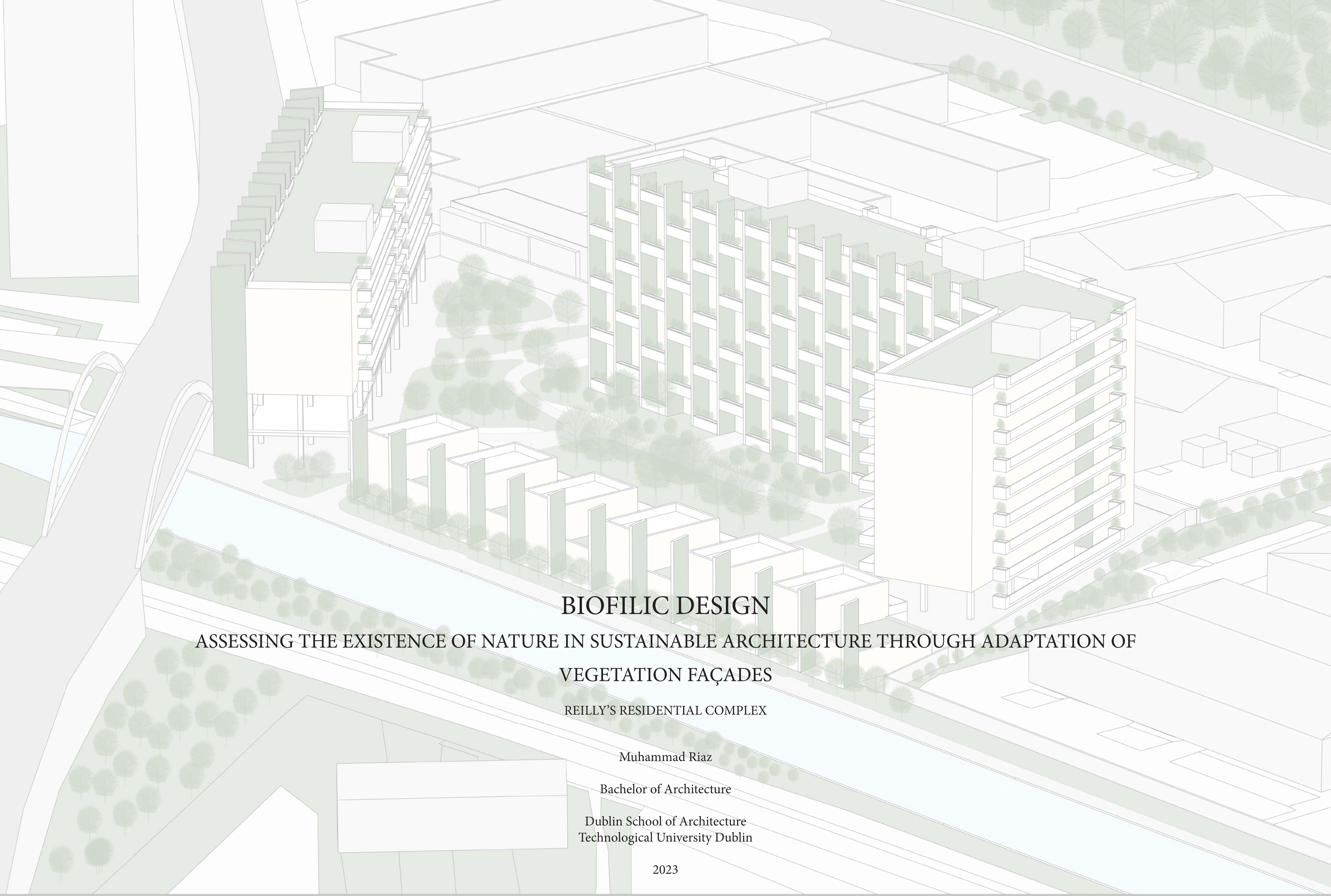

BIOFILIC DESIGN

ASSESSING THE EXISTENCE OF NATURE IN SUSTAINABLE ARCHITECTURE THROUGH ADAPTATION OF VEGETATION FAÇADES

REILLY'S RESIDENTIAL COMPLEX

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2023

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ACKNOWLEDGMENT

I would like to express my deepest appreciation to my TU Dublin tutors, my course coordinator Sima Rouholamin, and specially my project tutors Cian Deegan and Sarah Sheridan for their unending encouragement and drive to see my project through to completion.

I would like to everyone of my classmates specially, Adriana Nistorescu and Laura Vilone for the tremendous help over the last few years.

Finally, I want to thank my family for their unwavering support and encouragement, for which I will be eternally grateful.

ABSTRACT

Globally, there is a grave concern about climate change. Considering that biodiversity loss and noise pollution are two important environmental issues around the world and especially here in Ireland, integrating nature into design It has been discovered that using vegetation facades to mitigate noise pollution, biodiversity loss, and air purification is effective. A living wall acts like a sound barrier for the building, eliminating noise levels by up to 8 dB by absorbing 41% more sound than a traditional facade. As a result, the atmosphere both indoor and outdoor the building gets quieter.
Additionally, the vegetative facade's plants promote the habitat of a number of bird and insect species. The intention of this study is to extend knowledge about the possibilities of vegetation facades, particularly in acoustic management and as biodiversity booster for residential projects.

In my testing project which is a residential and Community complex based along Royal canal close to New Riley Bridge which is a major hotspot for pollution due to multiple traffic sources and needed proper mitigation for noise management. I incorporated green buffers to cater for this issue in all 3 blocks of this project. The blocks consists of single story to multistory buildings and green buffers at various angles, in addition to vegetation at roofs are provided to control the noise pollution effectively

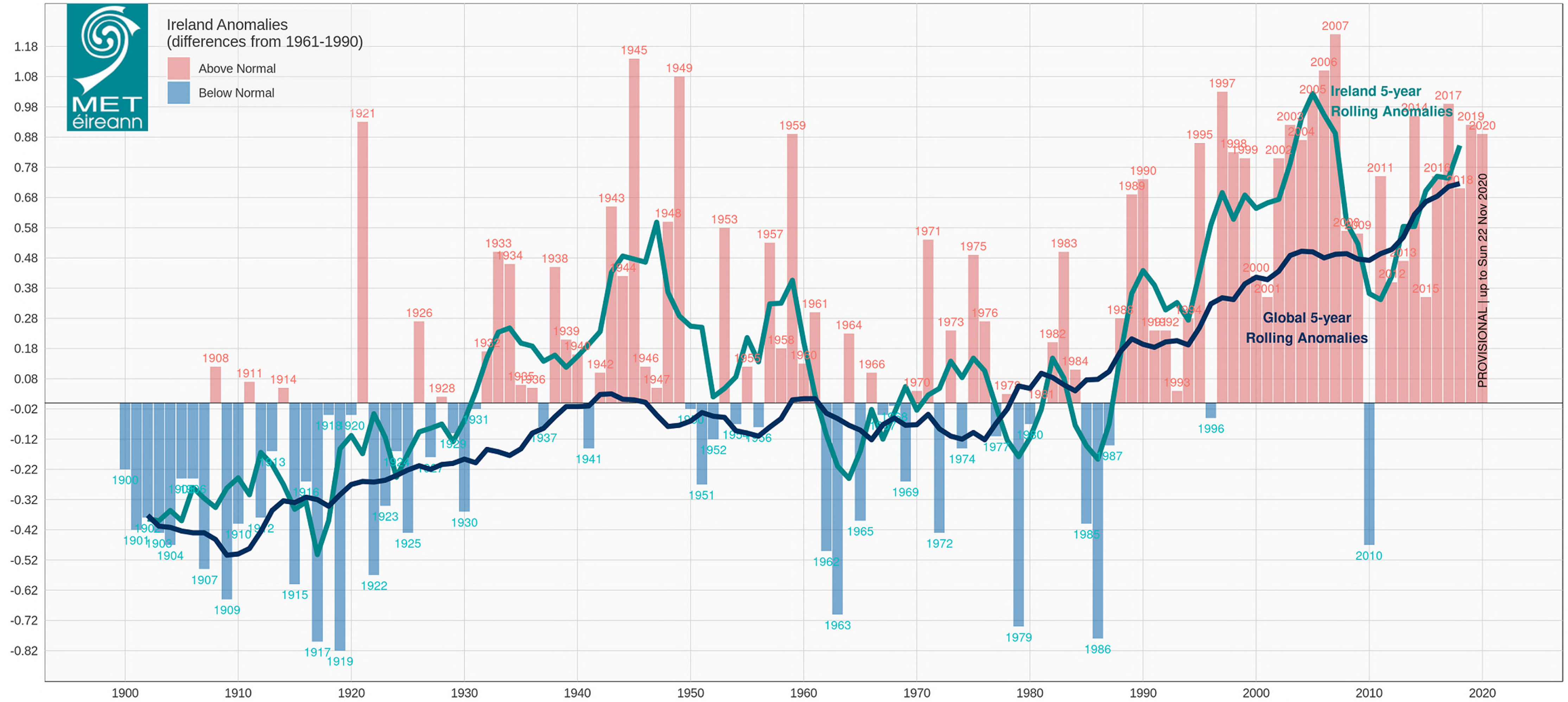
Furthermore, meticulous planning is necessary to ensure that the maximum amount of space is utilized. This includes taking into account the shadows cast by buildings and the presence of green buffers. Last but not least, the vegetation on building facades and on rooftops contributes to biodiversity and recreational areas as the roofs are accessible.

CLIMACTIC ISSUES

Climate change is a global issue, and for decades humanitarians and campaigners are trying to bring attention towards climate change related problems like air, water, and noise pollutions, global warming, biodiversity loss and need for sustainable development. Ireland's climate is also altering following the worldwide trend, with an average temperature increase of 0.8°C since 1900.

Depending on the emissions trajectory, it is predicted that the average annual temperatures will rise by 1.3–1.6°C or 1-1.2°C by the middle of this century i.e., 2041 ~ 2060. The frequency of heat waves is anticipated to grow, as well as the number of warm days. A major reason for this is that the amount of carbon dioxide in the atmosphere has risen by 25% since 1958, and by about 40% since the Industrial revolution in late 1700s.

Ireland Annual Air Temperature Anomalies (°C) 1900 and 2020*

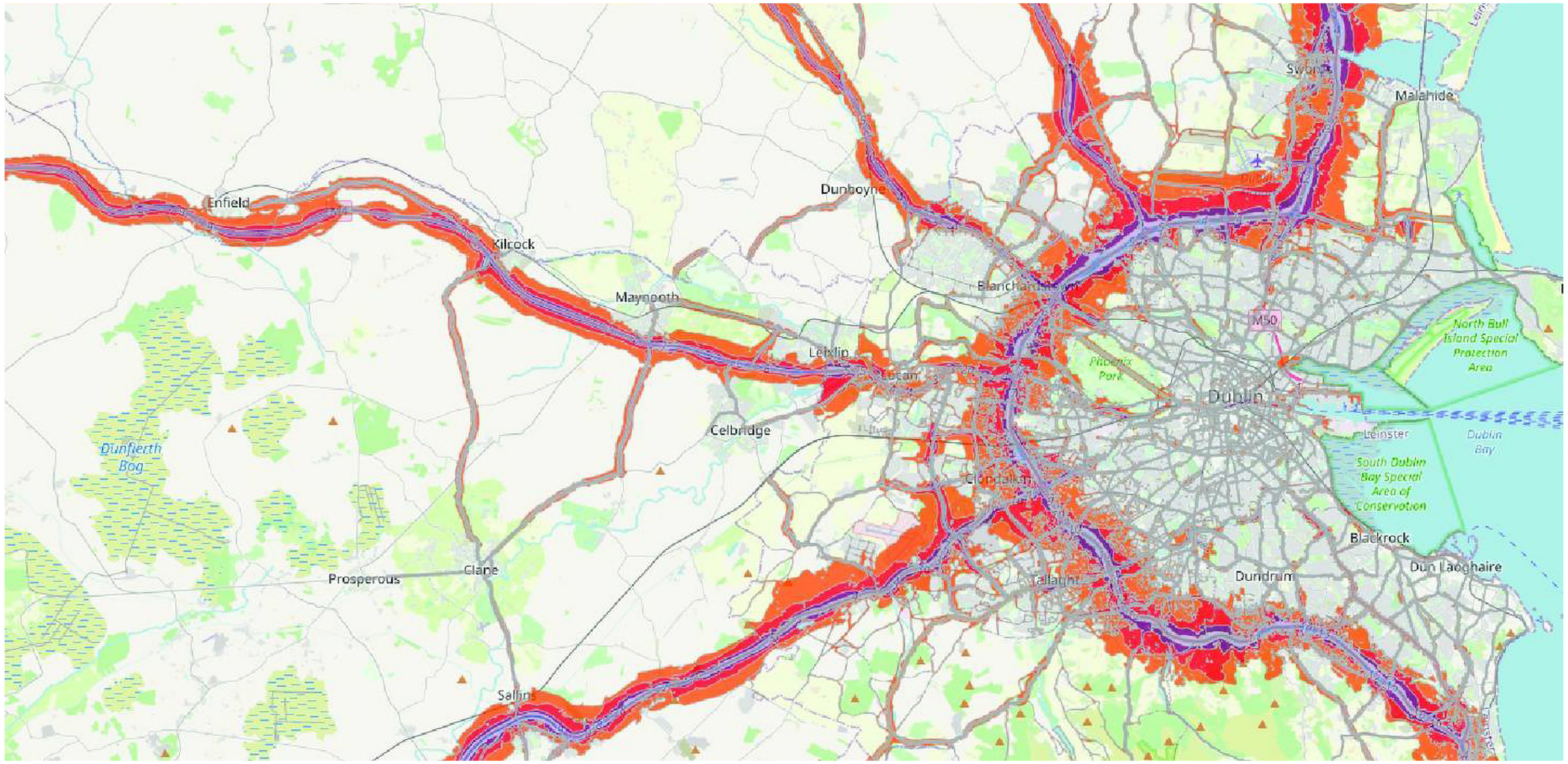


(Fig.1)

(Provisional Global Temperatures Anomalies, Climatic Research Unit, University of East Anglia)
(The Irish Meteorological Service)

Other than water pollution another type of pollution faced is noise pollution. Excessive noise pollution, mostly from transportation mediums, has negative impacts on human health and negatively affects sleep, metabolic and cardiovascular functions. A 2019 study by Environmental Protection Agency reports that more than 78 million people experience high levels traffic noises in the 33 member countries of the European Environment Agency. In Ireland, noise complaints around Dublin Airport have significantly increased in recent years and in 2018 only, authorities at Dublin Airport has recorded 1,453 noise-related complaints.

Recent assessments of the effects of noise highlight the significance of noise as a health concern and not only an annoyance issue. The European Environment Agency (EEA) estimates that long-term exposure to environmental noise from road traffic, railways, aircraft and industry contributes to 48,000 new cases of heart disease and 12,000 premature deaths each year in Europe. The EEA also estimates that 22 million people suffer from chronic high levels of annoyance and 6.5 million people suffer from chronic high levels of sleep disturbance as a result of long-term noise exposure.



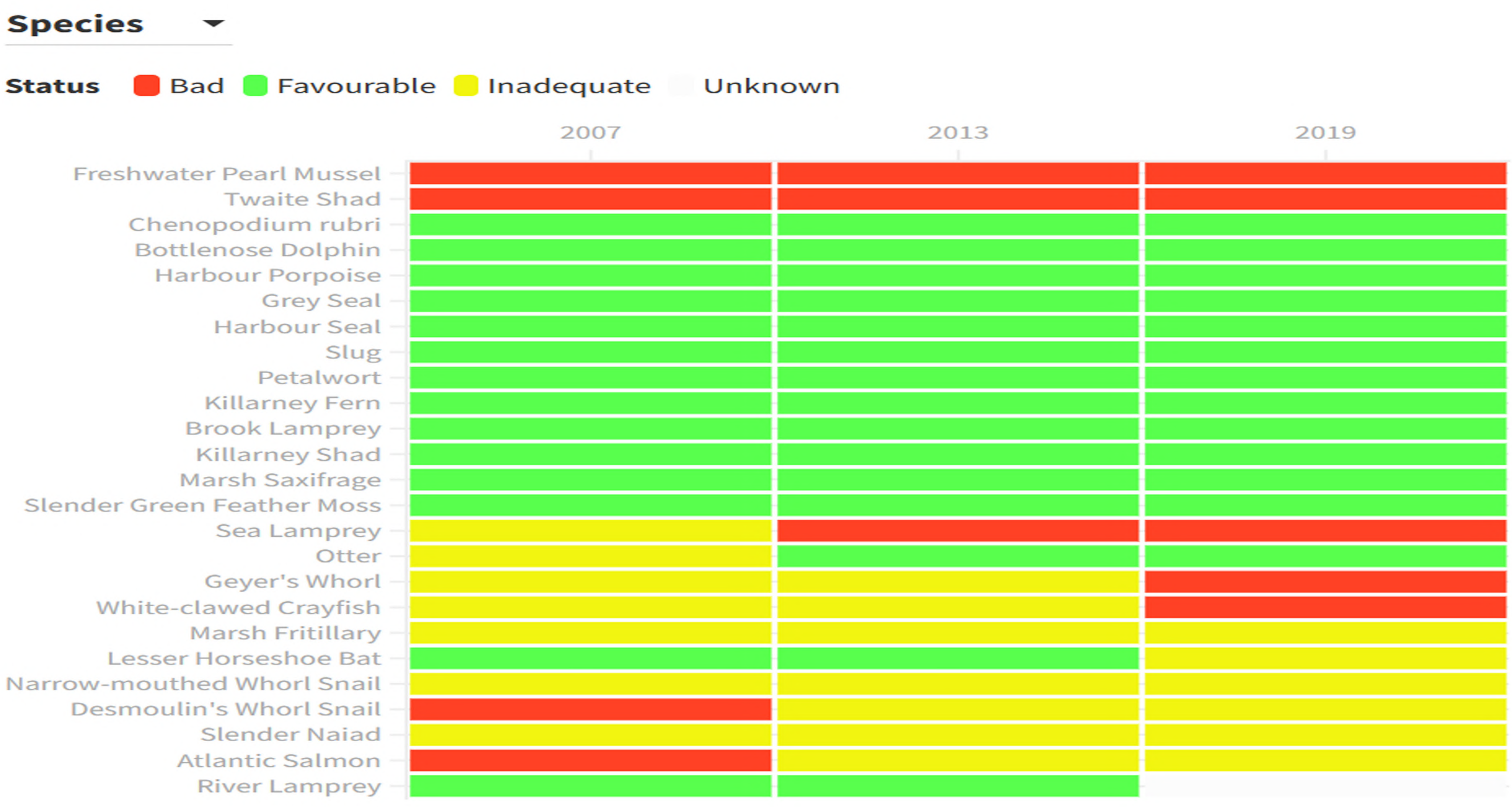
Noise Map of Dublin

(Fig.2)

Biodiversity loss is one of the world's most serious environmental challenges. As per a report by Environmental Audit Committee in Parliament of UK, "the Biodiversity Intactness Index i.e., BII estimates how much originally present biodiversity remains on average across the terrestrial biomes within a region. The global average BII 79% is below the proposed lower safe limit 90%.

The latest Article 17 report, released in 2019, states that 54 of the 59 habitats assessed were in an unfavourable state with the condition of 46% of habitats declining since the last report in 2013, including estuaries, shallow bays, reefs, our unique raised and blanket bog networks, fens and mires, our old oak woodlands and orchid-rich grasslands.

According to the UN, the future prospects of Ireland's habitats, and the species that depend on them, will require considerable management effort to improve their condition and reduce the impacts of pressures.



(Fig.3)

(Irish Habitats & Species Protected under EU Law)
(Numerous habitats are in bad or declining state)

It is safe to say that there should be more focus on awareness and solution for environmental issues. In the large scale urban world, the connection to nature is often left unnoticed and people forget the fact that for a sustainable future, we should bring back nature into our cities. A perfect balance between nature and urbanization is an outcome much desired and Architects may help in reduction of this imbalance of nature and urbanization and reduce the environmental issues at the same time.

Introduction of "vegetation architecture" is a notable method for bringing nature back to our cities in form of vegetation façades, green walls, parks, vertical and rooftop gardens to bring plants back into our lives where they can be valued most. Vegetation architecture is basically the combination of traditional architecture and landscape architecture, where traditional concrete and glass structures join nature and vegetation.

VEGETATION FAÇADES IN BUILDINGS

In light of above, one may ask the question: Is the use of vegetation façades and vegetation architecture as a whole just an ornamental addition to buildings or can it meaningfully help in creating a sustainable environment?

These lively pieces of architecture will help in reduction of Carbon dioxide emission, controlling environmental pollution. Which in-turn will help in tackling global warming and biodiversity loss issues.

Vegetation façades will also provide external and internal sound insulation due to their high mass and absorption through the surface, reduce and control of noise pollution in urban areas. In terms of acoustic benefit, vegetation, in general, affects the sound field in urban environments through mechanisms. When a sound wave impinges on the vegetation and is then reflected back sound absorption and diffusion occur; and when a sound wave is transmitted through the vegetation sound level reduction occurs.

This Project intends to contribute to research on the potential of vegetation façades in noise management and reduction. I will explore the question, are vegetation façades important in developing a sustainable architecture or are they just an ornamental addition to the building.

For any building element to be categorized as a functional element rather than an ornament, it has to contribute to some vital factors. I will further examine that whether vegetation façades play any vital role to be categorized as functional elements or not, along with some insight upon the working mechanism of vegetation façades, and does provision of vegetations façades have any benefit for this against environmental issues at out project site or not.

INTRODUCTION TO VEGETATION FACADE

The facade of a building typically refers to an outward-facing wall of the building that is exposed to an open area. Whereas a vegetation facade is a term used for a special type of Eco friendly facade that is covered with greenery.

This greenery can either be an extension of the facade or part of the building itself. The greenery mostly consists of climbing plants that spread over the extension of the facade. The extension is usually a mesh or similar medium installed in parallel with the facade of the building to support the greenery. To further save space for plantation at the ground, planter boxes are integrated into this system.

