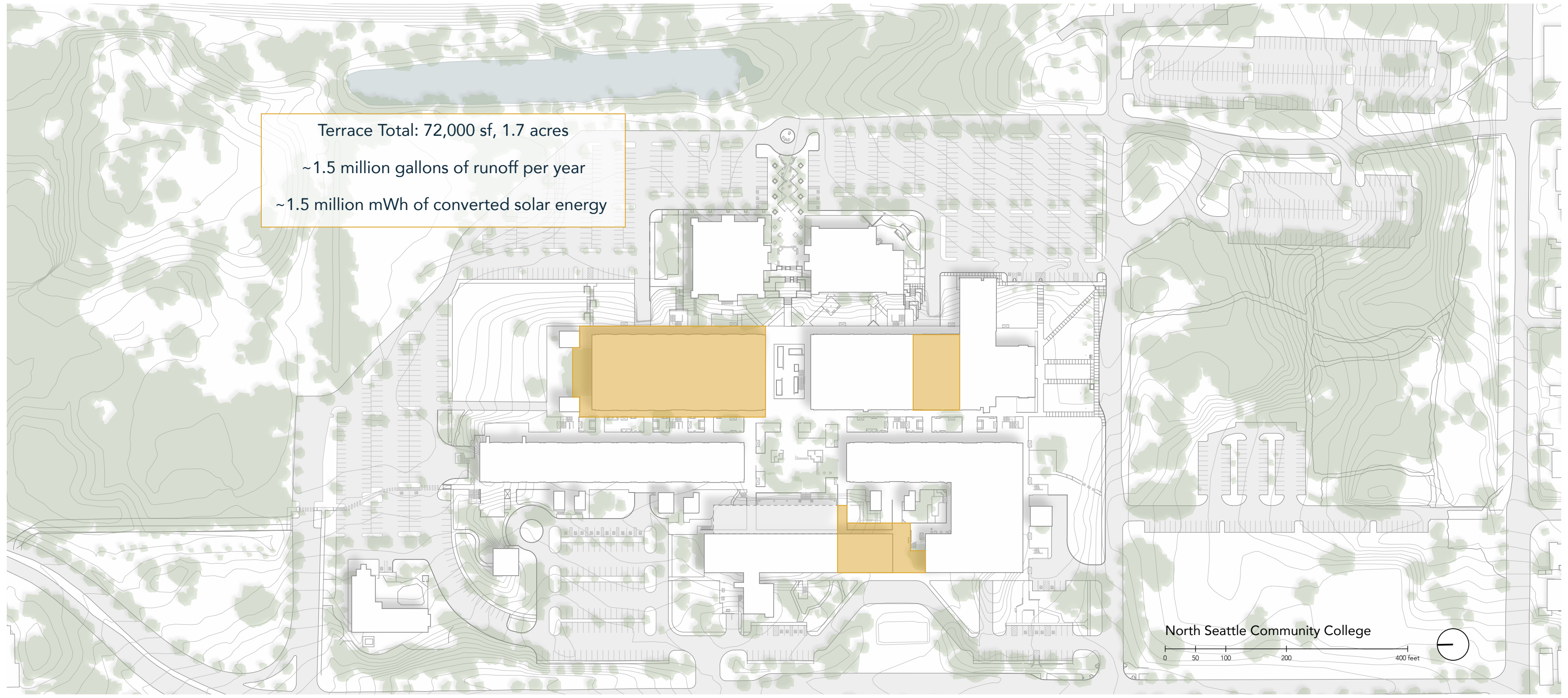


Fig 5.11 Terrace opportunities

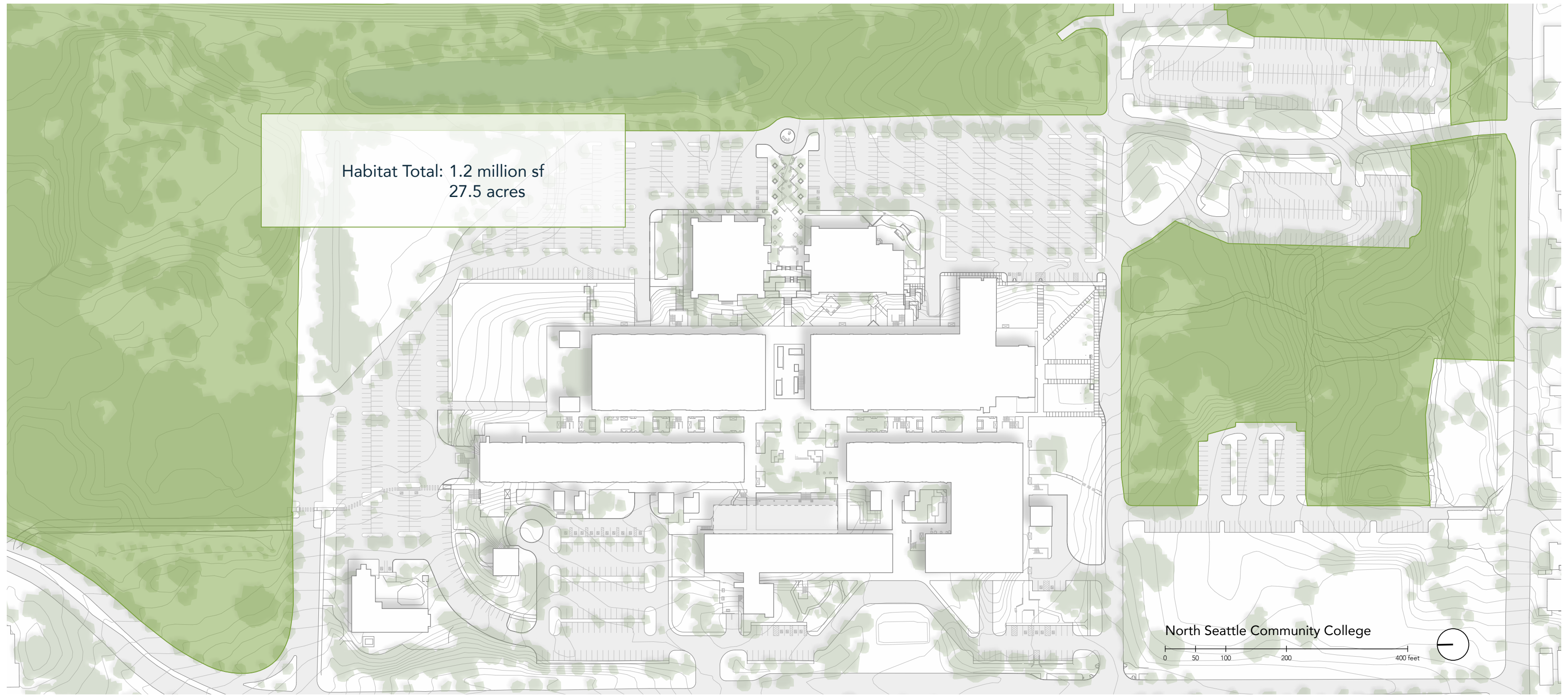


Fig 5.12 Habitat opportunities

Endnotes

1 Wong, Eva. 2019. *The Urban Nexus: Integrating Resources for Sustainable Cities*. United Nations ESCAP.

2 ICLEI -Local Governments for Sustainability. 2021. *City Practitioners Handbook: Circular Food Systems*. Bonn, Germany.

Interior Courtyard at North Seattle College

Chapter Six

Site Design

Design Concepts

The design proposals seek to integrate the concepts of the Urban Nexus and schematic resource flow diagrams with the existing site context of North Seattle College in three zones: the North Edge, the South Edge, and the existing building network of the central campus (Figure 6.1). In each area, interventions aim to integrate and highlight the resource flows of water, energy, and food. The North Edge will be characterized by a new entry to the campus at the terminus of the I-5 pedestrian bridge. This new entry will be bordered by new student housing and ground floor amenities which will extend along the western edge of the site. On the north-east corner of the site a large swath of surface parking will be removed to create space for new aquaculture ponds. The South Edge softens the hard edge of the campus and provides agriculture opportunities, habitat, and environmental services. Throughout central campus, existing buildings are transformed into productive components of a circular district. The future for North Seattle College focuses on transitioning away from a car-centered commuter campus to a vibrant, sustainably focused, living laboratory.

