Syllabus Diploma Project – Adaptive Reintegration

RAIC Syllabus Program Thesis Report

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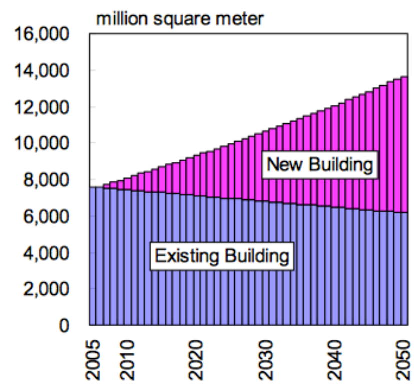
Introduction



From 2010 to 2030 eighty billion square metres of new construction will be built in urban areas worldwide. That is an increase of 60% of the world's total existing building stock, equivalent to all of New York City being rebuilt every 35 days. Of this new construction, the world's three biggest emitters will produce over 50% of these new buildings, with Canada and the USA being responsible for 15%, and China responsible for 38%.[1]

With all of this new construction in urban areas, land is at a premium and existing buildings are often demolished to make way for newer projects. Every year thousands of buildings are taken down, and hundreds of thousands of tons of still useful material is simply landfilled, resulting in a large waste of resources. However, even at the current rate of demolition, by 2030 nearly $^{2}/_{3}$ of the building stock will be pre-2010 construction, and by 2050 that percentage will still sit around ½ of all buildings.[2] With the building bylaws and codes getting more stringent on energy usage, water efficiency and land use, new construction is continually being pushed to be more environmentally sustainable than its

[1] Mazria, Edward. *Road to Zero; Building Lasting Change*, 2015 Keynote Presentation, (available from https://www.youtube.com/watch?v=KD07KY5ouqI; Internet;) Vancouver BC: Canadian Green Building Conference, 2015 sourced from UN Habitat, State of the World's Cities 2010/2011, McKinsey Global Institute.

[2] U.S. Department of Energy, *A Buildings Module for the Stochastic Energy Deployment System*, Berkeley, CA: Berkeley National Laboratory, 2008.

predecessors, and with the rising cost of energy, and natural resources, this trend can only be expected to continue. So the question is what can we do about the existing buildings, which will be the largest energy consumers in the future. The answer cannot be to continue to demolish our history to make way for new developments. Despite all the sustainable features a new development can pack in, the full embodied energy and environmental impact of a new development still causes more harm to the environment than reusing a building that already exists. Further to this, cities need old buildings; they preserve the sense of character, unique identity and history of communities where people live, work and play.[3] Preservation of old buildings is not about just saving museum-piece old buildings, neighbourhoods need those, but they also need plain, ordinary low-value buildings just as much.[4] If a city area has only new buildings, the businesses and population that can exist there are automatically limited to those that can support the high costs of new construction.

As described by Jane Jacobs in Death and Life of Great American Cities[5], typically only businesses that are well established, have high product turnover, are highly standardized or are heavily subsidized can afford to carry the costs of new construction. Businesses like chain stores and restaurants, banks and car dealerships go into new construction, whereas neighbourhood bars, foreign restaurants and mom and pop stores, go into older buildings. Well subsidized opera and art museums often go into new buildings but the art studios, galleries, stores for musical instruments and art supplies, go into old buildings. Perhaps more significant, hundreds of ordinary enterprises, necessary to the safety and public life of streets and neighbourhoods, and appreciated for their convenience and personal quality, can be successful in old buildings, but suffocate from the overhead of new construction. In addition, neighbourhoods today are also lacking light industrial enterprises in their

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3 Vancouver Heritage Foundation. *Conserving Heritage Buildings: In a Green and Growing Vancouver*. Vancouver, BC: VHF, 2012.
4 Jacobs, Jane. *The Death and Life of Great American Cities*, New York: Random House. 1961. pg 187.
5 Ibid., pp. 187-188.

communities, as new construction has decimated the former industrial lands of the downtown cores taking with them, a diversity of jobs and industry from these neighbourhoods. Jane Jacobs continues her discourse on old buildings by stating:

> *"really new ideas of any kind – no matter how ultimately profitable or otherwise successful some of them might prove to be – there is no leeway for such chancy trial, error and experimentation in the high-overhead economy of new construction. Old ideas can sometimes use new buildings; new ideas must use old buildings."*[6]

Preservation of the existing built environment along with a mix of new construction creates diversity, and is the most environmentally sustainable option. Conservation is an important part of ensuring that Vancouver achieves its affordability and greenest city goals, while retaining the character of its unique neighbourhoods and this must be done in a way other than the wholesale gutting of existing structures to be replaced by a single-use. So the question that is left is: can existing building stock be sensitively redeveloped to promote diversity, meet civic priorities of affordability, density, and environmental goals, such as the Vancouver neighbourhood energy strategy and the 2030 challenge, without adversely changing them or the neighborhoods in which they exist?

Project Statement:

Adaptive Reintegration: A building conservation strategy is needed to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for them to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency.

[6] Ibid. pg. 188.

Methodology:

The initial research will be two-fold, first I will review empirical data on different regional energy strategies and the how and why they work in the regions they are located in as well as different sustainability systems such as LEED, Passive House, and the Living Building Challenge and how each one might work with existing buildings. Secondly, I will research local and international historical preservation methods and sustainability options for neighbourhood developments.

The second phase will look at both local and international developments that have included historical building stock in their redevelopment as design precedents and review the quality of the product produced and the enhancements they were made to the existing buildings, and neighbourhoods and how they might work in the Vancouver climate. I will then develop a list of objectives and review project areas that are currently listed as endangered existing building areas in Vancouver to find three different sites that can use different strategies that were researched in the previous two stages, and compare and contrast schematically how the different sites might work against the objectives set by the clients.

I will then be selecting a single site from the three previously discussed and review the different energy and development strategies, to compare the different options to find which would seem most appropriate for the site selected.

The final stage will then be to design a neighbourhood development strategy that incorporates new and old construction within the mindset of the current civic priorities of affordability, density, and energy efficiency, and evaluate it against the empirical data reviewed in the earlier stages.

Adaptive Reintegration: A building conservation strategy is needed to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for them to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency.

The original ideas for this project came from both Jane Jacobs, in 'Death and Life of Great American Cities', specifically the chapter 'The need for aged buildings' and a keynote presentation 'Road to Zero; Building Lasting Change' by Edward Mazria given at the 2015 Canadian Green Building Conference in Vancouver that I attended. These two separate pieces led the discussion and research into the inherent value of building conservation, and how the increasing rate of development in Vancouver might be adversely affecting not just the affordability of the city, but also how the type of developments that are being created and the rate at which they are happening, might be irreversibly affecting the character of the neighbourhoods as well.

Research Synopsis – Jurisdictional Documents and Initiatives:[7]

As discussed in the project proposal, the research started with a review of the City of Vancouver's initiatives and documents such as: the Greenest City 2020 Action Plan, the Renewable City Strategy 2015, the Neighbourhood Energy Strategy, and the Energy Retrofit Strategy for Existing Buildings.[8] To summarize these documents, the Greenest City 2020 Action Plan lays out measurable targets that can be tracked year after year to see if the city is meeting its sustainability goals. These measurements include greenhouse gas emissions, % of renewable energy produced, bike trips taken, solid waste landfilled, trees planted, total water consumption, amount of local food grown, and the number of green jobs created. The Renewable City Strategy builds on the Action Plan, by laying plans for

[7] Refer to board 'Vancouver Heritage Conservation' attached at the end of this chapter.
[8] Refer to the Bibliography - By Reference Type section: Jurisdictional Documents and Initiatives for a complete listing of City of Vancouver documents.

zero emission building requirements, reducing building energy use and demand, increasing neighbourhood renewable energy options, increasing renewable energy generation, and increasing public transportation use. The Neighbourhood Energy Strategy builds on both of the previous documents regarding the amount of renewable energy used, by highlighting areas for expansion of existing systems, such as the South East False Creek neighbourhood energy utility (NEU), as well as highlighting areas for future district energy plant systems, such as Creative Energy.[9] Finally the Energy Retrofit Strategy quantifies the number of existing buildings by sector (commercial, residential, and industrial), and the greenhouse gas emissions emitted by both percentage and total emissions. However, the Energy Retrofit Strategy then focuses on only a small number of the largest emitters, (the five largest industrial plants, and 10% of the largest commercial property owners and multi-unit residential building owners), but does not have a strategy for energy retrofits for any small commercial or industrial properties.

What came out of a review of these documents is that the City of Vancouver has set a number of measureable targets, and looked into a number of strategies for meeting these targets; however, the different documents often did little more than list the targets and goals. What was lacking was how and when the targets could be achieved, and what to do if they do not meet the targets. There is also no information regarding enforcement strategies, or actual bylaw changes that could be put in place if voluntary participation by private business is not embraced.

Another key point of research into the City of Vancouver's documentation was a deeper look at Vancouver's current building conservation plans, specifically the Heritage Register, and the Heritage Action Plan. This review was to see how much protection the current register offers to existing buildings and how these documents currently work as an overall conservation plan for Vancouver's commercial districts. The initial finding in the documents that requires clarification was that being on the heritage register and a building

[9] Refer to section Research Synopsis – District Energy for more information.

designated as a heritage building are not the same thing. As described in the Heritage Action Plan, buildings on the Heritage Register are sometimes referred to as 'designated' sites; however, they are not protected unless they also have a heritage designation, a covenant on the property title, or are scheduled as protected in a heritage conservation area (such as the Chinatown historic areas [HA-1 and HA-1a] or the Gastown historic area [HA-2]).[10] So heritage designation is a legal way for the city to protect heritage buildings by regulating their demolition, relocation, and alteration through requiring a heritage alteration permit, which buildings on the Heritage Register do not require.[11] The Heritage Register, which was created in 1986, originally only including pre-1940s buildings, is in essence just a list of sites that are seen to have architectural or historical value, and is meant to be used as a planning tool and record of Vancouver's heritage. So in summary, all designated heritage buildings are on the Heritage Register, but only 25% of buildings on the register are designated and protected.[12] This leaves most buildings built after 1940 and 75% of the buildings on the register still open to change, alteration and or demolition with minimal oversight and protection. However, our purpose for wanting to conserve buildings is not because all existing buildings should be held sacred; instead it is just to protect the form, character, and function of the existing neighbourhoods, from losing large portions or entire city blocks to new developments. Again I looked to Jane Jacobs who explained it well be saying:

> *"For a city district to be successful some of the old buildings year by year are replaced by new ones---or rehabilitated to a degree equivalent to replacement. Over the years there is, therefore, constantly a mixture of buildings of many ages and types. This of course is a dynamic process, with what was once new in the mixture eventually becoming what is old in the mixture. Economics of time not hour by hour… but*

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[10] City of Vancouver, *Land Use and Development Policies and Guidelines: Vancouver Heritage Register*, Adopted by City Council on September 23, 1986; Last Amended: November 24, 2015. pg. 4.
[11] However, if a building on the Heritage Register applies for a development or building permit council may withhold approvals and permits to allow time for the Heritage staff to provide retention options or incentives.
[12] City of Vancouver. *Heritage Action Plan Report*. pg. 3.

economics of time by decades and generations. Time makes the high building costs of one generation the bargains of a following generation."[13]

Jane Jacobs continues this discourse by saying that the only harm of aged buildings is the harm that eventually comes of nothing but old age and that a city area in such a situation is not a failure because of being all old but that the area is all old because it is a failure. For some reason or combination of reasons, all of its businesses and/or people are unable to support new buildings or rehabilitation and it has also failed to attract newcomers, as they see no opportunities or attractions there.[14] A district with all old worn out buildings is bad for a neighbourhood, as it is unappealing to new investments and businesses, and a district of all new large developments is similarly bad for a neighbourhood because it has no room for new enterprises and the small day-to-day services needed in a lively community. A mix of older buildings and newer buildings is needed, but without any current protection for the majority of buildings, there is currently very little hampering large-scale demolition of districts for new developments.

To round out this section, in order to understand what it will take to build a new conservation plan for Vancouver, I also took a look at other jurisdictions across Canada and the United States to see what is being done. The findings are that most cities use a number of tax relief systems such as property tax abatements, property tax credits, property tax relief and sales tax grants and/or rebates to help conserve their heritage buildings. Other available options are increasing demolition fees for pre-1940 buildings, and in Vancouver there already exists the existing facade grants programs.[15] The issue with these policies is that they still do not deal with protection of buildings or neighbourhoods post-1940 and tax relief is negligible to developers that are looking to quickly build a new development and then turn over the property.

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[13] Jacobs, Jane. pg. 189.
[14] Ibid., pp. 188-189.
[15] City of Vancouver. *Heritage Report*. pg. 5.

Research Synopsis – Sustainable Design and Building Renewal:[16]

The research moved on to sustainable building programs such as LEED® for New Construction (NC), LEED® for Existing Buildings (EB:O&M), LEED® for Neighbourhood Development (ND), Passive House, and the Living Building Challenge.[17] However, with the exception of LEED® for Existing Buildings, the main focus of the other programs is on new construction. LEED® for New Construction incorporates some elements of partial building reuse, and recycling of building materials, but is more aligned to a major renovation which would incorporate substantial new work. Even looking at LEED® EB:O&M, it deals mainly with re-commissioning of mechanical systems, building maintenance and building operations, but does not encompass building envelope repair and replacement, other than how the building envelope reduces the building's energy use.[18]

This then led to a stream of research into sustainable renovation practices and conservation strategies in Vancouver and other cities across North America. In reviewing multiple cities, Preservation Green Lab kept coming up as referenced source. Preservation Green lab is part of the National Trust for Historic Preservation in Washington, a non-profit organization that works with cities across the United States to study and preserve historic buildings and communities. Two recent research papers in particular were reviewed pertaining to the topic at hand and these were: 'The Greenest Building: Quantifying the Environmental Value of Building Reuse'[19] and 'Older, Smaller, Better: Measuring How the Character of Buildings and Blocks Influences Urban Vitality'.[20]

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[16] Refer to boards – 'Existing Buildings Reuse vs New Construction' and 'Quantifying the Character of Buildings' attached at the end of this chapter.

[17] See Bibliography - By Reference Type section: Sustainable Design Sources for a complete listing.

[18] As of October 31, 2016 LEED® EB:O&M 2009 is no longer available, the replacement program in v4 is LEED® for Building Operations and Maintenance (O+M)

[19] Preservation Green Lab. *The Greenest Building: Quantifying the Environmental Value of Building Reuse*. Washington, DC, 2011.

[20] Preservation Green Lab. *Older, Smaller, Better: Measuring how the character of buildings and blocks influences urban vitality.* Washington, DC, 2014.

The Greenest Building: Quantifying the Environmental Value of Building Reuse, studied life cycle cost assessments of different building types; commercial office, warehouse to office, mixed use, elementary schools, single family residential, multi-family residential, and warehouse to multi-family residential. The studies looked at major cities across different climate zones in the United States, comparing new construction with renovating existing buildings. The studies found that building reuse almost always yields fewer environmental impacts than new construction when comparing buildings of similar size and functionality. These findings were not surprising, as operating performance was assumed to be equivalent for the reuse and new construction scenarios, and new construction typically uses more materials than a renovation.[21] However, even when the new building was assumed to be operating at 30-percent greater efficiency than the existing building, it still takes between 10 and 80 years for a new energy efficient building to overcome the impacts that were created during construction.[22] The report found that in mild climates similar to Vancouver (Portland, Oregon) demolition and new construction of an energy efficient commercial project takes on average 42 years to overcome the CO^2 deficit it caused through new materials over renovating the existing building. In contrast, in a more extreme climate such as Chicago, the newly constructed buildings time frame is reduced to an average of 27 years to reach carbon equivalency due to the greater number of degree heating and cooling days. The documents also explained how typically buildings built between the 1940s and 1980s are the worst energy emitters, as they typically contained a lot of inefficient mechanical equipment for supply and exhaust air, as well as space heating and cooling, which combine for over 50% of all energy costs in buildings.

With such a strong correlation, one would think building renovations would be more common, so the Greenest Building does explain what barriers exist that need to be overcome. One such barrier the study found was that in urban areas, there is a financial

[21] Preservation Green Lab. *The Greenest Building*. pg 62.
[22] Ibid., pg 66.
Note: 10 year was a primary school in Chicago, and the 80 years was for a single-family residence in Portland.

incentive to maximize the 'use potential' of sites, which often involves adding floor space to achieve economies of scale and heights for views. The study was comparing buildings of similar size and functionality, but it is quite common for developers to purchase and demolish small-scale buildings for much larger developments. Thus developers often perceive little economic justification for retaining existing buildings and instead look for developable land rather than buildings to retrofit. Further to this, rehabilitation work is typically regarded as riskier than new construction, because the process can be less predictable, and many developers fear being surprised by unforeseen challenges. This perception of risk and fear of the unknown can motivate decisions to demolish buildings even in instances where rehabilitation may be less costly and more profitable than new construction.[23]

In contrast to the Greenest Building, the second report 'Older, Smaller, Better: Measuring how the character of buildings and blocks influences urban vitality' looks less at energy performance and environmental costs, and more at the less tangible characteristics that make existing buildings worth keeping. Older, Smaller, Better looks into how many people use buildings, when they use them, how many businesses exist in an area, what kind of businesses exist, and how many workers they have. This study found that older mixed-use neighborhoods tend to be more walkable, have a higher density of people, a higher density of businesses per square foot, and jobs per square foot, as well as a more diverse mix of residents and age groups. These areas also support higher levels of small businesses and non-chain businesses, helping to keep dollars in the local economy, and providing more resilience against future economic storms. Of these businesses, older, mixed-use neighborhoods house significantly greater concentrations of creative jobs per square foot of commercial space compared to a new development. These older mixed-use neighbourhoods also have higher levels of nightlife, and in general a large mix of daytime and nighttime uses, as well as a higher level of common entrances and shared services per

[23] Preservation Green Lab. *Older, Smaller, Better.* pg 85.

square foot and very little space dedicated for cars. This research indicates that successful commercial and mixed-use districts benefit from new construction, but these changes should be gradual as the rate of change is important. The higher performance of areas containing small-scale buildings of mixed vintage suggests that successful districts evolve over time, adding and subtracting buildings incrementally, rather than comprehensively all at once.

> *"All across America, blocks of older, smaller buildings are quietly contributing to robust local economies and distinctive livable communities. Buildings of diverse vintage and small scale provide flexible, affordable space for entrepreneurs launching new businesses and serve as attractive settings for new restaurants and locally owned shops. They offer diverse housing choices that attract younger residents and create human-scaled places for walking, shopping, and social interaction"*[24]

The final conservation strategy that was reviewed was New York's OneNYC Green Building & Energy Efficiency plan. This plan provided a new energy conservation code, which requires annual benchmarking of water consumption, energy audits and retro commissioning every 10 years. The plan is meant to apply to all new buildings, major renovations and, more interestingly, building purchases. As shown in the introduction, half of all buildings that will exist in 2050, are already built today, so a new code that addresses just new construction and major renovations will not get every building updated to higher energy standards by 2050. However, enforcing building upgrades at the time of building purchase, increases the number of buildings that will get upgraded over the short term in order to meet emissions and energy use targets. In New York it was calculated that there is enough turnover in building purchases to upgrade the entire existing building stock by 2050. Tying building upgrades to the time of purchase also helps overcome the economic condition and financing that often hampers renovations, as many small business owners do

[24] Ibid.

not have the money to do intensive building upgrades. At the time of purchase, money is changing hands and new financing is available, so adding extra costs for deep efficiency reductions is possible. The OneNYC plan does provide an option to purchase renewable energy instead of doing deep upgrades. This option is meant to offset the energy efficiencies that an upgrade would have provided, and in turn creates a green market for renewable power sources and new green jobs.[25]

[25] Mazria, Edward. *Road to Zero; Building Last Change*, 2015

Research Synopsis – Precedents:[26]

I followed these research avenues with a precedent study of renovations to heritage buildings, as well as neighbourhood development projects that have reached high standards of sustainability to see what has already been done, and where this project might go.

The first project reviewed was the Alliance Center in Colorado, built by a nonprofit organization whose goal is to “advance sustainability through collaboration among nonprofits, business, government and education”. The Alliance building is a 100-year-old warehouse, previously renovated in the 1970s, in Denver’s historic Lower Downtown. A major renovation to the building in 2006 provided tenant space for 35 sustainably focused nonprofits, serving as a demonstration project of advanced design strategies in a rehabilitated historic building. The Alliance Center performs well in terms of actual energy use when compared with other buildings by performing 55% better than the average for U.S. office buildings. The project received LEED®-Existing Building Gold Certification and LEED®-Commercial Interiors Silver Certification.

In Canada, the University of Windsor decided to create a new downtown campus and help revitalize Downtown Windsor. The proposed academic and arts facilities incorporated three existing significant heritage structures for various adaptive and building reuse strategies. The strategies included complete building retrofit, new construction with heritage facades retained and restored in situ. The downtown campus demonstrates a best practice for North America for the reuse and regeneration of downtown and inner city sites. The inherent value of these existing building components, and their place within the community’s memory, helps to reinforce Windsor’s sense of place and the university’s position as a pillar of the city.

Locally, I reviewed the Salt Building, a historical landmark in Southeast False Creek. Built in the 1930s the Salt Building was originally used as a refinery of salt. Now owned by

[26] Refer to boards – ‘Single Building Precedent Studies’ and ‘Neighbourhood Precedent Studies’ attached at the end of this chapter.

the City of Vancouver, the historic Salt Building is an important gathering place for the local community. The rehabilitation initiated in 2007, integrated the concepts of adaptive reuse and heritage conservation, in the context of sustainable practices. As a result, the Salt Building is one of very few heritage projects to achieve Gold certification under LEED® Core and Shell in Canada. The rehabilitation included shell restoration and raising the building on piling extensions to align with the new street level.

The last single building project reviewed was Le Soleil, which is the first completely solar-powered condominium project in Canada. The project team chose a typical Montreal building type to test the feasibility of designing a net-zero multi-unit building in an urban context. The location provided easy access to public transportation, bike paths, parks, shopping and other urban amenities. In the end, the three-unit building produced as much energy in a year as it consumes using readily available equipment and material and conventional, though optimized, building techniques to create a repeatable model for sustainable urban housing. Further to this, each unit consumes less than 30% of the energy consumed by a typical apartment for a cost that is within the market price for the City. Le Soleil also integrates strategies of resource conservation, occupant health and encourages sustainable lifestyles. The project received LEED® for Homes Platinum certification, and meets Net Zero Energy.

On the larger neighbourhood scale I looked at three additional projects. The first project reviewed was BedZED, built in 2002; it was a pioneering eco-village in south London that reached for net-zero status. Among its successes is the continued low energy use of homeowners, with 45%, lower electricity and 81% less hot water usage than the borough average. The development showed that it is possible to build homes that are both socially and environmentally sustainable. One of the major setbacks of BedZED was that the biomass combined heat and power (CHP) plant failed to work at a reasonable cost compared to typical alternatives.

In Canada, Toronto Community Housing is building the Regent Park revitalization project, which will transform Canada's oldest and largest social housing community into a mixed income community for 5,100 households in Toronto's east downtown. With access to public transit, jobs, civic amenities and daily destinations the high quality pedestrian environment is designed to make a walk-friendly project with pedestrian connections within, through and beyond the site. Despite the high density, the design features new public realm tree canopy coverage, green roofs and high quality public open space amenities connected to the pedestrian network. Energy consumption is targeted to be 40% to 50% lower than building to the Model National Energy Code for Buildings (MNECB). This is to be achieved through energy-efficient building envelopes, lighting, appliances and mechanical systems. Connection to a district energy system also allows the use of commercial waste heat for residential heating to also contribute to energy savings. The project also targets a maximum runoff volume of 50% of average annual rainfall through strategies such as green roofs and porous pavers.

Locally the Olympic Village is one of the greenest communities in the world, using innovative energy efficiency and sustainability systems. It is a mixed-use community, with residential units, area parks, and a growing number of retail and service outlets (including the previous reviewed Salt Building). The development aligns with the City of Vancouver's goals, addressing environmental, economic, and social issues. The site is about seven hectares in size and consists of over 20 buildings, with approximately 1.2 million square feet of multi-unit residential and mixed-use development. This project received LEED® Neighbourhood Development Platinum certification, LEED® New Construction Platinum certification for the Community Centre and Net Zero Senior's Building, and LEED® New Construction Gold certification for all other buildings. Further to this the Neighbourhood Energy Utility (NEU) provides 70% of heating energy derived from a renewable source.

Research Synopsis – District Energy:[27]

At this point the research focused on synergies between the different City of Vancouver initiatives, energy systems research and building precedents. This highlighted that any conservation plan for a neighbourhood sized area usually included a neighbourhood district energy strategy, which then led to a review of international and local district energy systems, as well as international systems both historical and current.

