Rethinking the Starting Point: The Revitalization of Fall River

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Abstract

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Fall River, Massachusetts is historically known as a successful mill town from the industrial age and was one of the world's largest areas for cotton and cloth production during the early 1900s. Today, most of the city's industry have been shut down, and their facilities have been demolished, repurposed, or preserved for historic significance. However, an industrial campus along the Taunton River waterfront has been left untouched and underutilized by the community. In September 2018, the city of Fall River, MA proposed the Fall River Waterfront Urban Renewal Plan to revitalized three industrial waterfront districts. This thesis proposes that the Fall River Waterfront Urban Renewal Plan use sustainable design to achieve their project goals and transform the industrial waterfront from a polluted and abandoned district into a sustainable neighborhood. Using the Living Future Challenge (LFC) as the project's framework, this thesis proposes step-by-step design interventions onto the South Waterfront District outlined in the Fall River's Waterfront Urban Renewal Plan and demonstrates how sustainable design and technology can be used to meet the LFA's performance goals as well as address the city's needs for the project. This thesis is broken down into two parts: 1) The South Waterfront Masterplan Proposal, and 2) Adaptive Building Reuse Case Study for Existing Mill Buildings. The South Waterfront Masterplan Proposal integrates new construction with existing structures and introduces sustainable infrastructure that connects all buildings and site features within the district to increase the efficiency of resource use and site maintenance. The Adaptive Building Reuse Case Study is a precedent for all existing mill buildings on the site. The case study is the building redesign of an existing mill building within the district and demonstrates how to apply high efficiency design interventions and technologies to elevate the building's operational performance and ultimately advocate for adaptive reuse over new construction. This thesis serves as a precedent for similar, underutilized urban areas on how to utilize sustainable design and technology to achieve additional project goals. It is the goal of this thesis that large-scale urban redesign projects consider the various applications of sustainability and use existing built framework to build off of.

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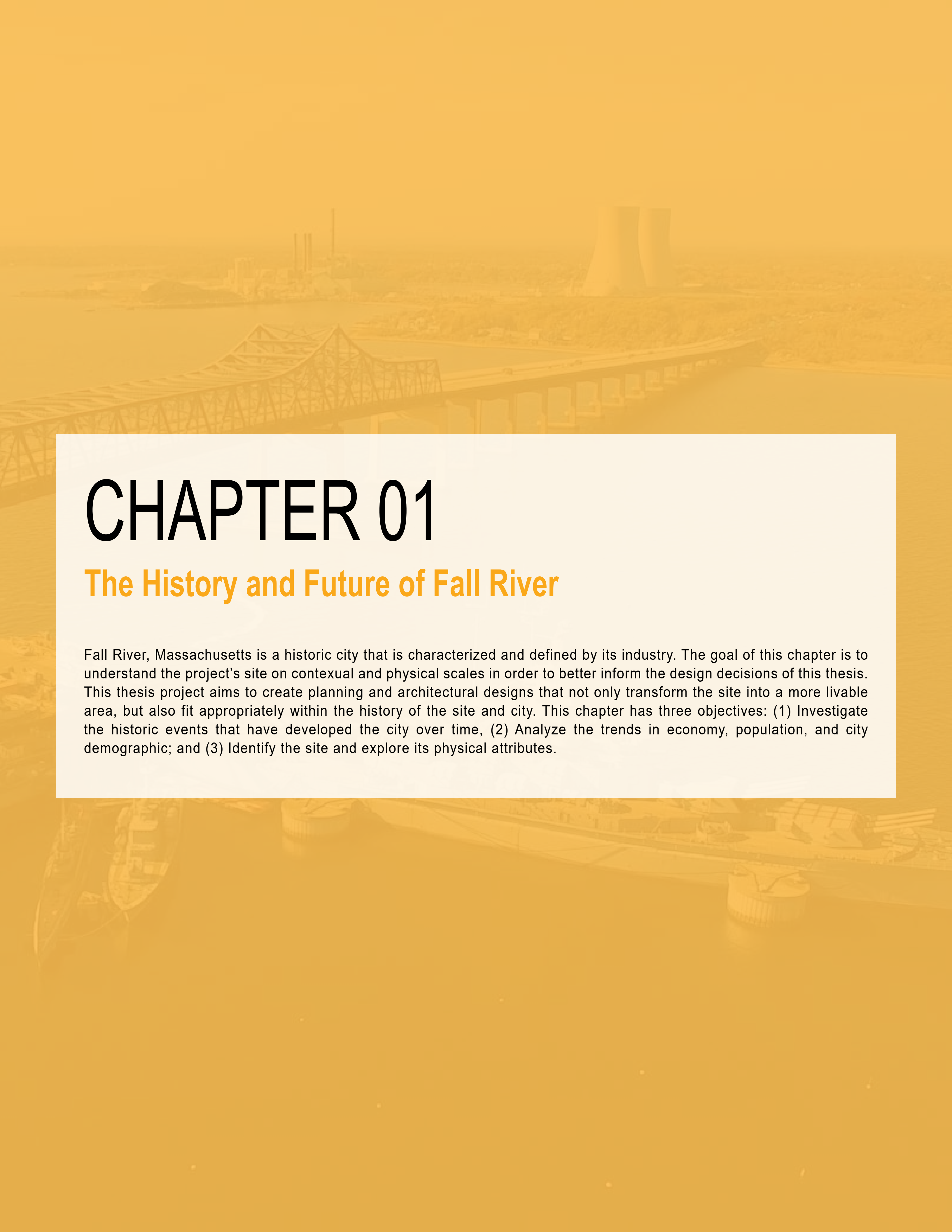
PART ONE



CHAPTER 01

The History and Future of Fall River

Fall River, Massachusetts is a historic city that is characterized and defined by its industry. The goal of this chapter is to understand the project's site on contexual and physical scales in order to better inform the design decisions of this thesis. This thesis project aims to create planning and architectural designs that not only transform the site into a more livable area, but also fit appropriately within the history of the site and city. This chapter has three objectives: (1) Investigate the historic events that have developed the city over time, (2) Analyze the trends in economy, population, and city demographic; and (3) Identify the site and explore its physical attributes.

01.1 History In The Making

The purpose of this section is to provide a brief overview of the history of Fall River and its origin and to analyze its current economic and demographic status. This section will develop a general understanding of the city's overall state on economic, industrous, environmental, and demographic platforms in order to assess how this thesis might better contribute to the city's needs, elevate the city's assets, and how this thesis might fit into the city's history.

A Brief History of Fall River

The city of Fall River was first established as a town of Massachusetts on February 26th, 1803. The city is located along the Taunton River with access to the Atlantic Ocean - which offer the opportunity for the city to have large port facilities for industry and travel, as well as the use of water power. Due to its location, the city quickly became a popular location for industry to import and export product domestically and internationally. Eventually, Fall River became one of the world's largest locations for cotton mill manufactoring and accommodated a diverse array of industry[1].

Figure 1.1.1 Fall River Diagram (Source: Morgan Warner)

Figure 1.1.2 City of Fall River Massachusetts Map 1877 (Source: Library of Congress)

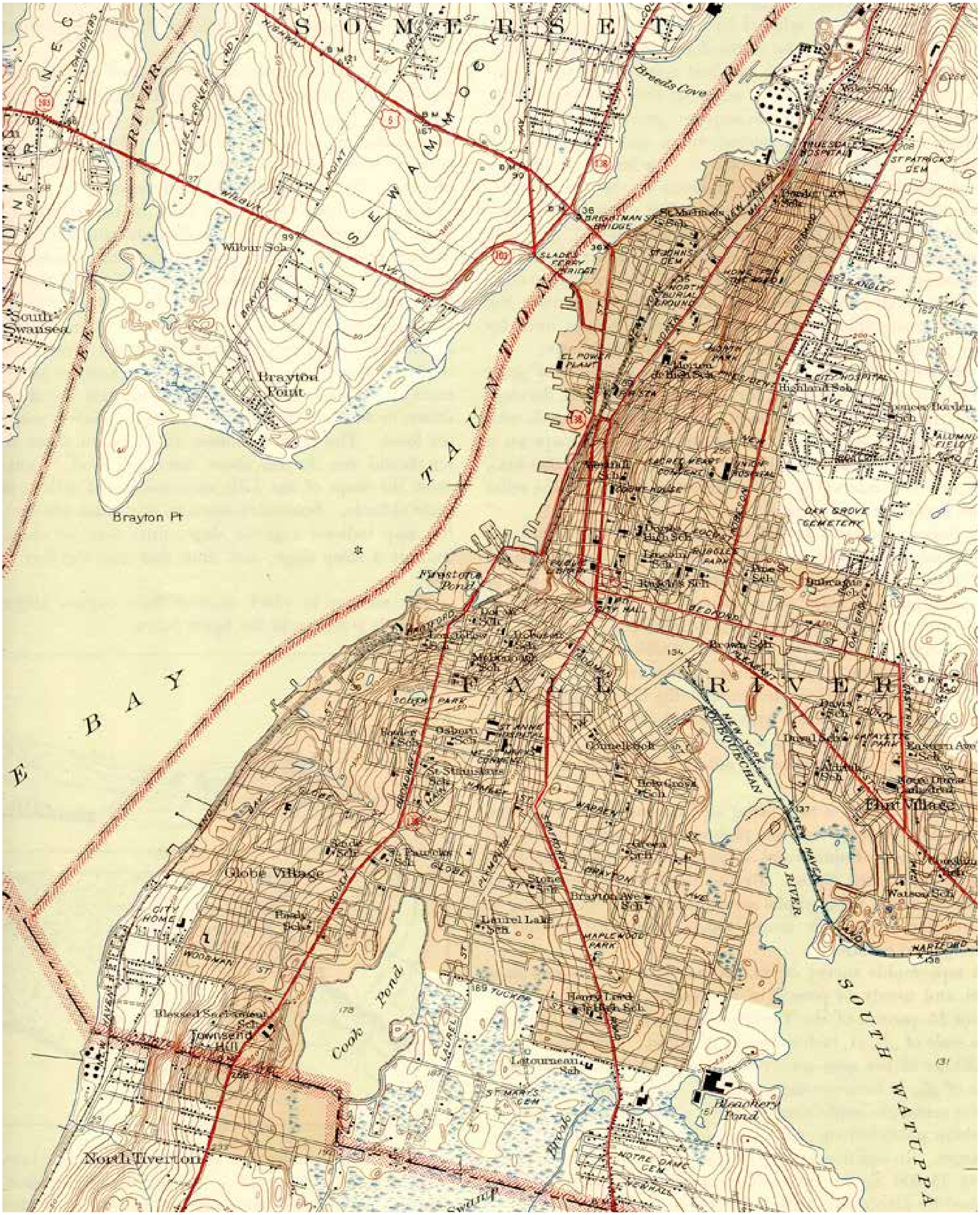
Figure 1.1.3 Fall River Village 1840 (Source: Boston Rare Maps)

The industrial history of Fall River began in 1811 when Joseph Durfee first opened the Globe Manufactory - the first spinning mill of Fall River - that kickstarted the town's early industrial development. By 1830, Fall River housed seven textile mills, provided steamboat transportation to Providence and Newport, Rhode Island, and had their own newspaper. Over time, Fall River's industrial profile expanded from textile mills to iron works, cotton production, and cloth printing. By 1910, The American Printing Company (APC) in Fall River employed six thousand people, and the company was the largest cloth printing company in the world, giving Fall River a global platform for American industry. At this time, cloth printing was Fall River's largest industry. Across the city and the New England region, cotton mills were dependent of the APC for their own business's, and the APC quickly became the backbone of Fall River's industry. The decline of the APC kickstarted the decline of the city's entire industry[2].

Fall River's economic decline began in the 1920's when textile manufacturing began to move south due to lower laber cost and more accessible coastline. The nation's overall economy began to slow post WWI and all industrial production quickly out weighted the nation's demand. In 1928, the largest city fire in Fall River's history destroyed the central business district and downtown - destroying industry businesses and mill factory buildings. During the Great Depression in the 1930's, many more industrial companies in the city went out of business. In 1930, the city of Fall River went bankrupt, and the city's finances were state operated from 1931 to 1941[3].

Figure 1.1.4 Algonquin Printing Co. (Source: The Digital Commonwealth)

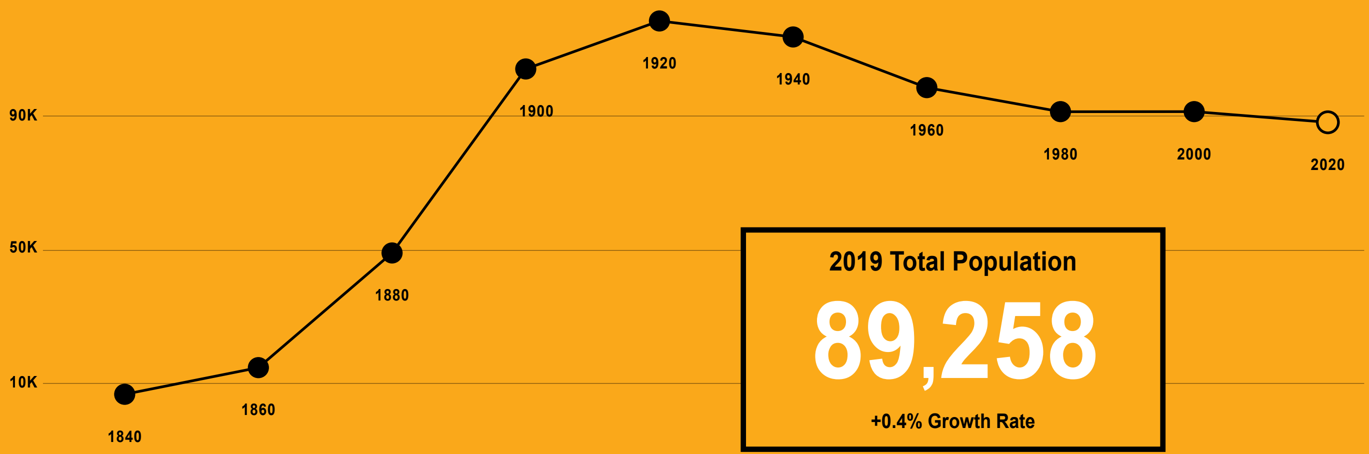
Figure 1.1.5 Historic Fall River Topographic Map (Source: PD-US)



Trends in Economy, Industry, & Demographic

Throughout Fall River's history, the population density has mimiced the growth and decline of the city's industry. The peak population count the city experienced was an estimate of 120 thousand resdients in 1920. Today, the city's population density is experiencing a 0.4% growth rate increase, and is currently at an estimate of 90 thousand residents. 81% of Fall River's population is White. the remaining 19% of the population includes Hispanic, African American, and Asian. 26% of Massachusett's population is of foreign birth. The most common places of origin for thic percentage include China, Dominican Republic, Brazil, Russia, Canada, and Western Europe. 20% of the overall population of Fall River is in poverty. This percentage includes 50% of Fall River's Hispanic population, 25% of the city's African American population, and 16% of Fall River's White population. The city's overall population is divided evenly between male and female. In Fall River, there are 4,570 veterans - 4,206 male veterans and 364 female veterans. The wars these veterans fought in include the Vietnam War, the First Gulf War, the Second Gulf War, the Korean War, and WWII. Most veterans are above the age of 54[4].

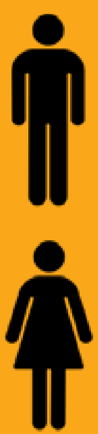
Figure 1.1.6 Fall River (Source: Billboards In My City)



2019 Total Population

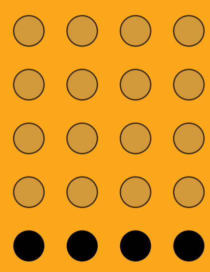
89,258

+0.4% Growth Rate

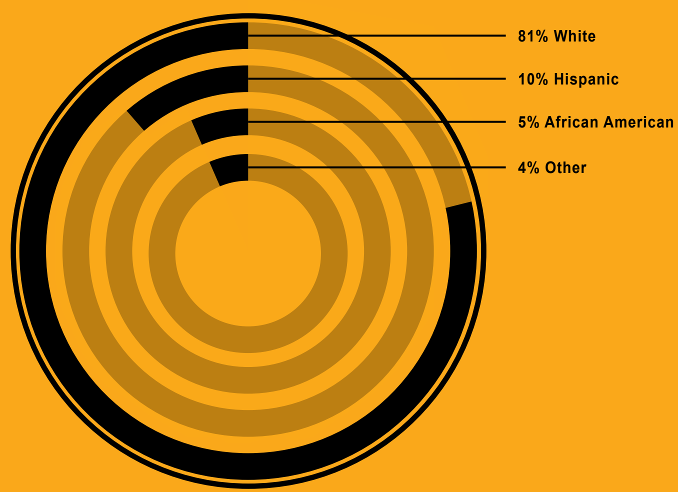


47%
MALE

53%
FEMALE



20%
POVERTY RATE



26%

OF MA. POPULATION IS FOREIGN BORN

Fall River, Massachuestts's population consists of 26% of citizens who were born outside of the U.S. The most common origin's of birth for foreign-born Massachusetts citizens include:

- China
- Dominican Republic
- Brazil
- Canada
- Russia
- Western Europe

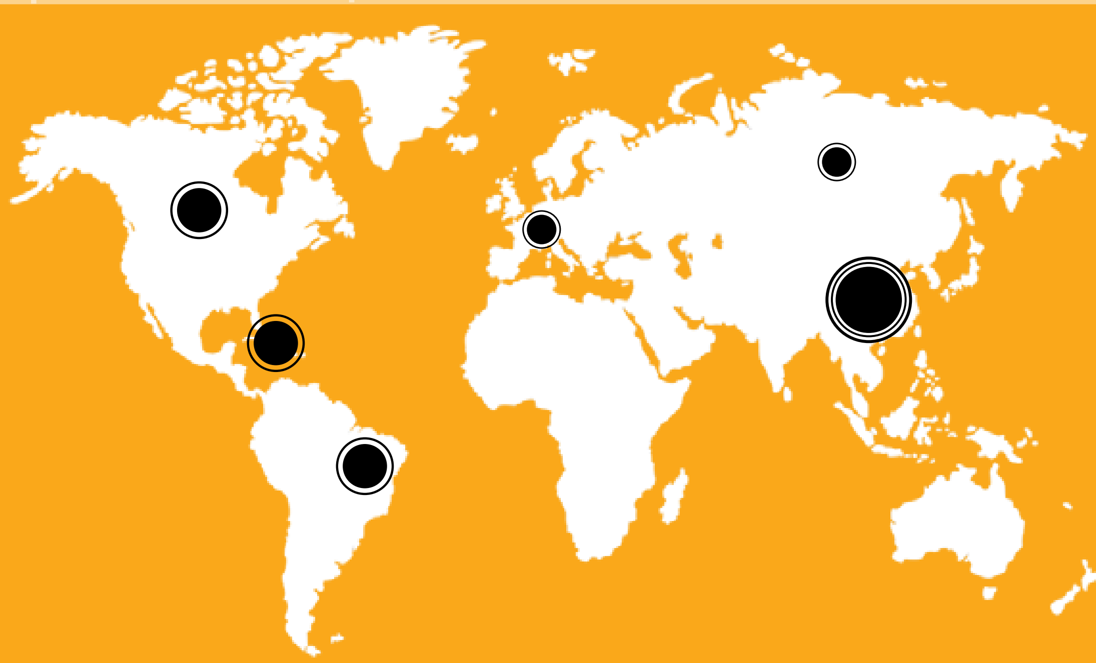


Figure 1.1.7 Spinning Room of Flint Cotton Mill (Source: Lewis W. Hine)

Fall River is a city built from industrial manufacturing. Historically, the most successful and largest manufacturing business was cloth printing and cotton production. After the decline of the city's industrial manufacturing, other, more common job types began to flourish. Today's most common job types include social assistance and healthcare, manufacturing, retail trade, food service, and construction. The job type most on the rise today is healthcare and social assistance. Professional office jobs remain the most common job description and cover all job types listed. The average annual household income remains $20,000 below the national average, dispite the state's status at $14,000 above the national average. Only 32% of Fall River's population is above the national average[5].

Figure 1.1.8 Historic Fall River Industrial Waterfront (Source: American Printing Company)

MOST COMMON JOB TYPE (NUMBER OF EMPLOYEES)

7,875
SOCIAL ASSISTANCE

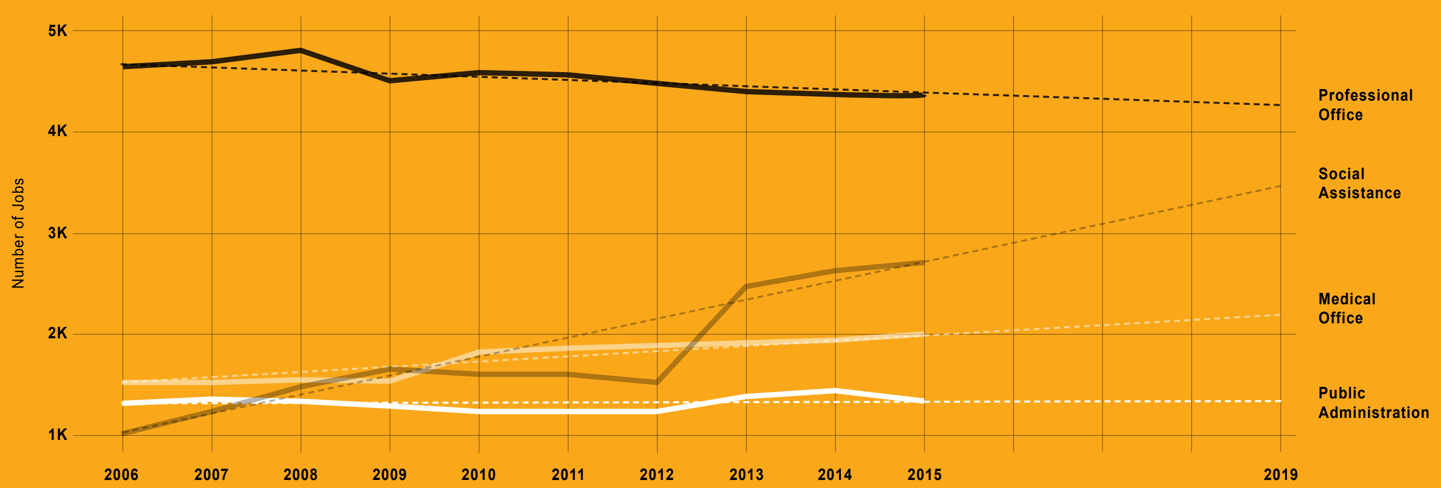
5,000
MANUFACTURING

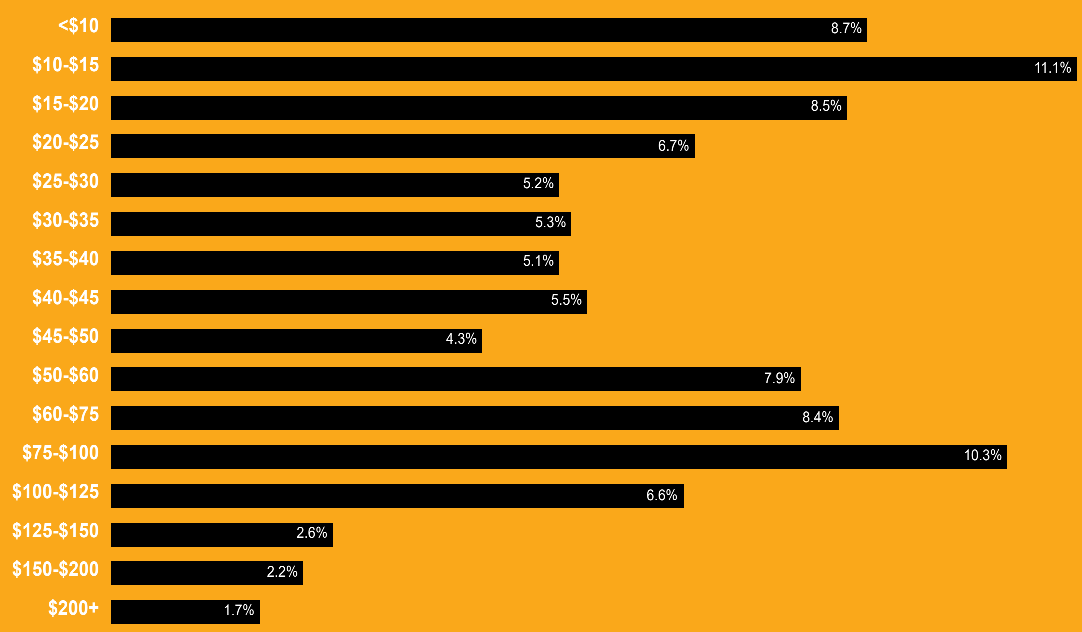
4,975
RETAIL TRADE

3,500
FOOD SERVICE

3,000
CONSTRUCTION

JOB TRENDS IN FALL RIVER, MA





$40K

AVERAGE ANNUAL HOUSEHOLD INCOME

The avg. annual household income in Fall River is $39,328, which is less than the U.S. average annual household income of $60,336 and the Mass. average annual household income of $74,167.

01.2 The Fall River Waterfront Urban Renewal Plan

In September of 2018, the City of Fall River announced their schematic draft of the Fall River Waterfront Urban Renewal Plan (FRWURP). The plan aims to clean up the industrial waterfront and repurpose the land for outdoor public use and private development. The plan is broken up into three sections: (1) South Waterfront, (2) Central Waterfront, and (3) North Waterfront. This section will provide a general outline for the FRWURP and focus on the goals and proposed objectives for the South Waterfront section of the plan.

Executive Summary

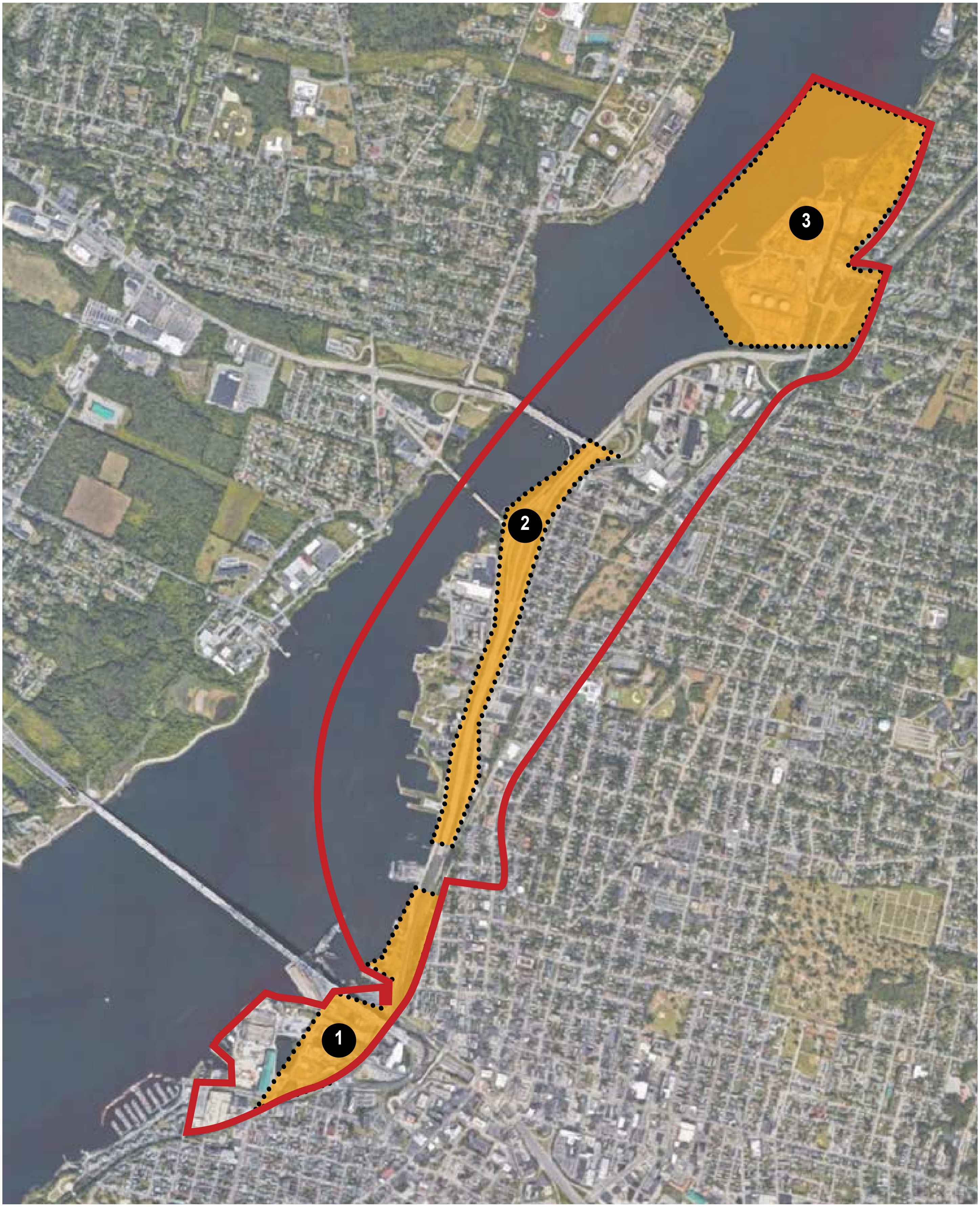
For each of the three sections of the plan, the FRWURP outlines specific objectives and goals for development that take advantage of existing opportunities and site features; address current site issues related to environmental health, economy, and social equity; and to celebrate the history of Fall River and strengthen its identity. The general plans for each of the sections are as follows:

1. **South Waterfront: Strengthening Current Assets: Arts, Museums, & Parks** - This section of the waterfront will focus on the acquisition and disposition of underutilized buildings and land under the Braga Bridge. These properties are historic to the waterfront's industry and are necessary to implement the proposed MassDOT Infra-Space improvements under the bridge. This section will also focus on elevating the public arts, museums, and parks in the area to better utilize and celebrate the waterfront.

2. **Central Waterfront: Developing a New Community: Route 79 and Davol Street -** This section of the waterfront will focus on creating a new neighborhood where Route 79 used to lay by integrating the existing neighborhood fabrics with the waterfront's commercial edge.

3. **North Waterfront: Rehabilitating Land for Jobs and Open Space/Recreation Us -**: Shell Oil Site Area - This section of the waterfront will focus on the acquisition, reparcelization, and disposition of the Shell Oil site. This site is significant within the Designated Port Area (DPA) and falls directly on the water's edge[6].

Figure 1.2.1 Fall River Waterfront Urban Renewal Plan - Plan Boundaries (Source: Morgan Warner)



Fall River Waterfront Urban Renewal Plan Strategies and Actions

SUSTAINABLE PRINCIPLES	FALL RIVER WATERFRONT STRATEGIES
Concentrate Development and Mix Uses	Zoning modifications to increase density and add land uses to parcels immediately adjacent to proposed train station sites.
Advance Equity	Recognition of the needs of the population for jobs, goods, and services.
	Improvement of existing and development of new alternative modes of transportation (sidewalks, bike lanes and paths, buses, and trains).
	Improve access to arts, museums, and institutions.
Make Efficient Decisions	Coordination between FRRA, Planning Board, and City Council for implementation actions.
	Parallel planning process with Downtown Urban Renewal Plan to streamline work and ensure cohesion in proposals.
Protect Land and Ecosystems	Improvements to parks and recreational facilities.
Use Natural Resources Wisely	Responsive to existing environmental hazards and focus on how these systems will be impacted by climate change.
Expand Housing	Encouragement of new housing at multiple income levels.
	Encouragement of housing typologies not currently available within Fall River.
Provide Transportation Choices	Development to support proposed of South Coast Rail station.
	Consideration of improvements to existing bus networ as area is redeveloped over time.
Increase Job and Business Opportunities	Redevelopment of vacant buildings.
	Strategic zoning changes to address planned commercial corridors to provide opportunities for business development.
	Expansion of permitted uses, including light/boutique and manufacturing.
Promote Clean Energy	Inclusion of energy-efficient measures in design guidelines.
Plan Regionally	Consistent with regional plans.

URBAN DESIGN CONDITION	PROPOSED SOLUTION
Some historic mills are vacant or underutilized, which may endanger their structural integrity and make them more vulurable to natural hazards or collapse; a few mills have fallen victim to fire and demolition, leaving empty spaces in the center of historic districts.	Collapse or demolition historic mills should be replaced by buildings and uses compatible with the district's historic character, land use patterns, and the community's vision for the future.
Building age and conditions of dispair in older residential neighborhoods affect rentability and owners' financial capability to rehabilitate, maintain, and upgrade deteriorated buildings.	Provide design guidance and financial assistance to homeowners in renovating and updating their buildings (e.g. create a Facade Improvement Program, and provide building improvement loans).
Asphalt-covered parking lots and lack of vegetation contribute to increase water runoff and 'heat island' effects in dense areas of the neighborhood, while detracting from the visual image and perception of safety.	Adopt guidelines to the design of parking lots and edges that promote the creation of green areas and landscape buffers to screen the view of parked vehicles from the street; and introduce design amenities such as sitting areas, benches, or trees along sidewalk.
Narrow or broken sidewalks, scarcity of trees, and lack of landscaping diminish the quality of the walking experience in some areas, restricting access and contributing to generate a perception of neglect.	Increase the provision, maintenance and upkeep of sidewalks and street trees; build sidewalks in places where they are missing, and add extensions to widen stretches of sidewalk that prevent universal access.
Large, new buildings and parking garages may present long blank walls along streets, sidewalks and public spaces, which may convey a perception of emptiness and discourage pedestrian activity.	Provide guidelines to promote the articulation of long blank walls through architectural elements, openings, or screen features that relate the building design to the human-scale.
Extensive areas along the waterfront's edge are at high risk of inundation by the 1% annual-chance flood event, with additional hazards due to storm-induced velocity wave action (up to 17 ft of Base Flood Elevation plus a 3 ft or higher breaking wave) and sea level rise.	Place the living areas of new buildings and necessary utility equipment above hazardous elevations and use the space beneath the buildings for parking or temporary activities consistent with FEMA policies and regulations.

PUBLIC INFRASTRUCTURE ACTIONS
Partner with MassDOT to implement concepts introduced in their Infra-Space proposal under Braga Bridge (including relocation of salt sheds, additional parking, and open space) and with local property owners to establish pedestrian and bike connectivity between the two sides of the bridge.
Improve Bicentennial Park Trail/Waterfront Boardwalk along Natinoal Grid/Remington Avenue Pier.
Work with MassDOT to facilitate South Coast Rail Project implementation by 2022.
Improve visual access to FIrestone Pond and visual and physical access to Crab Pond.
URBAN PLANNING ACTIONS
Undertake planning and implementation of improvements to the Anawan/Pocasset Street corridor as a link between the waterfront and the downtown, including opportunities for public access to historic Quequechan River falls, currently exposed at two locations in the Iron Works Mill Complex.

CHAPTER 02

A Composition of Existing Research, Data, and Applications

This thesis project will address various topics of sustainability on all scales of the built enviornment, including materiality, building design, and district planning. This chapter will study literature that cover these sustainable topics, study case studies similar to the Fall River site as well as express significant sustainable efforts, and research the various metrics to measure sustainable efforts. This chapter will inform possible objectives, strategies, and project scopes that this thesis may apply.

02.1 Literature Review

The purpose of this literature review is to identify and interpret the major topics and issues revolving around sustainability in order to better inform this thesis on sustainable design and planning practices. This section is categorized into five topics of discussion: (1) Theories of Sustainable Design for the Built Environment (2) Climate Change and the Life Cycle of Materials, (3) Adaptive Building Reuse, (4) Strategies in Sustainable Building Design, and (5) Strategies in Sustainable Planning and Landscape Design. Throughout this section, the cited works and ideas will be analyzed and applied to this thesis by both identifying useful research and developing new ideas.

Theories of Sustainable Design for the Built Environment

The Green Braid: Towards an Architecture of Ecology, Economy, and Equity is a collection of essays written by various authors that capture their responses to the sustainable movement through an architectural lens. The editors of the collection are Kim Tanzer and Rafael Longoria, both of whom practice and teach architecture in the United States. All essays and editor commentary showcase a commitment to design ethics in regards to environmental wellness and long term sustainability. The collection of essays have been divided into 6 categories of focus and theory. The categories include: (1) *The Green Braid,* (2) *Meta-Discourse in Pedagogy and Practice*, (3) *Phenomena and Technology,* (4) *Building Practices,* (5) *Settlement Patterns, and* (6) *The Shared Realm*[7].

The first category, *The Green Braid*, introduces "The Three Es" - Ecology, Economy, and Equity - that make up The Green Braid, or the "Triple Bottom Line". Tanzer and Longoria advocate that The Three Es must all be addressed in architectural practice in order to create holistic designs that achieve true Sustainability. The editors note: "...the joining of environmental outcomes with economic decisions allows us to recognize the crucial role architects play in brokering material and financial choices. Similarly the regrettable results of social inequity, whereby the world's wealthiest inhabitants consume a hugely disproportionate percentage of the world's resources, leave the globe's poorest citizens scrambling to meet daily needs in ecologically degraded and degrading circumstances." In this statement, the editors introduce the issue that political and economic decision making create a snowball effect that impacts environmental health, resource availability, and citizens' standards of living. Within this book, Tanzer and Longoria advocate to extend the definition of sustainability beyond the realm of the natural environment and ecosystem to include long term economic sustainability and social equity. Throughout the book, the editors and contributing authors elaborate on various additional factors that are included in this complex network of sustainability - including population sprawl, density allocation, social opportunities, citizens' access to resources, ratios of political and economic powers, student education, local knowledge, building materials, and building technologies[8].

The sixth category, *The Shared Realm* , articulates the importance of equalizing access to resources and opportunities by transforming the ratio of power. The Shared Realm uses network thinking between designers and all persons that live amidst a designers work to create architecture and urban design that addresses the immediate needs of a community as well as the long-term ambitions and goals of the community's leaders. According to Tanzer and Longoria, the sharing of power occurs only when decision making is made based on equality rather than the hierarchy of power. The overall intention of The Shared Realm is to equalize resources and opportunities for all individuals, community groups, and the natural environment[9].

Included in *The Shared Realm* section, Claude E. Armstrong's and Donna L. Cohen's essay, A Raptor Enclosure for the Zuni Pueblo: Construction and Reconsideration, discusses the Zuni Eagle Aviary and the collaboration between the Native American tribe, Zuni Pueblo, and the federal government. The idea for the aviary was originally to foster a humane method for collecting eagle feathers - eagle feathers are sacred for many Native American rituals and traditions, but in today's preservation of eagles, the Federal Government of the United States regulates the collection of these feathers. Inspired by the collaboration between the Zuni Pueblo and the Federal Government, the aviary was constructed to hold eagles that were unsuited for the wild where they can be held and cared for with dignity, and creates the opportunity for the caretakers of the aviary to collect feathers. The structure uses materials found in the pueblo lands and construction methods observed by the Zuni Pueblo tribe. The overall project is an example of two very different leadership groups working in collaboration to elevate culture, respect long-standing cultural tradition, and protect animals. Today, the aviary attraction has become a tourist attraction that celebrates and informs the public about Native American traditions[10].

This collection of essays and editor commentary contributes to the understanding that all designers of the built environment not only hold the ability, but have the responsibility to mindfully impact the natural environment, economic status, and social integrity of a community. The greatest take away from the book is that within The Three Es, each one impacts the other, therefore sustaining the health and success of one is impossible without the other two. This understanding of the greater complex network of sustainability involved in architectural design renders the small, footnote acts of sustainability inadequate. Architectural choices made as an after-thought in the name of sustainability will not cut it if a project truly wants to contribute to the sustainable movement. This also means that building architecture needs to extend past the property boundaries of a project, and all included in the design process must understand the building's role in its surroundings in relation to social equity, community needs, political influence, economic opportunity, and infrastructure systems.

Climate Change and the Built Environment

Sustainable Construction: Green Building Design and Delivery - Fourth Edition, is a complete textbook about sustainable building and infrastructure construction and practices. Among specific sustainable design detailing, Sustainable Construction references and explains scientific studies to support sustainable ideals as well as the social and economic consequences that call for sustainable practices. Sustainable Constr+uction explains these practices at all scales of the built environment - from materiality to regional planning. The textbook was written by Charles Kibert - a professor at the M.E. Rinker Sr. School of Building Construction, the Director of the Powell Center for Construction and Environment at the University of Florida, and a leader for several design organizations that advocate for green design[11].

In the sections discussing the carbon footprint of the built environment, Sustainable Construction discusses climate change and its relationship to construction. Kibert uses the US National Oceanic and Atmospheric Administration's definition of "climate change" as the long-term fluctuations in temperature, precipitation, wind, and all other aspects of Earth's climate. To discuss the built environment's role in climate change, Kibert focuses on construction energy and carbon output, as well as building systems that use energy, water, or thermal loads. The equation to determine the carbon footprint of a project is :

Carbon Footprint =(Operational Carbon + Embodied Carbon) / Project Area

- Operational Carbon - Carbon output resulting from energy produced to operate all project loads requiring electricity or thermal energy.
- Embodied Carbon - Carbon output resulting from material extraction, product manufacturing, product transportation, product installation, product maintenance, and product disposal for all components of a project[12].

Climate Change Mitigation refers to strategies or actions that attempt to limit the scale and rate of long-term climate change (Houghton, 2002). Strategies to reduce a building's carbon footprint include:

1. Dramatically reducing energy consumption
2. Shifting to renewable energy sources
3. Emphasizing compact forms of development
4. Shifting to mass transportation
5. Designing buildings for durability and adaptability
6. Restoring natural systems
7. Designing low-energy built environment hydrologic systems
8. Designing buildings for deconstruction and material reuse
9. Selecting materials for their recycling properties
10. Including the carbon footprint of buildings in building assessment systems[13]

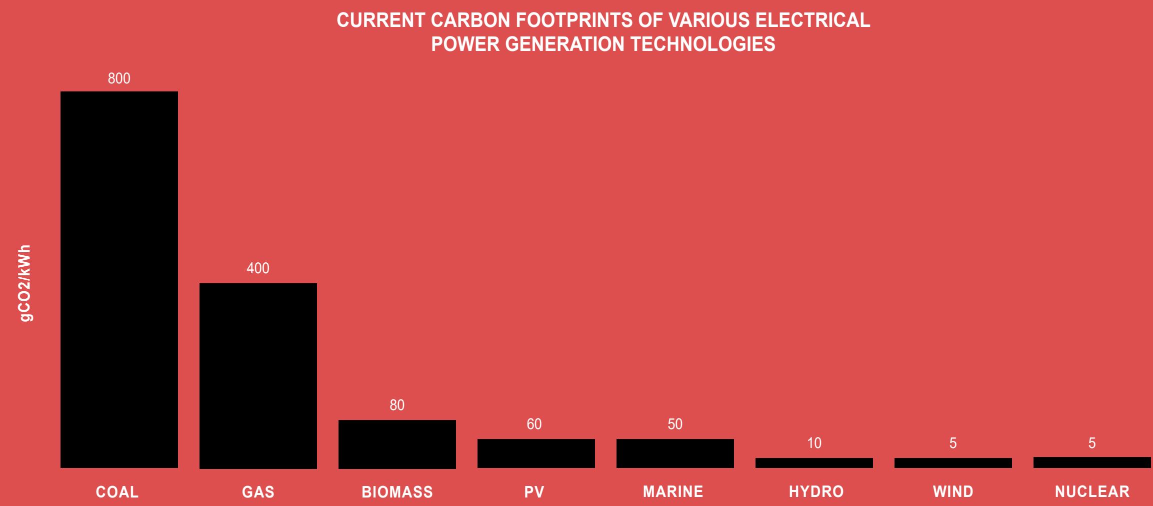


Figure 2.1.1 Current Carbon Footprints of Various Electrical Power Generation Technologies (Source: US Energy Information Administration)

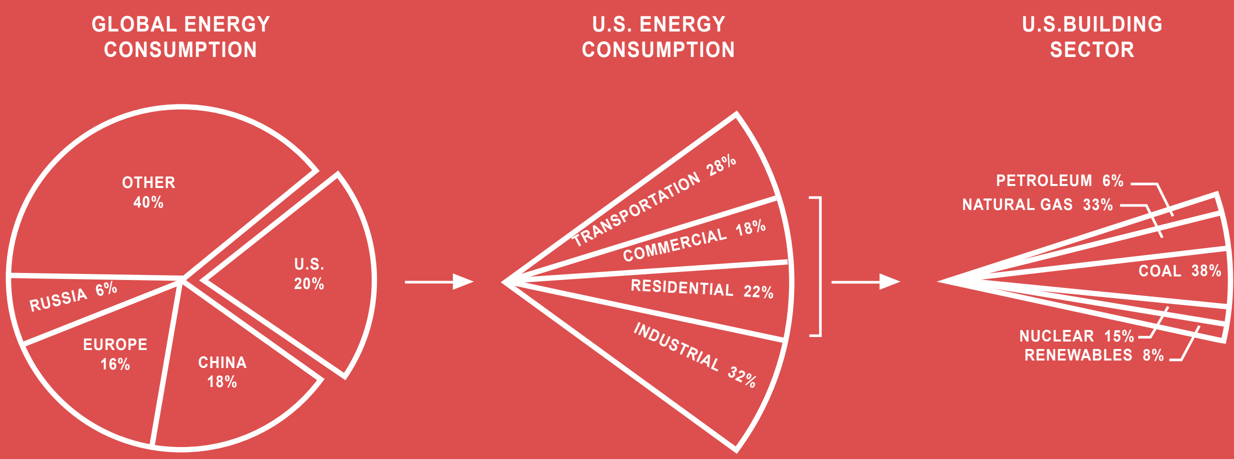


Figure 2.1.2 Energy Consumption Patterns (Source: US Energy Information Administration) The Energy Consumption Pattern data series represents the energy consuption of countries across the globe, within different US building types, and where US energy is sourced from.

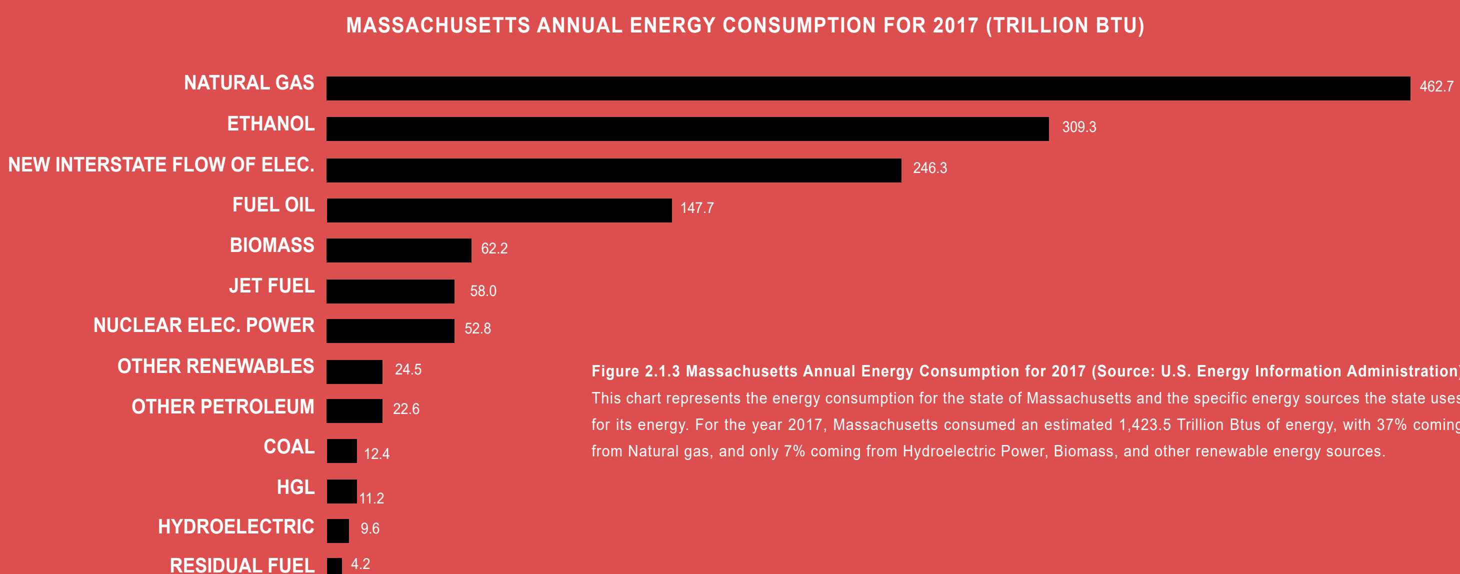


Figure 2.1.3 Massachusetts Annual Energy Consumption for 2017 (Source: U.S. Energy Information Administration) This chart represents the energy consumption for the state of Massachusetts and the specific energy sources the state uses for its energy. For the year 2017, Massachusetts consumed an estimated 1,423.5 Trillion Btus of energy, with 37% coming from Natural gas, and only 7% coming from Hydroelectric Power, Biomass, and other renewable energy sources.

Kibert introduces the topic of climate change and its direct and indirect relationship with the built environment. Understanding this relationship is key in recognizing flaws and successes with current building practices and pursuing practices that are more sustainable. This thesis will address direct causes of climate change inflicted by the immediate site and propose pollution clean up as well as design strategies aimed towards climate mitigation.

Adaptive Building Reuse

Building Reuse: Sustainability, Preservation, and the Value of Design, By Kathryn Rogers Merlino, is a textbook that advocates for buildings to be repurposed rather than demolished, and pleas for building demolition to be a last resort based on building integrity and feasibility. Merlino is a trained architect practicing in Seattle, Washington and is an architectural historian currently researching the sustainable benefits of building reuse. Her book, Building Reuse, provides information regarding methods and types of historic preservation, the contextual value of existing buildings for communities, metrics in which to measure the sustainable value of existing buildings, the sustainable features of existing buildings, the waste produced from demolition and new construction, and case studies for sustainable building reuse projects[14].

“The ultimate goal of historic preservation is to prevent the loss of valuable buildings and to maintain them for future generations. One of the biggest victories of the historic preservation movement was winning the ability to stave off a designated building’s demolition, either with landmark protection or through preservation incentives that provide economic relief.” - Merlino

Building Reuse identifies two types of value older buildings contribute: neighborhood granularity and existing passive design elements. Merlino references The Death and Life of Great American Cities by Jane Jacobs, agreeing that urban life, culture, and identity are taken when older neighborhoods are replaced with large, new, and more expensive buildings. Merlino adds that neighborhoods with buildings in varying size, age, and purpose provide neighborhoods with job diversity, affordable housing, retail, and office space, and vibrant activity[15].

Before sophisticated building technologies were invented, older buildings designs relied on passive energy features. These passive building features include natural daylight through window design, skylights, and courtyards; natural airflow through operable windows, chimneys, and vents; and cisterns for water storage[16].

Merlino urges that these passive features are cause for repurposing buildings rather than demolishing them and building sustainably. In addition to their passive designs already in place, existing structures could receive simple upgrades that improve their building envelopes, energy use, and system efficiencies that would improve the building’s overall energy performance to compete with new, sustainable construction - often using a smaller budget. Some of these intervention upgrades include window sealing to reduce heat loss and improve the building’s insulation; additional shading devices to reduce unwanted heat gain while allowing for natural ventilation; replacing plumbing fixtures with low-flow fixtures to reduce water use; or added insulation to the building’s envelope. In addition a revovation’s possible energy savings, building reuse drastically reduces project material waste[17].

Demolishing buildings create large amounts of waste and increases a project’s carbon and energy footprint - defeating the purpose for sustainable design. The United States uses 30% of the world’s natural resources, 18% of which is related to construction. Merlino clarifies that the term “recycling” is misleading and has varying definitions for materials. Some materials can be recycled an indefinite amount of times, others only a certain number of times, others only can be recycled into specific uses, and others cannot be recycled at all. Only about 10% of extracted materials go into final products - the remaining 90% is manufactured waste and ends up in landfills. The Brookings Institute estimates that between 2003 and 2020, the United States will have demolished 300-427 billion square feet of building - nearly one third of all of the country’s buildings. These statistics are cause enough to conserve and reuse materials whenever possible[18].

