

Biophilic design A new exploration of residential design in China, TianJing

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Index

-abstract	8
-Biophilic theory and development	9
-research background	13
-Current state of mental health in China	14
-The environment is an important actor affecting health	17
-What kind of environment do we need ?	19
-biophilic environment	20
-biophilic design	22
-The practice of biophilic design	25
-Site analysis and design based on biophilic design	29
-Biophilic design in architecture case study	41 44
-project design	83
-research&analysis	84
-design	115
conclusion	146
-Acknowledgements	148
-bibliography	150

abstract

In recent years, the mental health of urban residents has become an important issue in urban development. In the process of rapid urbanization, the improvement of infrastructure has brought convenience to life, but it is also changing the environment around us and the lifestyle of residents, the mental health problems of residents are also increasing. Recent studies have also shown that the urban built environment is closely related to the health of residents.

China has been exploring the architecture and urban form of the future.

Biophilic design can reduce stress, increase creativity and clarity of thought, improve our happiness and speed of recovery; As the world's population continues to urbanize, these qualities are becoming increasingly important. The purpose of this paper is to explore the design of future residential areas from the perspective of residents' health. Based on the biophilic hypothesis and the restorative environment theory, the biophilic design is used as a tool to design the future residential area experimentally.

Key words : Biophilic design, Residential areas design, Mental health

The development of biophilic theory

The term biophilia was first coined in 1973 by psychoanalyst Erich Fromm, who described it as the love of all life and the living. (Fromm, 1973) In 1984, Edward O. Wilson proposed the "biophilic hypothesis" in his book Biophilia, which defined biophilic as "the innate tendency to focus on life and lifelike Processes" (Wilson, 1984), adding to Fromm's statement, suggest that human interactions with nature are not only biological but also genetic, with genetic memories of environments and habits experienced during evolution and lasting effects. For example, people like to keep pets, like camping and a lot of nature-related sports. (Browning et al., 2014)

Since then, biophilic theories have spread to other fields. In 2008, Professor Stephen R. Kellert of Yale University first proposed the term Biophilic Design in his book Biophilic Design, which formally introduced the biophilic concept into the field of architectural design. He has also developed a framework of biophilic design that aims to provide natural experiences in artificial buildings, to complement and improve the connectivity between future residents and the natural environment, both directly and indirectly, in order to promote the national economy and national health and restore nature. (Browning & Garvin & Ryan & Kallianpurkar & Labruto & Watson & Knop, 2014; vvvKellert et al., 2008; Kellert & Calabrese, 2015)

In his frame, there are three ways for people to come into contact with nature in the built environment. The first is direct contact, such as direct contact with natural elements such as light, air, etc. The second is indirect contact, and in some inappropriate use real natural elements, to achieve the same as the direct contact of earnings, and mainly by visual contact indirect contact with nature, for example in the interior space with natural images, using natural color collocation, use natural design, on the design of the form using a fractal system, etc. Added to this is experience with space and place (Kellert & Heerwagen & Mador, 2008; Kellert & Calabrese, 2015).

Timothy Beatley, who introduced biophilia into urban design, is a champion of green cities and stresses that the research focus of future sustainable cities should be on nature.

In his book, Biophilic Cities, he argues that a biophilic city should be a biologically diverse city, a city that learns from nature and mimics its systems.

The use of natural elements in artificial construction and organic integration with nature, while the biophilic city should protect and cherish the existing natural resources, or restore the natural resources that were once there but have disappeared. In his book, he proposed 22 criteria for measuring biophilic cities, which can be used as guidance and reference for biophilic urban design and evaluation.

Countries such as Singapore and Chile have recognized the future benefits of biophilia, are

making biophilic cities a national development strategy, and are actively promoting the application of biophilic design in architecture and planning. (El-Baghdadi & Desha, 2017; Virginia et al., 2021; Xue et al., 2019),

especially in the context of global environmental degradation and epidemic, biophilic urban design and planning will play an important role (El-Baghdadi & Desha, 2017).

Biophilic design theory has received more and more attention in recent years. Many researchers began to use biophilic design theory to study some specific functions and geographical locations.

For example, the use of physical objects in interior Spaces can reduce negative emotions, maintain normal blood pressure and improve short-term memory (Yin et al., 2018). The increase of the number and area of indoor Windows can improve people's mood and working memory and enhance their sense of well-being (Ko et al., 2020). For office Spaces, biophilic design can improve productivity and user well-being (Ayuso Sanchez et al., 2018). For mental workers, natural space can enhance their creativity and productivity and reduce stress. They prefer a space with charm, quietness and development (Mangone et al., 2017).

Biophilic design is also used in many specific situations due to its beneficial mental health effects, such as improving mood and reducing stress. For special buildings such as prisons, the application of biophilic design can improve users' psychological burden, cognitive ability

and learning ability, reduce the possibility of re-offending, and improve criminal psychology and behavior(Jana & Peter,2017).

The application of biophilic design to hotel buildings can increase revenue and improve user reputation. A survey shows that hotels using biophilic design are considered to be of high quality and high quality.

The biophilic design elicited stronger positive emotional and behavioral responses than the non-biophilic design. So practitioners in the hotel industry are pushing the development of this theory in hotel design(Lee,2019). In the study of children's medical buildings, the biophilic rest garden is extremely important for users and will become an important infrastructure in children's medical buildings in the future(Reeve et al.,2017) .In addition, biophilic design can also play a guiding role in the color matching of children's hospitals (Maiqi Lin,2019).

For unconventional buildings, biophilic design has also received attention from the space sector, winning an award in the 2019 NASA Big Idea Design Competition for the application of biophilic design. With the development of aerospace science and technology and the future for space exploration, the function of the space station by the initial brief stay to live for a long time, so the space design also provided by the original ensure that astronauts live into daily life all functions, and biological affinity design can meet the user's physiological needs and can meet the psychological needs of users(Heather et al.,2020).

In addition, biophilic design has contributed to the updating of green building evaluation criteria, which many critics say focus too much on energy efficiency rather than human health and well-being.

They advocate incorporating biophilic theory into the evaluation criteria of green buildings, claiming that biophilic theory is an important missing part of the evaluation system of green buildings(Abdel et al.,2017; Boya et al.,2020; Niranjika & Arianna,2021).

The purpose of this study is to improve the urban environment by using the biophilic design theory in the context of rapid urbanization in China, so as to improve the health level of residents.

research background

Current state of mental health in China

Mental health problems have become one of the biggest threats to human health in recent years.

With the development of cities and economic growth, the number of people suffering from mental diseases in many countries in the world is increasing year by year (Spencer L James,2018) and showing a younger age trend. (Xue et al.,2019) Statistical results show that residents with psychological problems in China account for about 16.6% of the total population, while the permanent recovery rate after a medical intervention is not high. The current

status of depression and anxiety disorders as major mental illnesses is also a cause for concern.

According to epidemiological data in the journal Nature, the prevalence of depression in China is 3.02% (Smith,2014).The lifetime prevalence of depression was 6.9%, while the 12-month prevalence of depression was 3.6% (Huang et al.,2019).

The 2019 outbreak of novel coronavirus has also had an impact on people's mental health.

A study by Kunming Medical University on the health changes of students during the COVID-19 showed that the incidence of depressive symptoms among students was 22.4 percent, and more than one in five college students had depressive symptoms(Xie et al.,2020).

There is a strong correlation between mental illness and physical illness as risk factors for each other.Numerous studies have shown that various mental disorders are associated with an increased risk for a wide range of chronic physical ailments(Hildrum et al.,2006; Kate M. Scott et al.,2016).

A large population of sub-healthy people and the risk of karoshi

According to the data of the research institute, 76% of urban middle-income people are in the state of sub-health (Guanghua Bust,2020). Sub-health is considered to define the middle state between health and disease, and it has a trend towards health and disease. What leads to the state of sub-health?People living in a state of sub-health for a long time can easily lead to diseases (Guolin Li et al.,2013).However, the

medical community believes that sub-health is as dangerous as AIDS (Yan Yuxiang and Wang Wei,2008).

Signs of sub-health include chronic fatigue, dyspepsia, sleep disturbance, congestion, nervousness, distraction, nausea and bad mood, etc. (Lin,2013), which are also similar to some early symptoms of karoshi.Studies in the medical field have analyzed many causes of karoshi (Araki & Iwasaki,2005;Bo-Fan Yang et al.,2019) can be summarized as continuous high-intensity work, bad lifestyle and psychological factors.

The CDC in the United States considers psychological factors to be the main cause of karoshi, rather than physical exertion. Karoshi, originated in Japan in the 1980s, is a social medical term.The simplest description is sudden death caused by overwork (Wang Guifang et al.,2016). This phenomenon has spread throughout Asia since the 1980s, and this situation is becoming more and more serious in China (Phoenix Weekly,2019;China Newsweek,2013).

In the statistics and analysis of the death population, white-collar mental workers are the main death group (Wang Guifang and Guo Huiyue, Wei Yani and Zou Jianfang,2016).

The health situation of urban residents is becoming increasingly serious, the health level of urban residents is declining, the urban medical burden is increasing, and finally the development of the city is limited.The direct and indirect economic cost of lost productivity

due to disease in China is \$650 billion(Beijing Hoxinqing Mobile Medical Technology Co., Ltd.,2020).