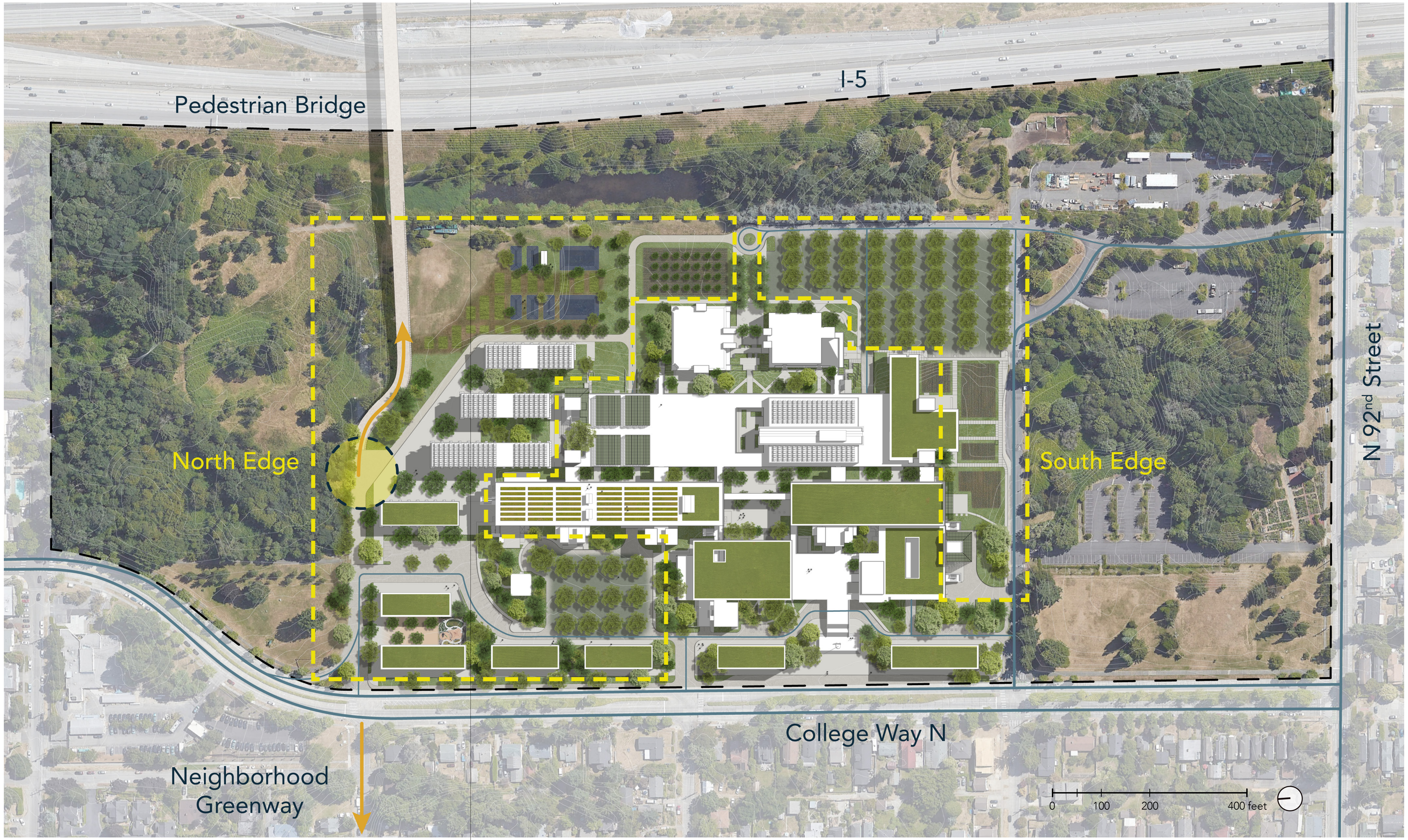


Fig 6.1 >
Vision for a transformed North Seattle College. Proposals are organized in three zones: the North Edge, the South edge, and across the existing building network in the central campus

Natural Integration

The new design proposals are organized around the concept of natural infiltration. The concept aims to integrate the natural elements of Barton Woods from the north and the woodland area from the south into the expanse of concrete that is NSC today (Figure 6.2). On the north edge, the corridors become vegetated urban spaces and wetlands adjacent to future student housing. The south edge transforms parking lots and lawn into productive agricultural spaces. These ideas push into the center of the site like fingers along the existing corridors formed by the buildings. The fingers not only represent places where the campus is transforming, but also provide opportunities to draw visitors into the transformed campus.

Urban Edge

The north edge is envisioned as a new gateway to the university that engages with the pedestrian and bicycle corridor (Figure 6.3). The gateway creates a vibrant entrance that strives to create a new identity for the campus that will be visible from beyond its borders. As commuters travel down the new pedestrian bridge, they will be greeted by views of a living, productive campus (Figure 6.4). Below they might see outdoor classes taking place at the aquaculture ponds or students tending to their garden plots. The north urban edge extends from the new transit corridor along the west side of the campus replacing expanses of parking lots with active community spaces on the ground floor and student housing above. New mixed-use public buildings create a welcoming front to the adjacent neighborhoods that students and community members are able to use.