***Building Reuse: Sustainability, Preservation, and the Value of Design* supports the practice of building renovation in place of new construction. The Fall River site is home to several industrial mill buildings that are subject to either renovation or demolition. Material waste, carbon emissions, and energy use are cause enough to attempt to save those buildings in efforts for a more sustainable project. These industrious mill buildings offer the city cultural and historic context that enrich the waterfront, create job opportunities, improve living conditions, and celebrate American history. The American landscape, especially the Northeast region, is riddled with industrious sites similar to Fall River's that are either underutilized or underappreciated. This project has the opportunity to educate the community and its visitors on the possibilities and implications for adaptive reuse projects through a sustainable lesn- acting as a case study for future projects of similar circumstances.**

Strategies in Sustainable Building Materials, Design, and Systems

Kibert's Sustainable Construction: Green Building Design and Delivery- Fourth Edition includes sections regarding the limitations of recycling and the dissipation of materials. Kibert references the 1999 book, Hawken, Lovins, and Lovins that suggests four specific shifts in business practices that are necessary for more sustainable uses in materials and resources. The four shifts are: (1) Radical Resource Productivity: Dramatically increasing the productivity of natural resources; (2) Ecological Redesign: A shift to biologically inspired models; (3) Service and Flow Economy: The move to solutions-based business models; and (4) Investment in Natural Capital: The reinvestment in natural capitalism. Each of these four shifts aim to dematerialize products, increase the recycling rate of products, and increase the durability of products[19].

In addition to these shifts introduced by Hawken, Lovins, and Lovins, this section also mentions the use of biological material when applicable. Biological material refers to building materials that are products from natural systems, that are biodegradable, and compostable. These materials include wood, hemp, and bamboo. Beyond their benefits, Kibert also stresses the concerns with using biological material, urging designers to understand the consequences and ripple effects of a mass shift in material use. These consequences include possible deforestation, land taken away from farming for building material cultivation, land that is pushed past its carrying capacity as a result from demand increase, and the misconception that biological materials are unlimited - they aren't. Kibert also mentions the little technology and research to support the idea that biological material has the structural capacity or material characteristics to replace certain synthetic materials, including steel or copper[20].

Sustainable Construction also includes sections that discuss low energy building strategies as well as information regarding overall energy use in the built environment. When suggesting sustainable design strategies, Kibert addresses all scales of building design. His suggestions and considerations to focus on during the design and planning process include:

- Using building energy simulation tools throughout the design process
- Optimizing the passive solar design opportunities of the building
- Maximizing the thermal performance of the building's envelope
- Minimizing internal building loads
- Maximizing daylighting and to integrate natural light with a high efficiency lighting system Designing a hyper efficient heating, ventilation, and air conditioning (HVAC) system that minimizes energy use
- Selecting high efficiency appliances
- Maximizing the use of renewable energy systems
- Harvesting and using waste energy, heat, cooling, and water.
- Incorporating innovative, emerging strategies such as ground coupling and radiant cooling[21]

Kibert's specific suggestions for sustainable architectural design are focused around the Passive House standards. Passive House design standards focus on energy efficiency, aims towards Net Zero Energy, and utilizes natural site components for a baseline of natural energy systems. Kibert's suggested practices include addressing:

- Local climate - sun angles and solar insolation, wind velocity and direction, air temperature, and humidity year-round.
- Building Aspect Ratio - the ratio of the building's length to width
- Building Orientation - laying a building's long axis oriented east-west and organizing program and room layout according to sunlight needs
- Building Massing - energy storage potential of materials, fenestration, and material color
- Building Use - occupancy schedule and use profile
- Daylighting Strategy - fenestration, daylighting devices, and shading devices
- Building Envelope - building geometry, insulation, fenestration, doors, air leakage, ventilation, shading devices, thermal mass, material color
- Internal Loads - lighting, equipment, appliances, people
- Ventilation - cross ventilation potential, paths for routine ventilation, chimney effect potential[22]

<u>Sustainable Construction: Green Building Design and Delivery - Fourth Edition</u> is a resource for sustainable material considerations. Kibert not only offers specific ideas to support a sustainable design foundation, but follows the concepts of Life Cycle Assessments and analyzes all aspects of material use - positive or negative. The use of biological material is an example of how Kibert analyzes the benefits, consequences, and limitations of suggested new ideas that follow the sustainable narrative not just for building design, but sustaining a healthy ecosystem. In addition to sustainable material use, Sustainable Construction is a reference for specific sustainable building design applications that cut energy use, construction waste, and conserves resources.

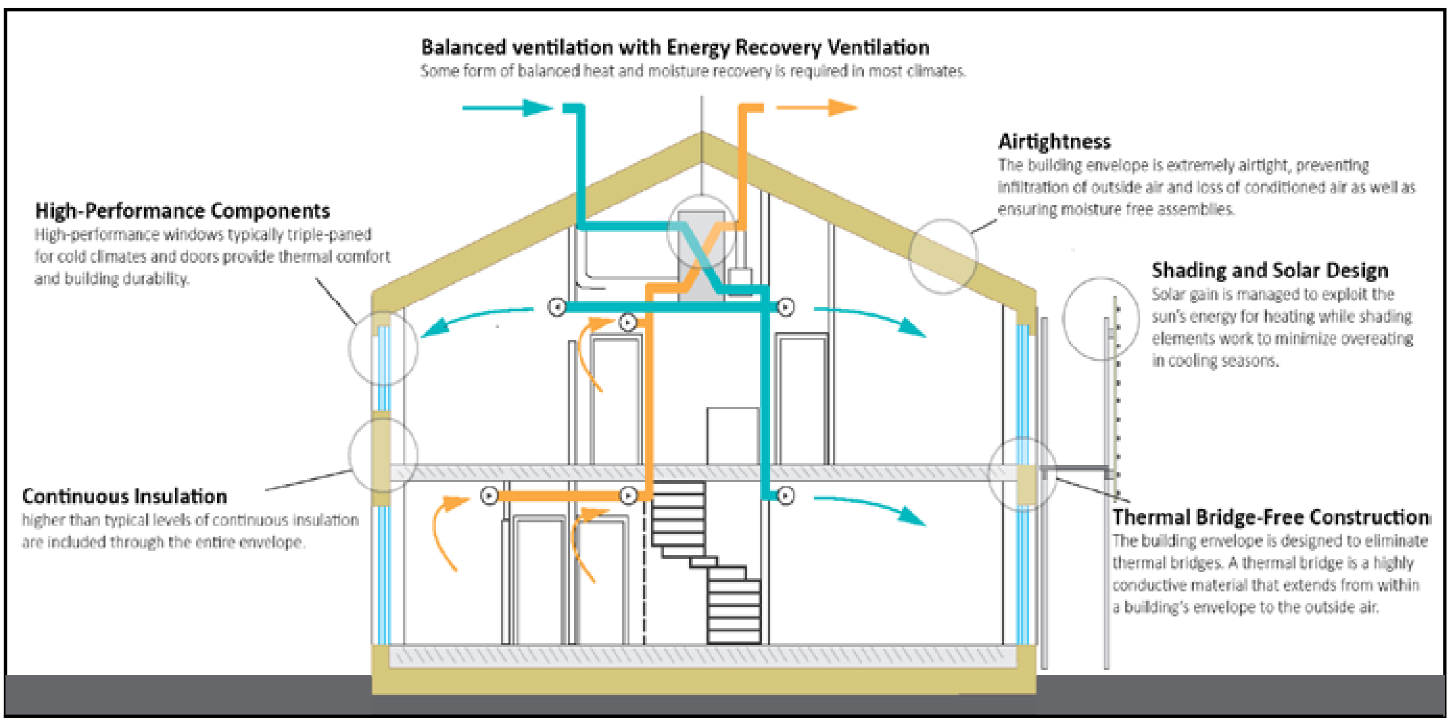


Figure 2.1.4 Balanced Ventilation with Energy Recovery Ventilation (Source: Passive House Institute) The Passive House diagram represents the basic Passive House principles for high performance design. These principles include airtightness, solar design, envelope sealing and insulating, natural heating, cooling, and ventilation, and heating/cooling recovery.

Strategies in Sustainable Planning and Landscape Design

Within the fifth category of The Green Braid, *Settlement Patterns* recognizes urban sprawl as a detriment to our natural environment. At the current rate of urban development, urban sprawl will inevitably continue throughout the next several decades. Tanzer and Longoria preach that in order to make the largest impact in improving the natural environment and protect it from further damage, the biggest change must come at the urban scale in building design, urban planning, and district level infrastructure. To make this scale of change happen, however, it is easiest through government intervention rather than private parties[23].

Included in the *Settlement Patterns* section, Monica Ponce De Leon's and Nader Tehrani's essay, The Role of Infrastructure in the Production of Public Spaces for the City of Miami, the authors discuss a specific example of infrastructure inefficiency involving general highway systems. They mention that, while highways are effective in connecting districts across great distances, the highway systems almost always lack a relationship with the communities they pass through and only accommodate for one mode of transportation. This disconnect results in wasted space under and adjacent to highways, underused material for highway structures, and renders highways as single-functioning infrastructure systems. De Leon and Tehrani use the Miami highway system as a case study for efficient highway planning, and reference a proposal that would repurpose the underpass of a highway system and transform it into a public use space that would connect downtown Miami to the Miami River[24].

This section of The Green Braid addresses urban sprawl as an ongoing issue in the built environment that threatens natural ecosystems. Similarly to Merlino's ideas in Building Reuse, Tanzer and Longoria urge designers to use all existing areas of the urban fabric efficiently and completely. Urban sprawl mitigation can be addressed through adaptive reuse at district scales. Construction can utilize run down neighborhoods and revitalize entire neighborhoods using materials already set in place.

Sustainable Urbanism: Urban Design with Nature, by Douglas Farr, is a comprehensive textbook outlining what sustainable urbanism is, how to shift to sustainable urban planning from the current methods of urban planning, how to design sustainably, and provides case studies where sustainable urbanism have successfully been implemented. This book not only serves as a learning tool, but is a plea for sustainable action against current conditions of the planet's environment and the continuing destruction our building habits are causing to natural ecosystems. Beyond Sustainable Urbanism, Douglas Farr is a leader in the sustainable movement and has been apart of the Congress for New Urbanism, Bioregional, EcoDistrict, and Energy Elevate, and is the Co-Chair for LEED-Neighborhood Development[25].

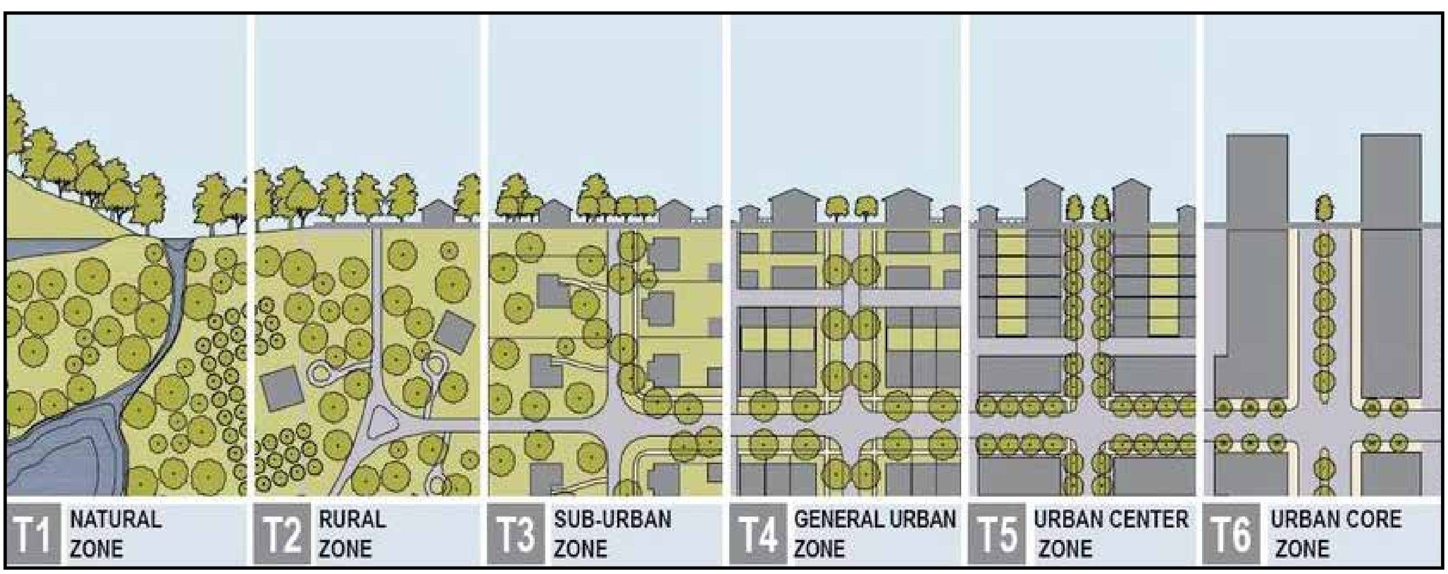


Figure 2.2.5 The Urban Rural Transect (Source: Farr Associates) The transect diagram showcases the varying densities and environments in section and plan.

Leading topics discussed in <u>Sustainable Urbanism</u> revolve around the Urban-Rural Transect, a shared idea from the “New Urbanism” method of urban planning. The Urban-Rural Transect describes the transition from the urban fabric to the rural environment. The Transect is divided into six zones based on scale, density, and character of place: 1)Natural, 2) Rural, 3) Suburban, 4) General Urban, 5) Urban Center, and 6) Urban Core. The purpose of the Transect planning method is to create a legible mixture of land uses that users can easily navigate, to create compact urban growth around pedestrians and transit, to fight automobile dependency, to equitably mix people of different incomes, ethnicities, race and age, and to improve the area’s ecological footprint[26].

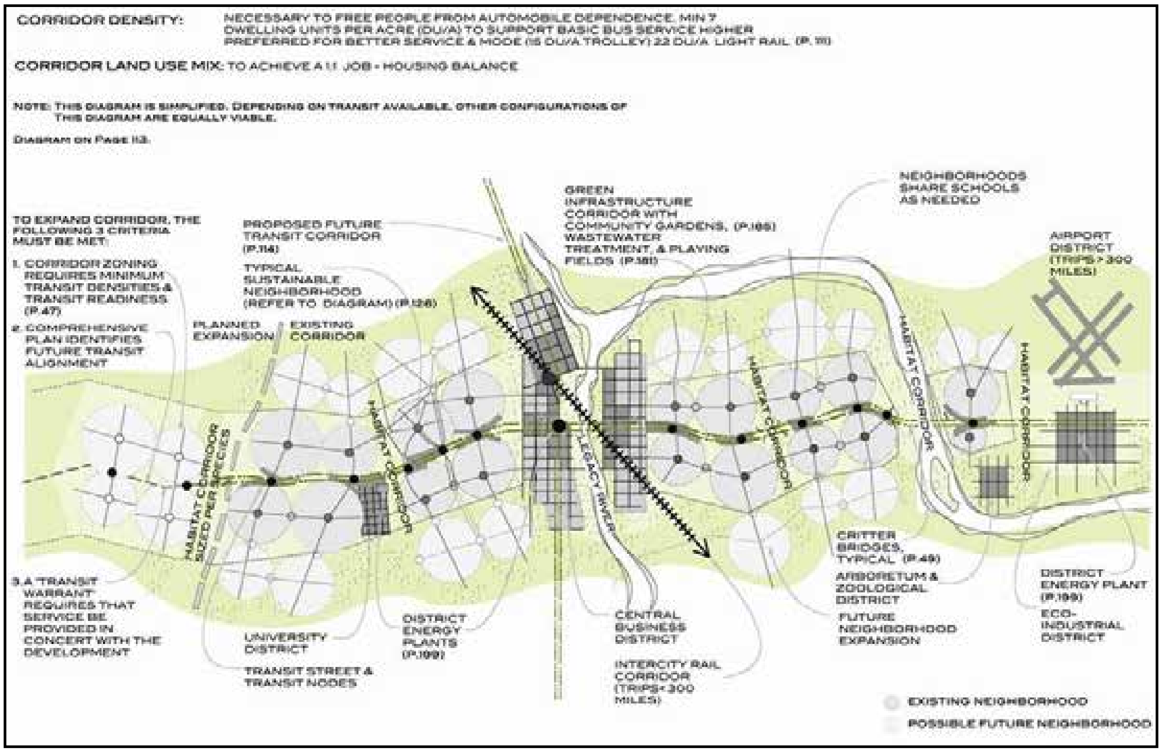


Figure 2.2.6 The Sustainable Corridor (Source: Farr Associates)

Based off of the Urban-Rural Transect, Farr Associates have created The Sustainable Corridor, a basic master plan aimed to reduce its energy and carbon footprint. This corridor offers a density of seven units per acre, satisfying the requirements for basic bus services. District energy plants are included in designated Eco-Industrial Districts to provide district energy sources. Future neighborhood expansion zones are included on the outskirts of the plan to adapt to changes in population and land use.

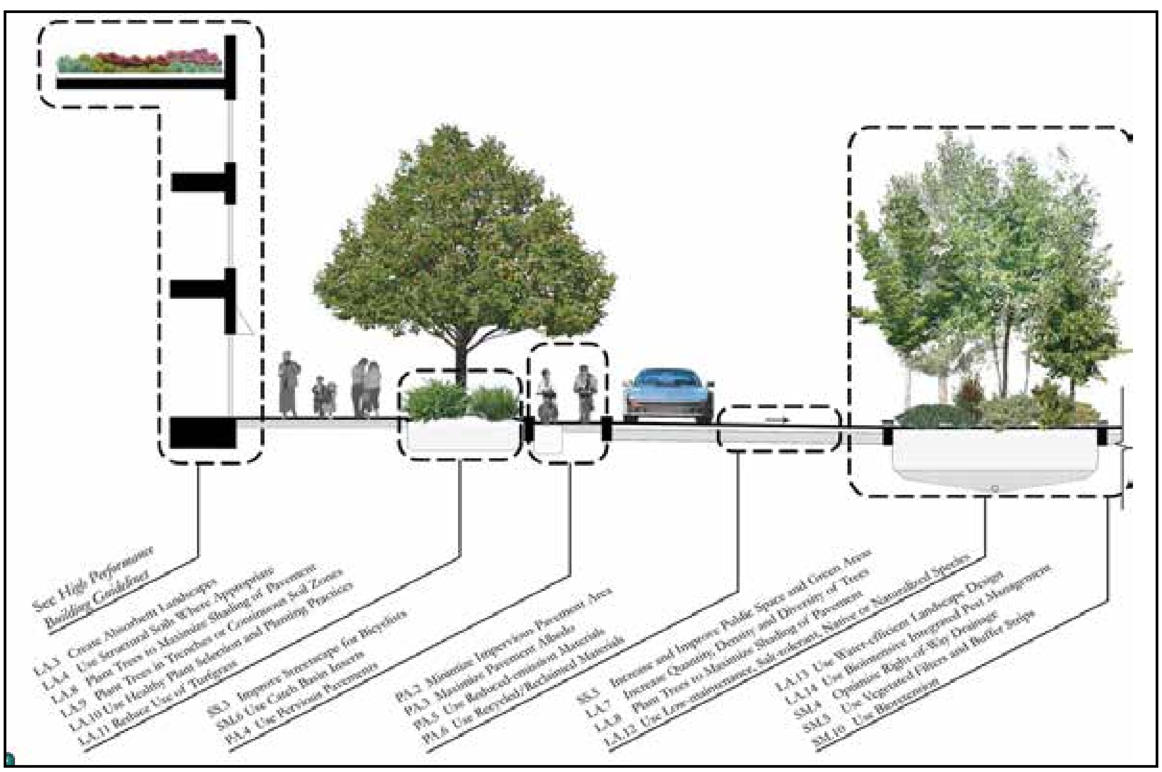


Figure 2.2.7 Street Design (Source: Farr Associates)

This street section outlines detailed design features to include in street design in order to create an efficient design that make street elements multifunctioning. The section separates zones of the street and offers methods to effectively design the Complete Street to accommodate for all modes of transportation and infrastructure.

Based off of the Urban-Rural Transect, Douglas Farr offers supportive tools to design for appropriate housing types, street types, and types of transportation based on demographics and density. Farr advocates for car-free housing as well as street designs that support pedestrian and cyclist use[27].

Farr explains that in order for sustainable urbanism to accomplish its goals, the urban planning and design must facilitate a shift in the user's daily behaviors to make more sustainable choices. A major behavioral change includes methods of transportation. Integrated networks of walkable streets provide safe and aesthetically pleasing methods of transportation for pedestrians, cyclists, and motorists. Walkable neighborhood streets feature sidewalks 6-8 feet wide, streets 22-32 feet wide, street furniture, tree canopies along the street edge, on street parking, and a neighborhood density ranging from 6-20 dwelling units per acre. Neighborhood scales suitable for walking range from 40-200 acres. Multiple neighborhoods this scale can be connected through biodiversity corridors, greenways, or a network of green spaces. Farr offers supportive tools to plan and design appropriate street types such as boulevards, avenues, and basic streets based on urban context and needs[28].

Farr's vision for a sustainable neighborhood incorporates street design, energy and resource efficient infrastructure, renewable resources, and appropriate urban environments based on present and future community needs. Farr offers specific design methodologies and applications that make neighborhoods more livable for the user and less impactful for the environment. He uses design strategies that offer multiple uses that combats aesthetics, function, and environmental aid. For the purpose of this thesis, Sustainable Urbanism is a tool for suggested design practices to apply to Fall River on the district scale as well as inform design decision making for individual building design. Farr's design strategies are not only funcitonal, but cost effective and would be sensitive towards Fall River's budget.

Kibert's Sustainable Construction: Green Building Design and Delivery - Fourth Edition includes sections regarding sustainable site planning, landscape design and maintenance, as well as information and practices for the built environment's hydrologic systems. Kibert begins this section with suggested site design and planning approaches when considering sustainable applications. Included in the list of suggestions are:

- Building on previously developed land - especially grayfields - instead of land that is untouched by human intervention
- Using brownfields - properties that are perceived to be contaminated
- Reusing existing building structures instead of constructing new ones
- Minimizing site impacts by minimizing building footprint
- Taking advantage of passive energy opportunities like sun, prevailing winds, and foliage on the site
- Minimizing impervious ground coverage on the site

This list focuses on strategies to minimize ecological impact by reusing existing structures and utilizing renewable resources. Kibert pushes for preserving greenfields and repurposing greyfields and brownfields.

- Greenfields - properties that have experienced little or no impact from human development
- Greyfields - blighted or obsolete buildings sitting on land that is not necessarily contaminated
- Brownfields - abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination
- Ghost Boxes - larger big-box stores that have been abandoned

In conjunction with his push for site repurposing, Kibert references Thompson and Sorvig (2000) to propose eight principles of sustainable landscape construction all designers should follow to build a sustainable foundation to their work:

- Keep sites healthy
- Heal injured sites
- Favor living, flexible materials
- Respect the waters of life
- Pave less
- Consider the origin and fate of materials
- Know the costs of energy over time
- Celebrate light, respect darkness[29]

Figure 2.2.8 Guthrie Green Brownfield Renewal (Source: Manhattan Construction Group)

The Guthrie Green Brownfield Revewal in Tulsa, Oklahoma transformed a 2.7 acre brownfield into a multi-purpose park with a cafe pavilion, outdoor stage, and multiple “green rooms”. The renewal project features the use of ground source heat pumps, LED lighting, bioswales, and solar panels on the pavilion roof. The project was awarded the 2013 Brownfield Renewal Award from the Brownfields for Energy category.

In addition to Farr’s Sustainable Urbanism, Kibert also offers specific design methodologies and applications for urban design and planning that not only mitigates environmental impact, but creates a cleaner, more livable environment for the user. Kibert’s suggestions contribute to the areas of water use, stormwater management, waste management, and environmental cleanup. Kibert shares ideals with Merlino’s Building Reuse that suggest the revitalization of previously used sites, such as greyfields and brownfields. Kibert’s ideas go beyond the ideas of reuse and suggest cleaning up environmental pollution and restoring a balanced ecosystem among local plant and animal species.

Life Cycle Assessment

Life Cycle Assessment is a book that explains the use of Life Cycle Assessment as a tool for designers to use for decision making when regarding material use and building systems. This book outlines the steps on how to conduct an LCA, methodologies for conducting each step, and the levels of quality and effort individual LCAs may aim to achieve. The author of Life Cycle Assessment, Kathrina Simonen is an Assistant Professor at the University of Washington, a licensed and practicing Architect and Structural Engineer in Seattle, Washington, and is the founding director of the Carbon Leadership Forum[30].

Life Cycle Assessment (LCA) is a standardized method of tracking and reporting the environmental impacts of a product or process throughout its full life cycle (ISO, 2006a: 8). There are four basic phases in conducting an LCA:

- Goal and Scope Definition: The LCA must have a clear intended application; a clear intended audience; clear reasons for the assessment; and must specify whether or not the results are intended for comparative assertions and are intended to be disclosed to the public. When defining the scope of the LCA, it must be clear which products and systems are being analyzed and which will be left out; which methodologies will be used to collect, analyze, and interpret data information; and what sources, quality of data, and type of critical review will be utilized.
- Inventory Analysis: This phase collects the data measured, calculated, or estimated and the data is calculated to attain the results for the individual systems or products being studied. Inventory Input quantifies the material and energy consumption during product life. Inventory Emissions - Unit Process Data quantifies emissions resulting from a specific process. Inventory Emissions - Economic Input/Output Data uses economic data as the foundation to establish life cycle inventories.
- Impact assessment: The data calculated relates the resource use to their environment emissions to estimate the impacts on natural resource supply, environmental health, and human health.
- Interpretation: After impact assessment, the LCA must draw final conclusions of the assessed data and identify it the LCA's strengths, weaknesses, limitations, and suggest recommendations to the process[31].

LCAs can be conducted on several levels of quality and effort. A Screening LCA is performed to develop estimates of the environmental performance of a system. It provides a quick economic understanding of a product or a building, and the level of analysis is not generally detailed. A Simplified LCA could be a stepping-stone to a Complete LCA or a focused study on one or more aspects of a building system. A Simplified LCA may include the contributions of a known process based on the results of previous studies. A Complete LCA is a refined version of Screening LCAs and Simplified LCAs that include complete inventories and high quality data that lead to more comprehensive analysis. The quality of data can be measured by representativeness of time, geography, and technology; data precision, completeness, and consistency; reproducibility and data sources; and the level of uncertainty of the data represented. When evaluating the credibility and quality of sources used in the assessment, the sources must be in compliance with ISO standards; the report must be transparent, consistent, and clear; all data must meet the LCA's specified quality standards; all data must be appropriate in regards to the goal of the LCA[32].

There are several methodologies for collecting and quantifying data for an LCA study, all of which may be used in conjunction with each other. Measured data may be taken through purchased records, such as utility bills or material purchases, or measured in the field. Modeled data can predict energy consumption and energy performance in specified building systems. Researched published data can utilize government and industry surveys previously conducted that provide details on typical consumption practices. Data that cannot be found or measured otherwise may be estimated using judgement, experience, or previous case studies. Estimated data may include material quantities, maintenance or repair schedules, etc[33].

The benefits of conducting an LCA are accountability with carbon output and energy use; cost assessment; analysis of total construction and operational waste; and future planning for building or site reuse. Designers and project owners who are concious of the waste in energy, resource, and material consumption have the ability to conserve each, therefore save money. The negative of conducting an LCA is the time and money to conduct it.

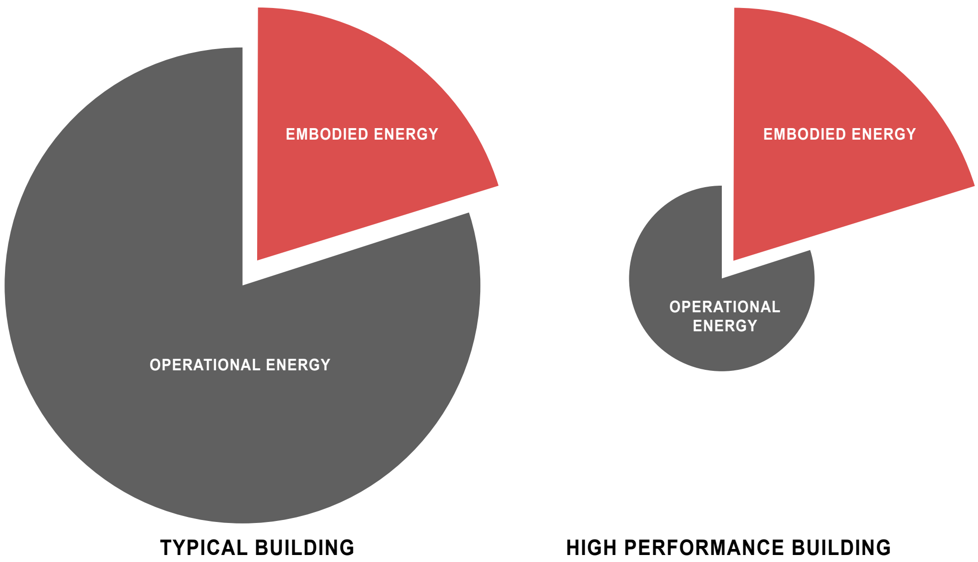


Figure 2.1.9 Total Lifetime Building Energy Use; (Source: Katherina Simonen; Life Cycle Assessment)

An existing building's embodied energy cannot be improved, however, an existing buildings operational performance can improve regardless of its embodied energy.

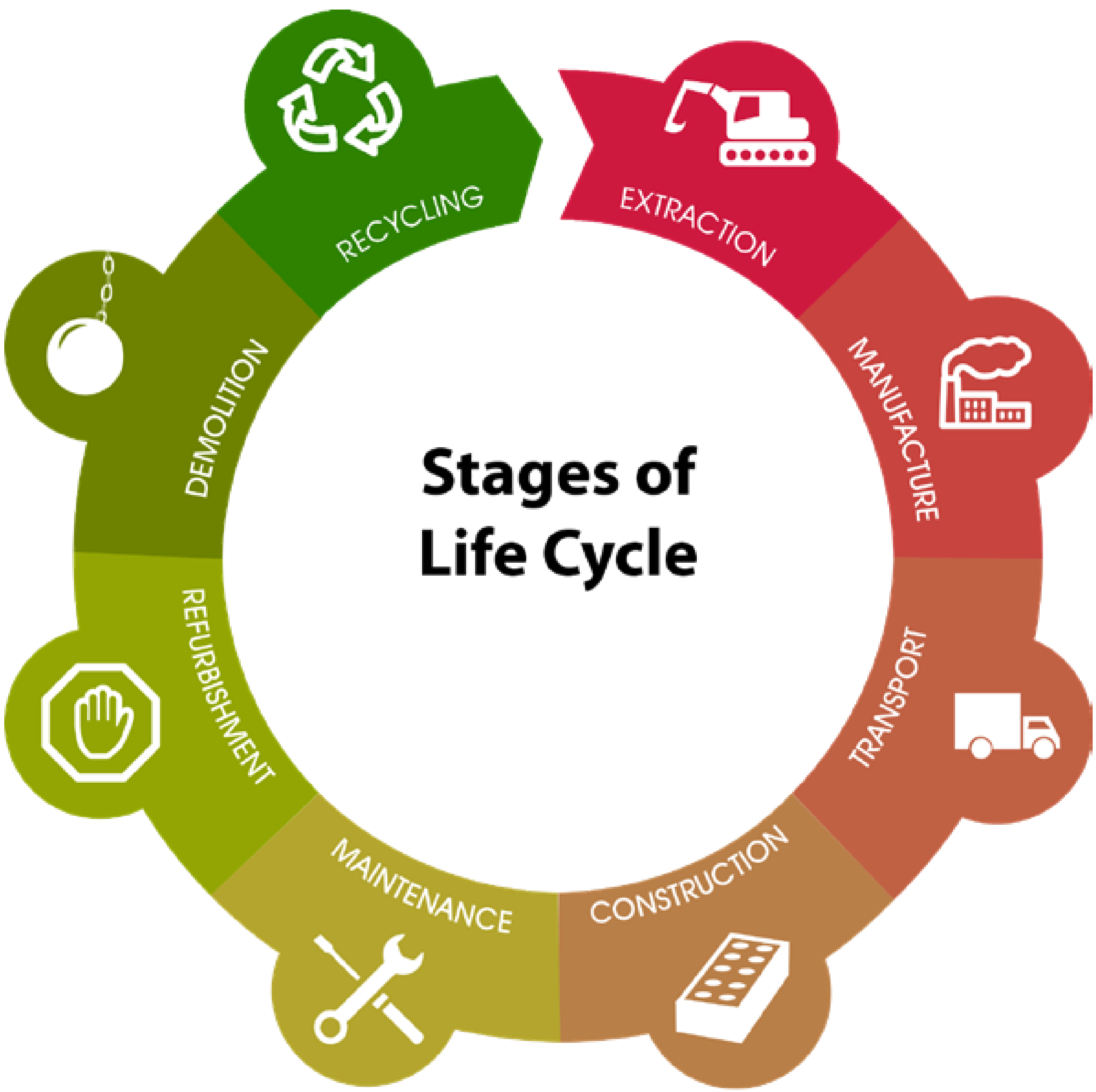


Figure 2.1.10 Stages of Life Cycle; (Source: The Irish Green Building Council)

The life cycle of materials and building products measure the embodied carbon and embodied energy that the use of the material or product requires.

02.2 Sustainable Metrics

The purpose of this section is to identify metric tools for measuring sustainable design and compare their benefits, limitations, and scope. The selected metric tools to are all methods for measuring a project's embodied energy, operational energy, carbon footprint, or water use, and/or assessing sustainable architectural design features. Designers use these tools as guidelines for sustainable design during all stages of the design process, and uses them to measure project performance after the project has become operational. The metric tools selected include (1) Life Cycle Assessment, (2) LEED, (3) Zero Energy Building Certification, (4) Living Building Challenge, (5) Living Community Challenge, and (6) EcoDistrict.

LEED™

The Leadership in Energy and Environmental Design (LEED) program is a rating system that evaluates and scores the performance of a range of five project types: Building Design & Construciton, Interior Design & Construction, Building Operations & Maintenance, Neighborhood Development, and Residential Homes. Each project type has their own rating system with varying criteria that fall under nine categories of performance: Innovation & Design, Location & Linkages: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Envionrmental Quality, and Awareness & Education. Under every performance category, there are specified credits a project can earn - the total number of credits make up a project's point score. Every project type has the potential to achieve one of four levels of LEED Certification based on the number of points achieved: Certified, Silver, Gold, or Platinum[34].

The benefits of applying for LEED Certification include tax benefits as well as the conciousness of design and its effects on the environment, its occupants, and its operational cost and energy consumption. Another benefit is its adaptation to different project types and project scales. LEED Certification is also increasingly transparent to a project's occupants and the public eye, contributing to the ever increasing popularity of sustainability.

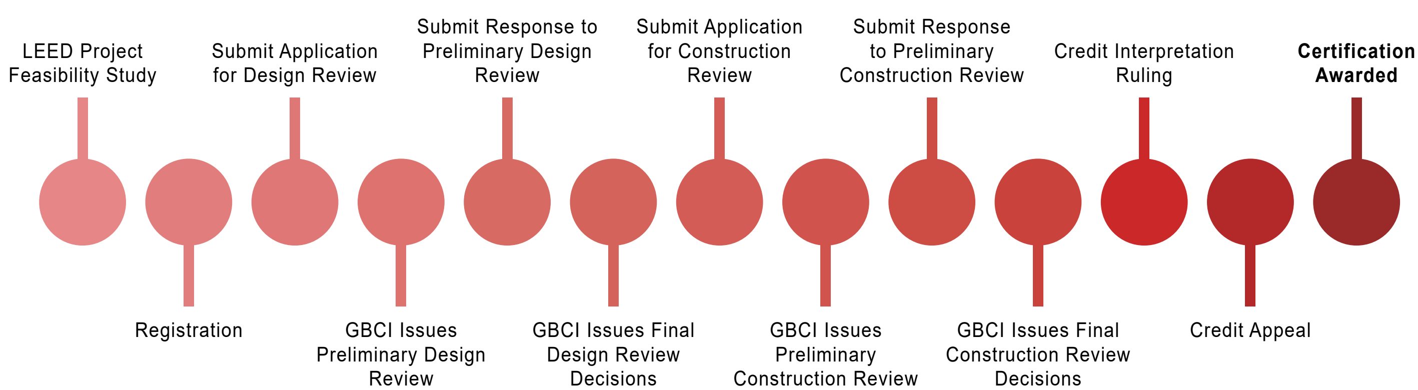


Figure 2.2.1 Phases of LEED Certification; (Source: Green Prep) This diagram shows the step by step process of LEED Certification during the life of a project.

Zero Energy Building Certification

The Zero Energy Building (ZEB) Certification is an international program under the International Living Future Institute that certifies a building that operates on renewable energy resources such as sun, wind, or earth. The ZEB Certification requires specific standards all certified projects must follow:

- 100% of the project's energy must be supplied by onsite renewable energy - no combustion is allowed.
- Certification is based on actual - not modeled- performance. Complete documentation is required to prove operational performance meets the ZEB standards.
- Exceptions for the use of offsite renewables, onsite combustion, and other exceptional circumstances must comply with the Energy Petal Handbook. Some of these exceptional circumstances include buildings which have either a very high energy intensity or project density, where even with the highest levels of efficiency are not able to offset their energy use on site; tenant improvements where the project owner does not control the exterior of the building and energy production is not feasible; and certain areas where the local grid cannot accommodate the renewables created by the project[35].

The benefits of pursuing ZEB Certification include a number of incentive programs to assist in achieving and maintaining Net Zero Energy. These incentive programs include tax breaks, loans to assist in paying upfront cost for sustainable technologies, and exceptions in zoning building code restrictions.

One of the negatives of the ZEB Certification is the strict standards that all certified projects must follow. These standards are not feasible for many project types based on scale, zoning, or other circumstances. Another difficulty to pursuing ZEB Certification is the requirement for actual measured operational energy rather than modeled energy use.

EcoDistrict

EcoDistrict Certification addresses the rapid growth in urbanization around the world and invests in the quality of living and design in the urban environment - focusing on social equity, city resiliency, impact on climate change, and the protection from climate change. The framework of the EcoDistrict model guides city projects from schematic planning to implementation and performance measurement. The EcoDistrict model concentrates on not just design and planning, but human-to-human interaction and human-to-built environment interaction as well. This model has a deep focus in the human experience of place and a the systematic design of all design and planning variables.

EcoDistricts outline the specific imperatives the project aims to address (Equity, Resiliance, Climate Protection), the specific priorities of the project (Place, Prosperity, Health + Wellbeing, Connectivity, Living Infrastructure, Resource Regeneration), and the specific design strategies that address one of the six priorities. Each planning strategy indicates the metric at which to measure its performance after the project is completed in order to determine the project's success[36].

The benefit of pursuing EcoDistrict Certification is acquiring a complete understanding of the future impacts of a project, as well as identifying the short-term and long-term goals of a project. Planning a project using the EcoDistrict model allows planners and city officials to design a project around goals greater than design aesthetics. The EcoDistrict model addresses social equity, livability, economics, and population culture and inclusion. These objective categories are in addition to the ecological categories also found in the other metrics.

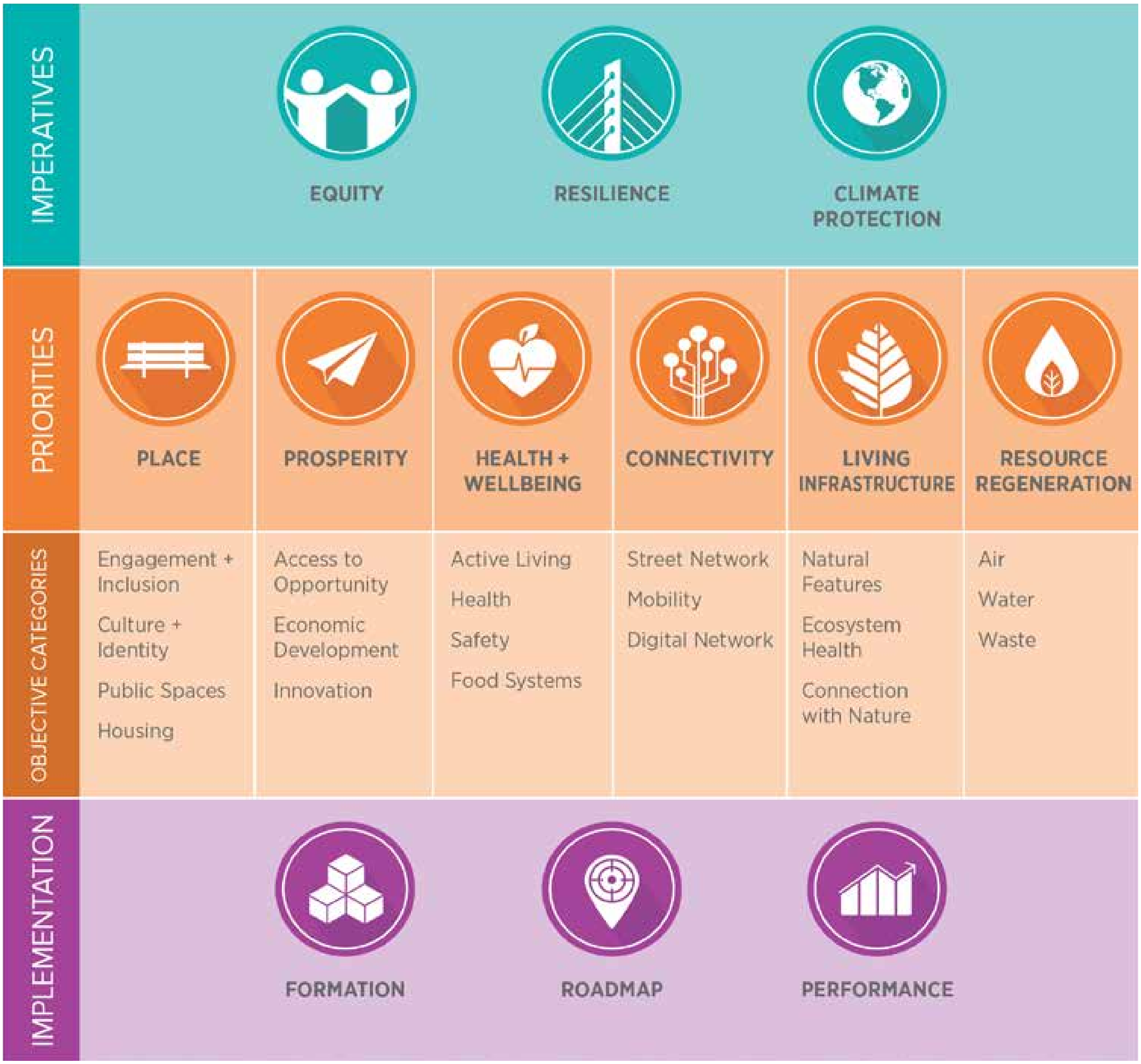


Figure 2.2.2 EcoDistrict Framework Table; (Source: EcoDistrict) This table outlines the 20 objective categories. which of the six priorities they fall under, the three imperatives, and the three steps of implementation.

Living Building Challenge

The Living Building Challenge 4.0 (LBC) is a program under the International Living Future Institute. The LBC is “ever-evolving” due to continuous breakthroughs in sustainable technology, city zoning and building standards, and design innovation. The goal of the LBC is to push architectural projects to create holistic designs that push efficiency and sustainability to its limits. In order to be Living Building compliant, project performances must be operational for at least twelve consecutive months before its first audit, and must be audited regularly once compliance is verified[37].

The LBC structure of broken up into matrix of seven areas of performance (Petals), their imperatives, and the specific building typology the project falls under. In order to adapt to different project types, the Living Building Challenge 4.0 version identifies the imperatives that are appropriate for each building typology:

The benefits for pursuing the LBC include setting a precedent for healthy architecture; becoming a catalyst for change; raising awareness of every ecological system’s decline; building a resilient building that will withstand current and future ecological, economic, and social stresses; and the flexibility of the program to adapt to different project typologies and scales. Projects pursuing the LBC also may take advantage of the incentive programs that aid in achieving and maintining Living Building status - including tax breaks, loans for upfront construction cost, and zoning exceptions

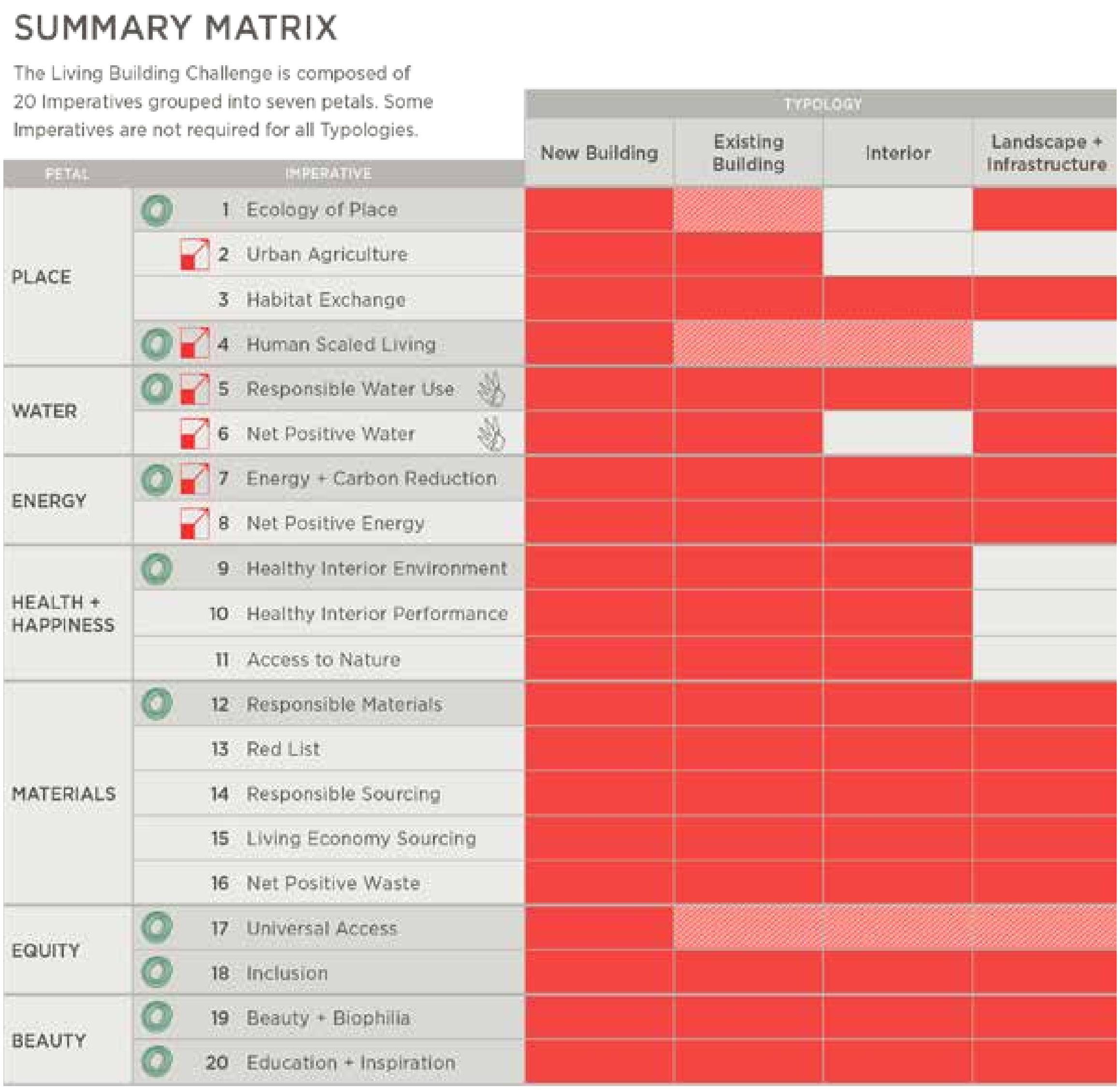


Figure 2.2.3 Living Building Challenge 4.0 Summary Matrix; (Source: Living Future Institute)

This diagram represents which of the 20 imperatives - grouped under the seven petals of the LBC - apply to each project typology.

Living Community Challenge

The Living Community Challenge (LCC) is a new program under the International Living Future Institute. The LCC is designed to inspire city leaders to "invest in the future of your community by using regenerative design strategies in your next project." This program is a framework for urban planning, design, and district-wide projects to strive for healthy living in all aspects of life - nature, species habitat, and human health - by reaching net positive water and energy use, preserving natural landscapes, designing responsible and proactive landscapes, and facilitating healthy and active lifestyles for its residents and visitors[38].

The LCC structure of broken up into a matrix of seven areas of performance (Petals) and their imperatives:

The benefits for pursuing the LCC include setting an example for a successful community; improving safety, access, and health; raising awareness of place, culture, and community goals; and boosting your local economy. One negative of pursuing the LCC is its lack of case studies and guidelines. The LCC is relatively new compared to the other metrics listed, making it difficult to assess successful design and planning strategies that would help aid in achieving the challenge.

SUMMARY MATRIX

Solutions beyond project footprint are permissible

THE 20 IMPERATIVES OF THE LIVING COMMUNITY CHALLENGE

	LIVING COMMUNITY CHALLENGE	
PLACE		01. LIMITS TO GROWTH
	SCALE JUMPING	02. URBAN AGRICULTURE
		03. HABITAT EXCHANGE
		04. HUMAN-POWERED LIVING
WATER	SCALE JUMPING	05. NET POSITIVE WATER
ENERGY	SCALE JUMPING	06. NET POSITIVE ENERGY
HEALTH & HAPPINESS		07. CIVILIZED ENVIRONMENT
		08. HEALTHY NEIGHBORHOOD DESIGN
		09. BIOPHILIC ENVIRONMENT
		10. RESILIENT COMMUNITY CONNECTIONS
MATERIALS		11. LIVING MATERIALS PLAN
		12. EMBODIED CARBON FOOTPRINT
		13. NET POSITIVE WASTE
EQUITY		14. HUMAN SCALE + HUMANE PLACES
		15. UNIVERSAL ACCESS TO NATURE & PLACE
		16. UNIVERSAL ACCESS TO COMMUNITY SERVICES
		17. EQUITABLE INVESTMENT
		18. JUST ORGANIZATIONS
BEAUTY		19. BEAUTY + SPIRIT
		20. INSPIRATION + EDUCATION

Figure 2.2.4 Living Community Challenge Summary Matrix; (Source: Living Future Institute)

This diagram represents the 20 imperatives grouped under the seven petals of the LCC.

02.3 Precedent Analysis

The purpose of this case study analysis is to identify sustainable practices and interpret their performance. The projects selected for analysis vary in scale and construction. including interior restoration, building reuse, new construction, landscape design, and district planning. Each project represents at least one metric previously listed in this chapter. Throughout this section, the case studies will be analyzed and compared to this thesis by both identifying specific design practices and developing new ideas based on the observed research.