The world's first combined heat and power plant was built in Denmark in 1903. It was a waste incineration plant, which made it possible to handle waste and provide electricity and heat to a nearby hospital, thereby delivering two services simultaneously. During the 1920's and 1930's, a collective district heating system was developed, based on using excess heat from local electricity production. From there on, district heating from combined heat and power (CHP) expanded in the larger Danish cities, and by the 1970's, around 30% of all homes were heated by district heating systems. By the time of the energy crisis in 1973/74, the fuel-efficient CHP systems expanded to medium and smaller size cities in Denmark connecting 63% of all Danish residential homes. A CHP plant may have a total efficiency of 85-90% resulting in an overall fuel saving of approximately 30%, compared to the separate production of heat and electricity. District heating and CHP have been – and continue to be – a key ingredient to Denmark's green transition.

Outside of Denmark, Sweden began switching their energy needs away from fossil fuels in 1980 by switching to district energy systems using biomass, solar, wind, and surplus heat from; industry, waste, peat and heat pumps. In 1980 these sources produced less than 10% of the country's energy needs, but by 2006 they were producing over 80% of Sweden's energy despite the overall energy consumption of the country doubling over that time. The switch to district energy led to Sweden's carbon dioxide emissions dropping to below 25% of its 1980 levels.

Historically, district energy has also played an important role in France and has

[27] Refer to boards – 'Community Energy Planning - International' and 'Community Energy Planning - Local' attached at the end of this chapter.

been developed mostly based on financial savings and the ability of securing France's energy supply. In 1927, the city of Paris created a network to deliver steam for heating national and public buildings. The goal was to reduce the city's coal and wood use in order to minimize fire risk and improve air quality, as well as to reduce the need for thousands of people to deliver coal or wood to the streets of Paris. The network started by delivering heat to a factory in Paris while also pre-heating passenger trains prior to departure, and quickly expanded as neighbouring buildings wished to benefit from heating that was cheap, safe and reliable. Today, the network continues to flourish using the underground tunnels and pipelines that already serve the Paris metro system. A 475 km network connects the equivalent of 500,000 households (including all of the city's hospitals, half of all social housing units, and half of all public buildings) and interconnects 13 towns. The target is to achieve 50% renewable or recovered energy in heat production by 2015, and 60% by 2020, in line with the Paris Climate Action Plan. This transition will include developing biomass and geothermal, heat recovery from sewers; and co-firing coal and wood.

Locally, Vancouver and its neighbouring jurisdictions have several district energy systems. Creative Energy expects to convert Vancouver's largest natural gas steam plant into a low-carbon energy system to provide heat to all of the downtown. At the core is the 47-year-old, 250-megawatt Central Heat Distribution steam plant, whose six natural gas boilers supply steam heat to 210 office and residential buildings. The company expects to build a new power plant by 2020 in False Creek that will burn low-carbon fuel, such as wood chips, to heat a recirculating hot water system. The plant will serve the legacy Central Heat steam customers, but will also hot water systems underneath Downtown South, Northeast False Creek, Chinatown and the Downtown Eastside. The False Creek Energy System (FCES) is a centralized hot water production facility, integrated with a new municipal sewage pump station that currently serves the Olympic Village and surrounding community. Sewage heat recovery is the primary energy source and supplies 70% of the annual energy demand. The FCES is achieving 60% CO^2 emission reduction and has grown 260% since 2010, with 4.2 million ft^2 of buildings now connected. The University of British

Columbia (UBC) Academic District Energy System (ADES) is a network of underground piping across the northern half of the UBC Vancouver campus and supplies buildings with hot water for space heating and domestic hot water. The ADES project involves replacing UBC's aging steam infrastructure with a more efficient hot water system and will provide the platform to achieve long-term targets of eliminating the use of fossil fuels on campus by 2050, as well as advancing clean energy research and development opportunities. The new hot water system will heat over 130 UBC buildings, including over 800,000 square metres (8.6 million square feet) of floor space for hot air and domestic hot water. The ADES will reduce UBC's, thermal energy use by 24%, greenhouse gas emissions by over 22%, and operational and energy costs by $5.5 million per year.

Analysis & Conclusions:

In summary, I reviewed two research papers: 'The Greenest Building' evaluated energy use and total life cycle cost analysis of different categories / uses of buildings, in both new and existing construction, in cities across several different climate zones in the USA; 'Older, Smaller, Better' evaluated the locations of new and old buildings, the types and numbers of businesses, number of employees, and number of people found in the different locations on different days and times. Combining the research in these two documents, showed that in mild climates that are similar to Vancouver (Seattle and Portland), reusing existing buildings was not only less expensive and produced less greenhouse gases than new construction, but also contained more diverse businesses, employed more people, provided more nightlife, and were more affordable, just as Jane Jacobs postulated decades earlier. I also reviewed several of Vancouver's documents and initiatives and, combined with our research into district energy systems, found that the city of Vancouver has several long term plans for creating and expanding its district energy systems, so this project would be more inclined to be ready to connect into one of these systems as opposed to dealing with the upfront costs of trying to create a new system on its own. Further to this the review of the current building conservation plan, found a need to create a energy retrofit strategy for small businesses, and a conservation strategy for the large number of buildings that have little to no protection within the current system. I also looked at alternate ideas for getting the existing building stock upgraded, like how New York is hoping to upgrade its entire building stock by 2050 by tying sustainability upgrades to the time of building purchases, which is an idea that a city like Vancouver, where property prices are skyrocketing for the limited supply of property, could look into incorporating. Lastly, I also reviewed a number of built projects that could provide ideas and options for how this project could be addressed both for conservation strategies and for sustainability strategies.

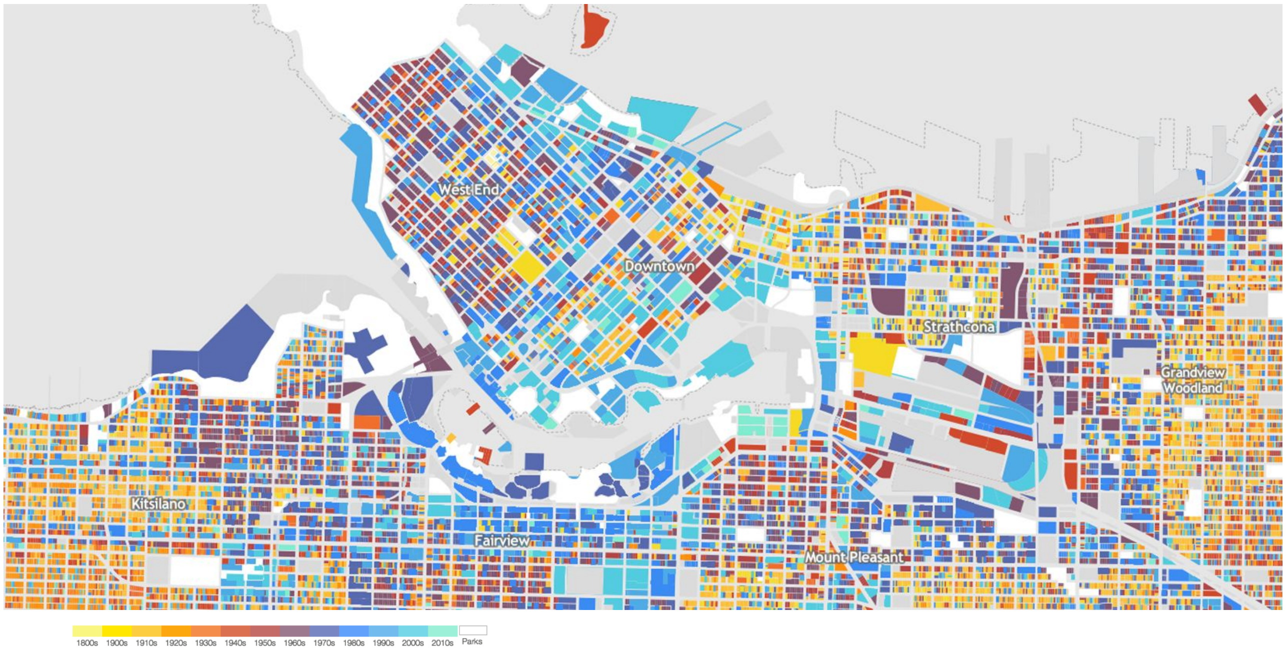
With all the original key themes reviewed, the next step was to take a closer look at the major commercial districts in Vancouver to study existing building types, ages, densities, neighbourhood characteristics, and zoning.

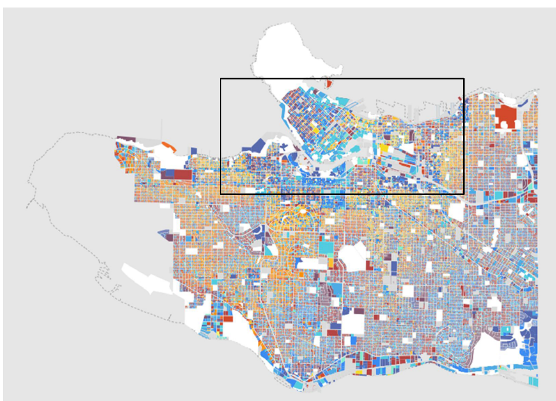
List of Research & Precedents Attachments:

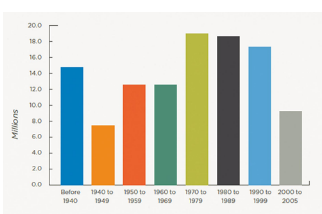
The following boards were presented at the RAIC 690 A (D9A) midterm and are attached for reference:

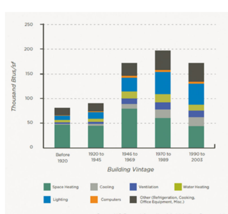
- Project Proposal [28]
- A-1.2 Vancouver Heritage Conservation
  (Review of Vancouver Building Ages, Heritage Guidelines and Registry)
- A-1.3 Existing Building Reuse vs. New Construction
  (Synopsis of Preservation Green Lab. The Greenest Building: Quantifying the Environmental Value of Building Reuse. Washington, DC, 2011.)
- A-1.4 Quantifying the Character of Buildings
  (Synopsis of Preservation Green Lab. Older, Smaller, Better: Measuring how the character of buildings and blocks influences urban vitality. Washington, DC, 2014.)
- A-1.5 Single Building Precedent Studies
  (Review of Restored International, National, and Local Heritage Buildings)
- A-1.6 Neighbourhood Precedent Studies
  (Review of International, National, and Local Sustainable Neighbourhoods)
- A-1.7 Community Energy Planning – International
  (Review of International District Energy Systems)
- A-1.8 Community Energy Planning – Local
  (Review of District Energy Systems in the Greater Vancouver Metropolitan Area)

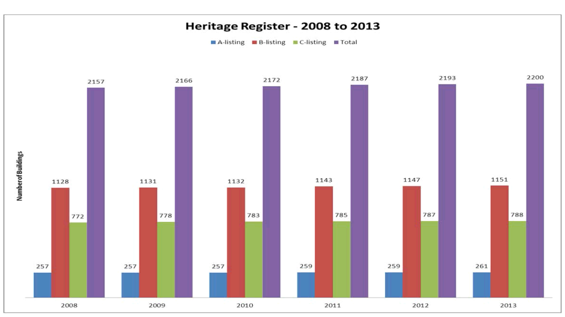
[28] See the introduction pages 1-3.

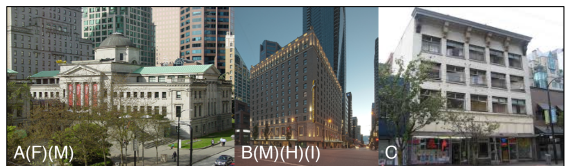












Heritage Building Catagories

A - Primary Significance
Represents the best examples of a style or type of building; may be associated with a person or event of significance.

B - Significant
Represents good examples of a particular style or type, either individually or collectively; may have some documented historical or cultural significance in a neighbourhood.

C - Contextual or Character
Represents those buildings that contribute to the historic character of an area or streetscape, usually found in groupings of more than one building but may also be of individual importance.

M - City of Vancouver
Indicates building or site that is protected by a legal heritage designation by the City of Vancouver

P - Province of British Columbia
Indicates building or site that is protected by a legal heritage designation by the Province of British Columbia

H - Heritage Revitalization Agreement
A notice of the agreement is registered on title in the Land Title Office. A copy of the agreement is on file in the City Clerk's Office.

I - Interior
Specific interior features and fixtures in the building are protected.

L - Landscape
Indicates that certain landscape features are protected.

CA - Heritage Conservation Area
Indicates that it is scheduled as protected within a Heritage Conservation Area.

HC - Heritage Conservation Covenant
Indicates that the building, or some portion thereof, is protected by a Heritage Conservation Covenant registered on title at the Land Title Office.

F - National Historic Site
Indicates that the site is identified by the Federal Government as a National Historic Site. However, it is not legally protected unless it also has municipal or provincial designation, or a Heritage Revitalization Agreement.

Protecting heritage sites through legal designation

Designating a site as a protected heritage property is a legislative tool the city can use to help maintain a legacy for the future. The purpose of designation is to protect a heritage building from unsympathetic alteration, and subsequent loss of character or value. However, some alterations may be required for the ongoing use of a designated building. The Vancouver Charter both gives Council the power to designate heritage properties, and dictates the process we must follow to protect a property. Buildings, interiors, or landscapes that merit designation are recommended to City Council by the Director of Planning, with the advice of the Heritage Commission. As part of the designation process, the property owner is sent a notification letter, council places notifications in local newspapers and a public hearing is convened. The property owner is compensated for any possible loss in property value, perceived or real. The property owner is also compensated for rehabilitation and ongoing obligations of the designation. Compensation can be in money or - most often - through bylaw relaxations. A majority vote of Council is required to pass a bylaw designating a building, any portion of its interior, or a landscape. The designation is then noted on the property title.
Buildings on the Heritage Register are sometimes referred to as “designated”. However, the Heritage Register and heritage designation are entirely separate classifications.

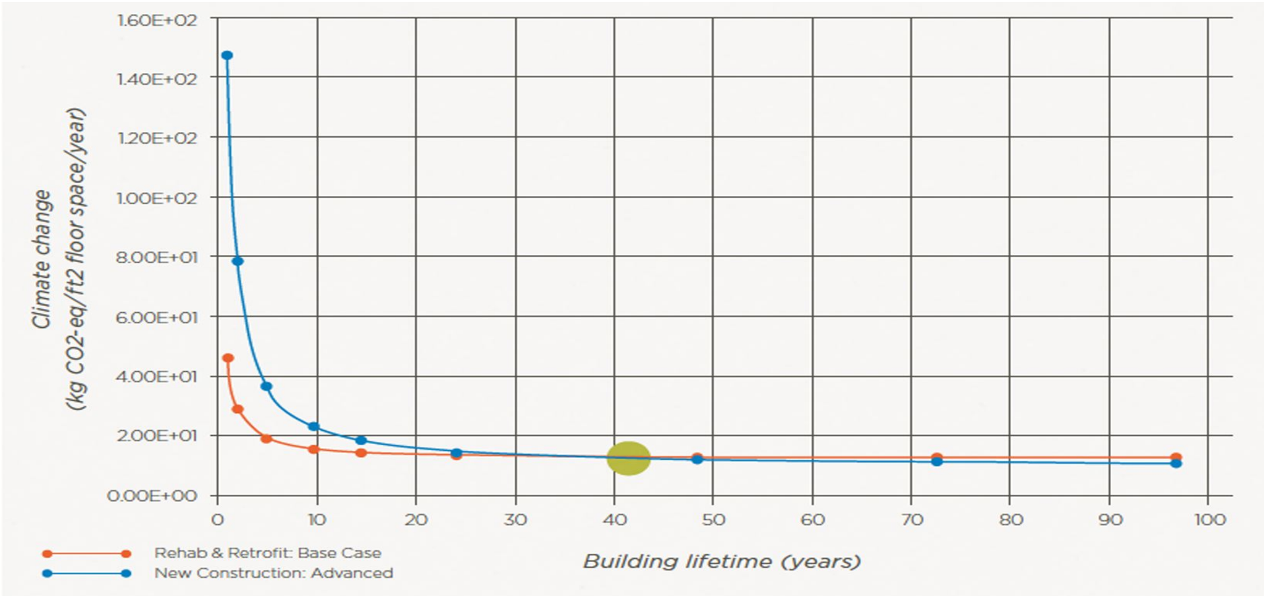
Sites on the Vancouver Heritage Register are not protected unless they also have heritage designation, an HRA or covenant, or are scheduled as protected in a heritage conservation area.

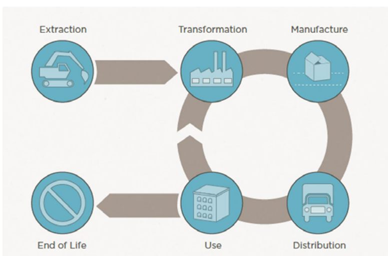
Heritage designation is a legal way to protect heritage buildings. When a building has heritage designation, the City can regulate its demolition, relocation, and alteration.Changes to a site that has a heritage designation require a Heritage Alteration Permit, while changes to the exterior of a building on the Heritage Register do not. Heritage designations are noted on the property's title, while a Heritage Register listing is not.

At present only 25% of buildings on the register are protected.

Other cities have heritage conservation plans that should be reviewed for ways to update the system in Vancouver. The City of Portland offers a simplified approval process whereas Victoria applies a directed incentive model where property tax incentives are provided to projects that include housing in vacant upper storeys of heritage buildings. Tax relief systems are used in several Canadian municipalities with four main approaches currently in use: property tax abatements, property tax credits, property tax relief and sales tax grants and rebates. Other options that are currently being reviewed in Vancouver are increasing demolition fees for pre-1940 houses, and continuing with the existing facaade grants program, or reactivating the transferable bonus density bank, that has been stalled since 2009.

City of Vancouver. Land Use and Development Policies and Guildlines: Vancouver Heritage Register, Adopted by City Council on September 23, 1986; Last Amended: November 24, 2015.





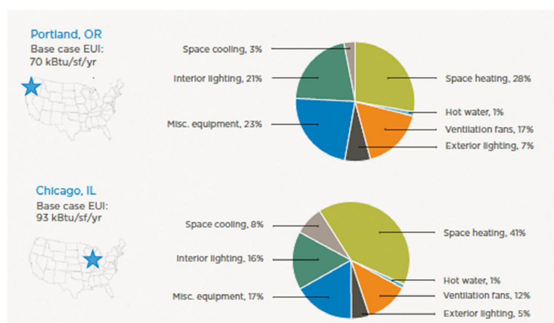
Extraction of raw materials for production of both new and replacement materials.
Transformation and refinement of raw materials.
Manufacture of products and distribution to suppliers.
Transportation of products to building site.
Use of building including construction-related activities and operating energy of the building over its lifespan.
End of Life disposal of materials, including transportations, to landfill, recycling or incineration.

Building Type	Chicago	Portland
Urban Village Mixed Use	42 years	80 years
Single-Family Residential	38 years	50 years
Commercial Office	25 years	42 years
Warehouse-to-Office Conversion	12 years	19 years
Multifamily Residential	16 years	20 years
Elementary School	10 years	16 years
Warehouse-to-Residential Conversion*	Never	Never

"Building Reuse Almost Always Yields Fewer Environmental Impacts Than New Construction When Comparing Building Of Similar Size And Functionality"

The results of the analysis indicate that the renovation and reuse of existing buildings, of comparable functionality and size and equivalent energy efficiency levels, consistently yeild fewer envinronmental impacts than demolition and new construction over a 75-year period.
This finding is not unexpected, as operating performance is assumed to be equivalent for the reuse and new construction scenarios, and new construction typically uses more materials than renovation.
The study reveals that the reuse and retrofit of buildings of equivalent size and functionality can, in most cases, meaningfully reduce the negative environmental impacts associated with building development.

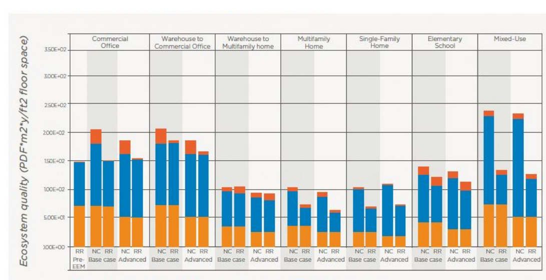
"Even If It Is Assumed That A New Building Will Operate At 30-percent Greater Efficiency Than An Existing Building, It Can Take Between 10 And 80 Years For A New, Energy Efficient Building To Overcome The Climate Change Impacts That Were Created During Construction"



BARRIERS TO REUSE:

"In urban areas, there is a financial incentive to maximize the use potential of sites, which often involves adding floor space to achieve economies of scale and heights for views, as well as higher rents"

Thus, developers often perceive little economic justification for retaining existing buildings and instead look for developable land rather than buildings to retrofit. Moreover, the environmental costs associated with building construction and demolition are external to developer pro formas and excluded from value-chain analyses; this creates an incentive to demolish buildsings in favour of new construction.



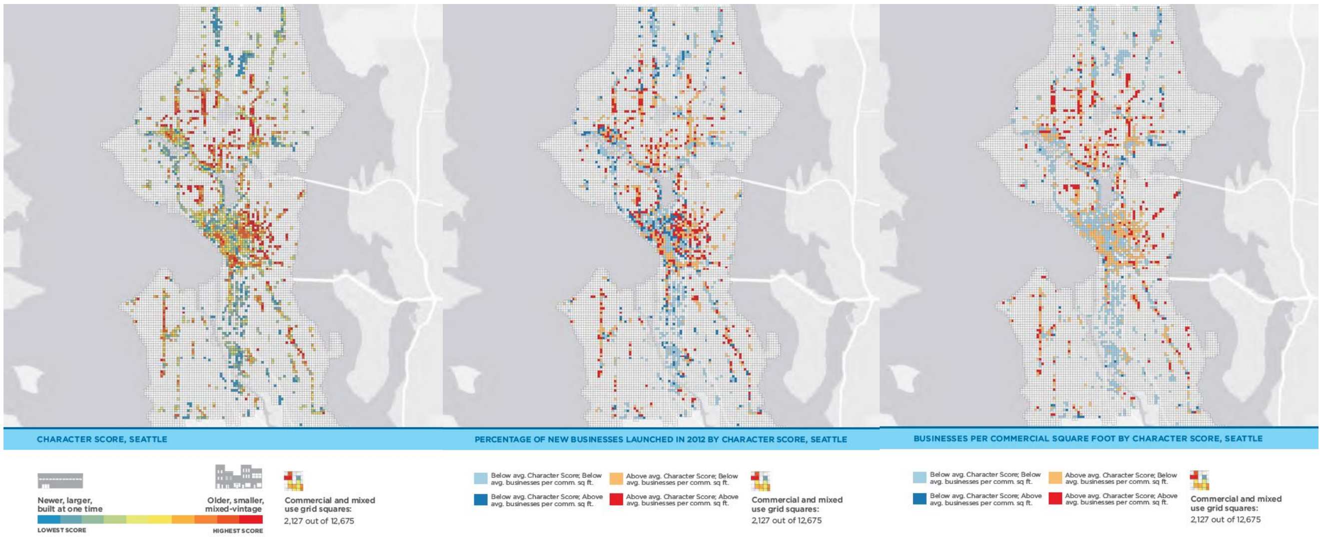
Rehabilitation work is typically regarded as far riskier than new construction, because the process can be less predictable, and many developers fear being surprised by unforeseen challenges once rehabilition is underway.

The perception of risk and fear of the unknown can motivate decisions to demolish buildings even in instances where rehabilitation may be less costly and more profitable than new construction. Developers need new sets of tools and skills, as well as financial and technical resources, to help them incorporate existing buildings into their portfolios.

"Building energy and zoning codes are particularly challenging for existing buildings; ... as they are typically not well adapted to the unique limitations and opportunities presented by individual buildings"

Regulations are also often obstacles to sustainability, inadvertently undermining efforts to reuse existing buildings. Building policies and codes have historically favoured the needs and goals of new construction. Today, existing buildings and older communities must conform to regulatory environments that do not encourage adapting buildings for new uses or retrofitting them for energy efficiency. Thus when added to seismic and accessibility requirements, these factors can be the 'tipping point' in decisions favouring demolition.

Preservation Green Lab. The Greenest Building: Quantifying the Environmental Value of Building Reuse. Washington, DC, 2011.



"All across America, blocks of older, smaller buildings are quietly contributing to robust local economies and distinctive livable communities. Buildings of diverse vintage and small scale provide flexible, affordable space for entrepreneurs launching new businesses and serve as attractive settings for new restaurants and locally owned shops. They offer diverse housing choices that attract younger residents and create human-scaled places for walking, shopping, and social interaction"

This study demonstrates the unique and valuable role that older, smaller buildings play in the development of sustainable cities. Based upon statistical analysis of the built fabric of three major American cities, this research finds that

"[E]stablished neighborhoods with a mix of older, smaller buildings perform better than districts with larger, newer structures when tested against a range of economic, social, and environmental outcome measures"

"Older, mixed-use neighborhoods are more walkable"

Older neighborhoods with a mixture of small, mixed-age buildings have significantly higher Walk Score® rankings and Transit Score® ratings than neighborhoods with large, new buildings.