The environment is an important factor affecting health

Lalonde published a report in 1974 and proposed that lifestyle, environment, medical services, and human biological characteristics are the four major factors that determine health (Canada,2006).However, 28 years later, he still agrees with this view. At the same time, he also suggests that the government should do more in the aspect of human health, especially the investment in the environment should consider the benefit to human health (Lalonde,2002).

As for the definition of environment, Lalonda believes that environment is all the external factors related to human health, and points out that people are helpless in front of the environment because they cannot control the environment.

Different from Lalonda, epigenetics believes that the environment defines the internal and external environment of the human body. Although both the environment and the original genes influence the health of the human body, in the case of non-communicable diseases, the environmental influence rate is as high as 70%-90%(Rappaport & Smith,2010).Although

there are differences in the definition and scope of the environment, it does not affect their acceptance of the view that the environment is an important factor affecting health.

There are mainly two kinds of environmental influence on people. The first is through the direct influence of exposure to the environment, and the second is through people's senses.

Direct effects of the environment on health.

People are mainly exposed to the environment directly, so toxic substances in the environment directly threaten people through breathing, touching and other ways (Center for Ecology and Environment of Chinese Academy of Sciences,2016).Radiation, noise.Chemical substances, automobile exhaust, pollutant emissions and other direct pathogenic factors for cancer and respiratory diseases (Ministry of Environmental Protection, PRC,2013).

In addition, the urban built environment can also influence the health through the urban transportation infrastructure, building density, parks and other influences on residents' sports behavior (for example, public transportation influences the walking commuting time) (Chun,2020).

Environment affects mental health in indirect ways (restorative environmental theory)

The environment can also affect a person's mental health by influencing the increase and decrease of a person's stress.Numerous studies have shown that environments with natural

elements are good for mental health. For example, exposure to nature can reduce stress and promote positive emotions (Tsunetsugu et al., 2013; Tyrvaäinen et al., 2014).

Kaplan's attention recovery theory and Ulrich's theory of psychological evolution (stress reduction theory) focus on the influence of environment on psychological changes.

Kaplan believes that environments with restorative characteristics can restore people's directed attention and thus help to reduce stress (Kaplan, 1995).

The theory is that a person needs directed attention in order to avoid distractions from the environment in the normal course of life and work. Directed attention, like energy in the body, is a finite resource, and when this resource is lacking, the person experiences stress; The recovery of such resources requires an environment with restorative characteristics. (Kaplan & Kaplan, 1989).

Compared with the theory of attention recovery, Ulrich's stress reduction theory believes that people are constantly under stress due to some unexpected events or being in the city for a long time without contact with nature, which leads to negative emotions and changes in physiological indicators (blood pressure, endocrine response, fatigue, etc.).

The observation of natural scenes has an improved effect on alleviating stress and positive changes in emotional states and physiological responses, and can even promote recovery time after surgery (Ulrich, 1981; Ulrich, 1984; Ulrich

et al., 1991).

What kind of environment do we need?

All the above theories show that nature is beneficial to people's health.

And the relevant studies have confirmed this point from different angles, pure natural environment naturally meets the above conditions, but here we are talking about artificial environment or improved environment.

For different environments, it is necessary to advance, first of all, no pollution source or very few pollution sources of the environment is the most basic. Secondly, Kaplan and Mrs. Kaplan proposed four characteristics of restorative environments, which are beneficial to mental health and restorative environment, namely, being away, to an extent, and compatibility.

Being away means to engage with curiosity and longing that are radically different from the current environment, to avoid psychological fatigue and to restore attention.; Shoe refers to fascination, to which a beguiling environment draws attention.; fascination refers to a beguiling environment that draws attention to us; Extent, an environment has enough content that one cannot explore or get all the

information about it for a short period of time;Compatibility means that the environment can provide the space you need;A space with the four most basic characteristics is restorative (Kaplan,1995).But there is no quantitative measure of the effect of recovery.

In Ulrich's view, restorative environment refers to the natural environment that does not threaten personal safety or the man-made natural environment with natural elements other than the city (Ulrich & Simons & Losito & Fiorito & Miles & Zelson,1991).In contrast to these two theories, what both have in common is a mental health perspective on the interaction between people and the environment. Both assume that people have strong positive tendencies towards the natural environment. Both assume that stress recovery mainly comes from visual contact with the environment.

biophilic environment

From the perspective of biology, the biophilic theory believes that the environment of human existence should first follow the biological characteristics of human beings, that is, human beings should establish contact with nature. Biophilia is in the genes of humans, who have been living in nature for most of their long evolutionary life, and have since become accustomed to it.his is why we are fascinated by fire and waves, why we love hiking, why we love camping, why we love certain types of nature and landscapes, such as the Orians & J. H,1992; Wilson, 1984).

According to the biophilic theory, the living environment of human beings should first follow the biological characteristics of human beings. That human beings should establish a connection with nature.Biophilia is in the genes of humans, who have been living in nature for most of their long evolutionary life, and have since become accustomed to it.This is why we are fascinated by fire and waves, why we love hiking, why we love camping, why we love certain types of nature and landscapes, such as the Orians & J. H,1992;Wilson, 1984).

In addition, we will also be alert to dangerous things in the natural environment for a long time. Biophobia is the fear or disgust of nature or living things (Ulrich,1993).The most common biological fear response is to spiders, snakes, and so on, which is also what motivates people to build buildings to insulate themselves from the danger factor, but when the danger factor is under control, the danger will induce a sense of curiosity and a desire to explore.

To some extent, these environments hold a fascination, which in turn can be restorative, such as zoos and aquariums.

based on that we see a resilient built environment that can exist in cities, but the benefits go beyond that.(See the next table for other benefits of a biophilic environment.)

Although we have an innate tendency to be close to nature, it takes cultivation to make it work.It requires constant contact with nature. Unfortunately, modern society has set up a lot of obstacles to get close to nature. Human's

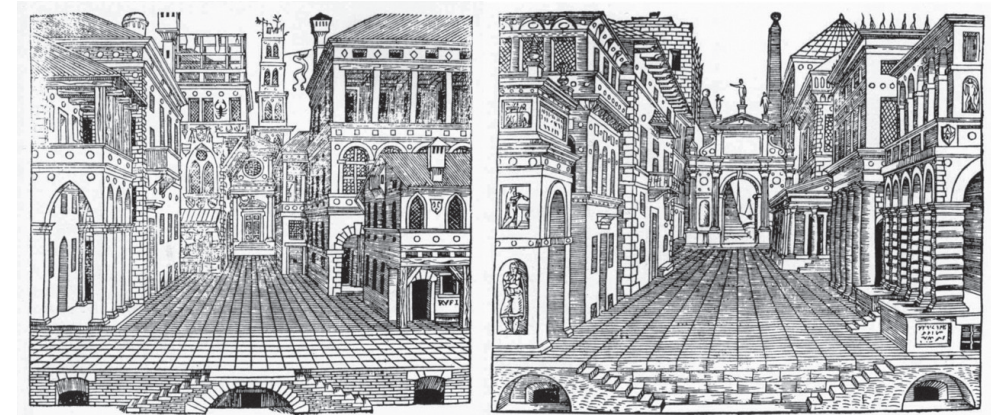
learning and creation is a double-edged sword. He can get close to nature or stay away from it. The main methods of modern architecture and landscape design regard nature as an obstacle or an irrelevant thing to a large extent (Kellert & Calabrese, 2015).

As a result, the connection between nature and humans is increasingly disconnected. However, the modern architectural design style and the application of modern new building materials, Modernist aesthetics, and so on accelerated this process. Since the beginning of the industrial revolution, nature has been more of a carrier of industrial resources. People have only paid attention to the resources in nature that are beneficial to industrial development, but ignored the benefits that nature as a whole can bring to people. But now people have begun to pay attention to this problem.

biophilic design

The goal of biophilic design is not to create an architectural space with natural elements, but to ultimately create a viable and resilient (resistant to damage) organic man-made environment over time. To become a human habitat, carrying nature and organisms. To improve human physical and mental health.

A good biophilic design needs to pay attention to the following points. First of all, the biophilic design focuses on connection. Different Spaces do not exist independently, but should complement and strengthen each other. Encouraging repeated and continuous contact with nature promotes interaction between people and nature and strengthens ties between



people and natural communities;

In addition to strengthening the connection on the physical latitude, biophilic design also encourages emotional feedback to a particular space, that is, space stimulates emotions. Perhaps architect Sebastiano Serlio's interpretation of comic space and tragic space can serve as a reference for space affecting emotions.

Fig. 1. Sebastiano Serlio, design for the stage set of a tragedy. Woodcut from his Second Book on Architecture (Lyon, 1545).

The concept of biophilic design has been around for a long time, although it is a recent invention. The buildings of every historical period since the Western Roman era have more than one biophilic characteristic, such as the location of castles on high mountains overlooking the land several kilometers away (vistas), thick walls and small Windows (refuges); Carvings of Gothic and Baroque cathedrals in the city, intricate architectural structures and segmented decorative vaulted ceilings (complex and ordered as well as bionic graphics); Large imperial gardens and fountains in city squares (water experience), as well as a large number of trees, flowers and grasslands realize the most basic visual and non-visual connection with



Fig. 2. FanXin, JinLing landscape picture (金陵景色图卷 Qing Dynasty).

nature (Shafikramzy,2015).