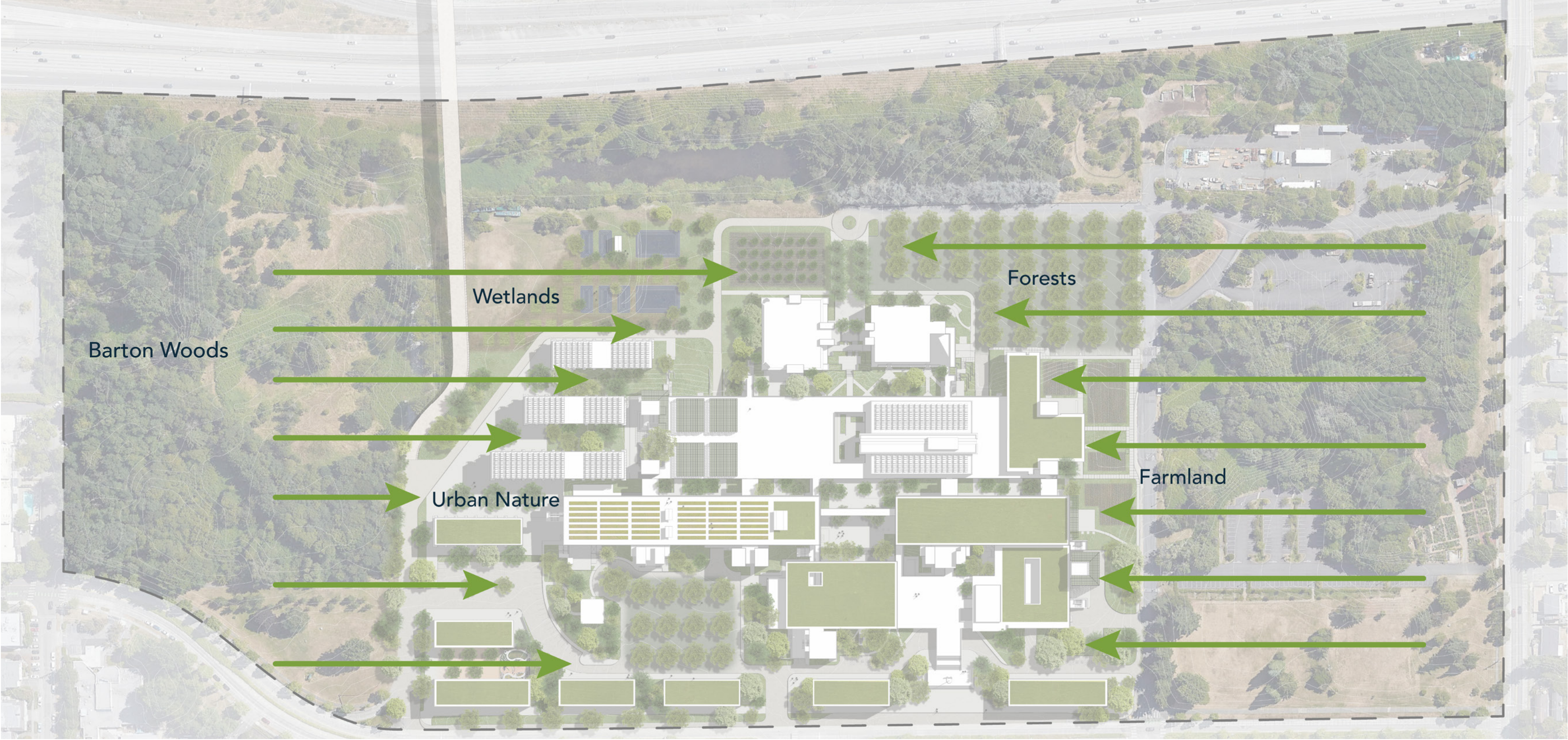


Fig 6.2 Natural Integration Concept Diagram

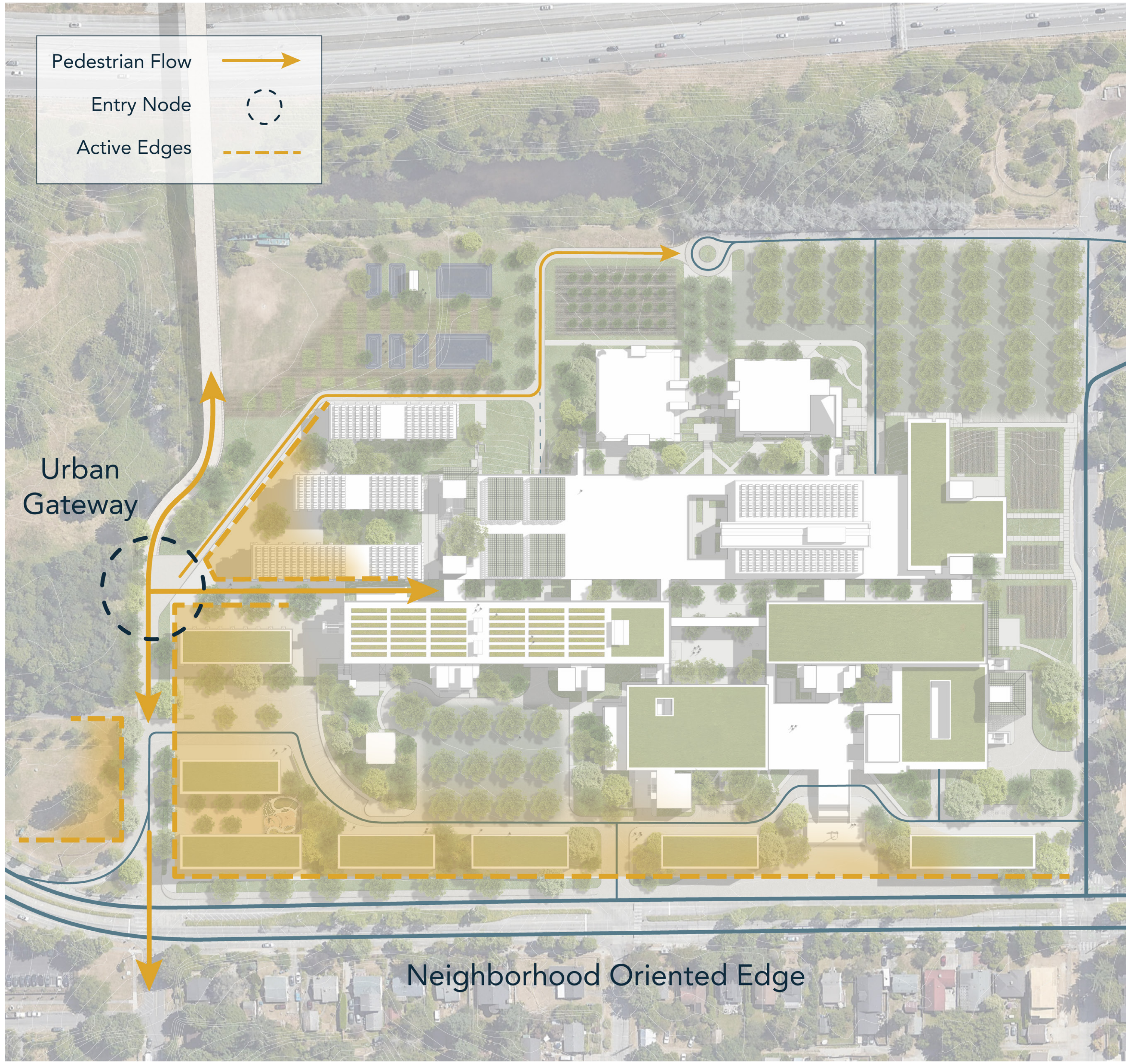


Fig 6.3 North Urban Edge schematic plan

North Edge Proposals

Throughout the project, every intervention is sited with the intent to connect water, energy, and food resources flows while integrating people and natural elements with the site. The pedestrian bridge will terminate at a new plaza that will draw students and passersby into the campus employing the vibrant public life at the ground level (Figure 6.6). The ground floor of the new student housing will include cafés, gyms, galleries, lecture halls and other public amenities. These spaces will provide a bridge between the campus and the surrounding community. The corridors are organic spaces that channel people toward the interior of the campus. Densely planted with native flora, the corridors also provide habitat for other native species as well as immersing students in a biophilic environment. Urban greens spaces not only improve the campus's environmental footprint but have also been shown to improve human physical and mental health.[1]

Moving east from the new gateway, a woonerf extends around the student housing connecting to aquaculture ponds, student garden plots, and research orchard, eventually linking to the existing circulation on the eastern edge of the campus. On the roofs of the new student housing are photovoltaic panels that provide energy to the dorms, to ground floor amenities, and to indoor farming ventures. Students living on campus will have hands-on experiences within these spaces.

< Fig 6.4
Perspective view of the re-imagined North Edge of NSC looking down from the new pedestrian and bicycle bridge