This technology is associated with green roofs and a vast variety of plants can be grown this way as compared to the limitation of traditional plants in vegetation façades. The plants can also be planted in holes or pots made inside the wall or climbing plants can also be used to ascent the wall itself, which makes the greenery part of the wall altogether.

A B C

(A - Direct living / vegetation facade)
(B - Indirect living / vegetation facade with plants grown from an underground trench)
(C - Indirect living / vegetation facade with plants grown from planter boxes)

(Figs.4)

Wall-based green walls with plant-trough modules

Wall-bound systems (Living Walls)

With self-climbing plants

With climbing trellis

wall-based or ground based in plant-troughs

(Fig.5)

HISTORY OF VEGETATION FACADE

Going back 4600 years in history, the ancient Greek people were already using rambling roses and grapevines to decorate Arbors in their gardens in 2600s BC. Some may argue that a decorated arbor being a small part of a garden may not be categorized as a building facade.

But the vegetation facade as a whole may then be traced back to 550 ~ 600 BC to the famous Hanging Gardens of Babylon in ancient Mesopotamia mentioned in ancient writings of the Greek people. Although, to date, there is no archaeological evidence of the Hanging Gardens of Babylon accommodated vegetation façades, and some even consider these gardens a myth altogether.

But even if we discard this wonder of the ancient world from our history, there is another even older example of ancient large scale gardens built in Nineveh, the city of Mosul in modern-day Iraq, near river Tigris by an Assyrian king in 680 ~ 700 BC.
Besides ancient history, there are numerous records of vegetation façades in modern history. These records date back to the 9th century A.D. started as a by-product of the large use of grapevines by Romans and later Germans for wine production.

These grapevines covered the walls, and façades of buildings making them lush green. The traditional vines were solely responsible for vegetation façades for a few hundred years until the introduction of new plants like creepers and vines in the 1600s in different locations in England, France, and Germany.

The lively architecture continued across Europe at a slower pace until the introduction of new climbing plants from North America and Asia in the 18th and 19th centuries, especially in the Biedermeier era i.e., 1815 ~ 1845 in which vegetation architecture notably flourished. In the second half of the 19th century, buildings were specially decorated with roses and greenery when the ruler or king came to a village or town.

In the early 1900s, the idea of green cities was thriving throughout Europe, and in the wake of this idea, houses and new societies lush with greenery started emerging. Vegetation façade or green walls were a prominent feature of such houses.

But the idea was not limited to residential buildings only, hospitals and industries also embraced the vegetation façades as a well-received concept. But the concept of vegetation façade started to fade away slowly with preoccupied life due to rapid industrial growth, world war, and the fact that the roses, climbing vines and fruit trellises needed care, pruning, and time.

The idea of Botanical Bricks to construct large-scale green walls or vegetation façades took root in 1937. Unfortunately, the large-scale industrialization of the post-war era was not a favourable climate for all this green idealism to thrive.

In 1939, the second world war started, which eventually stopped the already dwindling idea of vegetation façades and gardens. By the 1950s, surviving heirs and successors often had no idea about the care and pruning of the climbing plants, because the concept not being of precedence for so long and there was thus a pause until 1968.

In 1968, the environmental movement emerged against the worldwide increasing pollution. The said movement gave a second life to the concept of green buildings and façades. While the environmental movement is not an "architectural style," it has nevertheless significantly impacted the concept of vegetation façades. A growing interest in environmental issues arose in Europe in the 1980s, which resulted in resurfacing of the idea to bring nature into cities.

In many German cities, incentive programs were developed, including some that supported tenant initiatives for planting and maintaining climbers in their backyards and façades. One of the most widely used and recognized designs of green walls or vegetation façades known as "Mur Vegetal" started in France in 1986.

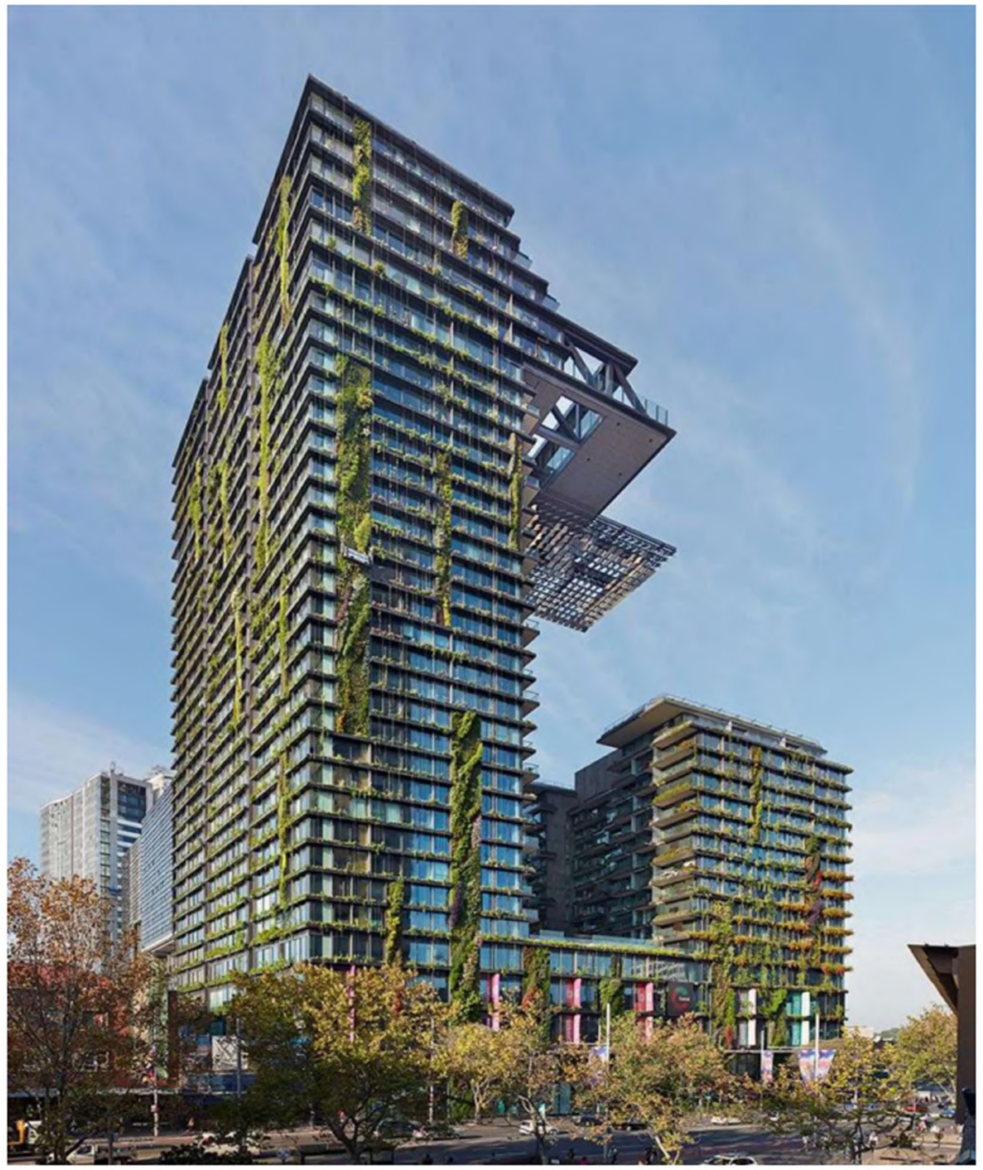
While older vegetation façades usually consisted of one type of vine or plant, it is no longer a limitation in the modern world. The first living wall in Canada was built in the Canada Life building in Toronto in 1994. What was remarkable about this green structure was that the plants were used to purify the air inside the building. With the rise of global awareness of the need for vegetation architecture, the number of green buildings is increasing day by day all over the world.

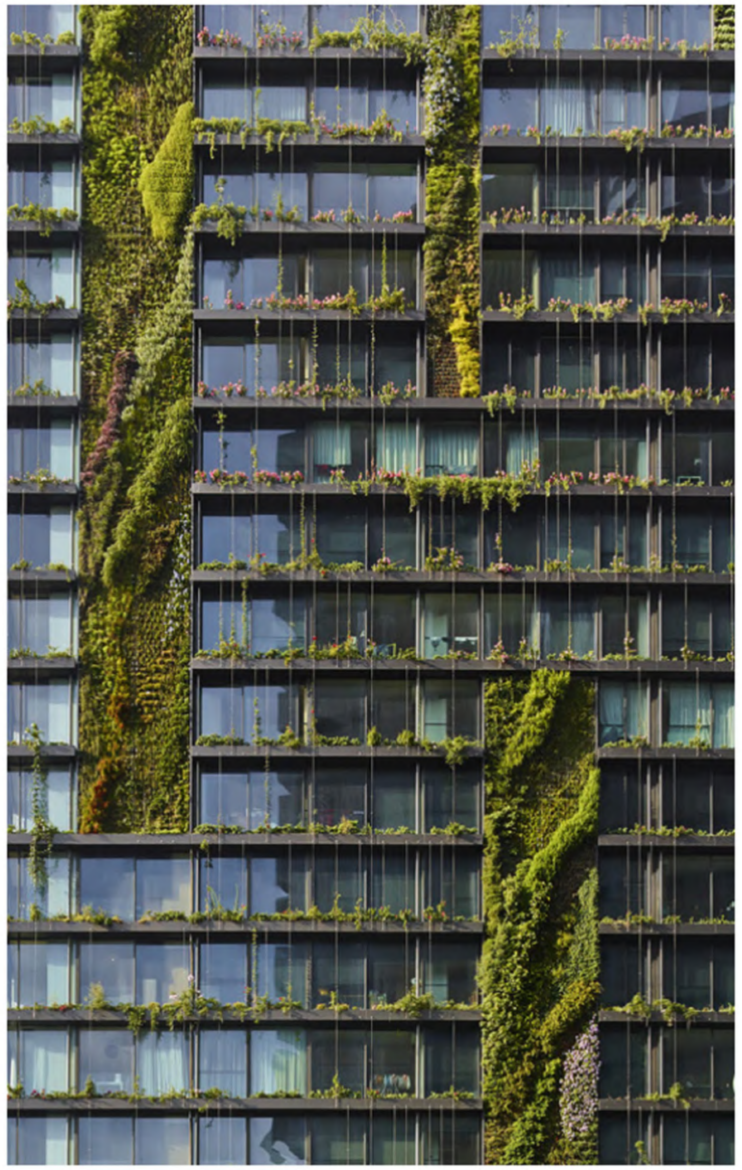
ONE CENTRAL PARK SYDNEY

A notable building in Sydney, Australia comprising of vegetation facade is One Central Park. The building comprises a park at the foot of the building which continues up the structure and transforms the facade of the structure into a lush green vertical garden. Approximately 250 species of Australian plants and flowers cover One Central Park, and as per reports, the building has 25% less energy consumption compared with a conventional building of its size.

One central park is an innovative and environmentally ambitious residential project, located near the central station in Sydney. French landscape artist Patrick Blanc was designed 1620 sq of vertical garden that covers the 34% surface of the building. 35200 plants and 383 different species were used, including some native such as acacias.

The purposed 1620 sq of green facade extract 3700kg of Carbon and producing approximately 3250kg of Oxygen per year. Using green façades one central park building saving 21% energy consumption. And also 1200kg of dust trapped per year from the air





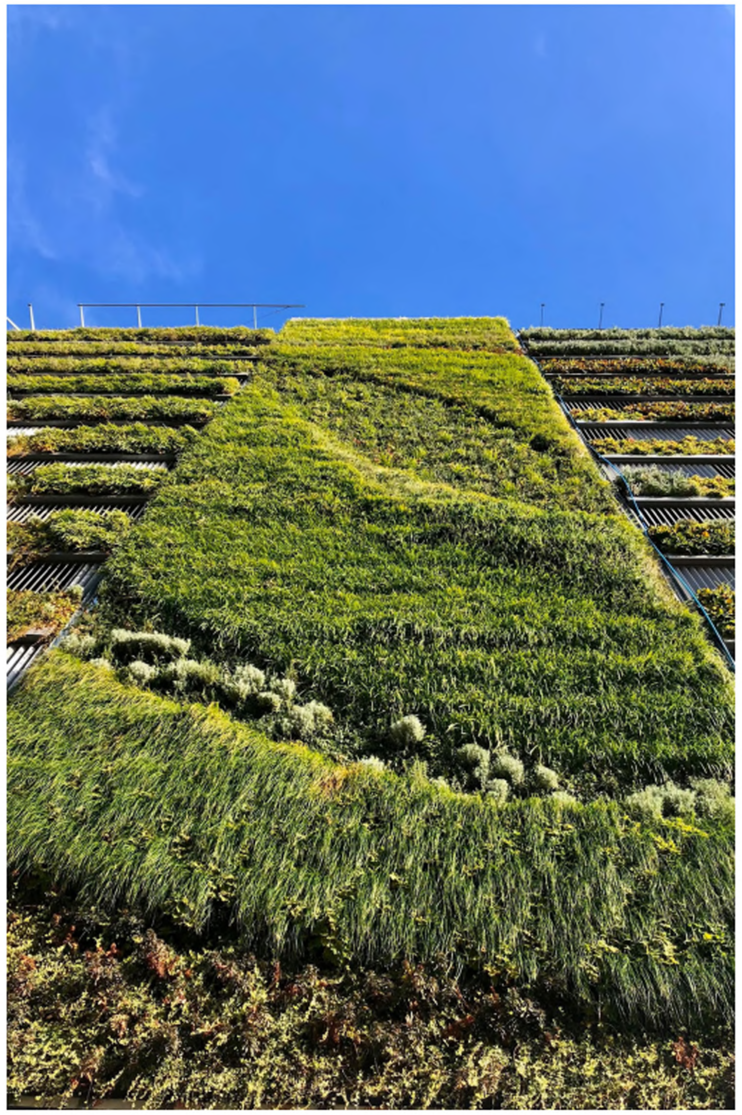
(Figs.6)

VICTORIA WAY CAR PARK

Another precedent for the project is Victoria way car park United Kingdom.

The building use as multi story car parking, which has 1700 sq of outdoor green facade area. The design has two objectives support local biodiversity and improve air quality. To support the biodiversity they focused to include native species (like the plants that are found and grow in the local area.

This means that the plants are native to the area and specially adapted to the ecosystem. In order to design wall for improving air quality, they selected plants like (plumbago) with significant air purification. With the design of 1700 sq green facade it extracting approximately 3900kg of Carbon and producing 3400kg of oxygen per year



(Figs.7)

BENEFITS OF VEGETATION FACADE

Vegetation façades can create a difference in cities where it lacks greenery due to crowded buildings. Other than the benefits of bringing nature back into cities. It is a widely recognized verity of modern architecture, and the following benefits cannot be provided by any other cladding material as a whole.

The first and foremost benefit of vegetation façades is that it helps in cleaning the air by absorbing the carbon dioxide and other pollutants in the air significantly contributing to removal of air pollution.

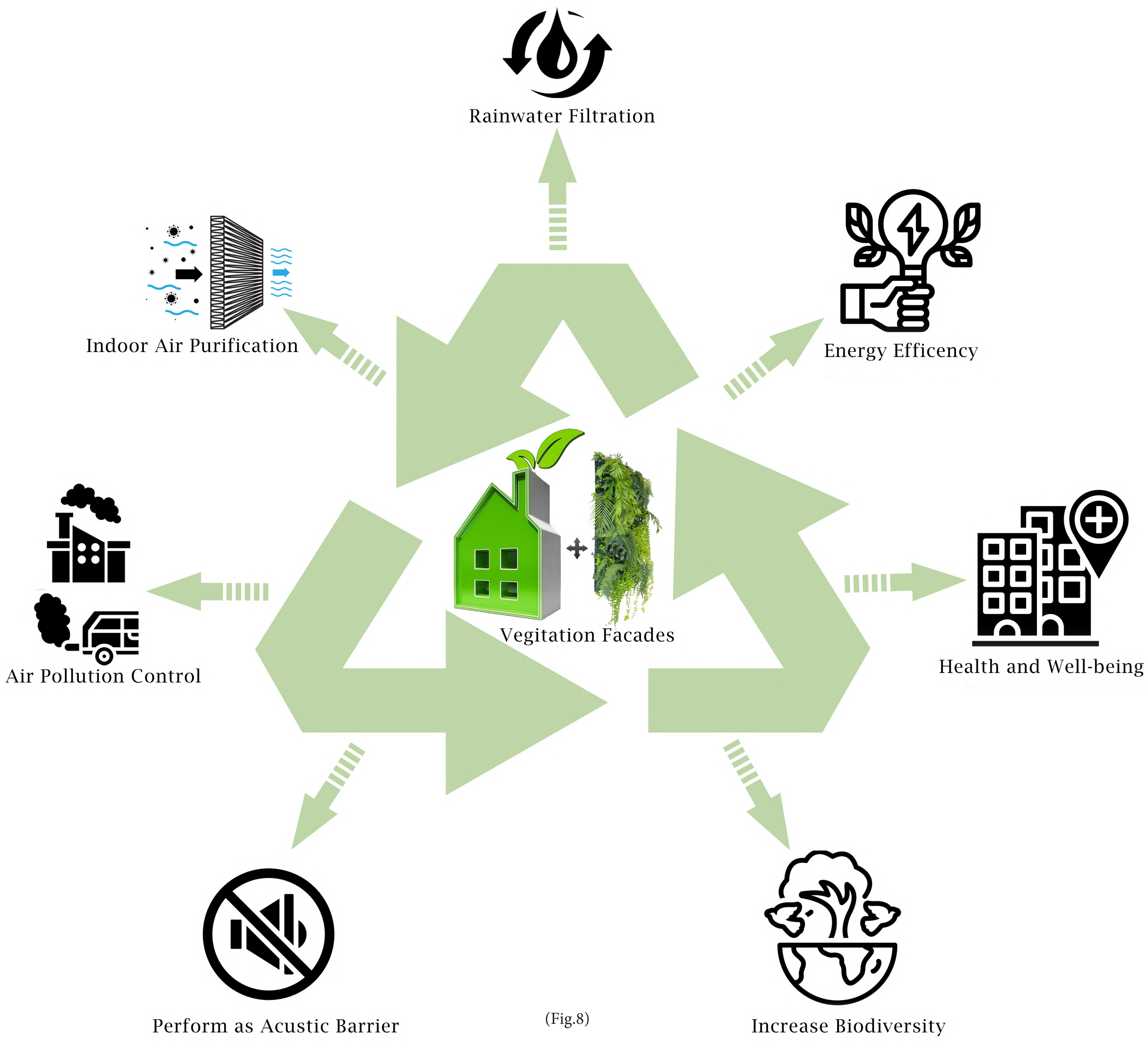
Beside air pollution, the vegetation façades also reduce noise pollution by acting as an acoustic insulator. As per a study, the vegetation façades can reduce noise from 1db up to 12db, depending on the thickness of vegetation. In another study it was derived that vegetation facade or green walls have a much potential of reducing noise at much higher extent with average reduction of 15db.

Cities usually have a higher temperature that the countryside due to lack of greenery. But because of the decrease in pollution with utilization of vegetation façades, the urban temperature also reduces. Besides the reduction of overall temperature, the wall of vegetation also acts as a protective layer against direct sunlight and provides Thermal insulation of structures. And at the same time, where external and internal temperature of building is significantly improved, a certain reduction of internal HVAC costs is also observed due to vegetation façades.

Another benefit of application of vegetation as façades of the buildings is improvement in regional biodiversity, as the abundance of local and foreign species of plants can be introduced in a comparatively small area. But by far the most important benefit of application of vegetation façades if recycling and proper utilization of Rainwater. With proper system like installation of storage tanks and pipelines the rainwater can automatically be stored and utilized. Although it significantly increases the cost due to provision of rainwater storage tanks, but it fulfils the water needs of the plants for a longer period while recycling the water which otherwise would be only adding to the pressure of the urban storm-water drainage system.

As mentioned above that the vegetation façades save the building from direct exposure to sunlight, rain, and dust, the protection from said conditions extends the life of walls of the building. It also makes building more fire-resistant. One might argue that vegetation is more prone to burning than regular facade material. But from a study by Madrigal et al. (2012) it can be derived that due to the moisture in plants, fire can be held for comparatively longer periods of time.

Besides the obvious benefits of vegetation façades that are mentioned above, such vegetation architecture can also Increase productivity and creativity as we as human beings like to be in nature, we like to look at nature because it can calm and uplift the human mind and restores mental fatigue. And by bringing nature back into the concrete jungles that are our buildings, we are readily greeted with a calm and soothing nature all the time. Also being around nature improves our health. And due to urbanization, traditional gardens are not accessible to most people. Vegetation façades are thus a way to bring vegetation into cities whilst maintaining higher densities.