But it also includes design elements that are also critical of biophilic theory. The French garden and architectural design of that period highlighted the expression of the subjective will of the designer or the right. The planning of natural elements such as trees, flowers and pools was dominated by rules and symmetry, symbolizing man's control over nature, which was contrary to the complexity, integrity and respect for the natural system in today's biophilic theory.

At the same time, there were also biophilic designs and art forms in ancient China. China's mountains and rivers (ShanShui) are one of them. Landscape is the abstract expression of natural landscape by ancient Chinese painters and architects. Landscape does not only mean mountains and water but all the natural environments represented by mountains and water (Wu Liangyong,2001). Chinese classical gardens and buildings are full of abstract imitation of natural elements, irregular rockery and artificial lakes, irregular distribution of flowers and trees, scattered in the garden of large and small buildings, and so on very intuitive reflect the perspective, complexity and order, bionics, water features, and other biophilic characteristics. In ancient China, the city site with mountains and water was preferred. Hangzhou is the most typical landscape city with half city and half landscape. West Lake, Lingyin Mountain and Hangzhou cross each other without a clear boundary.

What landscape expresses is not only a design or planning technique, but also the

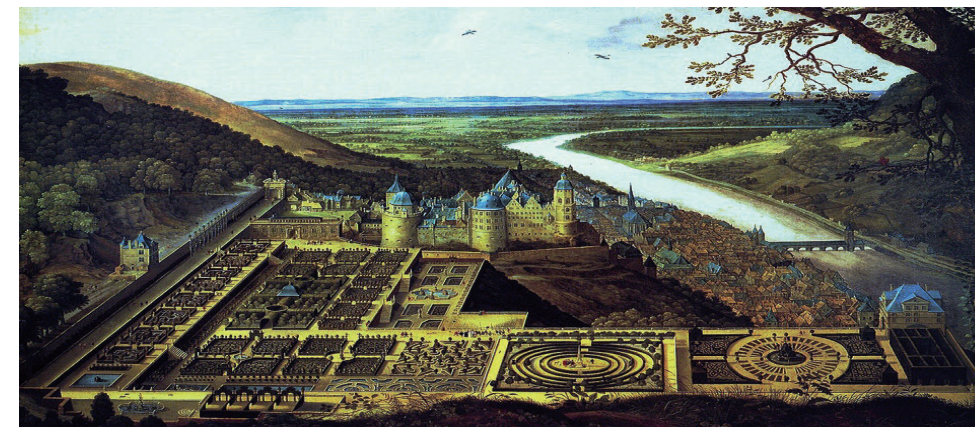


Fig.3. Jacob Focquier, Hortus Palatinus, (Kurpfälzisches Museum, 1926).

Fig. 4. XuYang, GuSuFanHua picture, (Qing Dynasty)

understanding of ancient Chinese people about the relationship between human and nature. They hoped that human and nature would be an organic combination, reflecting people's love for nature.

This is consistent with the principles of the biophilic hypothesis and biophilic design.

Compared with western gardens, Chinese gardens are more in line with the concept of ecological environment and the pursuit of a harmonious whole rather than excessive human intervention.

The practice of biophilic design

Users benefit from direct and indirect experience of the biophilic environment. Direct experience refers to the direct experience of the real nature through visual, auditory, tactile and other senses of natural substances and elements to obtain benefits. For example, the perception of light, air, water, plants, animals, weather, landscape, fire, and a series of natural elements;

Indirect experience is different from the direct experience of the senses. Indirect experience is like a metaphor and association. Through natural images, natural materials, natural colors, shapes and structures in nature (bionics), and natural timing methods (tree rings, mosses), people can get some natural experience. The sense of place and space includes PROSPECT AND REFUGE, ORGANIZED COMPLEXITY, INTEGRATION OF PARTS TO WHOLE (Stephen R. Kellert, 2015).

Prospect refers to the understanding of distant and near space by observing the surrounding environment. Sanctuary refers to the space where people can avoid risks and threats. Protective Spaces for the back and head, for example, may explain why primitive humans chose to live in caves with only one exit. Mies van der Rohe's Cosworth House is a famous case, which is proved by the words of the hostess. "In fact, in this glass house on all sides, I feel like a wandering animal, always on the alert. I can't sleep, even at night. I feel like I'm on guard every day and I can hardly relax or rest." In nature, computers do not copy and paste what is created. Some natural creatures follow a pattern of one or more types, like the spirals of conch shells and the polygons of cauliflower and

the shapes of ancient altars.

On this basis, William, Browning, Catherine, Ryan, Joseph, Clancy, summarized and proposed 14 pro-nature design strategies, each of which has the function of reducing stress, improving cognitive performance, regulating emotions, etc. in the built environment. The list is detailed below.

- 1. Visual connection with nature: observation of nature, ecosystems and natural life processes;*
- 2. Non-visual contact with nature: experience nature and life activities through non-visual means such as hearing, touch, and taste;*
- 3. Nonrhythmic sensory stimulation: human response to random movement of objects in nature and instantaneous exposure to natural sounds and odors, such as bird singing in nature and the sound of wind blowing in leaves;*
- 4. Changes in heat and airflow, relative temperature, relative humidity and changes in airflow felt by skin;*
- 5. The presence of water: feel the presence of water through seeing, hearing and touching;*
- 6. Dynamic and diffuse light: the change of light and shadow with time;*
- 7. Connection with natural systems: awareness of natural processes, such as the change of seasons and other natural dynamics;*
- 8. Biological Morphology and Biological Patterns: the natural arrangement of patterns and textures;*
- 9. Physical connection with nature: materials and elements from nature create a unique geographical atmosphere;*
- 10. Complexity and order. Spaces with a good sense of complexity and order feel engaged and informative, a balance between boredom and fascination.*
- 11. Prospect: can be observed at a distance without hindrance;*
- 12. Shelter: a space with a sense of security, with escape routes, a space for protection and support on the back*

14 PATTERNS	*	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	Visual Connection with Nature	* Lowered blood pressure and heart rate (Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)	Improved mental engagement/ attentiveness (Biederman & Vessel, 2006)	Positively impacted attitude and overall happiness (Barton & Pretty, 2010)
	Non-Visual Connection with Nature	* Reduced systolic blood pressure and stress hormones (Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jammer et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)	Positively impacted on cognitive performance (Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)	Perceived improvements in mental health and tranquility (Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdotter & Grahn, 2003)
	Non-Rhythmic Sensory Stimuli	* Positively impacted on heart rate, systolic blood pressure and sympathetic nervous system activity (Li, 2009; Park et al, 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)	Observed and quantified behavioral measures of attention and exploration (Windhager et al., 2011)	
	Thermal & Airflow Variability	* Positively impacted comfort, well-being and productivity (Heerwagen, 2006; Tham & Willem, 2005; Wigö, 2005)	Positively impacted concentration (Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)	Improved perception of temporal and spatial pleasure (alliesthesia) (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschong, 1979)
	Presence of Water	* Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure (Alvarsson, Wiens, & Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman & Vessel, 2006)	Improved concentration and memory restoration (Alvarsson et al., 2010; Biederman & Vessel, 2006) Enhanced perception and psychological responsiveness (Alvarsson et al., 2010; Hunter et al., 2010)	Observed preferences and positive emotional responses (Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphries et al., 2010; Karmanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)
	Dynamic & Diffuse Light	* Positively impacted circadian system functioning (Figueiro, Brons, Plitnick et al., 2011; Beckett & Roden, 2009) Increased visual comfort (Elyezadi, 2012; Kim & Kim, 2007)		
	Connection with Natural Systems			Enhanced positive health responses; Shifted perception of environment (Kellert et al., 2008)
NATURAL ANALOGUES	Biomorphic Forms & Patterns	*		Observed view preference (Vessel, 2012; Joye, 2007)
	Material Connection with Nature		Decreased diastolic blood pressure (Tsunetsugu, Miyazaki & Sato, 2007) Improved creative performance (Lichtenfeld et al., 2012)	Improved comfort (Tsunetsugu, Miyazaki & Sato 2007)
	Complexity & Order	* Positively impacted perceptual and physiological stress responses (Salingaros, 2012; Joye, 2007; Taylor, 2006; S. Kaplan, 1988)		Observed view preference (Salingaros, 2012; Hägerhäll, Laike, Taylor et al., 2008; Hägerhäll, Purcella, & Taylor, 2004; Taylor, 2006)
NATURE OF THE SPACE	Prospect	* Reduced stress (Grahn & Stigsdotter, 2010)	Reduced boredom, irritation, fatigue (Clearwater & Coss, 1991)	Improved comfort and perceived safety (Herzog & Bryce, 2007; Wang & Taylor, 2006; Petherick, 2000)
	Refuge	* * *	Improved concentration, attention and perception of safety (Grahn & Stigsdotter, 2010; Wang & Taylor, 2006; Wang & Taylor, 2006; Petherick, 2000; Ulrich et al., 1993)	
	Mystery	* *		Induced strong pleasure response (Biederman, 2011; Salimpoor, Benovoy, Larcher et al., 2011; Ikemi, 2005; Blood & Zatorre, 2001)
	Risk/Peril	*		Resulted in strong dopamine or pleasure responses (Kohno et al., 2013; Wang & Tsien, 2011; Zald et al., 2008)

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and top of the head;13.*Mystery: the sense of enticing the individual into the environment by partially obscured views or otherwise*;14.*Risks and hazards: manageable risks and hazards get the adrenaline pumping.*(William et al.,2014)

The relationships among the 14 biophilic design patterns are not independent of each other. Generally, in nature, more than two patterns are carried out together, such as the fountain in the park, which is composed of visual connection, non-visual connection, heat and air flow changes and other modes.