The projects to be studied are:

1. Miller Hull Seattle Studio
   Certified LBC Petal

2. DPR Construction Phoenix Regional Office
   Zero Energy Certified; Certified LBC

3. Discovery Elementary School
   Zero Energy Certified

4. Health, Wellness, and Nutrition Center
   Certified LBC

5. The Waterfront of Vancouver, WA
   Urban Masterplan

6. Queen Elizabeth Olympic Park
   Landscape Architecture

7. High Falls EcoDistrict
   Registered EcoDistrict

8. North Rainier Mt. Baker Hub LCC
   Registered LCC

9. Clif Bar Headquarters
   Attempts Net Zero Energy

10. The Rice Fergus Miller Office and Studio
    2015/2030 AIA Challenge

Figure 2.3.01 Open Office Floorplan (Source: Miller Hull Partnership)

Figure 2.3.02 Back Office (Source: Miller Hull Partnership)

MILLER HULL SEATTLE STUDIO

Figure 2.3.03 Office Views (Source: Miller Hull Partnership)

The Miller Hull Seattle Studio is located on the sixth floor of the historic Polson Building in Pioneer Square, Seattle, WA. This interior space is home toThe Miller Hull Partnership that not only practices architecture but is also involved with several projects affiliated with the Living Building Challenge, including the Bullitt Center also located in Seattle, WA.

Before renovation, The Miller Hull Partnership had occupied the space for more than 30 years. Their interior renovation gave them the chance to rethink how each individual's space was used and rescaled for efficiency which allowed the partnership to grow without moving offices. The goal of the overall office renovation was to create flexible workspace, foster collaboration amongst workers, and improve the office's metric performance. The Miller Hull Seattle Studio is Living Building Challenge Petal Certified for Place, Material, Beauty, and Equity.

Under the Place petal, The Miller Hull Partnership acknowledges the issue of waste with new construction and chooses to restore their historic preowned space rather than expand with new construction. They also participated in the Habitat Exchange where they helped Forterra to secure 18 acres of land along the shore of Anderson Island on Puget Sound in an effort to preserve and protect the marine ecosystem.

Under the Materials Petal of the Living Building Challenge, The Miller Hull Seattle Studio focused on being Red List free by avoiding paint with BPA and only using lighting and equipment that were REACH compliant. The project also focused on lowering their embodied carbon footprint by using local or reused material, using as little material as possible in the restoration, and having net positive waste. Unique material reuse for this project includes reusing acoustic insulation from demolished walls for new wall assemblies, reusing salvaged plywood from the contractor's other project, using salvaged lumber for new wood flooring, and reusing doors, steel, and furniture. By the end of the project's restoration, they achieved 88% savings in lighting electricity use, 25% savings in plug in electricity use, 22% overall savings in electricity use, 19% overall savings in energy use, and a new EUI of 45[39].

LOCATION: SEATTLE, WA, USA

DATE COMPLETED: JULY, 2016

ARCHITECT: MILLER HULL PARTNERSHIP

PROJECT SIZE: 14,092 SQFT

OCCUPANT COUNT: 85

The Miller Hull Seattle Studio is an example of using the Living Building Challenge Petal system as a guideline for historic and timber interior restorations. This project met various design difficulties regarding Red List and responsible material use, spacial organization, and historic compliance. The details of this project's successes outlines not only the possibilities for similar spaces, but the lengths each design detail must go to in order to comply with the Living Building Challenge Petal standards.

Figure 2.3.04 Open Office FLoor Plan (Source: SmithGroupJJR)

Figure 2.3.05 Indoor Outdoor Dwelling Spaces (Source: SmithGroupJJR)

Figure 2.3.06 Facade and Site Design (Source: SmithGroupJJR)

DPR CONSTRUCTION PHOENIX REGIONAL OFFICE

Figure 2.3.07 Exterior Design (Source: SmithGroupJJR)

The DPR Construction's Phoenix Regional Office is an example of a large-scale renovation project that successfully completed the Living Building Challenge. The DPR office renovates a 1997 building located in a developed compound of office buildings and contributes to the revitalization of its urban fabric. The DPR office meets the Place, Energy, Equity, and Beauty petals of the Living Building Challenge.

Under the Energy Petal, the DPR office achieves net zero energy with photovoltaic solar arrays, climate-controlled operable windows, a vampire switch, Solatubes, and Big Ass Fans. Climate-controlled operable windows automatically open and close based on the ideal conditions for natural ventilation. It was reported that the motorized windows initial were a problem due to the subtle noise when activated, but eventually became a way to connect the occupants to the rhythms of the day by notifying them when the weather was favorable to enjoy the building's exterior dwelling spaces. The vampire switch is connected to 95% of the noncritical plug loads and gets turned off at the end of the day - resulting in an overall reduction of 37% in plug load energy use. The DPR office also included 82 Solatubes throughout the building to draw in natural daylight into the space and 84 Big Ass Fans in the open office spaces to circulate air during the day and perform passive cooling at night. The annual energy used for the entire project is 129,624 kWh, the annual electricity generated is 142,871 kWh, resulting in a total annual net energy use of -13,255 kWh.

Under the Beauty Petal, the DPR office's renovation was designed to create a healthy and productive workplace for its occupants. Architectural designs to achieve this mission includes quiet spaces for workers to decompress, a fitness room with showers, indoor/outdoor spaces that connect the interior with the exterior using large operable doors, and connections to nature and raw material from the surrounding desert. The building features moments of exposed raw material on the interior and exteriors and uses biomimicry to emulate the Sonoran Desert.

Under the Equity Petal, the DPR office design tested and concluded that their building would not restrict any future development adjacent or near their site from meeting their own net zero energy requirements based on their building's orientation, shape, height, and any possible shading onto another site. In addition, the DPR office does not emit any hazardous fumes that would otherwise interfere with any other property's natural ventilation strategies[40].

LOCATION: PHOENIX, AZ, USA

ARCHITECT: SMITHGROUPJJR

The DPR Construction's Phoenix Regional Office is a detailed example of a renovation project not only meeting the requirements for the Living Building Challenge, but successfully reaching Net Zero Energy as well. This precedent offers detailed examples of how to create an otherwise industrious and unfriendly building into a healthy and productive space that people enjoy using. The efforts in small and large detailing this project puts forth showcases their attention to human detail, human function, and the use of natural resources found in their surroundings.

Figure 2.3.08 Cafeteria with Clear-Story Ceiling (Source: VMDO Architects)

Figure 2.3.09 Interior Alternative Learning Space (Source: VMDO Architects)

Figure 2.3.10 Interior Dwelling Spaces and Secondary Learning Areas (Source: VMDO Architects)

Figure 2.3.11 Dynamic Children's Playground (Source: VMDO Architects)

Figure 2.3.12 Exterior Dwelling Space (Source: VMDO Architects)

DISCOVERY ELEMENTARY SCHOOL

Figure 2.3.13 Building Entrance (Source: VMDO Architects)

Figure 2.3.14 Roof-Top Solar Panels (Source: VMDO Architects)

The Discovery Elementary School is an architectural project focused on the user experience, health, and wellness as well as resource conservation and environmental responsibility. The school became the second largest fully-conditioned zero energy building of North American and a joyous and exciting place for their young students to learn and play. The overall design relied on photovoltaic arrays as well as energy conserving design, materials, and technology.

The overall PV array was comprised of 1344 panels located on the roof of the building. Fully dimmable lighting controls and occupancy sensors were used in interior dwelling space to encourage occupants to only use lighting as required. The roof has an R Value of R30. The walls have an R Value of R27 using ICF construction with masonry and cement panel cladding. The floors have an R Value of R11. The windows used are 2 inches thick with excellent airtightness.

The annual energy used during the performance period is 246,000 kWh. The actual energy produced during the performance period is 354,300 kWh, rendering the building's net energy use at -108,300 kWH and the building EUI at 8.6 kBTU/sf/yr[41].

LOCATION: ARLINGTON, VA, USA

DATE COMPLETED: SEPTEMBER, 2015

ARCHITECT: VMDO ARCHITECTS

PROJECT SIZE: 97,588 SQFT

OCCUPANT COUNT: 715

The Discovery Elementary School is a detailed precedent that demonstrates methods for reaching Net Positive Energy in a large-scale project. This project dives into wall/roof/floor details, material choice, and insulating properties, in addition to energy production and energy use. Energy production is only a piece of becoming Net Zero - understanding the methods of energy conservation and weighing the initial, upfront costs to the long term energy savings is necessary to reach for the Net Zero Energy goal.

Figure 2.3.15 Water-Storage Cistern (Source: Farewell Architects)

Figure 2.3.16 Building Facade and Landscape Design (Source: Farewell Architects)

HEALTH, WELLNESS, AND NUTRITION CENTER

Figure 2.3.17 Building Front Facade (Source: Farewell Architects)

Figure 2.3.18 Building Back Facade (Source: Farewell Architects)

For the Willow School, a responsible relationship with nature supports a positive, nurturing relationship between students, professors, and peers, and the Health, Wellness, and Nutrition Center is the embodiment of this mission. The center houses classrooms, a faculty room, movement area, dining room, commercial kitchen, health and wellness spaces, agricultural and education gardens, and a teaching kitchen. The Health, Wellness, and Nutrition Center maintains their status as a Living Building and meets all 7 Petals: Place, Water, Energy, Health and Happiness, Material, Equity, and Beauty.

Under the Water Petal, The Health, Wellness, and Nutrition Center collects rainwater with a 10,000 gallon cistern that could sustain 100% of the building's water demand, eliminating the use of potable water for non potable water use. Current New Jersey regulatory constraints prevent the center from using rainwater for potable use, but the cistern is fitted to provide for potable water use in the event of future interventions in regulation and technology. Under the Energy Petal, the center anticipates to produce more energy than they need through a PV array of 500 panels on the roof of the building.

Under the Health and Happiness Petal, The Health, Wellness, and Nutrition Center provides optimal natural daylight and ventilation for every dwelling space. The heating, cooling, and ventilation systems are designed to recover heating and cooling for efficient energy use. The architectural design for the building uses biophilia features, including environmental features, natural shapes and forms, natural processes and patterns, light and space, place-based relationships, and evolved human-nature relationships[42].

LOCATION: GLADSTONE, NJ, USA

DATE COMPLETED: MAY, 2015

ARCHITECT: FAREWELL ARCHITECTS

PROJECT SIZE: 19,991 SQFT

OCCUPANT COUNT: 150

The Health, Wellness, and Nutrition Center provides an example of how a large-scale building meets Petal requirements, notably the Water Petal and Energy Petal, and how architectural design integrates with technology to meet these requirements. Many of the environmentally conscious interventions look outward to the exterior of the building and the surrounding landscape, and utilizes natural and renewable elements of the site to meet LBC requirements, including sunlight, rainfall, and native plants.

Figure 2.3.19 Phase 1 Waterfront Park Landscape (Source: Columbia Waterfront LLC)

Figure 2.3.20 Phase 1 Waterfront Boardwalk Design (Source: Columbia Waterfront LLC)

Figure 2.3.21 Phase 1 Waterfront Pier Design (Source: Columbia Waterfront LLC)

THE WATERFRONT

Figure 2.3.22 NBBJ Phase 1 Master Plan Rendering (Source: NBBJ)

Figure 2.3.23 Roof-Top Solar Panels (Source: Columbia Waterfront LLC)

In 2008, the Columbia Waterfront LLC, a collaborative of investors and planners, acquired 32-acres of the Vancouver, WA waterfront with the intention of revitalizing the entire site. The Waterfront Master Plan of Vancouver, Washington is an urban master plan that aims to rebuild a healthy, vibrant urban waterfront that celebrates the industrious history of the site and give back the underused land to the citizens of Vancouver, WA. The location of this waterfront is along the Columbia River, adjacent to the I-5 interstate Bridge. Throughout history, this site was home to sawmills, brickyards, shipbuilding, and paper mills, and has always been an industrious hub due to its waterfront location. This revitalization master plan aims to once again make this site the hub for not only visitors, but residents and local businesses as well.

The master plan is a $250 million project that is broken up into a series of phases. The overall scope of the project proposes mixed-use development including waterfront parks, outdoor recreation, 3,300 new residential units, over 1.25 million square feet of office space, hotels, restaurants, and retail spaces. The city selected NBBJ as planning consultants for the waterfront masterplan for Phase 1 located at Terminal 1 of the waterfront. Phase 1 of the project includes a fraction of the restaurants, retail space, and residential units as well as the boutique hotel, the pier, and the Waterfront Park expanding ½ mile along the riverfront[43].

LOCATION: VANCOUVER, WA, USA

DATE COMPLETED: 2008-PRESENT

CONSULTANT PLANNERS: NBBJ

PROJECT SIZE: 32 ACRE

INVESTOR: COLUMBIA WATERFRONT LLC

The Waterfront shares multiple parallels in design and planning as well as provide examples of methodology in project proposal and project execution. This project is led by various members of the community as well as the city's government. Public forums are held at every stage of design and planning that encourages and accepts public critique, wants, and needs. The project's planning as a whole includes its public community, private investors, private developers, government officials, environmentalists, and local planners, contractors, and designers. The integral planning process has given a voice and opportunity to every person or group who wants to be a part of it, making it an honest community effort and investment into the city's future.

Figure 2.3.24 Aerial Photograph of Park (Source: Hargreaves Associate LDA Design)

QUEEN ELIZABETH OLYMPIC PARK

Figure 2.3.25 Olympic Natural Stadium (Source: Hargreaves Associate LDA Design)

Figure 2.3.26 Landscape Artwork (Source: Hargreaves Associate LDA Design)

The Queen Elizabeth Olympic Park is a 274 acre site set to host the 2012 Olympic games. The site was originally home to a polluted industrious brownfield surrounding the River Lea. The park included the cleanup of post-war munition dumps, battery and match making factories, 52 electricity pylons, and polluted waterways. The overall park was designed to clean and transform the brownfield site into a city park, host thousands of fans for the Olympic games, and transform the Olympic games temporary sporting venues into more park space.

The Queen Elizabeth Olympic Park is the largest park created in Europe in over 150 years. The park design is split into two halves, the Northern natural environmental park and the Southern constructed landscapes. The Northern Park features a naturalized river corridor, wetlands, meadows, and open lawns for gathering spaces. The Southern Park features the 800 meter-long Olympic Gardens that includes terraced flowers lining the river where festivities of the Olympic games were held. The overall design includes over 250 thousand wetland plants that improve the health of the waterways as well as improve the water courses, and utilized 95% of the existing site materials. The Transformation Plan set up the park to redesign the temporary Olympic programming by replacing unnecessary concrete and structures with 45 hectares of new habitat, and extra outdoor recreational programming[44].

LOCATION: LONDON, ENGLAND

DATE COMPLETED: 2012

LANDSCAPE ARCHITECTS:

HARGREAVES

ASSOCIATE LDA DESIGN

PROJECT SIZE: 274 ACRE

The Queen Elizabeth Olympic Park provides an example of transforming a formerly industrious brownfield site into a healthy park. The Olympic Park is sustainable for reusing existing site material, restoring the watercourse of all of its waterways, using strategic landscaping to purify the soil and water and clean up decades of pollution, and strategic habitat placement to balance the local ecosystem. It is an example of natural and designed landscape and the balance between the two. At such a large scale, the Queen Elizabeth Olympic Park serves as a precedent for future landscapes to invest in its environment and community.

Figure 2.3.27 EcoDistrict Concept Design - Waterfront (Source: City of Rochester, NY)

Figure 2.3.28 EcoDistrict Concept Design - Pedestrian Bridge (Source: City of Rochester, NY)

Figure 2.3.29 EcoDistrict Concept Design - Waterfront Urban Design (Source: City of Rochester, NY)

HIGH FALLS ECODISTRICT

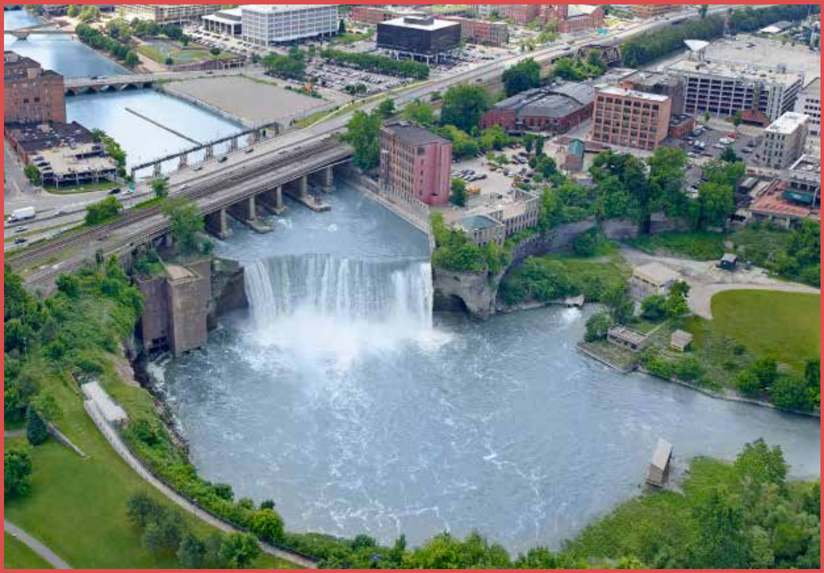


Figure 2.3.30 Aerial Photograph High Falls Waterfall (Source: City of Rochester, NY)

High Falls in Rochester, New York has been registered as an EcoDistrict since August 2017. The High Falls district is located in the heart of Downtown Rochester and is home to a 96-foot waterfall along the Genesee River that has attracted hydraulic powered industries, such as milling, shipping, and electricity, since the early 1900s. After industrious booms in the city, Rochester became an early leader in clean energy production for the Northeast region. The High Falls EcoDistrict aims to clean up pollution and overall transform the riverfront into a historic and public friendly community hub.

The EcoDistrict framework is broken up into three Imperatives: Equity, Resilience, and Climate Protection. Under the Equity and Resilient imperatives, High Falls acknowledges the surrounding communities and their vulnerable economic and social status. High Falls is adjacent to several poor neighborhoods that will benefit the most from the EcoDistrict's economic stimulation. The EcoDistrict will work to increase access to fresh food, green space, sustainable education, and reduced energy costs for the entire community. Strategies under these imperatives include mixed-use development, ADA retrofits to existing buildings and green space, resource library, tool library, car and bike sharing, enhanced bus stop shelters, diverse housing options at a range of affordability, community classes, and public art.

Under the Climate Protection imperative, the High Falls EcoDistrict aims for the community to use less energy, water, and paper products, as well as decrease environment pollution caused from decades of industry. Strategies under this imperative include tree planting, installing rain gardens, green parking lots, porous pavement, bioswales, water metering, water efficient retrofits, solar energy collection, architectural improvements to building envelopes, zoning and cost incentives for green development, and district-wide recycling[45].

LOCATION: ROCHESTER, NY, USA

DATE REGISTERED: AUGUST, 2017

PROJECT SIZE: 322 ACRE

OCCUPANT COUNT: 1,682

The High Falls EcoDistrict is an example of how an industrial waterfront neighborhood can transform the community with sustainable imperatives. The EcoDistrict framework includes not just architecture or planning, but community engagement, long term economic master plans, lifestyle changes, and community opportunities. The EcoDistrict framework observes similar ideals from "The Green Braid" that true sustainability cannot be achieved unless The Three Es are addressed and successfully managed. The leaders of the High Falls EcoDistrict acknowledge that there is a lot of community momentum for change but admit that Rochester, NY is not a progressive city. They say that the High falls EcoDistrict is working on advancing the level of sustainability culture in the area that will spark progress for the community and city as a whole.

Figure 2.3.31 Accessible Street Network (Source: City of Seattle, WA)

NORTH RAINIER MT. BAKER HUB LCC

Figure 2.3.32 Concept Artwork - Street Design (Source: City of Seattle, WA)

In 2010, Seattle, Washington released its North Rainier Neighborhood Plan Update that outlines its goals and strategies to achieve the neighborhoods new vision. This plan is North Rainier's response to the Seattle Comprehensive Plan initiative, a city-wide commitment to "preserve the best quality of Seattle's distinct neighborhoods while responding positively and creatively to the pressures of change and growth." The strategies under the North Rainier Neighborhood Plan addresses business and job creation, bolster a sustainable lifestyle, increase street safety, and reshape the transit systems of the neighborhood center. In 2016, the North Rainier Mt. Baker Hub became a Registered Community under the Living Community Challenge.

Under the initiative to adjust the transit system and create safer streets, strategies under the North Rainier Neighborhood Plan include creating more bike lanes, bus lanes, and crosswalks to adapt to a wider range of transportation methods as seen today. Planting more greenery along the street edges will not only act as a safety and noise buffer for pedestrians and building occupants, but also make walking and biking more attractive and feel safer. The introduction of a green belt will highlight and organize the open green spaces around the neighborhood. The vision to reshape the street networks of backroads, highways and bike paths will create more efficient paths of travel revolving around the neighborhood's center and access to Downtown Seattle, Wa.

Strategies under the initiative to facilitate a sustainable lifestyle include introducing green district infrastructure for stormwater management, introducing educational programs to introduce the public to new, green technology, and consider building a public sustainable demonstration site to showcase the green technology available for building and landscape design. The sustainable initiative also includes retrofitting existing buildings to reduce energy and resource use and setting standards and examples for new construction to reach net zero energy[46].

LOCATION: SEATTLE, WA, USA

DATE REGISTERED: 2016

The North Rainier Neighborhood Plan is an example of a cohesive urban plan that complies with the Living Community Challenge standards. The North Rainier Neighborhood Plan, as well as the city-wide Seattle Comprehensive Plan, recognizes and aims to preserve the successful, unique, and distinctive qualities of each Seattle neighborhood while making efforts to update the network of systems and technologies that make up the city as well as the standards for all aspects of the city's built environment. North Rainier's efforts to update their established networks of transportation showcases their commitment and specific strategies to changing with the rise in population, technology innovations, and health research.

Figure 2.3.33 Conference Room (Source: ZGF)

Figure 2.3.34 Interior Dwelling Space (Source: ZGF)

Figure 2.3.35 Ceiling Artwork (Source: ZGF)

Figure 2.3.36 Open Office Floor Plan with Recycled Bicycle Art Installations (Source: ZGF)

CLIF BAR HEADQUARTERS

Figure 2.3.37 Concept Artwork - Street Design (Source: City of Seattle, WA)

The Clif Bar Headquarters is an adaptive reuse project that transformed an industrious warehouse into a LEED Platinum office complex. The new headquarters brings greenery into the building with 4 interior gardens, living walls, natural light and an overall biophilic interior design. These interior courtyards provide a physically and metally healthy work environment that connects employees to each other and to nature. The open-air interior design reflects the Clif Bar initiative to for employees to collaborate and work as a cohesive unit. The Clif Bar Headquarters includes office space, a research and development kitchen, employee wellness area, on-site childcare, theater space, and a cafe. ZGF is currently working on an additional 45,000 square foot second story addition that will add office space and supportive programming.

The headquarters was one of the first buildings to comply with California's new energy efficiency standards, which are the strictest standards in the nation. To receive a LEED Platinum status, Clif Bar went further than the state's standards and reached for net zero energy. The headquarters has the largest smart solar array in North America, with over 500 kWh providing 100% of the office's electricity. The headquarter's solar hot water system supplies 70% of the building's hot water needs. In spirit with the adaptive reuse project, 75% of the materials used in this renovation were repurposed, including shipping containers and sporting equipment.

In addition to their environmentally sustainable efforts, the Clif Bar company reaches to provide a safe, productive, and sustainable lifestyle for its employees. The company provides all employees with childcare, 30 minutes of paid time to exercise each day, and spaces to decompress and relax during the work day. The company also has a Cool Commute program helps employees purchase hybrid or biodiesel cars to improve the companies fuel efficiency[47].

LOCATION: EMERYVILLE, CA, USA

DATE REGISTERED: 2012-PRESENT

ARCHITECT: ZGF

PROJECT SIZE: 107,000 SQFT

The Clif Bar Headquarters is an example of a healthy office environment, a sustainable company vision, and methods for any industrious adaptive reuse project. Clif Bar has a holistic approach to sustainability in that their desire for a clean and productive building stems from their company policy, treatment of employees, and cultivation of the sustainable lifestyle. Their company understands that the benefits of sustainability goes beyond environmental health, but includes the mental, physical, and emotional health of employees, and employees stamina and productivity, all of which contribute to the overall success of the company. Their examples of biophilic interior design, open and collaborative workspace, and supportive programs for employees set a precedent and standard all companies and building environments should strive for.

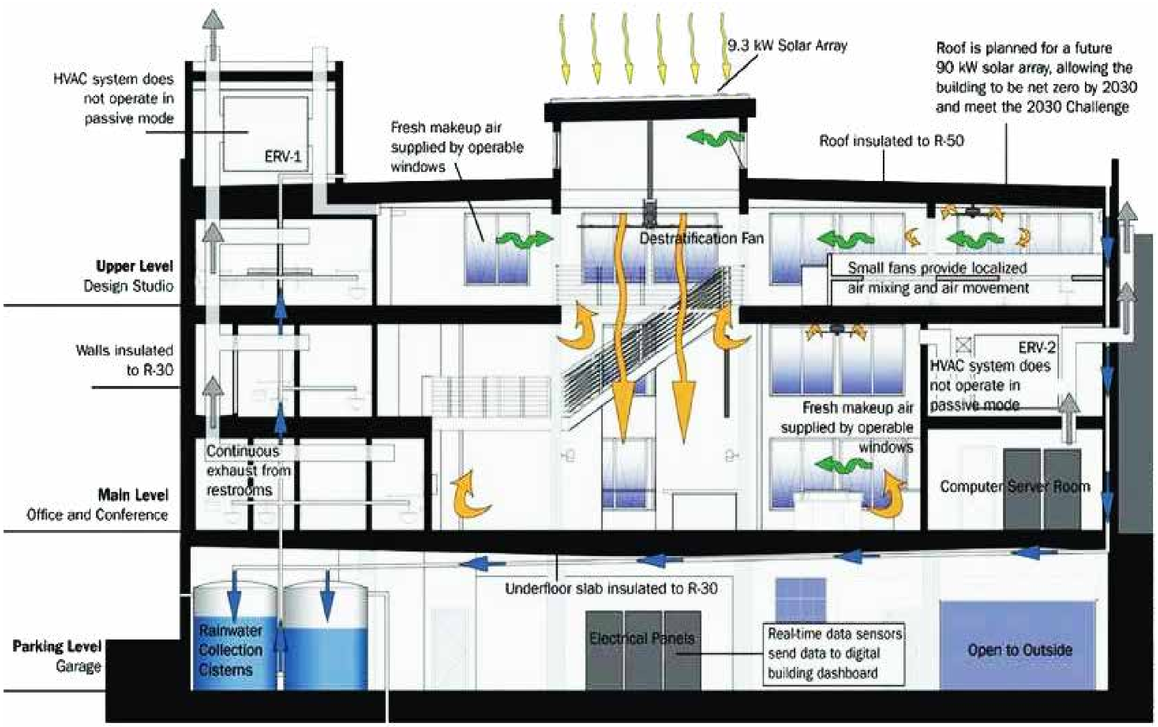


Figure 2.3.38 Building Section - Sysetms Diagram (Source: Rice Fergus Miller)

Figure 2.3.39 Building Condition Before Renovation (Source: Rice Fergus Miller)

Figure 2.3.40 Building Condition After Renovation (Source: Rice Fergus Miller)

Figure 2.3.41 Interior Dwelling Space (Source: Rice Fergus Miller)

RICE FERGUS MILLER OFFICE AND STUDIO

Figure 2.3.43 Building Exterior (Source: Rice Fergus Miller)

Figure 2.3.43 Interior Stair (Source: Rice Fergus Miller)

The Rice Fergus Miller Office Studio is a sustainable renovation project that rehabilitated the historic Sears Automotive Center. The Automotive Center was originially constructed in 1948 and was used as an automotive parts and repair shop.

The newly transformed office space not only was the first commercial office building in the Pacific Northwest to meet the 2015/2030 AIA Challenge, but exceeded the challenge's requirements. The overall building achieved an EUI of 18.2, using on-site solar arrays to produce an estimated 7% of the building's energy supply. The overall building's water consumption was reduced by 70% using rainwater harvesting techniques. Rooftop rainwater harvest met 100% of toilet and landscaping water needs - cutting potable water use for non-potable usage and providing an educational example for the community and future projects to study. The renovation project reused 93% of the original structure and recycled 95% of construciton waste in transforming the automotive shop to a sustainable architectural office space. 58% of wood was taken from sustainably managed forests; 24% of materials used in the overall renovation were recycled material; and 14% of material was manufactured and harvested locally[48].

LOCATION: BREMERTON, WA, USA

DATE REGISTERED: 2011

ARCHITECT: RICE FERGUS MILLER

PROJECT SIZE: 30,000 SQFT

The Rice Fergus Miller Office Studio is an example of an adaptive building reuse project where an abandoned and decrepit stucture was transformed into a precedent for envrionmentally responsible design. The overall design aims to reuse as much of the original structure and material as possible and minimizes as much waste as possible. Where material had to be supplied, the project was concious to select materials that required minimal transportation and use raw material that was harvested responsibly. The building showcases examples for cutting energy cost such as natural ventilation and air circulation methods, conservative heating and cooling technology, and rainwater harvesting.

PART TWO


Google

CHAPTER 03

Project Outline

This chapter will outline the project, its purpose, and the goals of the project. This chapter will identify the issue it will address, frame the context and scope of the project, and step through how this thesis will be executed. Metrics for measuring project success and organizing the project's objectives will also be addressed in this chapter.

03.1 Project Framework and Objectives

The Project Framework and Objectives section will outline the the design challenge the project will address, the project's goals, and how this thesis will be executed. This section includes four subsections: 1) Identifying the Design Issue and Addressing Design Challenges, 2) Project Goals and Objectives, 3) The Living Future Challenge Framework, and 4) Project Outline.

Identifying the Design Issue and Addressing Design Challenges

Fall River, MA is presented with a rare opportunity to redesign their waterfront in large parcels at a time. As outlined in the Fall River Waterfront Urban Renewal Plan, this district-scale redesign project will aim to transform the current industrial waterfront - which is currently privately owned and restricted from the public - into a community based district that will boost the economy and celebrate the waterfront and the city's history, while addressing the city's specific needs for the site. The current draft of the Fall River Waterfront Urban Renewal Plan, published in September 2018, only addresses urban planning on the topics of parcel rezoning and clearance. However, this scale of redesign has the opportunity to look deeper into urban design and planning and integrate existing and new site features with sustainable design and technology. Sustainable interventions at this scale have the potential to connect the district's exterior space, existing construction, and new construction with sustainable infrastructure, address the city's specific needs for the site, and help inform further design and planning decision making.

In addition to the design challenges outlined by the City of Fall River listed in Chapter 1, the design challenges to be addressed in this thesis are as follows:

- Determine if existing parcels require demolition and clearance or rehabilitaiton based on existing conditions and future use of the site

- Accommodate the city's needs for additional office, retail, and residental programming and dictate the density of each program type

- Choose the most appropriate locations for new programming as well as recognizing any needed rezoning required to facilitate future program

- Introduce design guidelines to regulate the growth and aesthetic of the district

Project Objectives

The overall project objectives of this thesis are as follows:

- Explore the application of sustainable technology on the urban scale and building scale for industrial sites

- Use sustainable technology and design to address design challenges and project goals set forth by the city

- Explore the Living Future Challenge and understand the design requirements to fulfill the challenge

- Advocate for Adaptive Building Reuse, material recycle and reuse, and the preservation of natural and existing site features.

- Create an urban masterplan to redesign the Fall River South Waterfront that will utilize shared infrastructure and resources, as well as use resources more efficiently.

- Create an adaptive building reuse design that would transform an existing New England mill into a sustainable and self-efficient building.

The Living Future Challenge Framework

The Living Future Challenge (LFC) has been chosen as the framework of this thesis in order to provide structure, organization, and performance goals to reach for. Among the other metrics that were researched, the LFC has the strictest sustainable performance goals, one of the most extensive and detailed structures, and offers alternative options to partially complete the challenge. The LFC is broken up into seven sections, or Petals: 1)Energy, 2) Materials, 3) Place, 4) Water, 5) Health + Happiness, 6) Equity, and 7) Beauty. In order to complete the challenge in its entirety, all of the Petals' requirements must be met. However, if a project is limited to its ability to fulfill one or more of the Petals, a project may still be eligible to be "Petal Certified" under the Petals the project is able to complete. For the Energy Petal, if a project is able to reach Net Zero Energy under the requirements of the Petal, a project is eligible to be Zero Energy Certified.

The alternative option for Petal Certification encourages projects to do what they can, under the Petals that are most important to the project, to take initiative and become more sustainable. The International Living Future Institute offer literary material and guiding support that encourage and aid projects that pursue the challenge. The material offered to the public include extensive and detailed guidebooks on how to fulfill each Petal, as well as a library of case study projects that have fulfilled the LFC. Support and aid offered to projects who pursue the challenge include zoning incentives that offer exceptions to zoning restrictions, tax incentives, and financial support to complete the project.

For this thesis, the LFC would not only push the project to reach challenging performance and design goals, but it would also provide structure and direction to frame the revitalization project. As a graduate student, using the LFC as a project framework would also provide the best opportunity to explore and learn about new sustainable design practices and technologies, to better understand their impact on design, and learn how to impliment them into existing sites.

Living Future Challenge Petal Requirements

Energy Petal

The Energy Petal requires that 105% of the project's energy needs are met with renewable energy that is supplied on-site without the use of combustion and provide on-site energy storage. To reach this petal's requirements, buildings and infrastructure must function at high levels of efficiency in order to minimize energy use and resource consumption.

Materials Petal

The Materials Petal requires that no red-list material or chemicals are to be used in project construction; that the project must account for the total embodied carbon impact from its construction; that the project must advocate for the creation and adoption of third-party certified standards for sustainable resource extraction and fair labor practices; that the project must include a percentage locally or regionally sourced material; and that a project must reduce or eliminate the production of waste during all stages of material and building life cycles.

Place Petal

The Place Petal requires that the project must set limitations to growth as to not encroach on sensitive ecological habitats; that the project include a percentage of project area that is dedicated for food production; that the project participates in the Living Future Habitat Exchange Program or an approved Land Trust organization; and that the project facilitates and encourages human powered living in an effort to reduce pollution and greenhouse gas emission caused by transportation;

Water Petal

The Water Petal requires that 100% of the project's water needs must be supplied by captured precipitation, other natural closed-loop water systems, or by recycling used project water. All water either collected or recycled must be purified as needed without the use of chemicals. The Petal also requires that all stormwater and water discharge, including greywater and blackwater, must be addressed on-site.

Health + Happiness Petal

The Health + Happiness Petal requires that projects provide operable windows in all regularly occupied interior space; that the project must facilitate exceptionally high levels of Indoor Air Quality (IAQ); and that the project must include biophilic design that promotes the human-nature connection.

Equity Petal

The Equity Petal requires that the project must follow the design guidelines for human scale and humane places; that the project must provide spaces that are accessible to all while providng public access to fresh air, sunlight, and waterways; that the project must donate at least half a cent for every dollar to a charity of its choosing; and that the project must house at least one registered Just Organization under its roof.

Beauty Petal

The Beauty Petal requires that the project must integrate public art that celebrates culture, spirit, and place and include educational materials about project operation and performance[49].

Project Outline

To complete this project, address all design challenges, and meet all project objectives, this thesis will be divided into two phases: 1) The South Waterfront Masterplan Proposal, and 2) The Existing Building Adaptive Reuse Proposal. The South Waterfront Masterplan Proposal will redesign the district's urban fabric using sustainable design and technology and transform the existing industrial district into a community-based neighborhood that will stimulate the city's economy and address design needs specified by the city. The Existing Building Adaptive Reuse Proposal will take a single existing building, that a) is suitable for rehabilitation and b)represents the Typical New England Mill Building, and introduce sustainable redesign and technolgy that will transform the outdated structure into a high-efficiency buidling.

Each phase of the project will step through design interventions one at a time and describe in detail its intention, application to the project as a whole, how to apply it, and how the intervention relates to the Living Future Challenge. The purpose of this thesis is to demonstrate various sustainable design interventions possible for industrial sites alike. The final designs for both the South Waterfront Masterplan Proposal and the Existing Building Adaptive Reuse Proposal represent all design interventions working together, however, all design interventions are independent from each other and can be executed individually.

The complete outline of the project's design is as follows:

1. South Waterfront Masterplan Proposal:
    - A. Site Analysis
        - District Location
        - Site Landmarks
        - Character of District
        - District Parcel Information
        - Urban Planning and Environmental Data
    - B. Masterplan Proposal
        - Existing Building Reuse, Rehabilitation, and Recycle
        - New Construction in Compliance with the Living Building Challenge 4.0
        - District Solar Energy Production, Installation, and Distribution
        - District Rainwater Collection and Distribution
        - Redesigned “Green Streets”, Road Organization, and Parking Strategy
        - Stormwater Management Infrastructure and Supportive Landscape Design

2. Existing Bulding Sustainable Adaptive Reuse
    - A. Case Study Site Analysis
        - Introduction to 104 Anawan
        - Character of Building and Site
        - Building and Site Documentation
        - Typical New England Mill Construction
        - Solar Study
    - B. Adaptive Reuse Building Case Study
        - Adaptive Reuse of Existing New England Mill Buildings on SIte
        - Building Envelope and Construction Assembly
        - Building Heating, Cooling, and Ventilation Systems
        - Independent Building Design Strategies and Technologies for Water Use
        - Roof Replacement with Skylights or Atrium Addition

CHAPTER 04

The South Waterfront Masterplan Proposal

This thesis project will address various topics of sustainability on all scales of the built enviornment, including materiality, building design, and district planning. This chapter will disect literature that cover these sustainable topics, study case studies similar to the Fall River site as well as express significant sustainable efforts, and research the various metrics to measure sustainable efforts. This chapter will inform possible objectives, strategies, and project scopes that this thesis may apply.

04.1 Site Analysis

The purpose of this site analysis is to establish site boundaries for this project as well as assess the current attributes within the site and its context. This section is categorized into three categorize: (1)Summary of Waterfront; (2) Site Features; and (3) Urban Planning and Ecosystem. This section will identify all important social attractions, physical features, and urban planning information in order to better inform this thesis on the current state of the site, the city's waterfront, and the city itself.

Summary of Waterfront

Fall River, is located in the Southeast leg of Massachusetts along the Taunton River. Along the waterfront resides Fall River's industrial factory sites accompanied by railroads, highway access, and port facilities. Since the decline of the city's industry, the waterfront industrial facilities are either vacant or underutilized. The natural environment suffers from over a century of industrious pollution in the soil, water, and air.

East of the waterfront and the Braga Bridge is the downtown and central business district. This district is the densest in the city. The downtown district is connected to the waterfront from Anawan Street, just beyond the highway entrance and exit ramps. Along the other sides of the waterfront and Downtown district are residential and mixed-use land use.

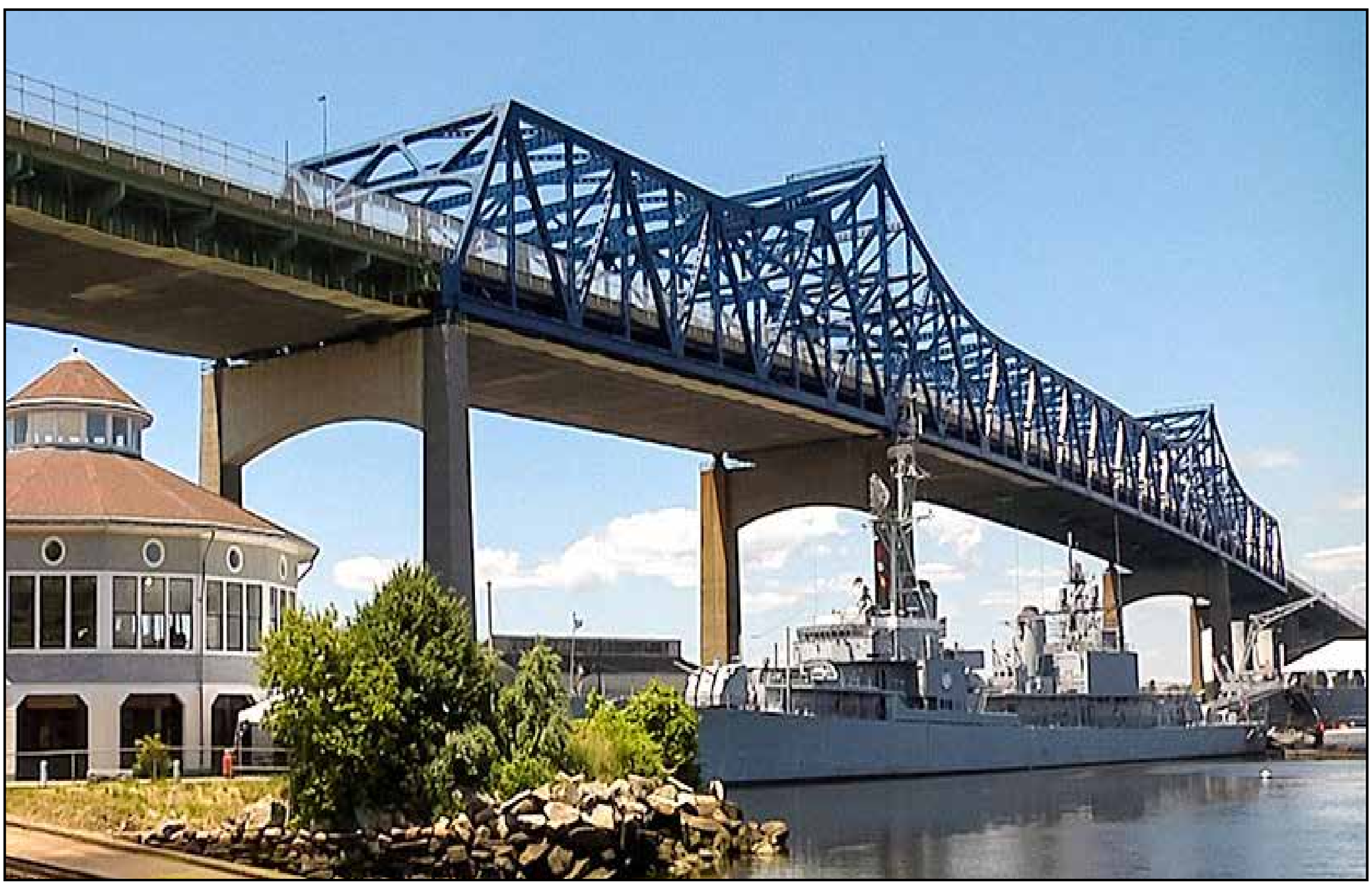


Figure 4.1.1 Night View of Braga Bridge (Source: Nancy Marshall)

Figure 4.1.2 Fall River Satelite Map (Source: Google Maps)

1. Battleship Cove

Fall River's Battleship Cove: America's Fleet Museum was first established in 1965 and is the home to five National Historic Landmark US Navel Ships:

- USS Massachusetts
- USS Joseph P. Kennedy Jr.
- USS Lionfish
- Hiddensee
- PT-617 and PT-796[50]

2. Fall River Carousel

The Fall River Carousel is located on the waterfront along Battleship Cove in Heritage State Park. The carousel was an icon of the Lincoln Amusement Park in North Dartmouth, Massachusetts for 70 years. The carousel was salvaged and brought to Fall River in 1991 and was refurbished for $250k[51].

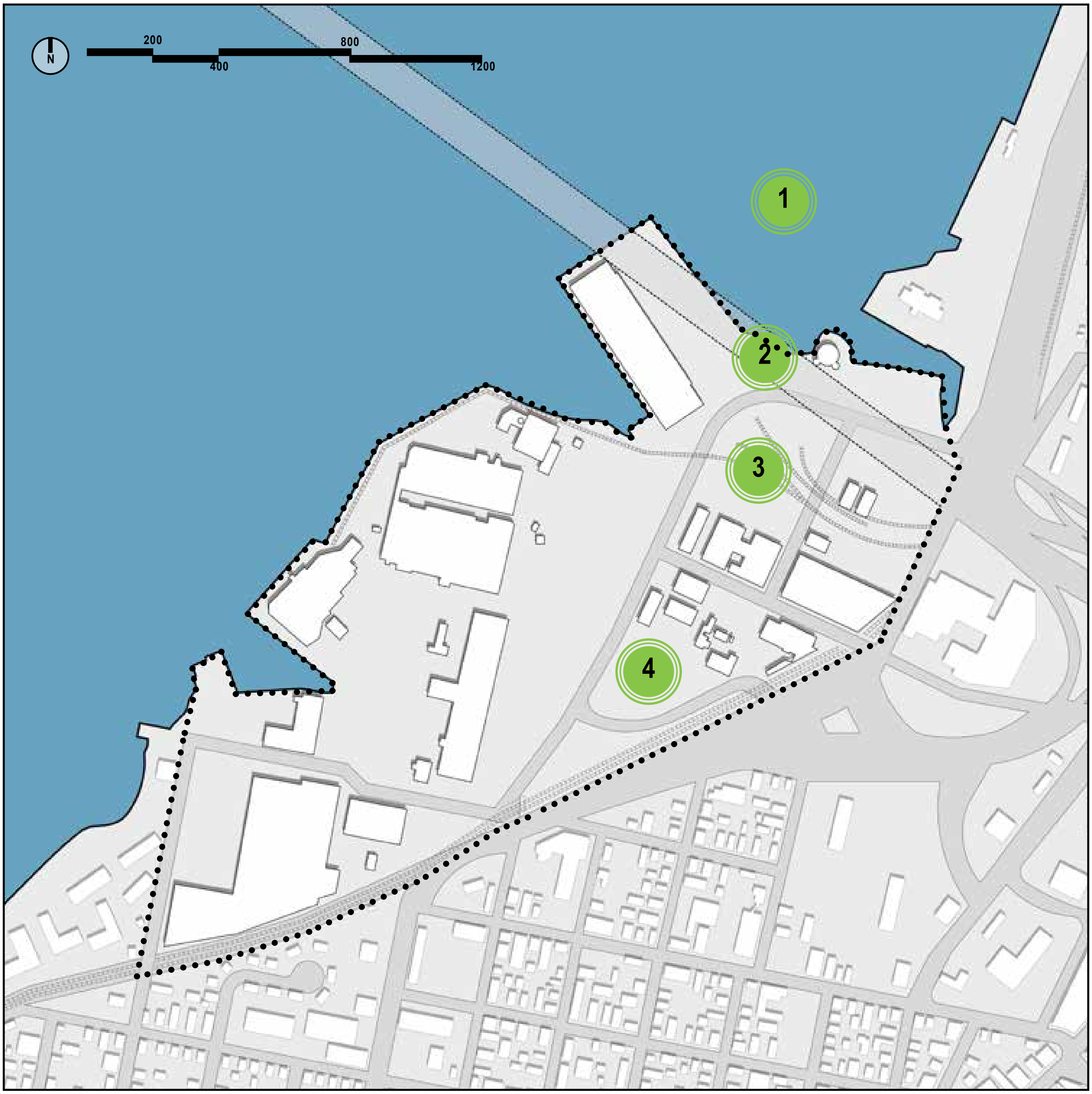
3. Old Colony & Fall River Railroad Museum

The Old Colony & Fall River Railroad Museum is located across the street from Heritage State Park and is home to several rail cars for public education and enjoyment.The Old Colony & Fall River Railroad operated from 1854 to 1863, and later became part of the Old Colony Railroad system. The museum closed down in September 2016 after a decline in popularity, but the railroad tracks,rail equiptment, and the Pennsylvania Railroad P-70B, remain on the site closed, off from the public[52].

4. City Gates Plaza

The City Gates Plaza is home to replica archways of the the original City Gates in Ponta Delgada - the capitol city of Sao Miguel. Ponta Delgada is the sister city of Fall River, MA. A large portion of Fall River's population emigrated from Sao Miguel, as well as the six other islands of the Azores - creating a strong relationship with Fall River. The City Gates were built in 2006 and were meant as a landmark to honor Fall River's Portuguese heritage[53].

Figure 4.1.3 Site Attraction Map (Source: Morgan Warner)



5. Fall River Line Pier

The Fall River Line Pier first opened in 1954. The pier provides Fall River will direct access to the Atlantic Ocean through the beautiful Narragancett Bay for importing, exporting, and travel. The pier offers ferries to Block Island and Newport, RI[54].

6. Maritime Museum

The Fall River Carousel is located on the waterfront along Battleship Cove in Heritage State Park. The carousel was an icon of the Lincoln Amusement Park in North Dartmouth, Massachusetts for 70 years. The carousel was salvaged and brought to Fall River in 1991 and was refurbished for $250k[55].

7. The Ironworks Complex

The ironworks complex is currently occupied by the Borden and Remington Corporation who resides over the 37 acre complex. The property is located at the foot of the Braga Bridge (I-195) with a mile of waterfront along the Taunton River and is accessible by road or by water[56].

8. Heritage State Park

The Fall River Heritage State Park is located along the Taunton River adjacent to Battleship Cove. The Heritage State Park is the Southern anchor of the Fall River River Boardwalk. The park is open from sunrise till sunset and is the home to public outdoor activities, including sailing, running, and other educational programs[57].