"Young people love old buildings"

In Seattle, San Francisco, and Washington, D.C., the median age of residents in areas with a mix of small, old and new buildings is lower than in areas with larger, predominantly new buildings. These areas are also home to a significantly more diverse mix of residents from different age groups.

"Nightlife is most alive on streets with a diverse range of building ages"

City blocks composed of mixed-vintage buildings host greater cellphone activity on Friday nights. In Seattle, areas with older, smaller buildings see greater cellphone use and have more businesses open at 10:00 p.m. on Friday.

"Older business districts provide affordable, flexible space for entrepreneurs from all backgrounds"

Neighborhoods with a smaller-scaled mix of old and new buildings host a significantly higher proportion of new businesses, as well as more women and minority-owned businesses than areas with predominantly larger, newer buildings.

"The creative economy thrives in older, mixed-use neighborhoods"

Older, smaller buildings house significantly greater concentrations of creative jobs per square foot of commercial space. Media production businesses, software publishers, and performing arts companies can be found in areas that have smaller-scaled historic fabric.

"Older, smaller buildings provide space for a strong local economy"

Streets with a combination of small, old and new buildings have a significantly higher proportion of non-chain restaurants and retailers, and areas of the city with older, smaller buildings host a significantly higher proportion of jobs in small businesses.

"Older commercial and mixed-use districts contain hidden density"

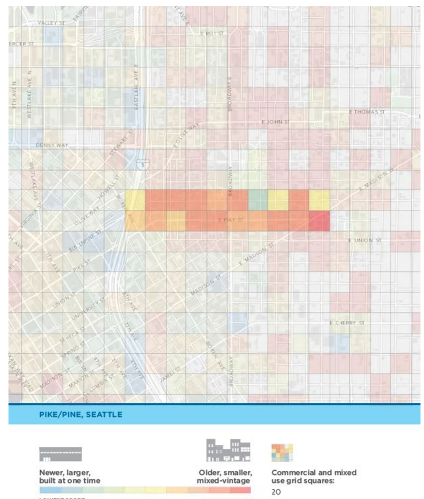
Streets with a mix of old and new buildings have greater population density and more businesses per commercial square foot than streets with large, new buildings. These areas also have significantly more jobs per commercial square foot. This research shows that older, smaller buildings and blocks "punch above their weight class" when considering a full spectrum of outcomes on a per-square-foot basis—from the number of jobs and businesses to the vitality of nightlife and presence of young residents. Older buildings employ time-tested, practical solutions to achieve these efficiencies: mixed daytime and nighttime uses; common entrances and shared services; creative use of small spaces and storage areas; and very little space dedicated for cars. With the new "sharing economy" emerging, older buildings also offer lessons in how to get more round-the-clock performance from our bricks and mortar investments. Codes and regulations can limit these uses, however, and may need to be revised to encourage the efficiencies that older, smaller buildings offer.

"Fit new and old together at a human scale"

Findings from the three study cities show that mixing buildings from different vintages—including modern buildings—supports social and cultural activity in commercial and mixed-use zones. Many of the most thriving blocks in the study cities scored high on the diversity of building-age measure. Scale also played an important role. Grid squares with smaller lots and more human-scaled buildings generally scored higher on the performance measures than squares characterized by larger lots and structures. These results support the concept of adding new infill projects of compatible size alongside older buildings.

"Support neighborhood evolution, not revolution"

While this research indicates that successful commercial and mixed-use districts benefit from new construction, these changes should be gradual. The rate of change is important. The higher performance of areas containing small-scale buildings of mixed vintage suggests that successful districts evolve over time, adding and subtracting buildings incrementally, rather than comprehensively and all at once.



"Steward the streetcar legacy"

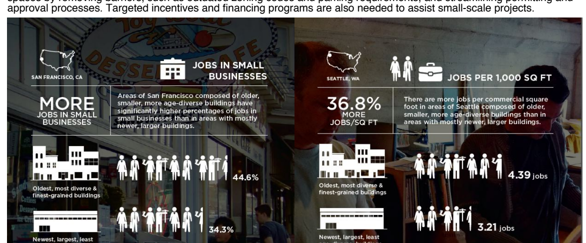
Many of the highest performing grid squares in our study cities are commercial areas with buildings that date to the streetcar era. Nearly every American city (and plenty of small towns) once boasted a network of streetcar lines. From the late 1900s until World War II, these lines spurred the construction of neighborhood service centers. Although most streetcar lines are long buried, the commercial districts they created can still be found in urban neighborhoods across the country. Examples of streetcar-era districts from the study cities include Seattle's Pike/Pine Corridor and Washington, D.C.'s H Street NE, which both scored well (and will soon have streetcars again). As cities seek to re-establish transit corridors and foster mixed-use development, the armature of streetcar-era commercial districts provides a head start.

"Make room for the new and local economy"

Richard Florida and other scholars have noted that technology start-ups and other creative companies are moving into diverse neighborhoods full of older buildings, such as New York's Silicon Alley, where even former warehouses are small relative to Manhattan buildings overall.3 The Older, Smaller, Better research confirms this connection, finding a correlation between a higher concentration of creative jobs and older, smaller-scaled buildings and blocks. These areas also support higher levels of small businesses and non-chain business, helping to keep dollars in the local economy, and providing more resilience against future economic storms.

"Make it easier to reuse small buildings"

Vacant and underused buildings are an untapped reservoir of already built density. The Older, Smaller, Better research illustrates the value of keeping older, smaller, diverse-age buildings viable and in full use. In some cities, however, older commercial buildings languish, with empty upper floors or vacant storefronts. Cities can help unlock the potential of these spaces by removing barriers, such as outdated zoning codes and parking requirements, and streamlining permitting and approval processes. Targeted incentives and financing programs are also needed to assist small-scale projects.

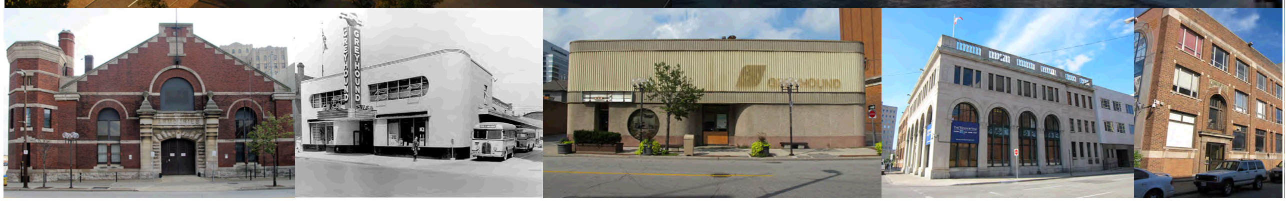


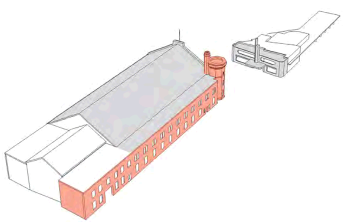
Preservation Green Lab. Older, Smaller, Better: Measuring how the character of buildings and blocks influences urban vitality. Washington, DC, 2014.

ADAPTIVE REINTEGRATION

QUANITIFYING THE CHARACTER OF BUILDINGS

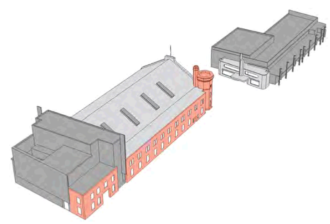
RAIC SYLLABUS DESIGN STUDIO D900 TERM 1 2016

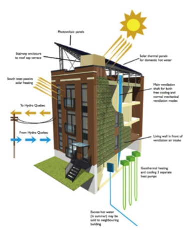




University of Windsor, Downtown Campus

The University of Windsor has agreed to become a vibrant partner in the revitalization of Downtown Windsor by creating a new downtown campus. The proposed interdisciplinary academic and arts facilities offer vital opportunities for partnerships in advancing the city's ongoing revitalization strategies, while capitalizing on the iconic qualities of three heritage properties: the 1902 Armouries landmark historic property; the 1940 Art Deco Greyhound Bus Depot; and the iconic 1927 Windsor Star building. As shown in other urban centres, this downtown campus project will serve as an economic catalyst to initiate a vibrant urban centre, one that will assist in increasing activity and vitality within the downtown Windsor core. This University of Windsor project has demonstrated a sustainable urban development, incorporating existing significant heritage structures for various adaptive and building reuse strategies. Strategies range from complete building retrofit (Armouries) to new construction with heritage facades retained and restored in situ (Depot and Star). It demonstrates a best practice North American exemplar for the reuse and regeneration of downtown and inner-city sites. The inherent value of these existing building components, and their place within the community's memory, helps to reinforce Windsor's sense of place and the university's position as a pillar of the city.



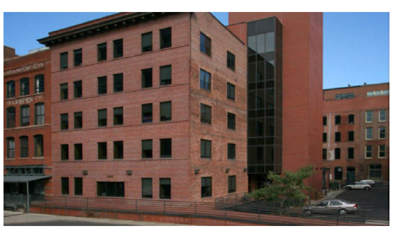


Abondance Monteal: Le Soleil

Le Soleil is the first completely solar-powered Condominium Project in Canada. The project team chose a triplex, a typical Montreal building type, to test the feasibility of designing a net-zero multi-unit building in an urban context. The location provides easy access to public transportation, bike paths, parks, shopping and other urban amenities. The 3-unit building produces as much energy in a year as it consumes and is slated to receive LEED for Homes platinum certification. The building uses readily available equipment and material and conventional, though optimized, building techniques to create a repeatable model for sustainable urban housing. Each unit consumes less than 30% of the energy consumed by a typical apartment for a cost that is within the market price for the City. In addition to an exceptional energy performance, le Soleil integrates strategies of resource conservation, occupant health and to encourage sustainable lifestyles.

Sustainability Features:

- LEED for Homes Platinum certified
- Net Zero Energy



Alliance Centre, Denver Colorado

The Alliance for Sustainable Colorado is a nonprofit organization started in 2004 to "advance sustainability through collaboration among nonprofits, business, government and education." To advance this mission, the Alliance purchased a 100-year-old warehouse, previously renovated in the 1970s, in Denver's historic Lower Downtown. A major renovation to the building in 2006 created the Alliance Center. The building provides tenant space for 35 sustainably focused nonprofits, fostering communication and collaboration and serving as a demonstration project of advanced design strategies in a rehabilitated historic building. The Alliance Center performs well in terms of actual energy use when compared with other buildings at 42 kBtu/sf/yr, which is 55% better than the average for U.S. office buildings.

Sustainability Features:

- LEED-EB Gold Certified
- LEED-CI Silver Certified

Vancouver Salt Co. Ltd.

The Salt Building is an iconic historical landmark in Southeast False Creek. Built in the 1930s when the shoreline bristled with ship builders, steel fabricators and sawmills, the Salt Building embodies rich industrial past of this neighbourhood. Originally, the building was used as a refinery of salt and the north end of the building still retains a small dock-like structure where the salt was loaded and unloaded. As railway transportation gradually replaced shipping, the building reoriented to the south and was later converted to a paper recycling plant. Now owned by the City of Vancouver, in 2013 a new coffee shop and brewpub made the historic Salt Building an important gathering place for the local community.
The rehabilitation of the Salt Building, initiated in 2007, presented a rare opportunity to integrate the concepts of adaptive reuse and heritage conservation, in the context of sustainable practices. As a result, the Salt Building is one of very few heritage projects to achieve Gold certification under LEED–CS in Canada. The rehabilitation included shell restoration and raising the building on piling extensions to align with the new street level.

Olympic Village - Vancouver

The Olympic Village is one of the greenest communities in the world, using innovative energy efficiency and sustainability systems. The development aligns with the City's goals, addressing environmental, economic, and social issues. The Olympic Village is a mixed-use community, with residential units, area parks, and a growing number of retail and service outlets. The site is about seven hectares in size and consists of over 20 buildings, with approximately 1.2 million square feet of multi-unit residential and mixed-use development.

Sustainability Features:

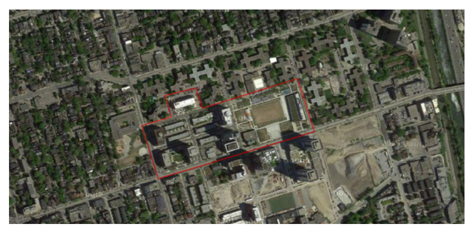
- LEED-ND Platinum certified
- LEED-NC Platinum certified (Community Centre and Net Zero Senior's Building);
- LEED-NC Gold certified for all other buildings, 2010
- Neighbourhood Energy Utility: 70% of heating energy derived from renewable source

Regent Park Revitalization - Toronto

Toronto Community Housing is leading the Regent Park revitalization, a $1-billion plan that will transform Canada's oldest and largest social housing community into a mixed-income community for 5,100 households in Toronto's east downtown.

With exceptional access to public transit, jobs, civic amenities and daily destinations the high quality pedestrian environment is designed to make this a very walk-friendly project with pedestrian connections within, through and beyond the site. Despite the high density, the design features new public realm tree canopy coverage, green roofs and high quality public open space amenities connected to the pedestrian network.

Energy consumption is targeted to be 40 to 50 per cent lower than building to the Model National Energy Code for Buildings (MNECB). This is to be achieved through energy-efficient building envelopes, lighting, appliances and mechanical systems. Connection to a community energy system that allows use of commercial waste heat for residential heating will also contribute to energy savings. The project targets a maximum runoff volume of 50 per cent of average annual rainfall through strategies such as green roofs and porous pavers.



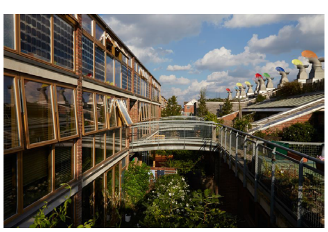
BedZED - England

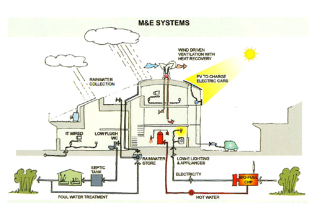
Built in 2002 BedZED, the community was a pioneering eco-village in south London that reached for net-zero status. Among the successes is the continued low energy use of homeowners at BedZED – 45% lower electricty and 81% less hot water than the borough average – reducing carbon emissions as well as residents' fuel costs. BedZED has also successfully fostered a strong and committed community where residents have a real sense of belonging and pride in their estate that has led to resales in the community at between 5%-10% higher than other local developments. The development shows that it is possible to build homes that are both socially and environmentally sustainable.

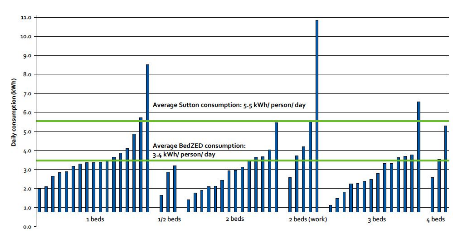
The challenges at BedZED, were the biomass combined heat and power (CHP) plant which failed to work at a reasonable cost compared to the typical alternatives.

Some of the key operational aims were as follows:

- reduce water consumption compared to the UK average by 33%
- reduce electricity consumption compared to the UK average by 33%
- reducing space heating needs compared to the UK average by 90%
- reduce private fossil fuel car mileage to 50% of UK average
- eliminate carbon emissions due to energy consumption.







ADAPTIVE REINTEGRATION

NEIGHBOURHOOD PRECEDENT STUDIES

RAIC SYLLABUS DESIGN STUDIO D900 TERM 1 2016

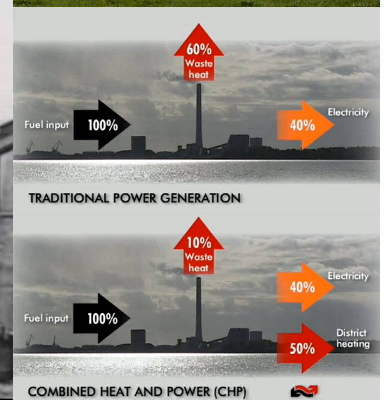
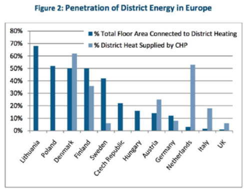


Figure 2: Penetration of District Energy in Europe



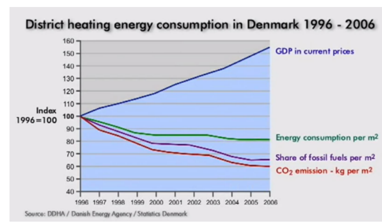
Data Source: International Association for District Heating, District Cooling and Combined Heat & Power. 2003. CHP = Combined Heat and Power

Denmark

The very first combined heat and power plant in Denmark was built in 1903. It was a waste incineration plant, which made it possible to handle waste and provide electricity and heat to a nearby hospital, thereby delivering two services simultaneously. During the 1920's and 1930's, a collective district heating system was developed, based on excess heat from local electricity production. From here on, district heating from combined heat and power (CHP) expanded in the larger Danish cities, and by the 1970's, around 30% of all homes were heated by district heating systems.

By the time of the energy crisis in 1973/74, a decision was made to expand the fuel-efficient CHP systems to not only the larger cities, but also, later on, to medium and smaller size cities in Denmark.

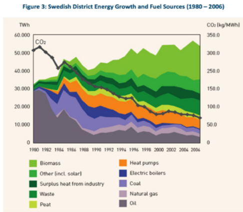
Today, 63% of all Danish residential homes are connected to district heating – not only for space heating, but also for domestic hot water. When producing heat and power using CHP, the overall energy efficiency is significantly higher than when producing heat and power separately. A CHP plant may have a total efficiency (combined heat and power) of 85-90% resulting in an overall fuel saving of approximately 30%, compared to separate production of heat and electricity. District heating and CHP have been – and continues to be – a key ingredient to Denmark's green transition.



Copenhagen, Denmark

The waste-to-energy plant, Amager Resource Center, is located in an industrial area, that throughout the years, has turned into an extreme sport destination for thrill seekers. Different extreme sports activities take place in the raw industrial facilities such as cable wake boarding, go-kart racing, and rock climbing among others. The Amager Resource Center is the most significant landmark in the area and the building is in need of renewal. Bjarke Ingels Group proposed a new breed of waste-to-energy plant, one that is economically, environmentally, and socially profitable. Instead of considering Amager Resource Center as an isolated object, they mobilize the architecture and intensify the relationship between the building and the city—expanding the existing activities in the area by turning the roof of the new Amager Resource Center into a ski slope for the citizens of Copenhagen. The new plant establishes Amager Resource Center as an innovator on an urban scale, redefining the relationship between the waste plant and the city. It will be both iconic and integrated, a destination in itself, and a reflection on the progressive vision of the company.

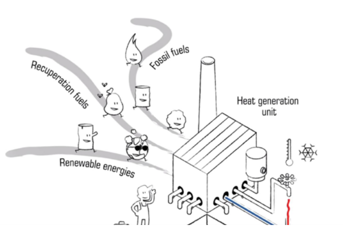
Figure 3: Swedish District Energy Growth and Fuel Sources (1980 – 2006)



Sweden

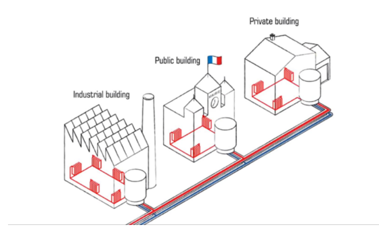
Sweden began switching their energy needs away from fossil fuels in 1980 by switching to district energy systems using biomass, solar, wind, surplus heat from industry, waste, peat and heat pumps. In 1980 this sources produced less than 10% of the countries energy needs, by 2006 they produced over 80% of the countries energy needs and despite the overall energy consumption of the country doubling over that time, their carbon dioxide emissions dropped to below 25% of 1980 levels.

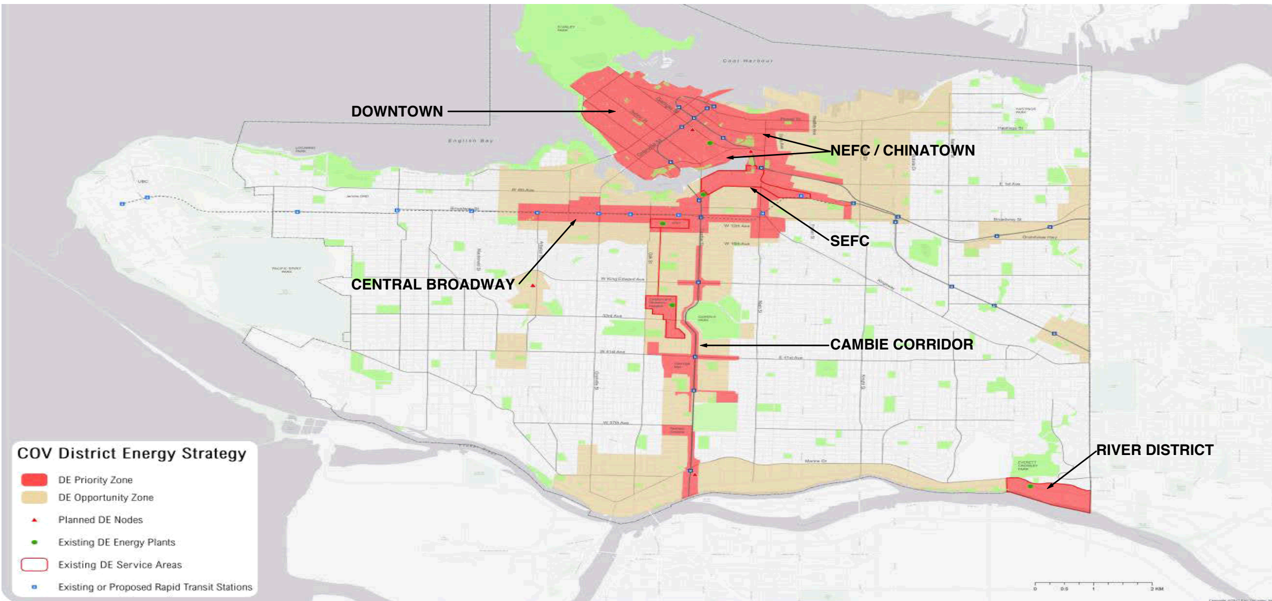
In 2013 the city of Uppsala invited BIG to design a biomass cogeneration plant to supplement Uppsala's existing energy infrastructure during the peak loads in the dark and cold fall, winter, and spring. BIG decided to radically transform the public perception of a power plant visually and functionally fusing two conventional industrial archetypes into an unconventional hybrid: the plant and the greenhouse. By harnessing the economies of scale associated with greenhouse structures it is possible to provide a 100% transparent enclosure allowing the citizens to enjoy educational glimpses of what happens within rather than the conventional, hermetic envelope of traditional power plants.

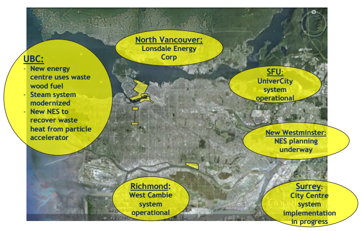


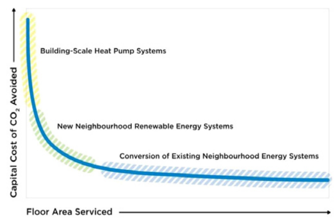
France

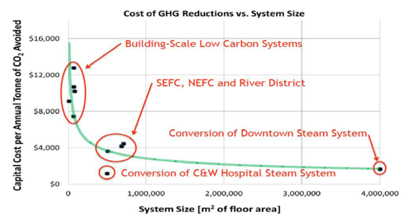
Historically, district energy has played an important role in Paris and has been developed mostly on its financial credentials and ability to provide security of supply. In 1927, the city created a concession for developing a network to deliver steam for heating national and public buildings. The goal was twofold: 1) to reduce the city's coal and wood use in order to minimize fire risk and improve air quality, and 2) to reduce the need for thousands of people to deliver coal or wood to the streets of Paris. The network started by delivering heat to a factory in Paris while also pre-heating passenger trains prior to departure, and quickly expanded as neighbouring buildings wished to benefit from heating that was cheap, safe and reliable. Today, the network continues to flourish using the underground tunnels and pipelines that already serve the Paris metro system. A 475 km network connects the equivalent of 500,000 households (including all of the city's hospitals, half of all social housing units, and half of all public buildings) and interconnects 13 towns (including Paris). Heat is produced at eight facilities – including two cogeneration facilities and three waste-to-energy plants – that have a combined total of 4 GW of generating capacity and produce 5.5 TWh of heat and 1 TWh of electricity per year. The target is to achieve 50 per cent renewable or recovered energy in heat production by 2015, and 60 per cent by 2020, in line with the Paris Climate Action Plan. This transition will include developing biomass and geothermal; heat recovery from sewers; and co-firing coal and wood.