Among the 14 design patterns, the author emphasizes that the real nature takes precedence over the simulated nature (William & Catherine & Joseph,2014).There are different understandings of this point of view at different scales. From the perspective of the well-being of the environment to people, the naturally formed natural space far away from the city or the edge of the city or with little human interference is better than the artificial natural space such as park, city green space, and public space with a few natural elements.

Site analysis was carried out using the biophilic theory

Site analysis with biophilic thinking
The application of biophilic design has an impact on every stage of architecture.For site analysis, the approach of scheme design is also different.According to the 24 kinds of biophilic characteristics, the investigation and analysis of the resources in the site are different from the past. The previous research analyzed the site from the perspective of history, spatial relationship, context, etc. However, from the

Table1.1.Biophilic design patterns & biological responses .© 2014 Terrapin Bright Green / 14 Patterns of Biophilic Design

perspective of the biophilic attributes, the value of all the natural elements in the site needs to be re-evaluated.

light

when analyzing people's experience of natural light, the first and most basic function is the lighting function. Second, natural light is different from artificial light source. Natural light naturally has time dimension. We can feel the change of the time of the day and even the change of seasons through the change of natural light and the shadow generated by natural light. Third, natural light allows us to feel changes in temperature through our skin through radiation.

So the same light source, direct natural light diffused natural light and the same analog light source give you a very different experience.

Based on the demand for natural light, such natural light resources will affect some functional arrangements of buildings, such as residence and office, but will not affect warehouses, garages, large shopping malls and other buildings.

Of course, the demand for natural light should be adjusted according to the geographical location and intensity, and the radiation amount of light should be controlled within a certain range through the design means of increasing irradiation and shading. If you are outside, you could control the density of trees, the type of trees and other natural elements to adjust the light.

Only from the biological Angle of view to compare the itanium ando's church of light and siza mimicry museum, South Korea, the light of the church of light more in line with the characteristics of biological affinity, here has the



characteristics of time and temperature, light light through the crack of light and shadow over time on mobile, also with the seasons shadow side or shorter, can also according to the cloudy day, the fog, light and shade. These allow the user to feel the light as a living element of nature through direct visual contact. The human experience of light in a museum may be limited

*fig.5.church of light .<http://ibaraki-kasugaoka-church.jp/gallery.html>
fig.6. Jewish Museum. Pictures and info from Daniel Libeskind weblink: <http://www.daniel-libeskind.com/>
fig.7. Mimesis Museum. Photographs: Fernando Guerra.
fig.8. Quinta da Regaleira*

by the fact that the building is less functional. People always feel the living light in the nature, but some light in the building is not so active.

In addition, light can also help a building to affect people's emotions. The light in the Jewish Museum is a good example. The long and narrow space with a certain height resembles a dry well, and the beam at the top blocks most of the well mouth, so only a small amount of light can pass through.

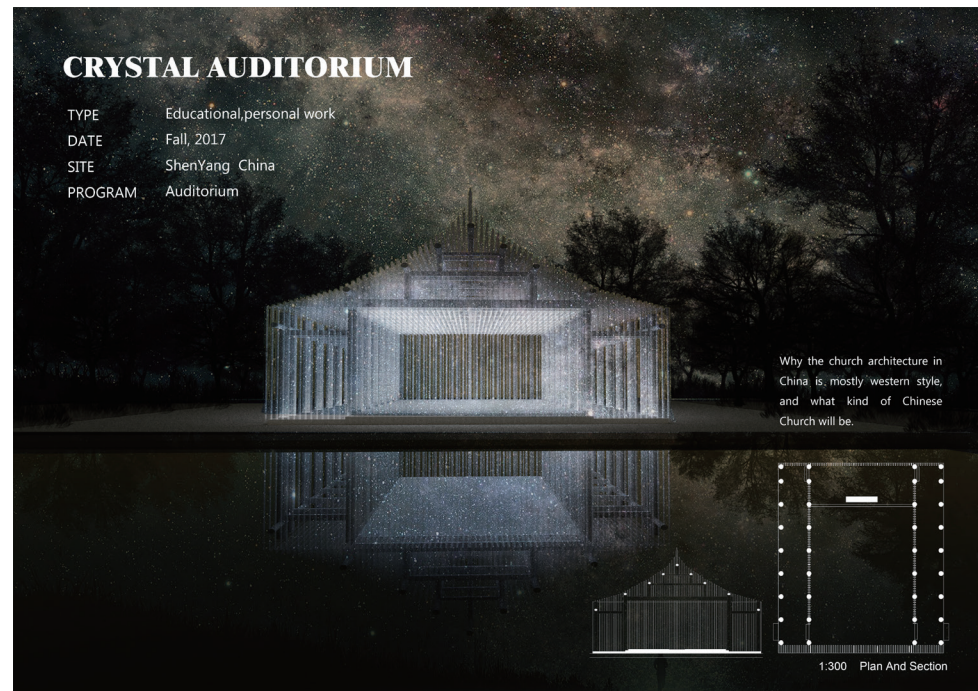
When one is in it, it is like one falling into a dry well (the Spanish Quinta da Regaleira has a similar feature), and the dry well is covered with branches that cover most of the wellhead, where the light is like hope.

"The Cruellest Thing you can do to a person who's living in panic is to offer him or her hope that turns out false. When the crash comes it's intolerable."

Robert Ludlum, *The Bourne Supremacy*

fig.9.

The auditorium design
Author: LiangZiqi



Starry Night

Starlight and moonlight are also a form of natural light, or rather the experience of moonlight and starlight is the experience of space. It is biophilic in its vision, mystery, and connection with nature.

The starry sky is an important landscape resource of the whole earth, but the internal lights of most cities are too bright, so the observation of the starry sky in cities is blocked, which is a problem that needs to be solved. If we build Windows in our walls to better observe our surroundings, then our buildings need to establish a new way to connect with the stars.

Air

Due to air quality has become the important indicator of health, so the air here refers to the flow of air and people also to air flow experiences, not limited to the experience of the skin, the air flow can change the dynamic of leaves, with trees to produce the auditory and visual experience, at the same time also can drive near the grass, trees, flowers the natural scent of molecular diffusion. An olfactory experience. Therefore, it is very important to investigate and analyze the air flow in the site. For different space, the air velocity is too fast and too slow is not easy to experience, for example, the acceptable wind speed range for people in tropical areas is 0.3-0.9m/s. (Gong et al., 2006) Wind speed can be increased or decreased according to different requirements, which can be enhanced by changes in air flow, temperature and humidity and pressure in the built environment. In the environment, the wind speed and direction can be controlled by setting barriers (buildings, trees, etc.)

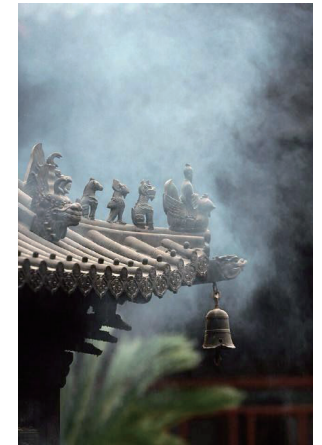


fig.10

The eaves of ancient Chinese buildings. <https://kknews.cc/zh-my/culture/52yp2g3.html>

fig.11

Rain vortex, the world's tallest indoor waterfall.
Singapore Changi Airport.
Design by Safdie Architects



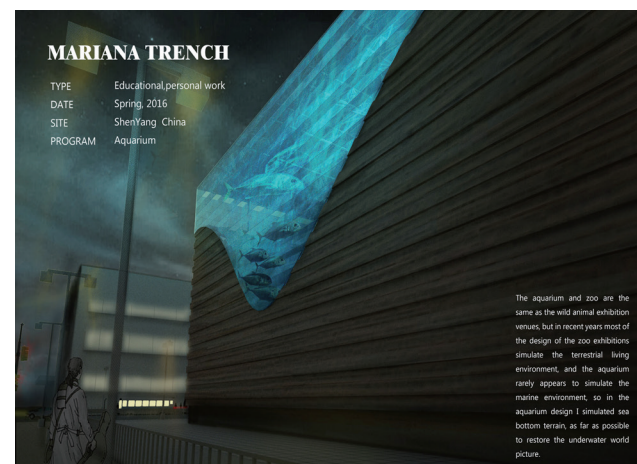
fig.12

The Aquarium design
Author: LiangZiqi

Wind chimes on ancient Chinese buildings are the embodiment of wind elements. The dynamic of the wind is transformed into the sound of the wind chimes, and the sound of the wind chimes will produce the corresponding sound according to the speed of the wind speed.