Figure 4.1.4 Site Attraction Map (Source: Morgan Warner)

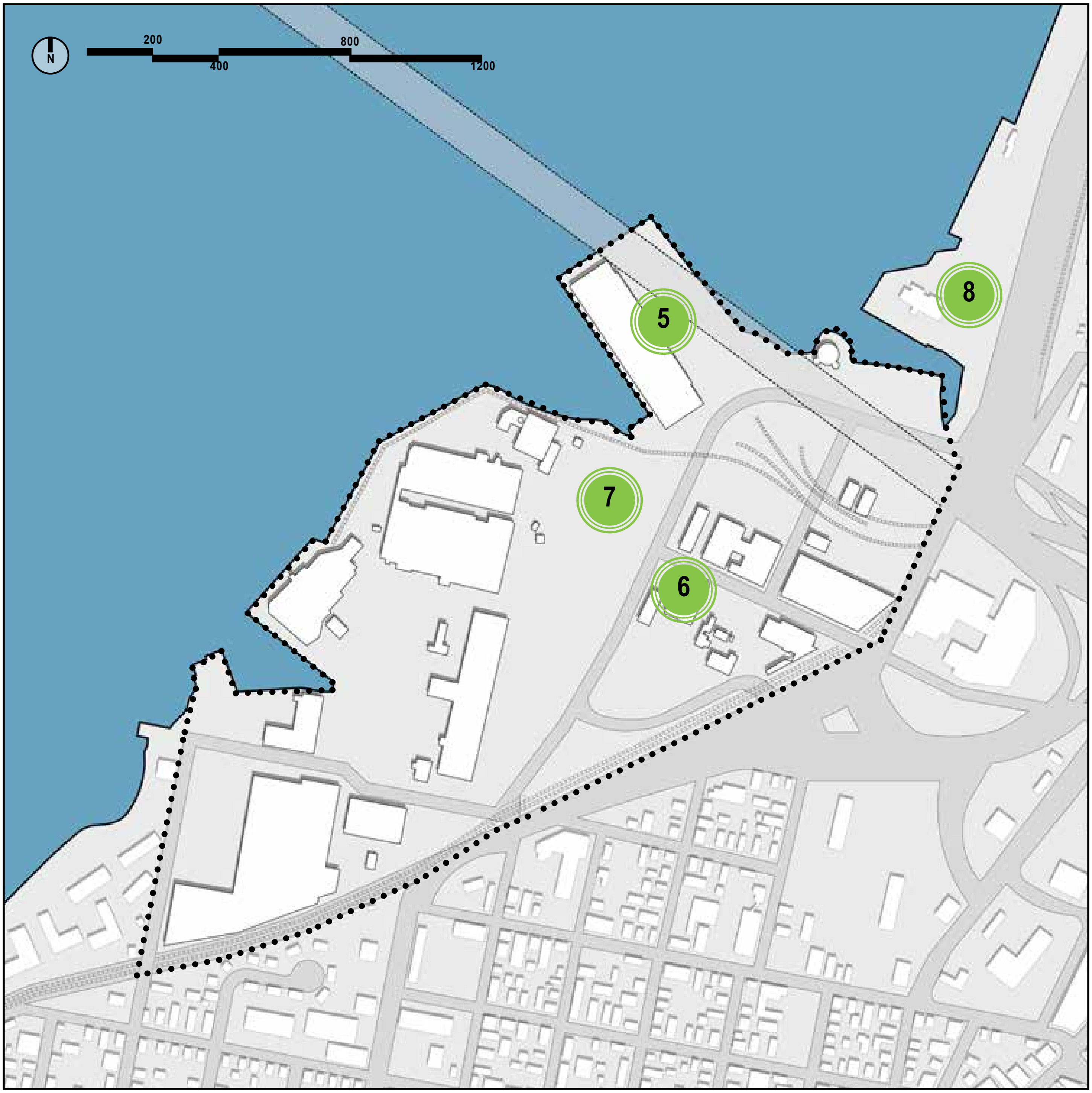


Figure 4.1.5 Battleship Cove (Source: Morgan Warner)

Figure 4.1.6 Boardwalk View (Source: Morgan Warner)

Figure 4.1.7 Historic Railroad Tracks (Source: Morgan Warner)

Figure 4.1.8 Maritime Museum (Source: Morgan Warner)

Figure 4.1.9 Aerial Photograph of Battleship Cove (Source: Roger Williams University)

Figure 4.1.10 Aerial Photograph of Fall River's South Waterfront (Source: Roger Williams University)

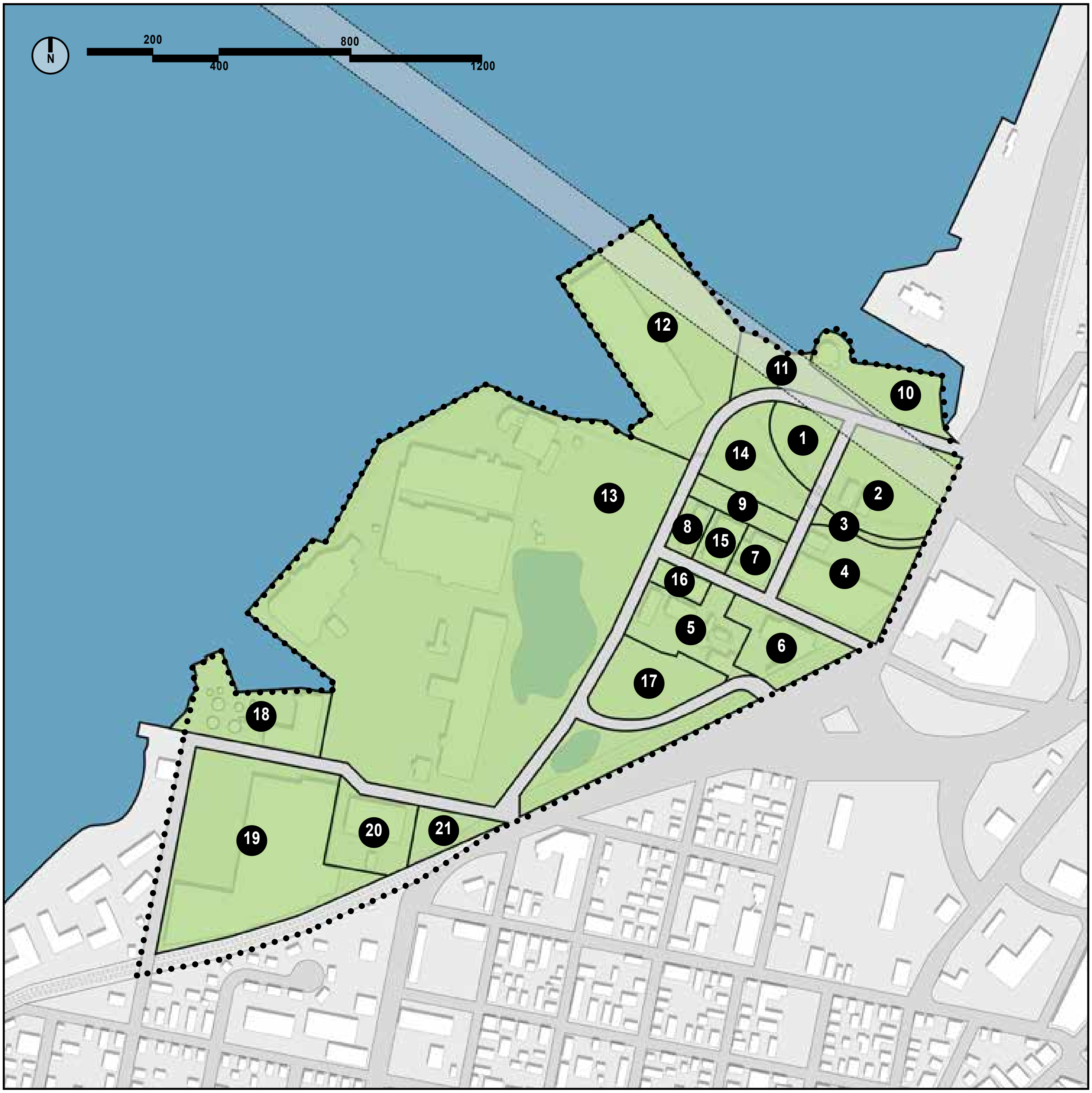
Figure 4.1.11 Aerial Photograph of Fall River's State Pier (Source: Roger Williams University)

Figure 4.1.12 Aerial Photograph of Braga Bridge (Source: Roger Williams University)

Parcel Information

#	PARCEL ID	ADDRESS	PROPERTY OWNER	SIZE	AS-SESSED VALUE	CURRENT LAND USE	YEAR
1	N-16-0032	Central St	Commonwealth of Mass; Dept. of Env. Management	1.18 acres	$174,700	Dept. of Conservation and Recreation	N/A
2	N-12-0011	30 Pond St	Commonwealth of Mass.	0.71 acres	$230,200	Dept. of Conservation and Recreation	1920
3	N-12-0013	Pond St	New York Central Lines LLC	0.35 acres	$2,800	Undeveopable Residential Land	N/A
4	N-12-0003	104 Anawan St	Shane Landing LLC	2.63 acres	$1,433,500	Manufacturing Operations	1870
5	N-16-0002	45 Anawan St	Liberty Utilities (New England Natural Gas Company) Corp	2.06 acres	$561,500	Manufacturing Operations	1900
6	N-16-0004	115 Anawan St	SAS International LLC	1.23 acres	$556,500	Manufacturing Operations	1930
7	N-16-0009	28 Anawan St	Megara Properties Mass. LLC	0.71 aces	$620,600	Manufacturing Operations	1870
8	N-16-0011	56 Water St	Azar Jeanne Etali	0.40 acres	$569,300	Eating and Drinking Establishments	1937
9	N-16-0016	Water St	Edward J Nasser II; Nasser Real Estate Trust	0.74 acres	$130,600	Developable Commercial Land	N/A
10	N-13-0001	6 Central St	Jobs For Fall River Inc	1.87 acres	$1,366,300	Public Recreation	1991
11	N-13-0021	Water St	Commonwealth of Mass.	2.02 acres	$301,300	Public Recreation	N/A
12	N-13-00020	1 Water St	Commonwealth of Mass.	7.18 acres	$3,085,100	Pier Facilities	1951
13	N-15-0002	63 Water St	Bordon & Remington F. R. LLC	29.21 acres	$3,254,400	Manufacturing Operations	1880
14	N-16-0030	Water St	New York Central Lines LLC	1.45 acres	$183,900	Railroad Museum	N/A
15	N-16-0010	14 Anawan St	Unitex Inc	0.60 acres	$539,100	Manufacturing Operations	1937
16	N-16-0001	70 Water St	Fall River Inc Marine Museum	0.44 acres	$718,400	Marine Museum	1881
17	N-16-0008	24 Ponta Delgada Blv	City of Fall River	0.69 acres	$158,200	Landmark	N/A
18	N-14-0001	52 Ferry St	Northeast Products CO	2.16 acres	$888,600	Manufacturing Operations	1965
19	I-02-0001	81 Ferry St	Lee Francis LLC	8.28 acres	$1,067,700	Manufacturing Operations	1947
20	I-02-0004	75 Ferry St	Ferry St Boat Barn LLC	1.41 acres	$796,800	Manufacturing Operations	1900
21	I-02-0006	Ferry St	New York Central Lines LLC	0.44 acres	$2,000	Developable Commercial Land	N/A

Figure 4.1.13 Parcel Map (Source: Morgan Warner)



Urban Planning and Environmental Data

The current zoning for the South Waterfront district only includeds industrial and mixed-use commercial programming. Surrounding the district includes more mixed-use commercial and residential. The majority of the mixed-use commercial are larger buildings with multiple businesses in each. These buildings are spaced out and do not share close relationships with each other. The majority of residential buildings are in the form of duplexes, triplexes, and fourplexes, with the exception of a few apartment or condo buildings. The South Waterfront district is entirely within the Coastal Zone and the Northern half along the water is within the 100 year Flood Line.

Figure 4.1.14 Land Use Zoning Map (Source: Morgan Warner)

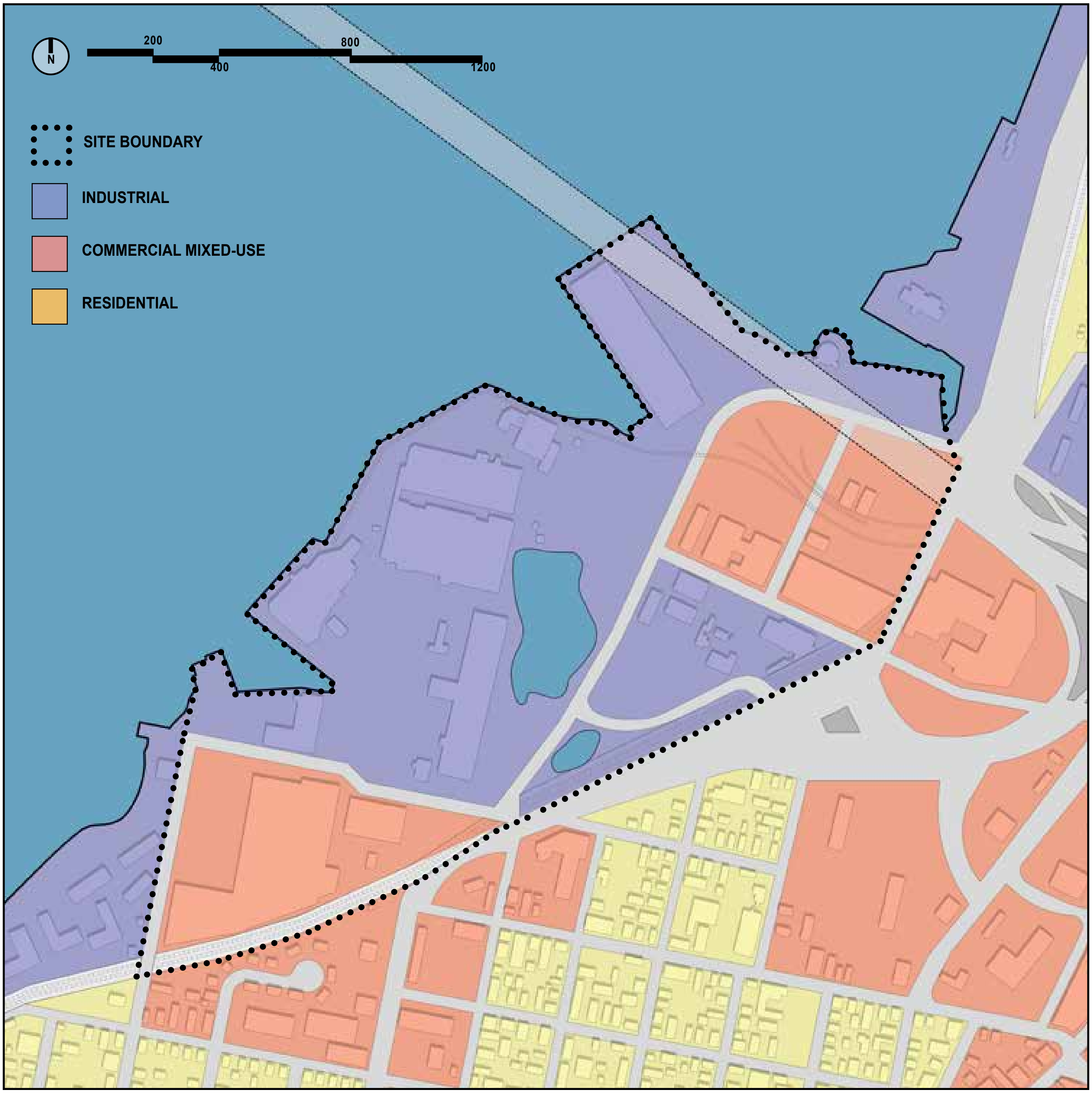
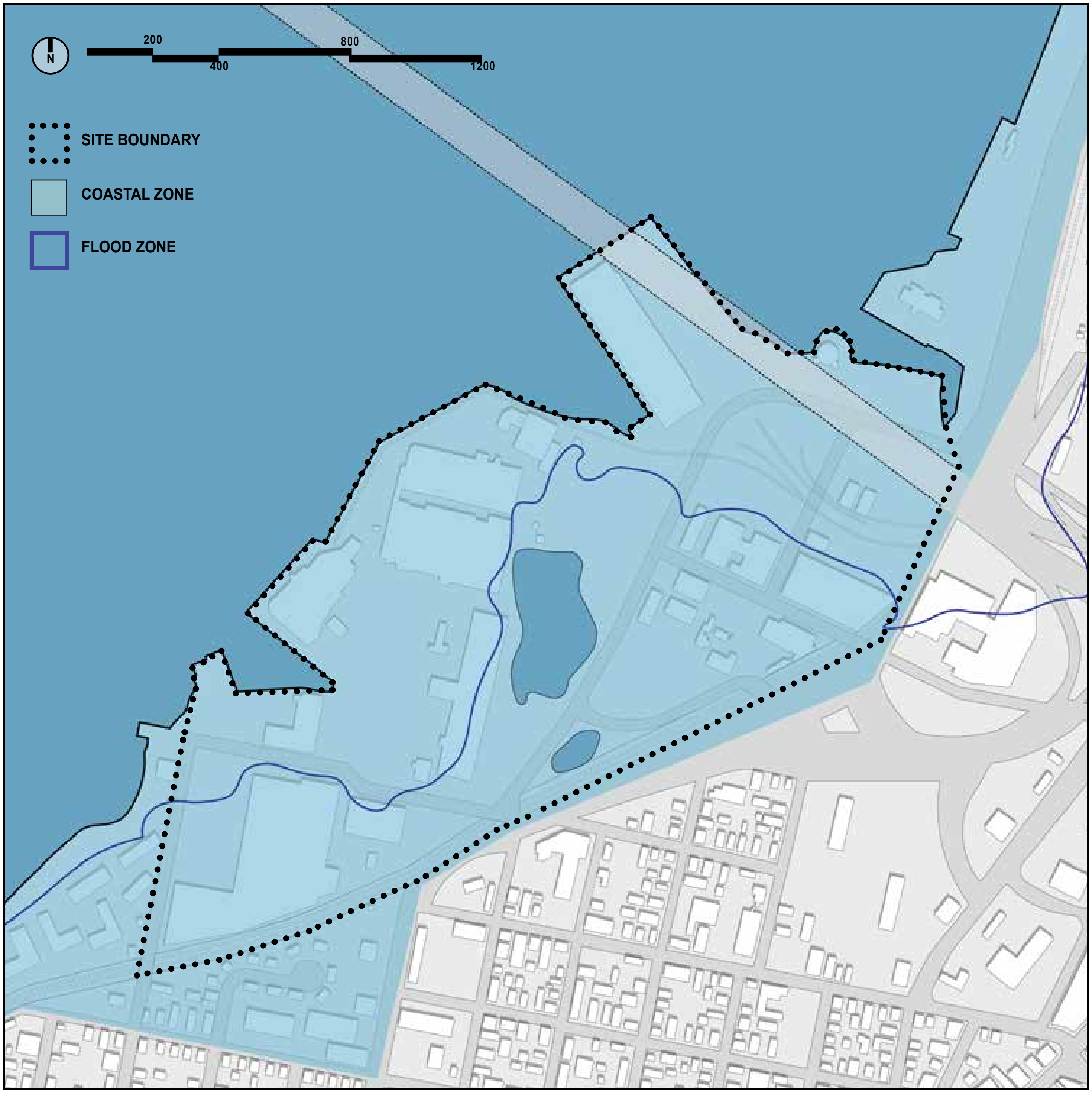


Figure 4.1.15 Coastline Map (Source: Morgan Warner)



04.2 The Masterplan

The South Waterfront Masterplan Proposal will transform the existing South Waterfront District step by step - providing data to support each design decision and addressing how each step applies to the petals of the Living Future Challenge. The goal of this masterplan proposal is to provide a list of sustainable interventions that may be applied on the district scale and demonstrate the application of these interventions so that other cities may duplicate them.

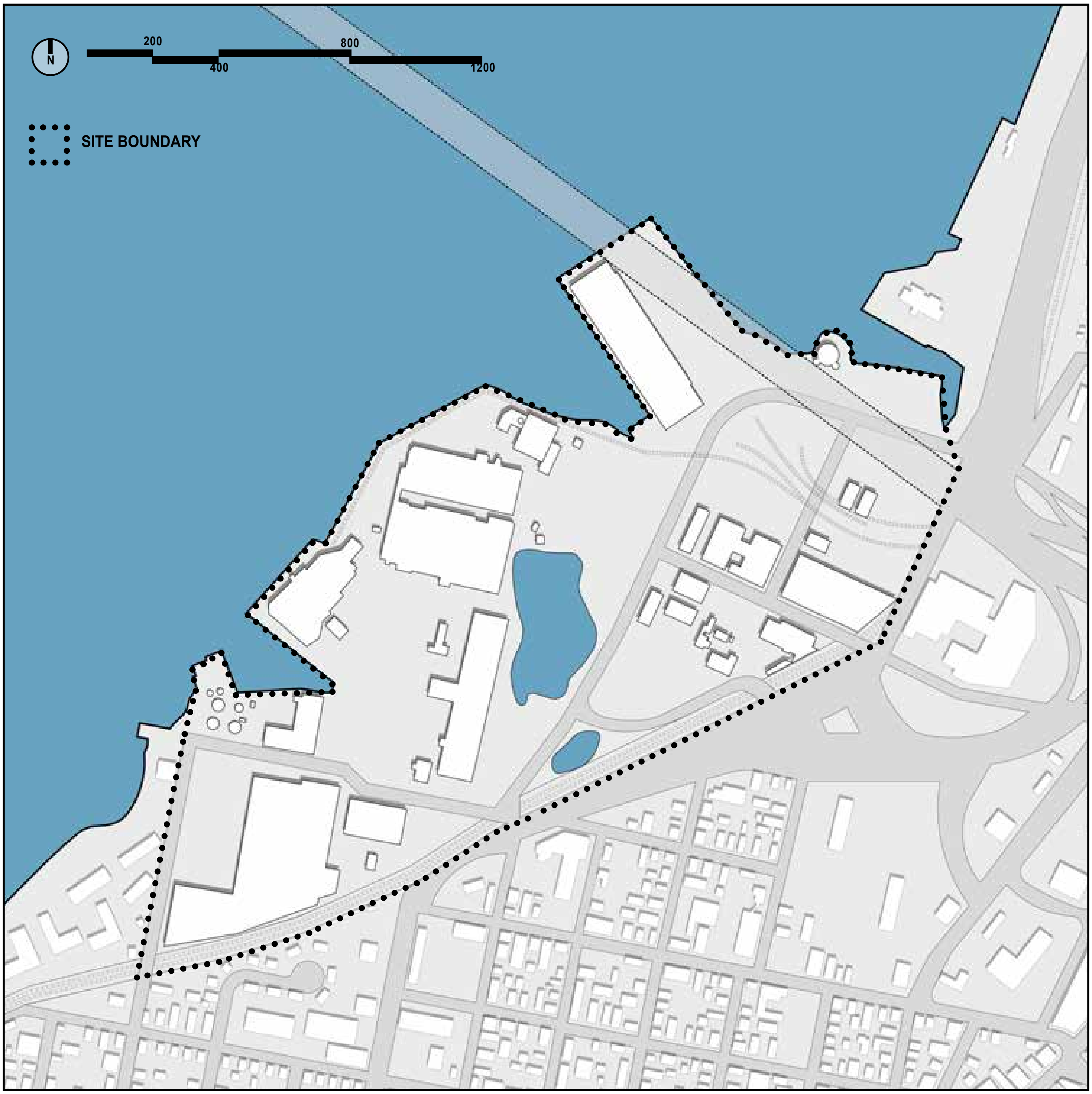
Sustainable Urban Design Strategies and the Living Future Challenge

Before the deisgn of the masterplan is addressed, the design strategies to be achieved are listed and outlined with the petals of the Living Future Challenge they correspond with. The design strategies to be used are determined based on the goals of the Fall River Waterfront Urban Renewal Plan outlined by the city of Fall River, MA, and the requirements of each Living Future Challenge petal. These design strategies are devised to not only meet the goals of the city, but to enhance their performance and maximize the design's potential for energy conservation, envrionmental health, social equity, and economic gain.

Figure 4.2.01 Living Future Challenge Urban Design Strategies; (Source: Morgan Warner)

The South Waterfront Masterplan Proposal outlines the sustainable design strategies that will be applied to the existing waterfront district and lists which petals from the Living Future Challenge each design strategy addresses.

Figure 4.2.2 Existing Map (Source: Morgan Warner)



Existing Building Reuse, Rehabilitation, and Recycle

Addressing the reuse, rehabilitation, and recycling of existing structures and site material is the first step in the proposed masterplan. Building reuse is an important initiative in sustainability because it conserves material and avoids additional energy and carbon output that occurs during the processes of material extraction, manufacturing, transportation, assembly, and demolition. This thesis is committed to reusing as many structures and materials as possible with the intention to reduce the project's overall embodied energy and carbon.

For the purpose of this thesis, there are three sets of criteria for deciding whether or not to reuse or demolish a building: 1) Physical appearance of the exterior, 2) Current building program and its relationship to the city's planned zoning changes, and 3) The city's proposal has already outlined the building for demolition. Based off of an in-person site analysis, each exisitng building was observed for its structure and material's physical integrity. If a structure wsa seamingly condemned or built as a temporary shelter, it was marked for planned demolition. If a structure was either not conditioned, temporary, or used as a garage or storing facility, they were considered for demolition based on the second set of criteria. If a structure was in good physical appearance and conditioned, the only reason for demolition is beacuse it's current location or program hinders the future masterplan of the site.

The September 2018 draft of the Fall River Waterfront Urban Renewal Plan outlines that Buildings 14-20 (outlined on Figure X) are to be demolished and their parcel's cleared for new urban development. For the purpose of buliding reuse and material conservation, this thesis argues against this design initiative and urges the city to preserve and rehabilitate Buildings 15, 16, 17, and 20. These buildings are in good phsyical condition, are conditioned, and represent the typical New England Mill building design and character. By choosing to keep these buildings, the district will have a greater historic layer to the new masterplan, adding depth and character to the waterfront.

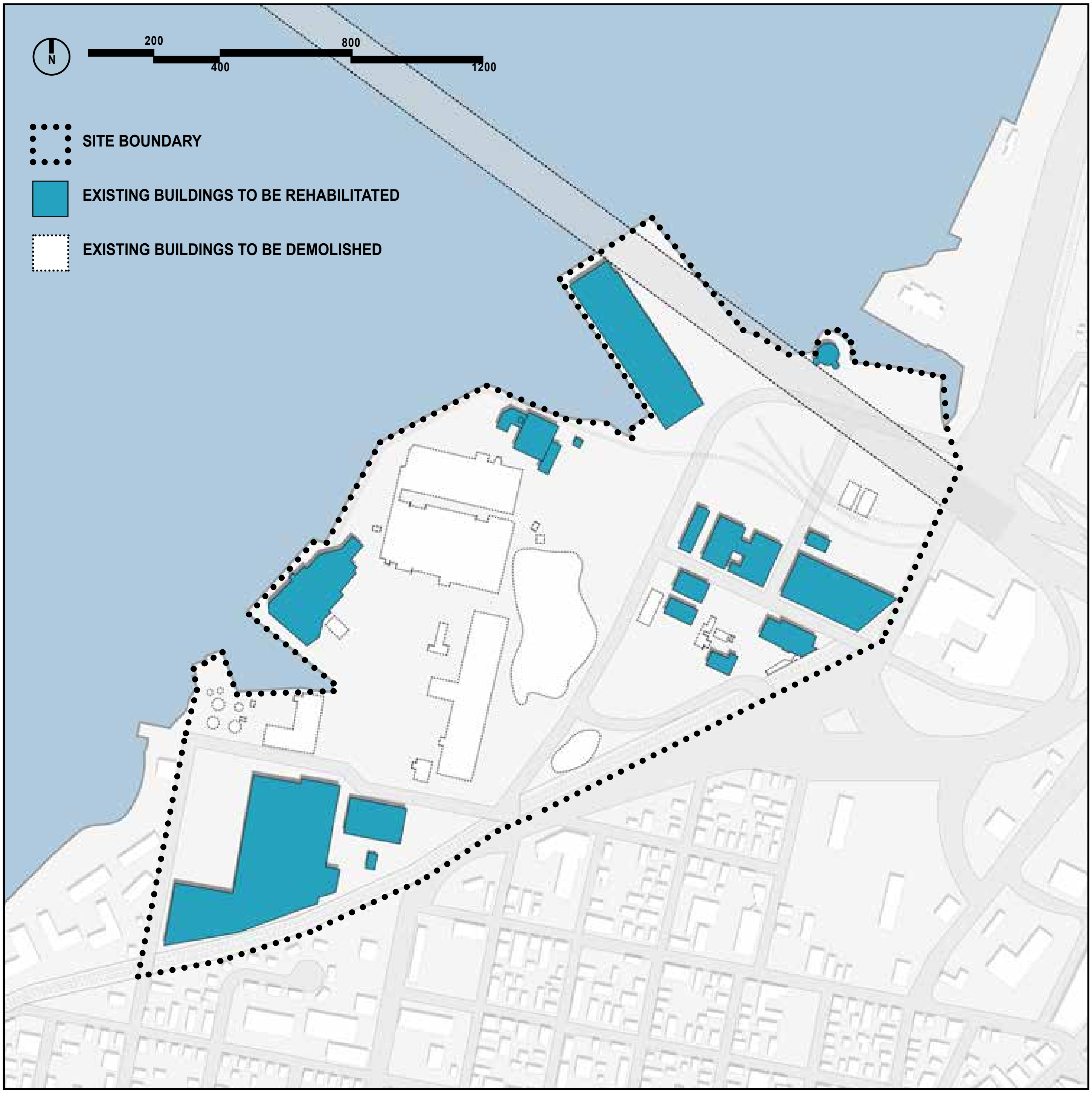
Among the buildings that are kept and rehabilitated include the State Pier facility, the Carosel, the current location of the Maritime Museum, six mill buildings that represent the typical New England Mill typology and character, and two industrial facilities. Among the buildings demolished are industrial storage facilities, garages, empty or condemned buildings, factories along the waterfront, and small unconditioned storage space.

Figure 4.2.3 Anawan Street View Looking East (Source: Morgan Warner)

Figure 4.2.4 Existing Mill (Source: Morgan Warner)

Figure 4.2.5 Aerial Photograph of Railroad Tracks (Source: Roger Williams University)

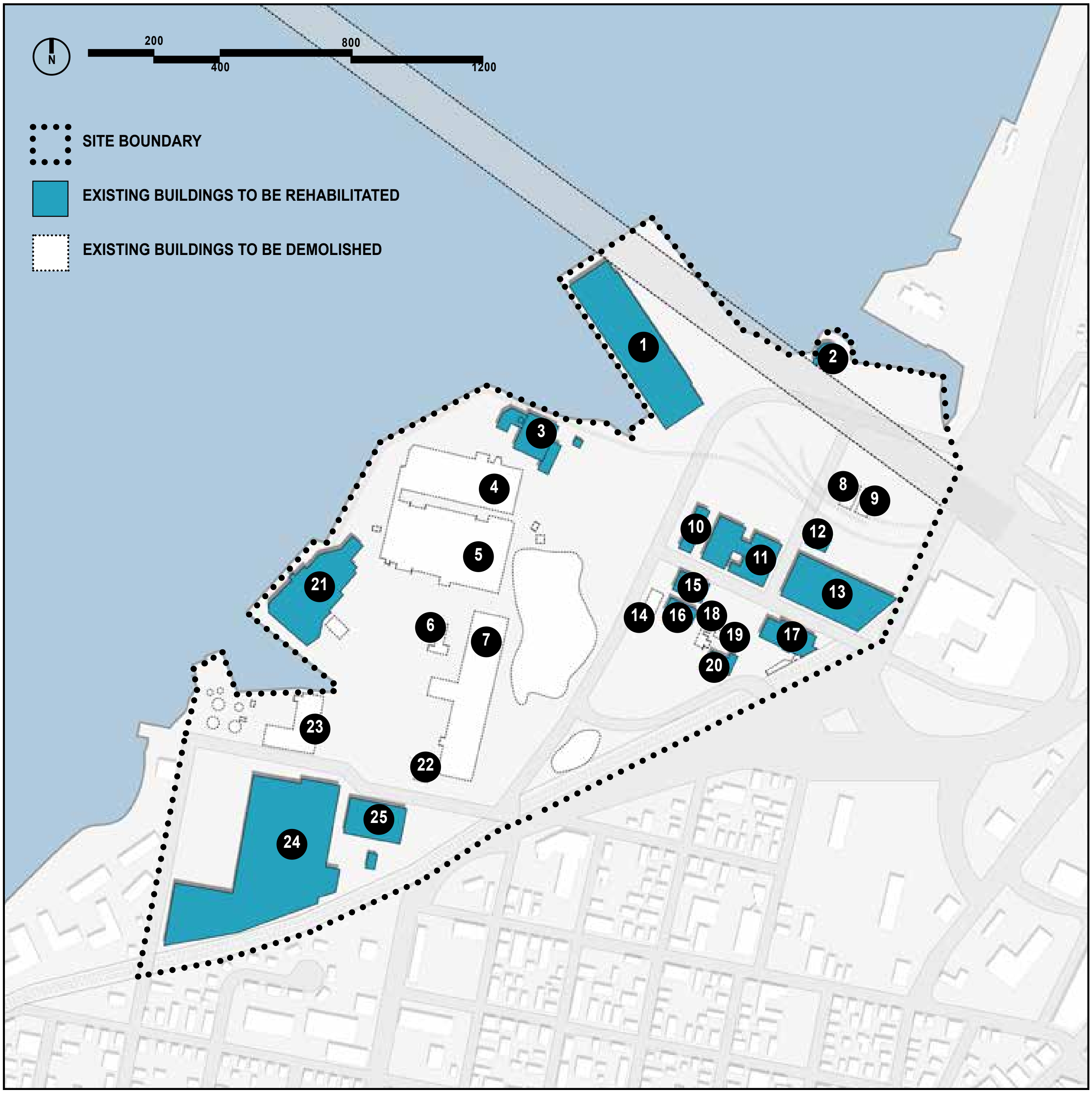
Figure 4.2.6 Existing Buildings to be Rehabilitated Map (Source: Morgan Warner)



Existing Building Demolition Plan

#	FOOTPRINT	TOTAL BUILDING	DEMO	REASON	ENVELOPE MATERIAL
1	100,830	100,830	-	-	-
2	4,100	8,200	-	-	-
3	26,250	78,750	-	-	-
4	61,500	61,500	X	Hinders waterfront development	Brick
5	98,400	98,400	X	Hinders waterfront devleopment	Brick
6	4,000	4,000	X	Temporary Structure	Aluminum
7	70,000	70,000	X	Temporary Structure	Aluminum
8	3,850	3,850	X	City's plan to demo	Brick
9	3,850	3,850	X	City's plan to demo	Brick
10	7,200	21,600	-	-	-
11	34,100	136,400	-	-	-
12	3,450	6,900	-	-	-
13	53,550	214,200	-	-	-
14	5,200	5,200	X	Unconditioned Garage / Storage	Brick
15	7,700	23,100	-	-	-
16	4,500	4,500	-	-	-
17	17,100	51,300	Partial	Unused Addition	Brick
18	3,000	3,000	X	Hinders Waterfront Development	Brick
19	1,350	1,350	X	Hinders waterfront development	Brick
20	4,250	8,500	-	-	-
21	49,025	98,050	-	-	-
22	3,750	7,500	X	Temporary Structure	Aluminum
23	22,750	22,750	X	Hinders waterfront development	Aluminum
24	186,000	186,000	-	-	-
25	25,000	50,000	-	-	-
Total Existing	*523,055*	*988,330*	-	-	-
Total Demo	*277,650*	*281,400*	-	-	-

Figure 4.2.7 Existing Building Inventory Map (Source: Morgan Warner)



Energy Petal

The initiative to reuse and sustainably rehabilitate existing structures rather than demolish and build new construction conserves the embodied energy of all existing structures that are saved. The embodied energy of a construction project includes all of the energy that went into each individual building's material extraction, material manufacturing, material transportation, building construction, and eventually, building demolition. Avoiding new construction and reusing what already has embodied energy reduces the projects overall added embodied energy, ultimately saving energy in project construction

Material Petal

Adaptive building reuse results in a fraction of material waste compared to building demolition that results in new, replacement construction. The volume of material saved is comparable to the volume of material that would be needed for new construction - doubling the amount of unnecessarily wasted material.

Place Petal

The initiative to reuse and sustainably rehabilitate existing structures enhances the South Waterfront historic identity as an industrial district and heightens it as a sustainable mixed-use district built off of its historic foundation. Reusing existing structures with modern building system technologies creates a new identity for the South Waterfront and for the city of Fall River as a progressive, clean, and historic place.

Beauty Petal

Rehabilitating the existing industrial structures in the South Waterfront district is an opportunity to educate the public of the industrial history of the city, the urban culture of the waterfront, and the building typology of the Typical New England Mill. Connecting to the history of the site can better integrate the historic landmarks and features of the site to the new construction and repurposed existing buildings. Sustainable design interventions applied to the existing structures are also an opportunity to educate the public on sustainable designs and how they can be applied to new and existing construction.

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New Construction in Compliance with the Living Building Challenge 4.0

After the demolition phase of the masterplan, new construction is introduced. The majority of new construction is built along Anawan St, transforming the street into its main axis through the district. Anawan St. leads directly to Downtown Fall River and is a natural location for more urban development. The new construction ends just before the waters edge, leaving an open space for landscape design and for the community to share.

Based on the floor plans and structure of existing buildings, it is suggested that existing buildings are used for commercial, business, or community use. The introduction of new construction is an opportunity to provide residnetial prorgam and additional commercial space on ground floors.

The shape of new buildings are based on program requirements and building system efficiency. The buildings designed for residential or office use form an L shape design that maximizes access to natural daylight and ventilation while minimizing dark and poorly ventilated building centers. The buildings intended for industrial use provide large open floor plans and simple designs that can easily accommodate industrial program.

Design ordinances can be put in place that outline acceptable building height, material use, and overall building design. For the South Waterfront district, it is important that new construction accents and celebrates existing buildings. For this purpose, it is recommended for new construction to use brick, wood, steel and metal materials in their design, and have clean geometry and for their facades. Ample fenstration is also recommended to improve the relationship between interior and exterior spaces.

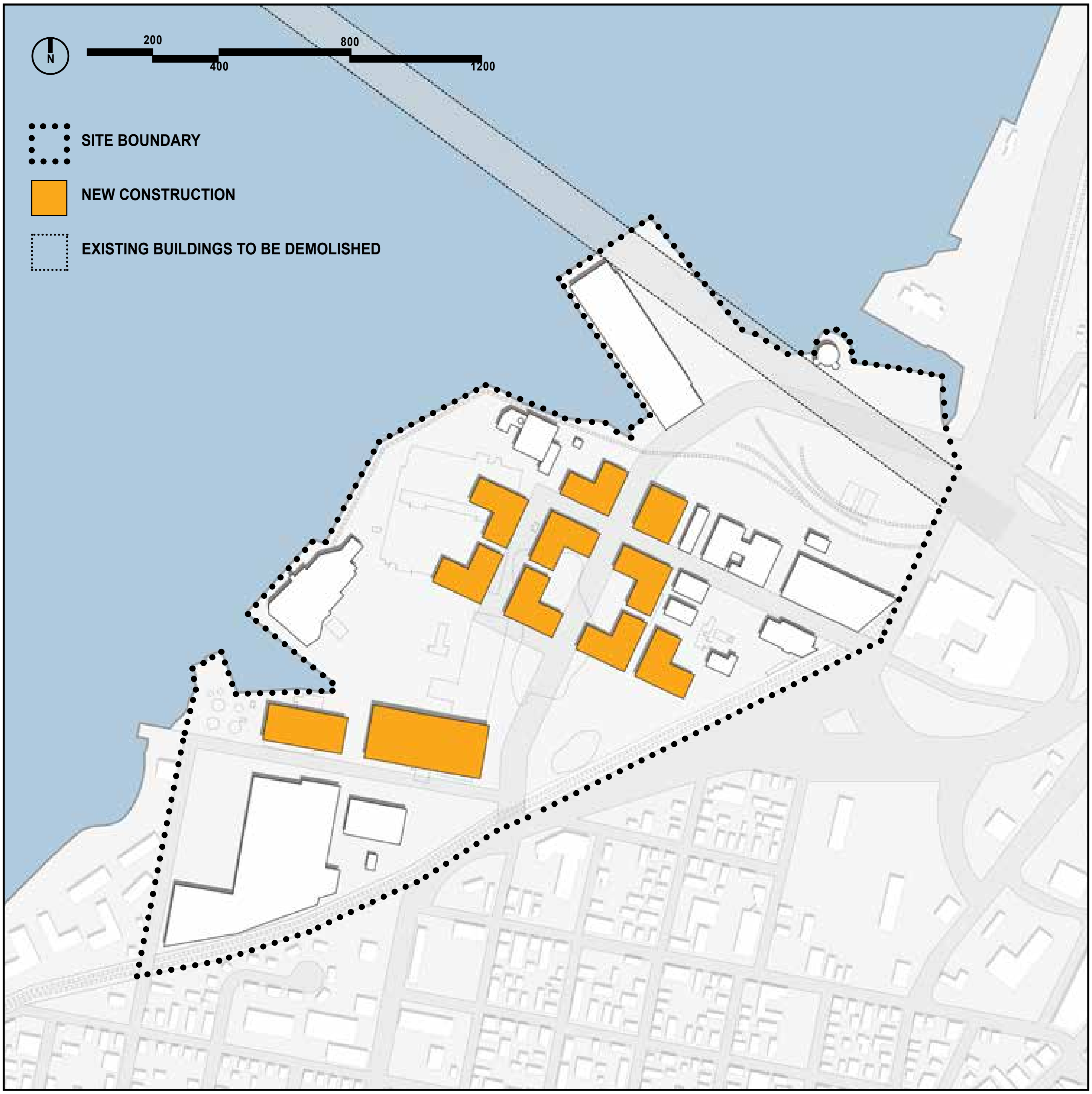
Figure 4.2.8 Fitzco Momentum Office (Source: Gensler)

Figure 4.2.9 South Philidelphia Shopping Center Redevelopment (Source: South Philly Review)

Figure 4.2.10 Materials List for New Construction (Source: Morgan Warner)

Masonry Brick Structure and Veneer | Heavy Timber and Wood Veneer | Steel Structure | Metal Cladding

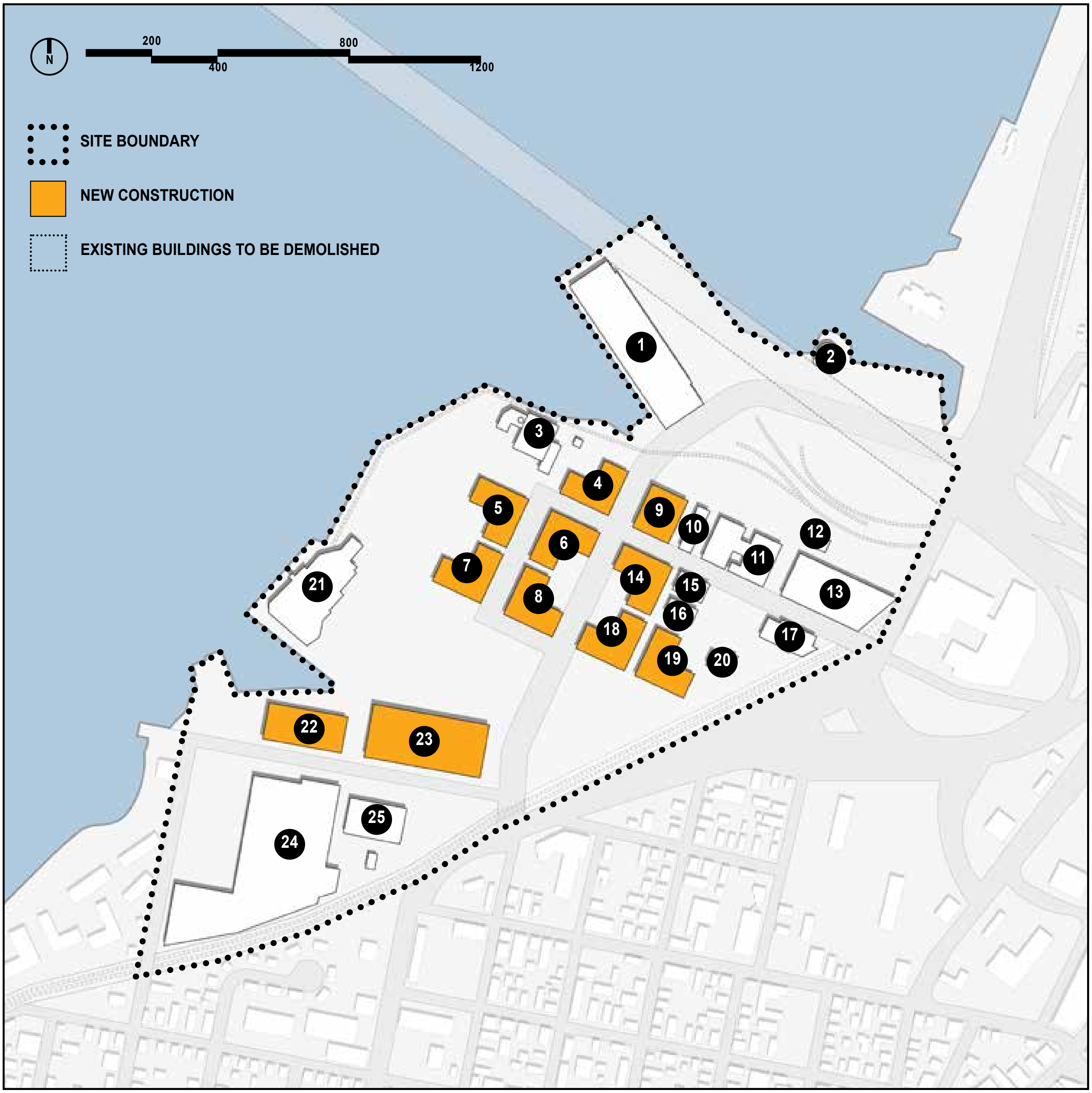
Figure 4.2.11 New Construction Map (Source: Morgan Warner)



Masterplan Program

#	FOOTPRINT	TOTAL BUILDING	BUILDING HEIGHT	INDUSTRIAL	OFFICE	RETAIL	RES.
1	100,830	100,830	-	X	-	-	-
2	4,100	8,200	-	-	-	X	-
3	26,250	78,750	-	-	X	-	-
4	20,000	60,000	-	X	X	X	-
5	22,500	67,500	-	-	-	X	X
6	22,500	67,500	-	-	-	X	X
7	22,500	67,500	-	-	-	X	X
8	22,500	67,500	-	-	-	X	X
9	20,800	62,400	-	-	X	X	-
10	7,200	21,600	-	-	X	X	-
11	34,100	136,400	-	-	X	X	-
12	3,450	6,900	-	-	X	-	-
13	53,550	214,200	-	-	X	X	-
14	22,500	67,500	-	-	X	X	-
15	7,700	23,100	-	-	X	-	-
16	4,500	4,500	-	-	X	-	-
17	17,100	51,300	-	-	X	X	-
18	22,500	67,500	-	-	X	X	-
19	22,500	67,500	-	-	X	-	-
20	4,250	8,500	-	-	X	-	-
21	49,025	98,050	-	X	-	-	-
22	37,500	75,000	-	X	-	-	-
23	72,000	144,000	-	X	-	-	-
24	186,000	186,000	-	X	-	-	-
25	25,000	50,000	-	X	-	-	-
Total	*830,855*	*1,802,230*	-	-	-	-	-
Total Existing	*523,055*	*988,330*	-	-	-	-	-
Total New Const.	*307,800*	*813,900*	-	-	-	-	-

Figure 4.1.12 Masterplan Proposal Building Inventory Map (Source: Morgan Warner)



Material Petal

In addition to a list of acceptable materials and design rules, new construction must only use non-Red List materials in all construction methods and designs. Red-List materials or chemicals contain toxicities that are harmful to the enviornment and human health. The list includes:

- Alkylphenols
- Absestos
- Bisphenol A (BPA)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethylene
- Chlorobenzenes
- Chlorofluorocarbons (CFCs) and Hydrocholorfluorocarbons (HCFCs)
- Chloroprene (Neoprene)
- Chromium 6
- Clorinated Polyvinyl Chloride (CPVC)
- Formaldehyde (added)
- Halogenated Flame Retardants (HFRs)
- Lead (added)
- Mercury
- Polychlorinated Biphenyls (PCBs)
- Perfluorinated Compounds (PFCs)
- Phthalates
- Polyvinyl Chloride (PVC)
- Polyvinylidene Chloride (PVDC)
- SHort Chain Chlorinated Paraffins
- Wood treatments containing Creosote, Arsenic, or Pentachlorophenol
- Volatile Organic Compounds (VOCs) in wet-applied products

As a part of the Living Economy Imperative under the Materials Petal, all new construction must source new material from local manufacturers and must adhere to material sourcing restrictions:

- 20% or more of the materials construction budget must come from within 500 kilometers of constructions site
- An additional 30% of the materials construction budget must come from within 1000 kilometers of the construction site or closer
- An additional 25% of the materials construction budget must come from within 5000 kilometers of the construction site
- 25% of materials may be sourced from any location.

Place Petal

The new construction phase of the masterplan aims to shape the way the South Waterfront is utilized by the city and by the community. The two main axis that go through the district are Anawan St and Water St. Anawan St. leads directly to the waterfront from Fall River's downtown district and is the major connector between the city center and the waterfront. The city of Fall River has outlined their need for a greater connection between these two districts. The construction phase builds up its urban development along Anawan St, creating a mixed use center.

The new construction phase has strategically left open exterior space for the public to enjoy. New construction has allowed for the waterfront along Battleship Cove to be cleaned up and used as park space. The State Pier has been opened up to the public and used as an anchor for the existing boardwalk that extends North along the waterfront. The open space preserved along the State Pier allows for further enjoyment of Battleship Cove from a new vantage point and showcases Battleship Cove as the first site for visitors to see who are coming off of the Newport and Block Island Ferries. The waterfront at the end of Anawan St is left open for the public to enjoy. The site was previously private industrial land congested with buildings and industrial equiptment. Giving the waterfront back to the public is a direct initiative set forth by this masterplan to transform this district into a community driven place, as is left as park space in case of flood or sea level rise.

The new construction follows a list of design requirements that ensures each new building respects the character of the existing buildings while still allowing for creativity and innovation. Material choice is outlined in the new construction phase as what is acceptable, necessary, and restricted. The current character of the district is preserved and enhanced. The interior spaces are spacially and visually connected with the exterior spaces. The heights and sizes of new construction is outlined to prevent overdevelopment and to ensure that all buildings have the opportunity for sustainable intervention, including natural daylight, natural ventilation, and solar power.

Beauty Petal

The Anawan St axis that the new development is built along preserves the line of site to the waterfront from Downtown Fall River. Moments of open space along the waterfront celebrate the water and the historic landmarks currently there., including Battleship Cove, Heritage Park, and The Carosel.

Equity Petal

Included in the new construction phase is the introduction of residential zoning to the South Waterfront district. The resdiential program is to provide Affordable Housing at a range of prices to provide housing opportunities to all so that everyone has the chance to experience and benefit from this new, sustainable district.

District Solar Energy Production, Installation, and Distribution

Shared district energy is a strategy that connects all buildings and landscapes in a designated area to one shared energy system where the energy is produced on site. In the case of the South Waterfront district of Fall River, MA, solar energy provides the most flexible options for energy production. Unlike wind or tidal energy, solar energy has the opportunity to be installed on building rooftops - minimizing the real estate taken away from new construction that may contribute to housing, office space, retail, or any other program that may boost the city's economy. Solar panels are also available at a range of affordability, size, installation requirements. Compared to wind or tidal energy, solar energy has the easiest installation process, is the least invasive to install, and can more easily be maintained.

One benefit of shared district solar energy versus independent building solar is the relinquishment of financial and maintenance responsibilities. In shared district solar energy systems, either the city or a third party would have ownership and responsibility of the solar equipment and the energy they produce. This provides the opportunity for building owners, as well as individual business and housing owners/renters, who cannot afford solar to financially benefit from the use of clean renewable energy.

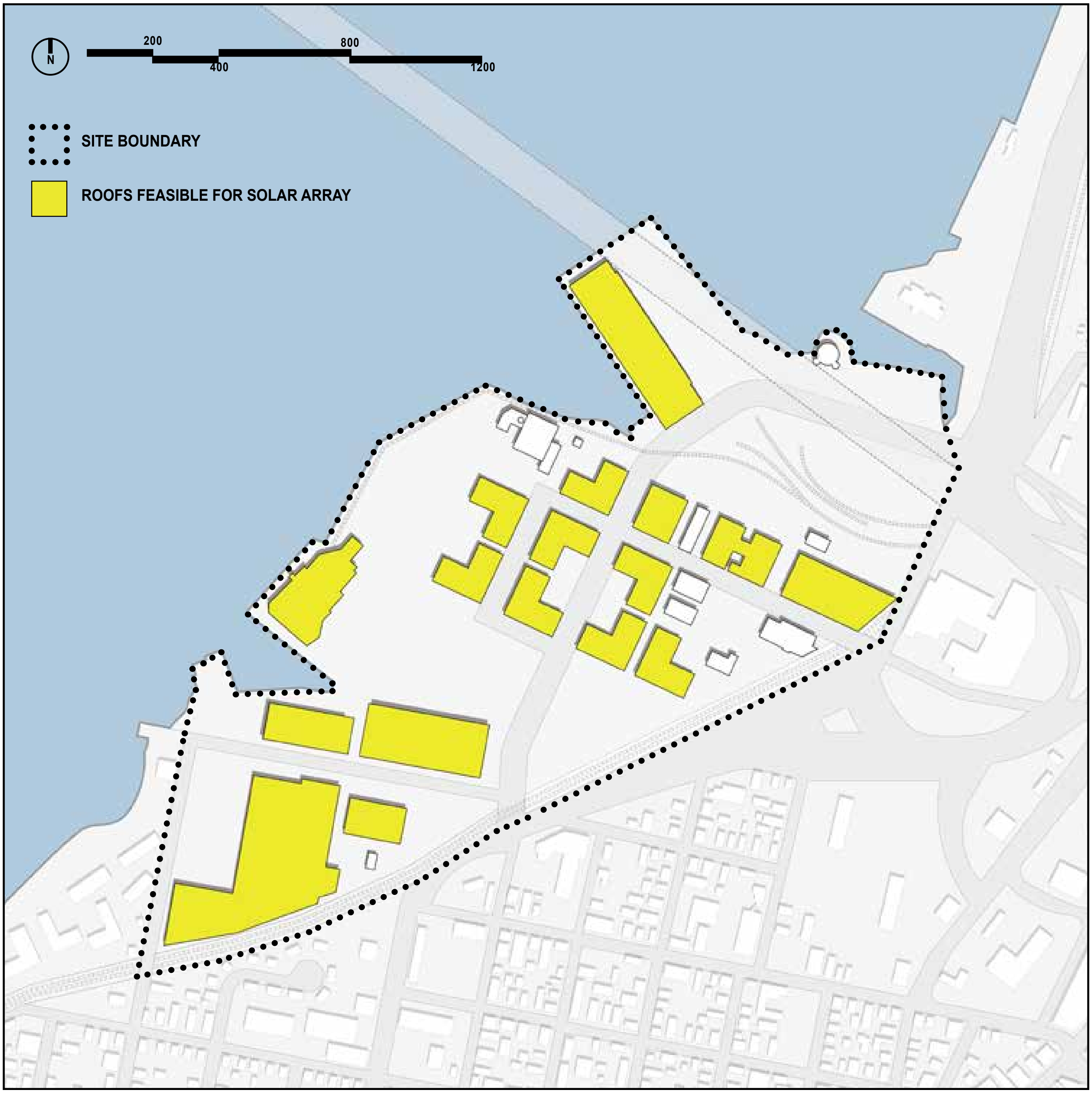
Figure 4.2.13 Three Types of Solar Arrays (Source: Solar Gains)

Monocrystalline are made of the purest silicon, are more expensive, and more conductive than Polycrystalline, which are made more simply. Thing-Film solar cells are the least conductive but are the most versatile because of their flexibility and customizable sizes.