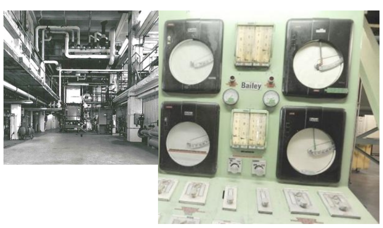










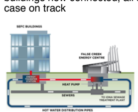


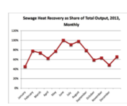
Creative Energy -Downtown Vancouver

Vancouver developer Ian Gillespie expects to invest upwards of $100 million over the next five years into converting the city's largest natural gas steam plant into a low-carbon energy system to provide heat to all of the downtown, from Stanley Park to the Downtown Eastside.
At the core is the 47-year-old, 250-megawatt Central Heat Distribution steam plant at 720 Beatty, whose six natural gas boilers supply steam heat to 210 office and residential buildings.
The company, which is regulated by the B.C. Utilities Commission, expects to build a new power plant on city-ownedland on Industrial Avenue in False Creek that will burn low-carbon fuel, such as wood chips, to heat a recirculating hot water system. The plant will still serve the legacy Central Heat steam customers, but the main plan is to put hot water systems underneath Downtown South, Northeast False Creek, Chinatown and the Downtown Eastside. The city has given Creative Energy 18 months to prove out its business case.
It will reduce by 90 per cent Creative Energy's estimated 70,000 tonnes of annual greenhouse gas emissions from the Beatty Street plant. The company is expected to file an application for the plant to the BCUC in 2017, and have it running by 2020.

False Creek Energy Centre

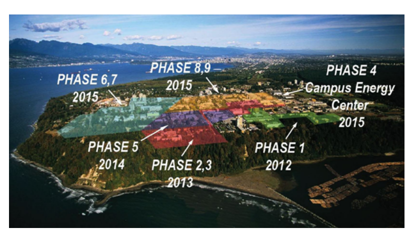
The False Creek Energy System is a centralized thermal energy (hot water) production facility, integrated with a new municipal sewage pump station. sewage heat recovery is the primary "base-load" energy source and supplies 70% of the annual energy demand. Natural gas boilers are used for back-up and peaking heat.
The FCES is achieving its 60% CO2 emission reduction target, with sewage heat recovery and has grown 260% since 2010, with 4.2 million ft2 of buildings now connected, all at competitive customer rates and business case on track





UBC District Energy System

The Academic District Energy System (ADES) is a network of underground piping across the northern half of the UBC Vancouver campus. The network supplies buildings with hot water for space heating and domestic hot water. The ADES project involves replacing UBC's aging steam infrastructure with a more efficient hot water system. The ADES will also provide the platform to achieve our long-term targets of eliminating the use of fossil fuels on campus by 2050, and advancing clean energy research and development opportunities. The new hot water system will heat over 130 UBC buildings, including over 800,000 square metres (8.6 million square feet) of floor space for hot air and domestic hot water. The project involves 11 kilometers of insulated pipes, over 100 energy transfer stations, a 60 megawatt, natural gas-powered campus energy centre hot water plant, and will conclude with the demolition of the existing UBC steam powerhouse. The ADES will reduce UBC's, thermal energy use by 24 per cent, GHG emissions by over 22 per cent, and operational and energy costs by $5.5 million per year.



ADAPTIVE REINTEGRATION
COMMUNITY ENERGY PLANNING - LOCAL
RAIC SYLLABUS DESIGN STUDIO D900 TERM 1 2016

A-1.8

Adaptive Reintegration: A building conservation strategy is needed to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for them to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency.

Site Selection & Analysis:[29]

The next direction the research took was to look at another key theme of development in Vancouver: Density. Density is a common theme when discussing affordability in Vancouver, especially regarding an over simplified argument of supply and demand. If developers are allowed to build more building stock, it will increase supply and thus lower demand and prices; however, this has not been the case as residential units are added at increasing rates and prices continue to skyrocket, as the demand for property in the city remains high. So, regarding density, the questions that need to be asked are: Where is the density? How much density is there? How does this density compare to other major cities? And then later we can ask: How much density is needed? Where does the city want it to go? And where should it go?

To answer the questions of where the density in Vancouver is, the University of British Columbia has produced a number of geographical maps highlighting different types of density in relation to a number of different topics. These geographical maps showed Vancouver's residential population per hectare, average bedrooms per capita, commercial nodes, transportation densities, and access to amenities. On reviewing these maps, it became apparent that the areas with the most density, and the areas where future development would likely be, were the popular commercial districts. Regarding how much density Vancouver actually has, despite all the commentary regarding a lack of land and buildable area due to its location trapped between the ocean, river, and mountains, it is actually not very dense, with an average of 1,650 people per square kilometer. This puts

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[29] Refer to boards – 'Vancouver Density Maps', 'Density Comparison', 'Vancouver Commercial Districts 1 & 2' and 'Research Key Themes' attached at the end of this chapter.

Vancouver at #123 on the list of densest cities in the world. That puts Vancouver behind cities like New York (#114 at 1,800 people per square kilometer), Copenhagen (#117 at 2,100 people per square kilometer) and Tokyo (#50 at 4,300 people per square kilometer). So I decided to focus in a little more at the downtown core of Vancouver, specifically the commercial areas in the West End, and I found that the density was indeed higher in this area, with 5,249 people per square kilometer. This fits with what we previously found concerning increased population densities around commercial nodes in the city. So for a better city-to-city comparison I looked at commercial districts in the previously mentioned cities, specifically, Soho in New York, Shibuya in Tokyo and Vesterbro in Copenhagen to compare with Vancouver's commercial area density. These cities all having commercial districts with similar five to six storey buildings and the numbers showed densities of 25,845 people per square kilometer in Soho, 13,540 people per square kilometer in Shibuya, and 13,688 people per square kilometer in Vesterbro, all much denser than Vancouver. So Vancouver is far from the overall densest city (#1 Dhaka at 44,400 people per square kilometer), and is not even the densest city in Canada (#97 Toronto).[30] So if other cities have much higher population densities with only five and six storey buildings, then why does Vancouver need to build large condo developments in commercial areas?

So based on this information, it is clear that the areas under the most pressure to develop are the major commercial nodes, so I choose four of them to look at more closely; Main Street, Commercial Drive, East Hastings and Davie Village. All four of these neighbourhoods shared a similar density and zoning, have mainly single storey buildings, with a few properties built to three or four floors, and a mix of small scale commercial businesses, corner stores, second hand stores, restaurants, and bars. The neighbouring blocks for these commercial districts are generally single family, or small-scale multifamily buildings with the Main Street and Hastings Street sites having some light industrial allowed and the Davie village in downtown Vancouver is getting a growing number of

[30] Toronto also has the distinction of having the most towers per capita in North America.

large-scale residential projects built around it. With the exception of the East Hastings area, the other three areas have all had pressure recently in the news regarding the development of the major street corners with large-scale projects. Main Street and Commercial have to date seen the projects either rejected, or cut back to a smaller scale due to public pressure; however, the Davie Village has not seen this and is being encroached on all sides by large scale development, limiting its ability to grow.

With a more specific look at the existing density of the commercial blocks, Commercial Drive is currently using 48% of its allowable buildable area, Hastings street has a similar percentage at 46% of its usable area built out, Davie Village comes next with 57% of its current allowable floor area built, and lastly Main street which is currently using 72% of its allowable area built. However, on a closer inspection of these areas it became apparent that the numbers are not a true comparison as Main Street which showed the highest percentage of built out area, actually has a smaller allowable floor area in its zoning then the other commercial districts, and all of them do vary slightly in what is allowable. So to correct this discrepancy, I proposed a new urban commercial district zone for all the districts that would allow the same density we saw when looking at international commercial areas of six storeys, and reworked the built area numbers based on this. The revised built area percentages for the districts came in as follows: Both Commercial Drive and Hastings Street would be using only 36% of their new possible density, Main Street would drop significantly as it would now only be using 26% of its comparable density, and Davie Village would be just slightly higher at 27.5%*.[31]

[31] *For a quick comparison of the neighbourhoods existing towers in Davie Village were removed from the calculations, as their densities do not fit in to the existing zoning allowances, and towers do not exist in the other commercial districts. A later analysis of the Davie village showed that the actual built density with the towers included rose to 46%.

Analysis & Conclusions:

At the end of the term it was decided that Davie Village would be the focus of the following term's programming and design as it is currently under the most pressure by developers looking to build large residential towers. Also, of the four commercial districts reviewed, Davie Village is the smallest in overall area at less than three blocks due to encroachment of large developments, and thus the closest to losing its character or of being completely lost to development. Further to this, the goals of the City of Vancouver for the Davie Village seem at odds as the City of Vancouver is currently looking at downgrading the built height in this commercial area, while allowing multiple large residential towers around it. This would bring in more residents to the area but stop any further growth of commercial spaces to accommodate the growing population.

Going forward from the research into the analysis, programming and design phase, we have to look back at the main statement of this project: building a conservation strategy to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for the neighbourhoods to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency. This led me to create some research key themes to move forward with. Foremost, neighbourhood character retention, which can be done through keeping a diversity of buildings, via a scheme that allows for an incremental rate of change. Secondly maintain the importance of energy efficiency, by incorporating neighbourhood level strategies, and upgrading poor performers, which ties back to character retention and incremental rate of change, where some buildings will get renovated, but others will be replaced. Next is affordability, which will allow small enterprises to use the commercial spaces, and density, which allows those small enterprises to prosper. Lastly is the importance of maintaining the pedestrian scale, which helps to maintain the character of the neighbourhood as the more the pedestrians feel comfortable with an area and enjoy it, the more customers there are coming to the area, spending time there and spending money at the local businesses.

List of Site Selection Attachments:

The following additional boards were presented at the RAIC 690 A (D9A) final and are attached for reference:

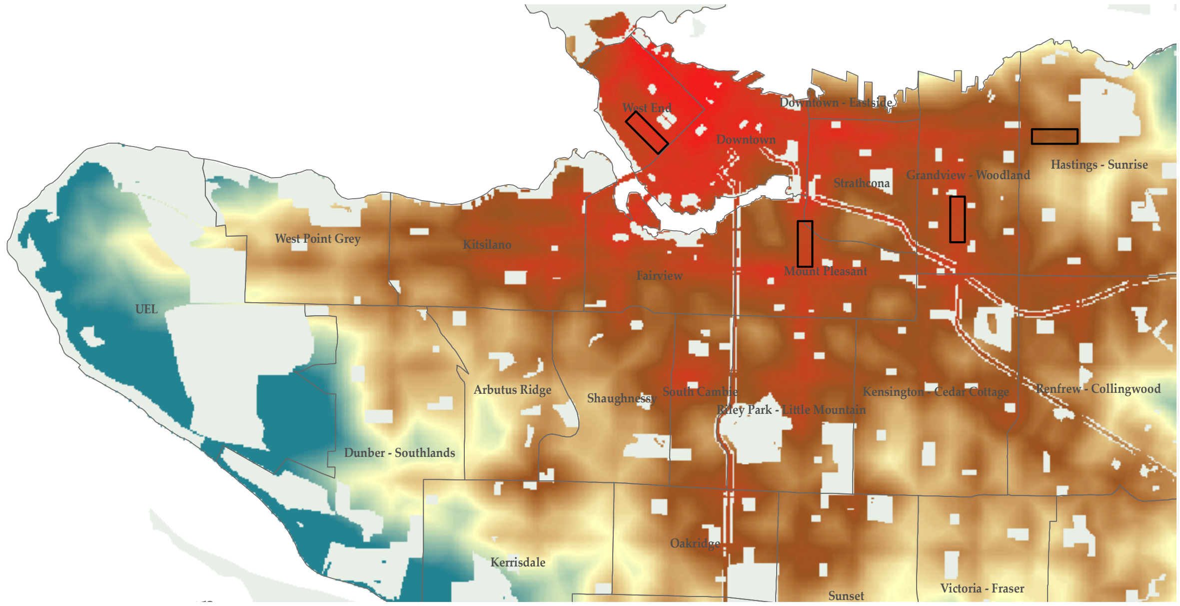
- A-2.1 Vancouver Density Maps
  (Review of Multiple Density Maps and projections produced by the University of British Columbia Geography Departments from multiple data sources dated 2001 to 2008.)

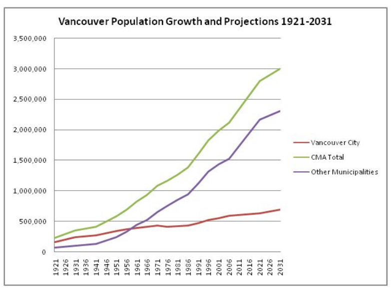
- A-2.2 Density Comparison
  (Review of Population Densities Internationally vs. Locally).

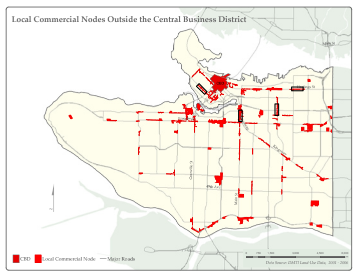
- A-2.3 Vancouver's North / South Commercial Districts
  (Review of Existing Street Massing, Built Area and Zoned Area Allowance)

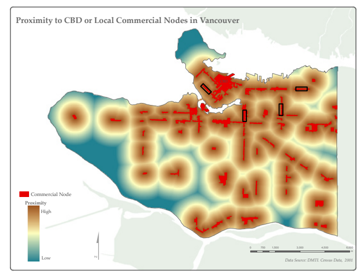
- A-2.4 Vancouver's East / West Commercial Districts
  (Review of Existing Street Massing, Built Area and Zoned Area Allowance)

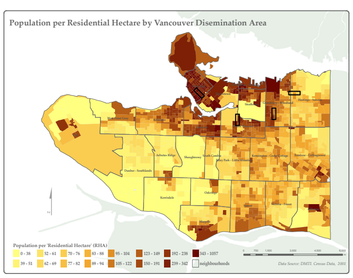
- A-2.5 Research Key Themes

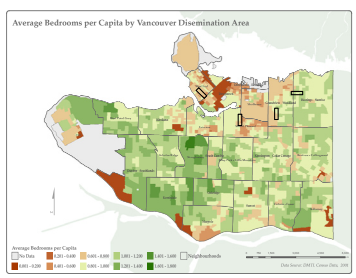


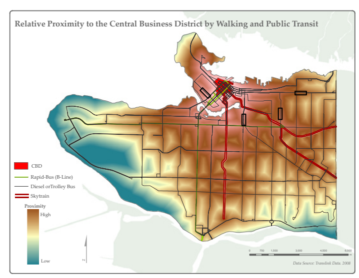


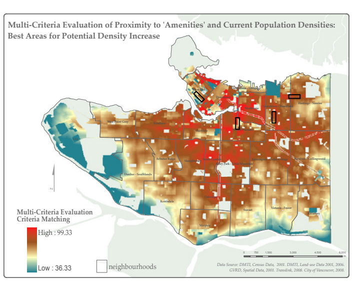


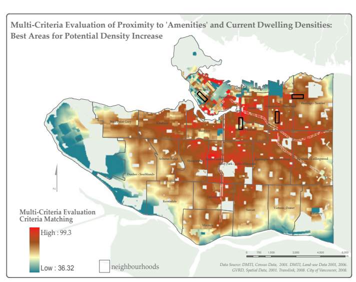


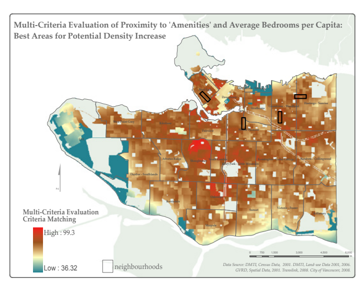












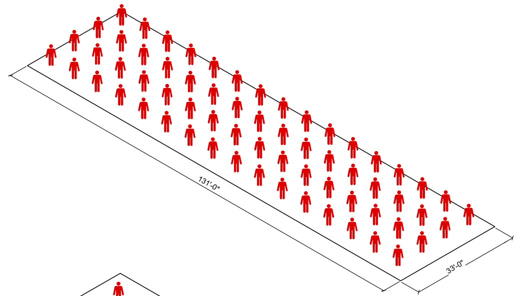
ADAPTIVE REINTEGRATION

VANCOUVER DENSITY MAPS

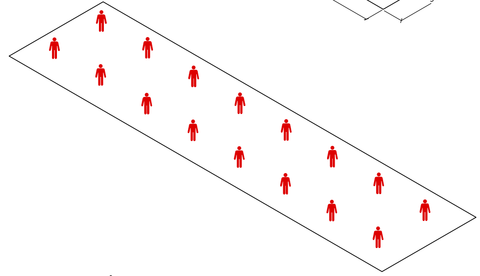
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 1 - TERM 1 2016

A-2.1

DHAKA, BANGLEDESH (LALBAGH)

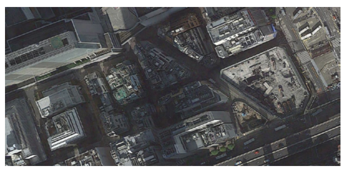


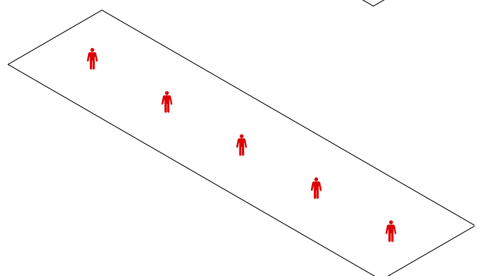
NEW YORK, U.S.A. (SOHO)



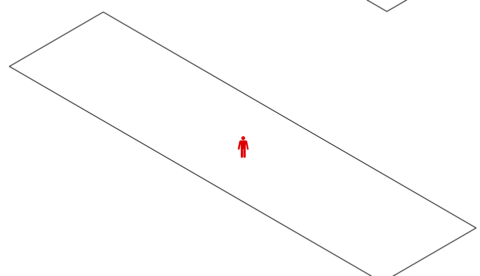
COPENHAGEN, DENMARK (VESTERBRO DISTRICT)

TOKYO, JAPAN (SHIBUYA)

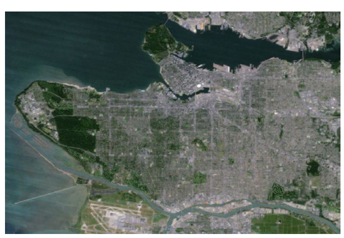


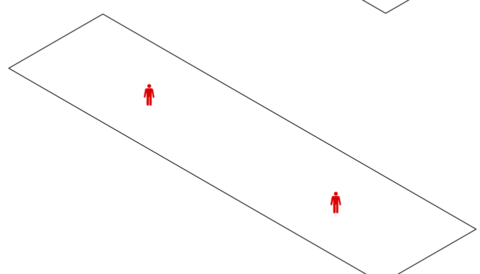


VANCOUVER (METROPOLITAN AREA)

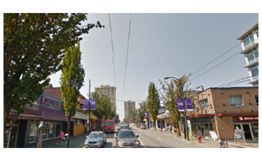


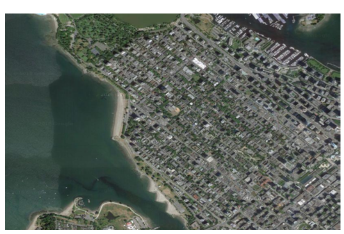
VANCOUVER (CITY PROPER)

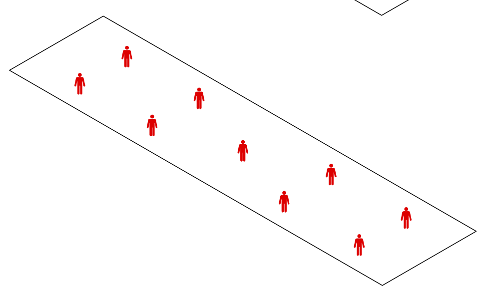




VANCOUVER (WESTEND)



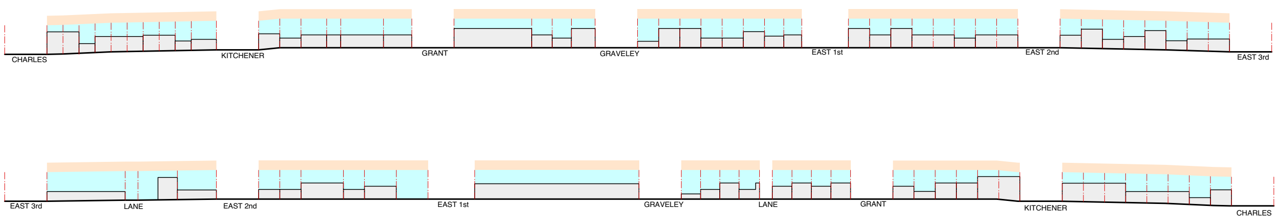




ADAPTIVE REINTEGRATION

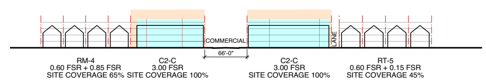
DENSITY COMPARISON

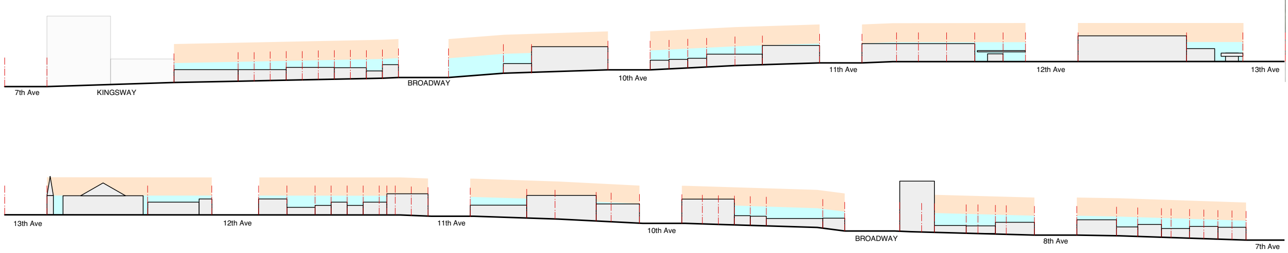
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 1 - TERM 1 2016



48% Built
52% Unbuilt
+30% Possible at 6 Storeys

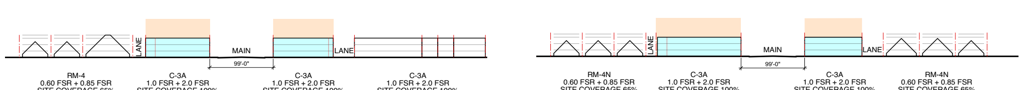
Commercial Drive





72% Built
28% Unbuilt
+176% Possible at 6 Storeys

Main Street

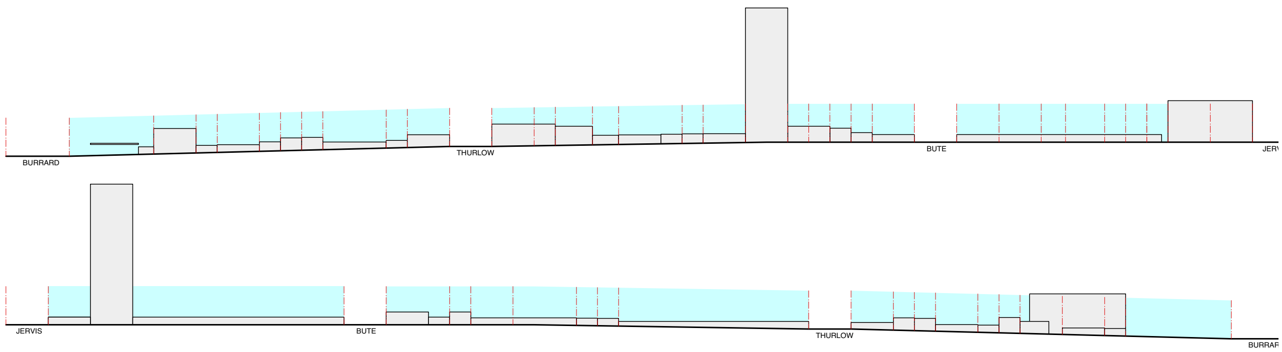


ADAPTIVE REINTEGRATION

VANCOUVER'S COMMERCIAL DISTRICTS

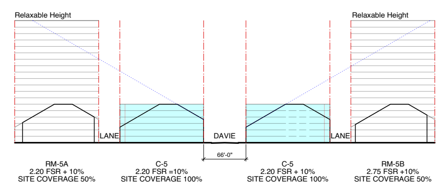
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 1 - TERM 1 2016