water

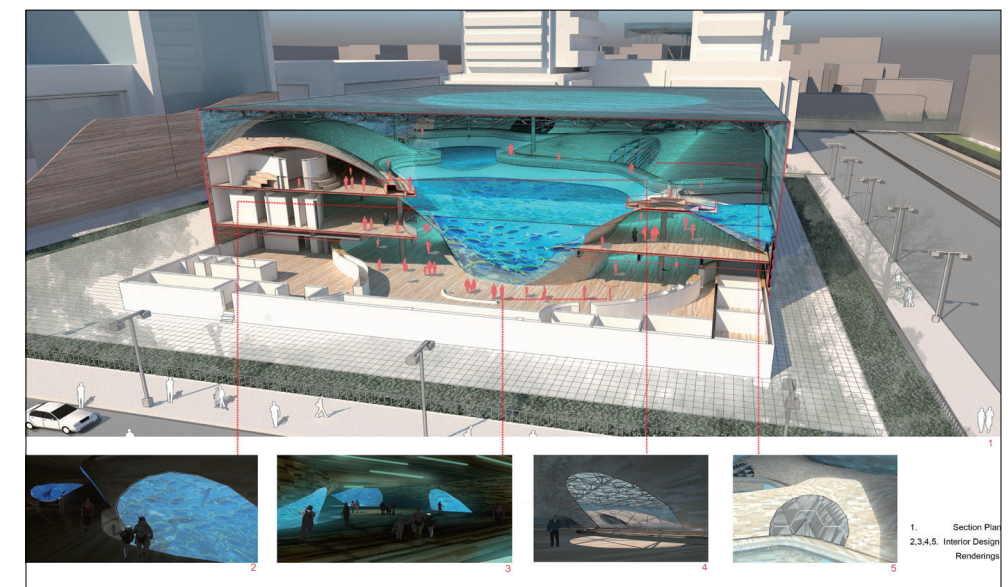
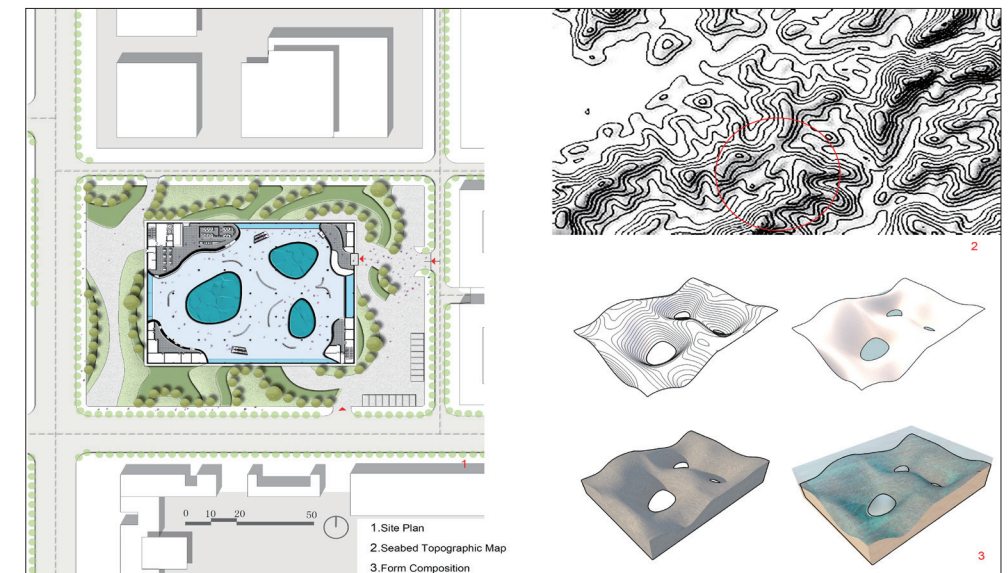
The experience of the element of water is more complex, the first way of water in nature itself has a variety of "existence" (here the existence of incomplete according to the classification of physical properties, including location, composition, dynamic, temperature, etc.), including natural drainage (oceans, lakes, rivers,) and natural precipitation (rain, snow, fog), etc., have different characteristics,



different forms of water. People have different experiences with different characteristics. Unlike static water, water in nature is mostly a kind of dynamic water, which has a unique sound, a special temperature, and a special smell. People can distinguish different water from each other by these characteristics.

fig.13,14

The Aquarium design
Author: LiangZiqi



For example, in the direct experience of sea water, people perceive the existence of sea water from multiple dimensions such as vision, hearing, smell and touch. These experiences change as a person's position and distance from the sea changes, creating new biophilic traits such as farsightedness, mystery, and so on. Different from water resources such as sea, river and lake, for areas far away from fixed water resources, in addition to artificial waterscape, people experience water more through rainfall. Through the processing of the element of rain in the design can produce some new experiences. For example, we designed and visualized the process of rainwater collection to produce an effect similar to small rivers or waterfalls (Waterscape design of Changi Airport in Singapore), which in turn produced restorative features such as being away and fascination (Kaplan, 1995) and bionic fascination.

Natural analogy (Kellert & Calabrese, 2015) and other biophilic characteristics, which mimics the occurrence of precipitation in different terrain forms in nature.

The process of precipitation can also be combined with specific architectural functions. For example, performance activities are combined with the real rainfall process in performance places such as theaters and cinemas. Just as movies experience the visual and auditory effects of rainfall to set off the scene atmosphere, different weather, as a dynamic natural landscape, also has charming, mysterious and other restorative and biophilic characteristics. Therefore, from the perspective of biophilic design, in addition to rivers, lakes and seas, rainfall and other natural weather

phenomena can be added to the design as natural landscapes like rivers and mountains to play the role of water experience.

In addition to truly experiencing the water, the building can also use natural analogies to mimic the ocean where it is lacking. For example, aquarium design, most of the current aquarium design is a kind of land building, which provides people with the experience of watching Marine animals indoors. If the aquarium is designed in combination with the geological form of the ocean, it will provide people with a simulated underwater world, rather than a big fish tank.

plants, animals

*Experiences of plants, animals and landscapes
People's contact with plants and animals is not only in the natural environment, but also in the man-made environment, such as potted plants and pets at home. However, potted plants and pets have reduced their ability to resist risks and disasters due to excessive human intervention,*

fig.15

Gardens by the Bay, Singapore
Photography by Patrick Bingham Hall



thus reducing their sustainability.
 From "contact with the natural system" and "complexity and order" point of view, due to their different living space and natural space, no want associated with the system, and there is no species diversity, so do not have more than one kiss biological features, so they are real natural people compared to the benefits of engagement are also very limited, Because it's not just animals and plants that you're dealing with in real nature, you're experiencing an environment that has a holophilic element. So the most effective experience for animals and plants is in the natural environment.
 For animals, the city is a desert, and animals rarely appear in the city. However, during the city closure caused by COVID-19 in 2020, many wild animals appeared in the city, which made people re-realize that although the city is built by human beings, it does not belong to human beings. Some animals have evolved to adapt to the urban environment (Sschilthuizen, 2018). The evolution based on unnatural environment may become less and less natural like that of human beings. Therefore, cities need natural environment, not only for human beings but also for animals and plants.

weather and natural landscape,

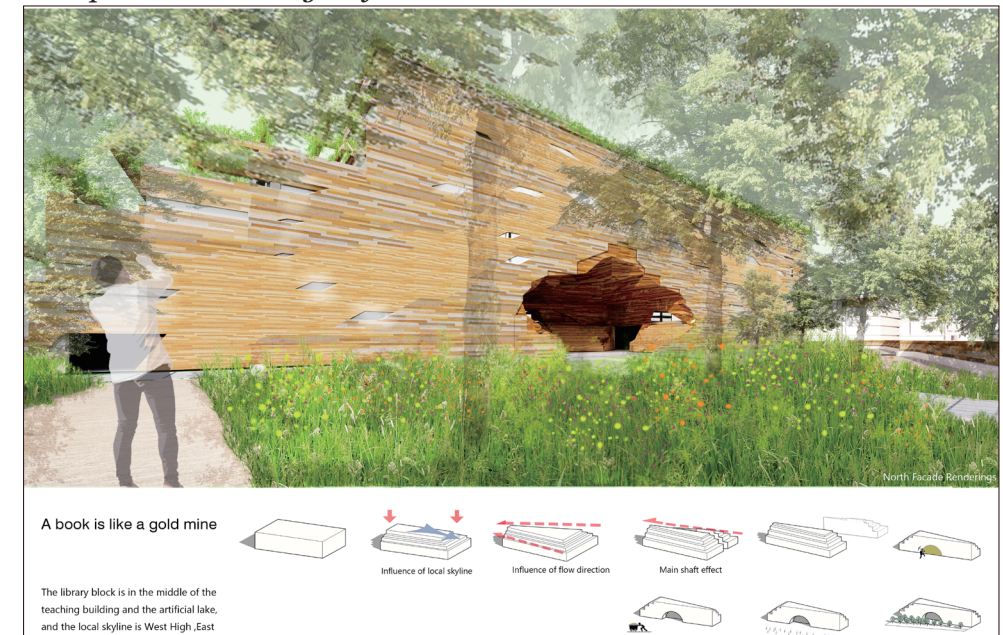
Natural landscape can be divided into geographical landform landscape, geological landscape, ecological landscape, meteorological landscape and climatic landscape. For people's experience, even the most common natural landscape is more favored by most people than artificial and human-dominated landscape. However, it is very difficult to achieve real natural landscape experience in the built environment. People can imitate geological,

geomorphological and ecological landscapes, but it is very difficult to become a real natural environment just by imitating.

The natural landscape consists of geology, landform, vegetation, water and other major elements. Extreme landscape such as deserts, though there is little or no vegetation and water is the natural landscape, is in the process of human evolution these sites are not suitable for human survival, so people for the love of the natural landscape is also has a priority, compared to the monotony of the desert people usually like to have rich content of forest and savanna. Therefore, if we want to experience the natural landscape in the city, we can only build an artificial landscape. In order to meet people's needs for real nature as much as possible, artificial natural landscape should imitate nature to the greatest extent. For the design requirements, the first is that the area should be large enough. The larger the area, the more organisms it can carry and the richer the species. The design of terrain should also

fig.16

Library design
 Author: LiangZiqi



be as real as possible. The changing terrain will deepen people's experience of nature. The design of terrain should not come from pure imagination or random imitation, but from the surrounding environment, terrain, and historical terrain.