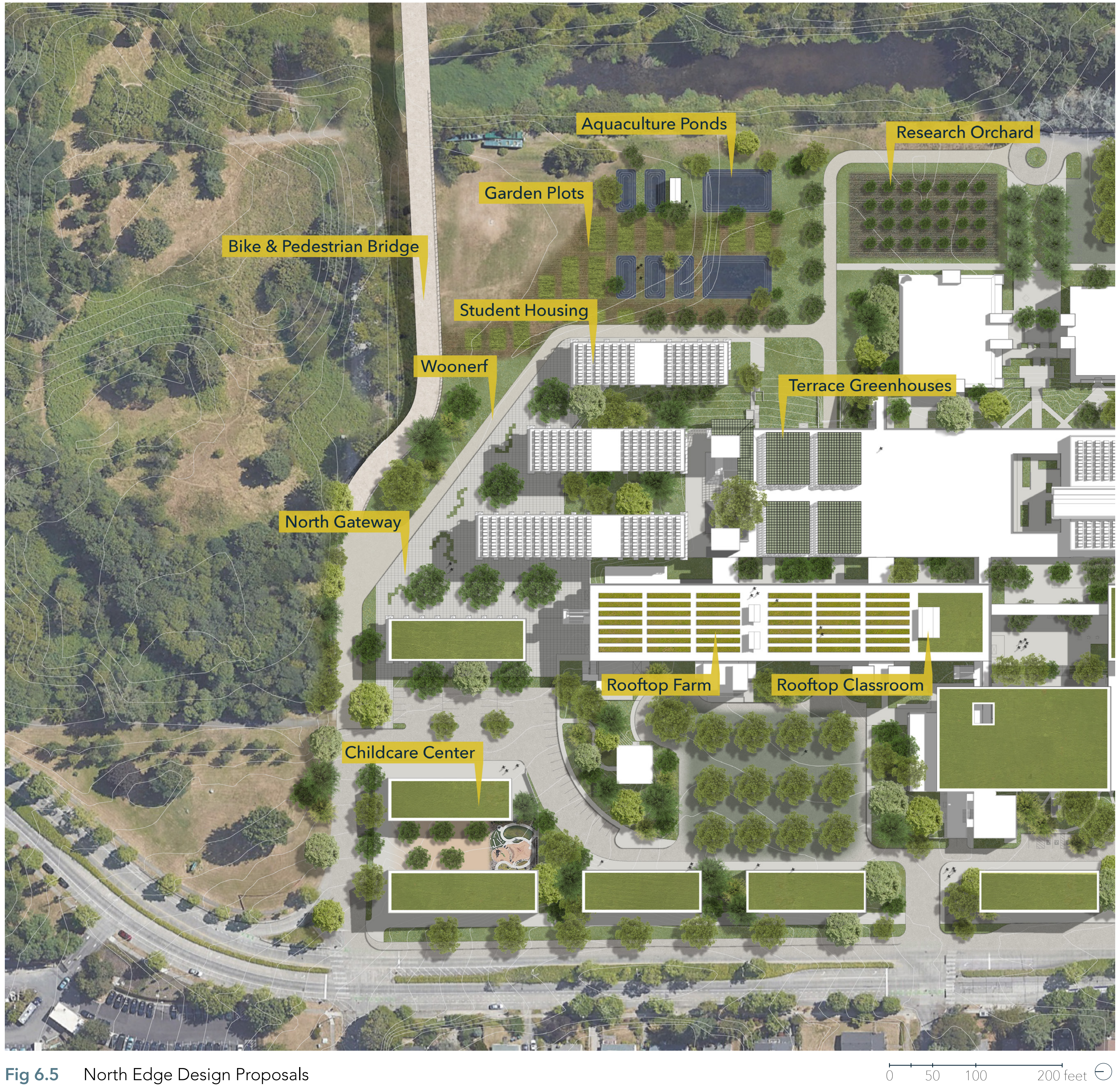
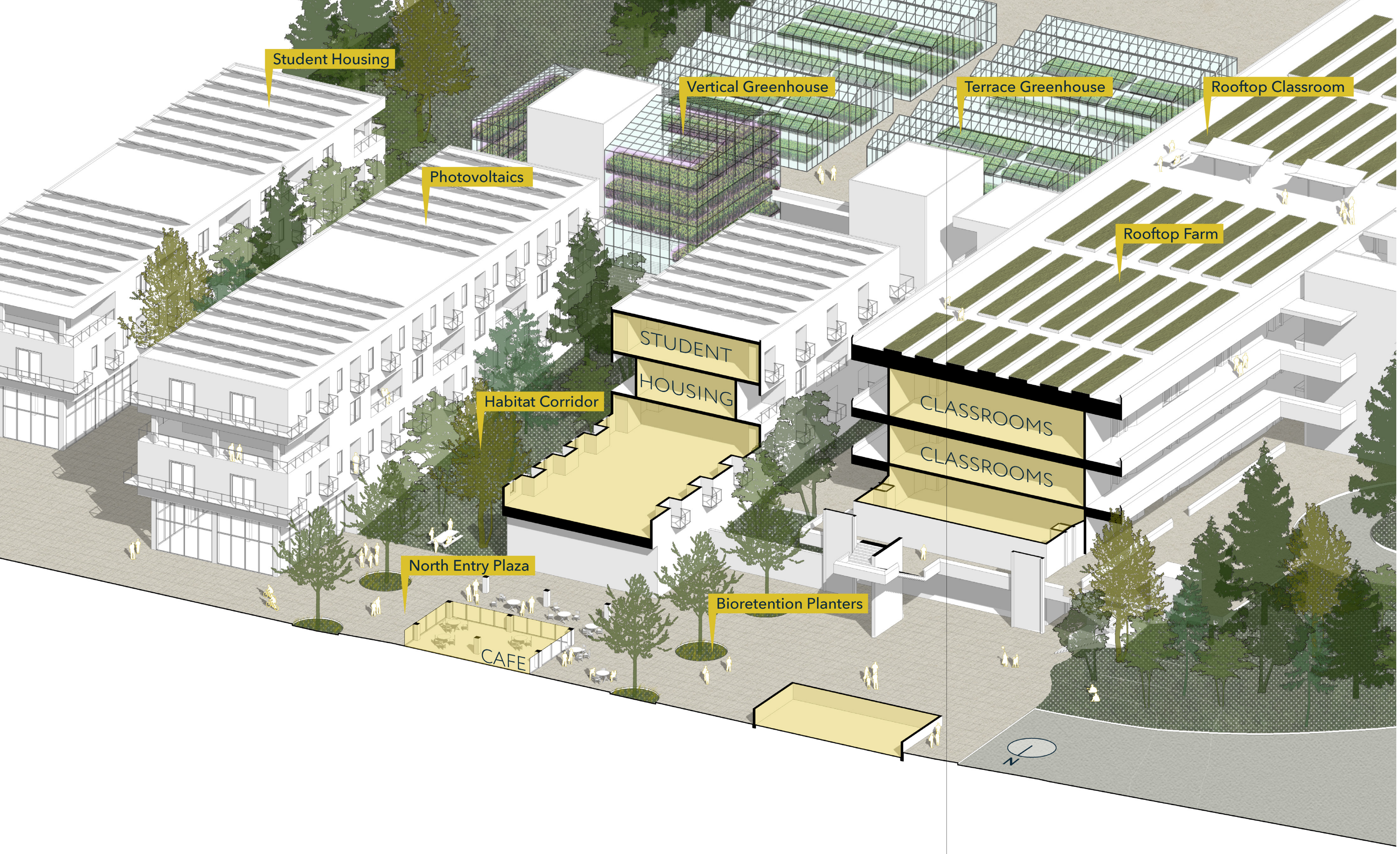


Fig 6.5 North Edge Design Proposals

Fig 6.6
The pedestrian bridge terminates at a new plaza that draws students and passersby into the campus through vibrant public life at the ground level. New student housing includes cafés, gyms, galleries, lecture halls and other public amenities.



Energy

The roofs and terraces of the existing buildings become soil-based rooftop farms, outdoor classrooms, and hydroponic greenhouses that connect students with the WFE Nexus. These spaces can be educational opportunities as well as productive spaces for food that can be used within the college. The North Entry axonometric drawing underlines the relationships between the new housing, existing classrooms, and productive spaces. The ground plane is activated by cafés and outdoor dining. Above are the student dorms and balconies with views out toward the habitat corridor and the terrace greenhouses beyond. Figure 6.8 highlights the flows between energy collected from solar panels, energy generated from anerobic digestors, geothermal energy, and the interventions that those systems can power.

< Fig 6.7
The North Entry axonometric section underlines the relationships between the new housing, existing classrooms, and productive spaces. The ground plane is activated by cafés and outdoor dining. Above are the student dorms and balconies with views out toward the habitat corridor and the terrace greenhouses beyond.