Figure 4.2.14 Solar Panels on Existing Roof; (Source: Morgan Warner)

This diagram illustrates the aerial view of solar panels when installed on the roofs of existing buildings.

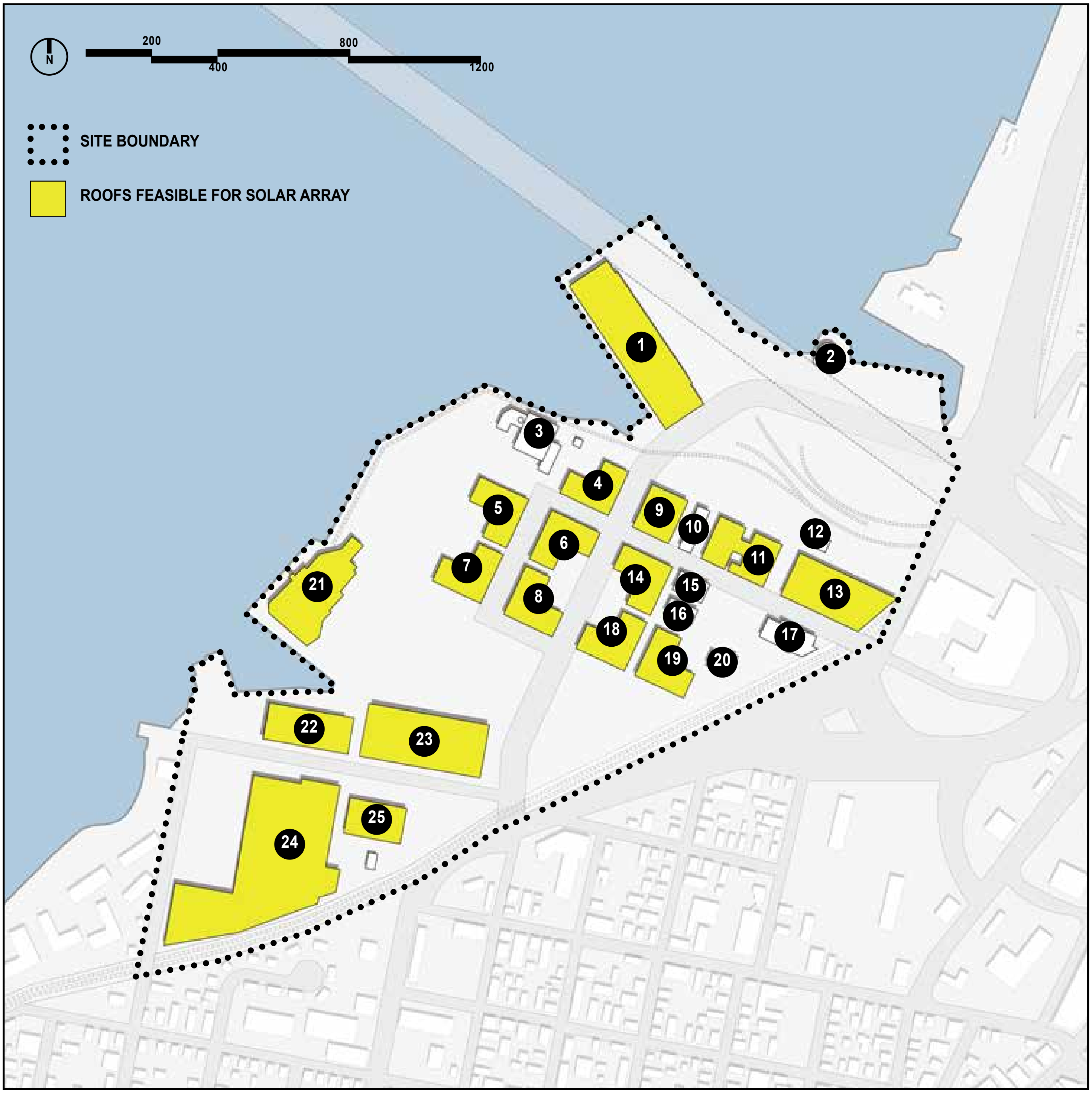
Figure 4.2.15 Roofs Feasible for Solar Array Map (Source: Morgan Warner)



Masterplan Program Inventory

#	FOOTPRINT	PV ARRAY	TOTAL BUILDING	INDUSTRIAL	OFFICE	RETAIL	RES.
1	100,830	100,830	100,830	100,830	0	0	0
2	4,100	0	8,200	0	0	8,200	0
3	26,250	0	78,750	0	78,750	0	0
4	20,000	20,000	60,000	20,000	40,000	20,000	0
5	22,500	22,500	67,500	0	0	22,500	45,000
6	22,500	22,500	67,500	0	0	22,500	45,000
7	22,500	22,500	67,500	0	0	22,500	45,000
8	22,500	22,500	67,500	0	0	22,500	45,000
9	20,800	20,800	62,400	0	41,600	20,800	0
10	7,200	0	21,600	0	14,400	7,200	0
11	34,100	34,100	136,400	0	102,300	34,100	0
12	3,450	0	6,900	0	6,900	0	0
13	53,550	53,550	214,200	0	160,650	53,550	0
14	22,500	22,500	67,500	0	45,000	22,500	0
15	7,700	0	23,100	0	23,100	0	0
16	4,500	0	4,500	0	4,500	0	0
17	17,100	0	51,300	0	51,300	0	0
18	22,500	22,500	67,500	0	45,000	22,500	0
19	22,500	22,500	67,500	0	45,000	22,500	0
20	4,250	0	8,500	0	8,500	0	0
21	49,025	49,025	98,050	0	98,050	0	0
22	37,500	37,500	75,000	75,000	0	0	0
23	72,000	72,000	144,000	144,000	0	0	0
24	186,000	186,000	186,000	186,000	0	0	0
25	25,000	25,000	50,000	50,000	W0	0	0
Total	*830,855*	*756,305*	*1,802,230*	*555,830*	*765,050*	*301,350*	*180,000*
Total Existing	*523,055*	*448,505*	*988,330*	*336,830*	*548,450*	*103,050*	*0*
Total New Const.	*307,800*	*307,800*	*813,900*	*219,000*	*216,600*	*198,300*	*180,000*

Figure 4.2.16 Roofs Feasible for Solar Array Inventory Map (Source: Morgan Warner)



To calculate possible energy savings, all scenarios of energy use and energy production must be calculated and compared. The Living Building Challenge 4.0 has different energy requirements for existing construction and new construction. Existing construction requires that the building's EUI be 50% of the National Baseline EUI. New construction requires that the building's EUI be 70% of the National Baseline EUI. This study compares the districts total EUI for three scenarios: 1) All buildings remain at the National Baseline EUI, 2) Only new construction meets the LBC4 energy requirements, and 3) All buildings meet the LBC4 energy requirements.

A benefit of shared solar energy on the district scale is that a project can add more solar arrays overtime based on real estate availability, project phases, and financial requirements. This study calculates the possible solar energy production of five different solar array scenarios: 1) Solar panels on the roofs of new construction only, 2) Solar panels on the roofs of existing buildings feasible to support solar panels (outlined in Figure X), 3) Solar panels on the roofs of all existing buildings (this would require new roofs for the buildings that cannot currently support solar panels), 4) Solar panels on the roofs of all feasible buildings, and 5) Solar panels on all buildings.

The results of this study conclude that there are two possible scenarios where the district creates more energy than is used. In these scenarios, all buildings must fulfill the requirements of the LBC4. The first solar scenario has solar panels on all feasible buildings outlined in Figure X. The second solar scenario has solar panels on all buildings. Both of these options require the most intervention and the highest number of solar panels, however, both scenarios can be achieved over time step by step, and it is encouraged that projects that pursue district solar have a phase by phase plan of solar panel installation and building energy use reduciton.

Total Building EUI (kBTU/yr)

= (A1 x B1) + (A2 x B2) + (A3 x B3) + (A4 x B4)

A1 = Industrial SqFt
A2 = Office SqFt
A3 = Retail SqFt
A4 = Residential SqFt

B1 = Industrial EUI
B2 = Office EUI
B3 = Retail EUI
B4 = Residential EUI

(Source: EnergyStar; US Climate Data)

EUI By Building Program - *(Source: EnergyStar)*

Building Program	National Baseline	LBC4 (Existing)	LBC4 (New)
Industrial	84	42	25.2
Office	53	26.5	15.9
Retail	51	25.5	15.3
Residential	60	30	18

kBTU-yr Produced from PV Array

= PV Net x Solar Production

Solar Production for Fall River, MA = 94.41 kBTU/sqft/yr
PV Net = PV Gross x 0.9
PV Gross = Roof SqFt

(Source: EnergyStar; National Renewable Energy Laboratory)

Figure 4.2.17 Ideal Angles of Solar Arrays for Massachusetts; (Source: Morgan Warner)

This diagram represents the ideal angles for solar arrays throughout the year as well as the option for a Fixed-All-Year angle.

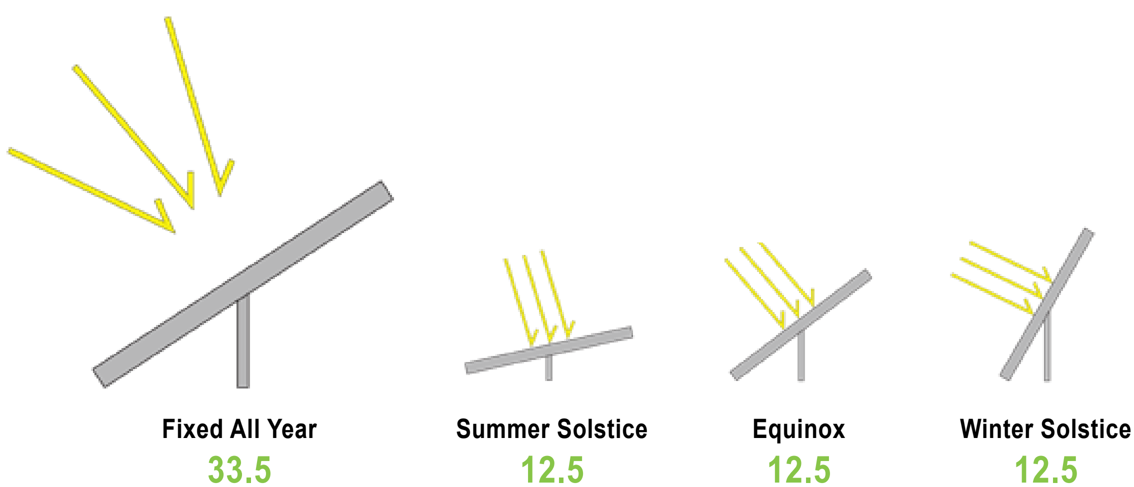
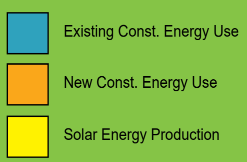
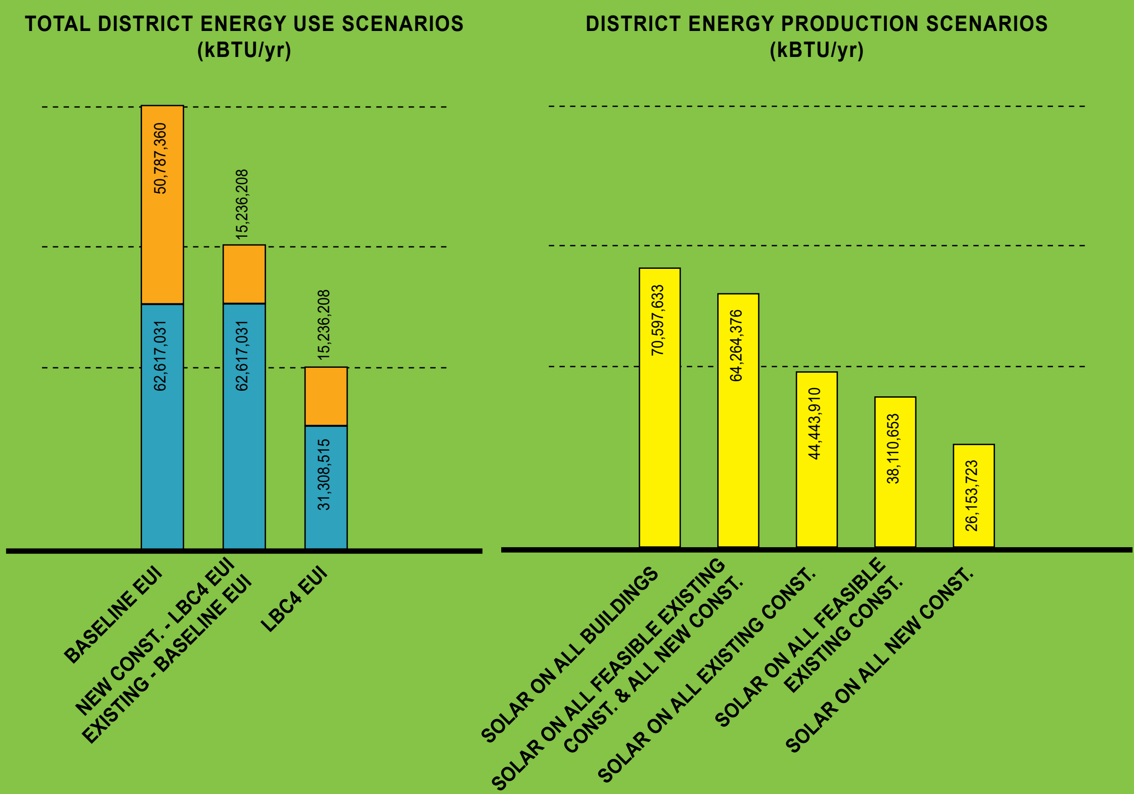


Figure 4.2.18 South Waterfront, Fall River, MA, Energy Use and Production (Source: Morgan Warner) These graphs represent the scenarios for possible district energy use and district energy production.





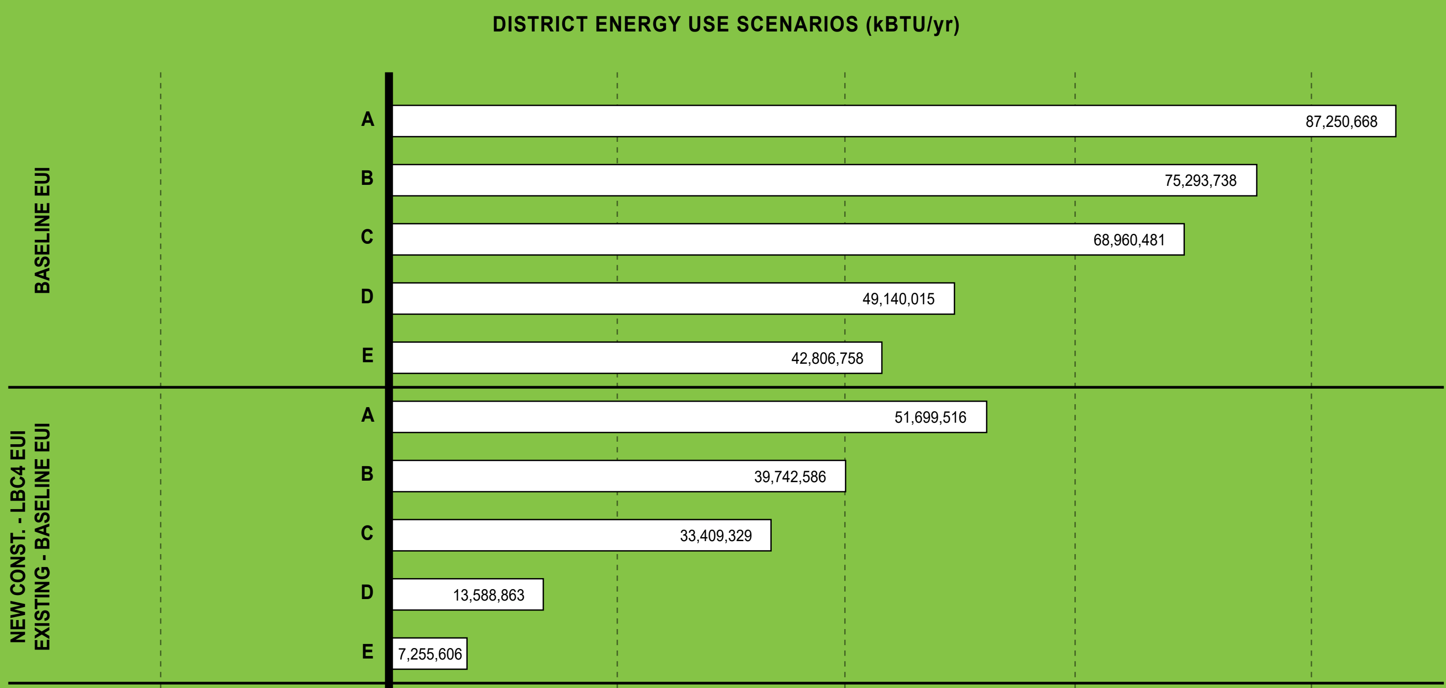


Figure 4.2.19 District Energy Use Scenarios (Source: Morgan Warner) This graph represents the district energy use scenarios for the proposed masterplan based on building EUI and number of solar arrays. The three building EUI scenarios are: 1) All buildings remaining at the National Baseline EUI, 2) All existing construction to remain at the National Baseline EUI with new construction following the Living Building Challenge 4.0 EUI requirements, and 3) All buildings following the Living Building Challenge 4.0 EUI requirements. The five solar array scenarios are: A) Solar arrays on new construction only, B) Solar arrays on feasible existing construction only, C) Solar arrays on all existing construction only, D) Solar arrays on all viable existing construction and new construction only, and E) Solar arrays on all buildings.

Energy Petal

For the proposed masterplan of the South Waterfront District of Fall River, MA to meet the Net Zero Energy initiative for the Living Building Challenge 4.0, 1) All existing buildings must reduce their EUI by 50%, 2) All new construction must reduce their EUI from the National Baseline by 70%, and 3) Solar arrays must be installed on either all viable building roofs or all building roofs.

Place Petal

The South Waterfront District of Fall River, MA is currently known for its historic industry, which has shaped its identity as a waterfront New England town. The city's industry is credited for the towns creation, as well as offering jobs to its residents during the industrial age. However, Fall River's industry is faulted with ecological pollution, bankrupcy, and current lack of community engagement. The introduction of Shared District Solar Energy Production is an opportunity for Fall River to invest into the clean, renewable energy industry and reshape and rebrand the city's image as a sustainable and modern city. Having energy that is produced directly on site, shared among the district, and sold back to the grid is an opportunity for industry to give back to the community and improve the city's economy as it once did.

Large solar arrays are most commonly installed either on the ground or on building rooftops. The advantages of having solar arrays on the ground are that they are more easily adjusted for sun angles, can be more easily maintained, and do not require any coordination with building structure or system equipment. However, the disadvantage of ground solar is the real estate taken away from the city for either urban development or community recreation space. In the case of Fall River, MA, it would be more beneficial to have large solar arrays installed on building rooftops. This insentive would not take away real estate from the development of this district that the city has outlined in the Fall River Waterfront Urban Renewal Plan, and would utilize unused rooftop space - making district and building programming more efficient. With solar arrays on rooftops rather than the ground, they will not distrub or subtract from user experience throughout the district, while still being visible from highway and bridge traffic around the site.

Equity Petal

Shared District Solar Energy presents the opportunity to provide all buildings, owners, and renters in the district with the benefits of using clean, renewable energy produced on site. These benefits include reduced energy bills, reduced carbon emissions, and a smaller ecological footprint. Sevreal factors may prevent a building, business, or resident from purchasing and installing solar arrays on their own - including the upfront financial cost, long term maintenance cost, building roof shape or roof area availability. District solar is an initiative that removes these factors and provide equal opportunity for energy savings.

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District Rainwater Collection and Distribution

In addition to Shared District Solar Energy Production, Shared District Rainwater Collection provides the opportunity for all buildings in the district to utilized recycled rainwater collected off of solar panels and buidling roofs. After the installation of solar panels on building rooftops, building rainwater capture systems can collect up to 80% of rainwater off of solar panels and redirect the rainwater into a shared district cistern. The cistern(s) can be placed either under ground, above ground, or in a designated building facility. The size and number of cisterns can be measured based on estimated rainwater capture and the number of solar panels installed.

As of Fall 2019, The Commonwealth of Massachusetts do not have any statutes or regulations against rainwater harvest for non-potable use. Harvested rainwater can be used for all non-potable water uses - including irrigation, toilet flushing, or laundry. To date, the Bullitt Center is only one building in the United States that has successfully turned harvested rainwater into potable drinking water[58]. The District Rainwater Collection and Distribution infrastructure can be sized and calculated to prepare the district for 100% water use met with rainwater harvest for when future building technology that has perfected rainwater filtration for potable uses.

To calculate possible potable water savings, all scenarios of water use and rainwater harvest must be calculated and compared. The Living Building Challenge 4.0 requires that all buildings use 100% non-potable water for non-potable uses with the inclusion of high effiency plumbing and fixtures. This study compares the districts total WUI for three scenarios: 1) All buildings remain at the National Baseline WUI, 2) Only new construction meets the LBC4 water requirements, and 3) All buildings meet the LBC4 water requirements. This study calculates the possible rainwater collection off of solar arrays of five different solar array scenarios: 1) Solar panels on the roofs of new construction only, 2) Solar panels on the roofs of existing buildings feasible to support solar panels (outlined in Figure 4.2.16), 3) Solar panels on the roofs of all existing buildings (this would require new roofs for the buildings that cannot currently support solar panels), 4) Solar panels on the roofs of all feasible buildings, and 5) Solar panels on all buildings.

The results of this study conclude that there are three possible scenarios where the district collects more water than is used - when all buildings fulfill the LBC4 WUI requirements and there are solar arrays on at least all feasible buildings.

Total Building WUI (kGal/sqft/yr)

= ((A1 x B1) + (A2 x B2) + (A3 x B3) + (A4 x B4)) / 1000

A1 = Industrial SqFt — B1 = Industrial WUI
A2 = Office SqFt — B2 = Office WUI
A3 = Retail SqFt — B3 = Retail WUI
A4 = Residential SqFt — B4 = Residential WUI

(Source: EnergyStar; US Climate Data)

WUI By Building Program (gal/sqft/yr) - *(Source: EnergyStar)*

Building Program	National Baseline	LBC4
Industrial	4	-
Office	11	5.1
Retail	5	-
Residential	42	20.1

kGal of Rainwater Collected off of PV Array

= (PV Net x 0.8 x A1 x 144) / 231 / 1000

A1 - Annual Rainfall for Fall River, MA = 48 in/yr
PV Net = PV Gross x 0.9
PV Gross = Roof SqFt

(Source: EnergyStar; US Climate Data)

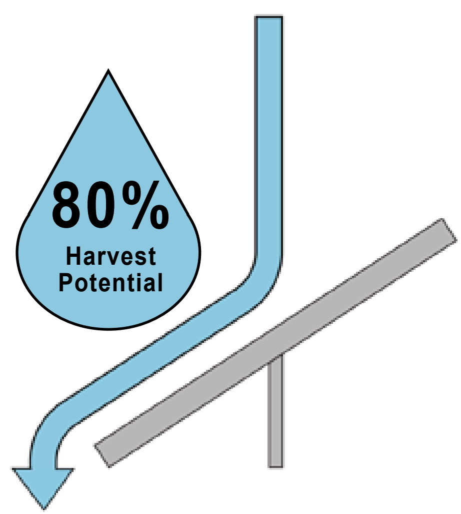


Figure 4.2.20 Solar Array Potential for Rainwater Harvest (Source: Morgan Warner)

Figure 4.2.21 Roofs Feasible for Solar Array and Rainwater Collection Map (Source: Morgan Warner)

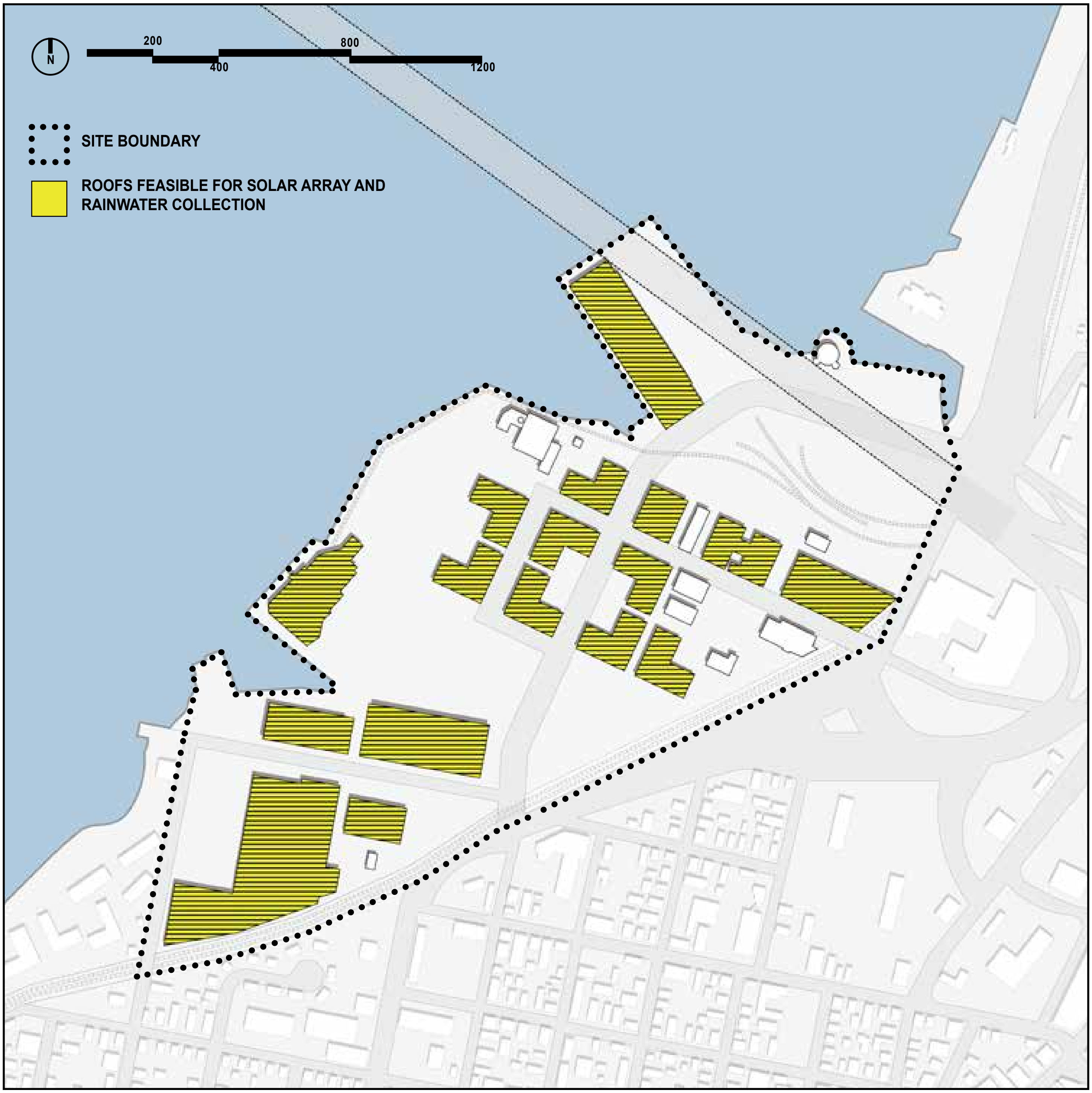


Figure 4.2.22 South Waterfront, Fall River, MA, Water Use and Collection (Source: Morgan Warner) These graphs represent the scenarios for possible district water use and district rainwater collection potential off of solar panels.

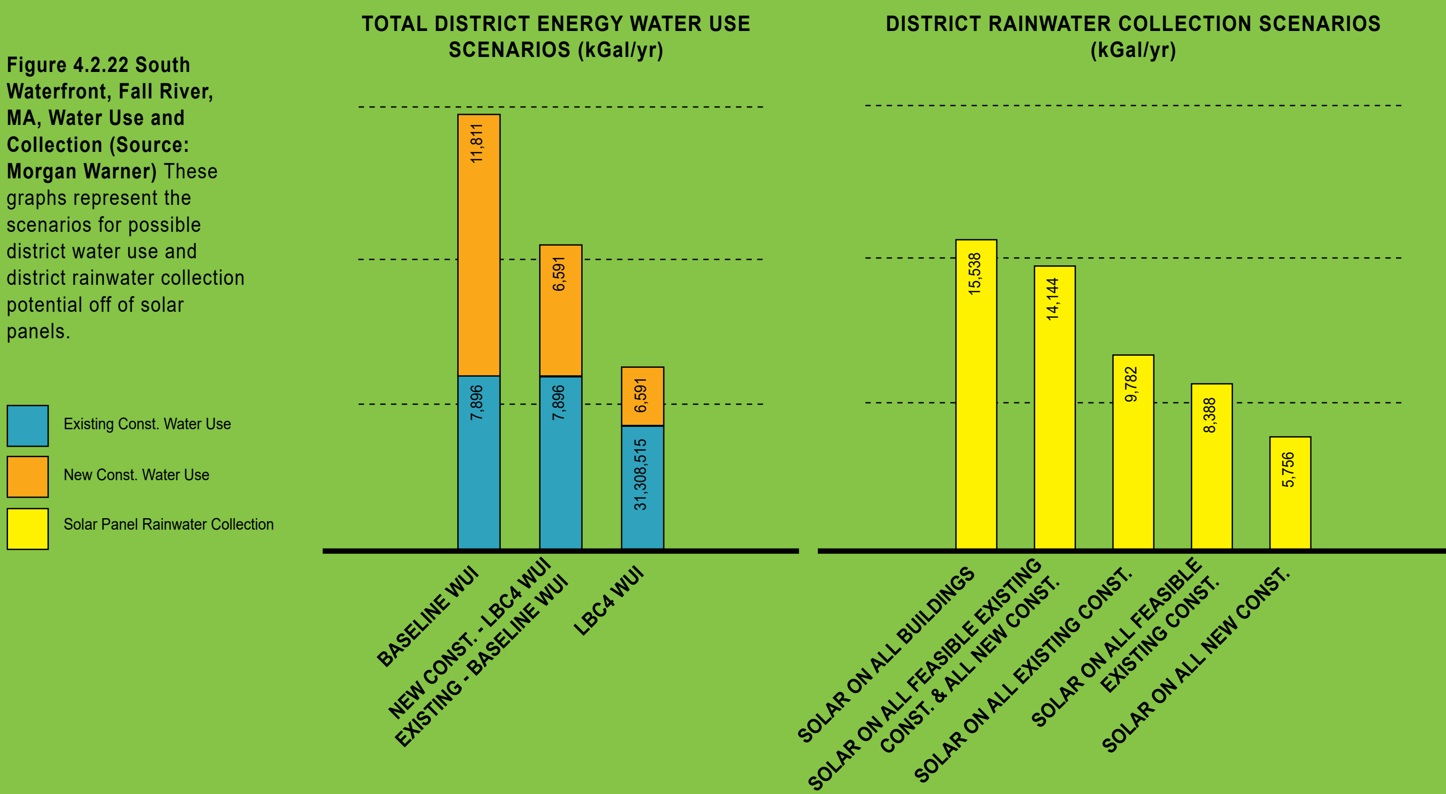


Figure 4.2.23 District Water Use Scenarios (Source: Morgan Warner) This graph represents the district water use scenarios for the proposed masterplan based on building WUI and number of solar arrays. The three building wUI scenarios are: 1) All buildings remaining at the National Baseline WUI, 2) All existing construction to remain at the National Baseline WUI with new construction following the Living Building Challenge 4.0 WUI requirements, and 3) All buildings following the Living Building Challenge 4.0 WUI requirements. The five solar array scenarios are: A) Solar arrays on new construction only, B) Solar arrays on feasible existing construction only, C) Solar arrays on all existing construction only, D) Solar arrays on all viable existing construction and new construction only, and E) Solar arrays on all buildings.

Place Petal

The collection of rainwater on the district scale introduces the opportunity for renewable resource use as well as responsible stormwater management. The cisterns used for storing the harvested rainwater are sized according to estimated harvest amount. These cisterns can be oversized for future expansion of the system or have added cisterns as needed. During collection, if the cisterns become full, the extra rainwater can be responsibly filtered back into the Earth - distributed evenly in the appropriate areas, or into the designated stormwater location of Firestone Pond.

The introduction of District Rainwater Collection and Distribution is an opportunity for Fall River to invest into clean and renewable resource use that will contribute to the reshaping and rebranding the city's image as a sustainable and self sufficient city. Having water that is harvested directly on site, shared among the district, and responsibly filtered back into the earth is an opportunity for industry to give back to the community, improve the district's ecological health, and improve the city's economy.

Water Petal

The goal of District Rainwater Collection and Distribution is to meet 100% of the district's water needs with harvested rainwater. This progam would capture rainwater, purify it as needed without the use of harmful chemicals, and distribute it in a closed loop system. It is currently illegal in the state of Massachusetts to use rainwater for potable uses, however, technology has already been created to filter rainwater and make it potable. For this thesis, it is assumed that this technology will one day be commercialized and commonly used. When the future allows for this technology to be generalized, the District Rainwater Collection and Distribution initiative will already have the infrastructure in place, sized, and ready to use. Similar to the Distirct Solar Initiative, the District Rainwater Collection and Distribution initiative can be built in phases over time.

Equity Petal

Shared District Solar Energy presents the opportunity to provide all buildings, owners, and renters in the district with the benefits of using clean, renewable water harvested on site. These benefits include reduced water bills, reduced carbon emissions, and a smaller ecological footprint. Sevreal factors may prevent a building, business, or resident from harvesting rainwater on their own - including the upfront financial cost, long term maintenance cost, building roof shape or roof area availability. District Rainwater Collection and Distribution is an initiative that removes these factors and provide equal opportunity for clean water usage and water conservation. The goal of the district wide rainwater capture is to conserve potable water as much as possible and utilize renewable and natural resources as efficient as possible.

Redesigned "Green Streets", Road Organization, and Parking Strategy

The indicated street paths represent locations of the the newly redesigned "Green Streets". These "Green Streets" offer 3-for-1 benefits:

1. Safety. The "Green Streets" introduce wider sidewalks and designated bike lanes that are separate from the designated vehicle lanes. The designated vehcile lanes are separated from the bike path and sidewalks by a physical barrier of vegetation. This separation creates a safer atmosphere for pedestrians and bicyclists to enjoy their travel.

2. Encouragement and Facilitation of Pedestrian and BIcycle Travel. The physical barrier of vegetation is made up of native New England plants that counteract noise and air pollution caused by vehicle traffic and make the streets more attractive to visitors and encourage pedestrian and bike travel.

3. Connection to Adjacent Districts. By extending the "Green Streets" into the adjacent districts throughout the city, those districts have a visual and physical connection to the waterfront - a specific goal outlined by Fall River, MA. The district also facilitates public transporation with an added bus stop and bike path that connects to the city's proposed bike path that weaves throughout the city's urban fabric.

In addition to accommodating for pedestrians and cyclists, the district has added small parking lots integrated into the urban design. This thesis acknowledges that the city's need for single occupancy vehicles will not dicipate over night. To accommodate for visitors and residents who prefer to have a vehicle, parking is made available throughout the site. All parking can be taken out if and when the South Waterfront finds little to no use for it and replace the parking lots with either field or buildings.

Figure 4.2.24 Landscape Materials; (Source: Land8)

The "Green Street" design has deliniated bicycle lanes and vehicle street parking separate from vehicle lanes. To support this separation, a change in material signifys the visitors of the appropriate circulation use in a way that is clear and more aesthetically pleasing than simple road paint. SImilar to the streetscape design, changing the materiality along the pedestrian walkways indicates the area's purpose and its type of circulation. For ease in mobility, seamless transitions between material are imperative - strollers and wheelchairs need to be able to navigate the walkways with ease, and visitors should not encounter seams in material that are tripping hazards.

Figure 4.2.25 Market Urban Design; (Source: Shop at Market Street)

One purpose of the "Green Streets" is to create a safer environment for bicyclists and pedestrians. Creating areas that are pedestrian only spaces take this initiative a step further by creating safe spaces for individuals to experience the exterior space without safety risk from circulation patterns.

Figure 4.2.26 Typical New England Trees; (Source: Morgan Warner)

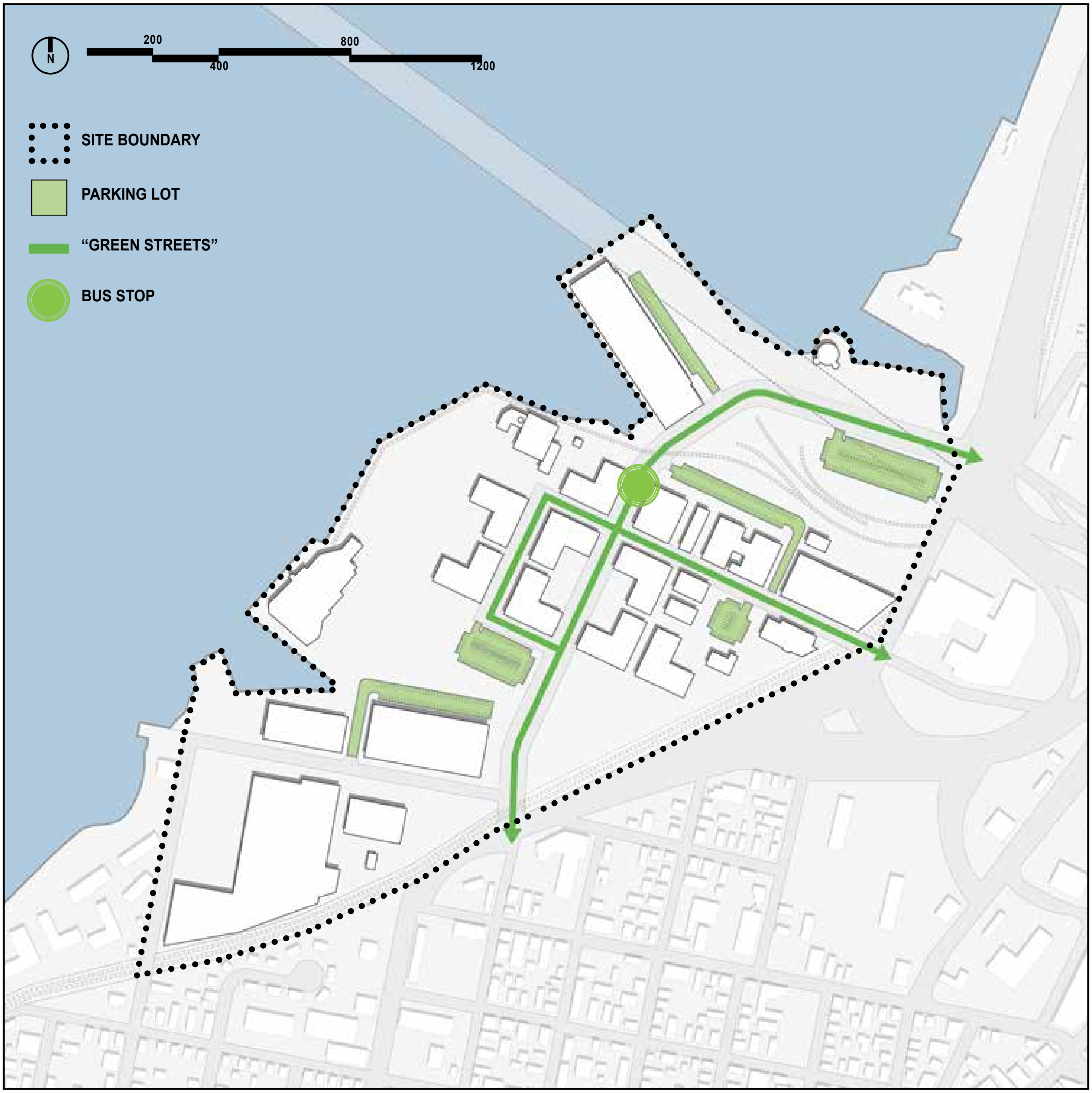
Typical New England trees come in a variety of sizes, colors, and vegetation needs. Due to Massachusett's full range of weather, all vegetation should be expected to have season transition changes .

Sweet Birch
(Betula lenta)

Tulip Poplar
(Liriodendron tulipifera)

Flowering Dogwood
(Corus florida)

Figure 4.2.27 Green Streets and Transportation Map (Source: Morgan Warner)



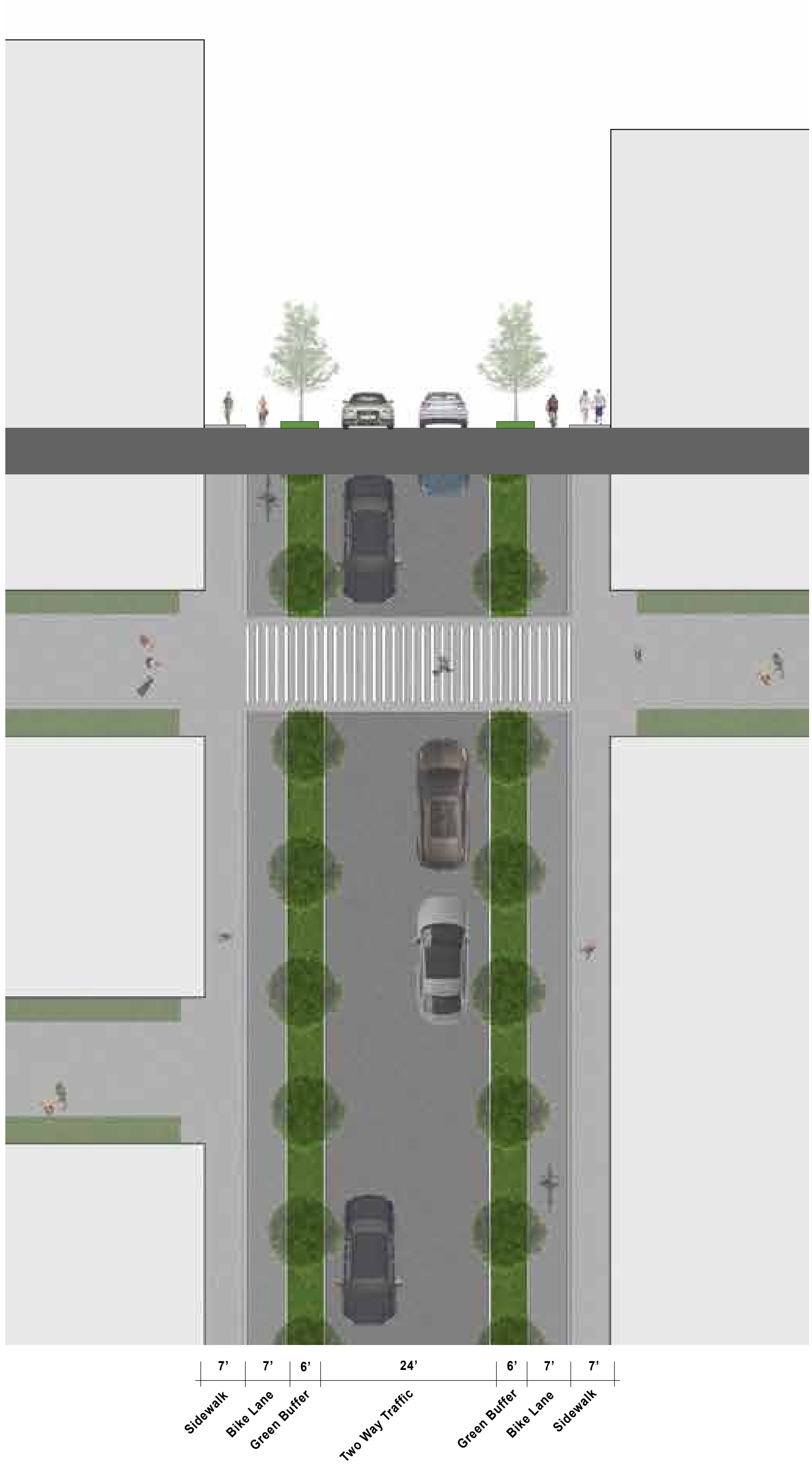


Figure 4.2.28 Green Street Layout A; (Source: Morgan Warner)

Layout A has a width of 64' and is meant to redesign Anawan St. and all other existing streets that are restricted to their existing street width. This layout of the "Green Street" redesign features wider sidewalks, added bike lanes, a green strip acting as a physica barrier between the vehicular lanes and all other modes of transportation, and has eliminated street parking.

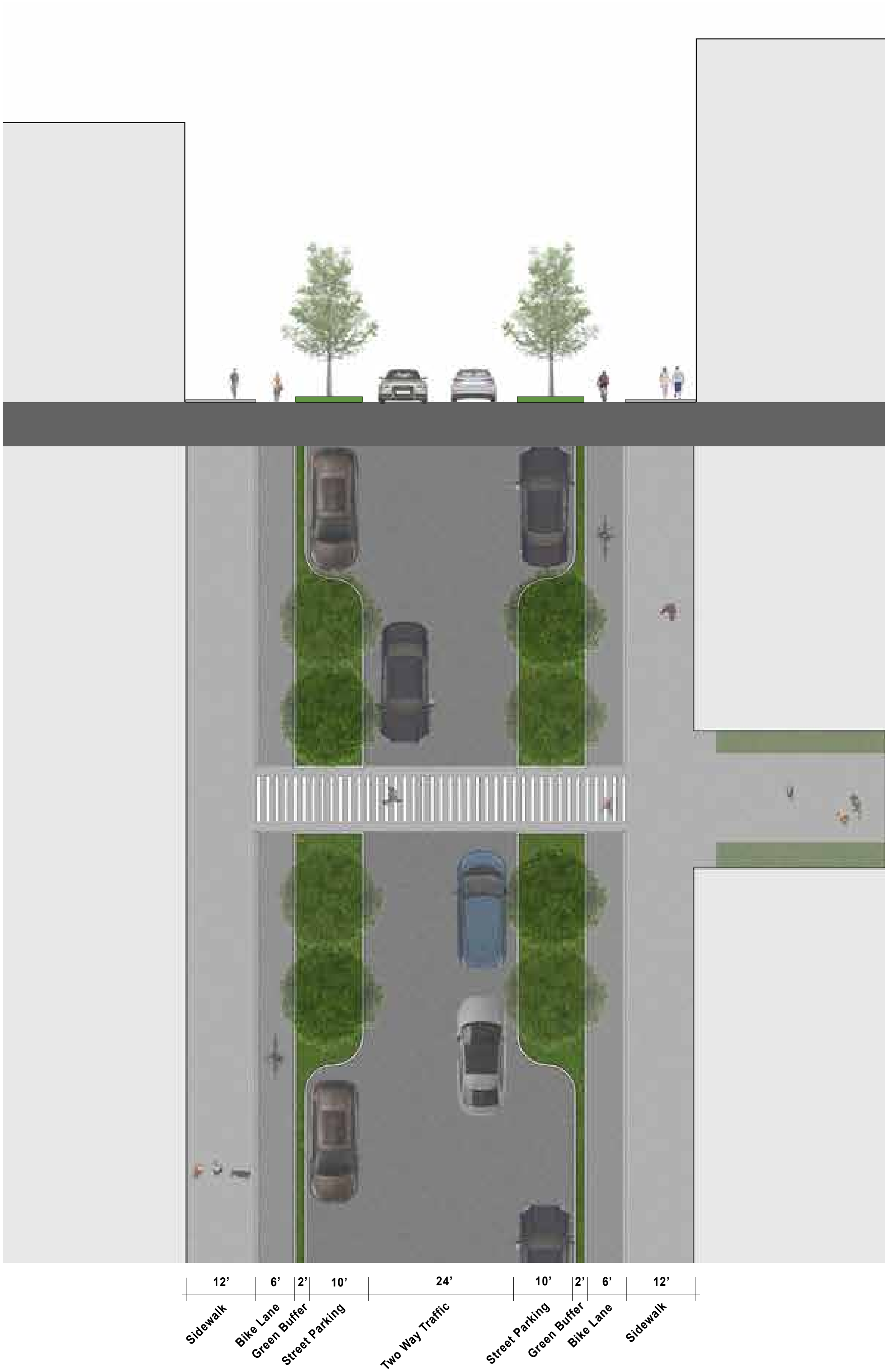
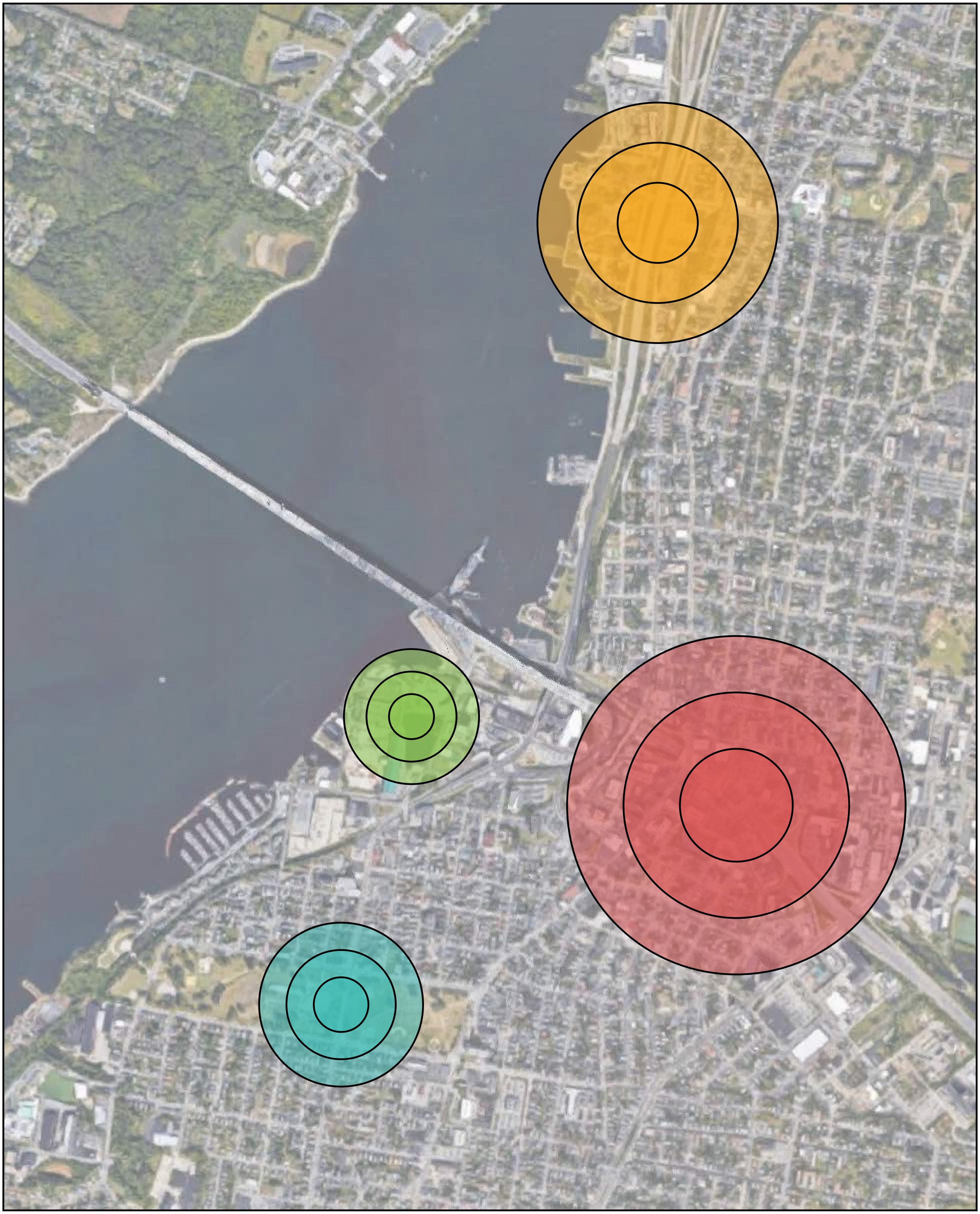


Figure 4.2.29 Green Street Layout B; (Source: Morgan Warner)

Layout B has a width of 84’ and is meant to redesign Water St. and all other existing streets that have the capability to extend their street width. This layout of the “Green Street” redesign features wider sidewalks, added bike lanes, a green strip acting as a physica barrier between the vehicular lanes and all other modes of transportation, and has reduced street parking.