At the same time, it should have local characteristics, such as the use of local natural materials (stone, wood, soil, etc.), and whether there is water should be based on whether there is natural water in the surrounding area. Of course, pure natural space is the best place to experience nature, but for urban residents, this is a luxury idea, so restoring nature in urban space and introducing nature into the city is the most feasible method.

The site design under the biophilic design, and the architectural design

(Since the birth of cities, buildings have been occupying the natural space. In fact, buildings and trees have the same position on the ground. They both occupy the ground space, but buildings only serve people while trees serve the whole ecosystem.) With a new understanding of nature and the value of its elements. There will also be changes in the planning of urban public space or the site design of projects.

Previous design prior to construction, road space, but in close biological theory, bearing natural soil as the most important carrier, it is all, including people, so the natural biological living space, and construction for people, so the design of the ground to equal or prior to construction, soil space share must be improved. In addition to this view from a biophilic point of view, the increase of soil area in cities is conducive to the natural water cycle, weakening the heat island effect in cities and alleviating the

water crisis in cities (Dan-jie et al.2015).

How to introduce nature into the city, the most important thing is to increase the soil area of the ground, as far as possible to restore the natural space. As far as space is concerned, no creature in nature can occupy the continuous space above, above and below ground at the same time. Only people can do that. The living space of truly natural plants is in the range of 7 m below ground and 10 to 15 m above ground (small species less than 9.1 m, medium species greater than 9.1 less than 15 m, large species greater than 15 m) (Canadell,1996; Jessica et al., 2013). The space for the building is 2,400 meters below ground (Dark Matter Lab) and

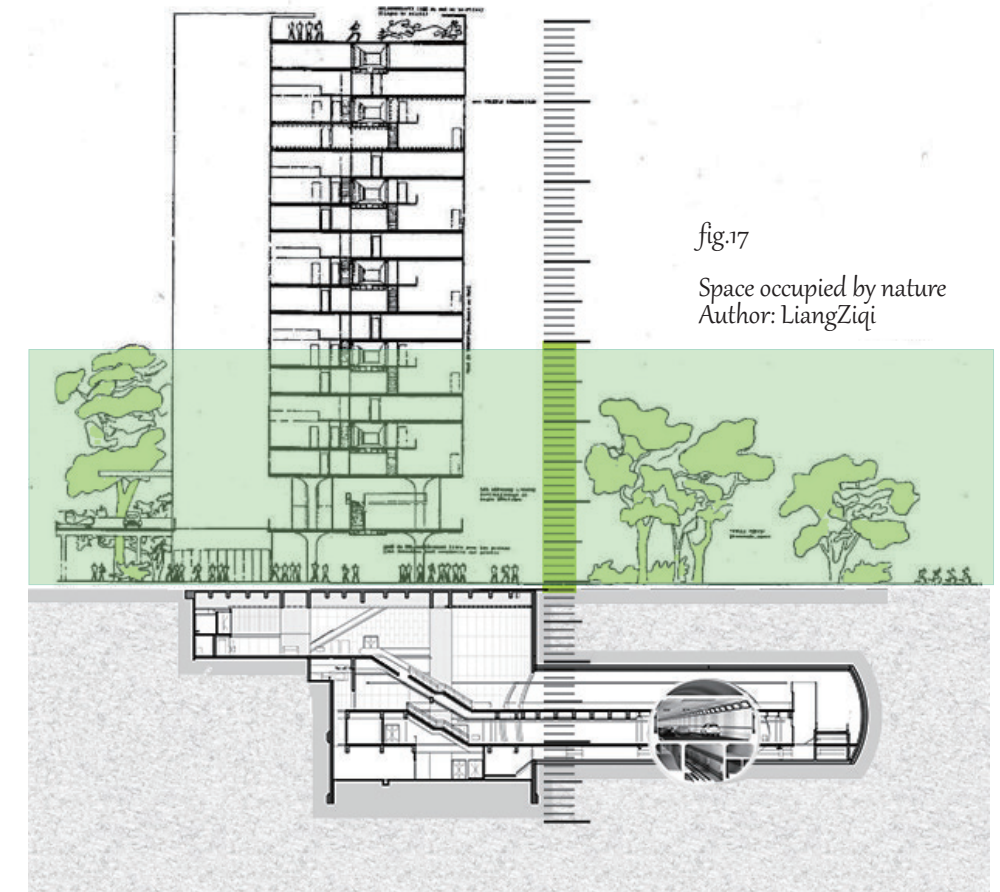


fig.17

Space occupied by nature
Author: LiangZiqi

828 meters above ground [Burj Khalifa]. So in addition to reserving the necessary space to return all other unnecessary space to nature, the road does not have to rely on the surface, and the skywalk system is a good solution, while occupying very little ground space, increasing the space of ground vegetation. Although Le Corbusier had a similar design in his Shining City. But they think in different ways, one from a functional perspective, the other from a natural perspective. This design also appears a lot in the urban design of Singapore. When nature has enough space, the experience of the above natural elements can be combined to incorporate light, water, air, plants and animals, geography and landforms into the design. Designed as an artificial nature with a natural system.

CASE STUDY

case study

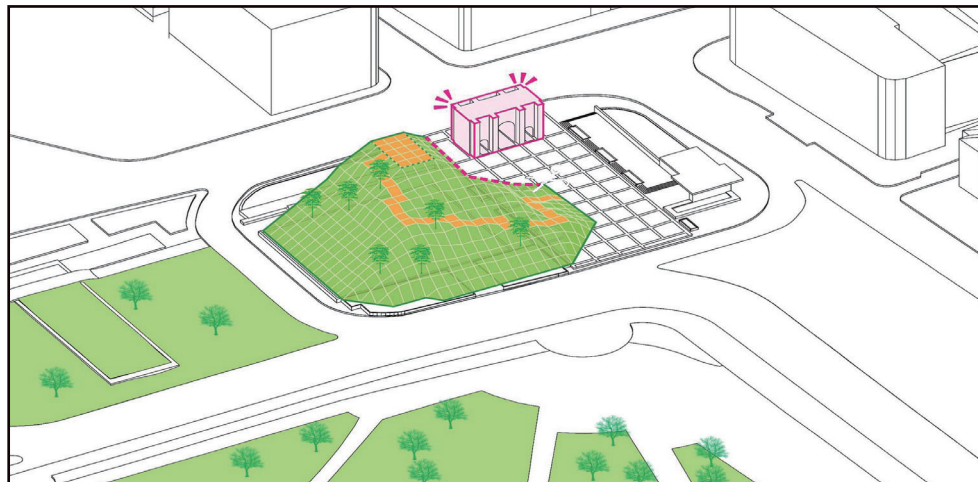
Marble Arch Hill /MVRDV

Located at the North-East corner of Hyde Park, the project is a public leisure space that can also be used as an exhibition space. Westminster City Council hopes that the new building will reactivate the area due to the negative impact of the outbreak on civic activities in the area.

Designed by MVRDV, a small building with a height of 25 meters imitates a mountain on the site. For the users, the project provides a new geographical form (the mountain), adding new natural Spaces, and the application of natural materials to increase the experience of people and nature.

In addition, its height of 25 meters creates a new vista for visitors to climb to the top of the mountain. The most obvious biophilic features of the project include direct and indirect links with nature, biological forms and patterns.

fig.1
Marble Arch Hill, Image of
design ©MVRDV



The purpose of the project is clearly to design a building that will continue to attract people. Based on the biophilic theory and its biophilic character, the project will become a new link between Hyde Park and Oxford Street, and a new landmark that will be attractive and enhance the experience of all the surrounding landscapes. And become a place where people are concentrated.

fig.2.3
Marble Arch Hill, Render of
design ©MVRDV

fig.4
Valley, Render of design
©MVRDV



Valley /MVRDV

Located in Amsterdam, the project is a mixed-use building with offices, residences, bars and restaurants.

The developers hope that the design of the valley will turn the area into a more livable urban space that will attract people to settle there.

The project is inspired by terraces and valleys.

The three main towers are modeled after three peaks of different heights.

The central valley serves as a public space

connecting the three towers and accommodating different functions

The biophilic nature of the design is reflected in the shape of the valley, with three completely different towers reflecting the complexity and order of nature, as well as the mystical outlook and sanctuary.

The shortcoming of the project is that all the green space is above the building space, without connection with the ground, or without connection with the ecosystem of the whole surface. The ability to resist risks is poor, and continuous investment of resources is required. To ensure the sustainable development of green space.

In addition, due to design factors, the biophilic welfare of the building is more inclined to the users of the building, and the biophilic experience for nearby residents outside the building is limited.