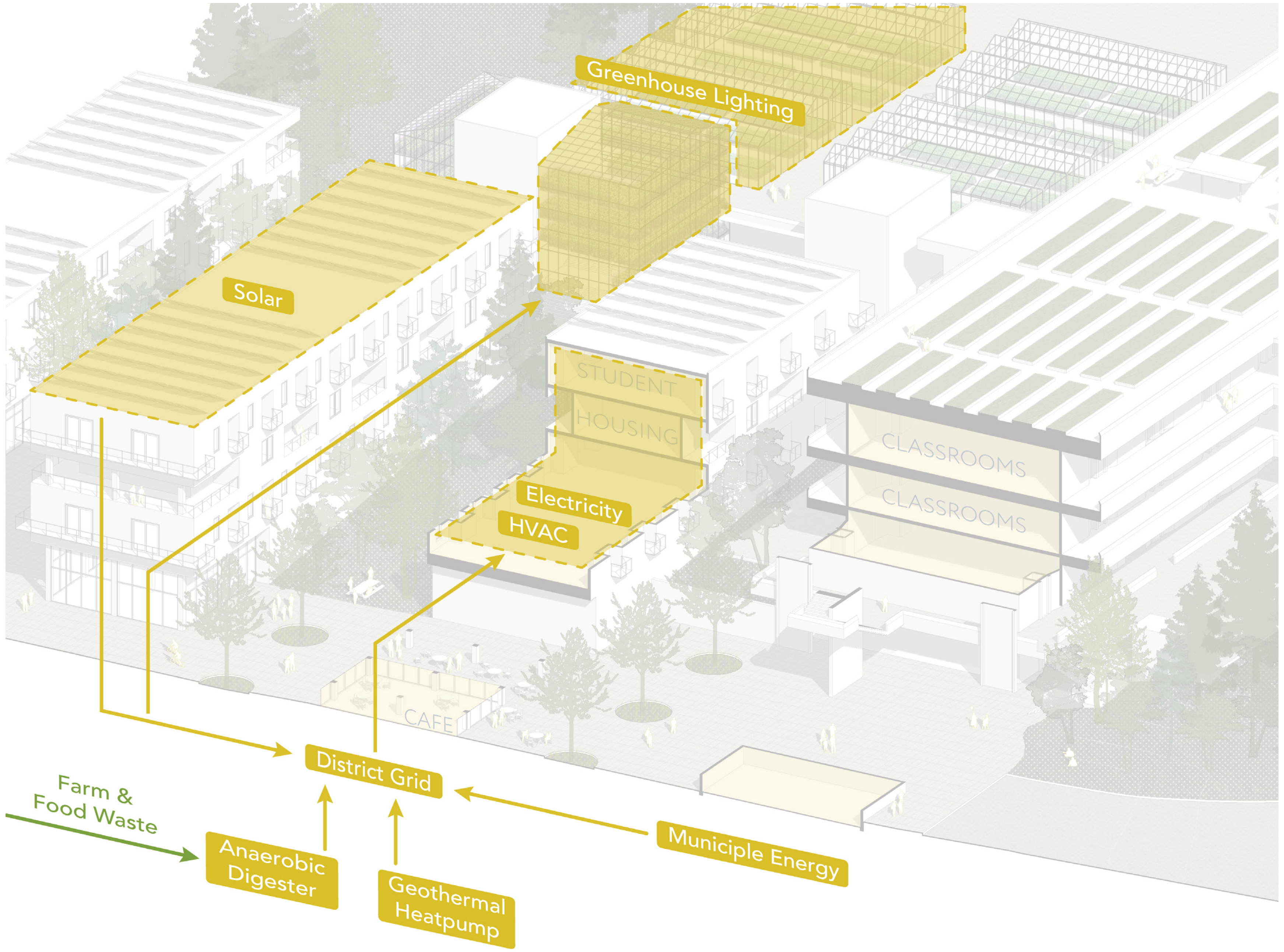
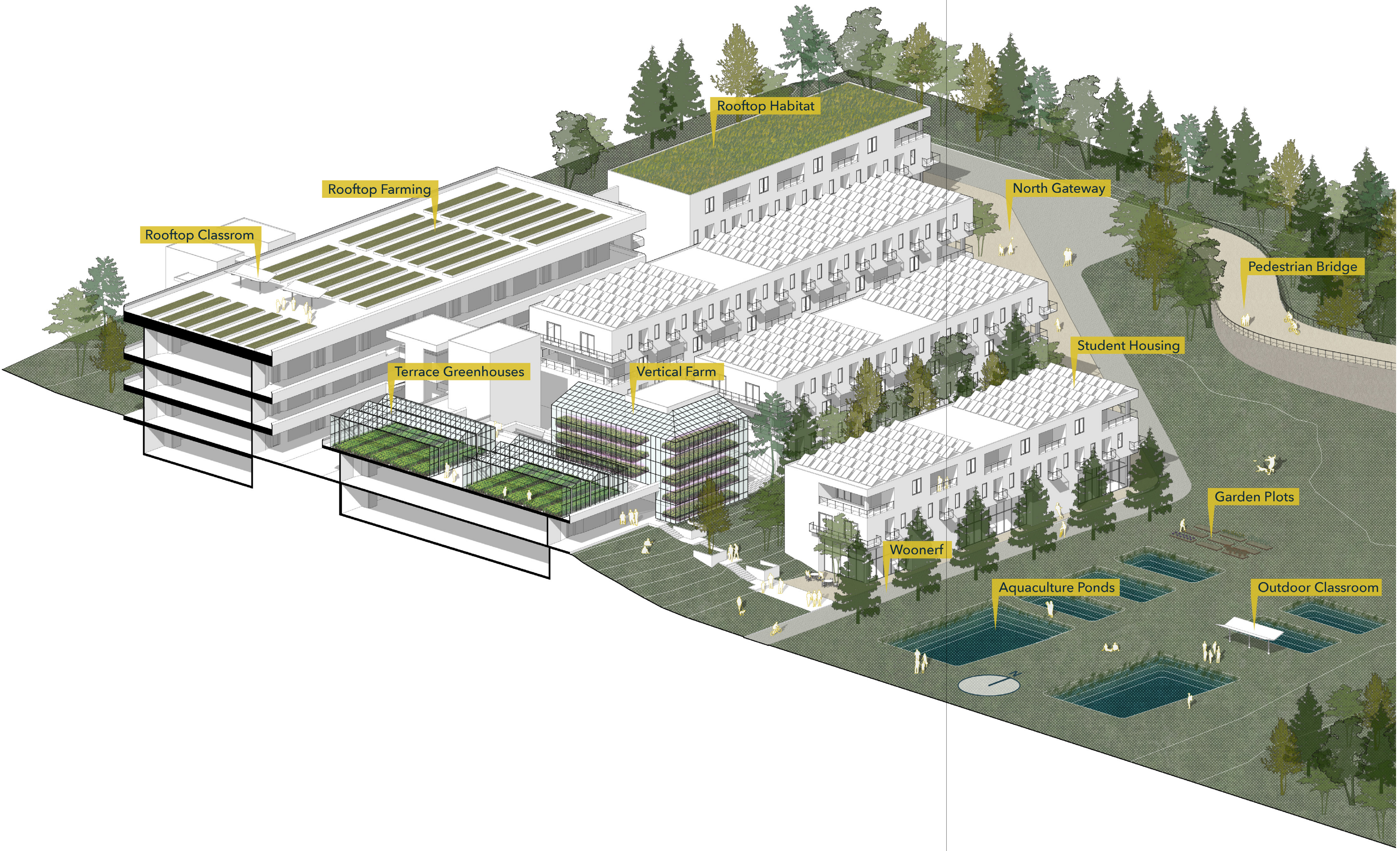


Fig 6.8
The diagrammatic axon highlights flows between the energy collected from solar panels, produced from anerobic digestors, geothermal energy, and the interventions that those systems can power.

Fig 6.9
View looking south from a student dorm balcony showcases views out toward the habitat corridor and the terrace greenhouses beyond



Water

Throughout campus, water will be collected from roofs and parking lots to be reused in buildings, greenhouses and for on-site irrigation. The circular nature of the water cycle will allow water to be stored underground, used in bathrooms or kitchen, and then cleaned to be used again to irrigate crops. In Figure 6.10, this cycle is shown moving water from roofs to aquaculture ponds. Not only is the collected water offsetting the need to use municipal water, but it is also being used to produce crops. The greenhouses here are a key example of the WFE Nexus; energy produced on site will be used to heat and light greenhouses that are irrigated by collected roof runoff and will producing food to be consumed on site. Figure 6.11 highlights how water can be collected, stored, cleaned, and used on site. These systems will work together to maximize efficiency and minimize the campus' environmental footprint. Additionally, they are designed to be accessible to students and classes and act as hands on teaching tools where students can learn about intricate systems and larger concepts that make them valuable.

< Fig 6.10
Water focused axonometric section shows rooftop farming, greenhouses and aquaculture ponds integrated with student housing. These systems work together to collect and reuse water throughout the campus.