Rainwater Filtration
Indoor Air Purification
Energy Efficency
Air Pollution Control
Vegitation Facades
Health and Well-being
Perform as Acustic Barrier
Increase Biodiversity

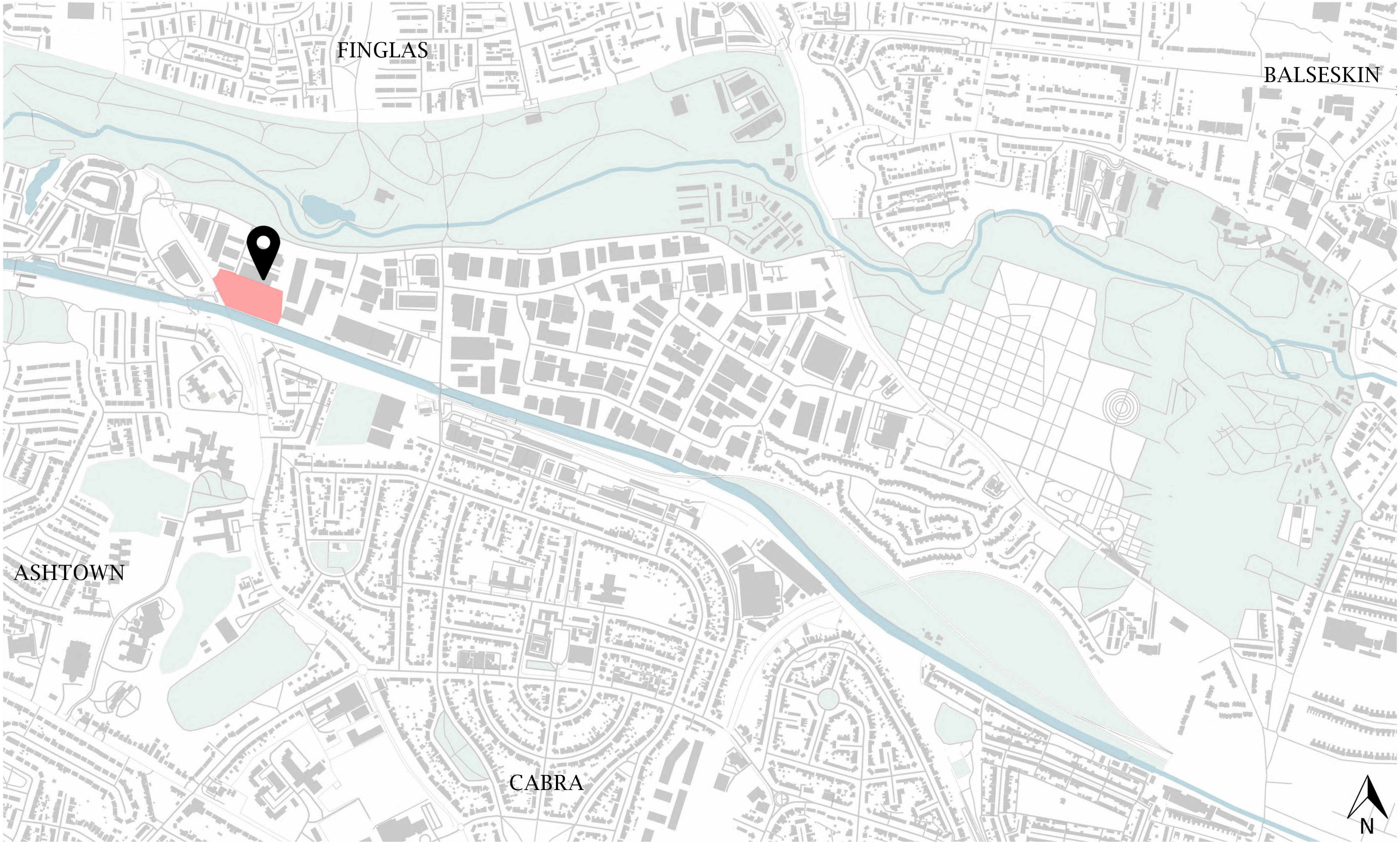
(Fig.8)

LIMITATIONS OF VEGETATION FACADE

Other than the above-mentioned advantaged, there are few minor but certain drawbacks or limitation to the application of vegetation façades.

No plants can thrive without proper care. And similarly, regular maintenance is needed for vegetation façades. And aside from the maintenance, there are also some limitations to the application of vegetation façades as not all plants can be used as facade. And sometimes it must be specially designed which make it typically more expensive than traditional facade works.

Another additional cost adds when adding rainwater control measures. As explained above in benefits, special storage tanks must be installed to store rainwater, which can later be used to hydrate the vegetation, but it certainly adds to the cost of facade. But even if cost is not an issue and the subjected greenery is properly maintained, certain seasonal plants will cease to thrive in winter anyway, that is why it is important to select all such plants for facade that can withstand the heat of summers and cold of winters.



Site Location Plan

PROJECT SETTLEMENT

Following the work and study in north-west Dublin. The area under study is the congested region between Ashtown and Finglas along with the Royal canal. This consists primarily of industrial and natural terrain. The site under study for this project is situated beside New Riley Bridge and tram route across Royal Canal.

The proposed site of the project is currently occupied by workshop of RMD Kiwiform, which makes and provides formwork material for bridges and other construction projects. The surface of the project is mostly flat with minor level differences.

The area of site is 10023 square meters. The site does not have any entrance from the Royal Canal Side, and the existing site is bounded by walls and fences. Most of the project site ground is concrete surfaces and a small portion is divided into green surface along the New Riley Bridge side.

The Green area of the site need to be preserved. So, at this project site, in addition to introducing vegetation façades and green roofs, I have also relocated the community garden to another location within the site to preserve biodiversity of the region.

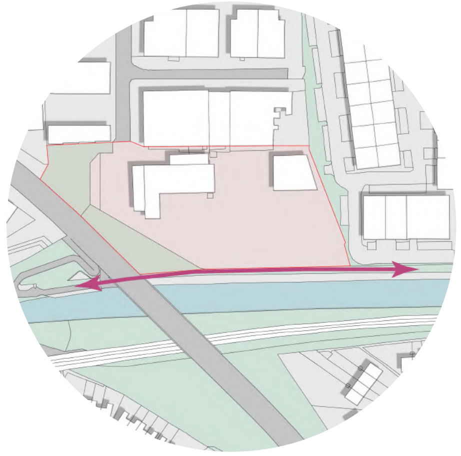
As the site has constant traffic on New Riley Bridge road and a tram line nearby, the site is without any doubt exposed to high decibel sounds.

Although provision of vegetation façades has numerous other benefits with their own limitations. For this specific test project, I will be focusing on these two major advantages of vegetation façades, i.e., Noise Reduction and improving Biodiversity in the region.

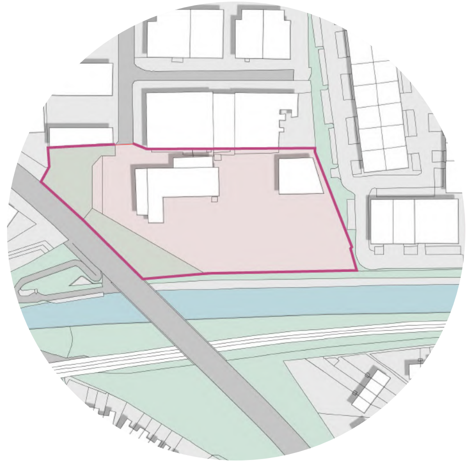
(Figs.9)

Current Site Condition

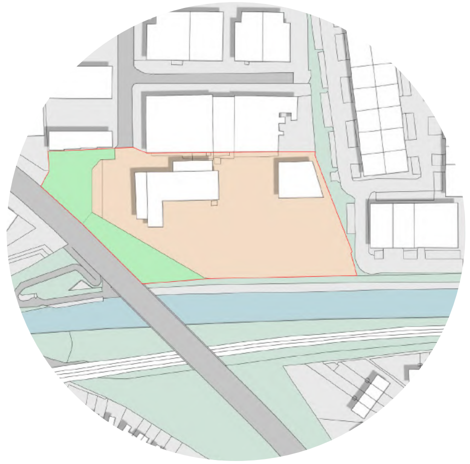
Existing Site Plan



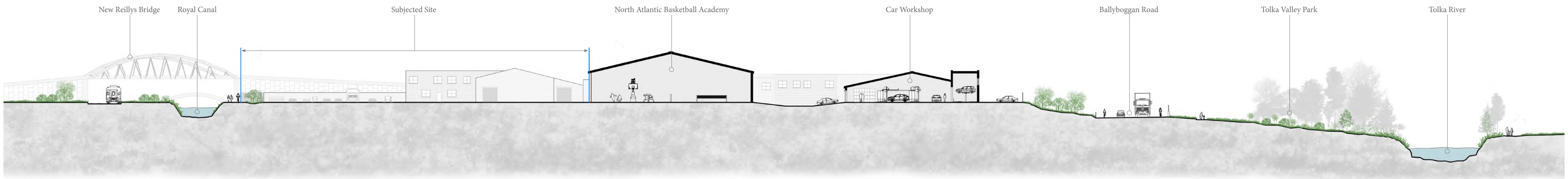
No Access from Royal Canal side



Site bounded with block walls and fences



Hard and Green Surfaces



Existing Long Section (A-A)

SITE ANALYSIS

Before designing any project there are certain factors that need to be studied for effective planning and design of the project. These factors mainly involves the following.

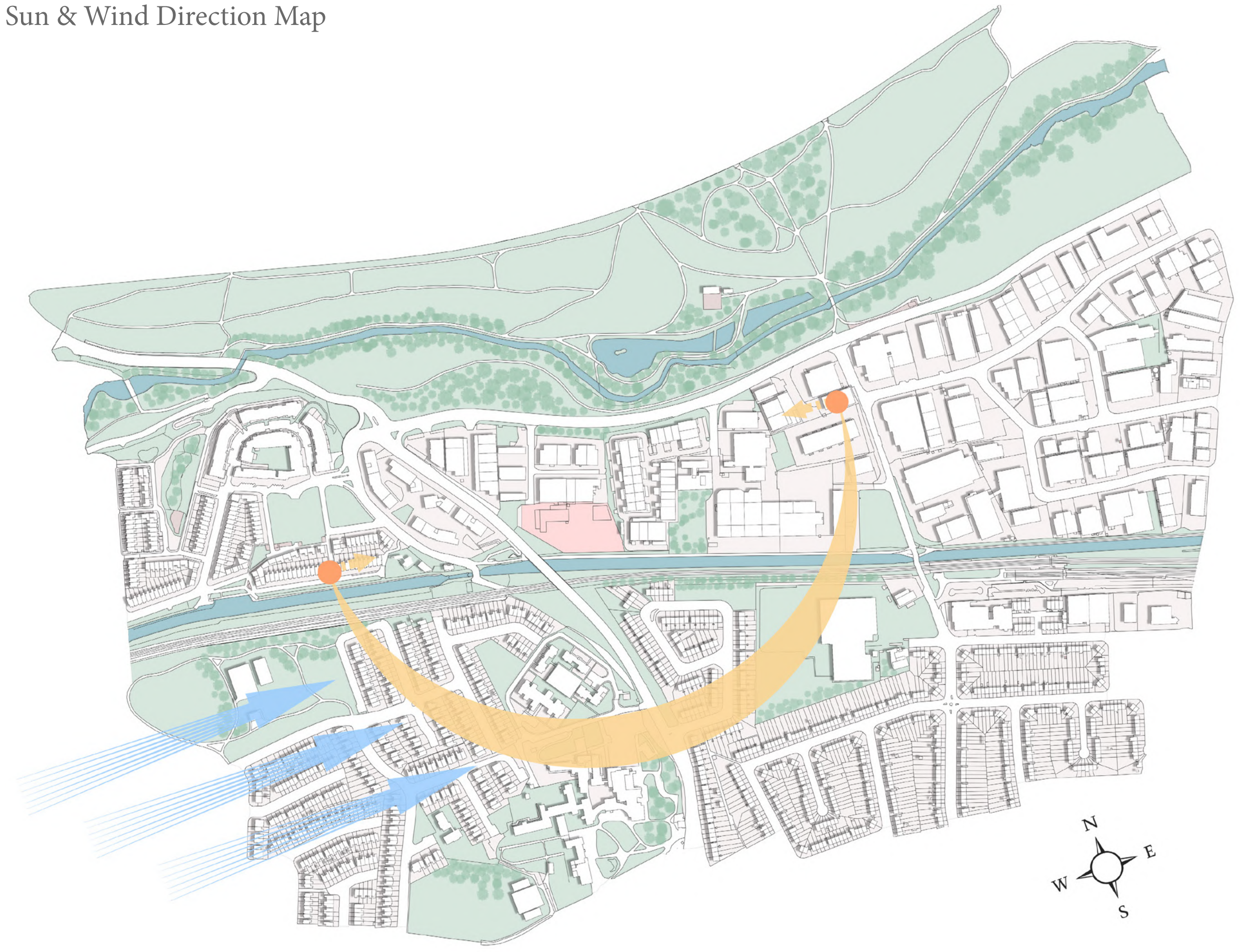
The Sun and Wind Directions: The Sun rises from the industrial side in the East and following the trajectory across Royal Canal finally sets in direction of New Riley Bridge at West Side. While the direction of winds is mostly from East to West and Vice Versa.

Transport Routes: The site has one major road and one small dead end road adjacent to it.

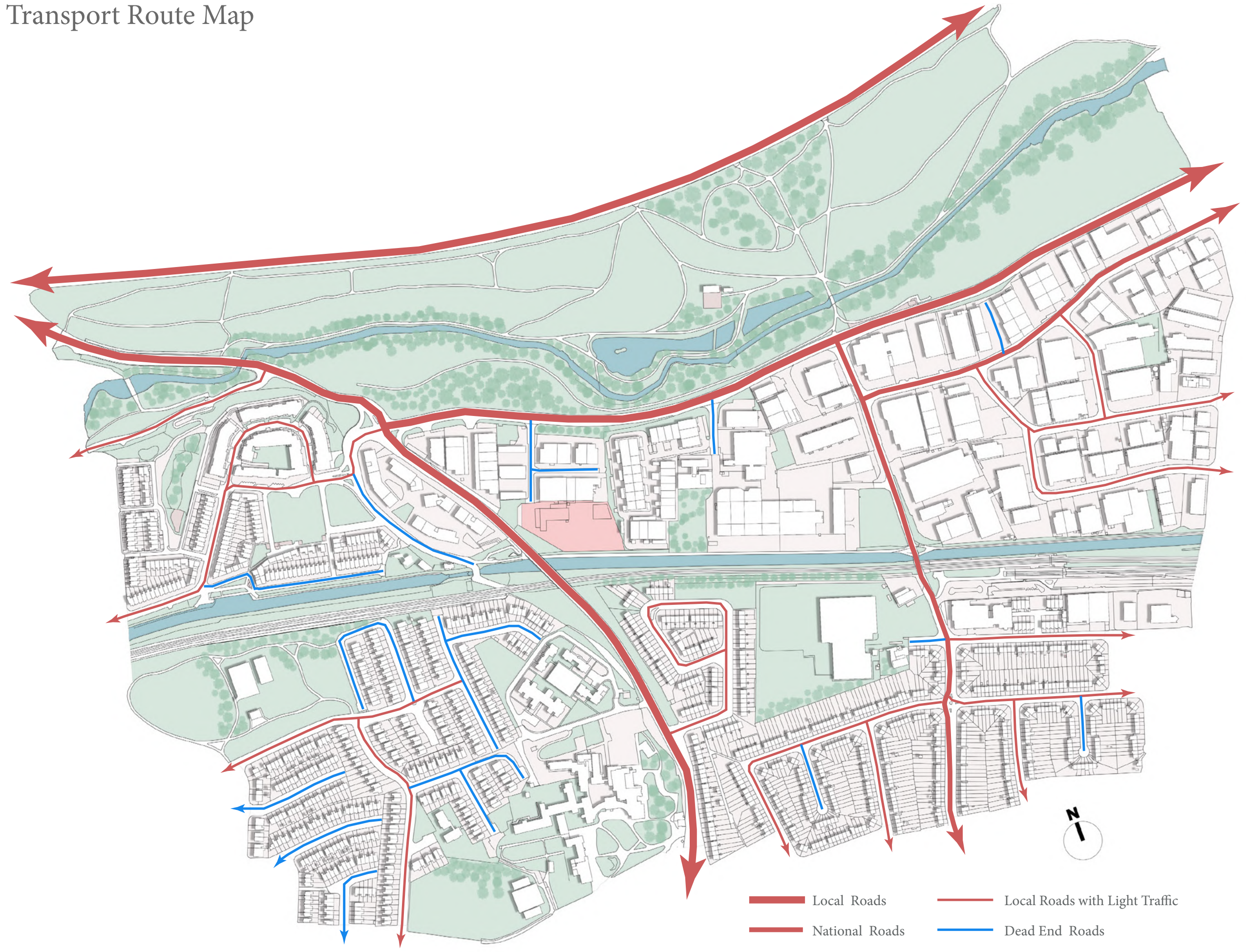
Building Use: The buildings around the site are of industrial nature mostly. While residential and educational building are also nearby across the New Riley Bridge and Royal Canal.

Ecology: The site only has one Semi Pubic green area and one private green area adjacent to it, the private green area is to be relocated within the project to preserve the ecology of the area.

Sun & Wind Direction Map



Transport Route Map



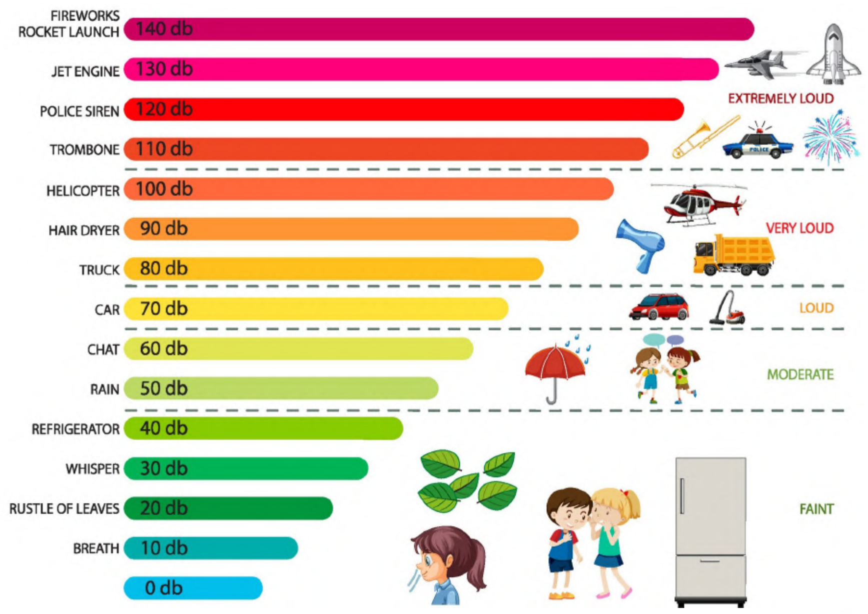
Building Uses Map

Ecology Map

But by far the most important factor to consider when designing a residential project in such area is acoustics of the region, which is also the main drive of our project. As the project site is situated in industrial area and is adjacent to New Riley Bridge and Royal Canal, so the is was very important to analyse the noise pollution from industrial area, traffic on New Riley Bridge and tram across the Royal Canal.

The noises along the road and tram line were measured at day time and night time and found to be ranging between 54db at edges of road and tram line to 79db at center of noise source at day time. The same areas become a bit more noisy with sounds from road traffic and tram line ranging from 56db at edges and 82db at center of noise source. These noise ranges can be categorized into moderate to high at nearby buildings and very high at center of noise pollution.

Similarly, industrial area adjacent to project site causes a noise that ranges from 56db to 71db. Few readings taken a few blocks away have even higher range of noise, i.e., 73db to 76db. This level of noise is also loud for residential projects. Which consolidates the need of some mechanism to control such