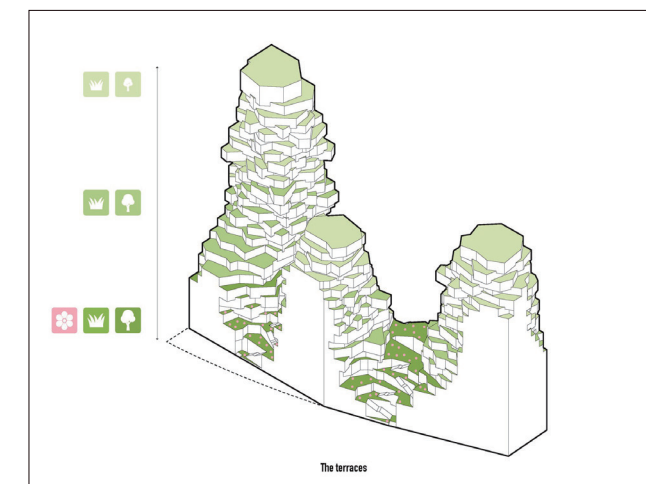


fig.5
Valley, Shape analysis
©MVRDV

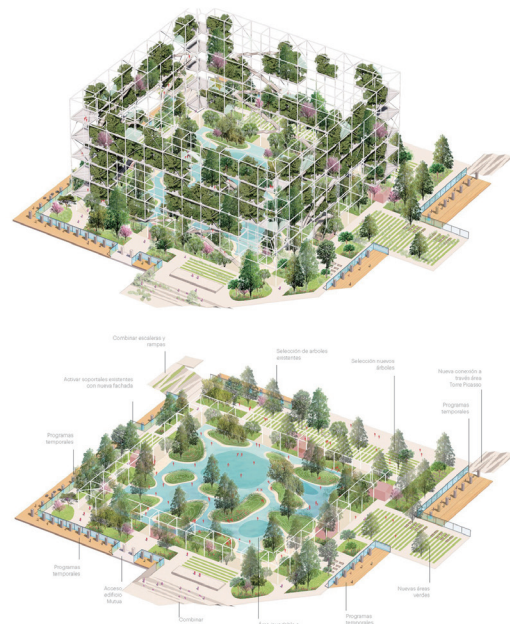
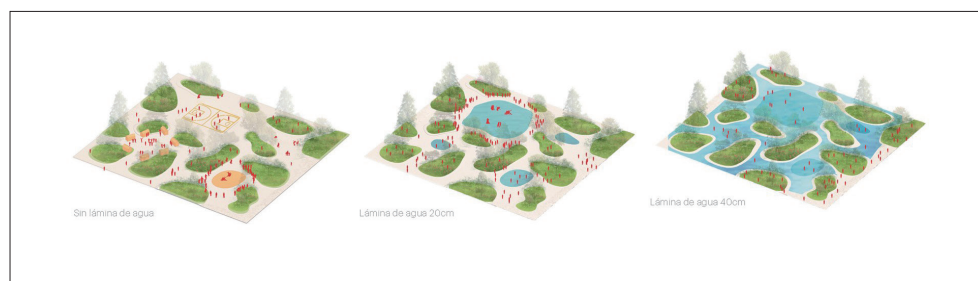


fig.6
Rander
SALÓN VERDE, ©MVRDV

fig.7
Water landscape analysis
SALÓN VERDE, ©MVRDV

fig.8
Axonometric of design
SALÓN VERDE, ©MVRDV

fig.9
Axonometric of ground
floor
SALÓN VERDE,
©MVRDV

SALÓN VERDE/MVRDV

The project is a competition project located in Madrid. The site is Azca, an important urban area of Madrid, close to the Santiago Bernabeu stadium of Real Madrid. The site has a large influx of people and international influence naturally, so how to make Azca better will be a big challenge. The key to the competition was how to transform the site into an open and sustainable urban space, while at the same time connecting with the city.

For these reasons, the competition attracted more than 50 international construction firms.

MVRDV's master plan will create a new green landmark for the city, designed as a vertical forest, with the aim of turning Azca into a new leisure living room for the city, bringing natural Spaces into the crowded city to attract citizens as well as visitors. The project itself consists of a rectangular space enclosed by a frame structure, which is covered by vegetation and has an open waterfront in the center, which changes with the seasons. The project was analyzed from a biophilic perspective.

The project features plants, water system, artificial island, small lake, and other natural elements. Many plants are planted on the frame, like a plant bookshelf, which satisfies the most basic biophilic characteristics. The structure can be according to the height of demand continues to increase or decrease at the same time, the choice of plants are near Madrid's original species, on the structure of each layer are all have different functions, coffee shop, flower shop, bookstore, etc., that connected the lines from export to entry will become a jungle road is surrounded by all kinds of plants around

The design itself is bionic, the application of natural materials, complexity and order. In the spatial experience, it has the characteristics of prospect, refuge and mystery. The project is very biophilic, even though the structure itself accentuates the regular geometry, this problem will be weakened as the plants grow, while the native plants will increase the sustainability of the design. It provides a highly biophilic experience for everyone inside and outside the building.



fig.11.12.13
Rander SALÓN VERDE,
©MVRDV



fig.14.15.16
Rander,
Peruri 88, ©MVRDV



PERURI 88/MVRDV

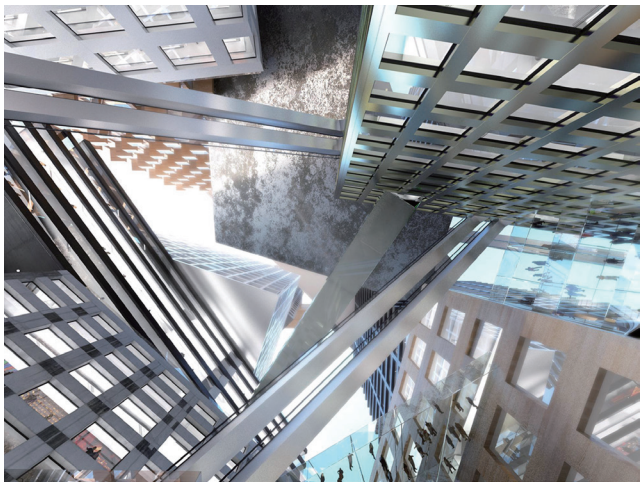
Peruri88 for cities with a biophilic base, how to use biophilic resources, or how to enhance other biophilic properties. Peruri 88 is located in Jakarta, Indonesia. MVRDV has created a vertical city with a high quality of life and a high sustainability certificate according to the developer's needs. The 360.000 square metre mixed-use development includes a variety of houses, offices and commercial Spaces, as well as internal and external public Spaces. Peruri 88 offers a variety of office and housing types, from large office surfaces to live/work units, from lofts to townhouses, and from terrace houses to terrace living. Each of these stacked city blocks features semi-public rooftop parks, numerous gardens, playgrounds, spas, gyms, outdoor restaurants and swimming pools for residents and office workers.

From a biophilic point of view, most modern skyscrapers are not biophilic, but in the case of Peruri88, the biophilic is hidden in space and between Spaces. The building according to the functional design into different size (according to the surrounding and traditional living form), and then combined together, the individual pieces of design by function as the guidance, rather than just according to the rules of aesthetics, experience in different position of the biological affinity not only comes from outside the building also comes from the building itself, the combination of different body piece of irregular, Public Spaces at different heights provide different types of lightning with their biophilic characteristics, but they all share important characteristics such as complexity, order and outlook.

From different heights of the open platform,

get a distant view. From the small park placed within the building, the direct and indirect contact with the elements of nature, especially the central viewing platform, is achieved simultaneously with the prospect, mystery and risk, an experience of risk that is rarely seen in contemporary architecture. The biophilic nature of the design mainly comes from the spatial design. In the site with the biophilic foundation (non-plain city, city with special topography and natural environment or water body), the source of the biophilic experience of the building will come from the spatial design to make better use of the original biophilic resources.

fig.17.18.19
Rander,
Peruri 88, ©MVRDV



La serre, MVRDV

MVRDV has come up with the idea for a hybrid house in Paris, France, which they call the Vertical Village, where traditional urban streets and natural Spaces are stacked in the form of building blocks, while existing public Spaces are superimposed on each other to create new public Spaces. To provide a new social space, MVRDV designed this new public space as a

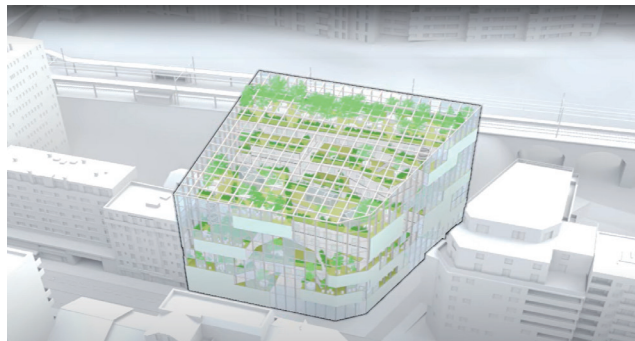
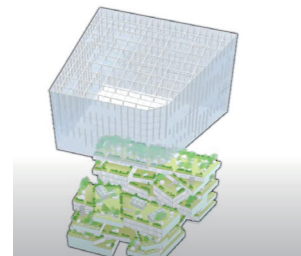
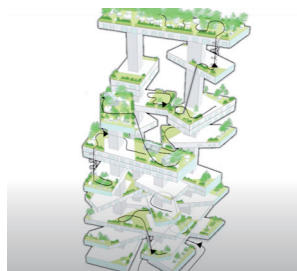
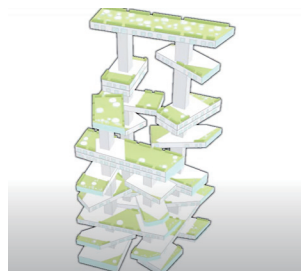


fig.20
Interior Rander,
La serre, ©MVRDV
fig.21.22.23.24
Block formation analysis
La serre, ©MVRDV



greenhouse.