A-2.3

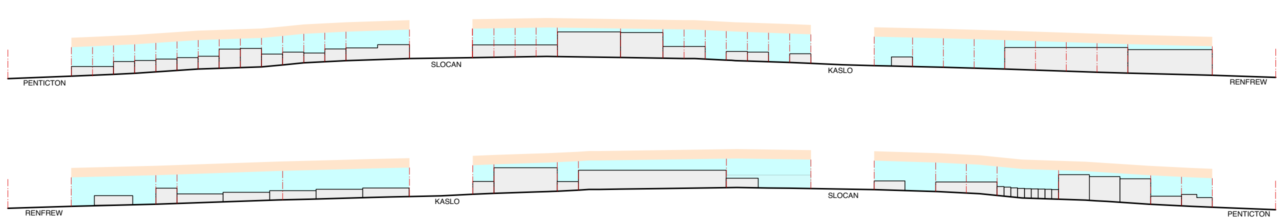


819,703 sf (57%) Built
613,457 sf (43%)Unbuilt FSR
1,433,160 sf Total

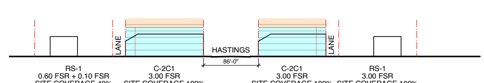
2,185,769 sf (+53%) Possible by Envelop
2,950,077 sf (+106%) Possible at 6 Store



Davie Street



46% Built
54% Unbuilt
+29% Possible at 6 Storeys

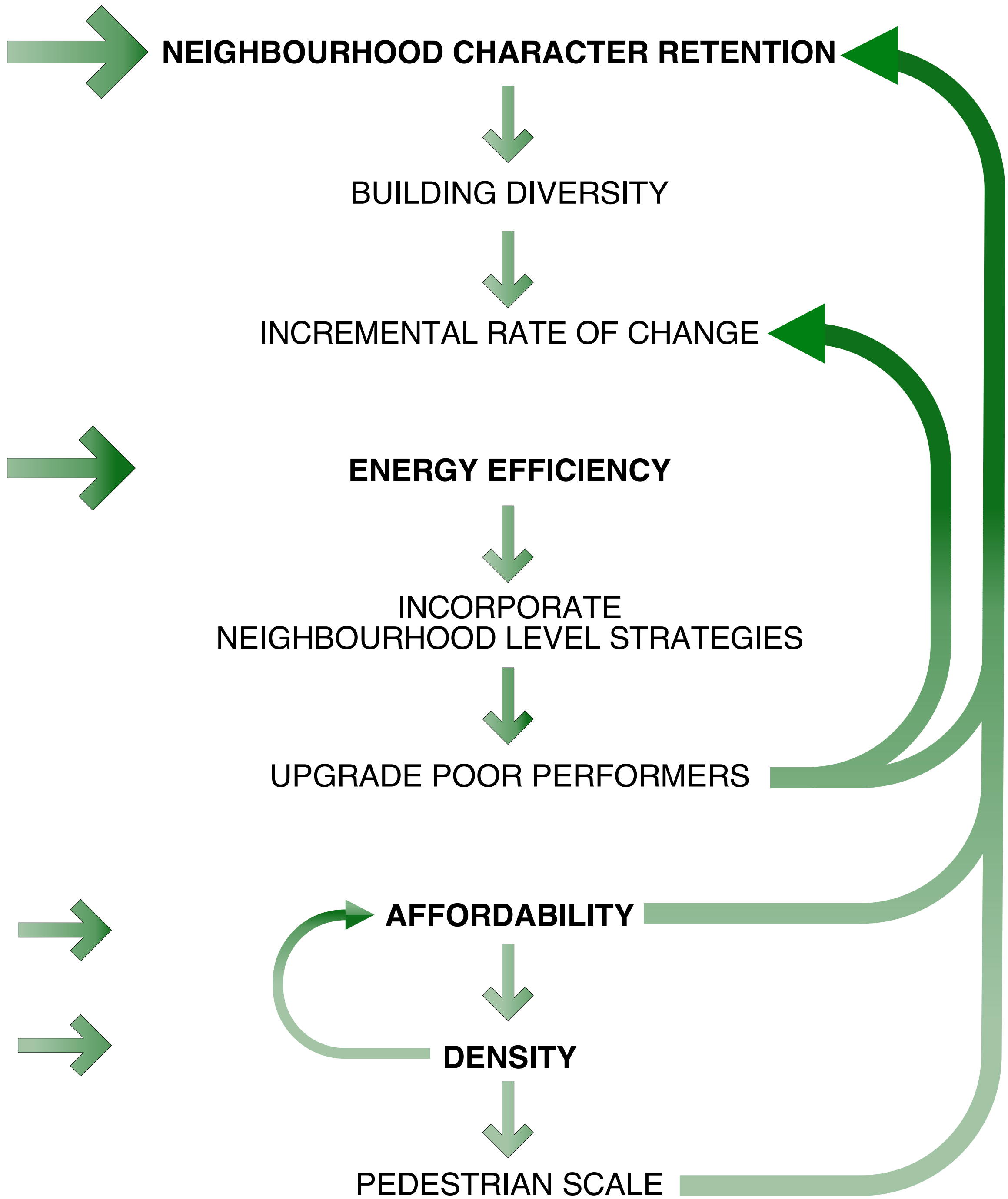


Hastings Street

ADAPTIVE REINTEGRATION
VANCOUVER'S COMMERCIAL DISTRICTS
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 1 - TERM 1 2016

A-2.4

ADAPTIVE REINTEGRATION:
A building conservation strategy is needed to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for them to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency.



Adaptive Reintegration: A building conservation strategy is needed to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for them to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency.

Site Analysis & Programming:

Davie Village as it exists today is a mix of original buildings from the 1890's, to buildings that were built in the last 20 years and small commercial spaces and restaurants that have been renovated within the last few months. As previously mentioned the buildings typically are between single storey and four storey buildings, with the exception being the hotel mid village. The previous zoning allowed for up to 6 stories along the street with a setback angle for the upper floors. This has changed in the more recent West End Community Plan that shows the City of Vancouver's vision of the street to be just two storeys.[32] This would mean that although the city is allowing increasing density of the residential neighbourhoods around the Davie Village, it is trying to reduce the density of the commercial street that is already being squeezed out just a few blocks to the West, and could soon be lost behind high-rise projects on Burrard Street to the East. In contrast the previous research showed that typical densities in popular commercial districts around the world are five and six storeys, and the residential density that Vancouver is now proposing around the Davie village is larger than most of those studied areas.

An in-depth analysis was made of the Davie Village neighbourhood and the project site was narrowed down to a single block. This term focused on reviewing the existing neighbourhood: densities, built space vs. void space and business types. I also looked at the individual existing buildings: their ages, heights, and densities. Along with the site analysis I reviewed the existing zoning bylaws as well as different possible development schemes and how they would or would not work with the project site and meeting the project statement and key themes of building conservation, energy efficiency, affordability, density

[32] City of Vancouver, *West End Community Plan*, Vancouver: City of Vancouver, October 2014

and pedestrian scale. This analysis started with showing the existing buildings, and contrasting it with the City of Vancouver neighbourhood plan. The next step was to look at what we could do if we added built area to just the void spaces on the sites, but found that this did not meet the requirements for pedestrian scale, and did not solve the building conservation strategy. Next I overlaid a proposed six-storey density over the entire site, to match the international models previously studied. This scheme allowed for some sort of building retention, energy efficiency schemes and upgrades, but was too uniform and also not pedestrian friendly. I did take this scheme one step further by raising the new density above the existing buildings, while maintaining the same height as the previous scheme, which held more potential but was still not quite right. The next scheme built on the last ones, but looked at the new density as a simple structural system that could be built over the existing buildings, by either the owner of the property or sold as air rights to a developer. This new structural shell could then be filled in as needed by new enterprises, and as more of these structures are built they can get connected together creating new streets and amenities above the existing buildings. If we then tied building upgrades for the existing buildings to the development above, we create new density, an affordable system, more pedestrian amenities, a conservation plan and energy upgrades all in one system. With this base idea we moved forward into the final design.

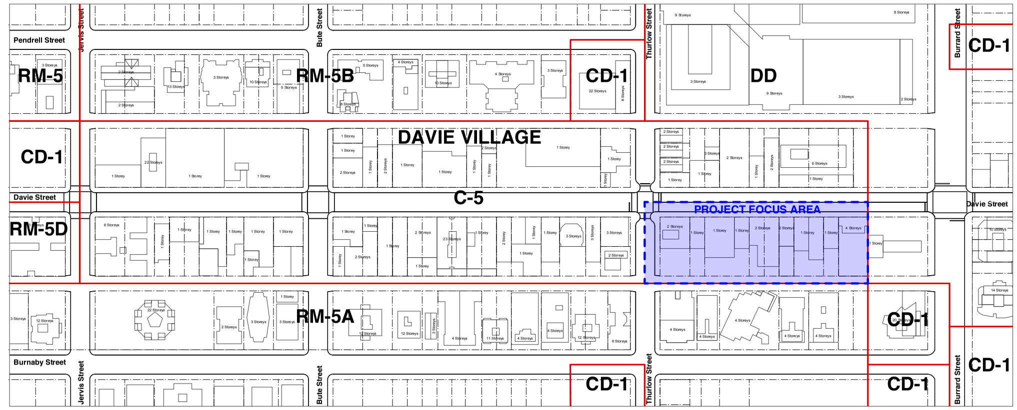
List of Site Analysis & Programming Attachments:

The following additional boards were presented at the RAIC 690 B (D9B) mid-term and are attached for reference:

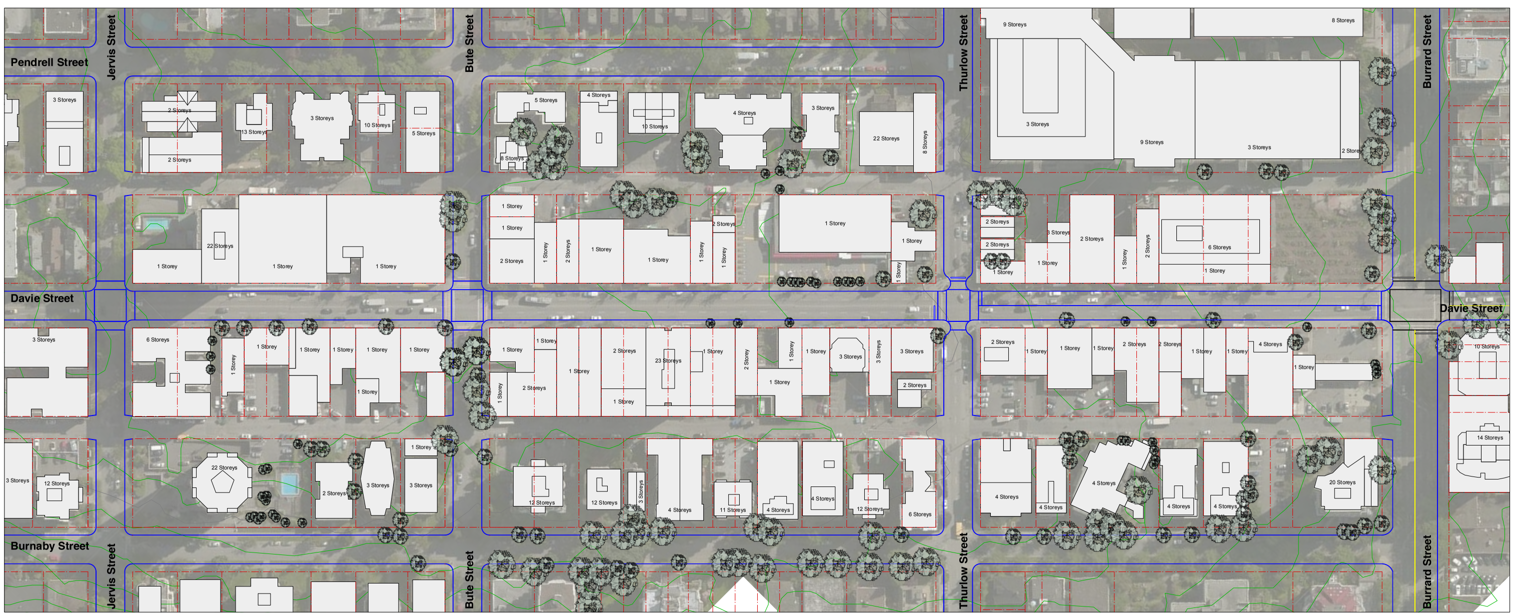
- A-3.1 Existing Site Plan
- A-3.2 Existing Site Elevation
- A-3.3 Program Site Analysis: Void and Space
- A-3.4 Programming Analysis

A-3.1

DOWNTOWN VANCOVUER



DAVIE VILLAGE

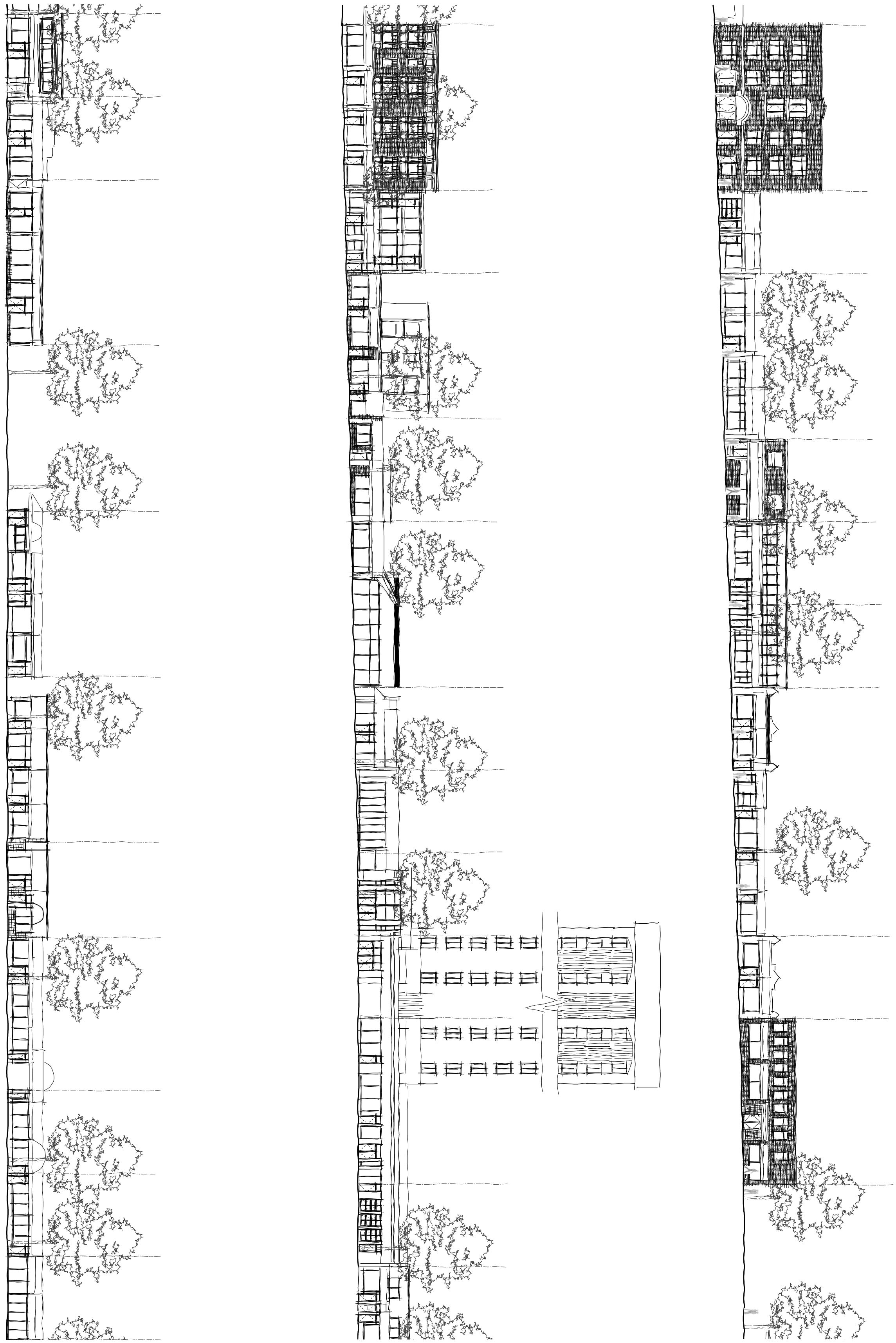


EXISTING SITE
SCALE 1:1000

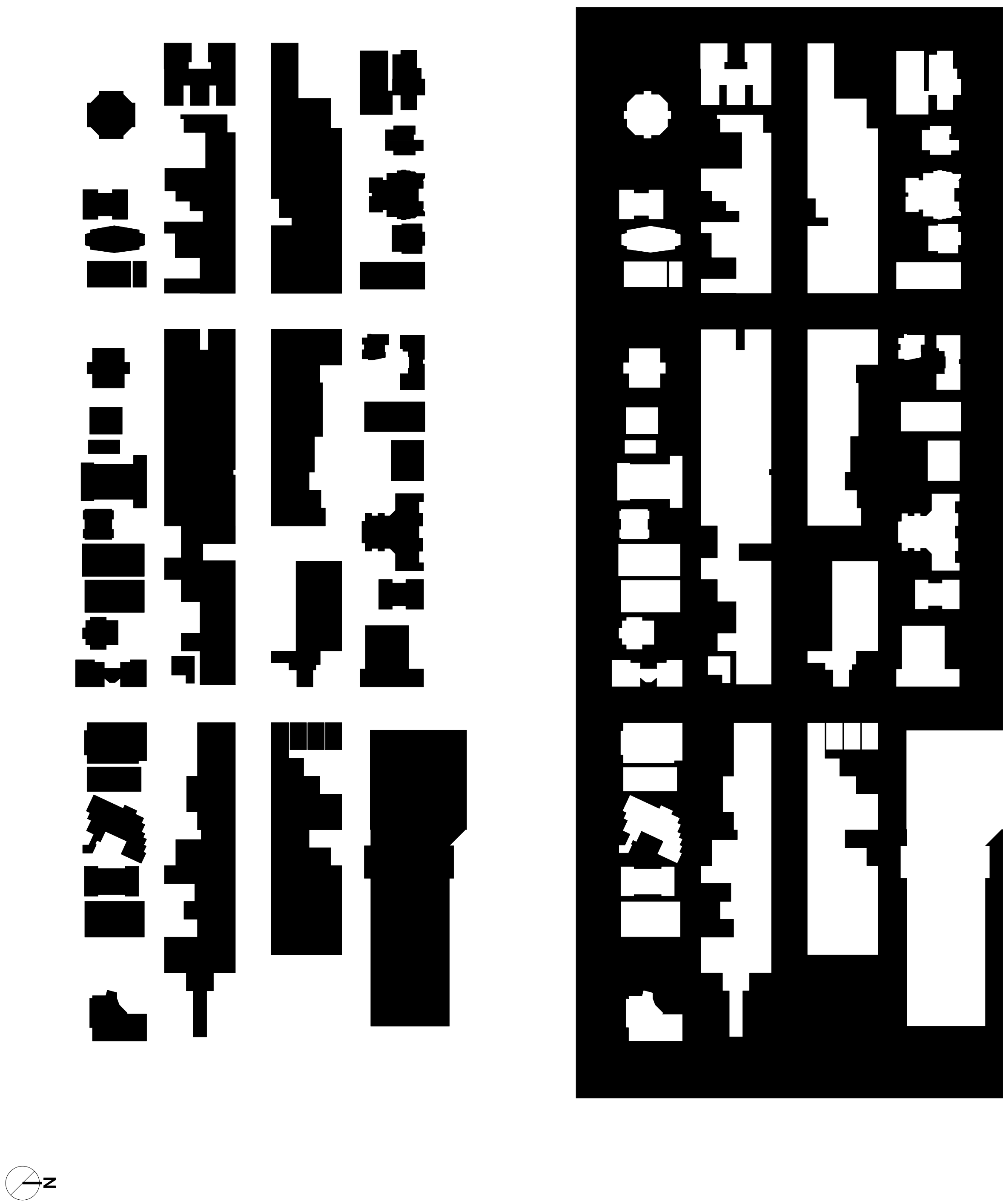
N

ADAPTIVE REINTEGRATION
EXISTING SITE INFORMATION
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

ADAPTIVE REINTEGRATION
ELEVATIONS
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016



A-3.2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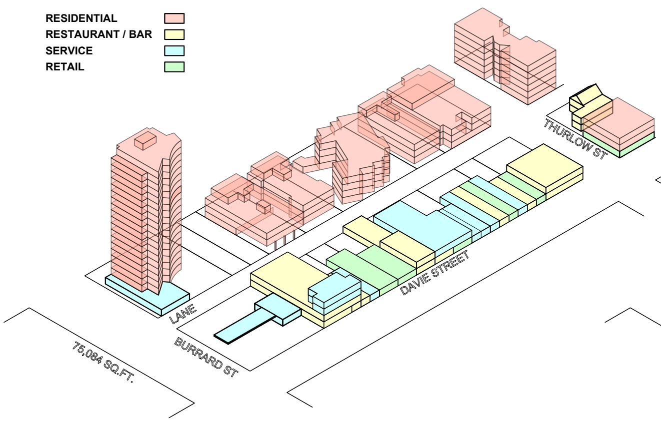
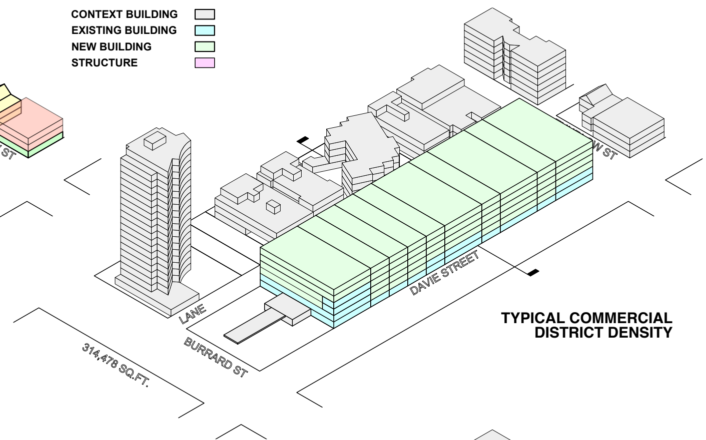
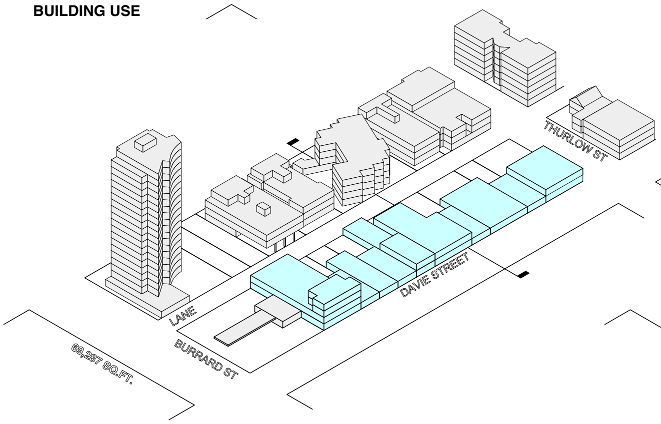