Acoustic Decibel Scale Chart

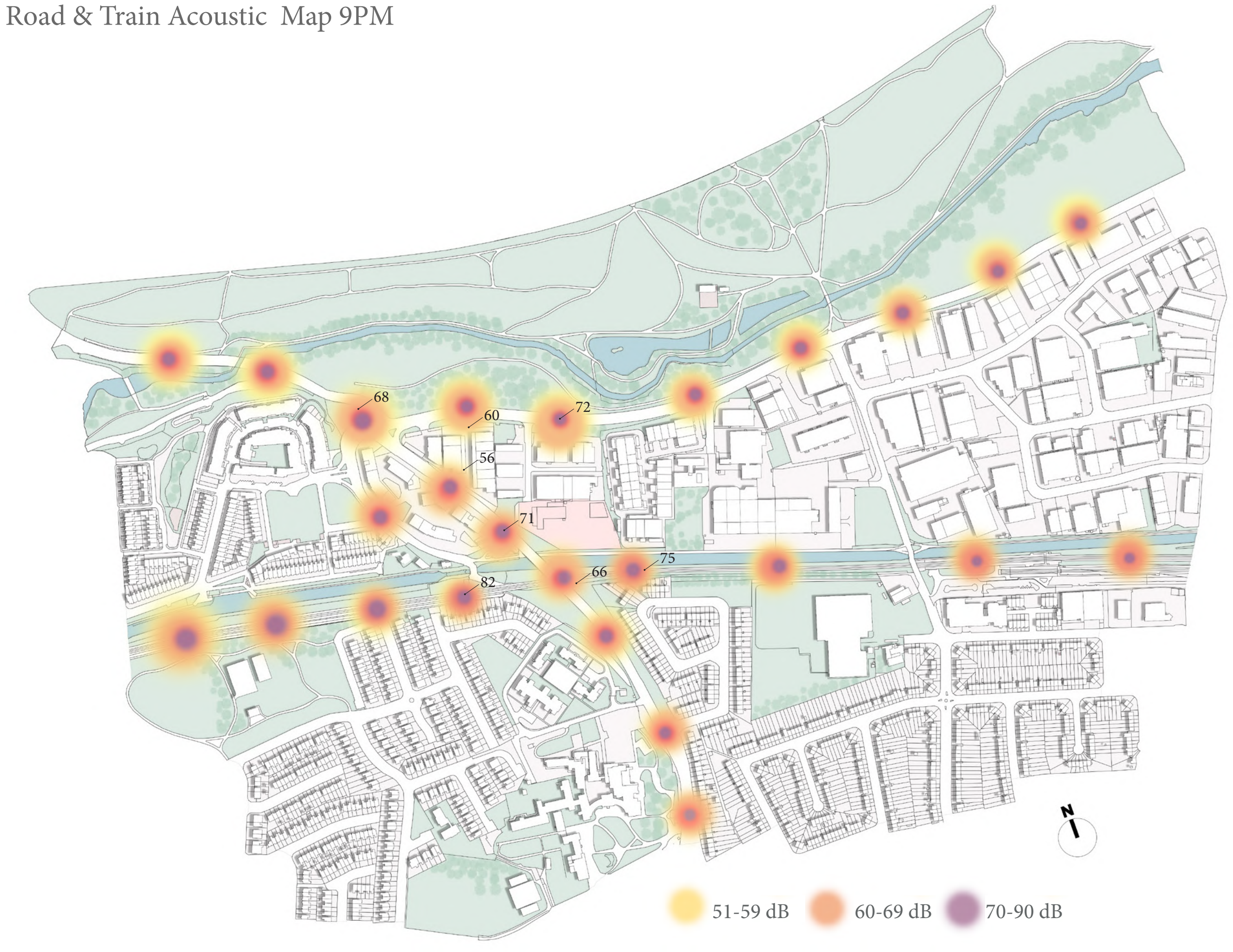
Source of Sound

- Transport (Cars)
- Transport (Truck)
- Pedestrian
- Wind
- Industries
- Birds

Average Road and Train Acoustic Map

Road & Train Acoustic Map 9AM

Road & Train Acoustic Map 9PM



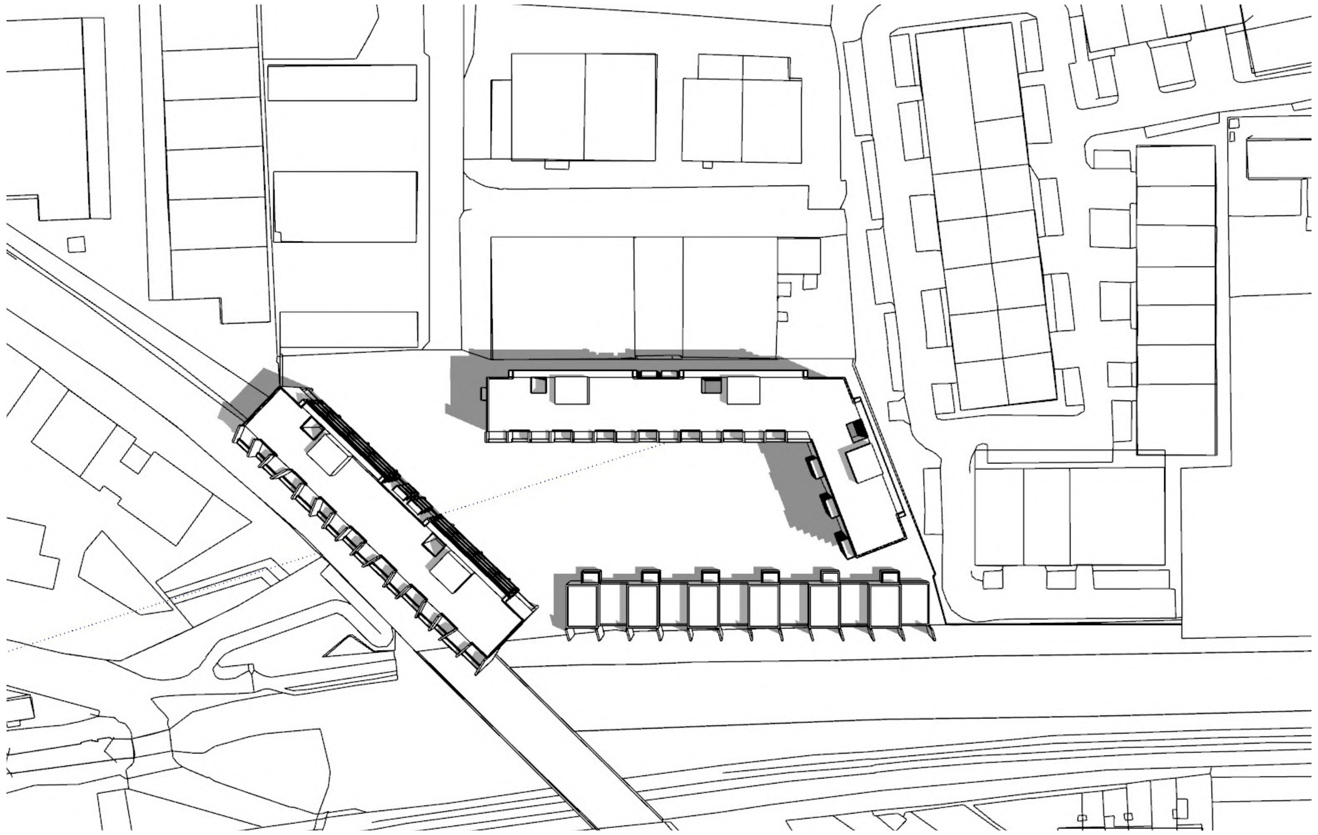
Industrial Acoustic Map

Pedestrian Acoustic Map

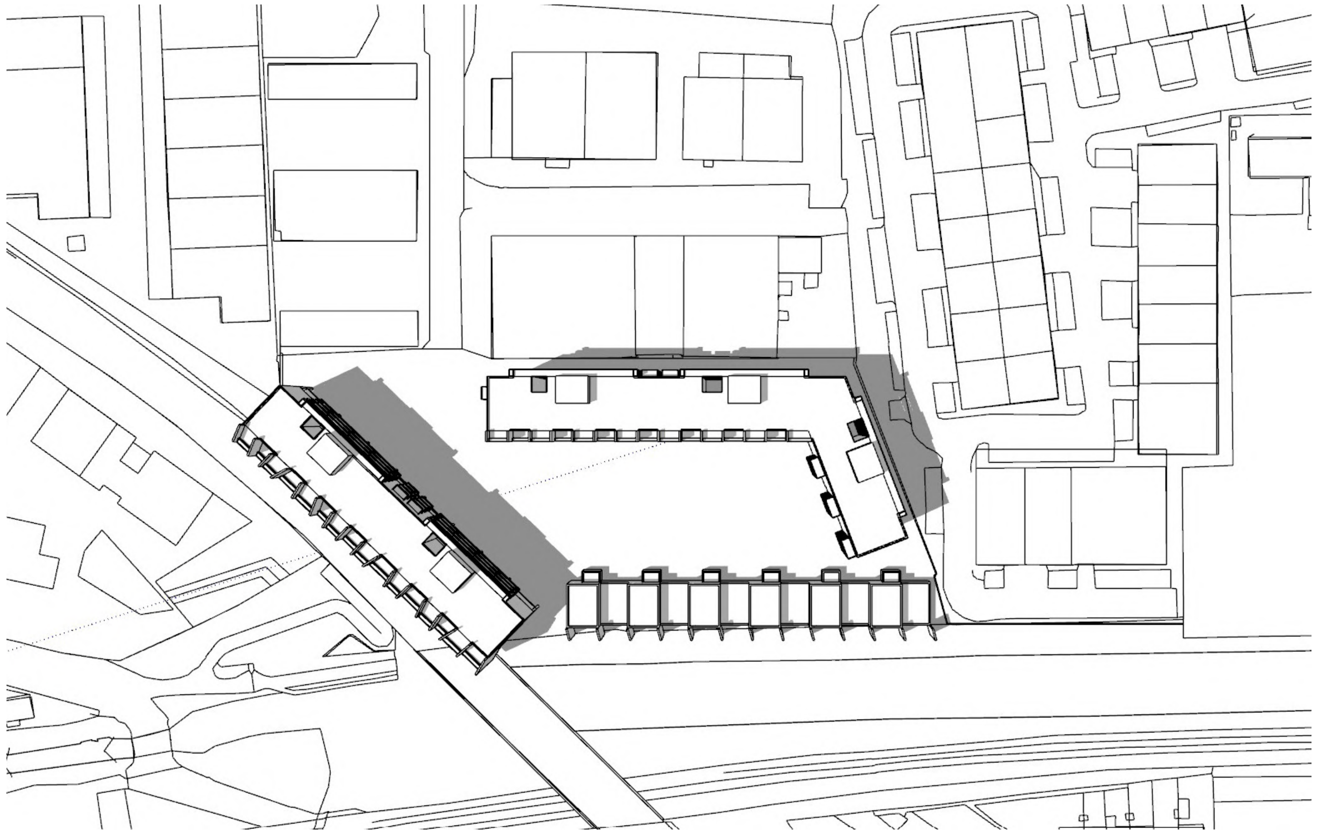
SUN STUDY FOR PROPOSED DESIGN

Another important factor to consider when designing a residential project the movement of the sun and how it shall effect the provision of natural sunlight and shadows of the structure. The study is also important to this specific project because we need to relocated the community garden in this area to such area which will not be affected by shadows of the buildings.

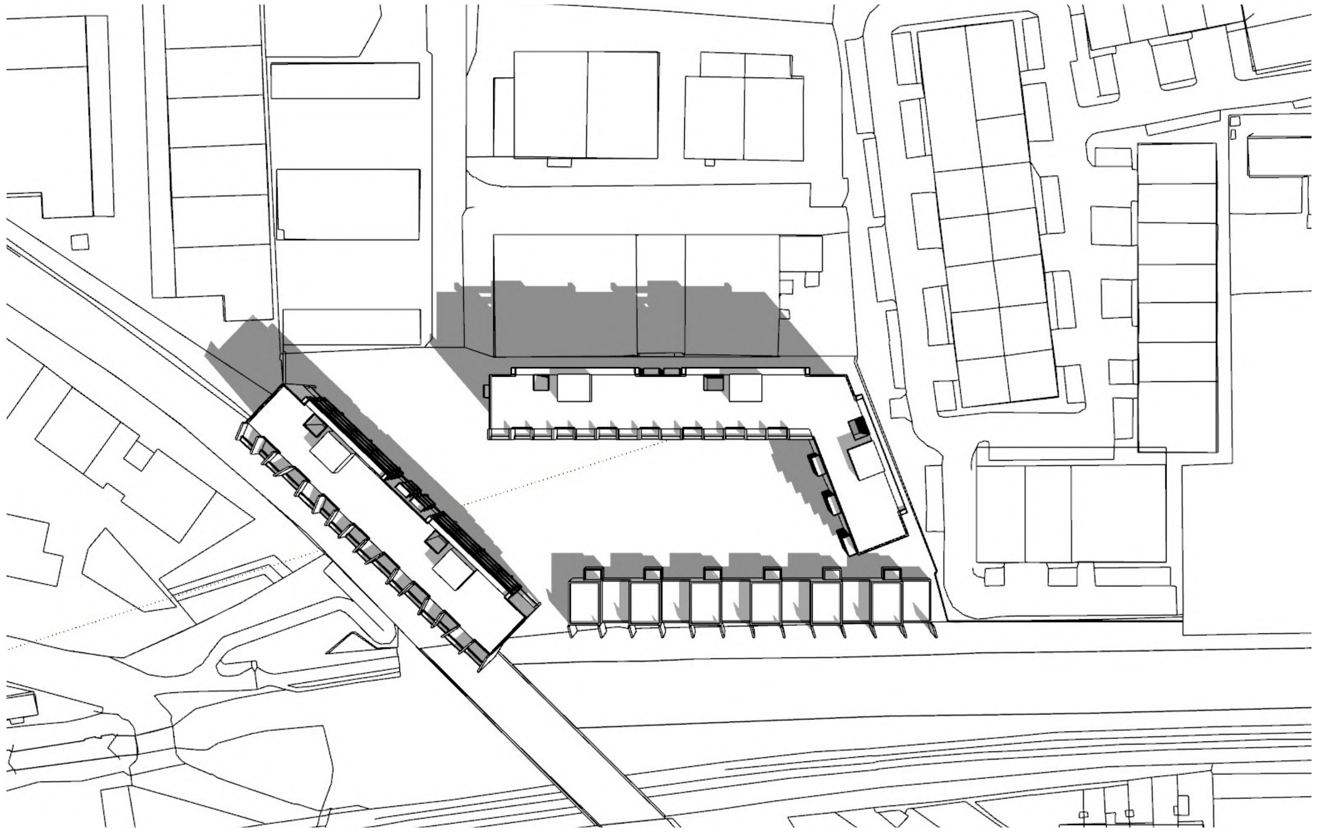
The most optimal location for relocating the green area shall be in center of building blocks as it is least affected by shadows in all seasons, as depicted in following drawings based on study of the sun movement in this region.



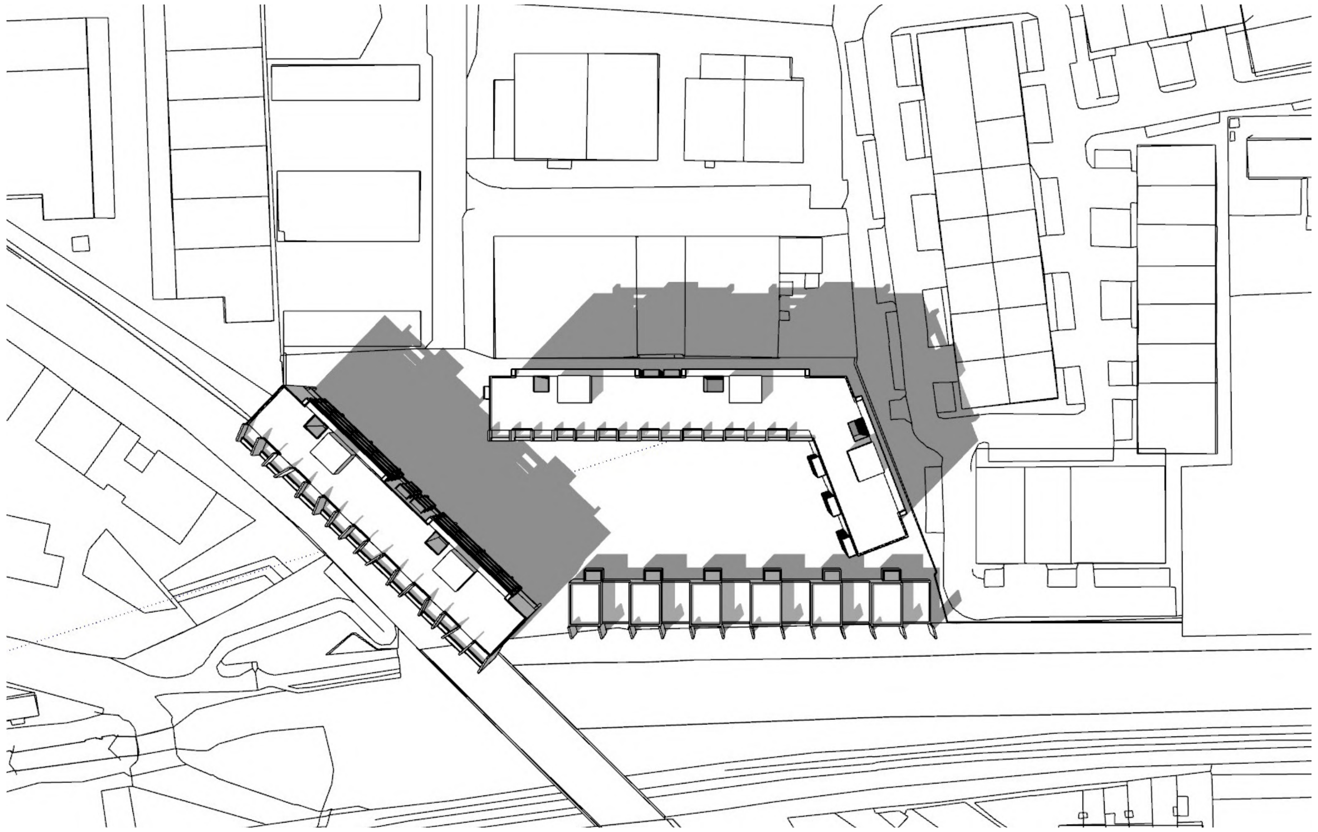
Summer Solistic
Time = 10AM
21 June 2023
Sun Angle = 57.86 degree



Summer Solistic
Time = 2PM
21 June 2023
Sun Angle = 57.86 degree



Autumn Solistic
Time = 10AM
21 September 2023
Sun Angle = 32.87 degree



Autumn Solistic
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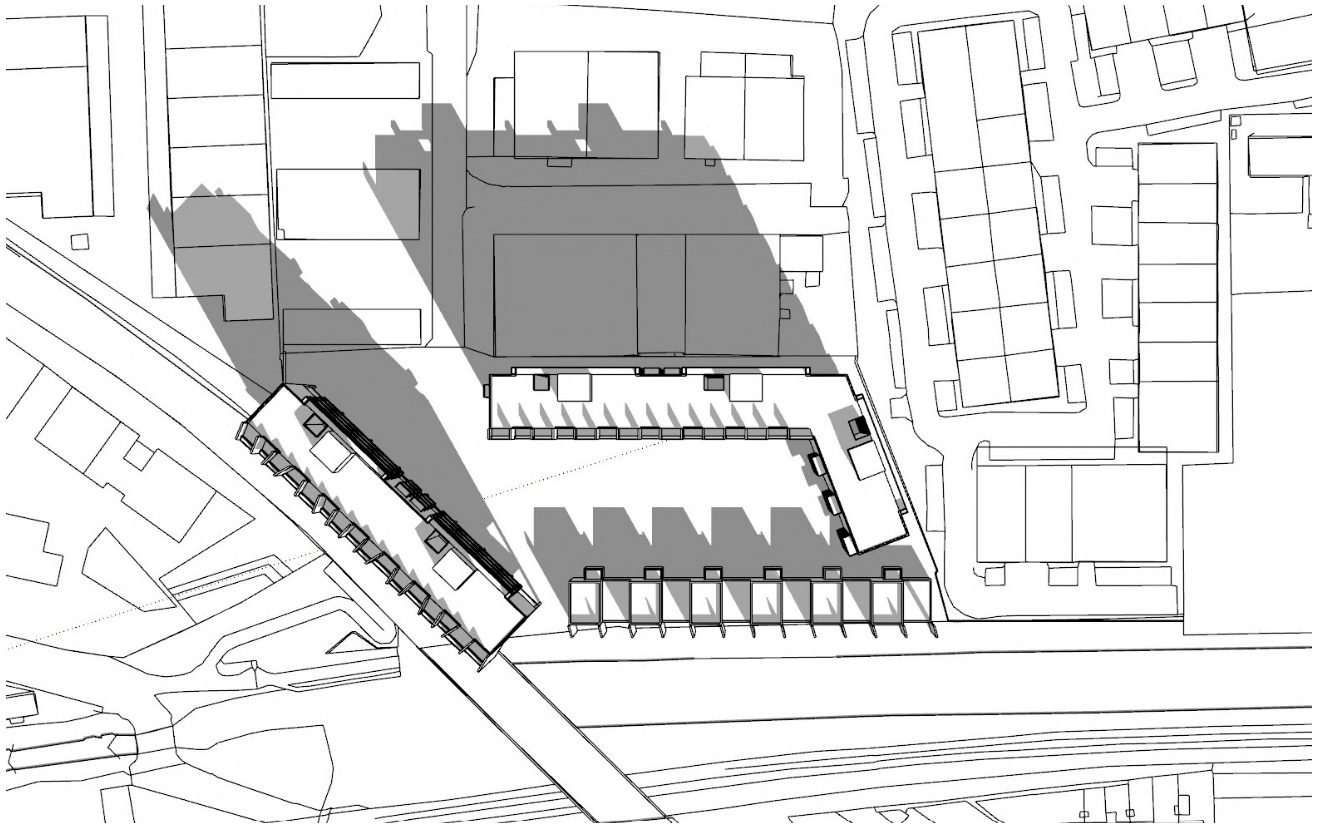
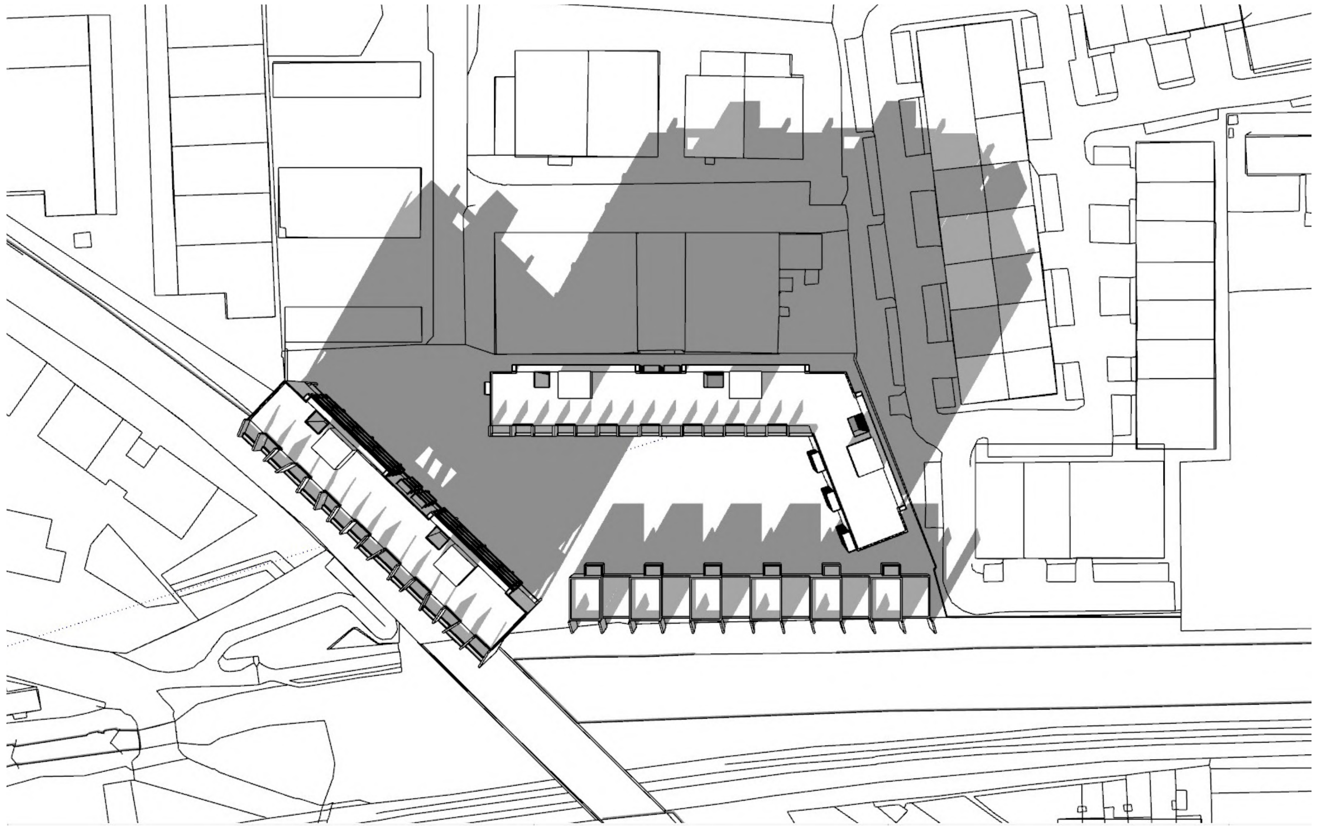
21 September 2023
Sun Angle = 32.87 degree