Figure 4.2.30 Fall River Satelite Map (Source: Google Maps)



Place Petal

The “Green Streets” transform the urban fabric of the South Waterfront District from a hardscape, dull, and industrial site to a clean, vegetated, and healthy environment where visitors and residents can enjoy the exterior scenery. Part of rebranding the South Waterfront as a sustainable and clean district is the inclusion and appearance of environmental health. The vegetation and introduction to vibrant materials in place of concrete will attract visitors to the site and will steer the landscape design around ecological health. By extending these streets into the rest of the city, the streets themselves create their own identity of “place” and creates an experience through travel, rather than just facilitating a destination. This in turn will promote more active lifestyles through walking and bicycling that also reduce the city’s vehicle emissions and ultimate air pollution.

Health + Happiness Petal

The current state of urban landscape and urban design of the South Waterfront district is uninviting, harsh, and lackluster. In order to transform this district into a vibrant, community-driven place, visitors need to feel comfortable, excited, and safe. The “Green Street” design supports safety for all modes of transportation and integrates plant-buffers that elevate the streetscape’s aesthetic, promote positive mental and physical human health, and reduces pollution across the district.

Equity Petal

The ultimate goal of this masterplan is to give back the South Waterfront district to the Fall River community - this goal cannot be achieved unless access to the site is properly addressed. The “Green Streets” provide easier, safer, and more attractive travel routes for pedestrians, bicyclists, and vehicles. By extending these “Green Streets” outwards towards Downtown, the North Waterfront district, and Kennedy Park, the “Green Street” facilitates all modes of transporation so that visitors from all directions have a way to get there safely.

Beauty Petal

The added vegetation along the “Green Streets” elevate the aesthetic of the urban design of the district. The more attractive design promotes visitors to come to the South Waterfront and the positive experience of exterior space elevates the district’s location and other amenities.

Stormwater Management Infrastructure and Supportive Landscape Design

The street redesign offers the opportunity for to introduce new stormwater management infrastructure and landscape design that supports stormwater management. The design of the street layout is naturally sloped downward towards the waterfront. This characteristic of the district allows for stormwater drainage to flow naturally along the street layout. To take advantage of this site feature, stormwater infrastructure can be layed out underneath or beside the streets - avoiding any areas for urban development.

The "Green Street" introduces vegetation that acts as a barrier between modes of transportation and an aesthetic atmosphere. This vegetation can be utilized for stormwater management by designing each strip to become a bioswale. The bioswale will collect the water from the streets and naturally purify it as it absorbs into the Earth. This feature will help keep the ecology of the district's soil and ground water safe from pollutants and impurities. The excess water that flows into these bioswales will be redirected to Firestone Pond through storm drains underneath the bioswales.

For the purpose of urban development, Firestone Pond has been relocated and shrunk in size. With stormwater management in junction with District Rainwater Collection, it is not required for the pond to be as large as it currently is.

To aid in flood management, the hardscape surfaces of the district must also allow for water to be reabsorbed into the Earth. Permeable pavers can be utilized where there is parking, pedestrian walkways, and bicycle lanes. These pavers rest more delicately on the ground than poured concrete, and lays ontop of loose aggrigate. Their construction design prevents water puddling, keeping pedestrians and bicyclists safe as they travel and maintain an even distribution of water across the district. For the vehicular streets, concrete with larger aggrigate can be used for the same purpose. The large arggrigate create airspace in the mixture which allows water to flow through it. This will give the same effect to street puddling as permeable pavers, but is cheaper and more easily maintained than pavers.

Figure 4.2.31 Stormwater Management Bioswale Design (Source: Morgan Warner)

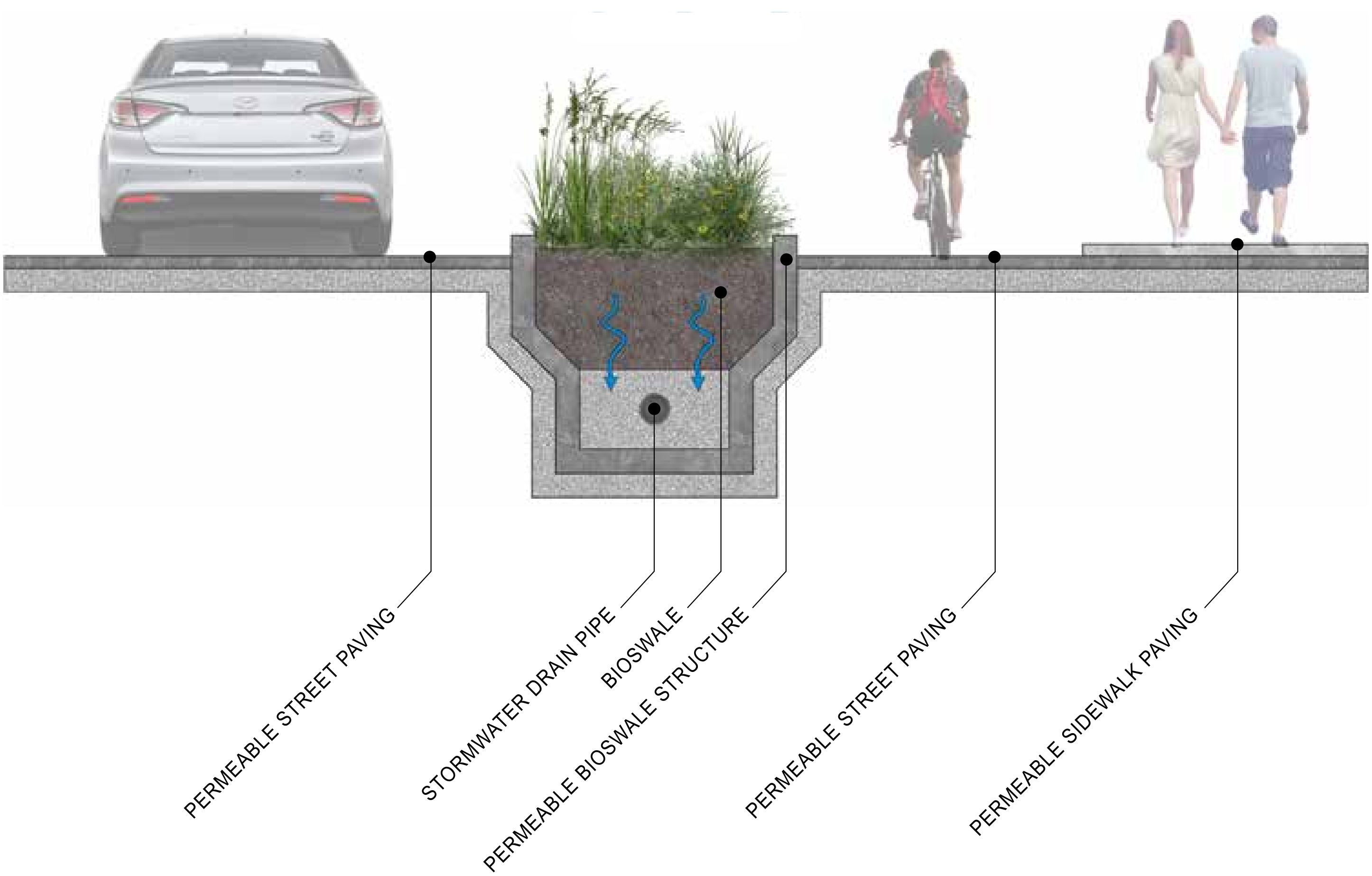


Figure 4.2.32 Stormwater Management Map (Source: Morgan Warner)

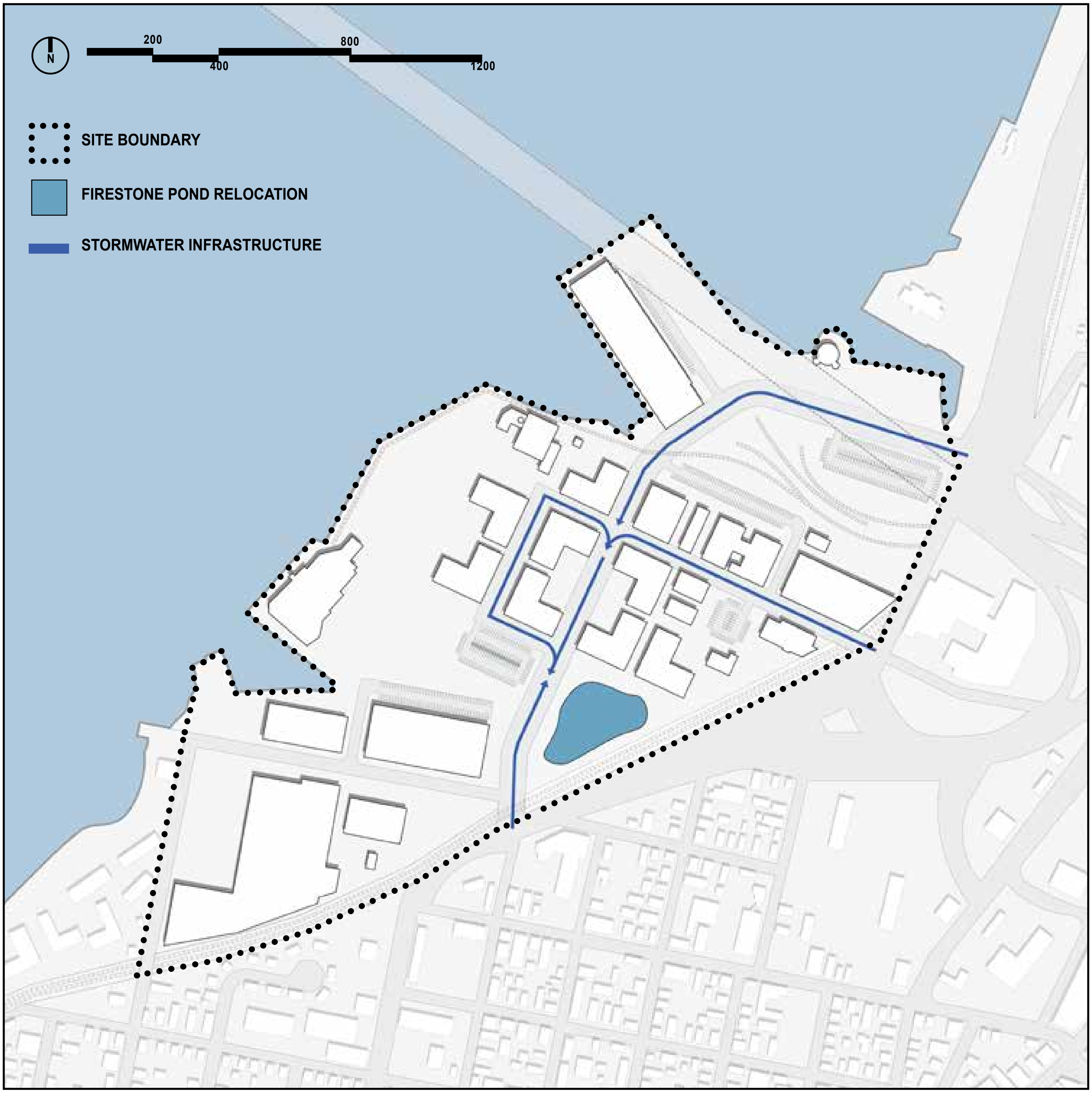


Figure 4.2.33 Bioswale Plant Types; (Source: Morgan Warner)

Switch Grass
(Panicum virgatum)

Little Bluestem
(Schizachyrium scoparium)

Red Twig Dogwood
(Cornus sericea)

Sweet Pepperbush
(Clethra alnifolia)

Turtlehead
(Chelone glabra)

Blue Wild Indigo
(Baptisia australis)

Black-Eyed Susan
(Rudbeckia hirta)

New Englad Aster
(Aster novae-angliaea)

Sensitive Fern
(Onoclea sensibilis)

Goatsbeard
(Aruncus dioicus)

Cardinal Flower
(Lobelia cardinalis)

Highbush Blueberry
(Vaccinium corymbosum)

Blue Iris Flower
(Iris versicolor)

Wild Bleeding Heart
(Dicentra eximia)

Columbine Flower
(Aquilegia canadensis)

Rosebud Azalea
(Rhododendron periclymenoides)

Figure 4.2.34 Permeable Paving Options; (Source: Para Blocos; Martin Pavers)

Figure 4.2.35 Permeable Paving at Work; (Source: ABC7 News; National Association of Transportation Officials)

Place Petal

Designing landscapes, hardscapes, and bioswales that are concious of district flooding and storm drainage creates a stronger connection between the masterplan and the site's ecology. Balancing stormwater and flood zones are an integral part of the way the streets are designed and utilized efficiently. By using the provided vegetation along the streetscape for stormwater management, the street design can be transformed into a 4-for-1 system, balancing aesthetics, noise and air pollution, physical safety, and stormwater management

Utilizing Firestone Pond as a retention pond for excess stormwater activates the pond and assigns it a function other than an existing landscape. Utilizing the current site features, including landscapes, coincides with the spirit of adaptive reuse and redesign. This initiative takes the current state of the district's landscape and transforms it into an efficient design feature - utilizing ever foot of the site. By doing this, the site has more meaning and a stronger identity.

CHAPTER 05

Existing Building Sustainable Adaptive Reuse

This chapter will demonstrate how the existing buildings on the Fall River Waterfront can be rehabilitated to meet the sustainable criteria of the Living Building Challenge 4.0 and how the buildings connect to the larger district systems introduced in Chapter 04. This chapter will select one building on the waterfront site to use as a case study to demonstrate sustainable rehabilitaiton strategies that can be duplicated for any typical New England mill building.

05.1 Case Study Site Analysis

The goal of this site analysis is to understand the chosen case study's contextual surroundings, history, and physical attributes that may inform required intervention, suggested rehabilitation, and opportunities for modern sustainable technology. Within this subchapter, this thesis will analyze climate, neighboring site, buidling orientation, building materials, building construction and assembly, and building condition.

104 Anawan

The building chosen for the Adaptive Building Reuse Case Study is located at 104 Anawan St, Fall River, MA. This building is located on the East side of the South Waterfront District and is the first building visitors approach when traveling West from Downtown Fall River. The building lays adjacent to the operable Fall River Railroad tracks and the Route 75 highway connecting to Anawan St.

In relation to the other existing buildings to be saved and rehabilitated from the proposed masterplan in Chapter 04, 104 Anawan is slighty above average in size, is the tallest building, and has the largest total squarefeet of any building on site. The building showcases visible layers of design introduced throughout its building life. These layers include window replacements, building additions, roof reconstruction, and interior program change. The condition of construction material is salvagable enough to either keep or reuse elsewhere in the redesign. 104 Anawan represents the classic New England Mill design. With a relatively simple floor plan and exterior design, this building

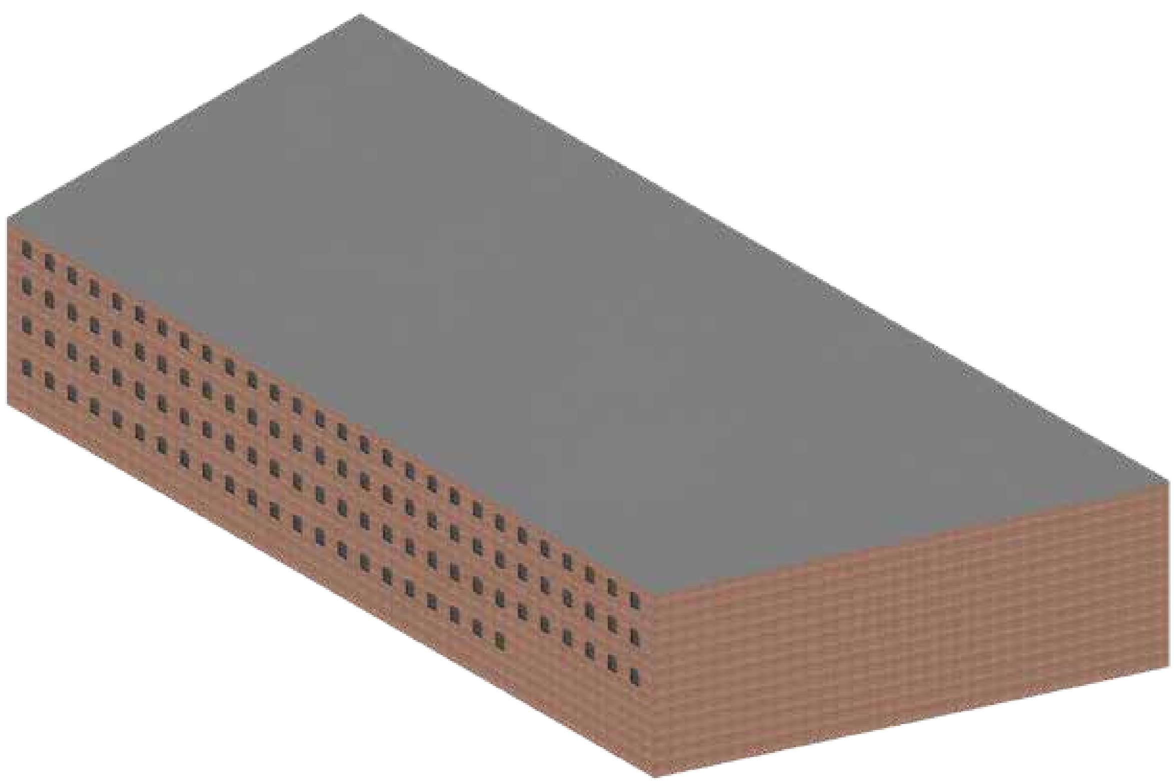


Figure 5.1.1 104 Anawan Existing Building Diagram; (Source: Morgan Warner)

This diagram is an axonometric diagram of the existing building located at 104 Anawan St. Fall River, MA.

Figure 5.1.2 Location of 104 Anawan Map (Source: Morgan Warner)

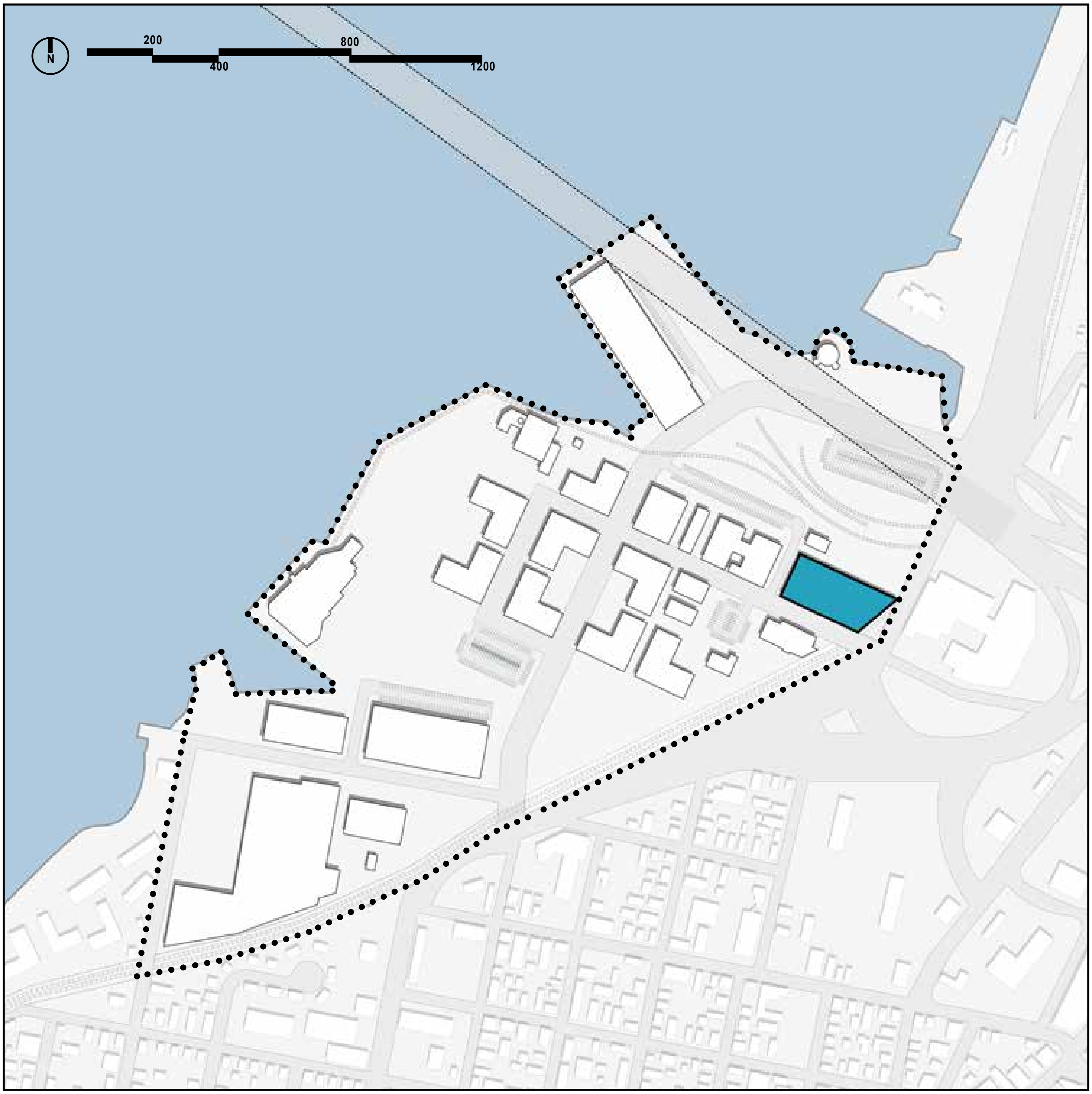


Figure 5.1.3 View of 104 Anawan From East Approach (Source: Morgan Warner)

Figure 5.1.4 View of 104 Anawan North Facade (Source: Morgan Warner)

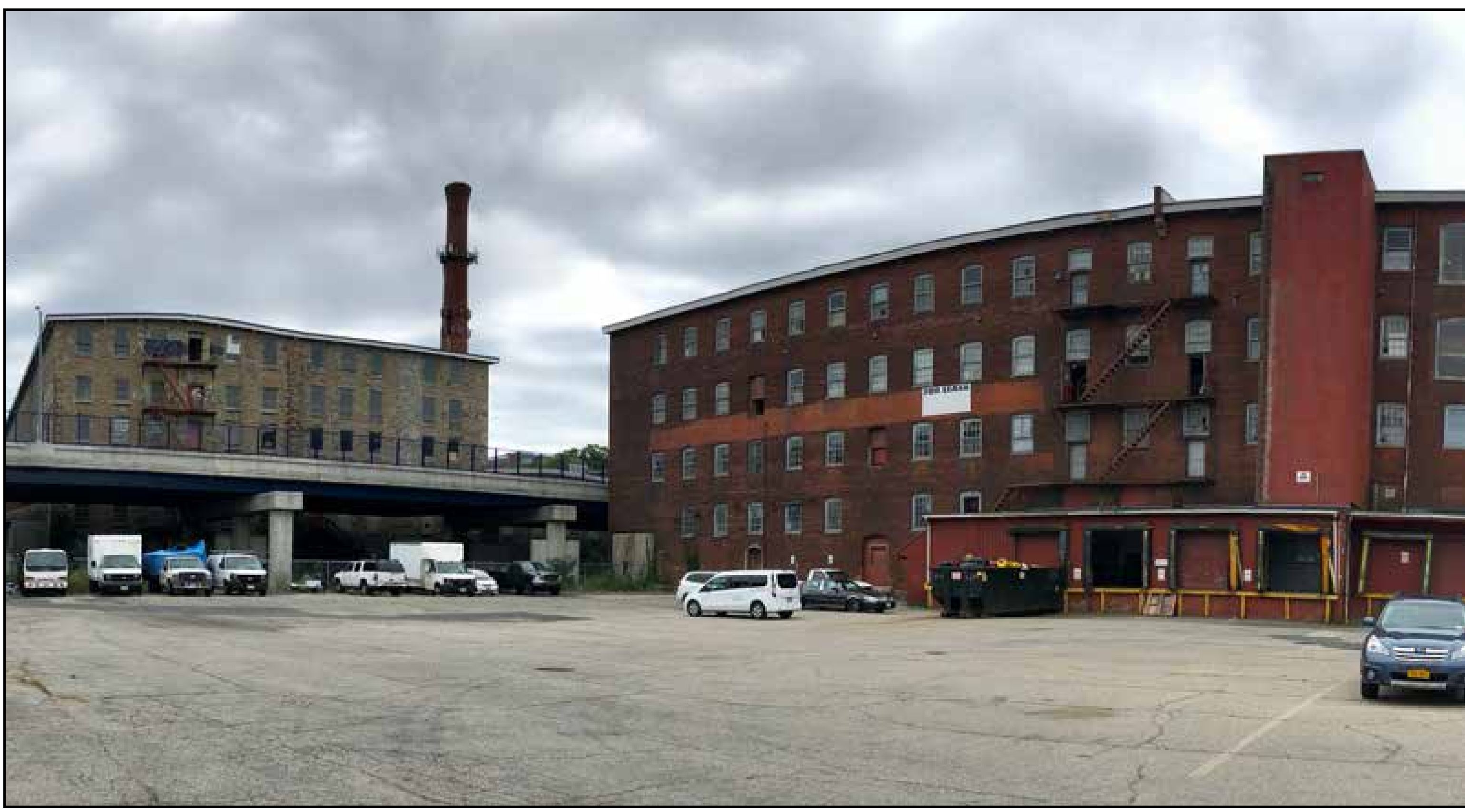


Figure 5.1.5 View of 104 Anawan East Facade (Source: Morgan Warner)

Figure 5.1.6 View of 104 Anawan Street Interaction(Source: Morgan Warner)

Figure 5.1.7 View of 104 Anawan West Facade (Source: Morgan Warner)

Figure 5.1.8 Tracks Adjacent to 104 Anawan East Facade (Source: Morgan Warner)

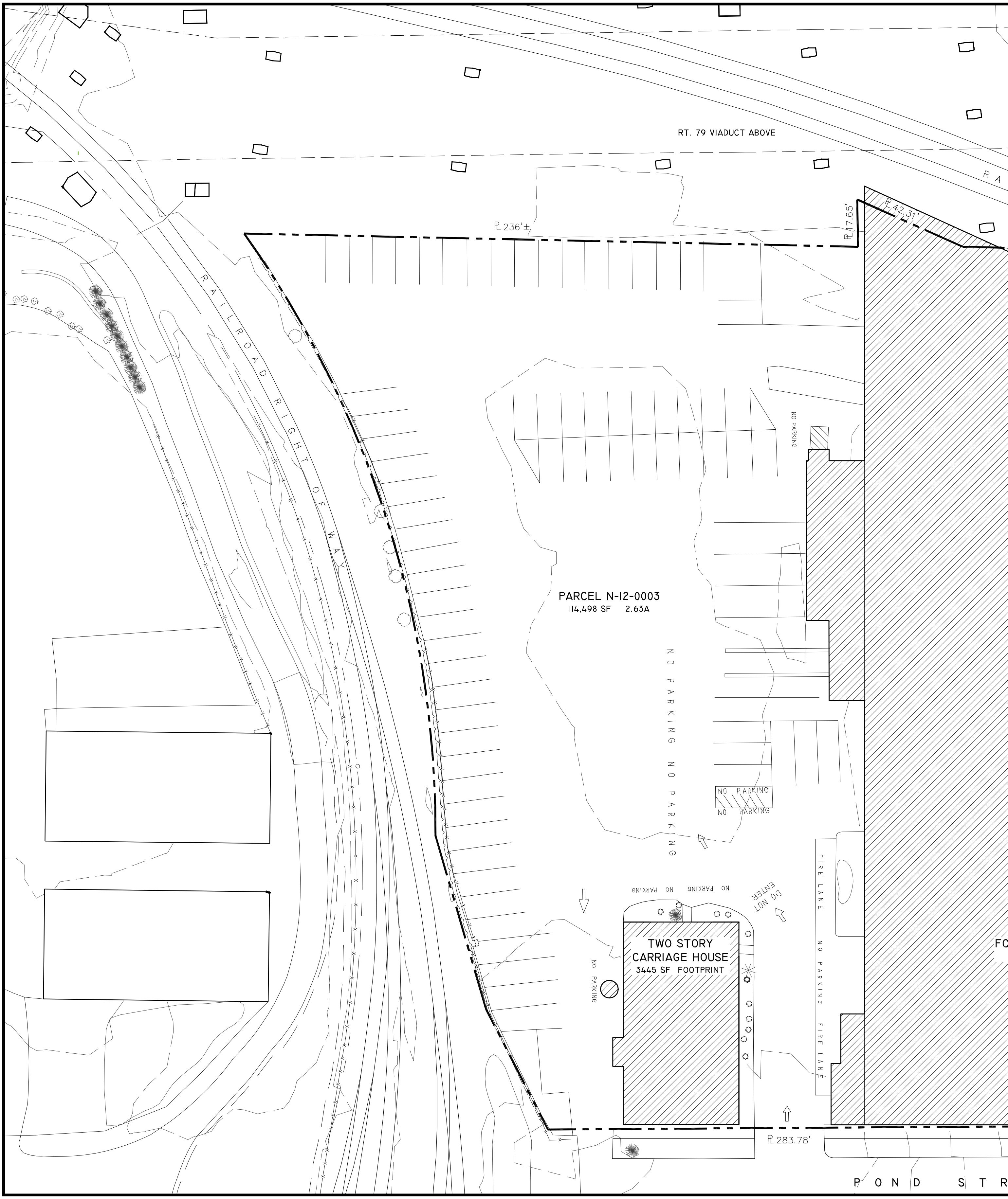
Figure 5.1.9 104 Interior Fire Door (Source: Morgan Warner)

Figure 5.1.10 104 Interior Window Condition (Source: Morgan Warner)

Figure 5.1.11 104 Interior Condition (Source: The Herald News)

Figure 5.1.12 104 Interior Condition (Source: The Herald News)

Figure 5.1.13 104 Interior Condition (Source: Morgan Warner)


RT. 79 VIADUCT ABOVE
RAILROAD RIGHT OF WAY
PL 236'±
PL 17.65'
PL 42.31'
NO PARKING
PARCEL N-12-0003
114,498 SF 2.63A
NO PARKING NO PARKING
NO PARKING
NO PARKING
DO NOT ENTER
NO PARKING NO PARKING
TWO STORY
CARRIAGE HOUSE
3445 SF FOOTPRINT
NO PARKING
FIRE LANE
NO PARKING
FIRE LANE
PL 283.78'
POND STR

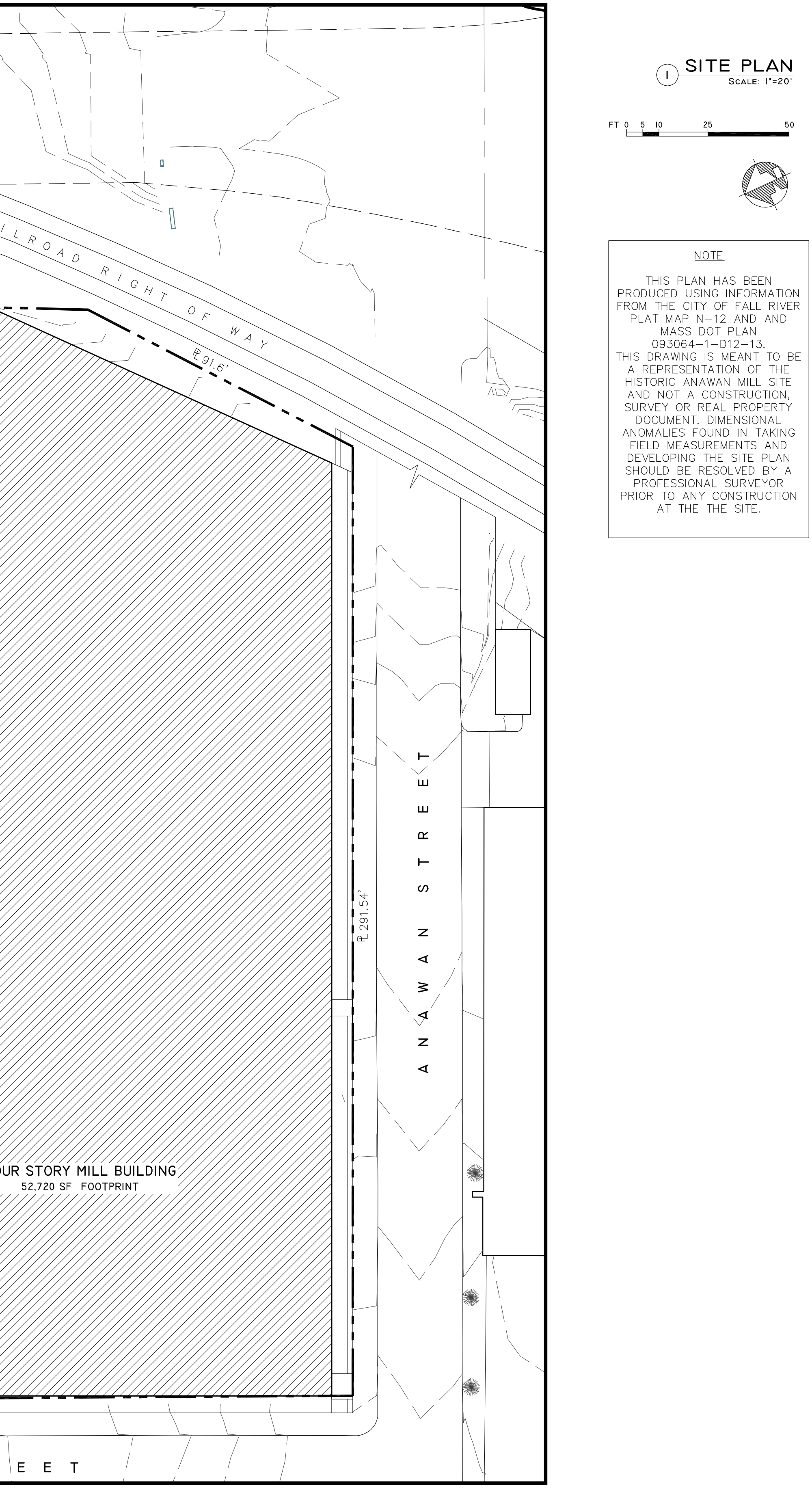
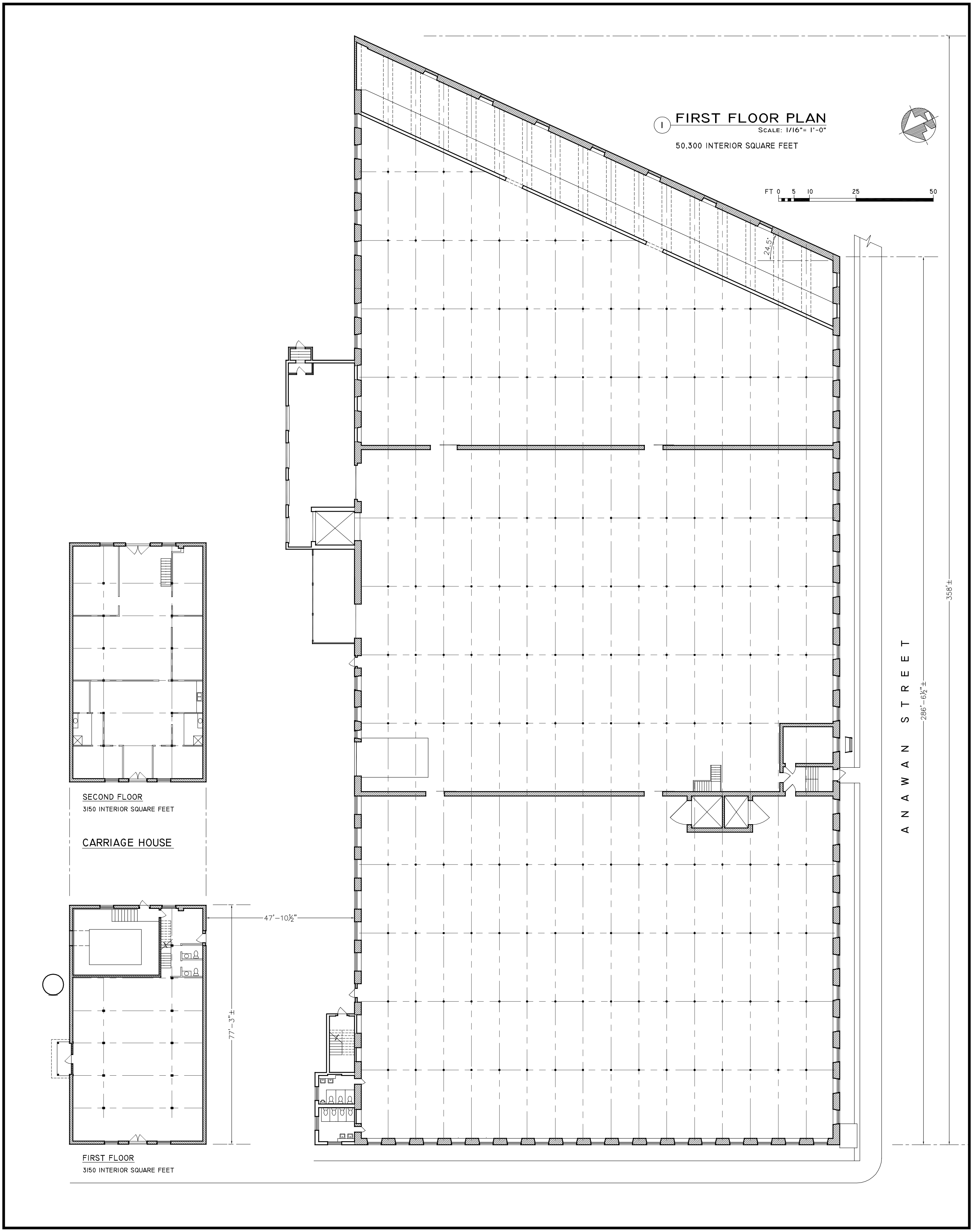


Figure 5.1.14 104 Anawan Site Map; (Source: Burgin Lambert Architects)

This site plan of 104 Anawan illustrate the site details of the entire parcel of land. The site plan was provided to Roger WIlliams University students by the Burgin Lambert Architects.


FIRST FLOOR PLAN
SCALE: 1/16"= 1'-0"
50,300 INTERIOR SQUARE FEET
FT 0 5 10 25 50
24.5'
358'±
286'-6½"±
ANAWAN STREET
47'-10½"
77'-3"±
SECOND FLOOR
3150 INTERIOR SQUARE FEET
CARRIAGE HOUSE
FIRST FLOOR
3150 INTERIOR SQUARE FEET

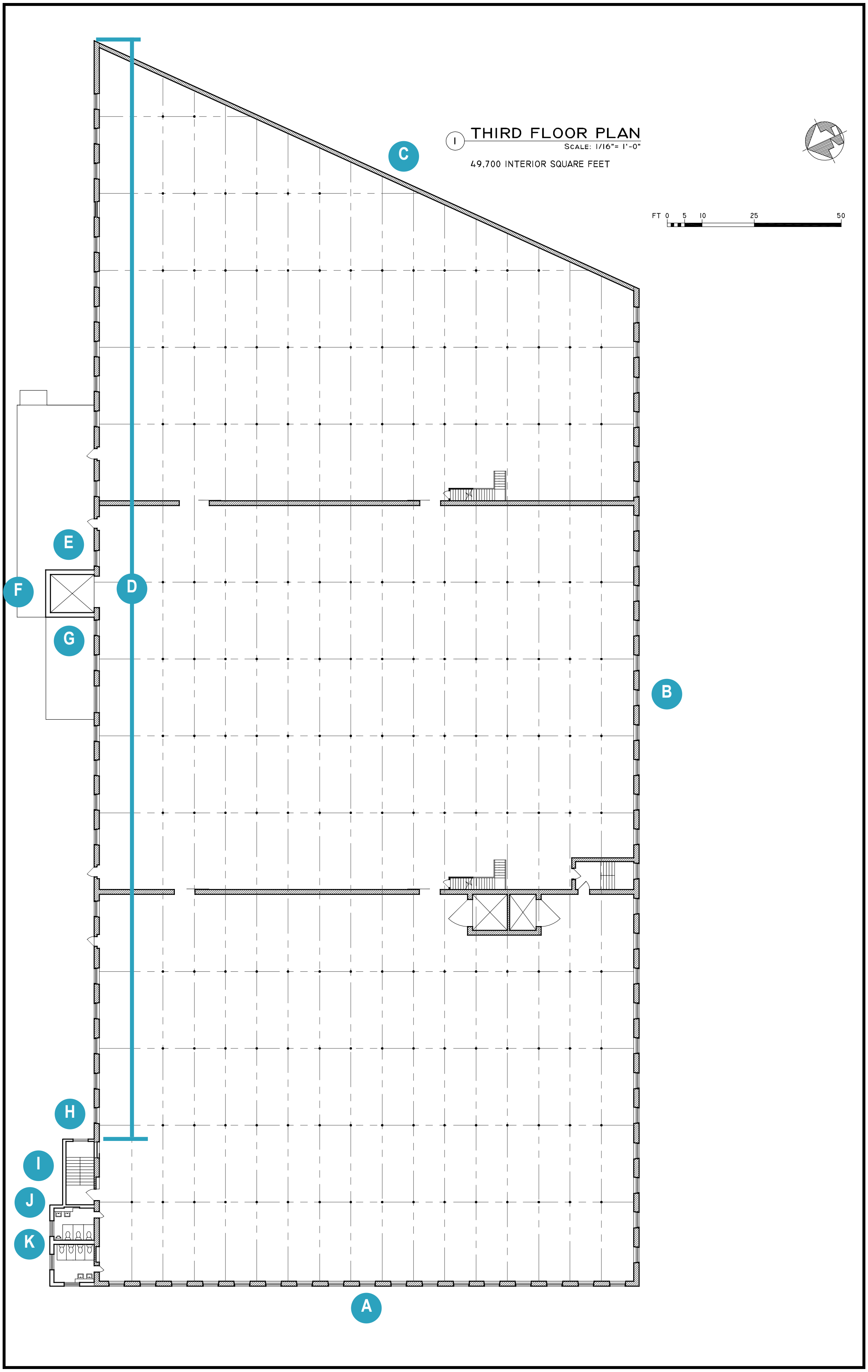


Figure 5.1.15 104 Anawan First Floor Plan; (Source: Burgin Lambert Architects)

This floor plan of 104 Anawan illustrate the first floor details and the building's relationship to the smaller mill on the North side of the building. The floor plan was provided to Roger WIlliams University students by the Burgin Lambert Architects.

Figure 5.1.16 104 Anawan Second Floor Plan; (Source: Burgin Lambert Architects)

This floor plan of 104 Anawan illustrate the second-fourth floor details and the building's relationship to the smaller mill on the North side of the building on the second floor. The floor plan was provided to Roger WIlliams University students by the Burgin Lambert Architects.