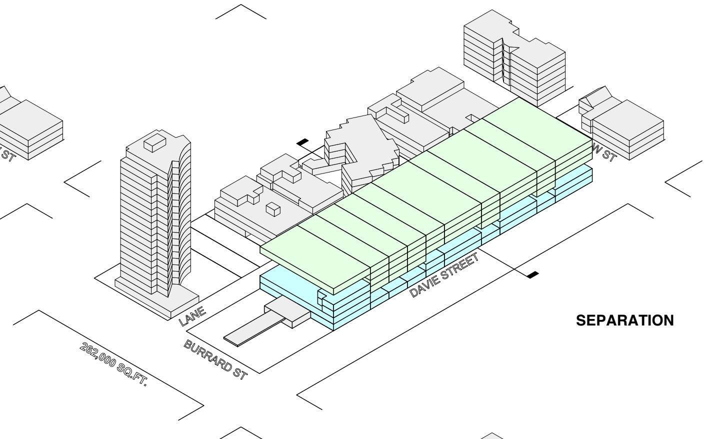
BUILDING USE



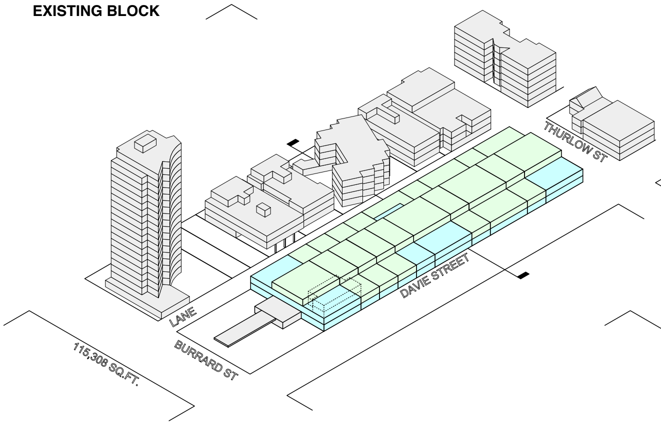
TYPICAL COMMERCIAL
DISTRICT DENSITY



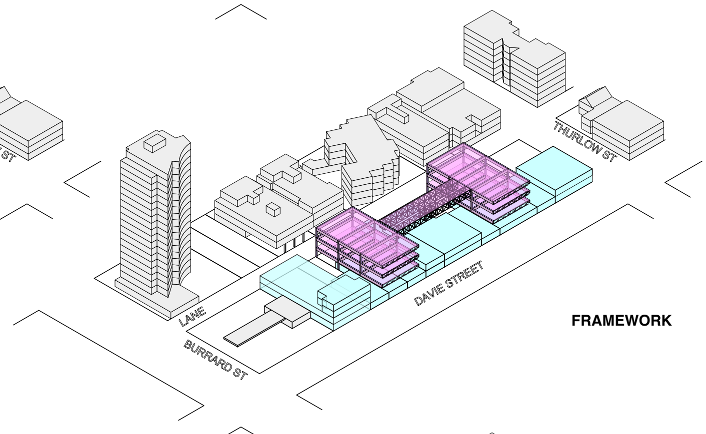
EXISTING BLOCK



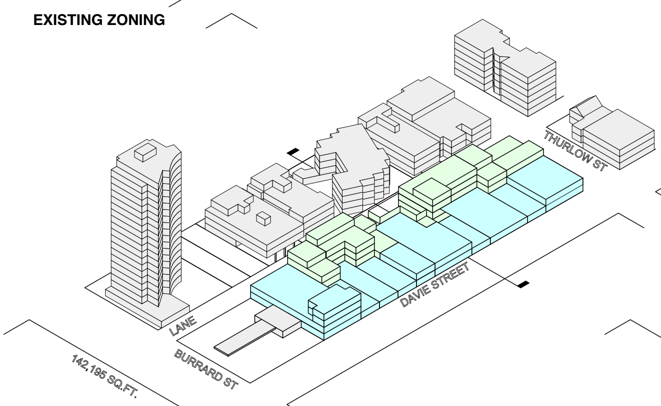
SEPARATION



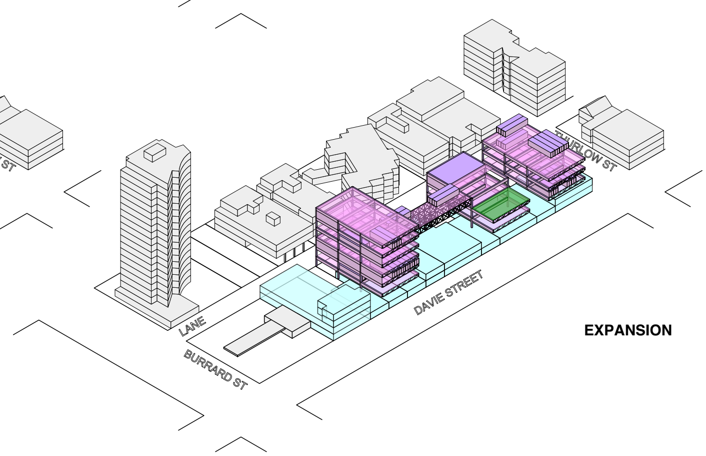
EXISTING ZONING



FRAMEWORK



EXISTING ZONING
NEW FOOTPRINT ONLY



EXPANSION

ADAPTIVE REINTEGRATION
PROGRAMMING ANALYSIS
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

Form, Progression and Design:

Before the final design case study could move forward, the design guidelines needed to be finalized. As discussed previously one of the project goals was to increase the density of the commercial neighbourhoods by creating new buildings, while still conserving the existing buildings, and allowing for a measureable rate of change. To do this the thought was to build over the existing buildings, without causing too much disruption to the buildings below. So a structural system that would minimally impact the lower buildings was developed, to work as the framework for new infill commercial businesses above. The steel structure uses standard sizes, based on the highest predicted loading to make for a simplified, mass producible, easy to install system. The steel structure is also designed such that the columns remain 40'-0" away from the commercial street, cantilevering the upper floors out in order to maximize the open space on the existing lower level buildings, and allow them to remain operational during construction. The steel structure system would also include required exit stairs and mechanical and plumbing connections for each floor, that could then be run through the open web steel joists to any location required by future tenants, thus being simple and yet robust enough to allow additional openings and adaptations to future tenant needs.

The added density would be based on a cap and trade system, with the density cap being based on the existing maximum allowed floor space ratio (FSR) currently prescribed in the zoning bylaws, but applied to the entire block and not the typical property per property basis. In the case of our project area, the current zoning (C-5) allows for a 2.42 floor space ratio, which equates to 146,463 ft^2 or 13,607 m^2. The block as it exists today with a majority of single storey buildings, a couple of two-storey buildings and one four-storey building is only currently using a combined 1.14 FSR (69,267 ft^2/ 6,435 m^2) leaving 1.28 FSR (77, 196 ft^2/ 7,171 m^2) still available for development. A cap and trade system would allow for the owners of the sites to sell the air rights above their buildings and/or the unused density on their property, without losing the property rights to their existing businesses. This system would allow for owners of the existing small businesses, to raise money from their underused assets without having to sell or move their businesses. The overall amount of density that could be built on any single property could never exceed what is allowed for the single block as defined by the cross streets and laneways, as well as the boundary of the zoning district. In the case study for this project, this would disallow the use of FSR to be bought or sold to or from the gas station at the end of the block as it is not in the Commercial C-5 zone but is part of the Downtown District (DD) zone which allows for densities of 6.00 FSR and heights of up to 91.4 m.

On the topic of height, in order to preserve sunlight access to the front street, regardless of density allotments, any new development should not exceed six storeys, unless it can be proven through sunlight models that additional storeys would not adversely affect the street life.[33] Six storeys also fits with the international case studies of commercial neighbourhoods, and per other discussions by Jane Jacobs and by Christopher Alexander in his iconic book 'A Pattern Language',[34] buildings above six storeys cause problems because you can no longer pick out the faces of people at street level, and thus you are physiologically distancing yourself from the neighbourhood. Above six storeys also puts a business out of the sightlines of pedestrians at street level which puts a small enterprise at a disadvantage if they want to bring in pedestrian street traffic.

Regarding street traffic, one of the features of downtown Vancouver is laneways that are the same widths as a residential street. As we noted earlier, the Davie Village is now locked into just three blocks by residential tower developments. So another way to get more use out of the existing density is to upgrade the laneway into a pedestrian street and allow small businesses to front the laneway. To make this happen infill commercial spaces will be allowed on the lanes, and the paving and landscaping will be upgraded to create comfortable pedestrian areas away from the traffic of the main street. This means

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[33] In cases where large condo tower development to the south of the development are already shading the street a case might be made that a taller commercial project could be allowable.
[34] Alexander, Christopher. *A Pattern Language: Towns, Buildings, Construction*. USA: Oxford University Press, 1977.

providing different types of foliage cover, places of rest, and upgrading lighting for pedestrian levels instead of vehicles. Additionally, a pedestrian breezeway should be introduced midblock, to allow circulation for pedestrians, to freely gain access between the new laneway businesses and the main front street businesses without having to walk around the entire city block to go between them. Regarding the main street frontage, following the City of Vancouver's own initiatives, the front street should have the sidewalk widened which would allow for more landscaping and a separated bike lane added to the roadway that would act as a further buffer zone, increasing the distance between pedestrians and vehicular traffic. This would create a safer, quieter, and more comfortable shopping area for pedestrians and the businesses themselves, while only losing a single lane of the existing four lane road.

Further to improving the pedestrian realm of the project area, it was decided the new development on top of the existing buildings will be stepped back a minimum of 3.5m from the property line. This allows for more sunlight penetration to the street below, further improving the quality at the sidewalk level. By stepping the building back it also helps maintain the character of the neighbourhood by not allowing the buildings on top to overbear the buildings below. Also regarding the overall building massing, one more item that needs to be added is regarding building frontage, and that is to not allow any single business to exceed 66'-0" of storefront. This is because when a business frontage exceeds 66'-0" it becomes monotonous at the street level. This also stops large box stores from taking over all of the commercial spaces, leaving them available for the smaller local businesses that are currently fitting two to four businesses in 33'-0" of frontage.

To finalize this section, I find the treatment of the roof of the buildings to be as important as, or even more so than, the façade of the buildings. A tremendous amount of square footage is left open that could be used for public amenity parks, or for urban agriculture. The project site area has potentially 60,522 ft^2 (5,623 m^2) of roof space that could be used. By designating the rooftops for these types of uses, it improves the amount of available public space, lowers the heat island effect (which is especially important in downtown core areas), the soil depth acts as an acoustic buffer, as well as thermal barrier when dry, and also helps with storm water management, by reducing runoff at peak flow times, and filtering the water as it slowly passes through the plant roots, and soil medium. So all roof areas not required for roof top equipment and maintenance, must either be extensively landscaped as amenity park space, designed for urban agriculture use, or can be used for power generation or solar heating to reduce energy demands.

In summary the FSR is capped at the existing zoning level and can be bought and sold from only properties on the same block with the same zoning. Laneways will be utilized for additional ground level commercial businesses, and pedestrian areas will be improved, and more access should be given to freely move between the front and back streets. The height is restricted to 6 storeys unless proven to not further shade the main street, building frontage is limited to 66'-0" maximum per business, and rooftop areas not necessary for mechanical equipment and maintenance must be used as intensive green space, agriculture or sustainable power generation.

With the overall massing qualified, we need to look at the sustainable efforts that need to be addressed for the new development and any renovations to the existing buildings below them, for our conservation strategy. A lot of smaller business owners would like their businesses to be more sustainable, and improve their buildings to be more energy efficient but either do not know how, or do not have the financing to do so. To help solve this issue, for every building that sells its air rights and has a new development built above it, the developer of the new structure and infill must complete the following for the base building:

- Provide a building enclosure condition assessment, documenting the condition of assets, provide testing and infrared scans, and identify potential building risks.
- Provide a mechanical and energy audit, documenting HVAC equipment and building systems.

- Provide energy bill analysis, to better understand how much energy is being used and where the energy is being used.
- Provide energy modeling and calibration to assess potential energy efficiency measures and savings.
- Provide costing and a financial analysis to assess metrics for various upgrade options.
- Perform an energy audit of the base building and provide the information to the building owner.

With this list of items in hand the owner of the base building will have all the documentation and information needed to make informed decisions on any future building upgrades for their property. On top of the testing and analysis that must be provided to the base building the following is a list of simple upgrades that will be required for all buildings to be upgraded in order to help meet the 2030 challenge:

- Upgrade insulation of base building roof to R-60.

    Since a new structure is already going above the building, and penetrations will need to be made for plumbing, mechanical and circulation, this would be an appropriate time to increase the roof insulation to help the businesses below reduce their energy bills due to heat loss through the roof.
- Pre-1996 Mechanical / Plumbing equipment including boilers, water heaters, furnaces, base board heaters to be updated to newer energy efficient models.

    Mechanical equipment has increased its efficiency year after year, with systems more than 20 years old performing poorly against anything after that time when industry was locked into energy and efficiency upgrades. Further to this, the major mechanical and plumbing equipment will need to be upgraded anyway to supply the project spaces above.

- Install heat recovery ventilators (HRV) where possible.

  If a ducted mechanical system for supply and exhaust air already exists, a heat recovery ventilator reduces the amount of energy required to heat or cool the supply air as the supply air is already tempered at the HRV by the exhaust air leaving. Adding an HRV is adding free energy.

- Upgrade plumbing fixtures, fittings and appliances to lower flow devices.

  Similar to the mechanical and plumbing equipment; plumbing equipment and appliances have increased efficiency, lowered energy use and lowered water consumption over the years.

- Add separate water and energy metering for each tenant space.

  The rule of thumb is that if people see how much energy and water they are using on their bills, they become more aware of how their usage affects their costs and are more inclined to reduce their usage.

- Install rainwater collection systems for use in landscape irrigation.

  The use of potable water for landscape is a waste. Xeriscaping to eliminate the need for any landscape irrigation is preferred

With these guidelines in place, a case study was designed to show one possible evolution that could happen to the commercial district. This started with a site evolution review showing how the site has changed from the founding of Vancouver to today, and then how the site might move forward into the future. This was followed with taking one moment of time in that evolution to show how the new development might look within the existing context, the idea being that these guidelines could be used in any of the reviewed commercial districts. Also to show how the neighbourhoods would evolve would be unique block to block, as the amount of floor space available could be used in multiple different ways depending on how the neighbourhoods naturally expanded over time.

List of Final Presentation Attachments:

The following additional boards were presented at the RAIC 690 B (D9B) final and are attached for reference:

- A-4.1 Design Guidelines (Key Points)
- A-4.2 Design Guidelines (Illustrated Part 1)
- A-4.3 Design Guidelines (Illustrated Part 2)
- A-4.4 Site Evolution Part 1 (Past to Current)
- A-4.5 Site Evolution Part 2 (Current to Future)
- A-4.6 Program Assembly (Exploded Axonometric)
- A-4.7 Proposed Site Plan
- A-4.8 Proposed Ground Level Plan
- A-4.9 Possible Upper Plan Layout
- A-4.10 Proposed Elevation (Front Street)
- A-4.11 Proposed Elevation (Laneway)
- A-4.12 Perspectives 1 (Base Structure Exposed)
- A-4.13 Perspectives 2 (Davie Village Street View)
- A-4.14 Perspectives 3 (Davie Village Looking South-West)
- A-4.15 Perspectives 4 (Davie Village Looking South-East)
- A-4.16 Perspectives 5 (New Laneway Looking East)
- A-4.17 Perspectives 6 (New Mid-Block Breezeway)

ADAPTIVE REINTEGRATION:
A building conservation strategy is needed to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for them to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency.

FLOOR SPACE RATIO

Cap and trade system set at existing zoning levels (2.42 FSR). FSR and air rights can be bought / sold / traded from neighbours on the same block within the zoning distict.

BUILDING HEIGHT

Based on sunlight models, cannot exceed 6 stories unless shown through modeling that additional height will not adversly affect street life and adjacent buildings.

BUILDING FRONTAGE

No single business can exceed 66'-0" of street frontage

ROOFTOPS

All non-mechanical roof areas are to be extensively landscaped as amenity park space, designed for use as urban agriculture, or used for power generation and/or solar heating.

BASE BUILDING CONSERVATION

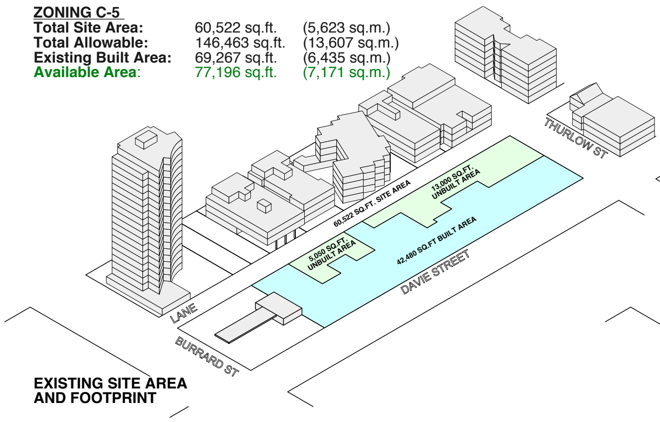
Provide to the building owner and tenants; a building enclosure condition assessment, a mechanical and energy audit, an energy bill analysis, energy modeling and calibration, costing and financial analysis, and an energy audit of the base building.

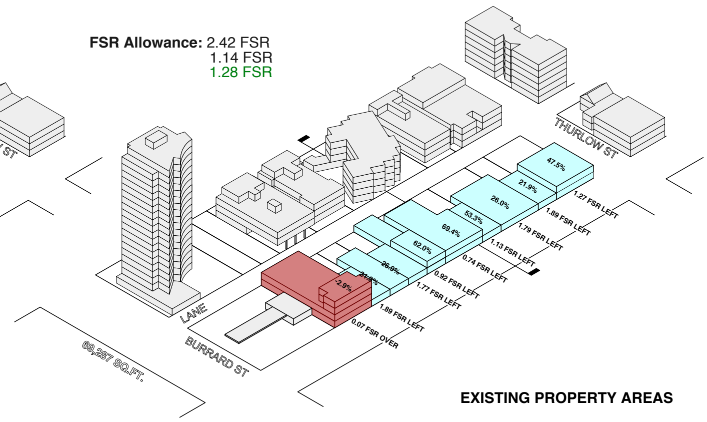
BASE BUILDING UPGRADES

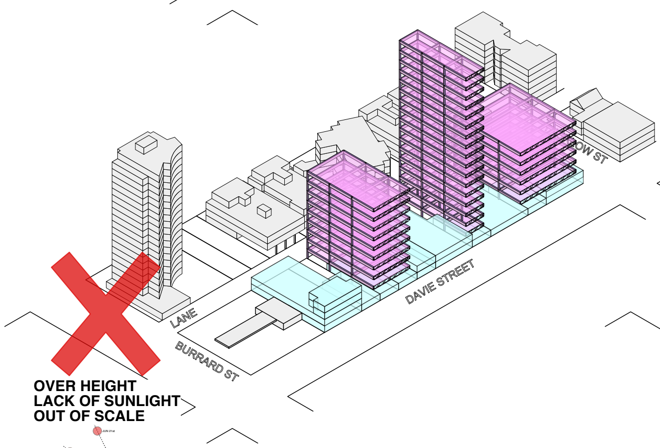
Upgrade insulation of base building roof to R-60; update all pre-1996 mechanical and plumbing equipment; install HRVs where possible; upgrade plumbing fixtures, fittings and appliances with low flow devices; add separate water and energy metering for each tenant space and; install rain water collection systems for use in landscape irrigation.

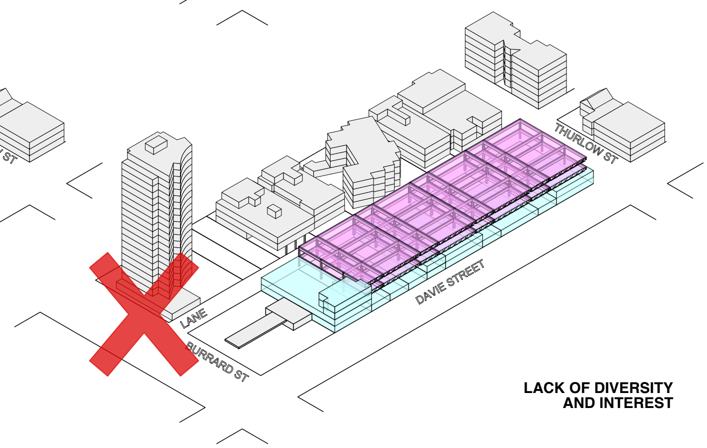
PEDESTRIAN UPGRADES

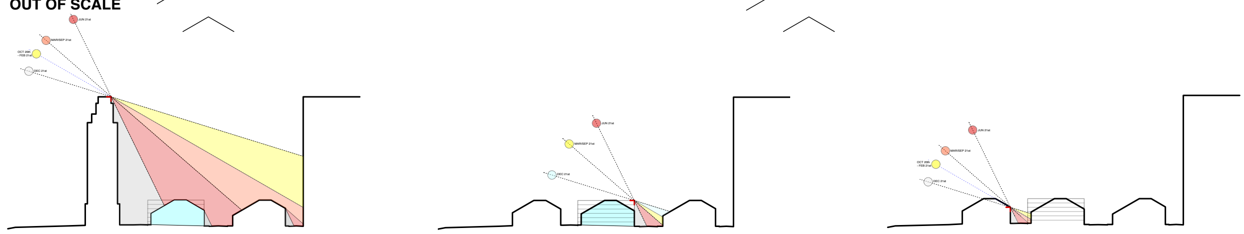
Upgrade all street frontages, and laneways to enhance the public realm through separation of traffic, increased vegetation, improved rain and sun protection, provide seating, improve pedestian flow and ease of movement.


ZONING C-5
Total Site Area: 60,522 sq.ft. (5,623 sq.m.)
Total Allowable: 146,463 sq.ft. (13,607 sq.m.)
Existing Built Area: 69,267 sq.ft. (6,435 sq.m.)
Available Area: 77,196 sq.ft. (7,171 sq.m.)
THURLOW ST
60,522 SQ.FT. SITE AREA
13,000 SQ.FT. UNBUILT AREA
5,000 SQ.FT. UNBUILT AREA
42,480 SQ.FT BUILT AREA
DAVIE STREET
LANE
BURRARD ST
EXISTING SITE AREA
AND FOOTPRINT


FSR Allowance: 2.42 FSR
1.14 FSR
1.28 FSR
THURLOW ST
47.5%
21.9%
26.0%
53.3%
69.4%
62.0%
1.27 FSR LEFT
1.89 FSR LEFT
1.79 FSR LEFT
1.13 FSR LEFT
0.74 FSR LEFT
0.92 FSR LEFT
1.77 FSR LEFT
1.89 FSR LEFT
0.07 FSR OVER
LANE
BURRARD ST
69,267 SQ.FT.
EXISTING PROPERTY AREAS


DAVIE STREET
LANE
BURRARD ST
OVER HEIGHT
LACK OF SUNLIGHT
OUT OF SCALE


THURLOW ST
DAVIE STREET
LANE
BURRARD ST
LACK OF DIVERSITY
AND INTEREST

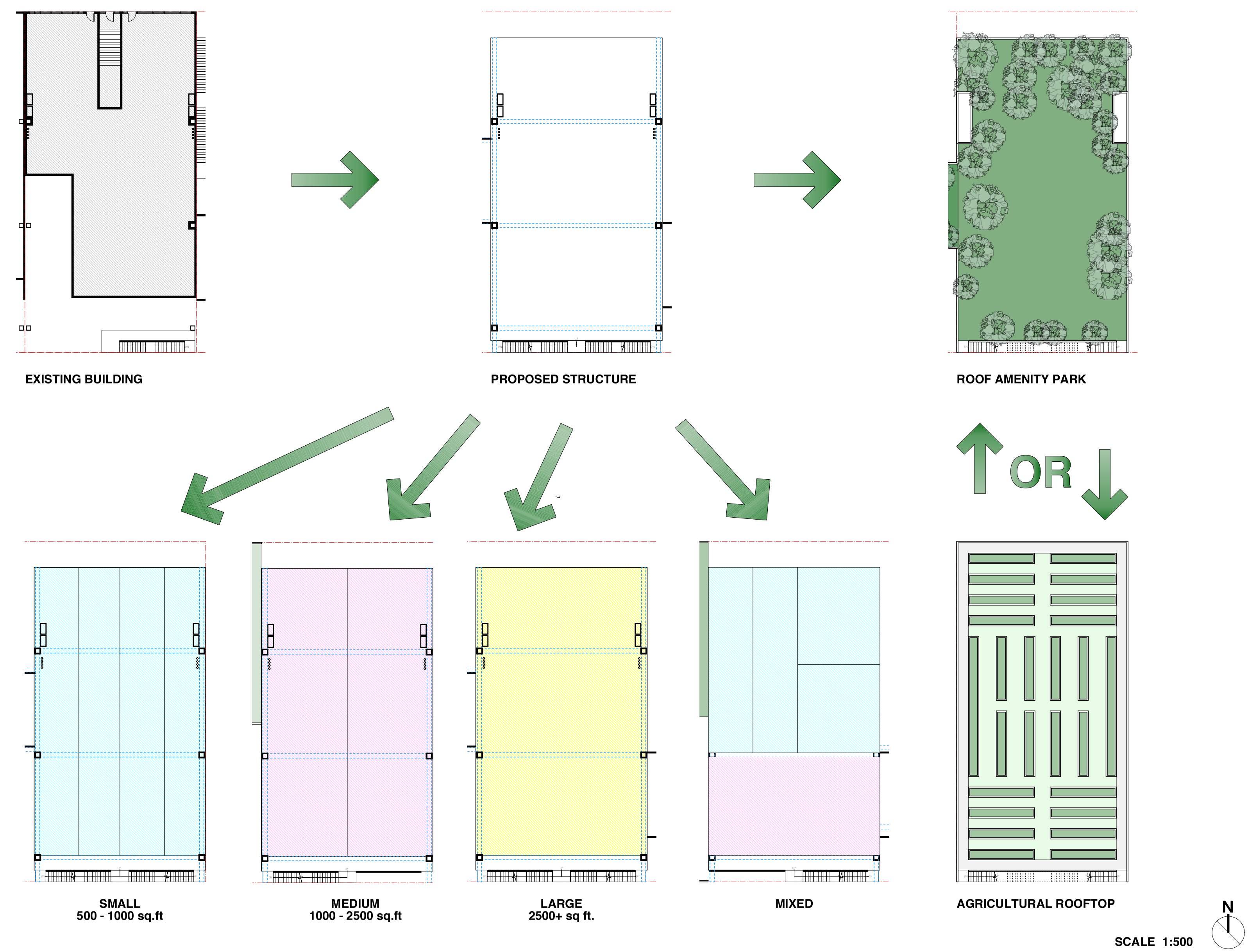



INHOSPITABLE

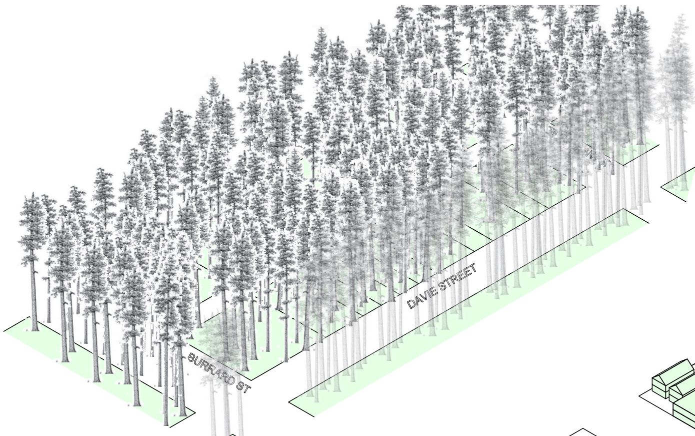

UNUSABLE


USABLE

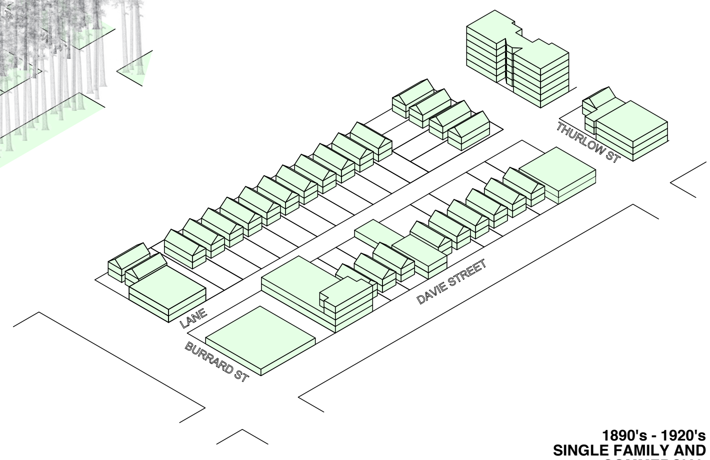

POSITIVE SPACE



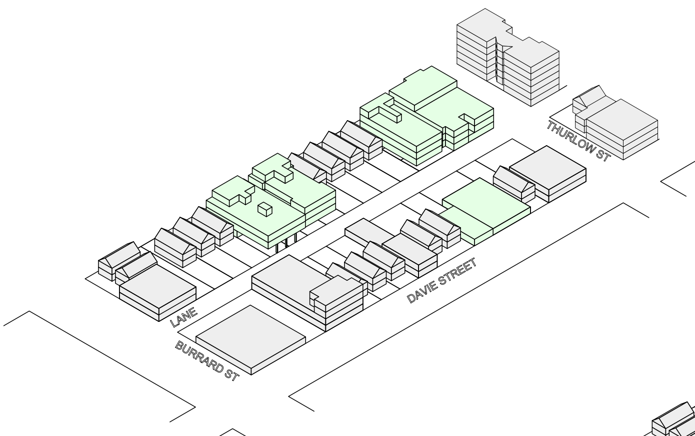
ADAPTIVE REINTEGRATION
DESIGN GUIDELINES ILLUSTRATED PART 2
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016