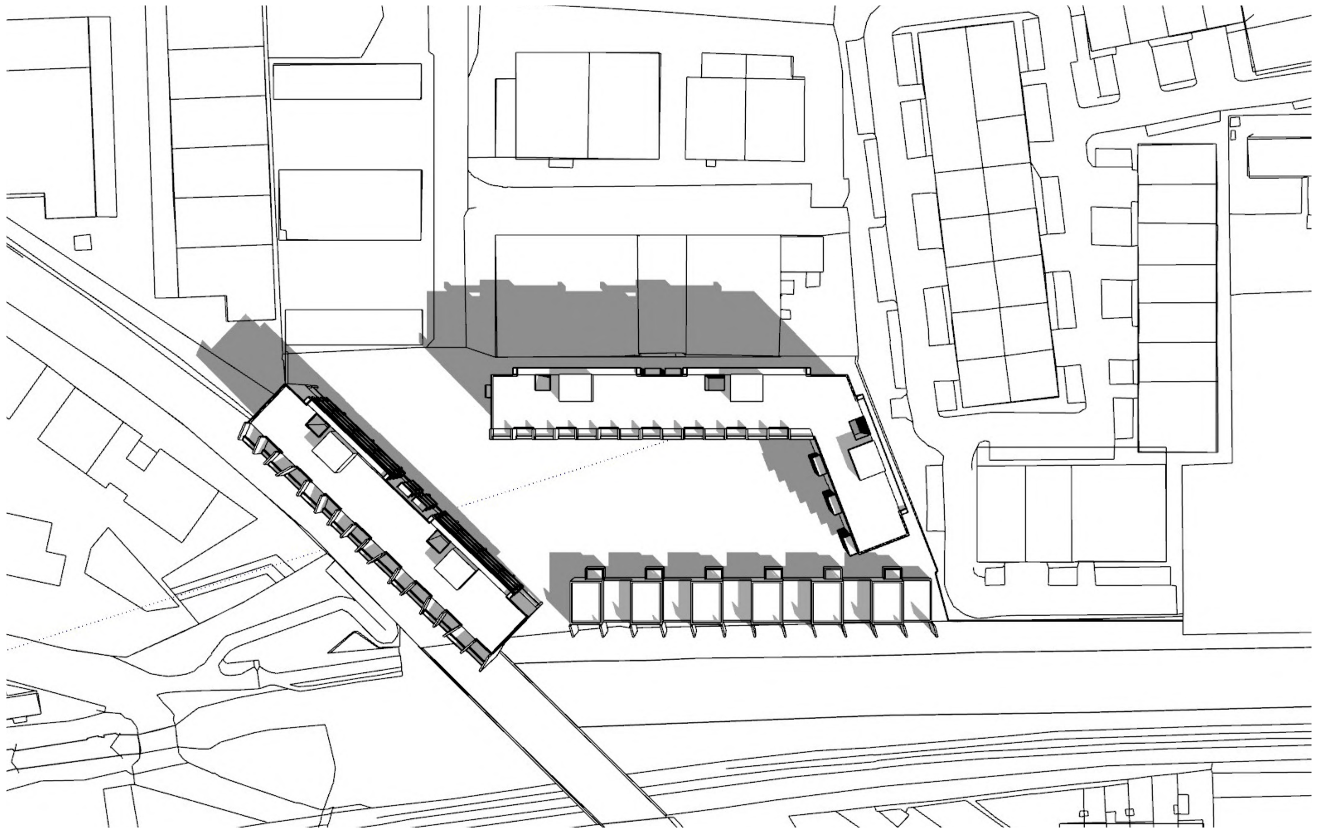
Winter Solistic

Time = 10AM
21 December 2023
Sun Angle = 12.24 degree



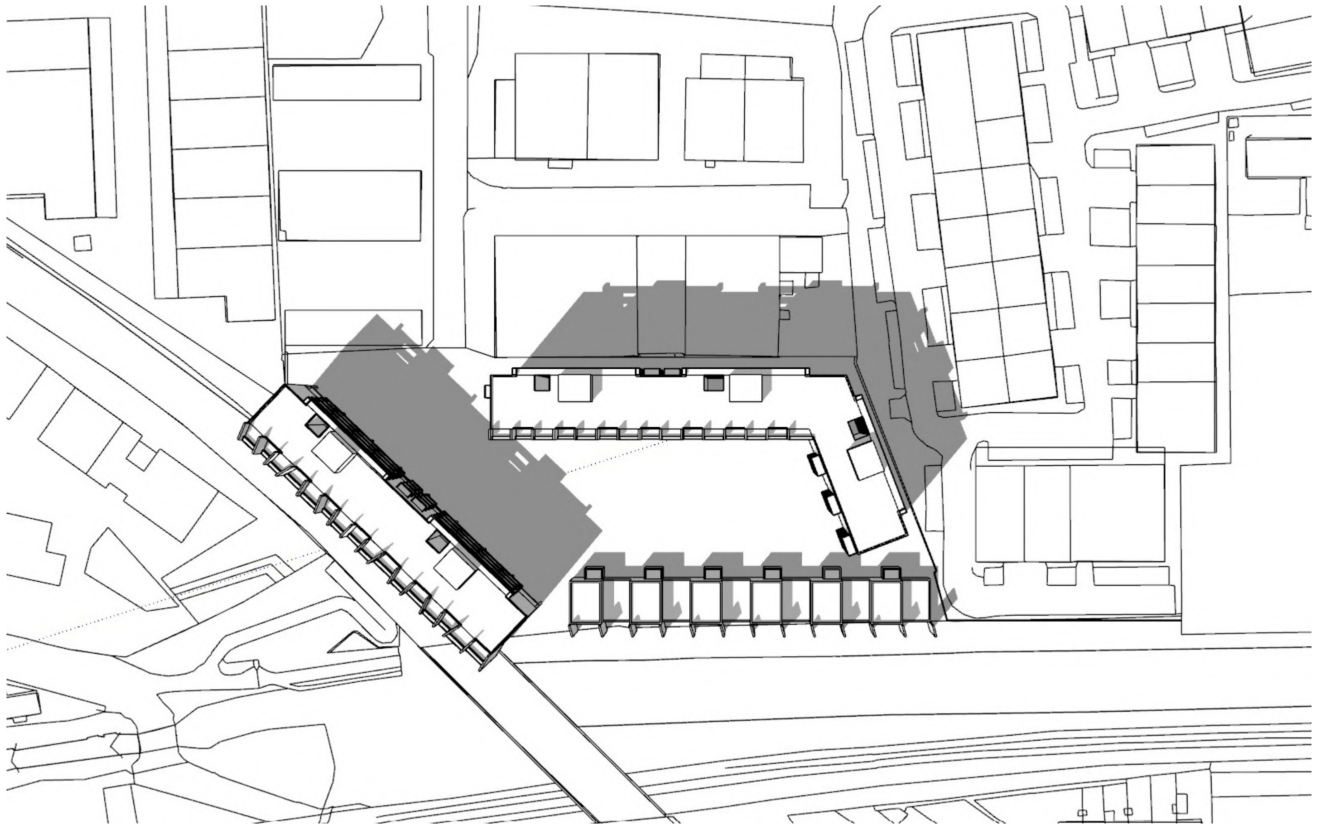
Winter Solistic

Time = 2PM
21 December 2023
Sun Angle = 12.24 degree



Spring Solistic

Time = 10AM
21 March 2023
Sun Angle = 31.01 degree



Spring Solistic

Time = 2PM
21 March 2023
Sun Angle = 31.01 degree

DESIGN PRECEDENTS

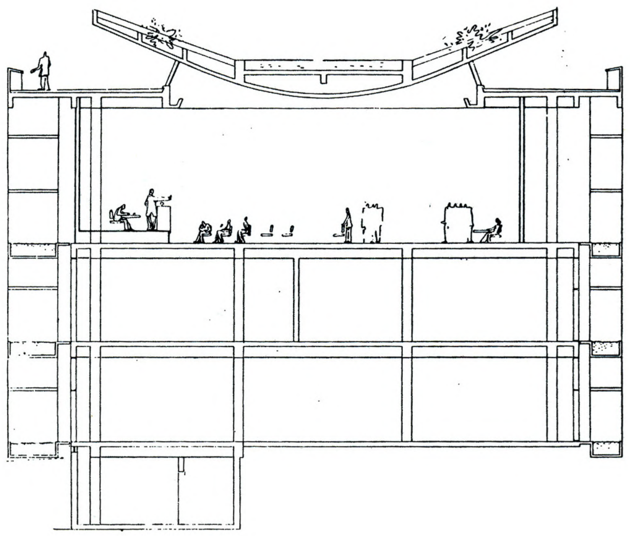
The following projects were used as precedents for this proposal.

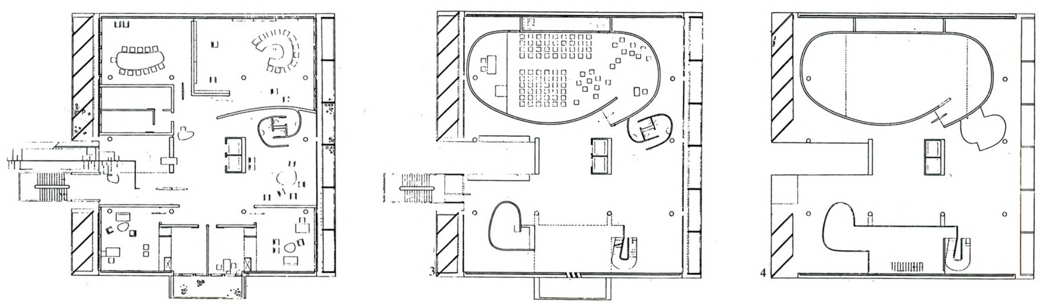
Mill Owners by Le Corbusier Ahmedabad, India: This project has concrete panels constructed at an angle to effectively utilize sunlight. Which gave me the idea to design angular green buffers facing noise directions to effectively control the incoming noise.

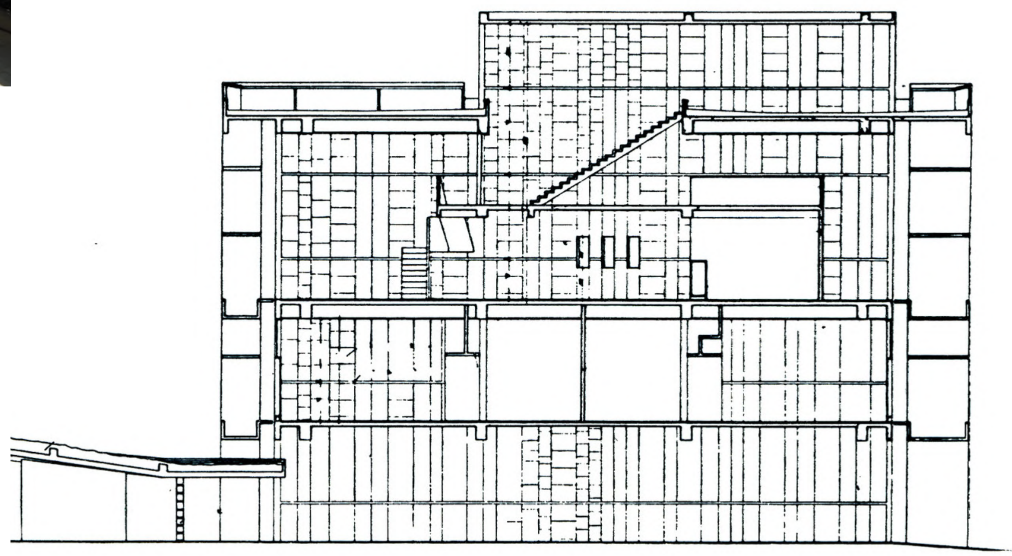
Housing Development Brunnenhof Zurich, Switzerland: This building and adjacent park faced a similar issue of noise pollution and it was mitigated with alighting the building along the park to protect it from incoming noises from road. This gave me an idea of designing Block B along the New Riley Bridge to shield the community park from noise.

Quai Branly Museum Pairs France: This building in France implemented the idea of adopting a glass wall to protect from noise. This strengthen the idea of using Green buffers in my design project. This building also gave the inspiration of elevated floors for parking and other facilities.

MILL OWNERS BY LE CORBUSIER INDIA DRAWINGS

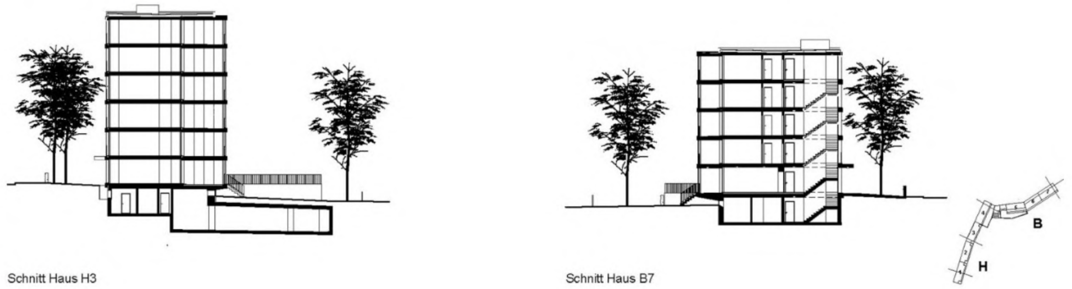






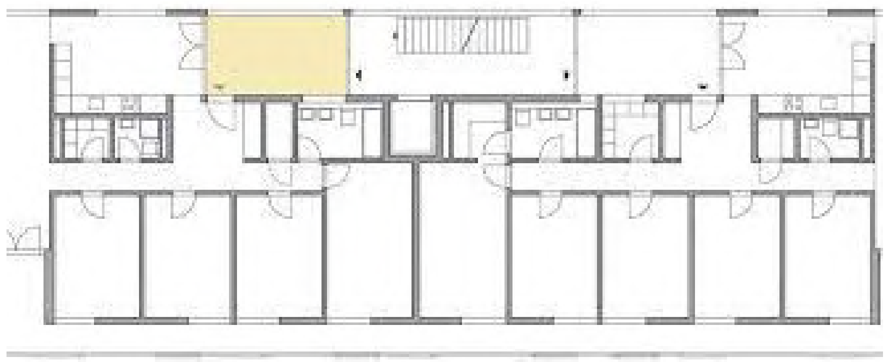
(Figs.10)

HOUSING DEVELOPMENT BRUNNENHOF ZURICH SWITZERLAND DRAWINGS



Sections

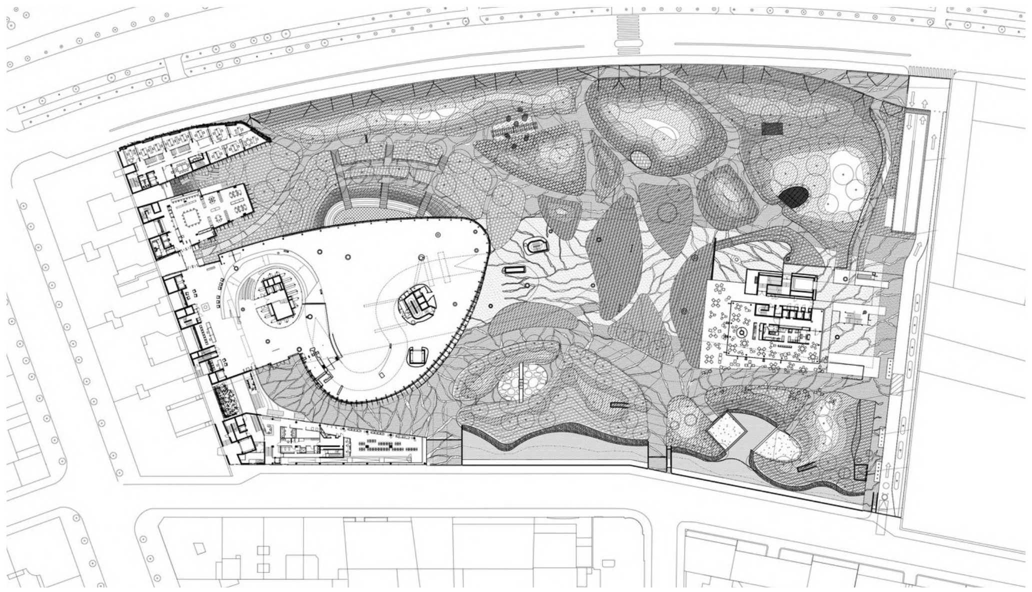
(Figs.11)

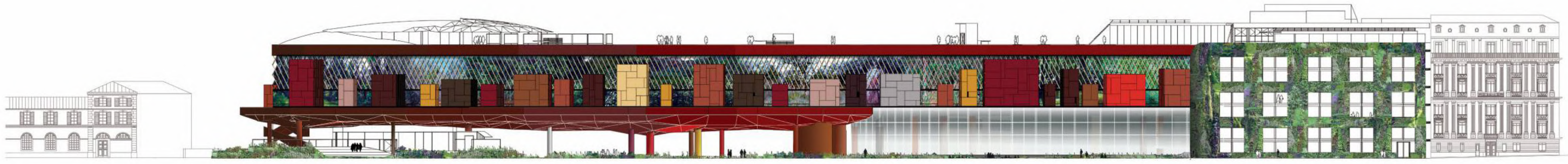


QUAI BRANLY MUSEUM FRANCE DRAWINGS







(Figs.12)

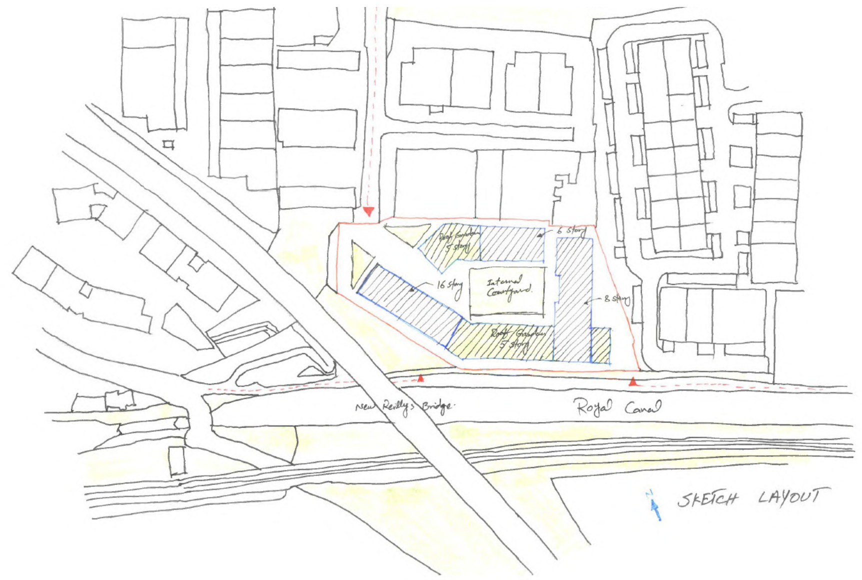
INITIAL DESIGN SKETCHES

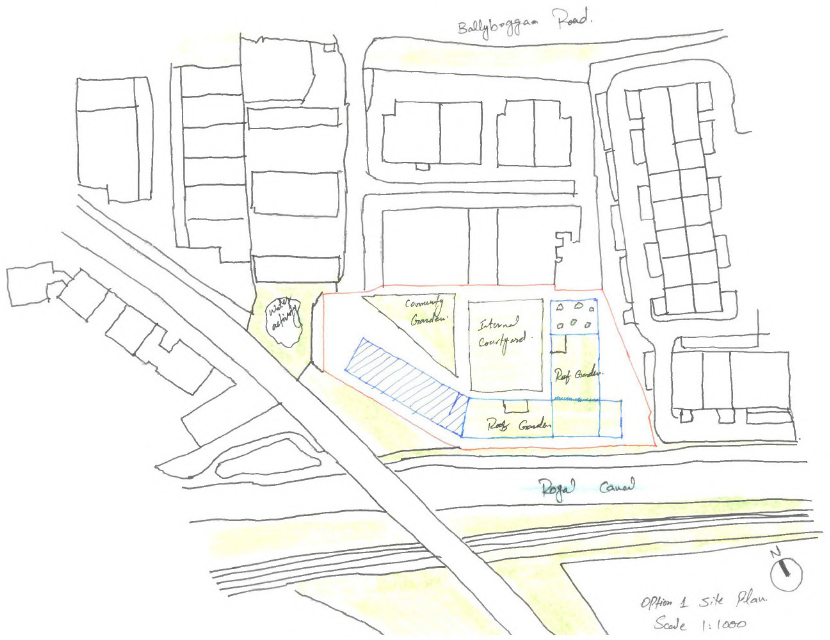
Based on the locality of project, analysis of site for noise, ecology and sun study for the project, several ideas were explored different types of shapes and orientations were tested for each scenario. Some of the preliminary sketches show the some of the options that were explored for this project.

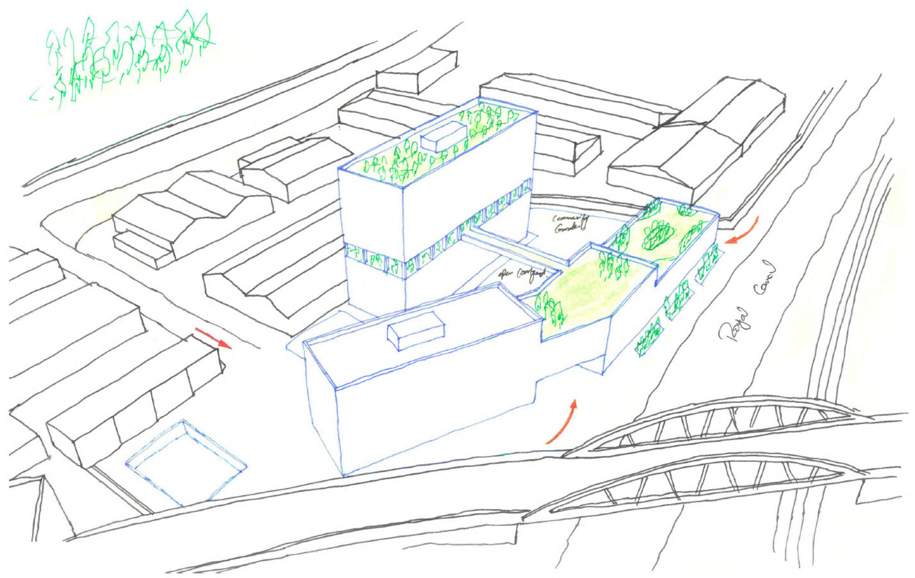
Similarly, different sketches for proposed details of area are also illustrated on next pages. The sketch of Community Garden show the facilities and attractions of the garden. And the sketch of roof treatment explores the idea of protecting the roof, making it more accessible.