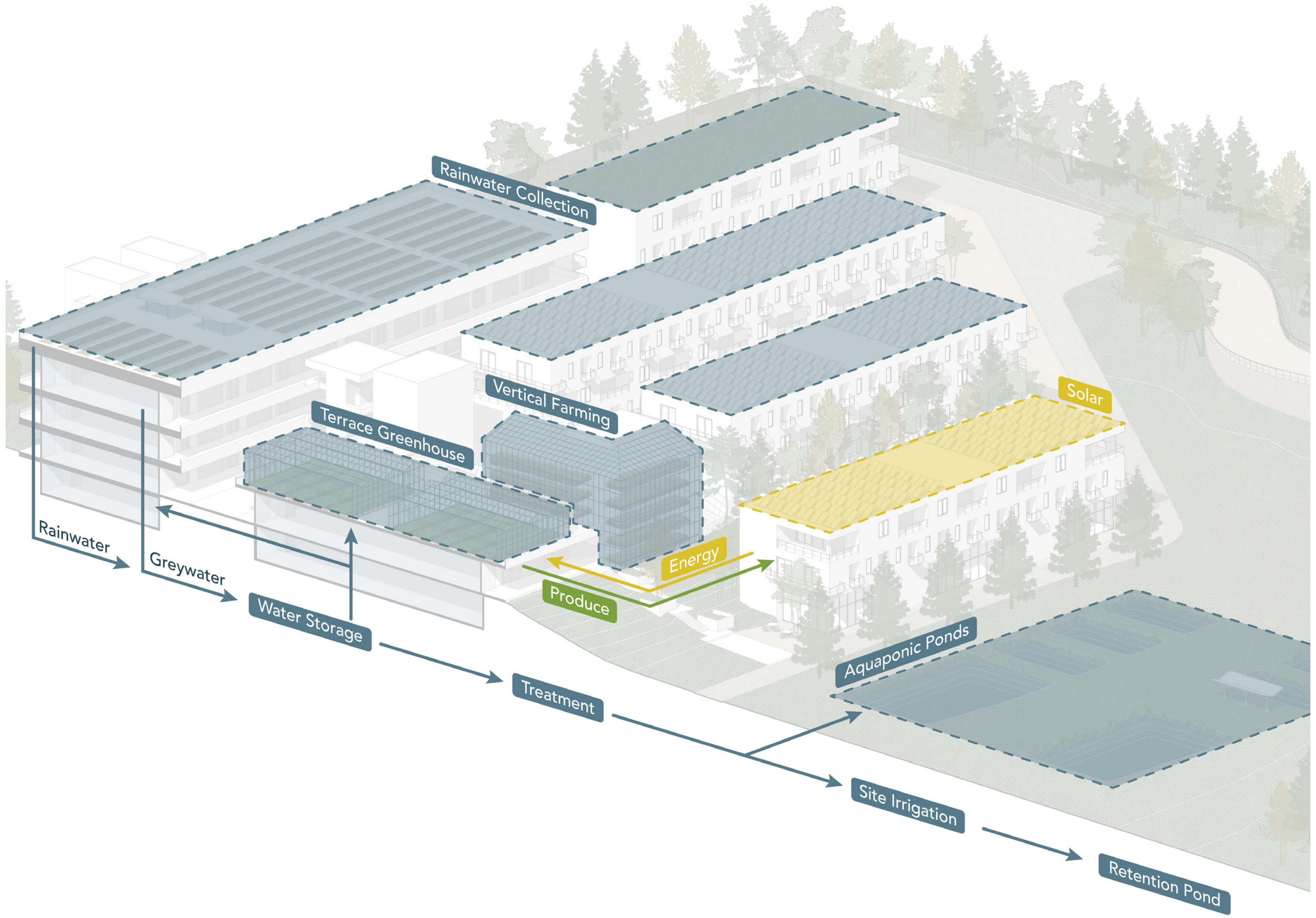


Fig 6.11
The water focused diagrammatic axon highlights the circular flows of water from roof to green house to aquaculture ponds. The greenhouse is a key element of the WFE Nexus efficiently using resources produced or collected on site and growing food for students and community members.

Fig 6.12
View looking north from the aquaculture ponds showcasing the interconnectedness of the productive, educational, and living spaces. During Seattle's rainy months, the flow of water is highlighted thoughout the campus.

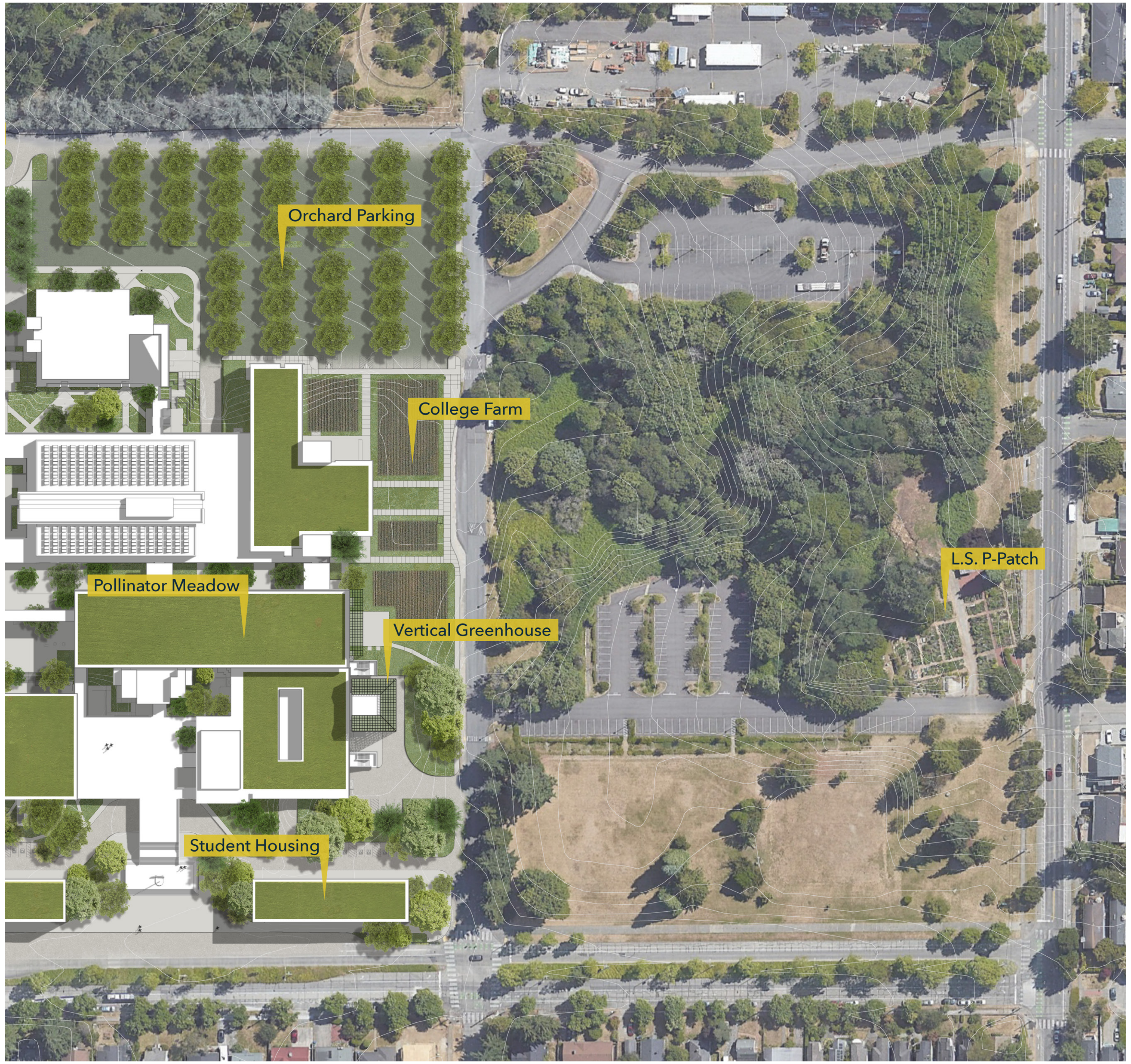


Fig 6.13 South Edge Design Proposals

South Edge Proposals

The goal for the south edge is to soften the hard edge of the campus and provide agriculture opportunities, habitat, and environmental services. Building from the Licton Springs P-Patch, the south edge strives to integrate agriculture in a multitude of ways. Forested orchard parking will replace asphalt with permeable paving and densely planted nut trees to reduce runoff and the potential for the heat island effect. These orchards will not only provide shade but can provide a valuable nut crop. Expansive green roofs will cover many of the existing buildings to increase habitat as well as slow rainwater during large storm events. Classes can access these spaces for wildlife viewing and to observe a student run apiary (Figure 6.17). Mown lawns transform into productive student farms. Large brutalist facades are hidden behind vertical farming operations that take advantage of the southern exposure (Figure 6.18). This transforms the site and the existing buildings into productive spaces that can serve as educational tools. Students at the university have the opportunity to learn about traditional forms of agriculture as well as more hi-tech methods such as the indoor hydroponic or aquaponic systems which use less water than traditional methods and can be powered by energy generated on site. These interventions intersect the WFE Nexus by reducing water and energy use and transforming these resources into food to be used on-site and by the neighboring communities.