PRE-1890's
FORESTED

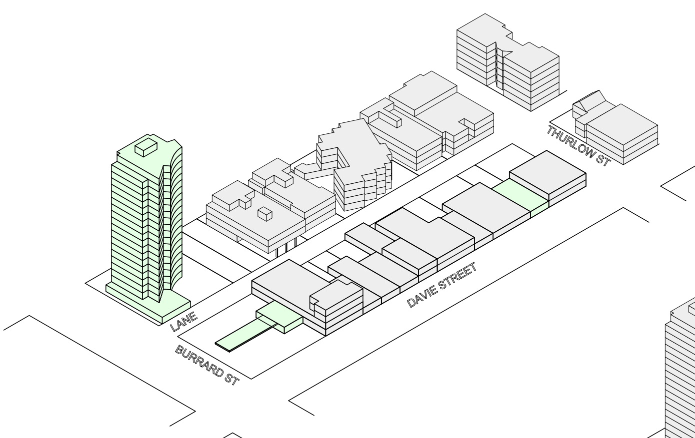


1890's - 1920's
SINGLE FAMILY AND
COMMERCIAL

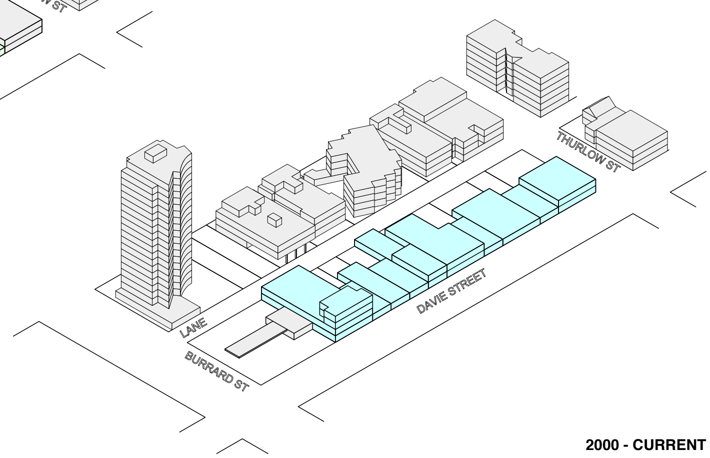


1930's - 1950's
CONSOLIDATION TO
MULTI-FAMILY

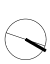
1960's - 1970's
CONTINUED CONSOLIDATION
AND GROWTH