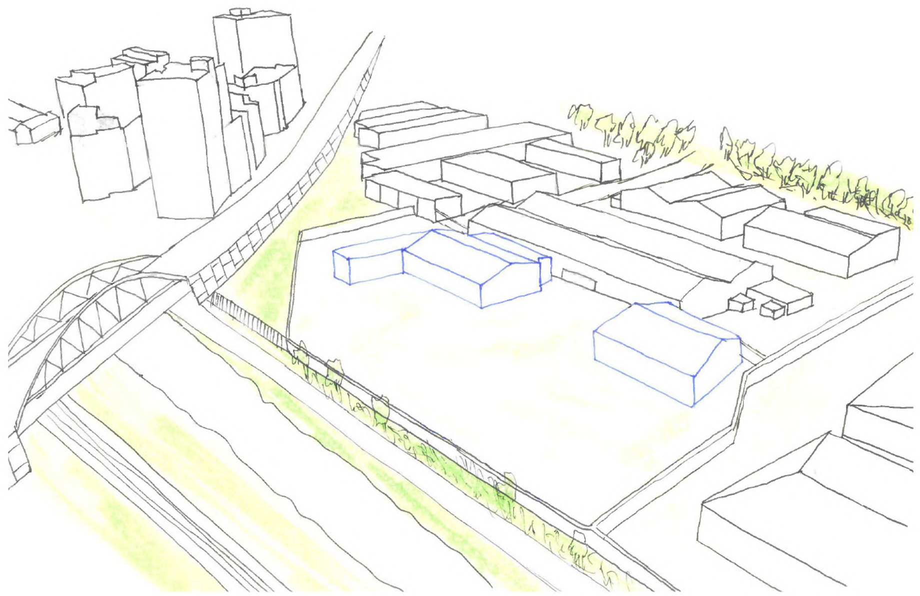

① Passive Surveillance of Canal
② Permeability of Site
③ Create Lives of activities like (community Gardening water activities)
④ Connecting nature
inviting people to walk along the Canal (As currently its closed edge)
Site strategy

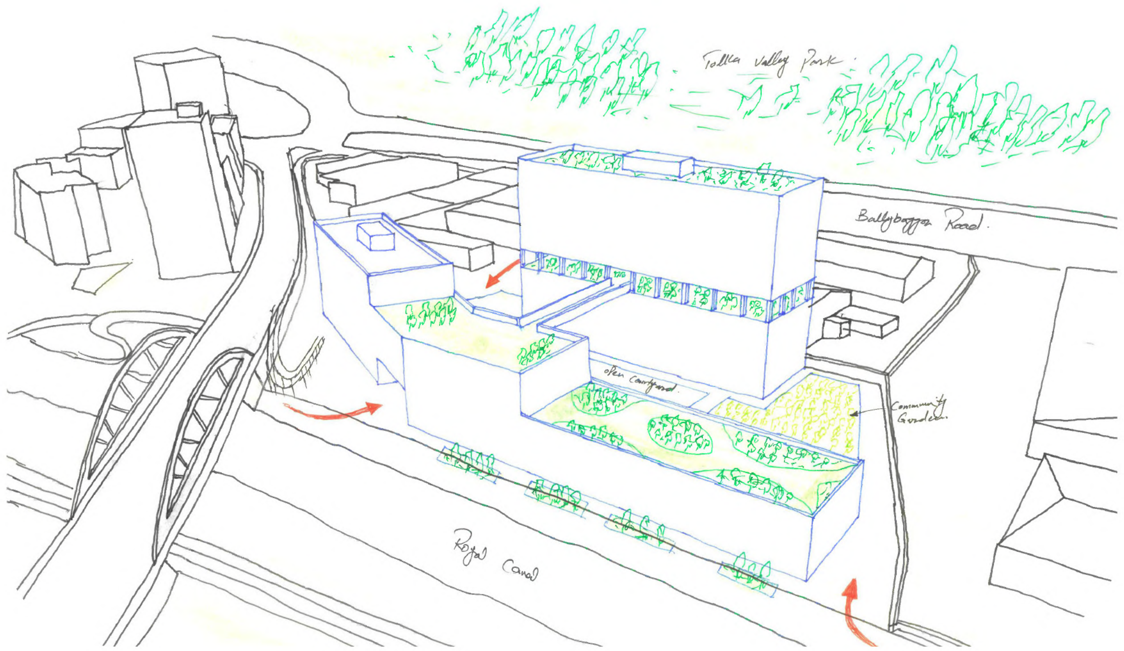

Community Garden
Royal Canal
Option 2 Site Plan
Scale 1:1000

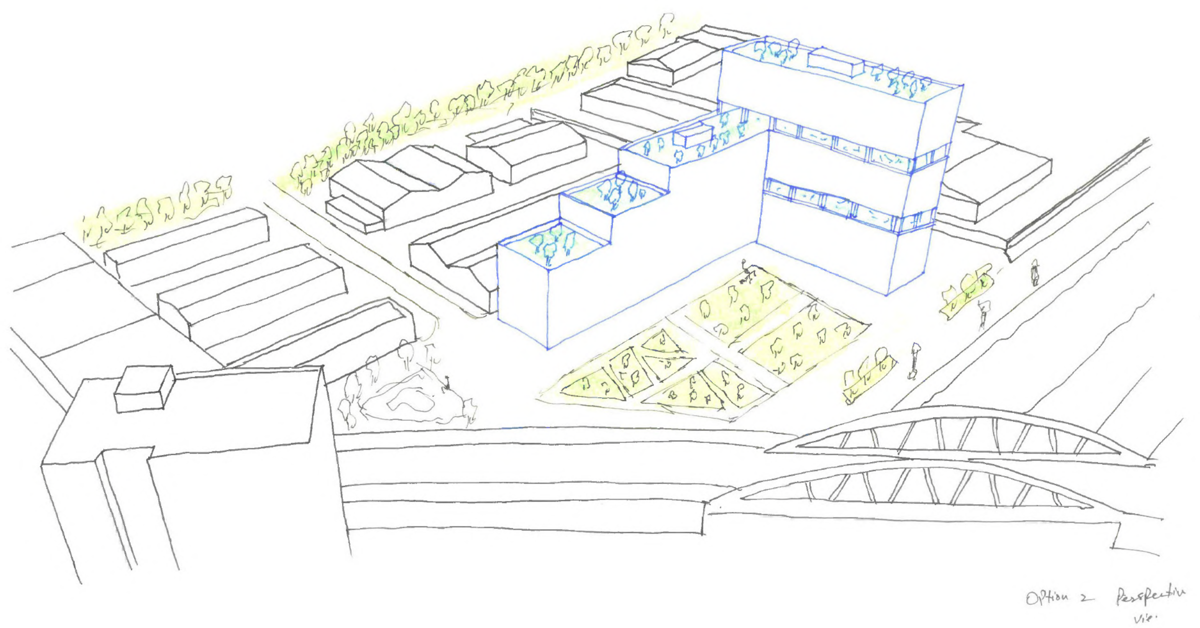

Internal Courtyard
Royal Canal
SKETCH LAYOUT

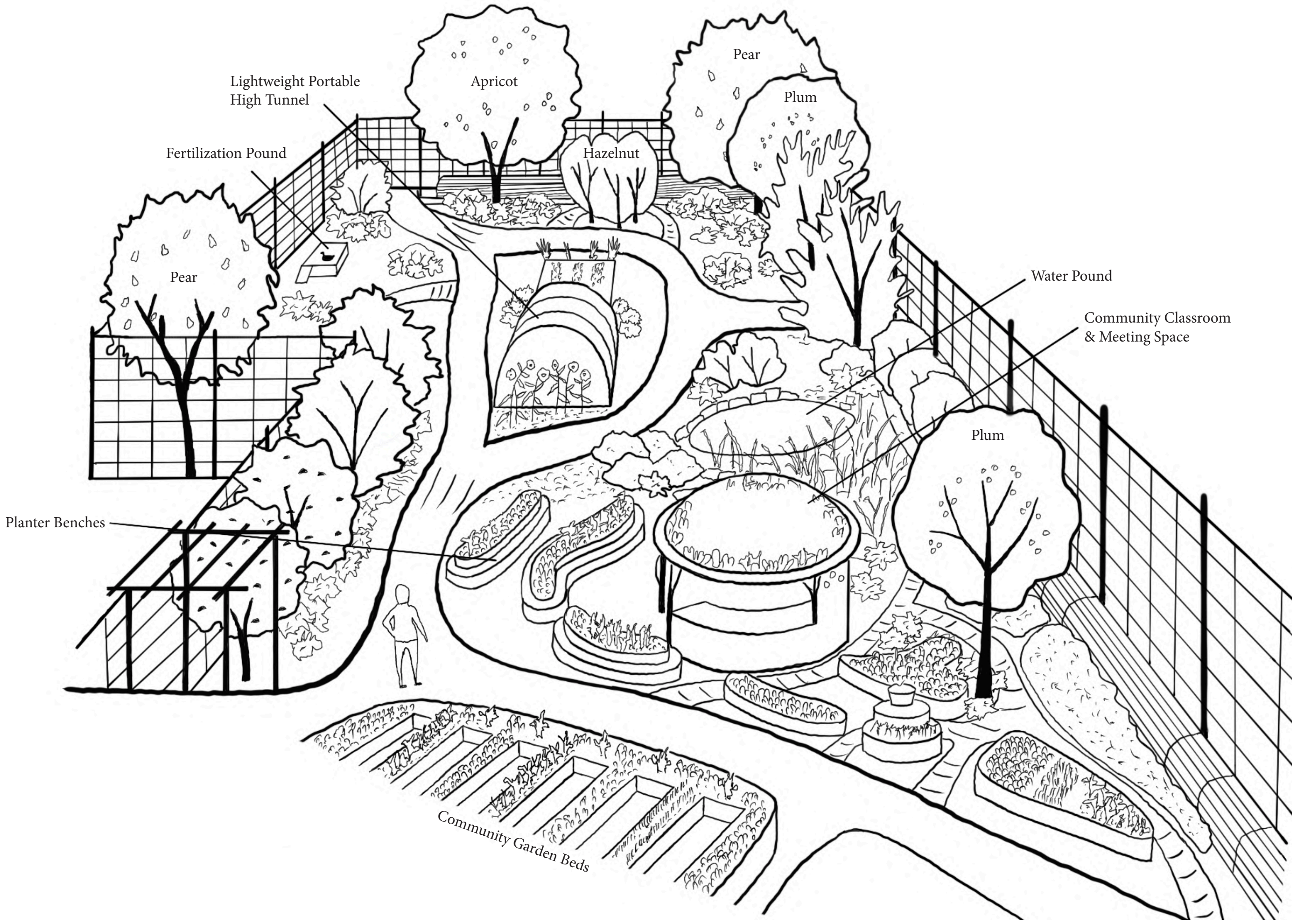

Ballyboggan Road
Community Garden
Internal Courtyard
Roof Garden
Royal Canal
Option 1 Site Plan
Scale 1:1000


Royal Canal



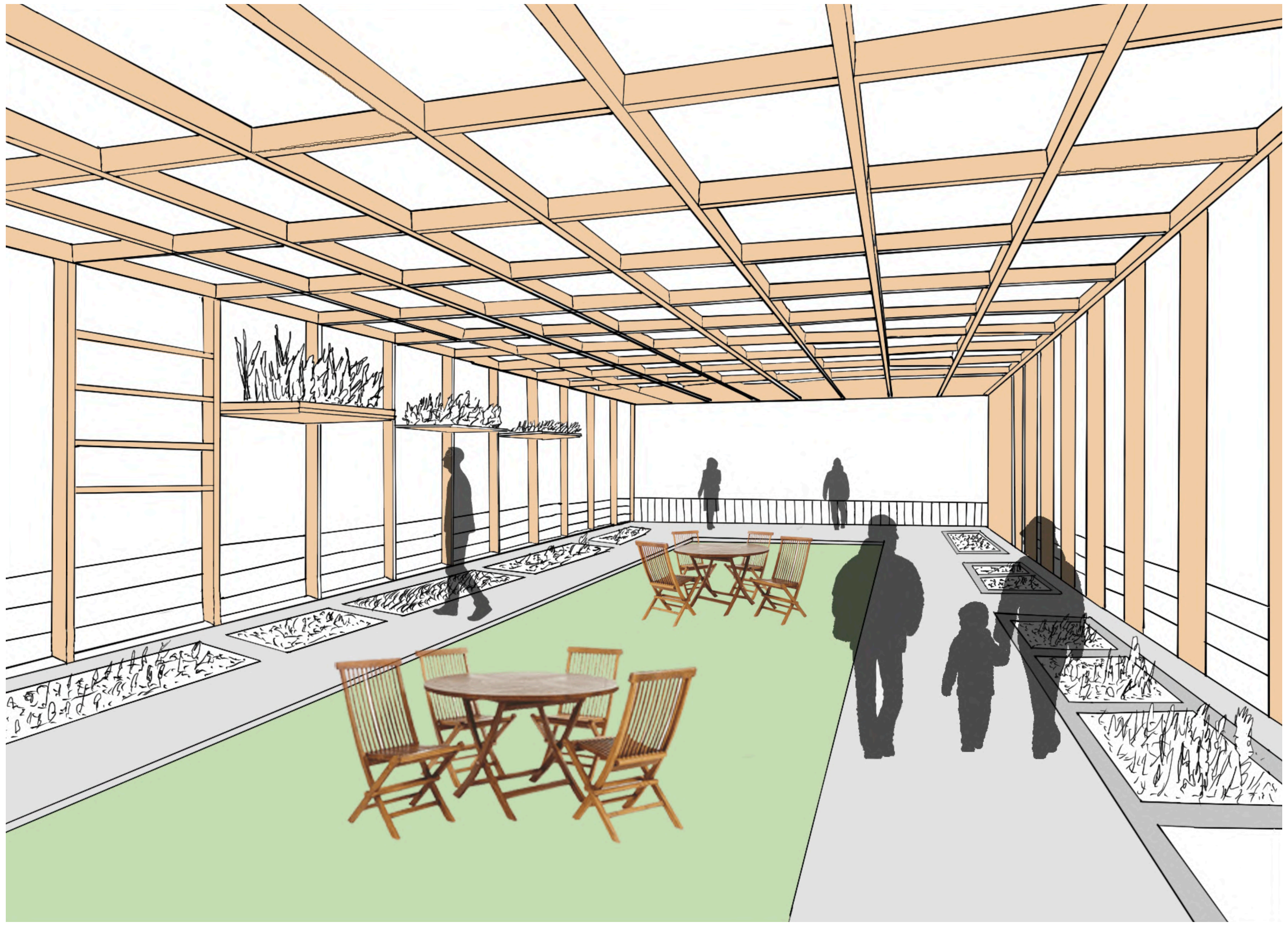

Tolka Valley Park
Ballyboggan Road
Open Courtyard
Community Garden
Royal Canal


Option 2 Perspective View.



Reilly's Community Garden Sketch

(Fig.13)



Roof top Treatment Sketch

(Fig.13)

PROJECT DESIGN OBJECTIVES

The objective of designing this residential complex is achieving a perfect balance among the following;

Zero Carbon Emission: The meaning of zero carbon emission to absorb an equal amount of carbon di oxide that it would usually produce. It one of the foremost objectives of this design proposal and for this building materials are carefully selected which will not emit any carbon traces and in addition the vegetation façades being used will absorb additional CO2 and produce Oxygen which is a plus point.

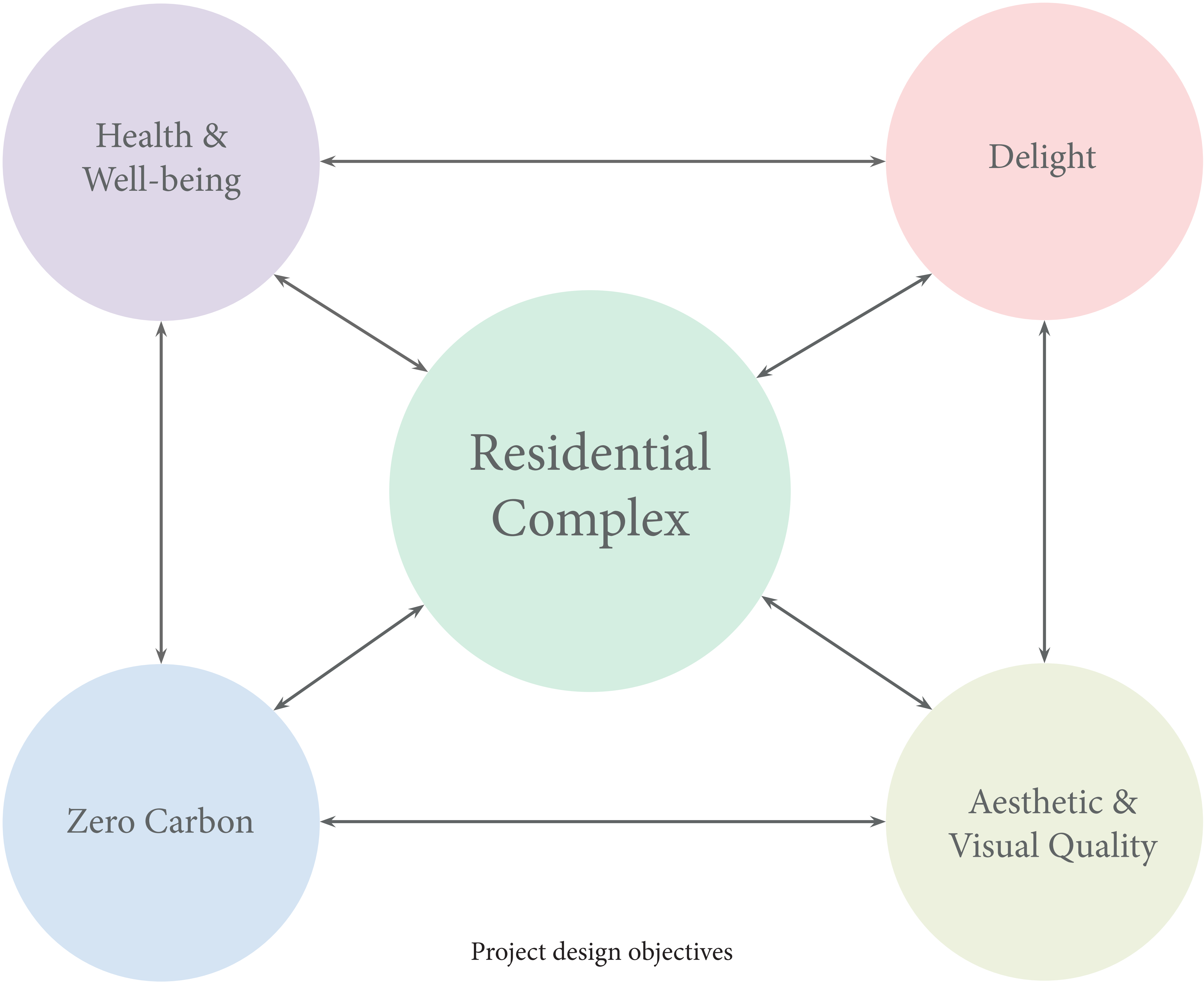
Health & Well-being: The project is designed in such a way that it would promote more walking and other healthy activities. The project will also facilitate access to green spaces which shall boost the air quality, ultimately resulting in a healthy living environment.

Delight: It states that the personality of a building as exhibited in individual traits is what we find delight in, as humans tend to personify things they interact with. The project is designed in such a way that through the complexity of traits and their interactions there is the potential for continued discovery and delight.

Aesthetic and Visual Quality: As basis of architecture, aesthetic and visual quality has also been put as primary objectives of the project design. Aesthetics are important in architecture because they can make a building more visually appealing, which can in turn increase its value and attract more occupants.

Building visual aesthetic quality is related to the style, volume and colour of buildings, including not only the modelling aesthetic elements such as balance, rhythm and symbolism but also the functional aesthetic elements such as technology, practicality and publicity.

Along with above, the project aims to provide passive surveillance of canal, permeability through site, creating hives of activities such as community garden, play area, community gathering area, and last but not least improving nature connection within the site and provision of vegetation fade as green buffers will reduce 41% of noise as well.



Project design objectives

FINAL DESIGN DRAWINGS

The project site is divided into 3 residential blocks around the perimeter of site with ample open space for community garden carefully selected in central portion of site on basis of aforementioned sun study and other site analysis.

The community garden provides a lush green environment with proper walkways pond and play area. It has sitting spaces to enjoy the nature within the comfort of home along with beautiful view of vegetation facade covered apartment buildings it-selves.

The description of each block is discussed in detail in final design section.