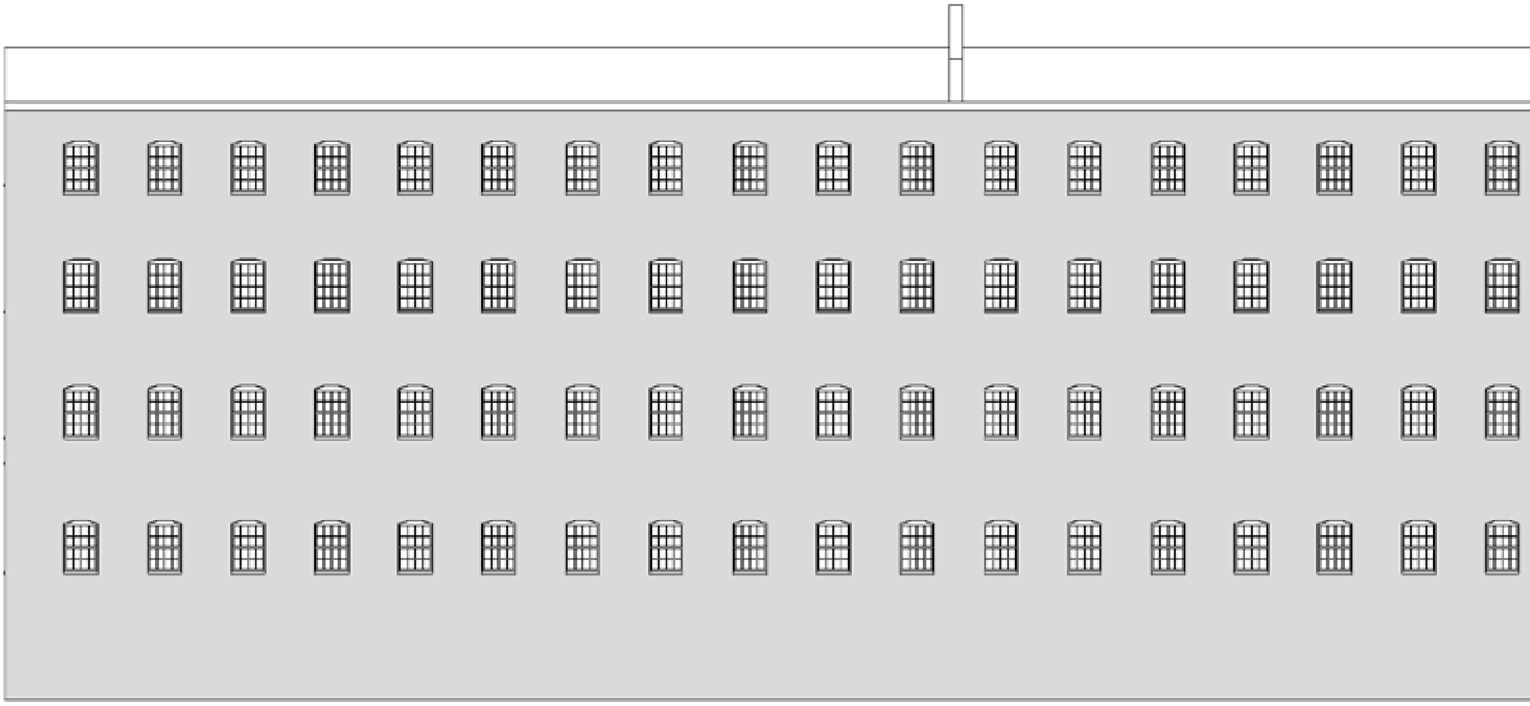


Figure 5.1.17 104 Anawan South Facade (Source: Morgan Warner)

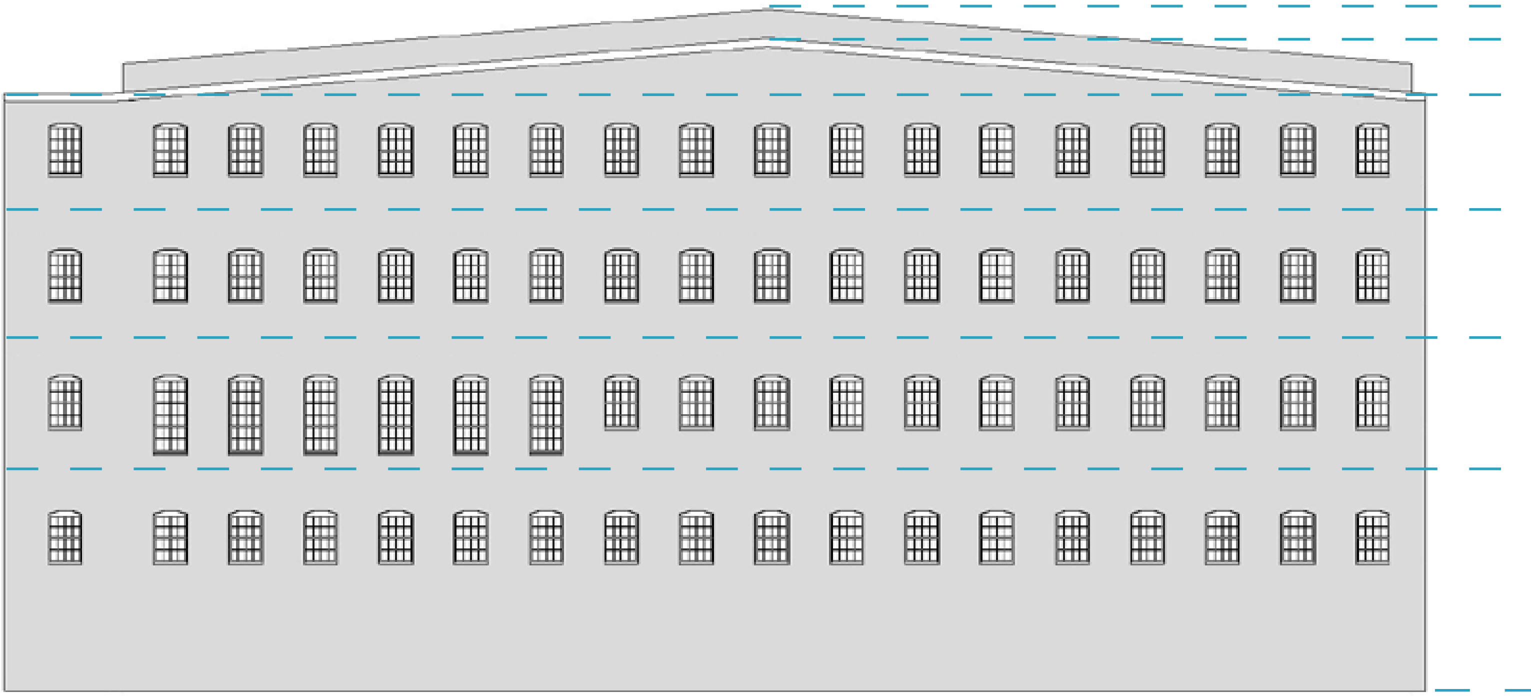
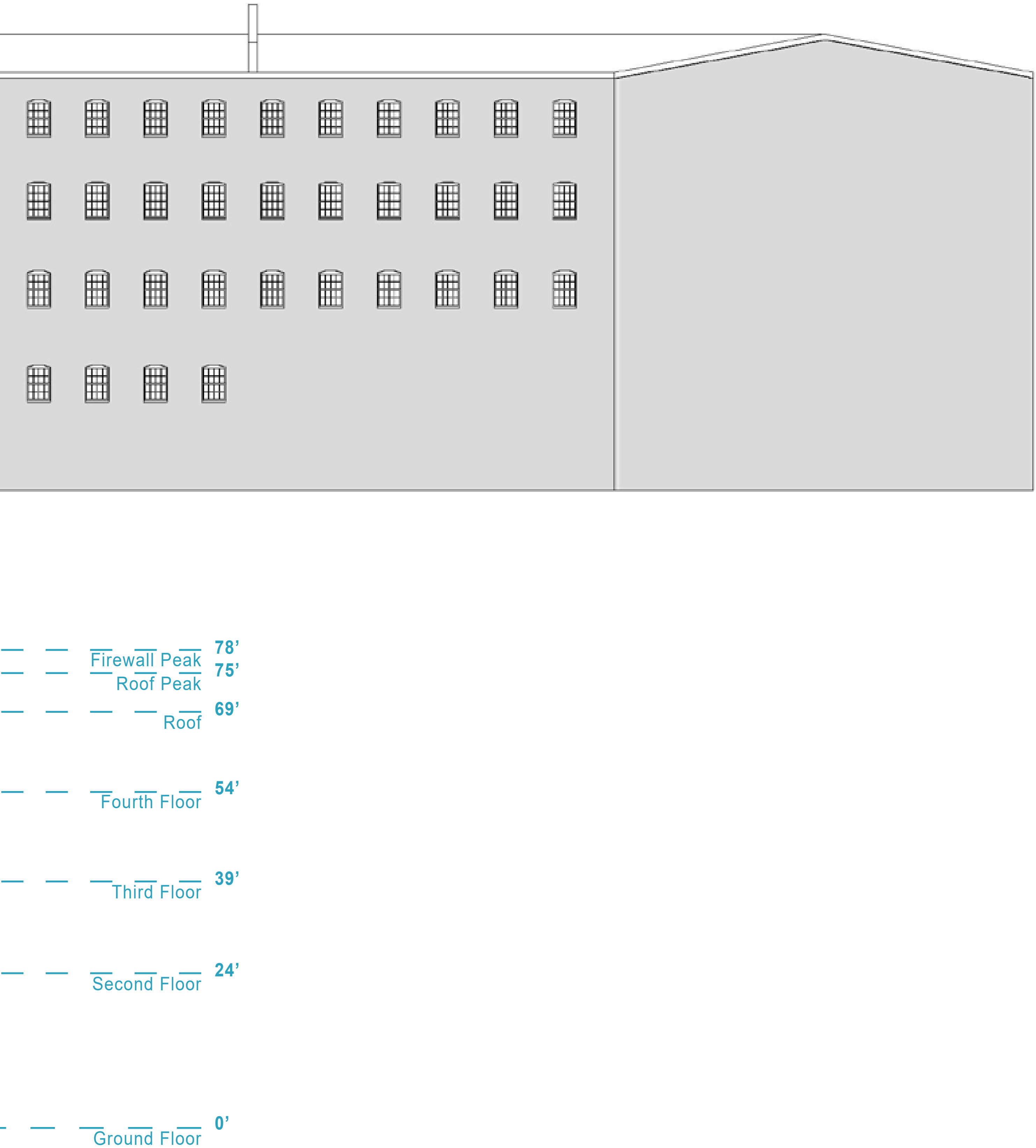


Figure 5.1.18 104 Anawan West Facade (Source: Morgan Warner)


78'
Firewall Peak
75'
Roof Peak
69'
Roof
54'
Fourth Floor
39'
Third Floor
24'
Second Floor
0'
Ground Floor

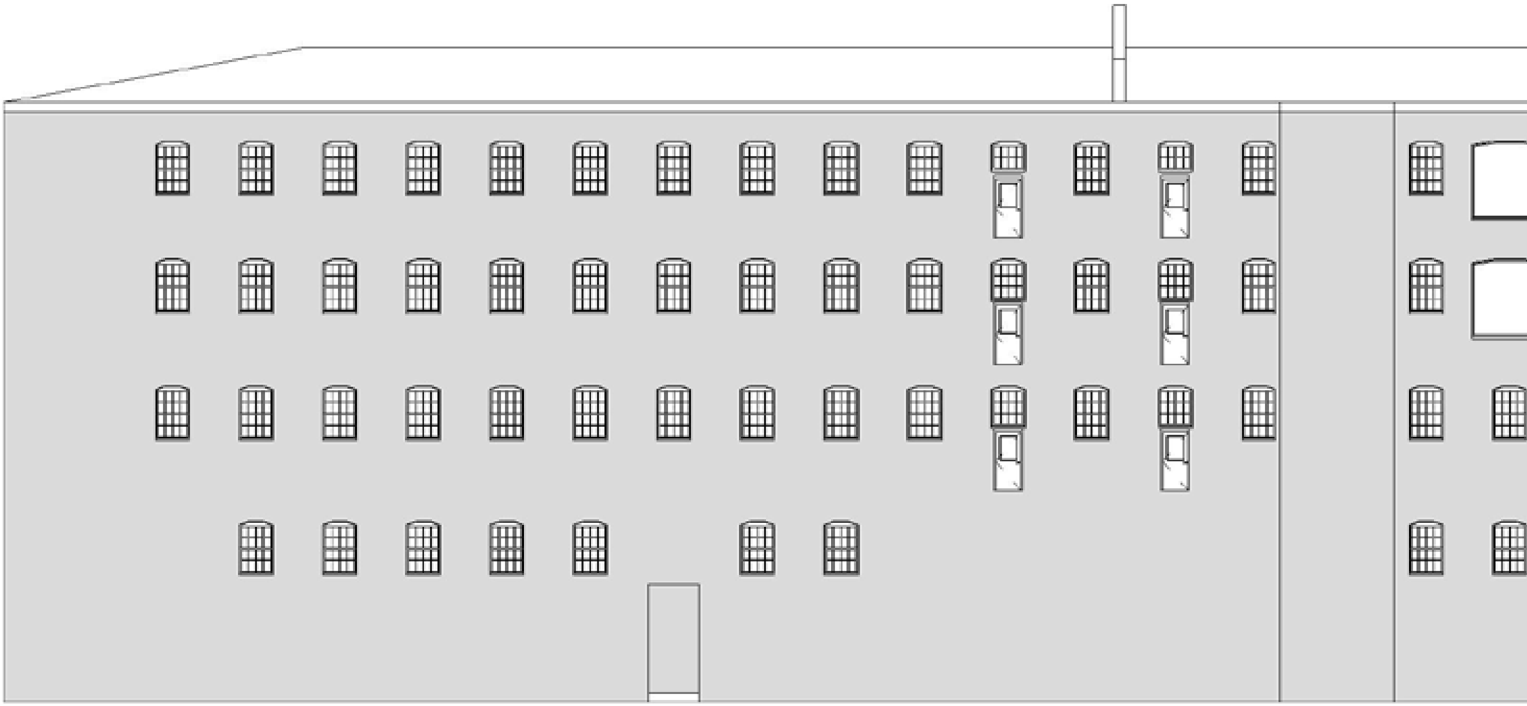


Figure 5.1.19 104 Anawan North Facade (Source: Morgan Warner)

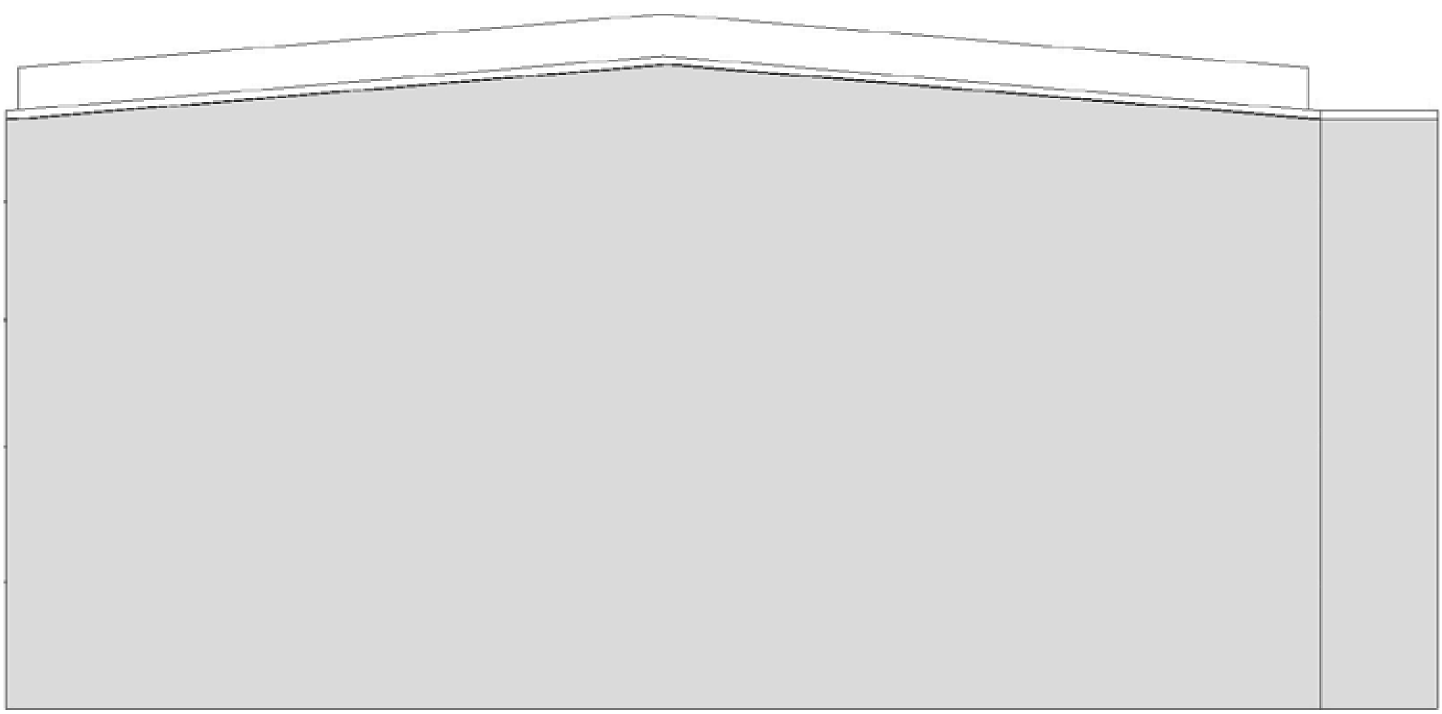
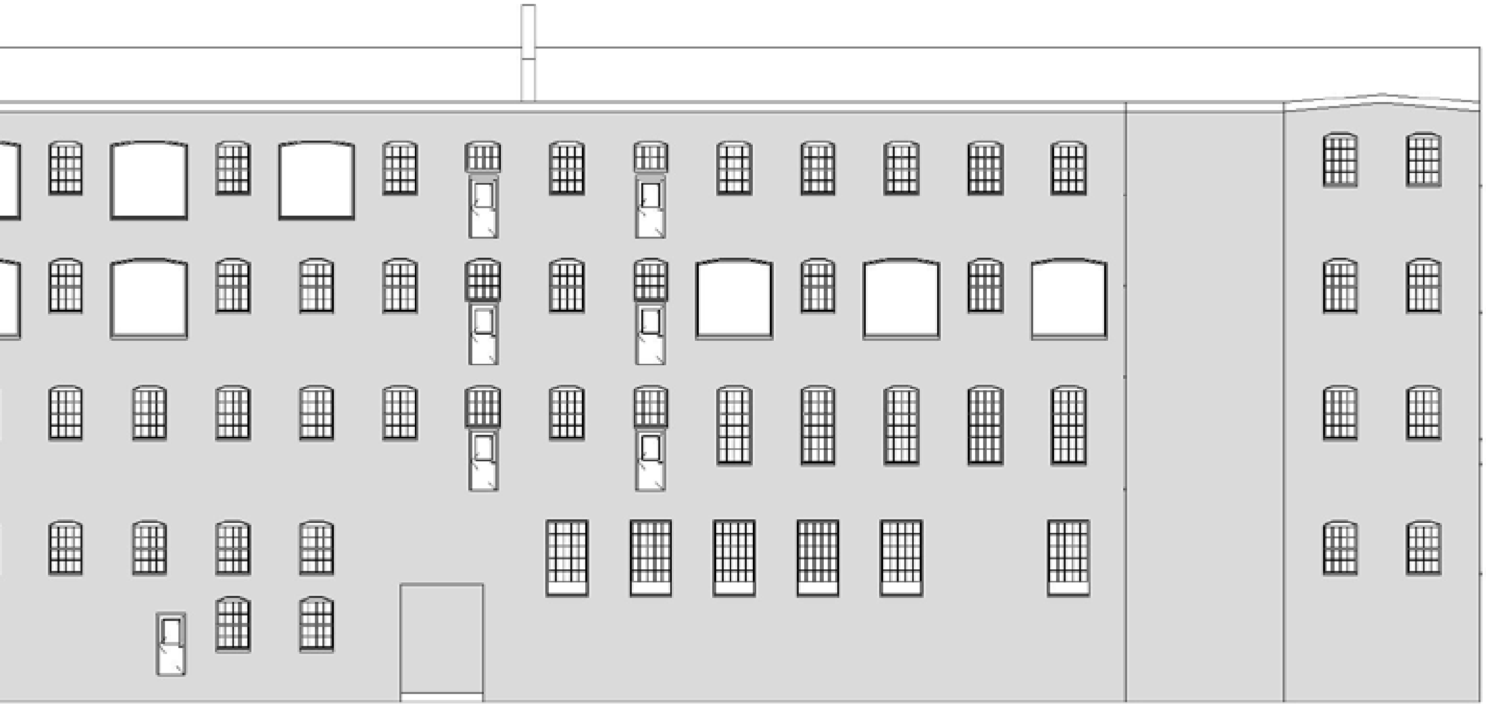
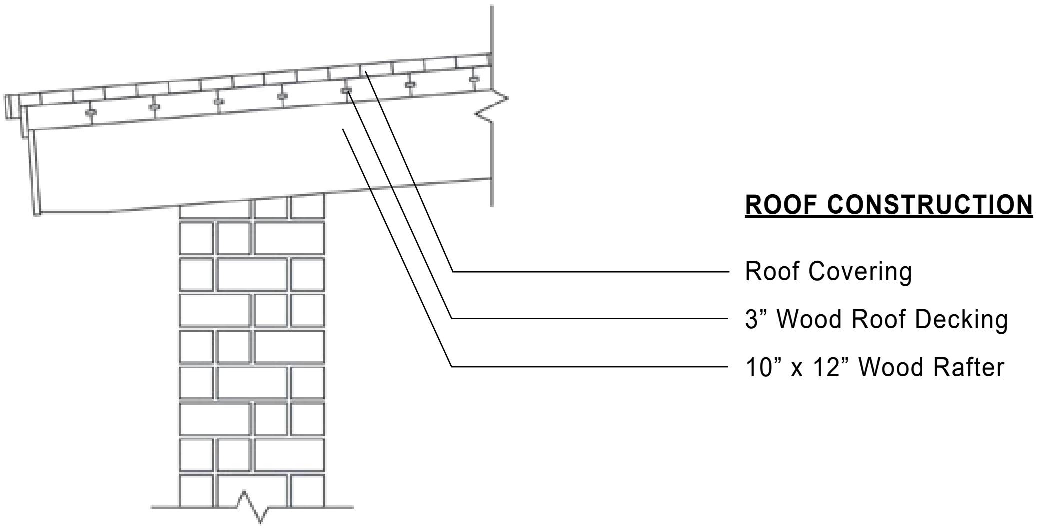
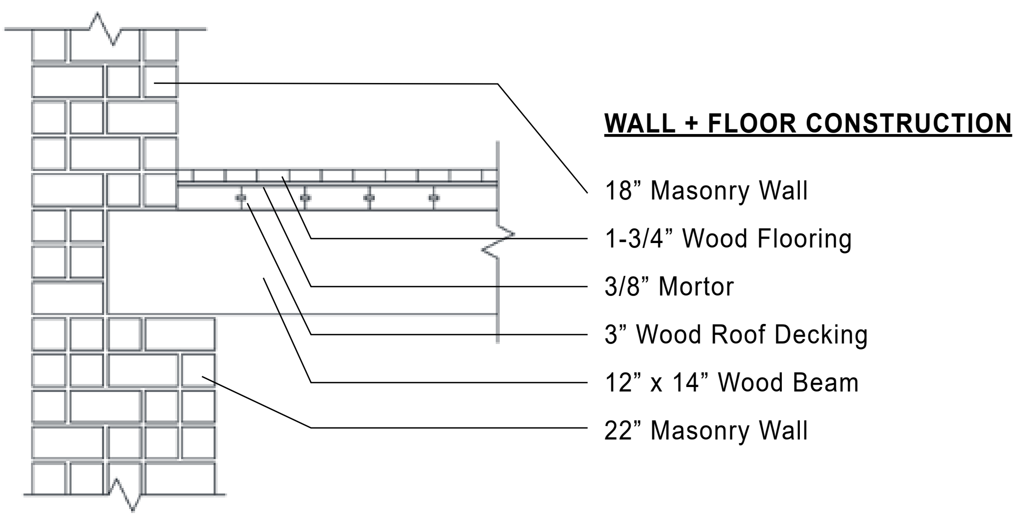
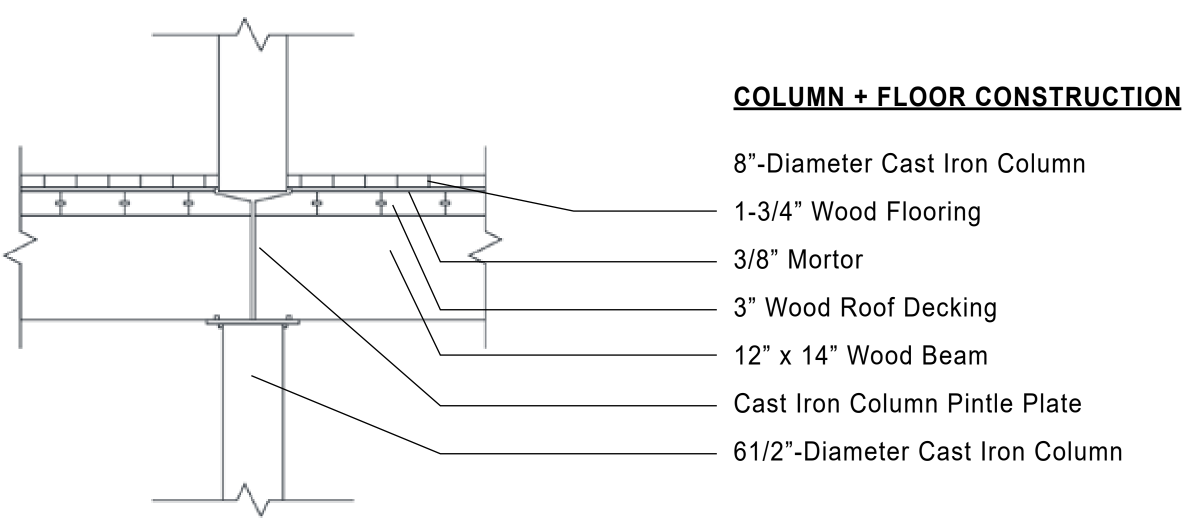


Figure 5.1.20 104 Anawan East Facade (Source: Morgan Warner)




ROOF CONSTRUCTION
Roof Covering
3” Wood Roof Decking
10” x 12” Wood Rafter


WALL + FLOOR CONSTRUCTION
18” Masonry Wall
1-3/4” Wood Flooring
3/8” Mortor
3” Wood Roof Decking
12” x 14” Wood Beam
22” Masonry Wall


COLUMN + FLOOR CONSTRUCTION
8”-Diameter Cast Iron Column
1-3/4” Wood Flooring
3/8” Mortor
3” Wood Roof Decking
12” x 14” Wood Beam
Cast Iron Column Pintle Plate
61/2”-Diameter Cast Iron Column

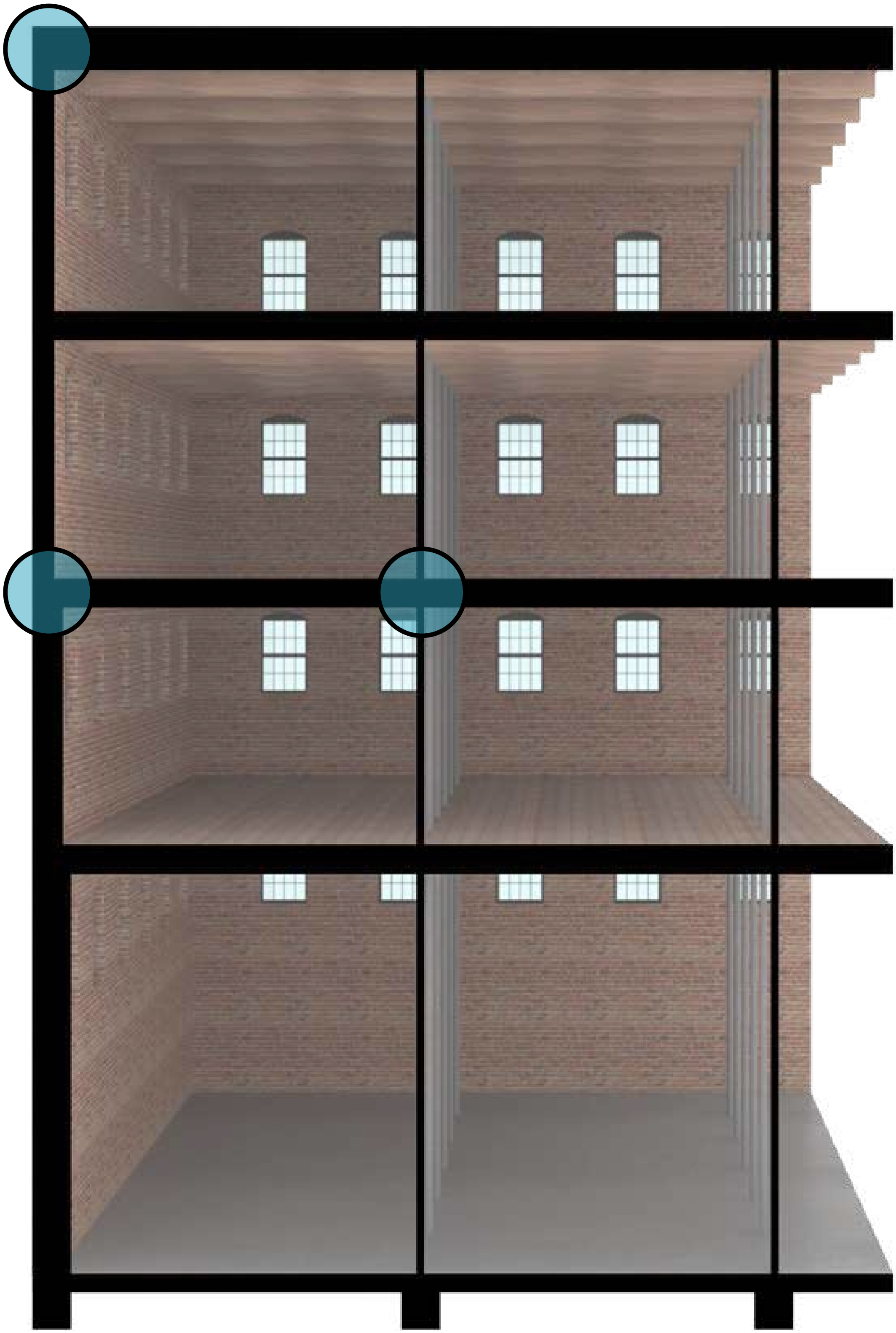


Figure 5.1.21 Typical New England Mill Construction Assembly and Material; (Source: Morgan Warner; Kidder)

This diagram illustrates the Typical New England Mill Construction represented in the 104 Anawan. This diagram includes an axonometric section diagram of 104 Anawan and section details of existing roof, wall, and floor construction.

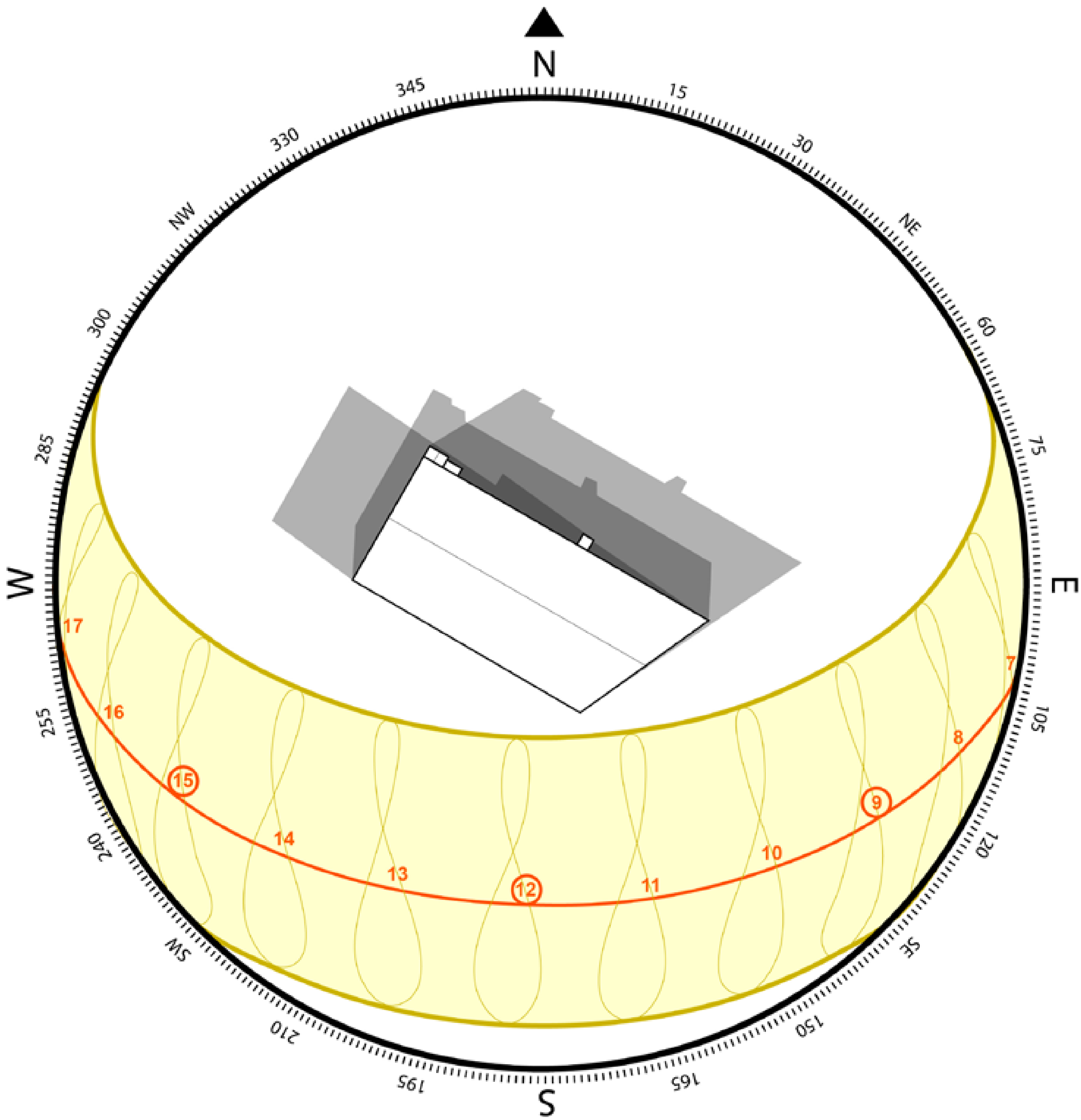


Figure 5.1.22 Solar Study of 104 Anawan (Source: Morgan Warner)

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05.2. Adaptive Reuse Building Case Study

The Adaptive Reuse Building Case Study will transform the 104 Anawan mill building step by step into an energy efficient and enviornmentally responsible adaptive reuse building while providing data to support each design decision and addressing how each design step applies to the petals of the Living Future Challenge. The goal of the design is to preserve as much of the mill as possible and apply sustainalbe design strategies that will take advantage of the existing design while elevating its efficiency for energy use and resourse use. The goal of this case study is to create an adaptive reuse project that is duplicable for all Typical New England Mill Buildings.

Sustainable Building Reuse Strategies and the Living Future Challenge

Before the building deisgn is addressed, the design strategies to be achieved are listed and outlined with the petals of the Living Future Challenge they correspond with. The design strategies to be used are determined based on the requirements of each Living Future Challenge petal and the previous precedent study. These design strategies are devised to enhance the performance of the building and maximize the design's potential for energy conservation, envrionmental health, social equity, and economic gain.

Figure 5.2.1 Living Future Challenge Adaptive Building Reuse Strategies; (Source: Morgan Warner)

The South Waterfront Masterplan Proposal outlines the sustainable design strategies that will be applied to the existing adaptive building reuse case study and lists which petals from the Living Future Challenge each design strategy addresses.

Adaptive Reuse of Existing New England Mill Buildings on Site

The decision to preserve existing structures rather than demolish and rebuild new, more efficient structures not only saves the Fall River Waterfront Urban Renewal project money, but reduces the project's carbon output, energy use, and material waste.

Although 104 Anawan, along with the other existing structures in the South Waterfront district, were constructed in the 1800s, their open floor plans and simple construction provide opportunitiy for modern use. The foundation of these buildings are solid, efficient, and flexible in size and shape for new inserted program.The simple design of these buildings offer opportunity to take advantage of existing and potential passive design strategies as well as updated and efficient electrical, plumbing, heating, cooling, and ventilating systems that conserve resource and energy use.

The condition of each building in the South Waterfront district varies. The condition and quality of materials at 104 Anawan are still salvagable, and their structural integrity are still intact. Although there is continuity in the buildings construction assemblies, there are visble layers of intervention onto the building in the floor construction, building envelope, and roof construction.

The structure and construction assembly of 104 Anawan represents the Typical New England Mill. The building features cast iron columns across a grid of 9ft x 21ft. The columns taper from top to bottom and their average diameter is 8in. The columns sit on exposed 12x14 heavy timber beams spanning the length of the building. The average ceiling height is 15ft, with the exception of the first floor ceiling height at 25ft. The floor construction includes wood decking, mortar, and wood plank flooring. There are two 2ft thick masonry firewalls separating the length of the building. The exterior walls are masonry and taper from top to bottom, with the thinnest wall thickness at 18".

Based on the structural type, building size, and envelope potential, it is suggested that 104 Anawan becomes an office or commerical building. These program types are supported by the current structure and do not require any extra structural support, assuming the existing structure is sound and stable. The building floor plan is large and open, a feature that can be exploited by most office space or commercial programs. The building envelope requires updating, however, office or commercial interior space have less-strict conditioning requirements than residential or museum interior space.

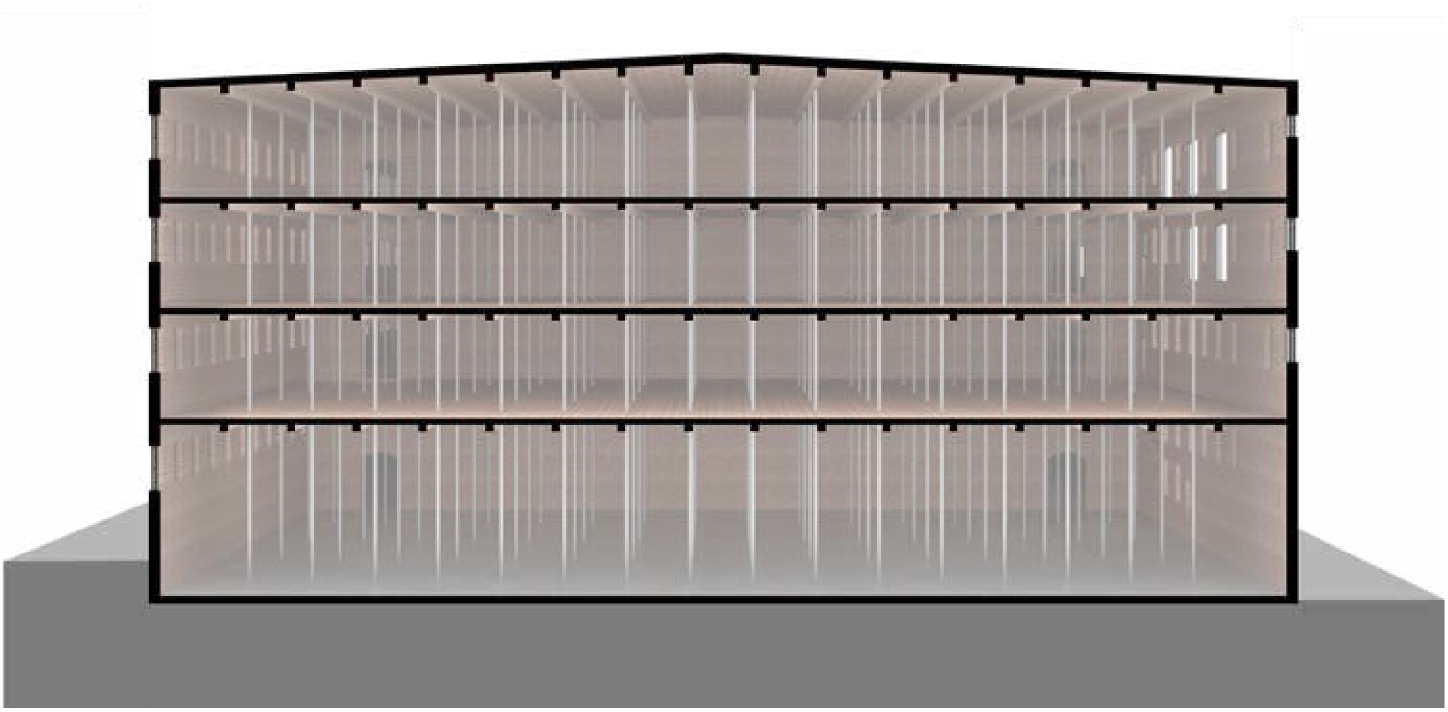


Figure 5.2.2 Existing 104 Anawan Section Perspective (Source: Morgan Warner)

Volume of Existing Brick Walls

ELEV.	DIM. (FT)	WALL (SQFT)	OPENINGS (SQFT)	TOTAL WALL (SQFT)	VOLUME TOTAL (FT)
A	167' X 69' 1'-6"	11,523	1,890	9,633	14,450
B	284' X 69' 1'-6"	19,596	1,691	17,905	26,858
C	169'-8" X 69' 1'-6"	11,707	0	11,707	17,560
D	314' X 69' 1'-6"	21,666	3,787	17,879	26,819
E	13'-3" X 69' 1'-6"	914-1/4	0	914	1,371
F	12'-4" X 69' 1'-6"	854-1/4	0	854	1,281
G	13'-3" X 69' 1'-6"	914-1/4	0	914	1,371
H	8' X 69' 1'-6"	557-1/2	120-1/2	437	656
I	18'-9" X 69' 1'-6"	1297-1/4	0	1,297	1,946
J	3'-6" X 69' 1'-6"	247	0	247	371
K	21'-8"' X 69' 1'-6"	1497-1/4	0	1,497	2,246
L	165'-6" X 69' 1'-6"	11,419-1/2	0	11,420	18,271
M	165'-6" X 69' 1'-6"	11,419-1/2	0	11,420	18,271
Total	-	-	-	*86,126*	*131,471*

Volume of Existing Window Glass

SIZE (FT)	GLASS PER WDW (SQFT)	#	GLASS TOTAL (SQFT)
4 X 3	9	4	36
4 X 4	13.5	8	108
4 X 6	18	268	4824
4 X 9	27	11	297
5 X 9	45	6	270
9 X 9	70.5	8	564
Total	-	*305*	*6099*

Volume of Existing Cast Iron Columns

HEIGHT (FT)	HEIGHT (IN)	RADIUS (IN)	AREA PER (SQIN)	VOLUME PER (IN^3)	#	VOLUME TOTAL (IN^3)	VOLUME TOTAL (FT^3)
22' 5-1/2"	269-1/2"	3-1/2"	11	2,961-3/4	171	506,469	293
13' 5-1/2"	161-1/2"	3-1/2"	11	1,774-3/4	513	910,516	527
Total	-	-	-	-	*684*	*1,416,985*	*820*

Volume of Existing Wood Beams

LENGTH (FT)	LENGTH (IN)	ACTUAL DIM. (IN)	AREA PER BEAM (SQIN)	VOLUME PER BEAM (IN^3)	#	VOLUME TOTAL (IN^3)	VOLUME TOTAL (FT^3)
110' 1-1/4"	1,321-1/4"	11-1/2" X 3-1/2"	40-1/4	53,180-1/4	160	8,508,850	4,924
94' 5-1/2"	1,133-1/2"	11-1/2" X 3-1/2"	40-1/4	45,623-1/2	80	3,649,870	2,112
Total	-	-	-	-	*240*	*12,158,720*	*7,036*

Energy Petal

The initiative to reuse and sustainably rehabilitate existing structures rather than demolish and build new construction conserves the embodied energy of all existing structures that are saved. The embodied energy of a construction project includes all of the energy that went into each individual building’s material extraction, material manufacturing, material transportation, building construction, and eventually, building demolition. Avoiding new construction and reusing what already has embodied energy reduces the projects overall added embodied energy, ultimately saving energy in project construction

Material Petal

Adaptive building reuse results in a fraction of material waste compared to building demolition that results in new, replacement construction. The volume of material saved is comparable to the volume of material that would be needed for new construction - doubling the amount of unnecessarily wasted material.

Place Petal

The initiative to reuse and sustainably rehabilitate existing structures enhances the South Waterfront historic identity as an industrial district and heightens it as a sustainable mixed-use district built off of its historic foundation. Reusing existing structures with modern building system technologies creates a new identity for the South Waterfront and for the city of Fall River as a progressive, clean, and historic place.

Beauty Petal

Rehabilitating the existing industrial structures in the South Waterfront district is an opportunity to educate the public of the industrial history of the city, the urban culture of the waterfront, and the building typology of the Typical New England Mill. Connecting to the history of the site can better integrate the historic landmarks and features of the site to the new construction and repurposed existing buildings. Sustainable design interventions applied to the existing structures are also an opportunity to educate the public on sustainable designs and how they can be applied to new and existing construction.

Building Envelope and Construction Assembly

The existing building construction, materials, and building envelope for 104 Anawan still intact and reusable, however, require updating for interior contional quality and energy use efficiency.

Dwelling interior conditions for office, commercial, or residential space require consistancy, customization, and comfort. The building construction has three main responsibilities that support interior dwelling conditions: 1) Seal the building's interior spaces - eliminating any thermal bridges where heat or cooling may escape, 2) Provide thermal insulation quality appropriate for the interior program, and 3) Allow for controlled natural daylight and ventilation to enter the building's interior spaces.

The Typical New England Mill construction design was meant for facotry environments and storage facilities, which require the least amount of insulation quality compared to other dwelling programs, including office, commercial, or residential. To improve the existing insulation quality for future program use, insulation can be added to existing exterior walls, floors, and roof. The added insulation layers can be custom based on the new program's requirements for heating, cooling and sound absorption.

The existing structures in the South Waterfront district, including 104 Anawan, are an average of 200 years old and reveal layers of building construction intervention that have changed the building's appearance and functions overtime. These interventions in 104 Anawan include window and door demolition and closure, added floors, new roofs, replaced floor boards, and interior wall demolition and additions. The open floor plan and repetative structural grid make the interior spaces flexible and easily changed overtime. It is the intention of this thesis that these buildings will continue to be around for a long time, meaning their function and program will continue to change and evolve with the district's needs. To continue this design characteristic of adaptability, all interior walls for existing mill buildings are to be built for easy deconstruction, reuse, or recycle.

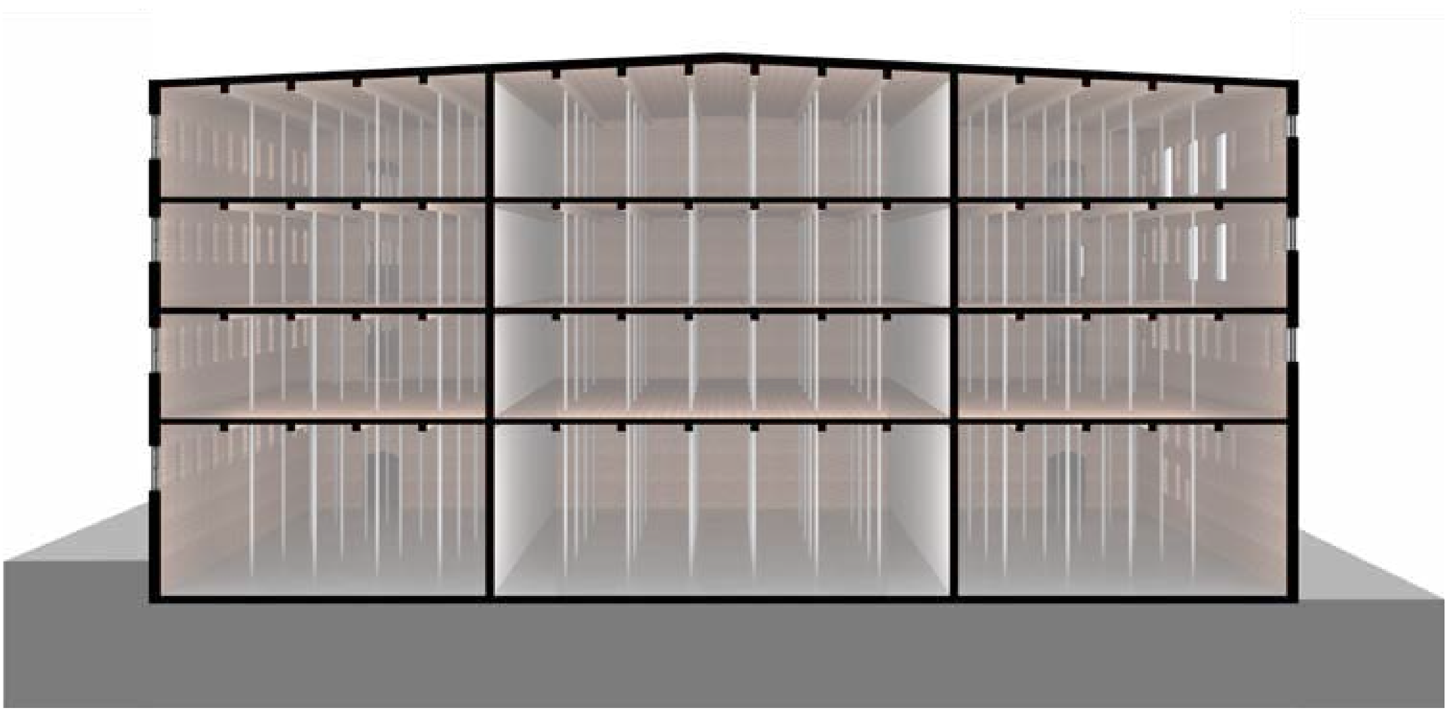


Figure 5.2.3 104 Anawan Construciton Assembly and Materials Update Section Perspective (Source: Morgan Warner)

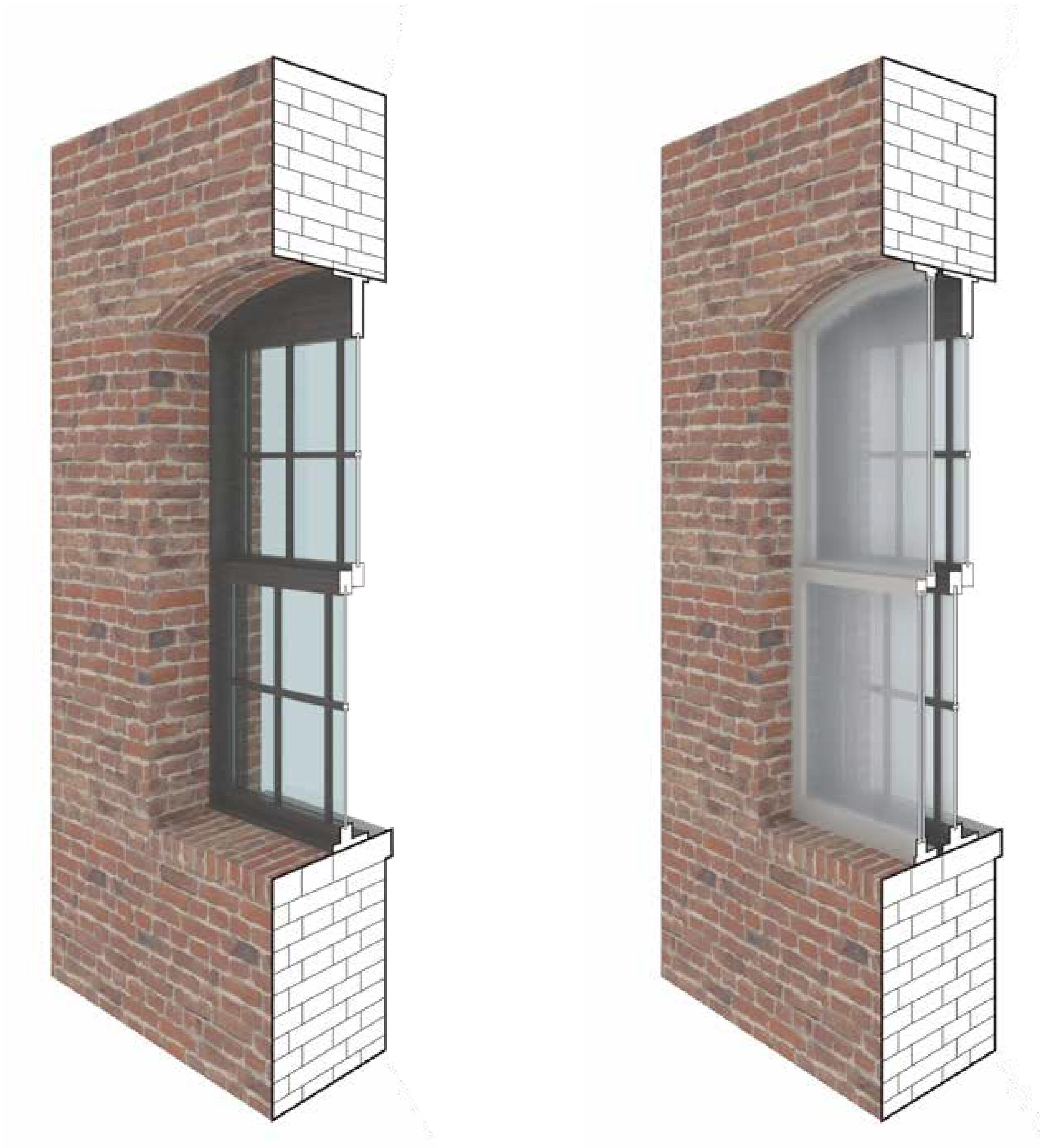


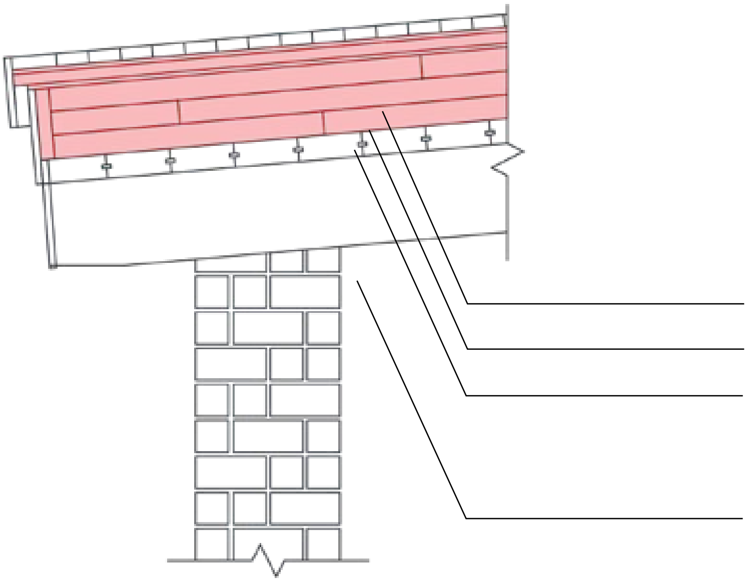
Figure 5.2.4 Window Upgrade Axomametric Diagram (Source: Morgan Warner)

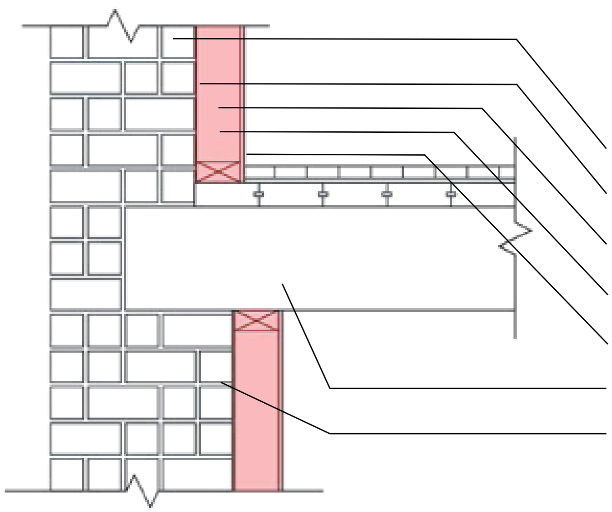
This diagram illustrates the addition of an interior storm window onto the existing 104 Anawan building envelope.

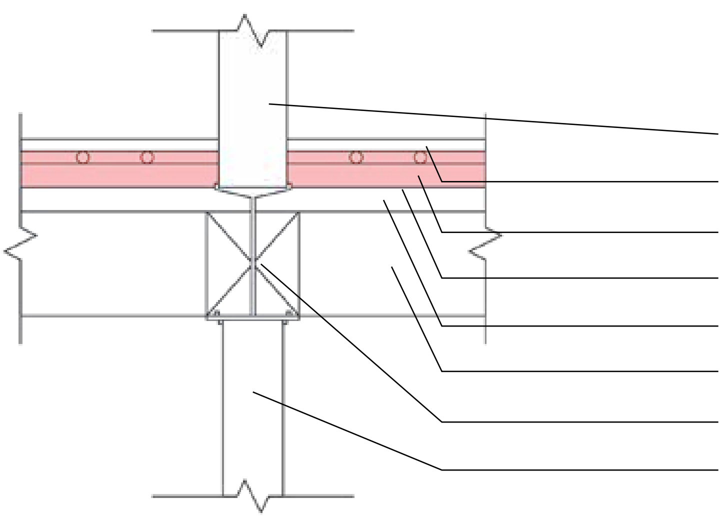
For a mill building of this size, it is important that all openings of the building's envelope are sealed properly. The existing windows on 104 Anawan are in acceptable condition, however, have lower insulation value than modern window construction. There are two approaches to the window design that can improve the buildings envelope continuity: 1) Replace the existing window frame, or 2) Add a storm window to the interior side of the window. These two approaches can be done separately or in unison.

Replacing the existing window frame would require that all windows be reconstructed with new wood. The existing window frame can be recycled or reused elsewhere in either the project's design or on site. The single pane glass window is efficient enough to satisfy the insulation requirements of the envelope, and can be reused as is.

Adding a storm window to the interior side of the existing windows can be done as needed per the interior programming conditional requirements, or instead of replacing the existing window's frame - conserving project waste and preserving the existing window. The storm window will add a layer of insulation and sealing to each window, while still being operable to allow for natural ventilation. The storm window can be single pane or double pane based on the requirements of the interior program, and can utilize modern glass technology that offer adaptive shading to control the quality of natural daylight in the interior space.