Fig 6.14 Orchard Parking

Food

The southern edge emphasizes many of the overlaps that food creates in the WFE Nexus. Urban agriculture, in addition to producing food, provides other ecosystem services such as improving air or soil quality, habitat and cultural services.[2] This holistic view of urban agriculture is sometimes called multifunctional urban agriculture and tries to improve the circularity and overall urban metabolism of a city.[3] The collection of food interventions on the south edge capitalizes on these qualities and creates a network of productive and educational spaces that improve human and environmental health. Architect and Urban designers Katrin Bohn and André Viljoen describe these types of landscapes as Continuous Productive Urban Landscapes (CPUL). A CPUL is a landscape that compliments and supports the built environment and is one that changes "the way societies and individuals experience, value and interact with that landscape.[4] The new south edge embodies the idea of the CPUL and tries to envision a more self-sustained way of living.

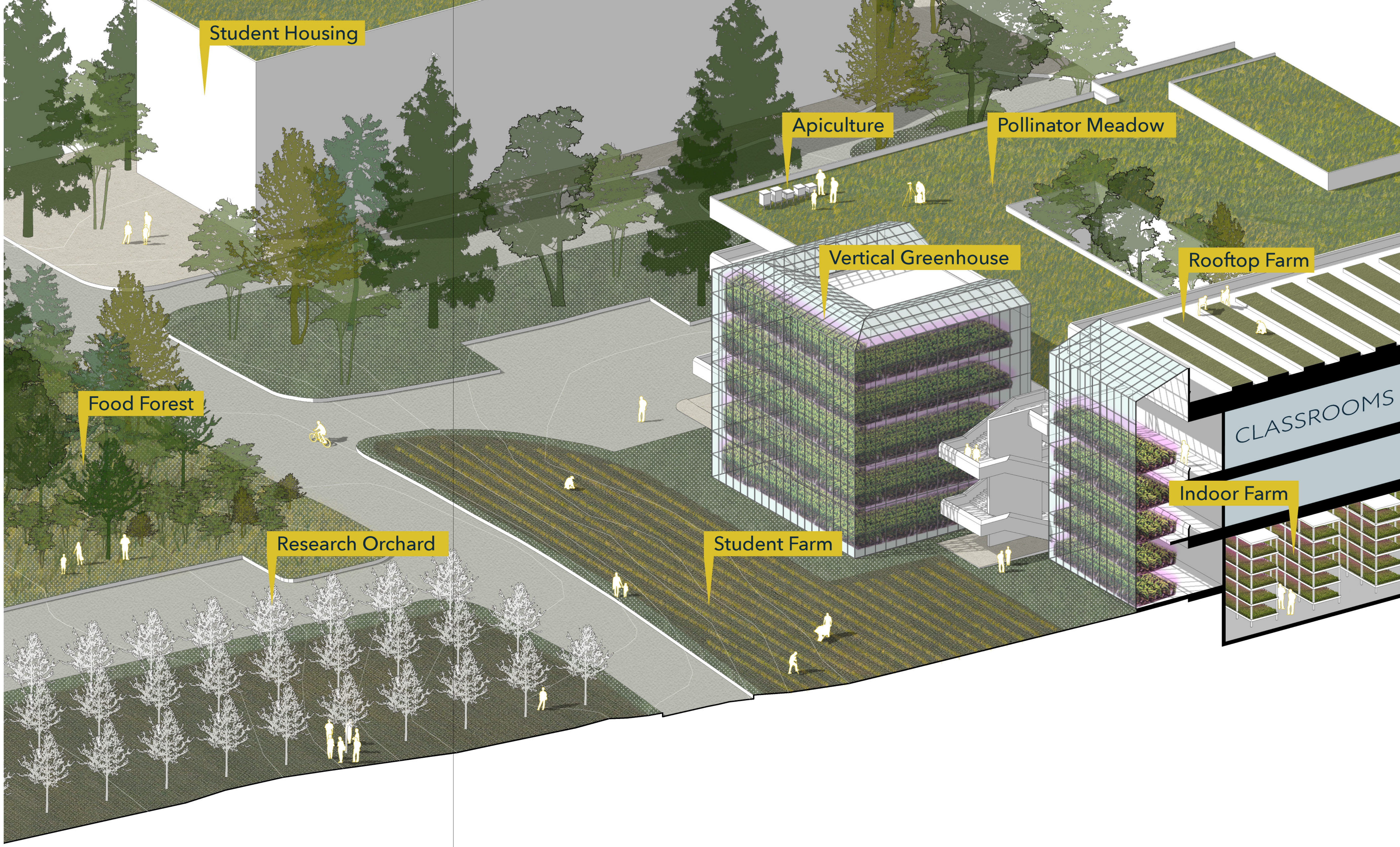


Fig 6.15 >
Southern edge axonometric section depicts the proposal for numerous food producing systems on campus. These occur on the surrounding site as well within the existing buildings.