Proposed Site Plan
N
0 1 2 4 8 12
Royal Canal
New Reill's Bridge

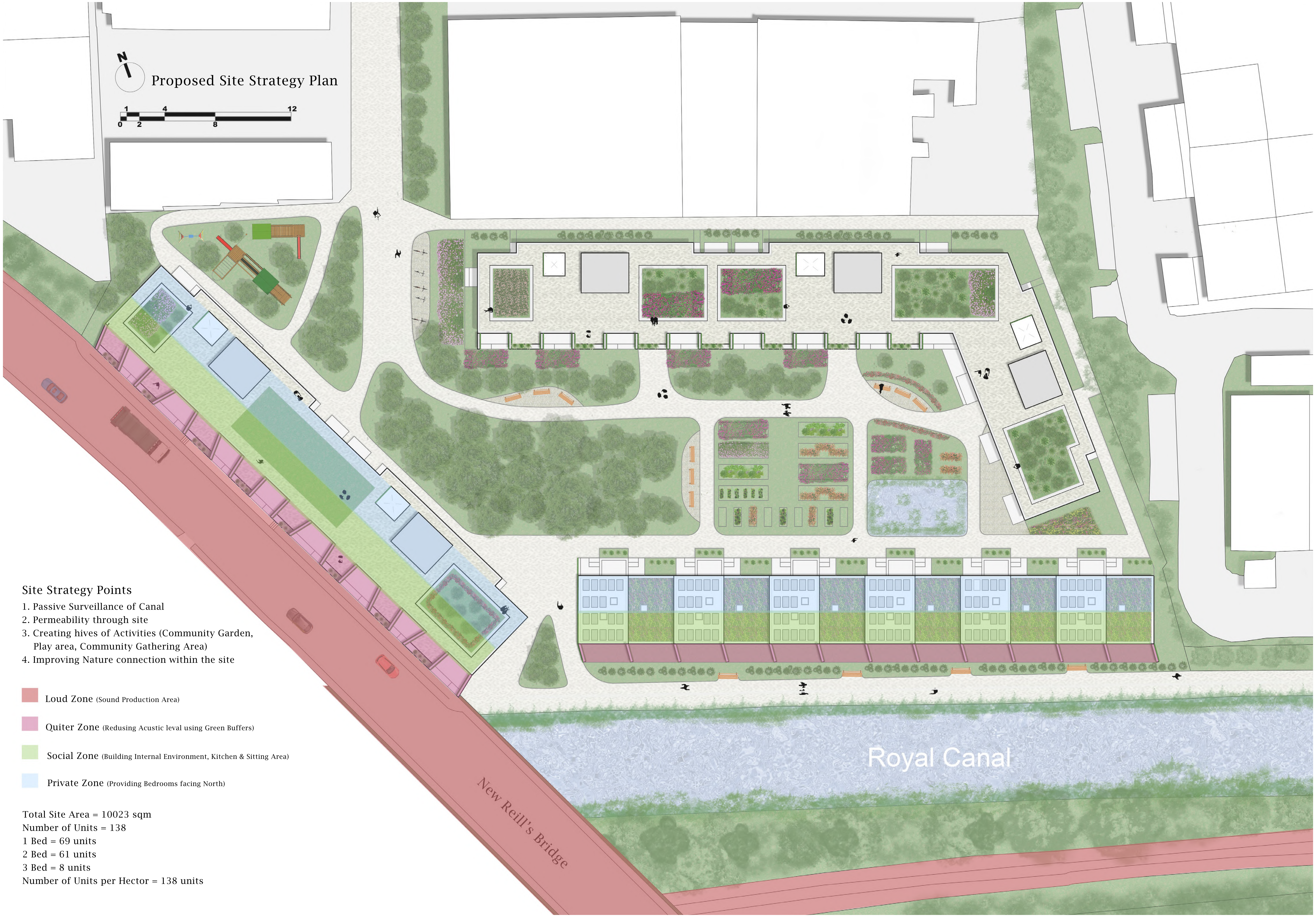
As the major focus of the project is to moderate the noise pollution, The provision of green buffers as noise absorbent are the main element. But since the site is so close to noise pollution sources, the site is further designed with reference of noise zones for additional reduction the noise.

Loud Zone: This zone consists of New Riley Bridge and Tram line across the Royal canal, which are the main source of acoustic for the project site. The zone is highlighted in Red.

Quieter Zone: This zone highlighted in Pink denotes the area in which reduction of acoustic levels occur with help of green buffers. This zone is limited to external sides of the building.

Social Zone: The social zone consists of building inside areas like sitting areas and kitchen etc. This zone is highlighted in Green.

Private Zone: The zone is designed away from sources of noise towards north side to provide most effective noise reduction in the project site. This zone is highlighted in Blue.



Proposed Site Strategy Plan

Site Strategy Points

1. Passive Surveillance of Canal
2. Permeability through site
3. Creating hives of Activities (Community Garden, Play area, Community Gathering Area)
4. Improving Nature connection within the site

Loud Zone (Sound Production Area)

Quiter Zone (Redusing Acustic leval using Green Buffers)

Social Zone (Building Internal Environment, Kitchen & Sitting Area)

Private Zone (Providing Bedrooms facing North)

Total Site Area = 10023 sqm
Number of Units = 138
1 Bed = 69 units
2 Bed = 61 units
3 Bed = 8 units
Number of Units per Hector = 138 units

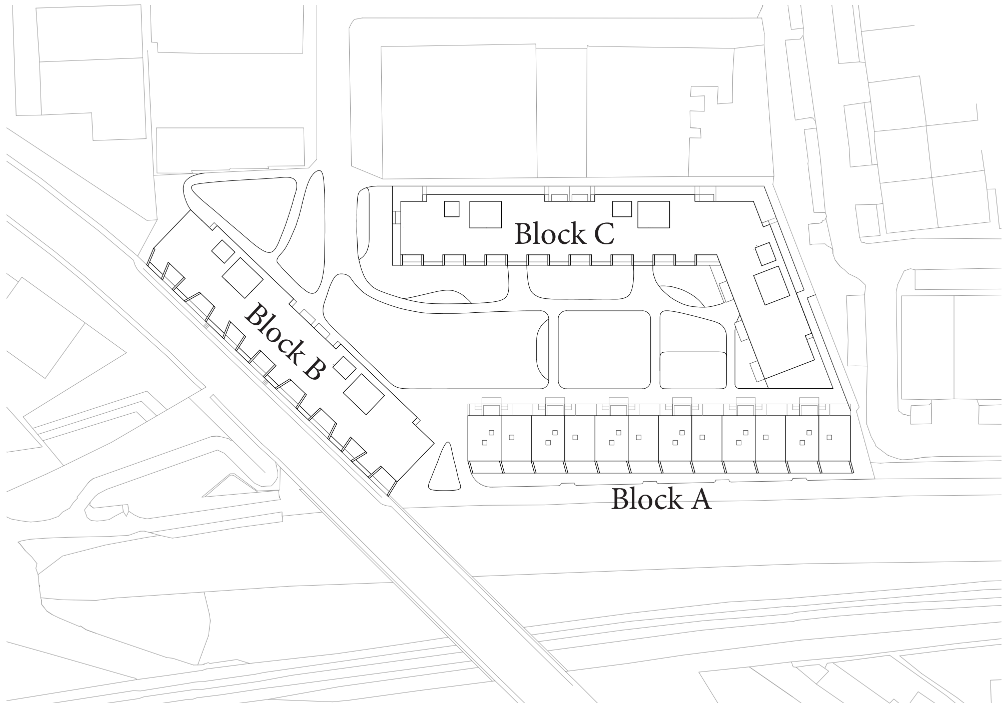
Zoning Strategy in Section

Loud Zone (Sound Production Area)

Quiter Zone (Redusing Acustic leval using Green Buffers)

Social Zone (Building Internal Environment, Kitchen & Sitting Area)

Private Zone (Providing Bedrooms facing North)



DESIGN ELEMENTS

This Residential Project consist of 3 blocks.

Block A, is along the Royal Canal. It is a fully residential block with alternative single and double story houses. Green buffers are provided in this block at an angle to reduce the noise from the bridge and tram line across the canal effectively. The roof of this block also serves a dual purpose. Duplex houses roof is covered with solar panels and single story rooftops are used as biodiversity boosting purpose providing habitat to different species of plants and bees.

Block B, is along the New Ratoath road. It is Semi-public plus residential block. The first 2 floor of this block are for Semi-Pubic use and consists of bicycle parking, plant room, storage section, a retail unit and a cafe. The entrance of this block is from 1st floor which has access directly from the bridge. Other 4 floors of the block are completely residential. Vegetation facade used as green buffers for this block is also provided at various angles to effective noise reduction directly from the bridge. Furthermore, the roof of this block is used for recreational purposes with inclusion of rooftop gardens in addition to blue roof technology for rainwater utilization for passive watering of the green façades.

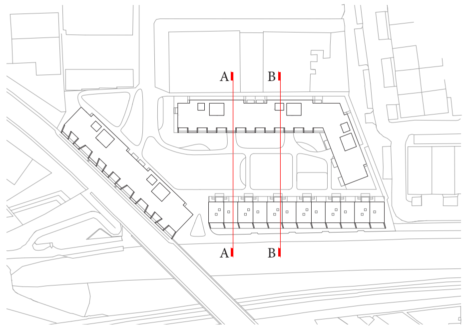
Block C, is the L-shaped block which closed the site and provide additional residential space. It has 8 stories and the rooftop this block is also used for vegetation to boost biodiversity. The vegetation facade / green buffers are provided in straight lines for this block.


N
Ground Floor Plan
1 4 12
0 2 8
Plant Room
Storage
Storage
Storage
Storage
Community Garden Storage
Royal Canal


N
1st Floor PLan
Royal Canal
New Reill's Bridge


2nd & 4th Floor Plan
N
0 1 2 4 8 12

3rd Floor Plan

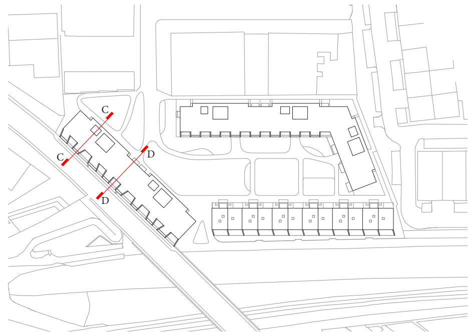


Proposed Section A-A

(Section A-A is cut across Block-A and Block C to exhibit the details of single story houses of block A and front vegetation facade of Block C)

Proposed Section B-B

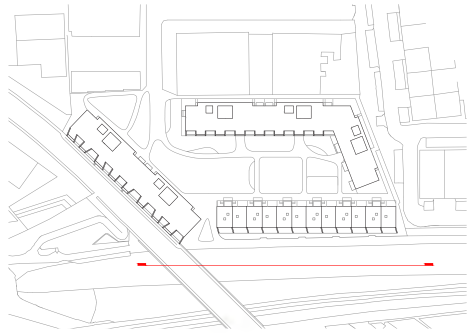
(Section B-B is cut across Block-A and Block C to exhibit the details of double story houses of block A and front and back vegetation facade of Block C)



Proposed Section C-C

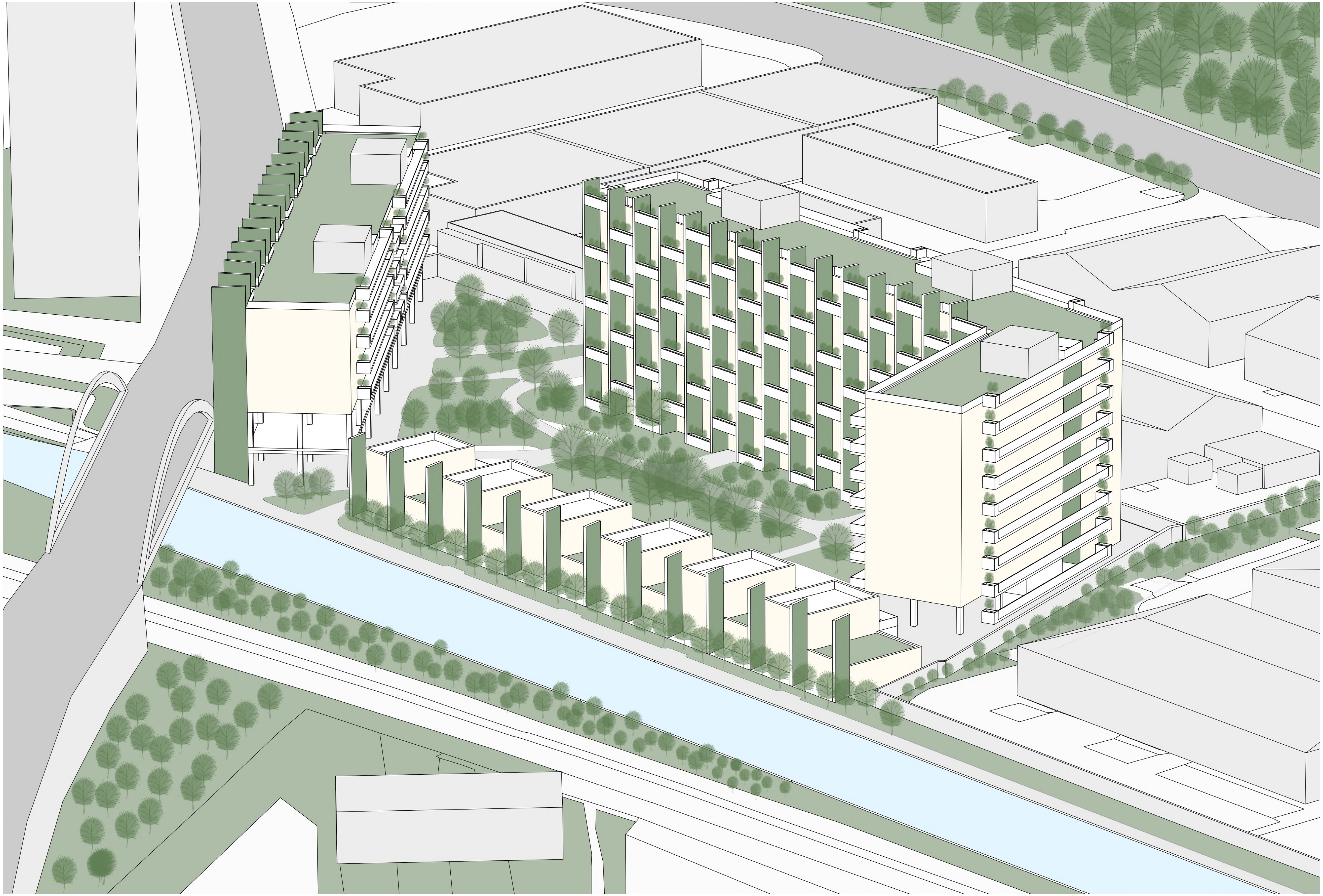
(Section C-C and Section D-D are cut across Block-B to exhibit the details of apartments, green façades and new Reilly's bridge)

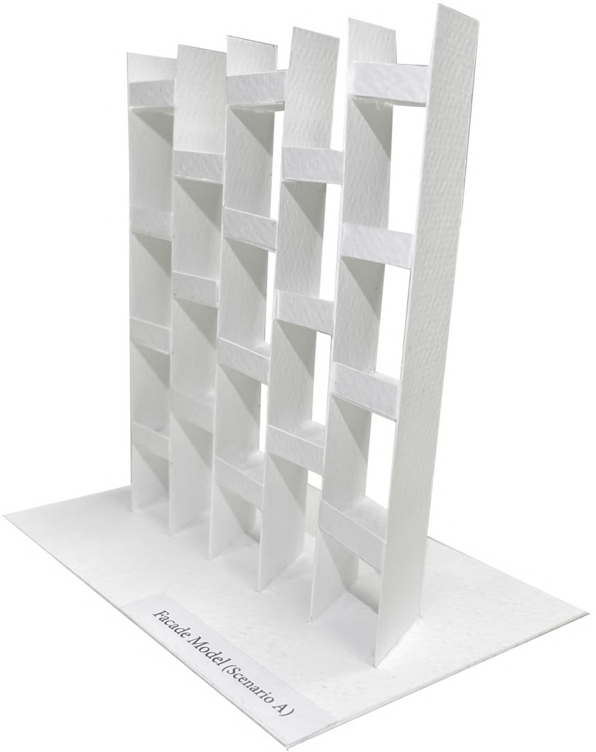
Proposed Section D-D

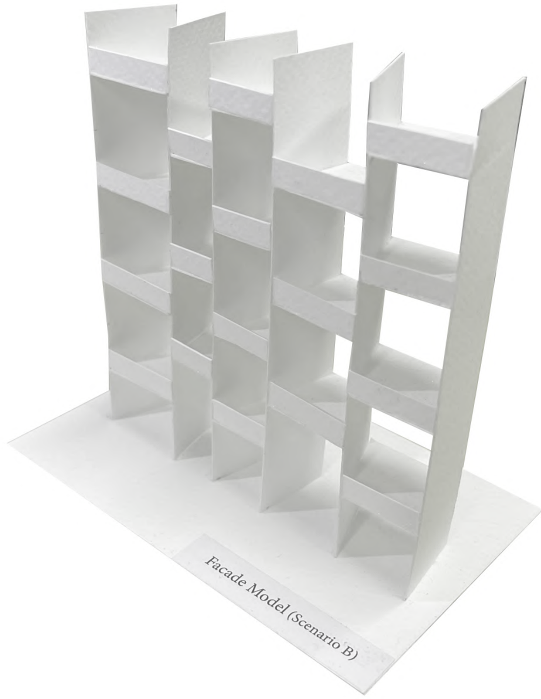


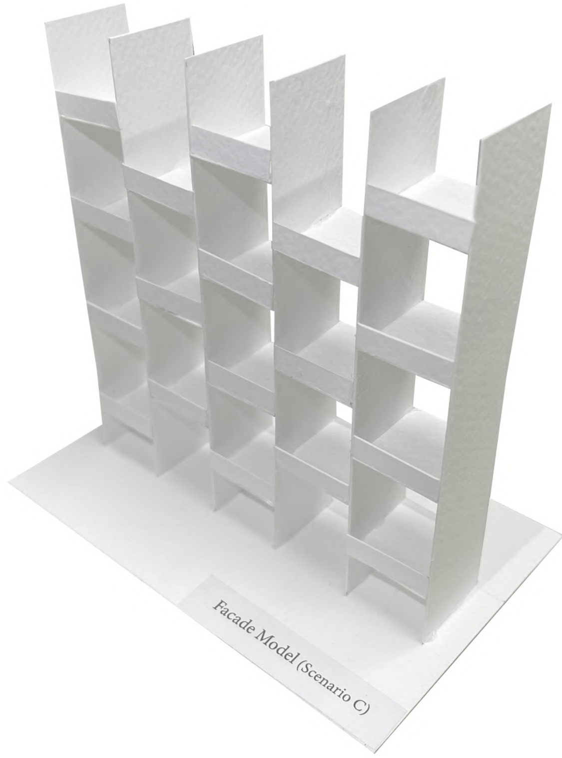
Proposed North Elevation

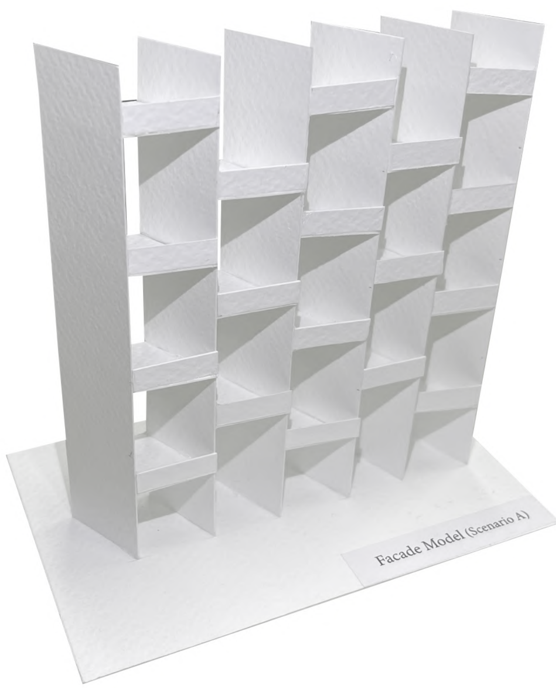
(North elevation took along with Royal canal looking towards block C)