NEW ROOF CONSTRUCTION
Roof Covering
Roof Sheathing
Air Venting Channel
Roof Sheathing
9” Exterior Rigid Foam
3” Wood Roof Decking
10” x 12” Wood Rafter


NEW WALL CONSTRUCTION
18” Masonry Wall
Water and Air Control Layer
2x6 Wood Frame Assembly
Cellulose Cavity Insulation
Gypsum Wall Board
12” x 14” Wood Beam
22” Masonry Wall


COLUMN + FLOOR CONSTRUCTION
8”-Diameter Cast Iron Column
1-3/4” Wood Flooring
3” Wood Floor Sheathing w/ Heating Tubes
3/8” Mortor
3” Wood Roof Decking
12” x 14” Wood Beam
Cast Iron Column Pintle Plate
61/2”-Diameter Cast Iron Column

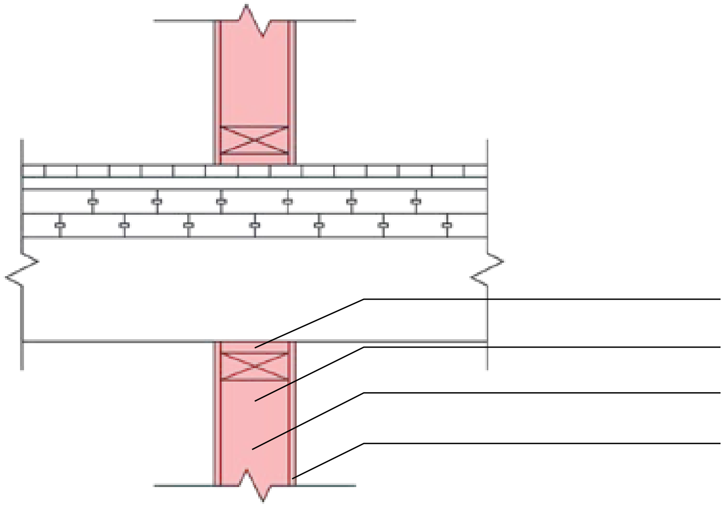


Figure 5.2.5 Typical New England Mill Construction Assembly and Material; (Source: Morgan Warner) This diagram illustrates the upgrades to the Typical New England Mill Construction represented in the 104 Anawan. This diagram includes upgrades to the section details of existing roof, wall, floor construction, and interior walls.

Energy Petal

The existing construction assembly for 104 Anawan represents the Typical New England Mill construction. The existing exterior walls average 1 foot - 6 inches; the windows are single pane with wood framing; the roof is supported by wood rafters and is made up of simple plank roof sheathing and coverings; and the floors are supported by wood beams, cast iron columns, and are made up of simple plank floor sheathing and flooring planks. The existing assemblies have unacceptable R-Values to support residential, office, or retail interior program and require upgrades to the assembly.

Sealing thermal bridges in the existing building envelope will improve the consistancy of the interior environment, hot or cold. Reinforcing the insulation of the building envelope will in turn require less energy use and cost to heat and cool the interior. The added insulation throughout the interior will also create stronger sound proofing from room to room.

Material Petal

All new construciton added to the existing structure will not include any Red-Listed materials. All new cosntruction will be assembled to be able to be easily disassembled without compromising the structure or integrity of any existing material or construction assembly. Planning for disassembly looks ahead and ensures that the existing building remains flexible and adaptable to future changes in program or building use.

Building Heating, Cooling and Ventilation Systems

Due to its large floor plates and tall ceiling heights, The Typical New England Mill construction is generally not energy efficient when it comes to heating, cooling, ventilating, and lighting the building as a whole - espeically when alternative programming is inserted in the building that was not originally designed to accommodate for its conditioning needs. Residential or office program require higher intensity of heating and cooling than industrial programming, and the Typical New England Mill's envelope was not designed to accommodate these neetds. To make the building more energy efficient, building systems need to be designed specifically for the spacial needs, utiliziing modern technology and creating design.

The typical air ventilating systems that push warm air and extract cold air through a space is inefficient for the large volumes of space featured in Typical New England Mills. Heated floors and chilled beams are more efficient and modern technologies that can be applied to existing structures that are more energy efficient.

Heated floors radiate heat from the floors up - providing greater heat intensity where the occupants need it most. This method allows for less heat to be used and less heat to be wasted in the higher volumes of space closest to the ceiling.

Chilled beams provide cooling from the ceilings to settle downward into the dwelling spaces below. Chilled beams takes room temperature air from the space it is treating, passes the air through cooling coils, mixes it with pre-treated primary air from an air duct and pushes the air back into the room. Chilled beams can be used actively with the duct ventilation or passively if a separate system, such as natural ventilation, is supplying fresh air to the space. This method recycles interior air while cooling and circulating the air in natural air flow patterns and has passive energy options for energy savings that can be paired utilized in mixed-mode building systems.

Mixed-Mode building systems utilizes natural ventilation and daylight for lighting, heating, cooling, and venting interior space. Mixed-Mode systems uses sensors to automatically shut off the mechanical systems when the exterior environment is ideal to perform interior conditioning passively. Mixed-Mode saves on energy use, resource use, and contributes to healthy and natural interior living environments.

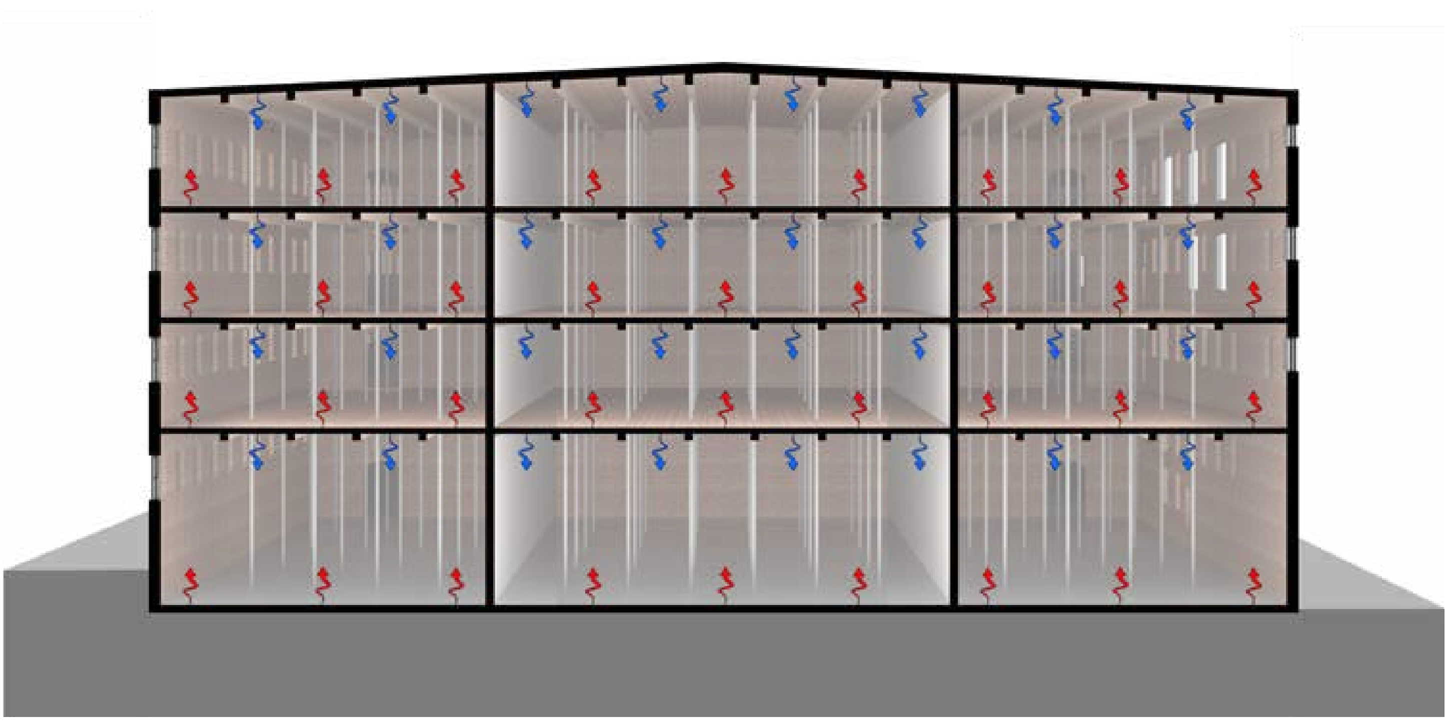


Figure 5.2.6 104 Anawan HVAC Update Section Perspective (Source: Morgan Warner)

Figure 5.2.7 Heated Floors System; (Source: Radiant Floor Heating)

This image showcases the layers of floor construction included in heated floor systems and its assembly.

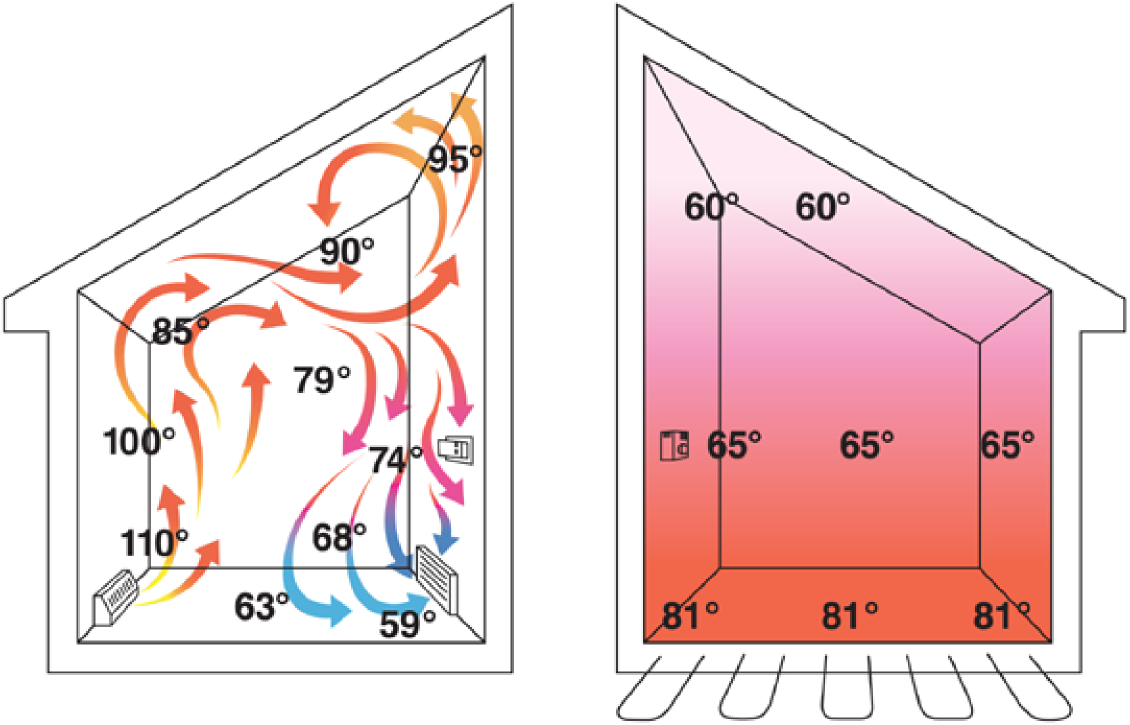


Figure 5.2.8 Heated Floors Heat Distribution Diagram; (Source: Building Green)

This diagram illustrates the difference in heat distribution from a conventional ventilation heating and cooling system vs. radiant heating from floors. The air is more evenly distributed and targeted around the floor occpant along the floor plain, rather than hottest along the ceiling plain where the occupant isn't.

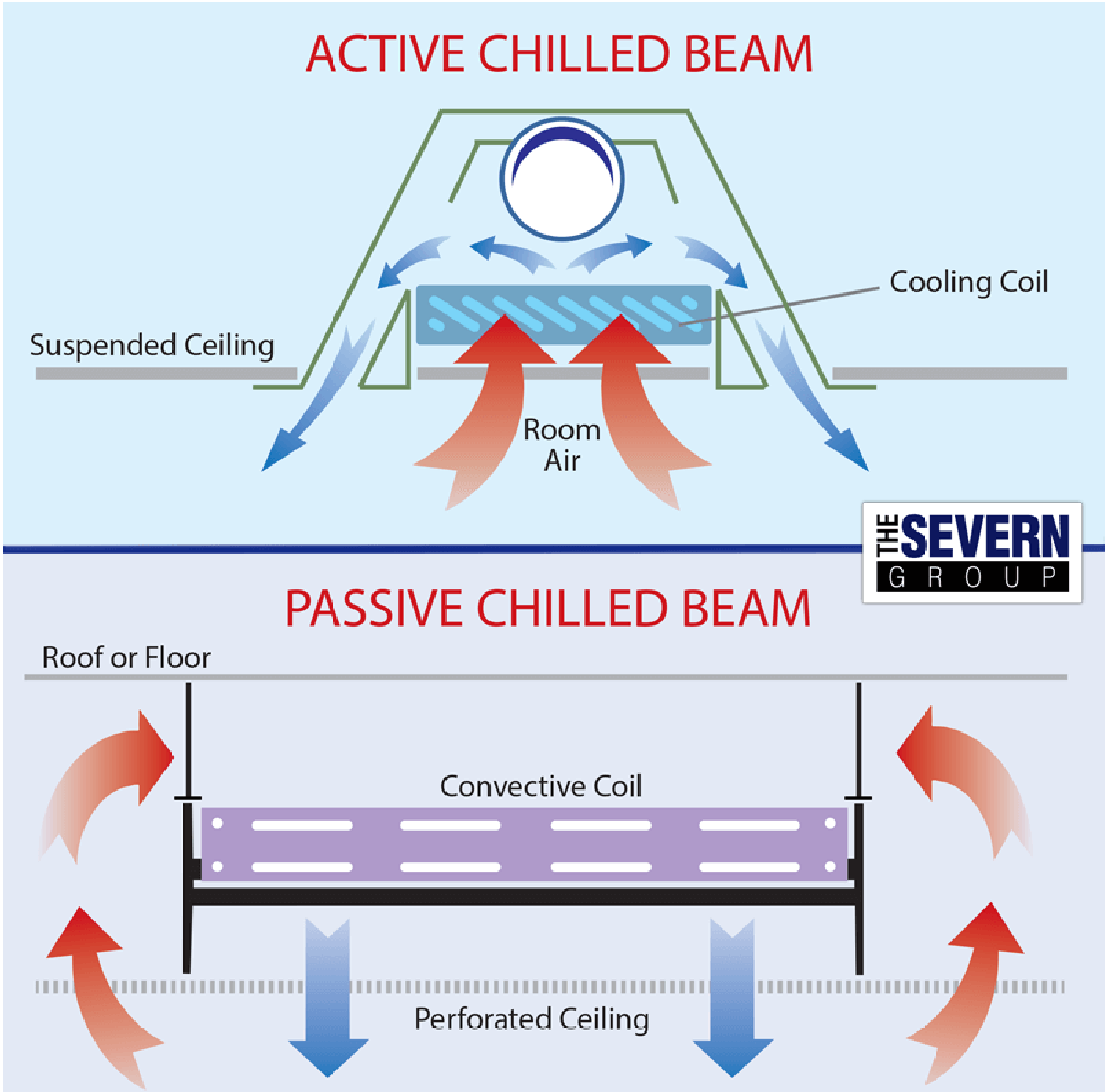


Figure 5.2.9 Chilled Beam System Diagram; (Source: The Severn Group)

This diagram illustrates the systems of a chilled beam in its active state and passive state.

Figure 5.2.10 Chilled Beam; (Source: Building Green)

This interior office space demonstrates the application of a chilled beam, representing its aesthetic and interaction with the ceiling plain and occupant dwelling space.

Energy Petal

Existing buildings pursuing the Living Building Challenge 4.0 are required to lower their building's Energy Use Index (EUI) to below 50% of that of the National Baseline EUI. To achieve this goal, the building systems are selected and designed based on the building's existing size, shape, and program requirements to ensure maximum efficiency while still achieving the required conditions for the interior program. Heated floors provide heating directly to the occupants dwelling space rather than consistantly keep an entire volume of space heated - wasting heat on higher spaces within a room and struggling to keep the dwelling area heated. Chilled beams provide diffused cooling evenly distributed throughout an interior space, and includes passive and active settings to accommodate for mixed-mode building systems that save energy and resources.

Health + Happiness Petal

The temperature comfort and air quality of interior spaces greatly effects the physical and mental health of the occupants. The heating and cooling temperatures of the building not only need to meet their comfort temperatures, but the interior space needs to be evenly heated and cooled for consistancy per square foot and throughout the day. The fluctuation of temperature throughout the interior space or throughout the day can cause negative effects to the human body's physical health. The use of heated floors and chilled beams present the opportunity to customize the heating and cooling experience of interior spaces while evenly distributing the desired temperature. Chilled beams specifically also offer the chance for controlled ventilation.

The inclusion of passive daylighting and ventilation in mixed-mode systems support healthy Indoor Air Quality (IAQ) and reinforce the human body's natural circadian rhythm. Natural ventilation helps reduce the interior's Carbon Dioxide concentration and purifies the interior air from allergens and germs.

The human body's natural circadian rhythm is the body's natural clock that triggers human function, such as sleep, insulin secretion, and cardiovascular / skeletal strength. When the circadian rhythm is on track, the body's performance is at its best - resulting in peak alertness, peak reation time, peak coordination, and best physical and mental health. To support the circadian rhythm, the body must experience the varing qualities of daylight throughout the day by the presence of daylight and views in interior space.

Independent Building Design Strategies and Technologies for Water Use

There are four goals when implementing design strategies and technology to facilitate a building's water use: 1) Reduce the building's water demand, 2) Recycle water, 3) Reduce or prevent wastewater overflow in the wastewater treatment facilities or sewer systems, and 4) Manage stormwater on site as to not allow flooding but not disturb the ground's natural aquifer.

Technology to reduce a building's water demand include half flush toilets, composting toilets, censor opporated water faucets, low flow shower heads, water-efficient laundry machines, waterless urinals, and pressure-reducing valves.

Greywater is the waste water sourced from hand sinks, laundry machines, showers and baths. Blackwater is the waste water product from toilets. Recycled greywater can be stored, treated, and used to supply cooling towers, surface irrigation, laundry machines, or toilets. Overflow greywater can be designed to be responsibly put back into the earth to recharge the aquifer once water has been treated. Recyceld blackwater can be stored, treated, and used to source cooling towers or sent to a collection plant.

Design strategies to responsibly manage stormwater include the use of rain gardens, greenroofs, or rainwater roof collection. Rain gardens are landscapes that harvest ground stormwater, utilize plants that require or can withstand heavy amounts of water, filter and clean the rainwater from any impurities, and allow the excess rainwater the garden does not use to reenter the earth. Similarly, greenroofs are designed greenery on building rooftops that utilize rainwater, filter excess rainwater and store it for building use or aquifer recharge. Rain water roof collection harvests and stores rain water for building use or aquifer recharge.

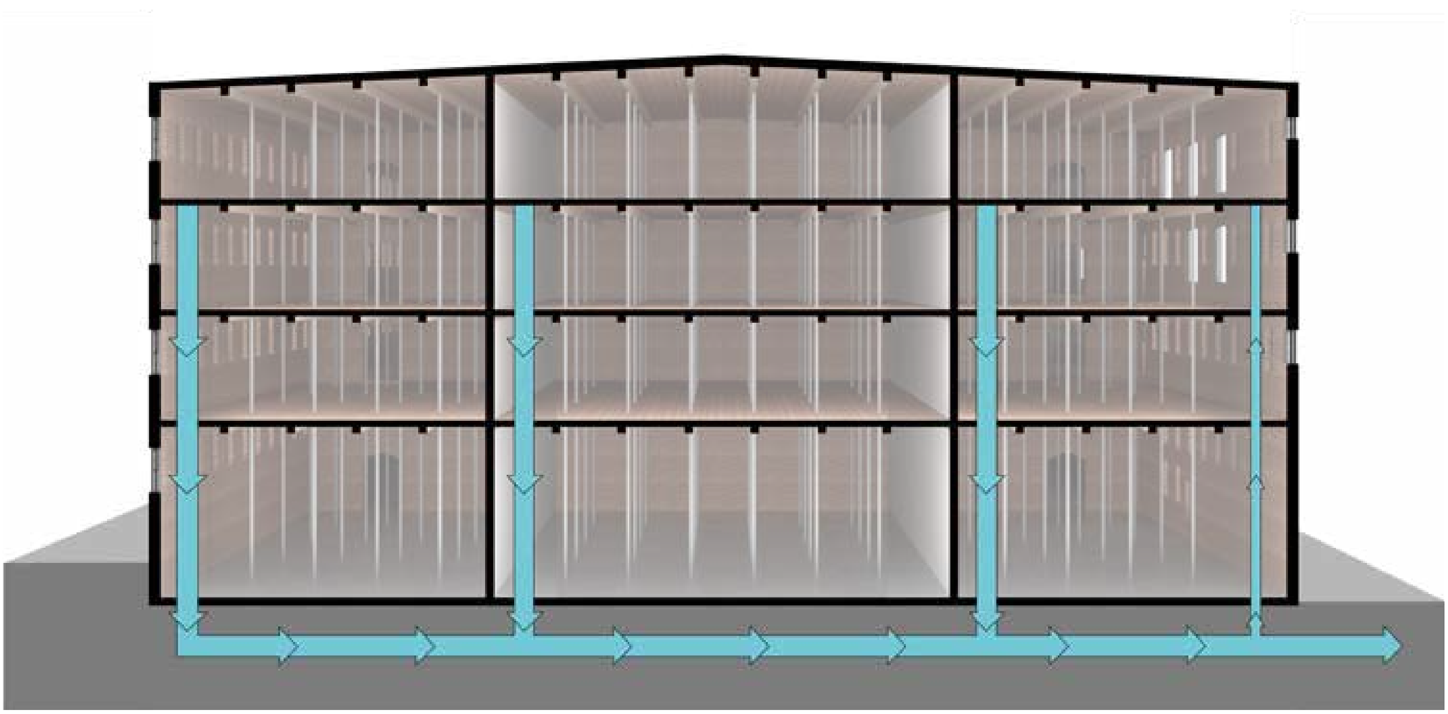


Figure 5.2.11 104 Anawan Greywater Reuse Section Perspective (Source: Morgan Warner)

Building's Flush Fixtures (can be met with non-potable) WUI (kGal/yr)

= (A1 x B1) + (A2 x B2)

A1 = Office Flush WUI
A2 = Residential Flush WUI
B1 = Office Occupancy (140/sqft)
B2 = Residential Occpancy (500/sqft)

(Source: EnergyStar)

Greywater Production (kGal/yr)

= (A1 x B1) + (A2 x B2)

A1 = Office Greywater Production Index
A2 = Residential Greywater Production Index
B1 = Office Occupancy (140/sqft)
B2 = Residential Occpancy (500/sqft)

(Source: EnergyStar)

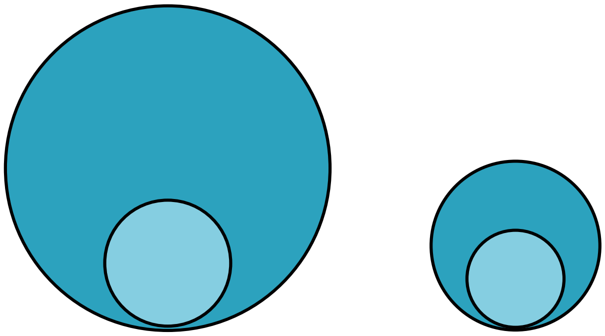
Greywater Produced (Kgal/yr/occupant) - *(Source: EnergyStar)*

Building Program	National Baseline - Conventional Fixt.	LBC4 - High Efficiency Fixt.
Industrial	-	-
Office	0.423	0.328
Retail	-	-
Residential	9.8	9.8

Flush Fixtures WUI (Kgal/yr/occupant) - *(Source: EnergyStar)*

Building Program	National Baseline - Conventional Fixt.	LBC4 - High Efficiency Fixt.
Industrial	-	-
Office	1.09	0.57
Retail	-	-
Residential	2.91	2

Figure 5.2.12 Water Reuse Efficiency Diagram; (Source: Morgan Warner)
This diagram represents the amount of water that flush fixtures use and the amount of greywater is produced for conventional flush fixtures and high efficiency fixtures.



CONVENTIONAL FIXTURES

Flush Fixtures WUI
1,161 kGal/yr

Greywater Produced
450 kGal/yr

= 38.8% Non-potable
Water Use Met With
Greywater

HIGH EFFICIENCY FIXTURES

Flush Fixtures WUI
607 kGal/yr

Greywater Produced
350 kGal/yr

= 57.5% Non-Potable
Water Use Met With
Greywater

Water Petal

The inclusion of high efficiency fixtures, high efficiency flushing, and grey water recycle, 104 Anawan can reach the initiative for 100% Non-Potable Water Sourcing For Non-Potable Water Use. Reducing the water demand with modern plumbing technology is critical in the reduction in the building's water demand. The reduction in water use will not only conserve potable water, but will also lower the water bills for the entire building and save all tenants money on operational costs. Grey water recycle ensures that water that is used for human use is used to its fullest extent - minimizing waste production and keeping continuity with the identity of the South Waterfront district as a sustainable, reuse district.

Roof Replacement with Skylights or Atrium Addition

The Typical New England Mill has a deep and open floor plate. Daylight generally only penetrates the building double the length of the ceiling height. The average ceiling height of 104 Anawan is 15ft, meaning daylight only enters 30ft from the exterior walls. For this building typology, one method of providing natural daylight to the interior of the space is adding atrium(s).

Atrium space has the potential to add natural daylight to the center of a building, determined by its location within the building, its size, and its shape. For 104 Anawan, several atrium options were tested for their affect on the illuminance levels of each floor. It is suggested that the atrium take a rectangular shape through the middle of the building, opening the space between the two firewalls. This design open the space shared circulation between privately owned floors or spaces. Additional windows can be added to each of the firewalls for direct and ambient light to enter the entire building center.

The atrium skylight and floor plate cut outs require additional reinforced structure to support the floor structure. This structure can be created through recycled wood floor beams. Additional lateral supports are needed for structural stability.

The atrium design strategy also offers the opportunity for added air circulation through skylights. The atrium acts as a large air shaft that pulls natural air flow through exterior windows, into the atrium, and out of the roof. This ventilation strategy can be performed passively though interior windows or actively through air ducts.

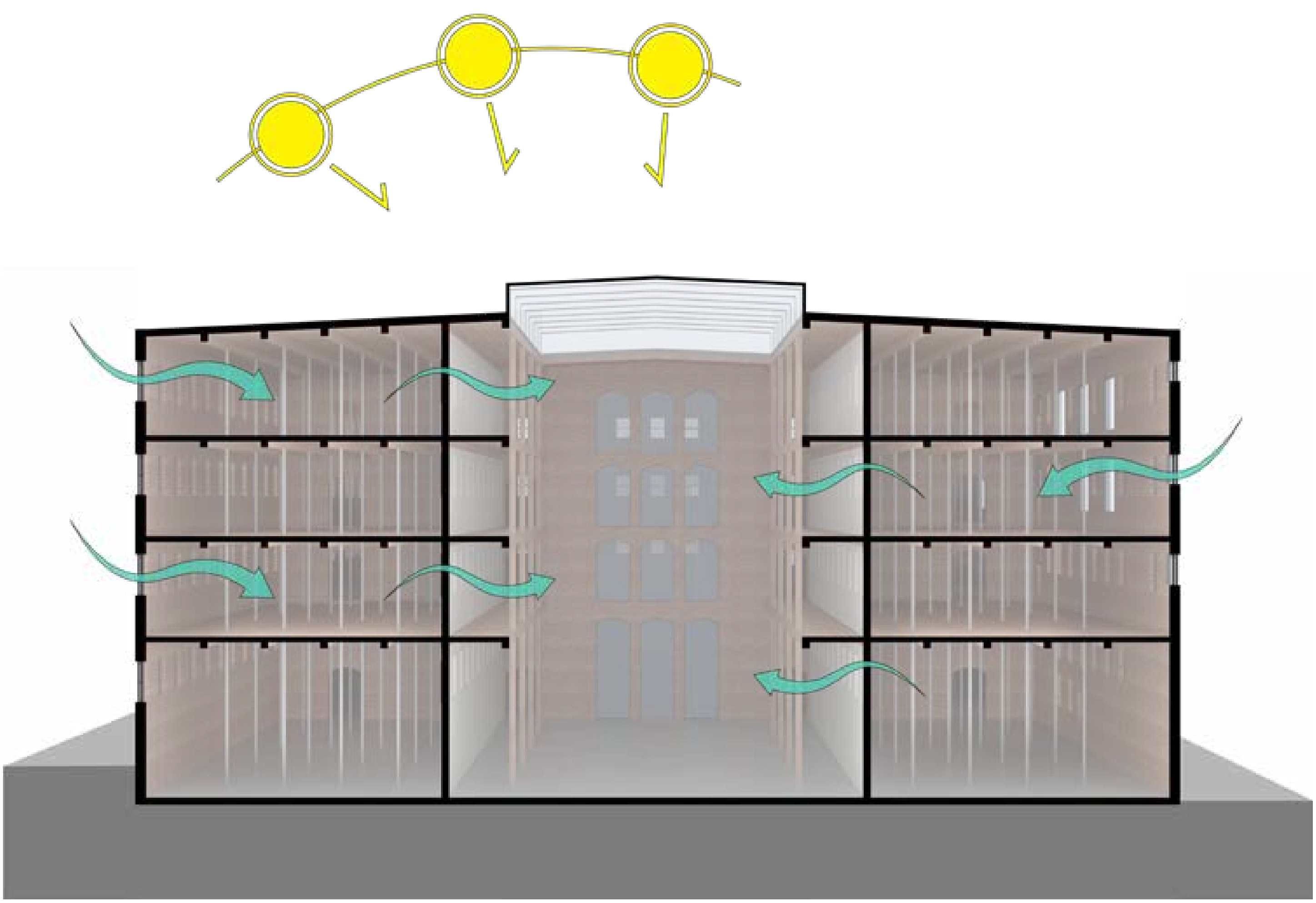


Figure 5.2.13 104 Anawan Roof Update Section Perspective (Source: Morgan Warner)

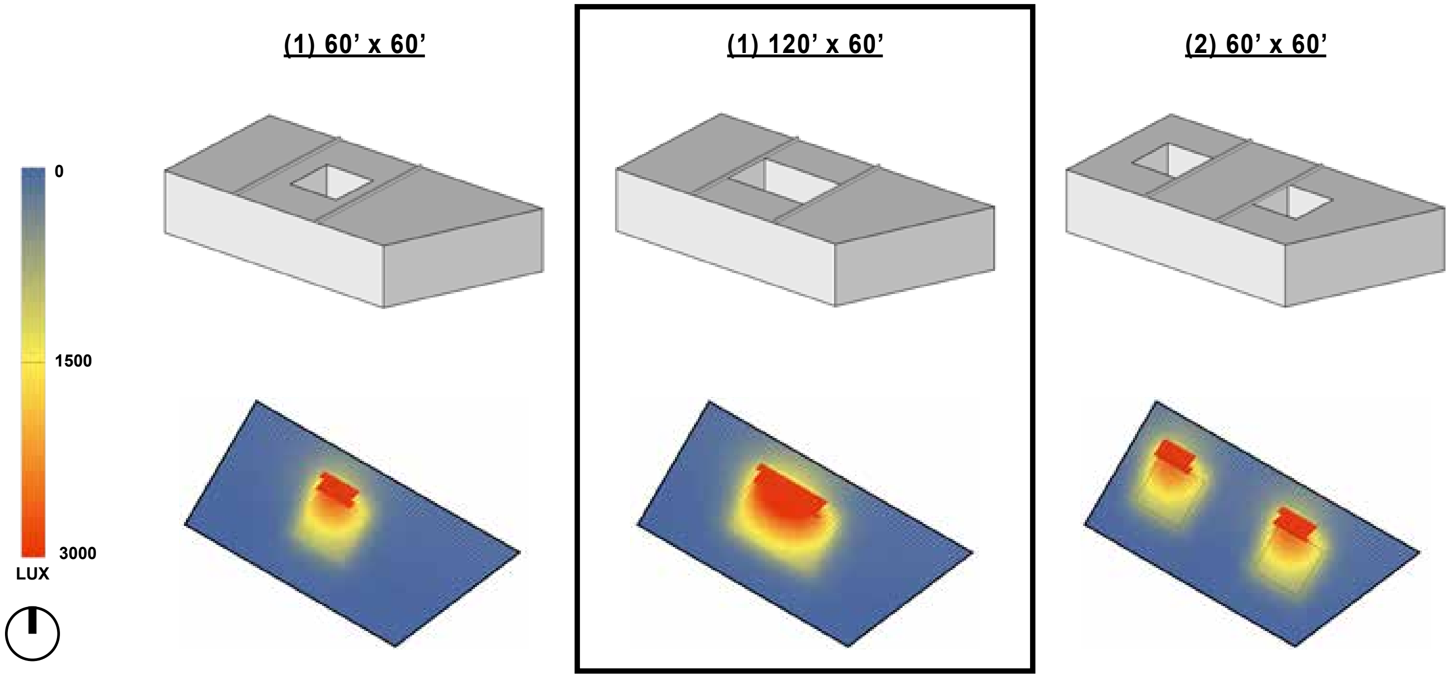


Figure 5.2.12 Atrium Variation and Illumination Diagram; (Source: Morgan Warner) This diagram presents axons of three atrium options onto the existing 104 Anawan building and illumination studies of the second floor of the building. The illumination studies represent the effect the atrium has to the building's natrual daylight availability. The option chosen for this thesis is the single 120' x 60' atrium in the center of the building.

Energy Petal

Redesigning the interior space to introduce maximum natural daylight and ventilation has the potential to result in a reduction in energy use. This strategy creates an interior environment that is suitable for a mixed-mode HVAC system that can utilize natural heating, cooling, ventilation, and lighting and turn off or reduce the intensity of mechanical systems -reducing the building's operation energy.

Materials Petal

New construction may also utilize material salvaged from demolished existing structure. Wood beams, wood floor construction, and cast iron columns taken out of the building design for the atrium addition can be repurposed elsewhere for interior construction, furniture design, or new supportive roof structure added around the atrium.

Health + Happiness Petal

Design strategies can be applied to maximize the amount of natural daylight and ventilation that penetrates the interior spaces. The 104 Anawan redesign benefits from an added atrium in the center of the building where the interior space has the lowest quality of natural ventilation or daylight. The choice of atrium size and shape is determined based on building width and spacing of the shear firewalls. The atrium acts as a light shaft as well as a ventilation shaft that pulls air through the building facades, into the atrium, and out the roof.


Google

CHAPTER 06

Thesis Conclusion

This chapter will reflect on the project's research and execution. The chapter will be split into two sections: 1) Project Summary, and 2) Work Cited. The Project Summary will outline the design interventions executed, highlight the areas of success and those that require further exploration, suggest next steps for the project, and specify the margin of error. The work cited will provide a Figures List as well as a Work Cited reference page.

06.1 Project Summary

The Project Summary will provide an overview of the thesis along with a reflection of its execution. The summary will cover four parts: 1) An overview of final urban and building designs, 2) An outline of design strategies and which LFC petals each design strategy applies to, 3) Next steps for the project, 4) Project significance, and 5) Margin of Error. The goal of this summary is to highlight the success of the thesis and note the areas of improvement.

Final Designs for Fall River Waterfront Urban Renewal and Adaptive Building Reuse

The final design of 104 Anawan exemplifies standard sustainable design strategies that can be applied to the Typical New England Mill typology that elevate the building's operational performance and efficiency. The overall design is strongest if all sustainable interventions are present, however, each sustainable design strategy that is represented in the rehabilitation design is independent and can stand alone. This quality allows for similar projects to prioritize which elements of building operational performance are most important if their project's budget are limiting or if their existing building's design is restrictive. The 104 Anawan reuse design features sustainable design strategies that are complimentary to each other, to mixed-mode building conditioning systems, and to passive house design.

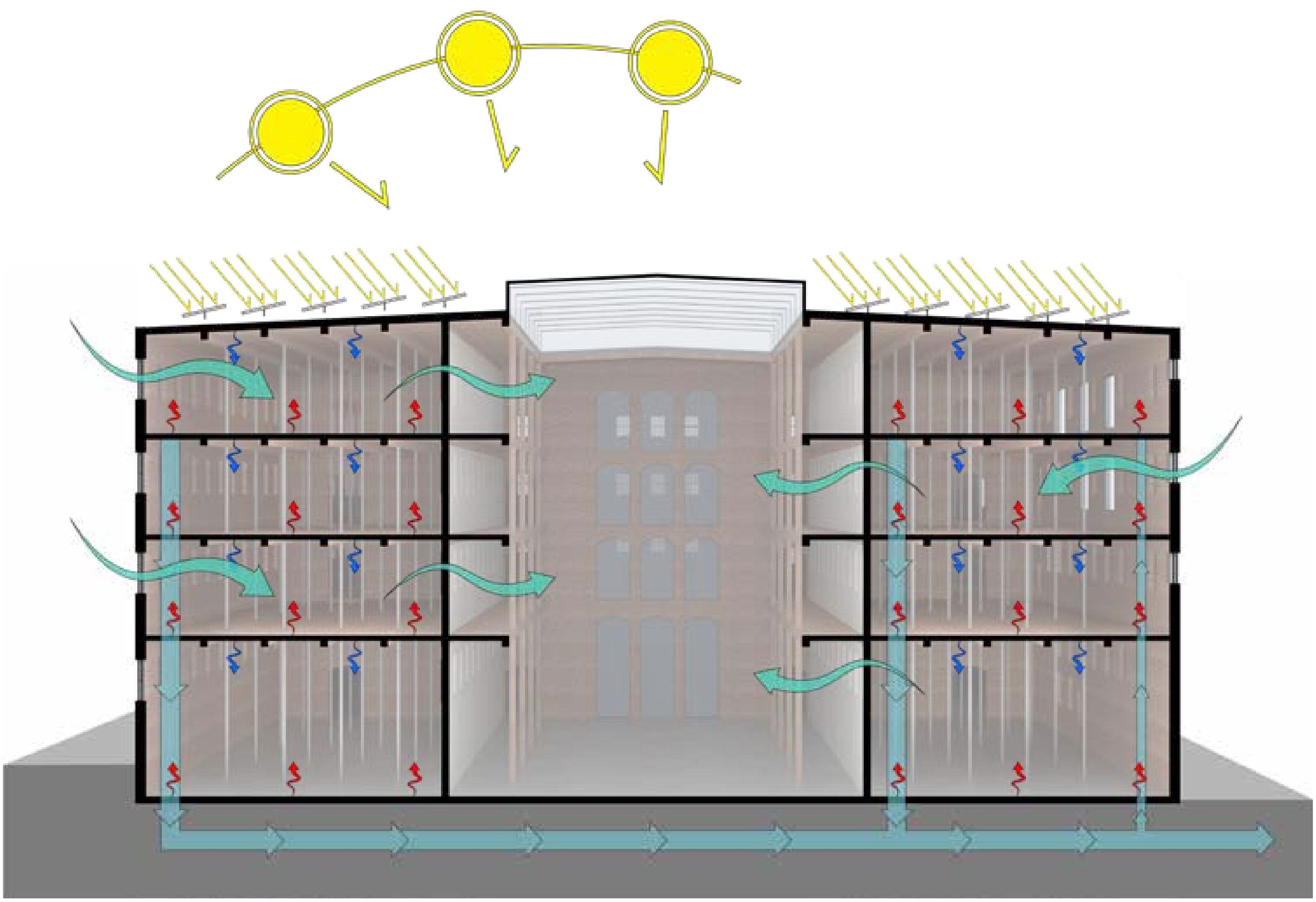
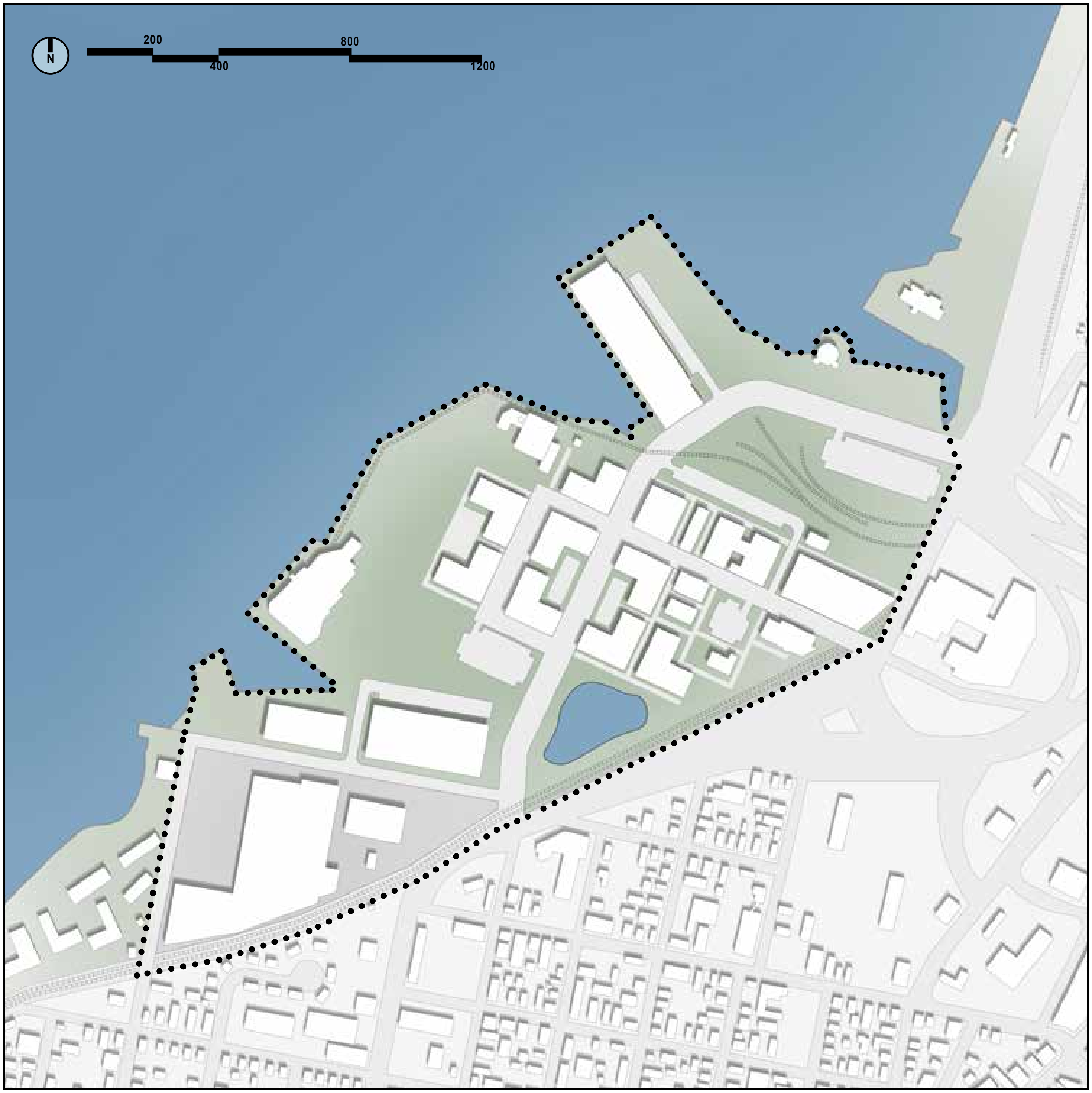


Figure 6.1.1 104 Anawan Adaptive Building Reuse Section Perspective (Source: Morgan Warner)

The final design for the South Waterfront district Masterplan integrates new construction with existing structures in line with Fall River's goals for urban development. This plan introduces residential program to the district as well as increase the density for commercial and office program. This masterplan suggests that the city decrease its industrial program for this area due to its close proximity to Downtown Fall River and its inclusion of multiple historic landmarks and attractions. The density is focused along the Anawan St. axis and provides multiple open public space that celebrate natural, historic, and existing features of the site. Detailed site design features are multifunctioning to meet several design and sustainability goals for the site. Features such as District Solar Energy Production and District Rainwater Collection connect all buildings in the district by using shared resources.

Figure 6.1.2 Fall River South Waterfront District Masterplan Proposal Map (Source: Morgan Warner)



Design Strategies Under Living Future Challenge Petals

Collectively, the South Waterfront district's masterplan and the 104 Anawan Adaptive Building Reuse redesign fulfill the Living Future Challenge petal requriements. The following is a complete list of the executed design interventions this thesis has included for both the urban masterplan and building redesign:

Energy Petal

1. Preservation of Existing Construction
2. All New Construction Built to Meet Living Building Challenge 4.0 EUI Requirements
3. Shared District Solar Installation, Production, and Distribution
4. Building Envelope and Construction Assembly Upgrade for All Existing Construction
5. Heated Floors; Chilled Beams; Mixed-Mode Mechanical Systems in All Existing Construction
6. Introduction of Atrium to Existing Construction as Necessary

Materials Petal

1. Preservation of Existing Construction
2. All New Construction to Use Non-Redlist Materials
3. All New Construction to Source New Material From Local Manufacturers and Meet Living Building Challenge 4.0 Material Sourcing Restrictions
4. All New Construction to Use Materials Outlined in District Design Guidelines
5. Demolished Site and Building Material to be Reused in New Construction as Feasible

Water Petal

1. District Rainwater Collection and Distribution
2. Independent Building Greywater and Blackwater Reuse
3. Stormwater Runoff Addressed On-Site

Place Petal

1. Preservation of Existing Construction
2. All New Construction to Follow District Design Guidelines for Exterior Design and Building Height
3. Urban Growth Density Along Anawan St.
4. Public Open Space Along Waterfront and Battleship Cove
5. District-Wide Solar Production and Rainwater Collection as New Industrial Identity
6. “Green Streets” to Connect Waterfront to Adjacent City Neighborhoods; Reinforce Travel Safety; Introduce Vegetation to District; Introduce Bus Stop and Bike Path; Facilitate an Active Lifestyle
7. Stormwater Management and Supportive Landscape Design

Health + Happiness Petal

1. “Green Streets” to Reinforce Travel Safety; Introduce Vegetation to District to Combat Noise, Air, and Water Pollution; Facilitate an Active Lifestyle
2. Heated Floors; Chilled Beams; Mixed-Mode Mechanical Systems in All Existing Construction
3. Introduction of Atrium to Existing Construction as Necessary for Natural Daylight and Ventilation

Equity Petal

1. New Construction to Include Residential Program and Provide Affordable Housing
2. District Solar Installation and District Rainwater Collection
3. “Green Streets” to Connect Waterfront to Adjacent City Neighborhoods; Reinforce Travel Safety; Introduce Bus Stop and Bike Path; Facilitate an Active Lifestyle

Beauty Petal

1. Preservation of Existing Construction
2. Preserve Waterfront Views from Eastern Approach Along Anawan St.; Along Waterfront; Along Battleship Cove
3. “Green Streets” to Introduce Vegetation for Aesthetic Appeal

Next Steps for Thesis Project

The overall goal of this thesis was to demonstrate all possibilities for sustainable intervention onto existing industrial sites. However, the duration of this thesis was limited to 3 months of research and 3 months of project execution. Consequently, not all sustainable interventions - including building and site analysis; building design strategies; and building and site technology - were able to be explored. The steps missed during the process of project research are as follows:

- Two sets of comparable Life Cycle Assessment reports. The first set would compare embodied energy and the second set would compare embodied carbon. Each set would use the same three variations: 1) 104 Anawan as is, 2) 104 Anawan renovated with modern building technology and construction assembly, and 3) New construction comparable to 104 Anawan in size, using modern building technology and construction assembly. These LCAs would be performed to argue in favor for the reuse and renovation of existing mill buildings, rather than their demolition and new construction.

- Research and outline specific measures to clean and rehabilitate brownfield sites. The city of Fall River, MA has outlined in their draft document, The Fall River Waterfront Urban Renewal Plan, the measures the city will take for each of their waterfront districts in order to ensure the site’s soil, air, and water is healthy and rid of pollutants caused by previous industrial activity. The purpose of this research would be to suggest any further measures this specific site should take and to better understand the site’s limitations for future uses based on its current ecological health risks - guiding future program and land use.

If this thesis were to be extended indefinitely, the next steps for this project would as follows:

- Perform LCAs at the district scale, analyzing the embodied energy and embodied carbon saved and lost when selecting which buildings to keep and which to demolish.

- Apply specific programming within every structure of the district masterplan and measure EUI more specific to program.

- Explore the possibilities for alternative renewable resourcing; including wind power energy, geothermal heating, and second-hand heat production resulting from other technologies.

- Calculate the possibilities for Shared District Greywater Reuse.

- Use building energy modeling software to more specifically design the envelope and construction assembly of 104 Anawan.

- Explore more sustainable building design strategies and technologies; including alternative heating and cooling systesms and roof design.

- Outline possible sources of financing for this district-wide project - incluidng any insentive programs earned by completing Living Future Challenges.

Margin of Error

Ultimately, this thesis is an educational exercise performed by a graduate student with the purpose of exploring sustainable applications onto existing sites. All aspects of the project execution - including site analysis, site measurements, and building performance calculations - are all subject to a margin of error. The following is a list of possible error within the project:

- The site analysis was conducted and is based on human observation from the public perspective - private access onto individual privately owned sites was not permitted. This restriction results in speculation for building height, interior building squarefootage, building material, building condition, site material, and site condition.

- Official building and site plans were only provided for 104 Anawan St. - all other site measurements, including topography, were provided using MassGIS as a reference. All measurements were rounded to the nearest 5ft.

- Existing building program information was collected using human observation and Google Maps. Complete or up-to-date program information could not be obtained.

- Measured building EUI and Solar Energy Production is 1) Limited to office, retail, residential, and industrial program, 2) Calculated using squarefootage rounded to the nearest 10ft.

- Measured building WUI and Greywater Reuse is 1) Limited to office, retail, residential, and industrial program, 2) Calculated using squarefootage rounded to the nearest 10ft.

The purpose of this thesis was to explore the opportunities for sustainable design interventions at every scale of the built environemnt, and to demonstrate their applications into existing industrial sites. Across the United States, there are industrial sites as well as existing, underutilized sites similar to that of the Fall River Waterfront that present the opportunity and need for large-scale urban redesign. Sustainable design and technology are most efficient when working as an urban scaled system of buildings and site infrastructure, rather than singular buildings independent from site context or district infrastructure. Industrial sites up for urban redesign offer a rare opportunity to introduce large-scale sustainable infrastructure that can not only be incorporated into their urban redesign, but can be used to support and reach additional goals for the project as well. Using programs like the Living Future Challenge as a performance standard and a design framework provide guidelines and assisting resources to projects to help achieve design and performance goals most important to the project.

Industrial sites that are comparable to that of the Fall River Waterfront share similar design challenges, including the decision to either rehabilitate or demolish existing structures. Rather than clear parcels and start from scratch, this thesis advocates for building reuse and rehabilitation for all viable structures and site features. Demolishing structure for the purpose of new cosntruction to take its place goes against the goals of sustainability to reduce a project's embodied carbon, embodied energy, and carbon emissions. This thesis demonstrates that with the use of high efficiency design and technology, existing structures have the potential to drastically decrease their use of resources, minimize their operational energy, and minimize their operational carbon output. The rehabilitation of existing structures decrease project waste and preserve a site's connection to its history and culture as the future of sustainability and urban growth progress.

This thesis serves as a case study for existing and underutilized sites on how to introduce sustainable design interventions and utilize sustainable design and technology to achieve additional project goals. It is the goal of this thesis that large-scale urban redesign projects consider the various applications of sustainability and use existing design framework to build off of.

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