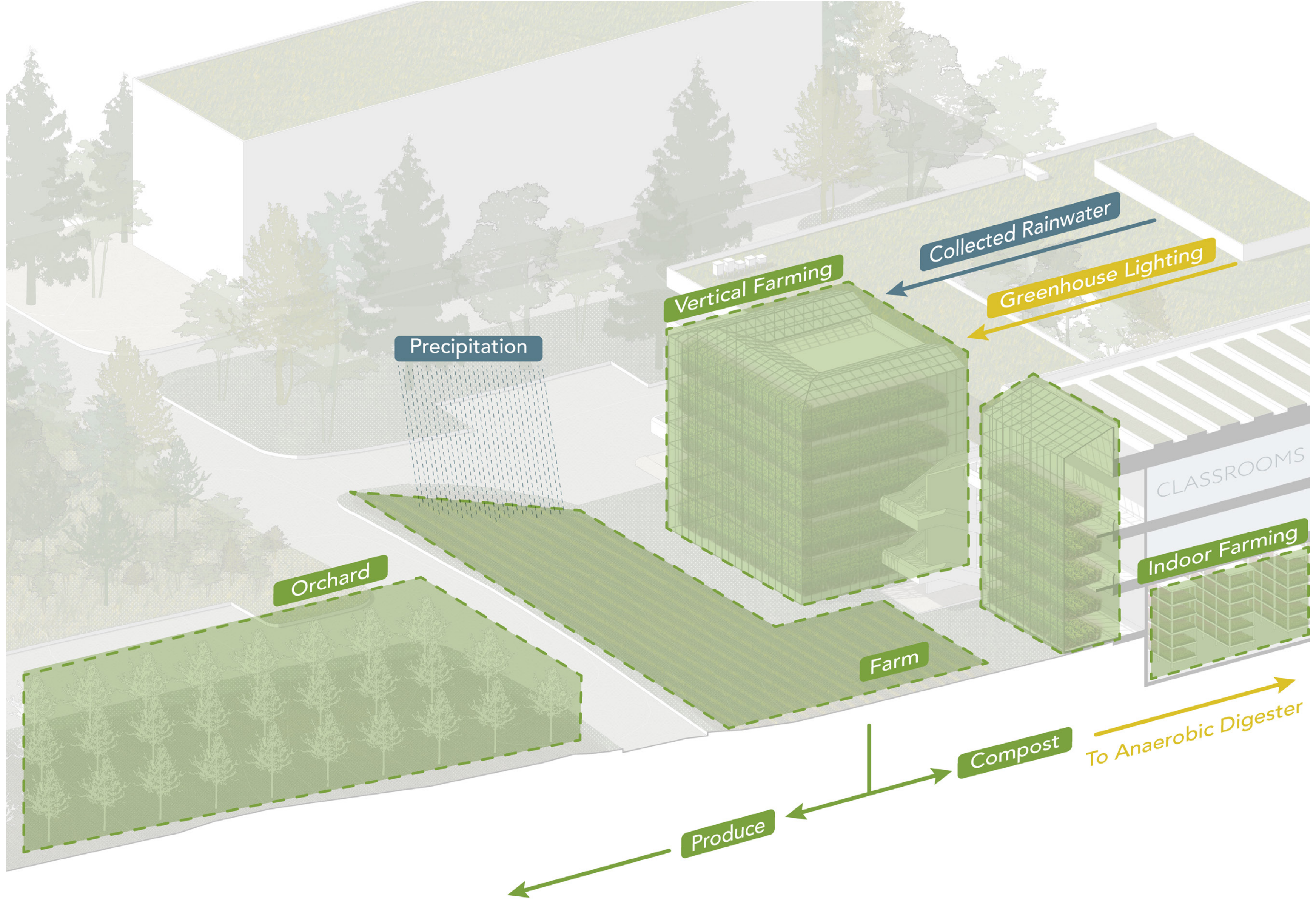


Fig 6.16
Food focused diagrammatic axon highlights flow of resource through the south edge food systems. Food produced by used on site at dining halls and cafés as well as be exported to the local community

Fig 6.17
Rooftop apiary provides educational opportunites and habitat on currently unused rooftops, vertical growing and orchards beyond

Design Conclusions

The design proposals in this thesis highlight the opportunities that arise from designing for the overlaps of water, energy, and food systems. Applying these overlaps to a campus district allows the proposals to come to life at the human scale and provide environmental and human benefits. By developing sites with these relationships in mind, designs can integrate systems in ways that create sustainable human and ecological environments. At North Seattle College, the circular systems integrate with the existing and proposed infrastructure to create an ecosystem that embodies a future where the built environment and ecological systems of a site work together to push the boundaries of what it means to be sustainable.

< Fig 6.18
Vertical greenhouses replace empty concrete facades, taking advantage of southern exposure and acting as a beacon for the re-imagined campus

Endnotes

1 Beatley, Timothy. 2011. *Biophilic Cities: Integrating Nature into Urban Design and Planning*. Washington, DC: Island Press. 6.

2 Orsini, Francesco. 2020. "Innovation and Sustainability in Urban Agriculture: The Path Forward." *Journal of Consumer Protection and Food Safety* 15 (3): 203–4.

3 Orsini.

4 Viljoen, André, and Katrin Bohn. 2014. *Second Nature Urban Agriculture: Designing Productive Cities*. London: Routledge, Taylor & Francis Group. 12.

Great Smoky Mountains National Park, photo by Michael Hicks

Chapter Seven

Looking Forward

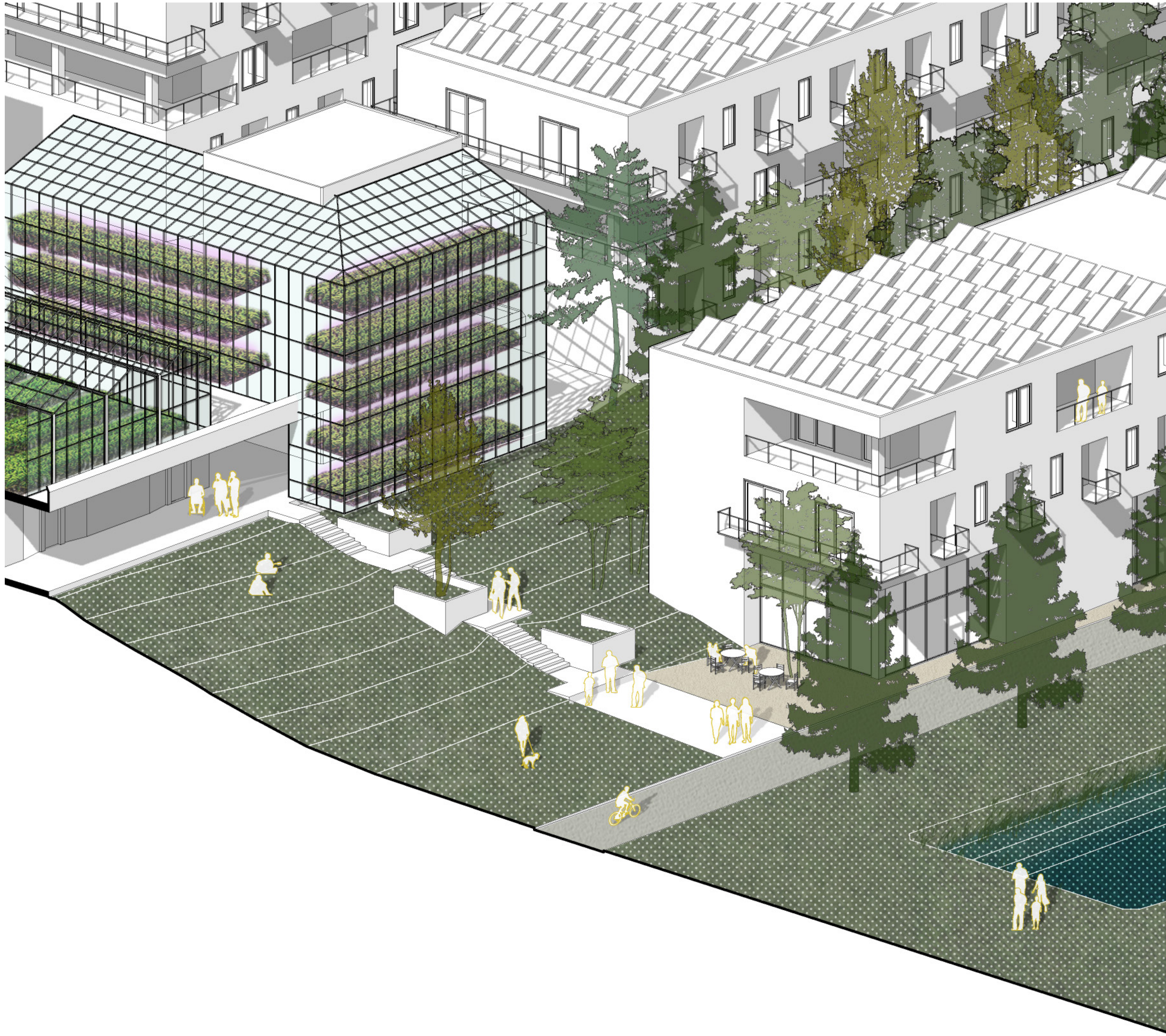
Green New Deal

As the United States continues to better understand the importance of alternative sources of energy as well as come to terms with the country's unsustainable way of life, it has become clear that the US needs to undergo a cultural shift toward sustainability. The Green New Deal, a congressional plan to tackle climate change, aspires to wean the US economy from its reliance on fossil fuels and spur the development of a new clean energy economy that centers on renewable energy. North Seattle College, reimagined as a Living Laboratory, will be the ideal place to shape the minds of the next generation as well as train them. A green collar curriculum that focuses on hands-on experience with the sustainable systems that are revolutionizing the green economy will give NSC students the opportunity to lead developing clean energy industries.

Fig 7.1 Green New Deal by Irena Gajic

A Living Laboratory

As a Living Laboratory, the future North Seattle College is undeniably one that places ecological health and sustainable design initiatives at the forefront. This thesis shows how the concept of the Urban Nexus, applied to a site of this scale, can transform a college campus, once stuck in concrete, into a productive, living place. At a reimagined NSC, the built environment integrates natural processes with human activity to minimize negative impacts on the larger ecosystems. The college is envisioned as a testing ground for sustainable design ideas and can be used as an educational tool for future generations. The nature of community college allows students to be immersed in the latest sustainable technology both in the classroom as well as in person. By choosing NSC, students will have hands on access to the latest sustainable technologies ranging from Anerobic digestors to indoor aquaponic farming. The proposals for NSC hope to foster an environment where people feel connected to themselves, the community, and the land. Through education, training, and leading by example, the college will spread messages of sustainability and the importance of climate action far beyond its edges.



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