1980's - 1990's
END OF SINGLE FAMILY
RESIDENCES



2000 - CURRENT



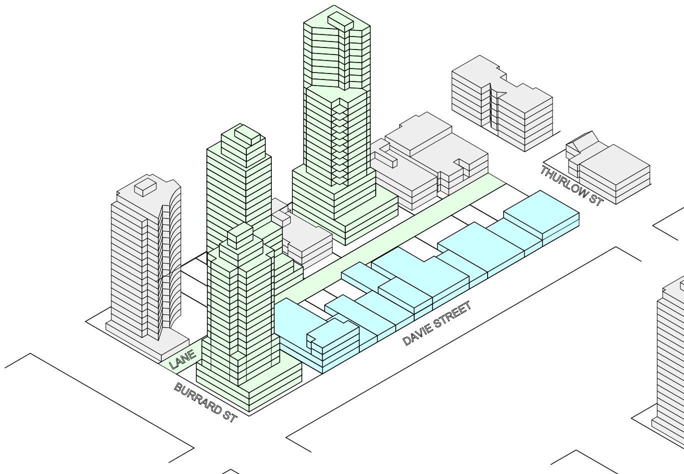
SCALE 1:1000

ADAPTIVE REINTEGRATION

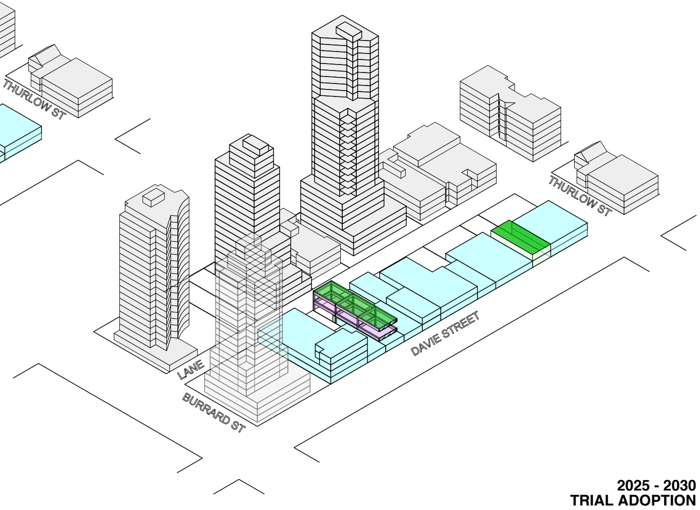
SITE EVOLUTION PART 1

RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

A-4.4

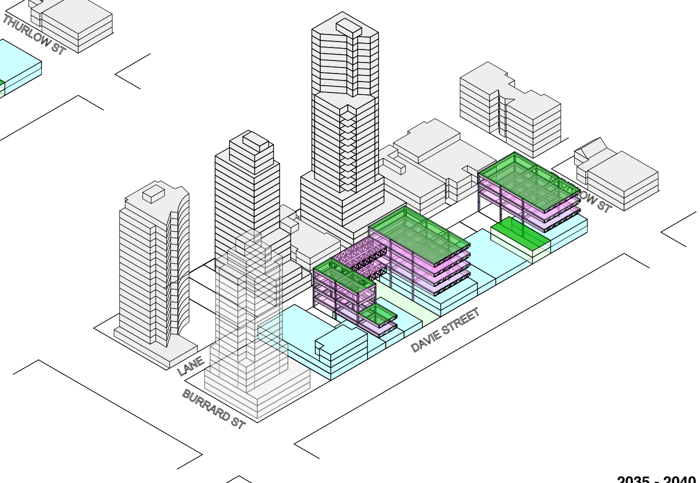


CURRENT - 2025
CONTINUED ENCROACHMENT

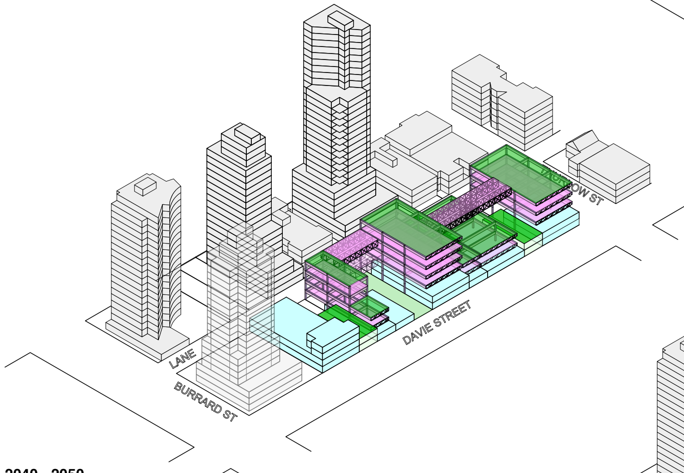


2025 - 2030
TRIAL ADOPTION

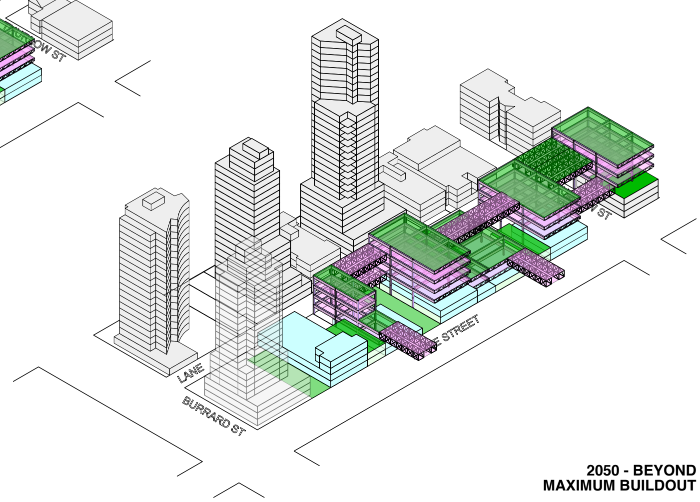
2030 - 2035
FULL ADOPTION



2035 - 2040
EXPANSION



2040 - 2050
CONTINUED GROWTH



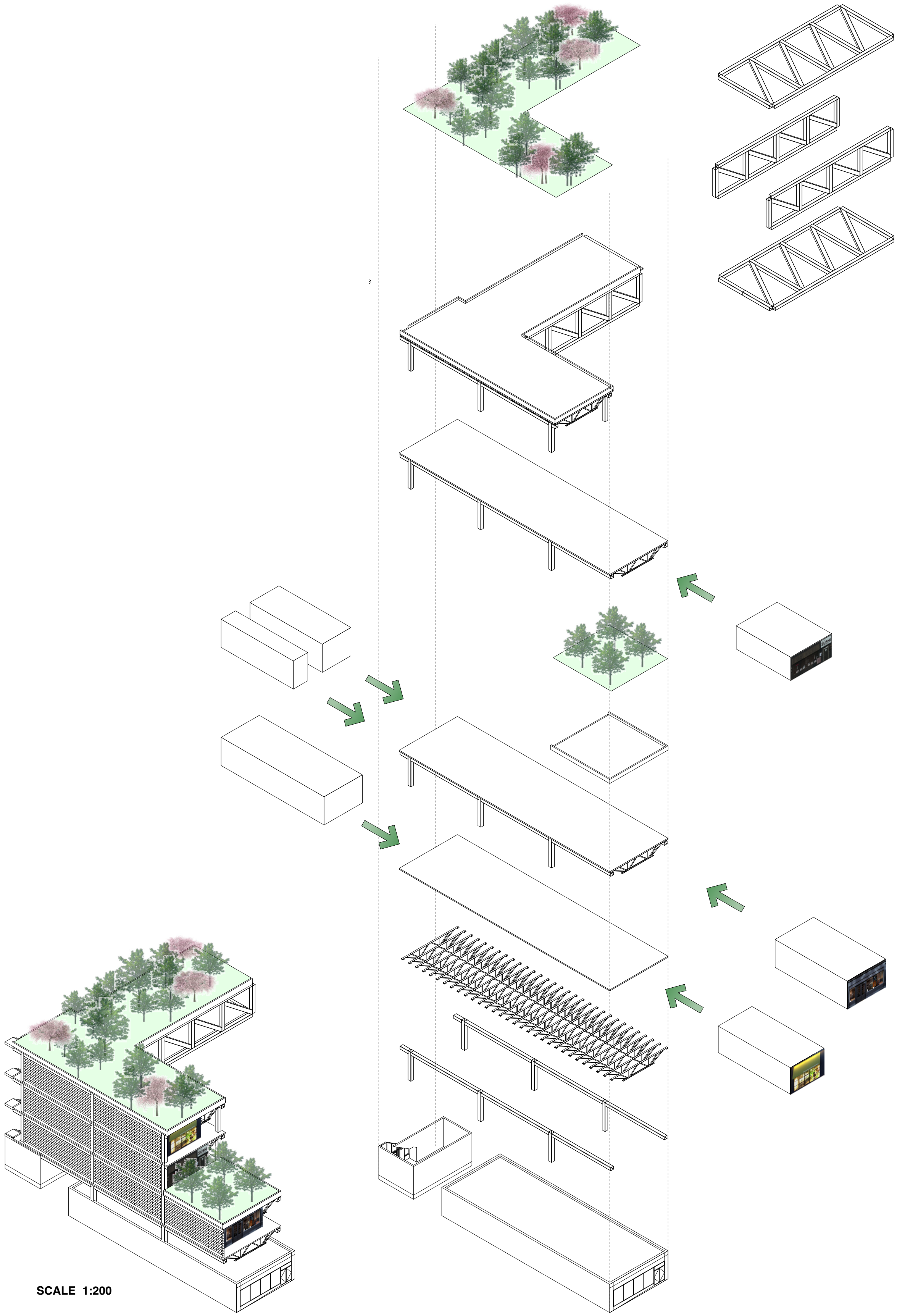
2050 - BEYOND
MAXIMUM BUILDOUT

N

SCALE 1:1000

ADAPTIVE REINTEGRATION
SITE EVOLUTION PART 2
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

A-4.5



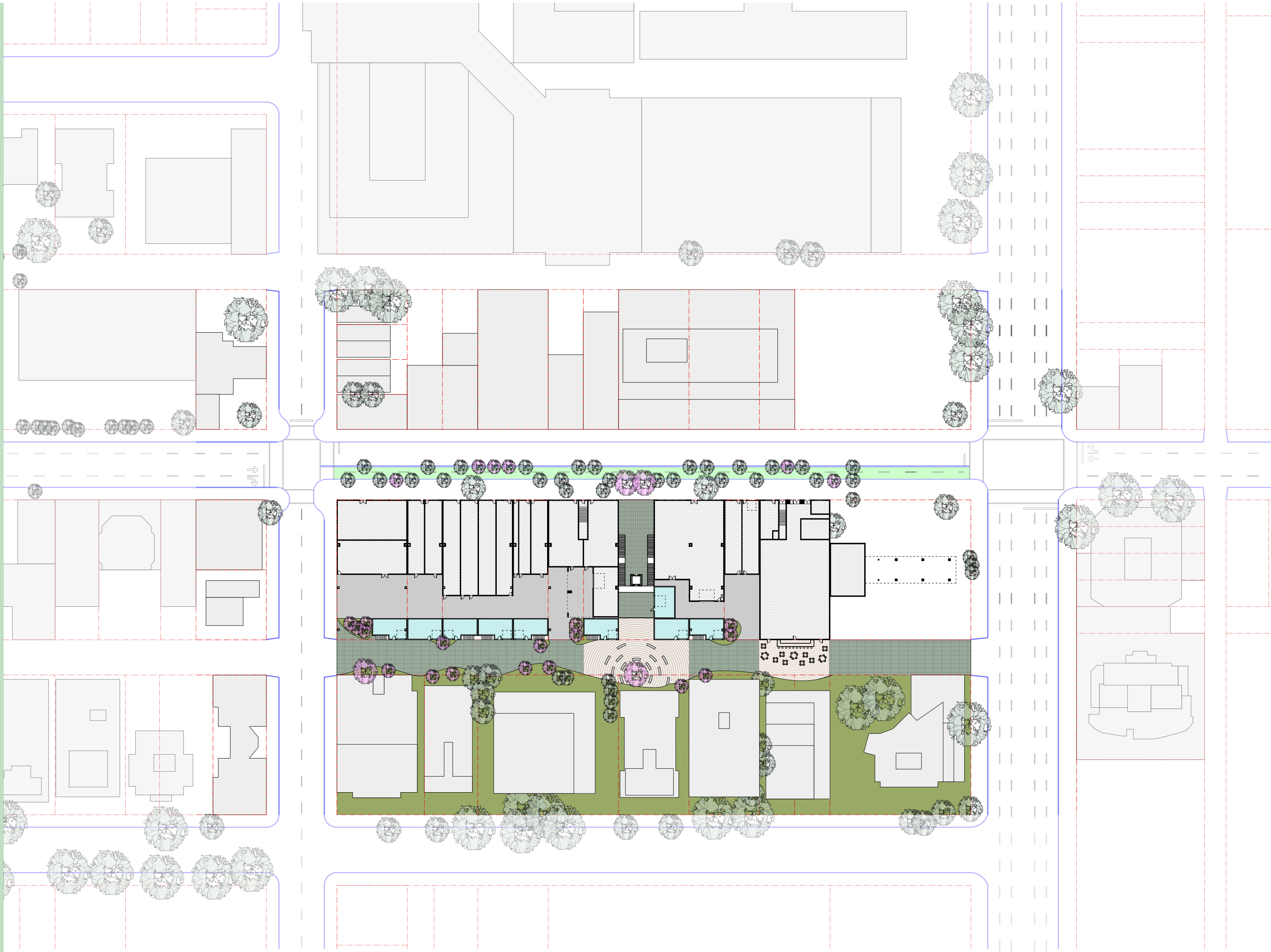
SCALE 1:200

ADAPTIVE REINTEGRATION
PROGRAM ASSEMBLY
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

A-4.6

ADAPTIVE REINTEGRATION
PROPOSED SITE PLAN
RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

A-4.8



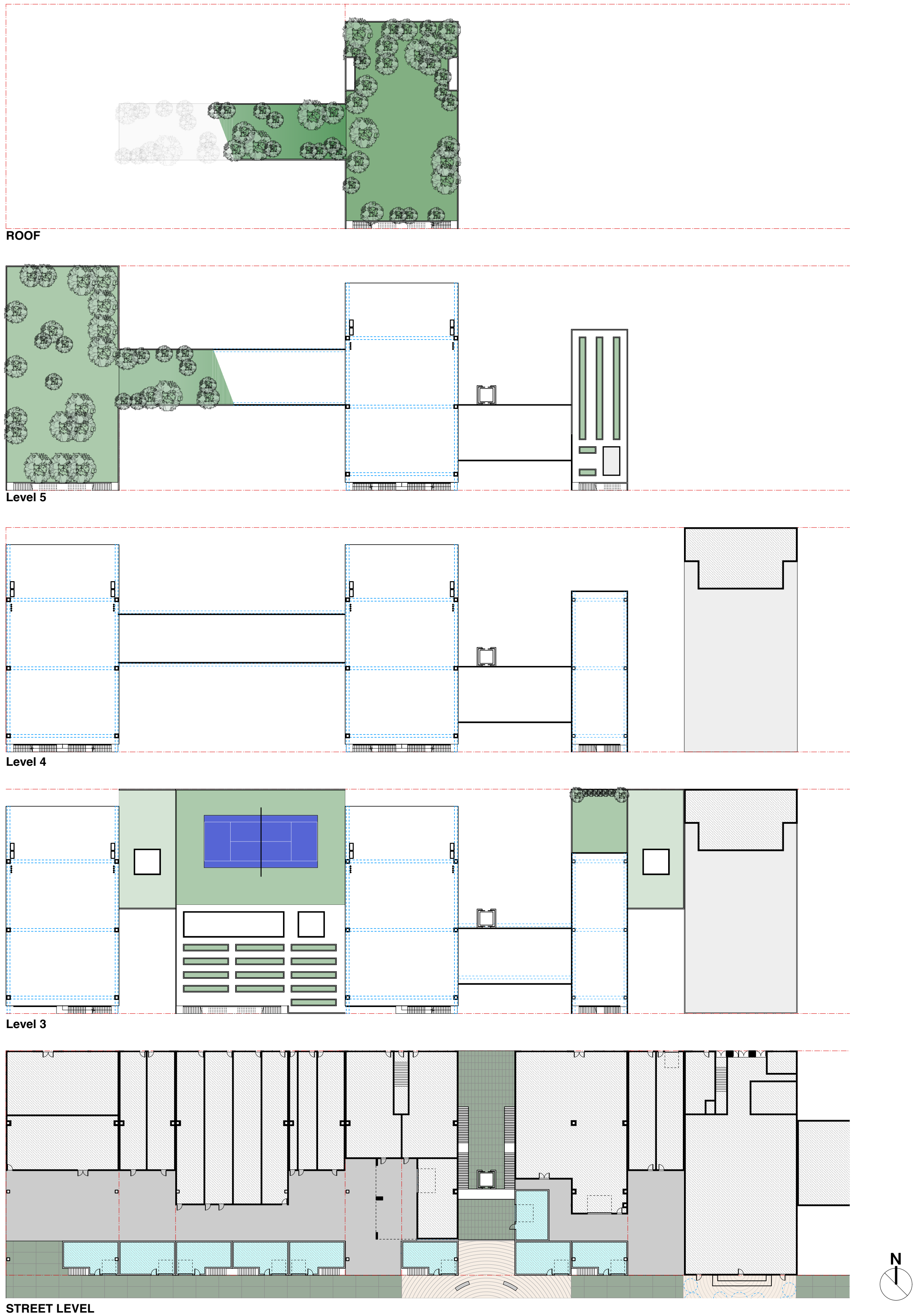
SCALE 1:500

N

ADAPTIVE REINTEGRATION

PROPOSED SITE PLAN

RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016



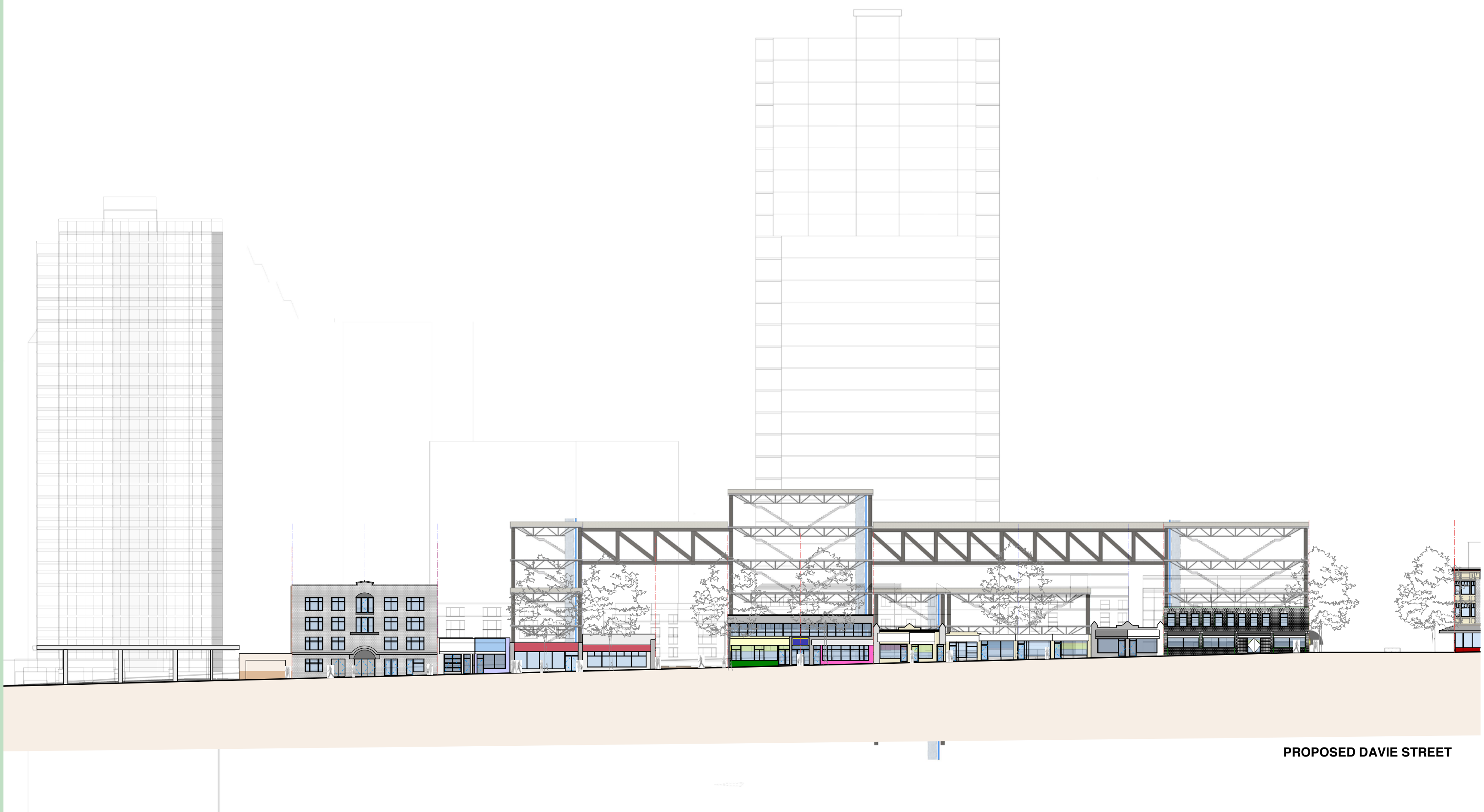
ADAPTIVE REINTEGRATION

POSSIBLE FLOOR LAYOUT

RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

A-4.9

A-4.10



ADAPTIVE REINTEGRATION

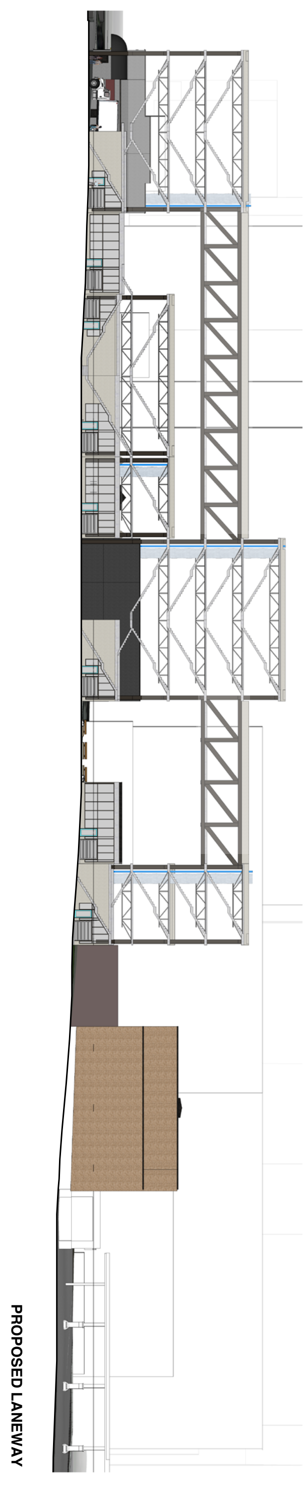
PROPOSED ELEVATIONS

RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016

ADAPTIVE REINTEGRATION

PROPOSED ELEVATIONS

RAIC SYLLABUS DESIGN STUDIO RAIC 690 PART 2 - TERM 2 2016



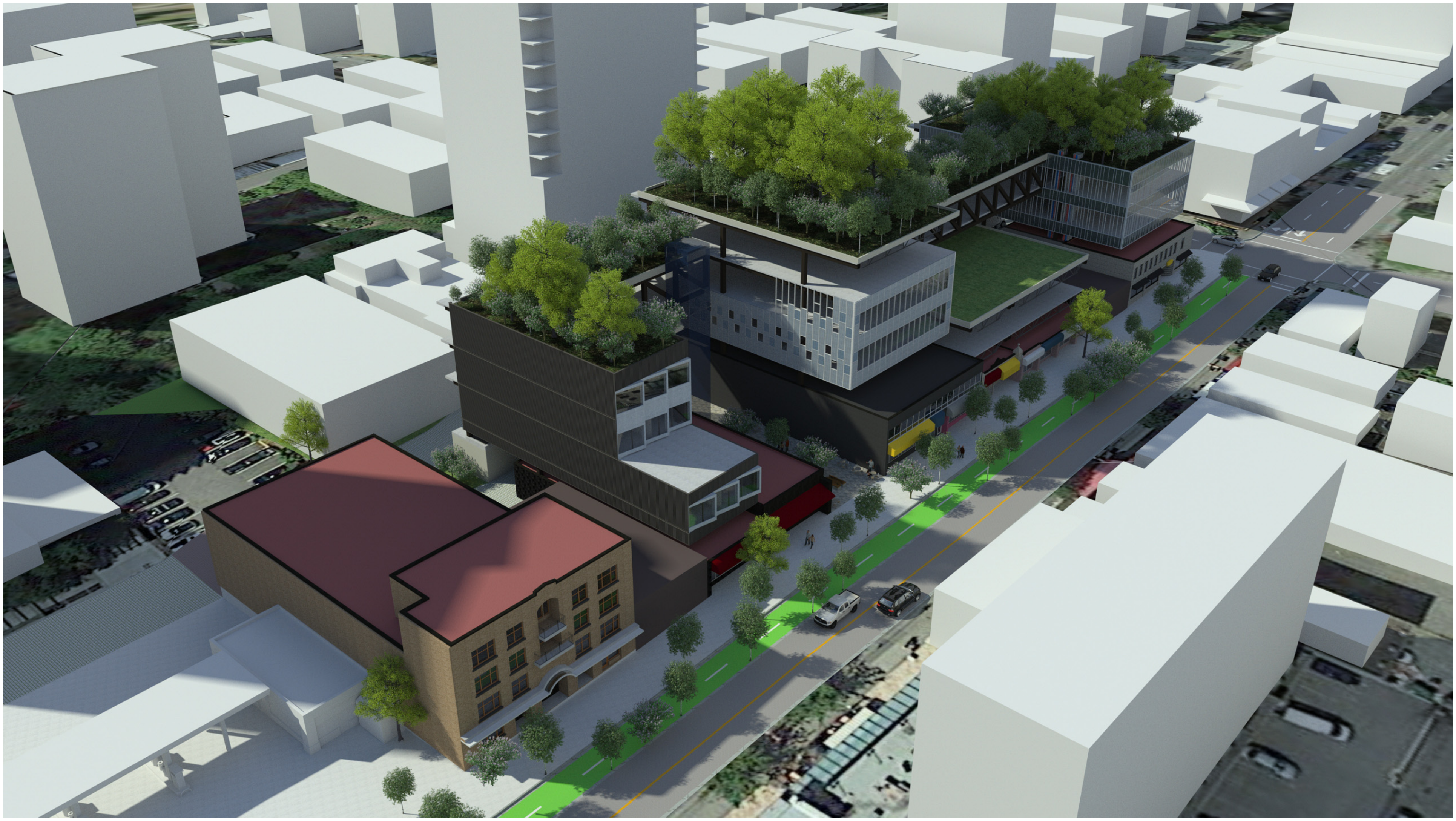
A-4.11

A-4.12

DAVIE STREET BASE STRUCTURE

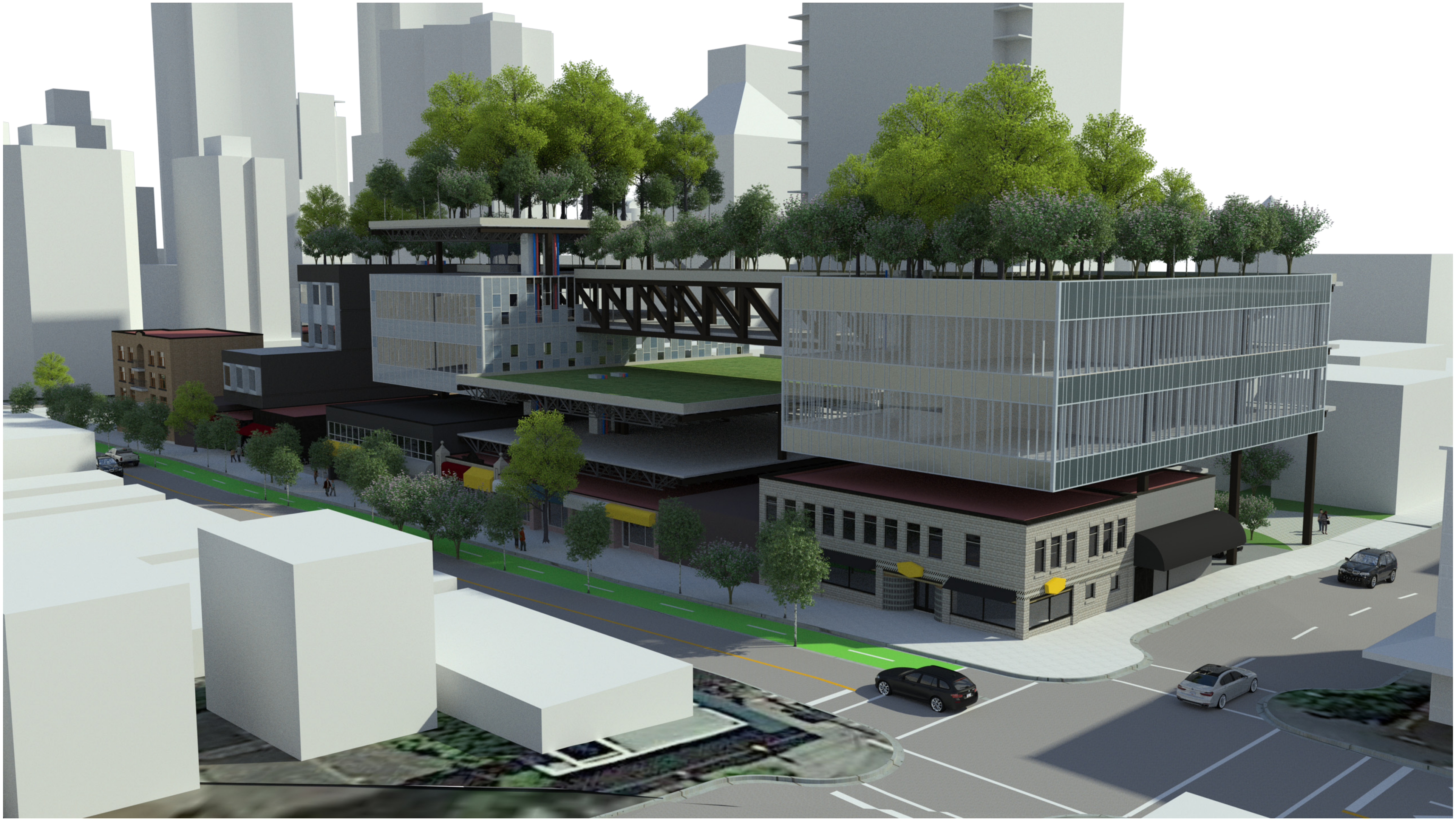
A-4.13

DAVIE VILLAGE STREETVIEW



A-4.14

DAVIE VILLAGE LOOKING SOUTH-WEST



A-4.15

DAVIE VILLAGE LOOKING SOUTH-EAST

A-4.16

NEW LANEWAY LOOKING EAST

A-4.17

NEW MID BLOCK BREEZEWAY

Conclusion:

Adaptive Reintegration: A building conservation strategy is needed to protect the character, identity and history of Vancouver's unique neighbourhoods, while finding ways for them to achieve diversity of the built environment and meet the civic priorities of affordability, density and energy efficiency.

Going back to key themes that came from the research, the conservation strategy was to help retain neighbourhood character, through allowing building diversity and an incremental rate of change. We were to increase energy efficiency though a neighbourhood level strategy, and help upgrade the poor performers, while keeping affordability possible, increasing density and upgrading the pedestrian realm. We suggest that the above proposal generally achieves these aims.

As one more test of the project, however, we can again look at 'The Death and Life of Great American Cities" where Jane Jacobs lists four conditions necessary to generating diversity in a city:

1. *The district must serve more than one primary function, preferably more than two. These must insure the presence of people who go outdoors on different schedules and are in the place for different purposes, but who are able to use many facilities in common.*
2. *Most blocks must be short; that is, streets and opportunities to turn corners must be frequent.*
3. *The district must mingle buildings that vary in age and condition, including a good proportion of old ones so that they vary in the economic yield they must produce.*
4. *There must be a sufficiently dense concentration of people, for whatever purposes that may be there, this includes dense concentration in the case of people who are there because of residence.*[35]

[35] Jacobs, Jane. *The Death and Life of Great American Cities*, New York: Random House. 1961. pp. 150-151.

The proposed case study and existing street meet the first condition by providing shops and services during the day, multiple dining options in the evening and variety of clubs and 24-hour stores to keeping a concentration of people at all hours of the day.

By introducing the breezeway mid-block, which acts as a circulation hub for the development we have also allowed for pedestrians to cross to the new laneway businesses meeting the second condition.

The existing street has a series of buildings that range from the 1890's to buildings built in the last 20 years, and several that are renovated for new businesses; however, large developments have already started showing up on Davie cutting off the commercial street with residential towers and wiping out an entire block of existing buildings. The proposed project would allow for development and new businesses to be built alongside the existing. Over time some of the existing buildings might get demolished for a new building, but never an entire block, meeting Jane Jacob's third condition.

The fourth condition is also met with the high density of people already living in the Vancouver West End, and the increasing number of condo developments on the adjoining streets. The issue that we are hoping to resolve with this project is to continue to meet the fourth condition without ruining the first and the third.

Bibliography – By Reference Type

Existing Building Renewal:

Canada's Historic Places. Standards and Guidelines: For the Conservation of Historic Places in Canada, 2nd ed. Ottawa, ON: Her Majesty the Queen in Right of Canada, 2010.

City of Vancouver, Land Use and Development Policies and Guidelines: Vancouver Heritage Register, Adopted by City Council on September 23, 1986; Last Amended: November 24, 2015.

Heritage Vancouver Society. Top Ten Endangered Sites (2001-2015), available from http://www.heritagevancouver.org/topten.htm; Internet; accessed 17 January, 2016.

Jason F McLennan, "Salvage Modernism: A new design philosophy, aesthetic and ecological approach" in Trim Tab October 2015 ed. Jason F McLennan (Seattle, Washington: International Living Future Institute, 2015) pp 10-18.

National Trust for Historic Preservation. The Greenest Building: Quantifying the Environmental Value of Building Reuse. Washington, DC, 2011.

Preservation Green Lab. Older, Smaller, Better: Measuring how the character of buildings and blocks influences urban vitality. Washington, DC, 2014.

Preservation Green Lab. The Greenest Building: Quantifying the Environmental Value of Building Reuse. Washington, DC, 2011.

Vancouver Heritage Foundation. Conserving Heritage Buildings: In a Green and Growing Vancouver. Vancouver, BC: VHF, 2012.

Vancouver Heritage Foundation: http://www.vancouverheritagefoundation.org/learn-with-us/heritage-site-finder-interactive-map/

Sustainable Design Sources:

7group (Boecker, J., Horst, S., Keiter, T., Lau, A., Scheffer, M., & Toevs, B.), & Reed, B. The integrative design guide to green building: Redefining the practice of sustainability. Hoboken, NJ: Wiley, 2009.

Brophy, V., and Lewis, J., A Green Vitruvius: Principles and practice of sustainable architectural design, 2nd ed. Washington, DC: Earthscan, 2011.

Canadian Green Building Council, Canada Green Building Trends: Benefits Driving the New and Retrofit Market, New York, NY: McGraw Hill, 2015.

Canadian Green Building Council, LEED Canada for Existing Buildings: Operations and Maintenance 2009. Ottawa, On: CaGBC, 2009.

City of Vancouver, Passive Design Toolkit: Large Buildings. Vancouver, BC: 2009.

Grondzik, W., Kwok, A., Stein, B., & Reynolds, J. Mechanical and Electrical Equipment for Buildings. 11th ed. Hoboken, NJ: Wiley. 2010.

International Passive House Association (IPHA), Passivhaus Primer: Designer's Guide – A guide for the design team and local authorities, Hertfordshire, U.K.: BRE, 2010.

International Living Future Institute (ILFI) Living Building Challenge 3.0, A Visionary Path to a Regenerative Future, Seattle, WA: ILFI, 2014.

Kwok, Alison G and Grondzik, Walter T, The Green Studio Handbook: Environmental Strategies for Schematic Design, 1st ed. Oxford, UK: Elsevier, 2007.

Mazria, Edward. Road to Zero; Building Lasting Change, 2015 Keynote Presentation, (available from https://www.youtube.com/watch?v=KD07KY5ouqI; Internet;) Vancouver BC: Canadian Green Building Conference, 2015.

United Nations Human Settlements Programme (UN Habitat), Cities and Climate Change: Global Report on Human Settlements 2011, London, UK: Earthscan, 2011.

U.S. Green Building Council, LEED 2009 for Neighborhood Development, Washington, DC: USGBC, 2008.

U.S. Green Building Council, LEED 2009 for New Construction and Major Renovations, Washington, DC: USGBC, 2008.

U.S. Department of Energy, A Buildings Module for the Stochastic Energy Deployment System, Berkeley, CA: Berkeley National Laboratory, 2008.

Jurisdictional Documents and Initiatives:

BC Housing: Single Room Occupancy Renewal Initiative

City of Vancouver. Energy Retrofit Strategy for Existing Buildings. Vancouver: City of Vancouver, June 25, 2014.

City of Vancouver. Neighbourhood Energy Strategy: Downtown Update, Vancouver City Council, April 14, 2015.

City of Vancouver. Greenest City 2020 Action Plan: 2014-2015 Implementation Update, Vancouver: City of Vancouver, 2014.

City of Vancouver. Greenest City 2020 Action Plan: Part Two: 2015-2020, Vancouver: City of Vancouver, 2015.

City of Vancouver. Heritage Action Plan Report, Vancouver: City of Vancouver, November 2013.

City of Vancouver, Renewable City Strategy, Vancouver: City of Vancouver, November 2015.

City of Vancouver. Vancouver Heritage Register, Vancouver: City of Vancouver, Adopted by City Council on September 23, 1986; Last Amended: November 24, 2015.

City of Vancouver, West End Community Plan, Vancouver: City of Vancouver, October 2014

City of Vancouver. Zoning and Development Bylaws, Vancouver: City of Vancouver, 2015.

Design Guidelines:

Alexander, Christopher. A Pattern Language: Towns, Buildings, Construction. USA: Oxford University Press, 1977.

Jacobs, Jane. The Death and Life of Great American Cities, New York: Random House. 1961.

United Nations Human Settlements Programme (UN-Habitat), State of the World's Cities 2012/2013: Prosperity of Cities. New York, NY: Routledge, 2013.

Bibliography - Alphabetical

Alexander, Christopher. A Pattern Language: Towns, Buildings, Construction. USA: Oxford University Press, 1977.

BC Housing: Single Room Occupancy Renewal Initiative

Brophy, V., and Lewis, J., A Green Vitruvius: Principles and practice of sustainable architectural design, 2nd ed. Washington, DC: Earthscan, 2011.

Canadian Green Building Council, Canada Green Building Trends: Benefits Driving the New and Retrofit Market, New York, NY: McGraw Hill, 2015.

Canadian Green Building Council, LEED Canada for Existing Buildings: Operations and Maintenance 2009. Ottawa, On: CaGBC, 2009.

Canada's Historic Places. Standards and Guidelines: For the Conservation of Historic Places in Canada, 2nd ed. Ottawa, ON: Her Majesty the Queen in Right of Canada, 2010.

City of Vancouver. Energy Retrofit Strategy for Existing Buildings. Vancouver: City of Vancouver, June 25, 2014.

City of Vancouver. Neighbourhood Energy Strategy: Downtown Update, Vancouver City Council, April 14, 2015.

City of Vancouver. Greenest City 2020 Action Plan: 2014-2015 Implementation Update, Vancouver: City of Vancouver, 2014.

City of Vancouver. Greenest City 2020 Action Plan: Part Two: 2015-2020, Vancouver: City of Vancouver, 2015.

City of Vancouver. Heritage Action Plan Report, Vancouver: City of Vancouver, November 2013.

City of Vancouver, Land Use and Development Policies and Guidelines: Vancouver Heritage Register, Adopted by City Council on September 23, 1986; Last Amended: November 24, 2015.

City of Vancouver, Passive Design Toolkit: Large Buildings. Vancouver, BC: 2009.

City of Vancouver, Renewable City Strategy, Vancouver: City of Vancouver, November 2015.

City of Vancouver. Vancouver Heritage Register, Vancouver: City of Vancouver, Adopted by City Council on September 23, 1986; Last Amended: November 24, 2015.

City of Vancouver, West End Community Plan, Vancouver: City of Vancouver, October 2014

City of Vancouver. Zoning and Development Bylaws, Vancouver: City of Vancouver, 2015.

Grondzik, W., Kwok, A., Stein, B., & Reynolds, J. Mechanical and Electrical Equipment for Buildings. 11th ed. Hoboken, NJ: Wiley. 2010.

Heritage Vancouver Society. Top Ten Endangered Sites (2001-2015), available from http://www.heritagevancouver.org/topten.htm; Internet; accessed 17 January, 2016.

International Passive House Association (IPHA), Passivhaus Primer: Designer's Guide – A guide for the design team and local authorities, Hertfordshire, U.K.: BRE, 2010.

International Living Future Institute (ILFI) Living Building Challenge 3.0, A Visionary Path to a Regenerative Future, Seattle, WA: ILFI, 2014.

Jacobs, Jane. The Death and Life of Great American Cities, New York: Random House. 1961.

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Kwok, Alison G and Grondzik, Walter T, The Green Studio Handbook: Environmental Strategies for Schematic Design, 1st ed. Oxford, UK: Elsevier, 2007.

Mazria, Edward. Road to Zero; Building Lasting Change, 2015 Keynote Presentation, (available from https://www.youtube.com/watch?v=KD07KY5ouqI; Internet;) Vancouver BC: Canadian Green Building Conference, 2015.

National Trust for Historic Preservation. The Greenest Building: Quantifying the Environmental Value of Building Reuse. Washington, DC, 2011.

Preservation Green Lab. Older, Smaller, Better: Measuring how the character of buildings and blocks influences urban vitality. Washington, DC, 2014.

Preservation Green Lab. The Greenest Building: Quantifying the Environmental Value of Building Reuse. Washington, DC, 2011.

Vancouver Heritage Foundation. Conserving Heritage Buildings: In a Green and Growing Vancouver. Vancouver, BC: VHF, 2012.

Vancouver Heritage Foundation: http://www.vancouverheritagefoundation.org/learn-with-us/heritage-site-finder-interactive-map/

United Nations Human Settlements Programme (UN Habitat), Cities and Climate Change: Global Report on Human Settlements 2011, London, UK: Earthscan, 2011.

United Nations Human Settlements Programme (UN-Habitat), State of the World's Cities 2012/2013: Prosperity of Cities. New York, NY: Routledge, 2013.

U.S. Green Building Council, LEED 2009 for Neighborhood Development, Washington, DC: USGBC, 2008.

U.S. Green Building Council, LEED 2009 for New Construction and Major Renovations, Washington, DC: USGBC, 2008.

U.S. Department of Energy, A Buildings Module for the Stochastic Energy Deployment System, Berkeley, CA: Berkeley National Laboratory, 2008.

7group (Boecker, J., Horst, S., Keiter, T., Lau, A., Scheffer, M., & Toevs, B.), & Reed, B. The integrative design guide to green building: Redefining the practice of sustainability. Hoboken, NJ: Wiley, 2009.