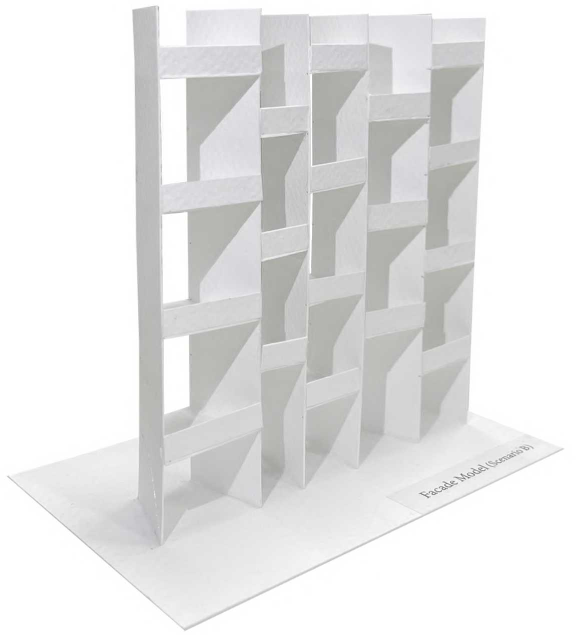


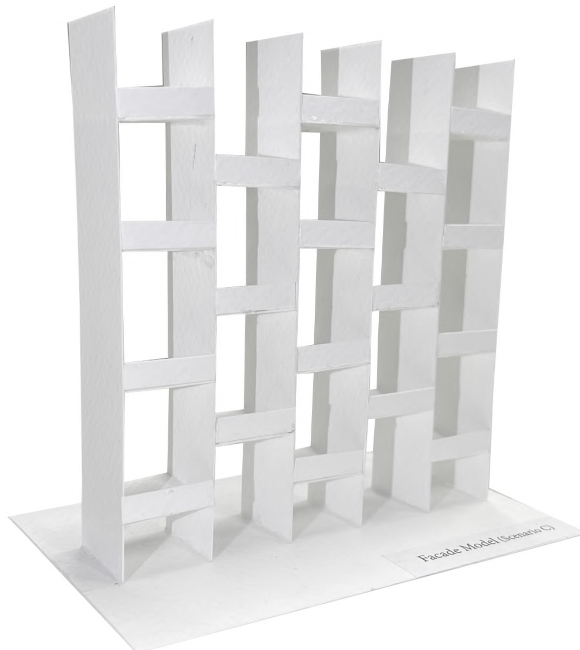








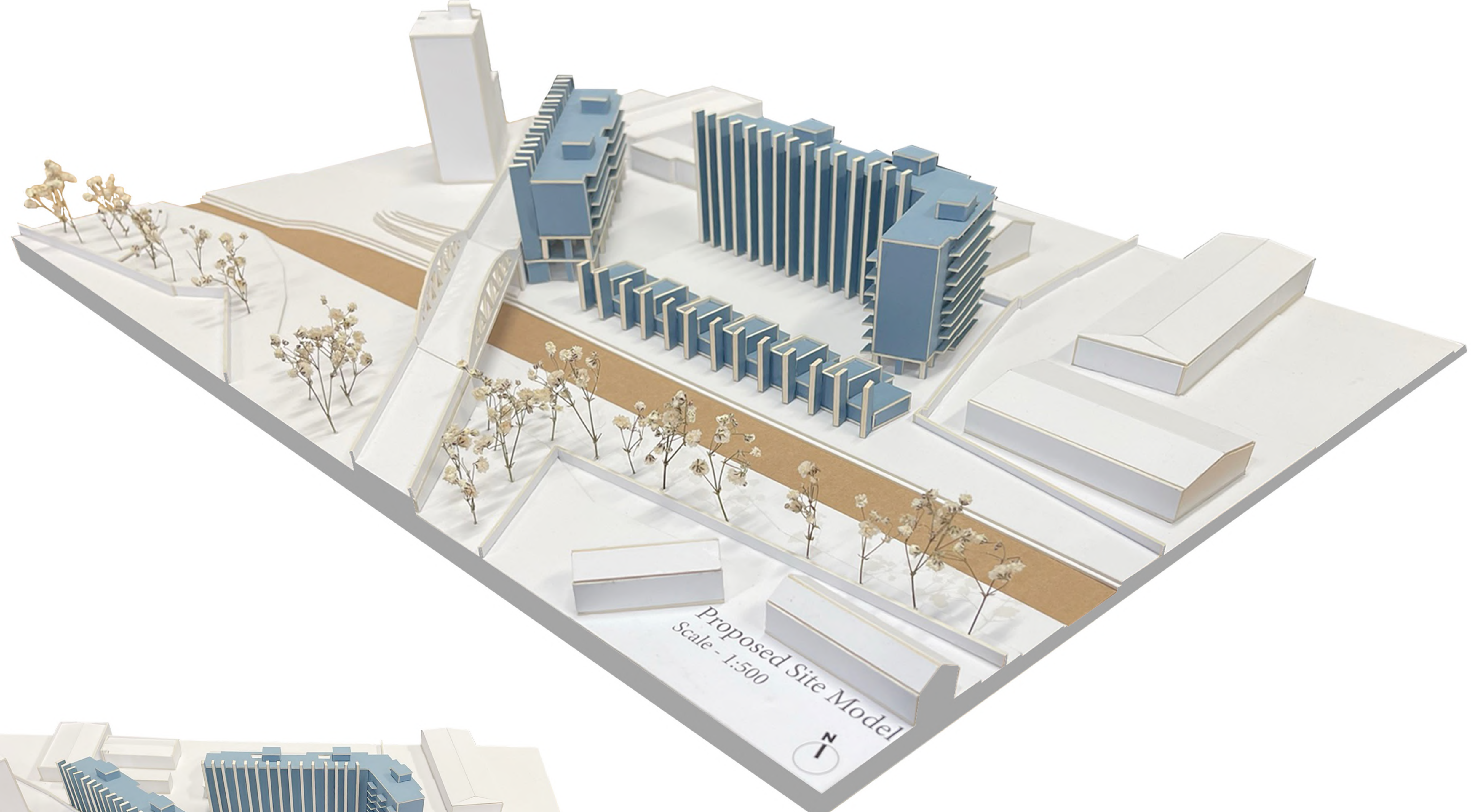


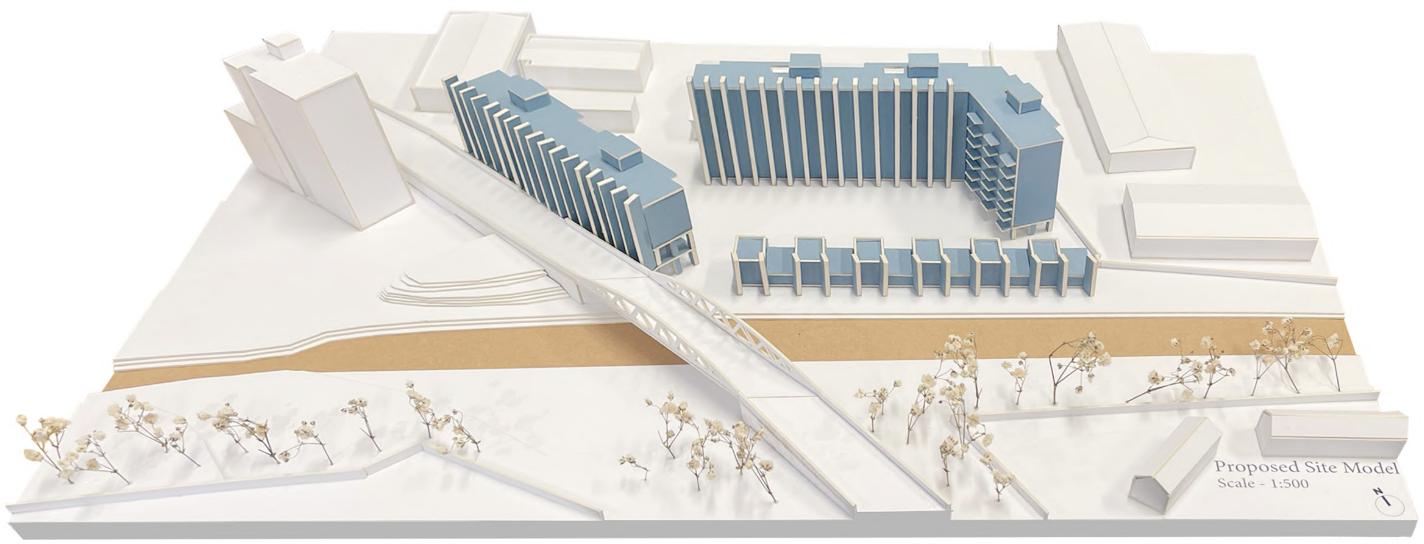


Facade Model (Scenario A)

Facade Model (Scenario B)

Facade Model (Scenario C)


Proposed Site Model
Scale - 1:500
N


Proposed Site Model
Scale - 1:500
N

Block C Rooftop Treatment

Block C Rooftop Treatment

Entrance to Apartment from open Corridor

Apartment Balcony View

(Figs.15)

Apartment Sitting Area view

(Fig.16)

Apartment Kitchen & Dining View

(Fig.17)

Apartment Bedroom View

(Fig.18)

FLORA FOR THE PROJECT

Although the benefit of vegetation facade is that different plants from around the world can be introduced to any area to boost biodiversity of the specific region without occupying a lot of area, but for this project I have mostly utilized the flora native to Ireland as it provides a familiar sense while boosting the biodiversity of the region at the same time.

Following plant and trees are considered for this design.

Outdoor Flora (Trees)

Acer Palmatum

Sorbus Aucuparia

Willow Tree

Rowan Mountain Ash

Tilia Cordate Greenspire

Alder Tree

Indoor & Outdoor Plants


Monstera


Peace Lily Spathiphyllum


Diffenbachia


Strelitzia


Sanseveria


Areca Palm


Ferns Plant


Buxus Sempervirens


Devil's Ivy


Anthurium Diamond Red


Dracaena


Chamaedorea eleyans

Outdoor Shrubs and Flowers

Erica Cirerea

Dog Rose

Sundance Brica

Clemats Evergreen

Heathers Erica

Cornus Alba Elegantissima

Meadowsweet

Bellflowers Ivy Ieaved

Cornus Sanguinea

Phalaris Feesey

Artenisisa Vulgaris

Helichrysum Italicum

MATERIALS FOR PROJECT

The material for this project are selected to ensure that the carbon emission is minimal. With the use of materials like CLT panels, Cedar Cladding and Plywood the carbon emission can be controlled. A graph of difference materials and their embodied carbon values can be visualized in this section.

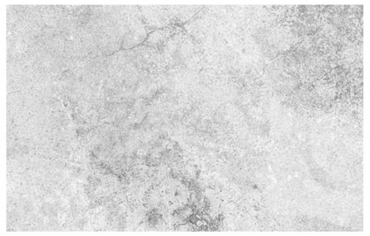
After a careful section of such materials, the following embodied carbon calculation establishes that the project has no adverse affect on the environment.

Materiality & Embodied Carban Calculations

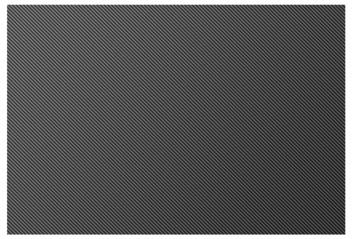
CLT Panel

Cedar Cladding

Glass



Concrete



Water pfoor Membrance

Insulation

Steel

Playwood

Wood-Aluminium frame Window

show result in pyramid ↑ | reset calculation | type project name | m 2

	material	group	impact / m3	volume [m3]		area [m2]		thickness [mm]		result
1	Cross-laminated timber CLT	tree	-664.0 kg CO2eq/m3	6064.97	m3		m2		etc	-4,027,140.1 kg CO_2 eq
2	Glass pane, triple-glazed	components	415.6 kg CO2eq/m3	103.56	m3		m2		etc	43,039.5 kg CO_2 eq
3	EPS insulation Graphite 80	plastic	43.5 kg CO2eq/m3	2832.01	m3		m2		etc	123,192.4 kg CO_2 eq
4	Concrete C20/25	mineral	229.0 kg CO2eq/m3	1863.68	m3		m2		etc	426,782.7 kg CO_2 eq
5	PP roofing membrane	plastic	271.5 kg CO2eq/m3	46.56	m3		m2		etc	12,641.0 kg CO_2 eq
6	Plywood	tree	-649.0 kg CO2eq/m3	3031.2	m3		m2		etc	-1,967,248.8 kg CO_2 eq
7	Wood-Aluminium frame window	components	762.6 kg CO2eq/m3	203.41	m3		m2		etc	155,120.5 kg CO_2 eq
8	Paint, matte	other things	2851.0 kg CO2eq/m3	56.87	m3		m2		etc	162,136.4 kg CO_2 eq
9	Galvanized steel	metal	22923.1 kg CO2eq/m3	41.4	m3		m2		etc	949,016.3 kg CO_2 eq

Total amount of Embodied Carbon = -4,122,460.0 kg CO_2 eq

Material Volume

CLT = 6064.97 m3
Glass panels = 103.56 m3
Insulation = 2832.01 m3
Concrete = 1863.68 m3
Water Proof Membrance = 46.56 m3
Playwood = 3031.2 m3
Wood-Aluminium frame window = 203.41 m3
Paint = 56.87 m3
Steel = 41.4 m3

Note :
It has been established by the embodied carbon calculations above that the building has no adverse effects on the environment.
It is a building with zero carbon emissions.

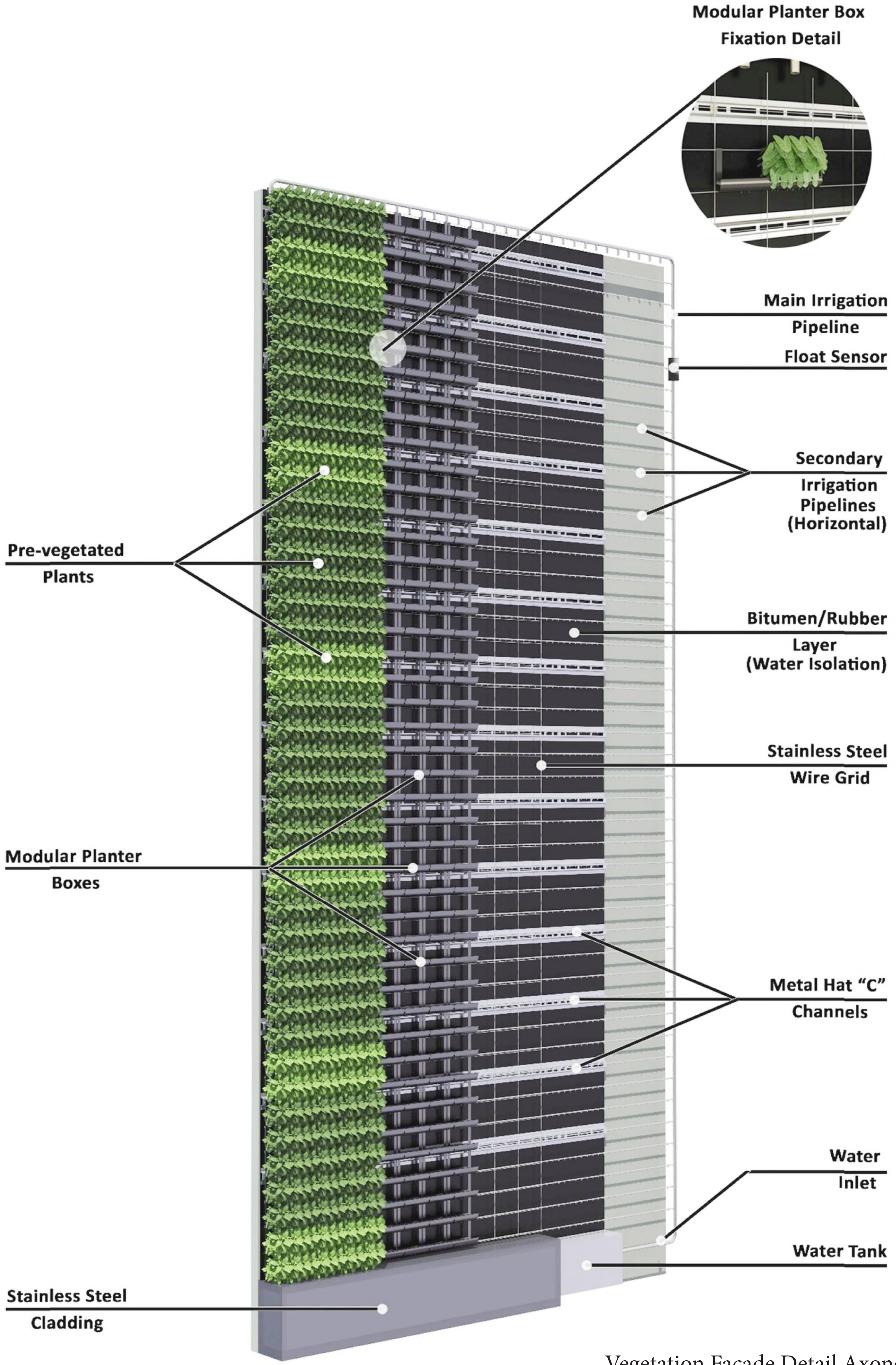
(Fig.19)

DETAIL STUDY

For the construction of vegetation facade a bitumen layer is provided above CLT Structure. Metal frames and channels are installed at the bitumen layer. The planter boxes are installed on these frames and the plants are planted in these boxes.

The benefit of providing planter boxes over ground planting is that any number of different non-climbing plants can be planted which increases the aesthetic of building while boosting biodiversity at the same time.

But plants need water nourishment, which is provided by installed pipelines connected directly to water storied with blue roof technology above each block, which stores rainwater and is used to provide passive water source using gravity method for the facade and roof gardens.



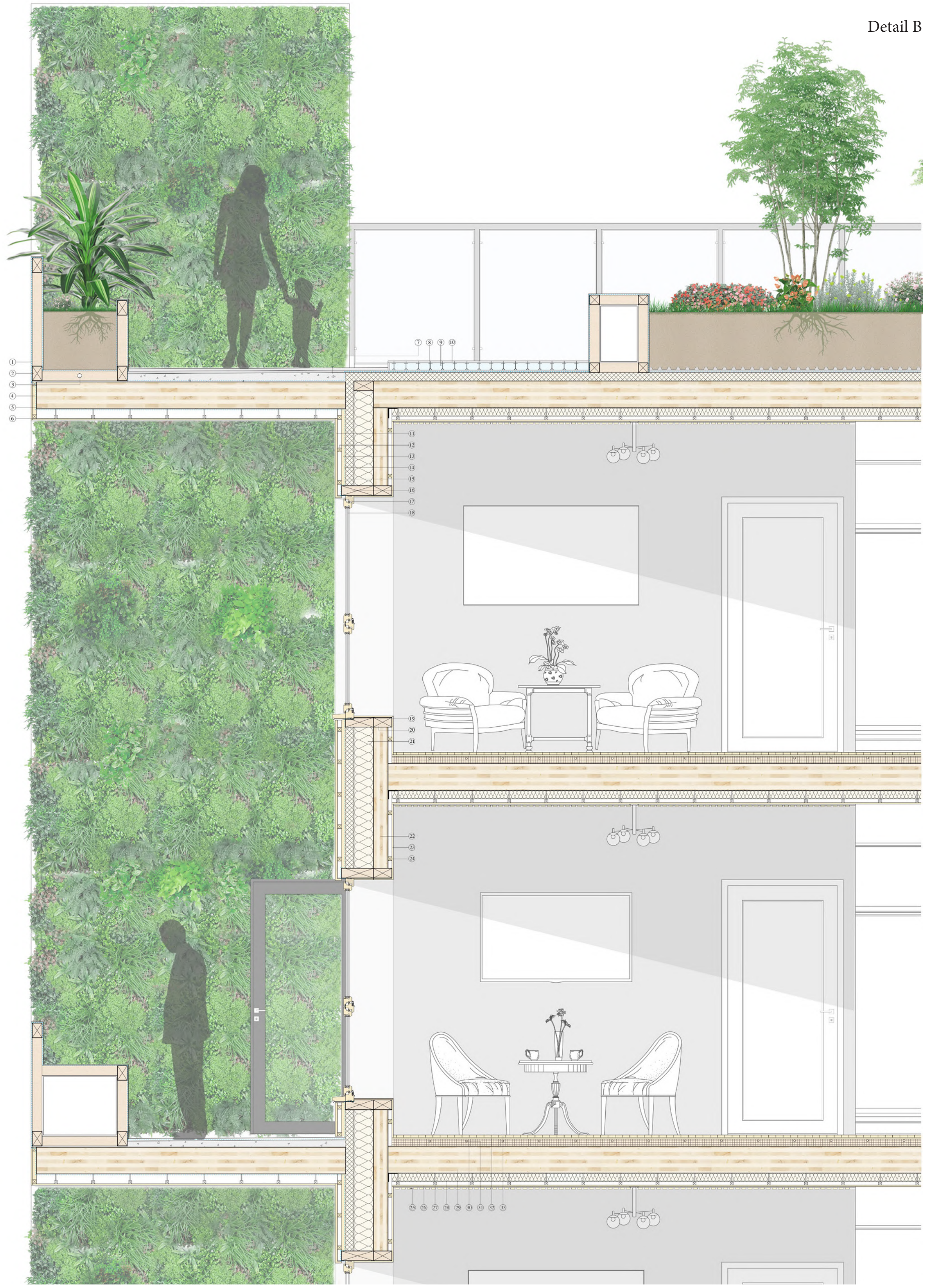
Vegetation Facade Detail Axonometric

(Fig.20)

Detail Section A

Legends

1. 10mm Recycled Fiber Sheet
2. (120x60mm) Timber Block
3. Drainage Pipe
4. Water Proof Membrane
5. 220mm deep CLT Floor Slab
6. 12mm Timber Capping
7. 80mm Concrete Screed
8. Fiber Glass Water Proof Roof Membrane
9. Steel Pedestals
10. Concrete Paviour
11. 20mm Cedar Timber Cladding
12. 32x32mm Timber Batten (Horizontal)
13. 32x32mm Timber Batten (Vertical)
14. Water Proof Mambrance
15. 70mm Rigid Insulation
16. 260x80mm Timber Block
17. Timber Window Frame
18. 68mm Triple Glazed Timber Window
19. Steel Plate
20. 160x80mm Timber Block
21. 160mm Kooltherm K5 Insulation
22. 120mm CLT Wall Panel
23. 12mm Plywood Board
24. 32x32mm Timber Batten
25. Acoustic Wooden Slats Panel
26. 12mm Plywood Board
27. Steel Clipper
28. 70mm Floor Insulation
29. 220mm CLT Floor Slab
30. 60mm Acoustic Rigid Insulation
31. Steel Pedestals
32. Plywood Board
33. Timber Floor Finish



Detail B

Long Section

CONCLUSION

Vegetation façades have been used since ancient times for improving aesthetic of the buildings. But modern research confirms that vegetation façades are not aesthetics ornaments only but also contribute in tackling environmental issues.   It is a known fact that rapid industrialization and urbanization has caused loss of nature from our world, vegetation facade is not only a way of bringing nature back to our cities but it can also resolve most of the urban issues especially noise and air pollution, and biodiversity loss.

A number of technologies are be adopted in design this project, resulting in zero carbon emission to adopting blue roofs for rainwater utilization and most importantly the ground breaking use of vegetation façades as green buffer to reduce absorb up to 41% sound than a conventional facade. As a result, the atmosphere both indoor and outdoor the structure becomes more quieter, as depicted in out project where we not only achieved a quieter neighbourhood by focusing the green buffers in direction of noise but also provided habitat for bees and plants increasing biodiversity of the region.

In light of above, it is evident that in such time of climatic issue, we, as architects, can bring balance to traditional architecture and nature by introducing vegetations façades in modern projects.

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Figs. 4 Drawn by Muhammad

Figs. 5 Google.com - https://www.google.com/search?q=Green+facade+systems

Figs. 6 Google.com - https://en.wikipedia.org/wiki/One_Central_Park

Figs. 7 Google.com - https://www.ansgroupglobal.com/learn/case-studies/exterior-living-wall/victoria-way-car-park

Fig. 8 Drawn by Muhammad

Figs. 9 Photos taken by Muhammad

Figs.10 Google.com - https://www.archdaily.com/464142/ad-classics-mill-owners-association-building-le-corbusier

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Figs.12 Google.com - https://en.wikiarquitectura.com/building/quai-branly-museum/

Fig. 13 Drawn by Muhammad

Fig. 14 Drawn by Muhammad

Figs.15 Outdoor Render done by Muhammad

Fig. 16 Indoor Render done by Muhammad

Fig. 17 Indoor Render done by Muhammad

Fig. 18 Indoor Render done by Muhammad

Fig. 19 Google.com - https://www.materialepyramiden.dk/

Fig. 20 Google.com - https://www.google.com/search?q=Vegetation+Facade+Detail+section

THANK YOU