In this way, natural space is brought into the design. It also provides a green view of the city. This vertical village brings the spatial relations, human relations, and natural space of the village into modern architecture.

From the biological point of view, on the scale of the city the greenhouse design is a big city, the building block of randomly placed in the greenhouse, the formation of a public space, and irregular to imitate the natural mountain, disorderly and rules, the greenhouse with the natural elements of close contact, at the top of the transparent design allows sunlight to take most of the interior space. The use of natural materials and colors will transfer people's experience from the urban space to the building to form a natural-like space. It creates a biophilic experience. The biophilic experience of the design is friendly to the building's users, with visual and non-visual contact with natural elements, spatial complexity and order, mystery and dynamic light, etc. For those outside the building, its biophilic nature is experienced only visually.

The core theme of the design is the vertical village and the greenhouse. The spatial structure generated by the vertical village and the natural space brought by the greenhouse, this design is like a utopia in the city, which will give the user a better experience than the general urban space.

fig.25
Yang Shuo, The town of
Yangshuo, China, from a
nearby karst peak known as
the TV tower. The Li river can
be seen in the background.
Author: Ericbolz



fig.26
Rander, Himalayas Center,
©MAD



fig.27
Photo, Himalayas Center,
©MAD



Nanjing Zhengda Himalayas Center/ MAD

Located in Nanjing, the site consists of six plots of land, two blocks of which are connected by a three-dimensional urban plaza. Corridors of different scales are interwoven in several undulating commercial complexes, guiding people from the busy ground streets to the three-dimensional park.

The central area of the site is made up of some sloping roofs, imitating the environment and structure of small villages, and providing a village-style space different from that of the city for large-scale urban projects. The small bridge connects the neighborhood, the small buildings in the interior are villages, and the high-rise buildings outside imitate the mountains. The addition of light becomes an abstract dynamic feature of nature, such as water and wind. And parts of the water feature bring the experience of water. The overall plan of the project mimics the rural landscape of Guilin, providing a completely different experience in the city from the monotonous urban space of the past.

Although the project design and planning are clear, the overall project still tends to a kind of aesthetic purpose, away from the real natural space, rural biological affinity from completely based on the natural space, difference is very big, the proportion of the architectural space and natural space which makes the architectural space is only part of the natural space is very small. And the city is built on asphalt and concrete where there is a huge gap between nature and architecture, but here nature is the decoration. The natural elements in this design are indirect and the abstract expression can

also play a pro-biological role, but the design is too much abstract landscape design, the only lack of real natural experience, nevertheless, in the urban scale, the architectural scale, this is still a pro-biological work. Since this is a semi-public space, the design creates a biophilia for everyone inside and outside of it.

MAD is trying to live out an ideal "landscape city" through this city-scale work.

From an aesthetic point of view, the design really perfectly represents the mountains and water of China.

However, from a biophilic point of view, excessive use of traditional Chinese artistic expression (abstraction) reduces the existence of real nature. In art, the landscape is simply reflected on paper, but in reality, the value of mountains and water is its own value, as a natural ecosystem.

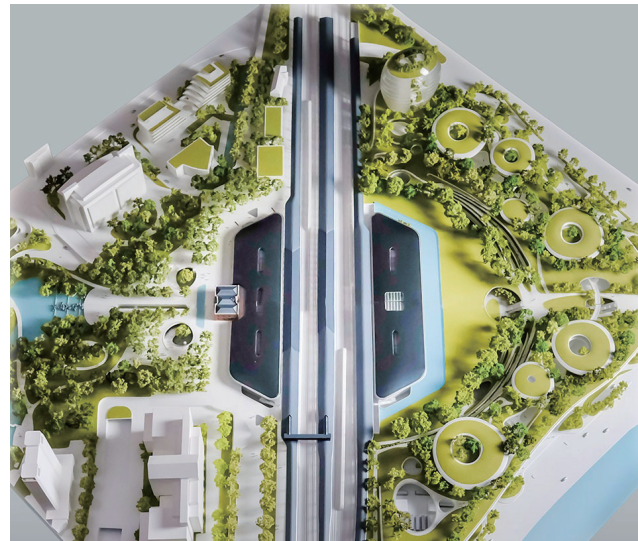


fig.28.29
Rander, Himalayas Center,
©MAD



fig.30
Master Plan , Jiaxing Railway
Station, ©MAD

fig.31
Modle ,Jiaxing Railway
Station, ©MAD



Jiaxing Railway Station/MAD

MAD Architects has presided over the design of Jiaxing's "Railway Station in the Forest".

The project will start in late 2019.

Nanhu District, where the railway station is located, is the main urban area of Jiaxing City and the center of the old city. It is one of the districts with the longest history in Jiaxing.

In highly urbanised Chinese cities there are

many barriers to provide close biological experience, first of all, it is difficult to obtain from the surroundings of natural elements, the second residential green space between rarity, and independent, closed, the outside people is hard to use, and large public buildings such as for the railway station, not only occupies lots of land in the heart of the city and to provide the real public space.

So MAD's forest station design abandons the previous station design model, which takes up a large amount of land area above ground and serves only those who travel by train.

Most of the railway station buildings in the forest exist underground, the above part retains the original historical relics as a kind of historical landscape architecture, and the rest of the above area is a forest park. This design satisfies the basic functions of the railway station, while providing the maximum natural space.

Compared to other Chinese urban railway stations, the design provides a biologically viable solution for large urban public buildings. In today's highly urbanized world, the city continues to expand from the three-dimensional direction, while the public green space in the core area remains unchanged or even decreases. As urban public space, large public buildings have the obligation to provide real public space beneficial to citizens. Further, if every inch of land in the city fulfills this obligation (i.e., providing public true natural space to the maximum extent while satisfying its own function). Then the whole city will be more biophilic.

fig.32.33
Rander, JiaxingCivic Centre,
©MAD

fig.34
Master Plan Jiaxing Railway
Station, ©MAD



Jiaxing Civic Centre /MAD

Zhejiang Jiaxing Civic Center is close to Nanhu Lake, located in the central axis of Jiaxing city, with beautiful Jiangnan waterscape, lush vegetation base, next to the sea salt pond water system and the largest park in the city, Central Park. The project includes three venues: Science and Technology Hall, Women and Children's Activity Center and Youth Activity Center.

MAD's design combines architecture with a park. With the central circular lawn as the centre, three pavilions surround the central lawn, with an annular roof extending from the building to the ground. This allows the public space to expand in a vertical direction, while the annular roof connects the building, creating a wavy skyline within the building.

The combination of architecture and landscape makes the building physical and ground integrated, reducing the sense of spatial thickness of the large building. The combination of lake and wetland forms a kind of artificial landscape. The combination of natural elements and landscape, the use of colors and materials all reflect enough natural atmosphere, making users feel more natural than architectural sense. Due to the surrounding environment, such as water system, river bank and wetland, the site is inherently biophilic and strongly biophilic. So the focus of the design is on how to use the surrounding environment, rather than creating a new biophilic environment.

From this point of view, the design makes good use of the original environment, and introduces the green biology from the outside to the inside of the building, and because of the connection

between the ground and the roof, it provides the users and visitors of the building with the view, mystery and risk of the pro-biotic experience. In addition, direct and indirect contact with nature, natural elements, natural materials and natural graphics all provide a strong green biological experience.

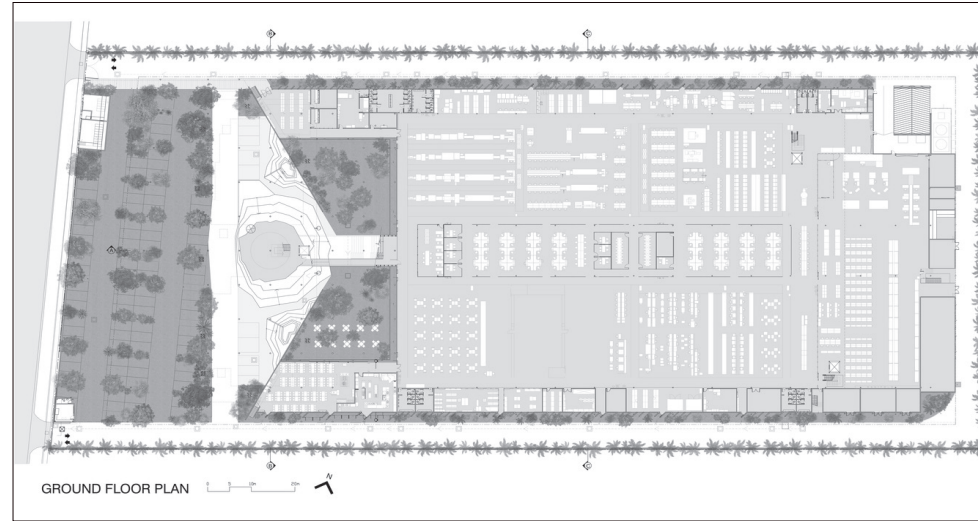


fig.35
Ground floor plan ,Factory
in the Forest ©Design Unit
Architects Snd Bhd

Factory in the Forest / Design Unit Architects Snd Bhd

© Lin tHo Photography

The project is located in Malaysia and was designed by Design Unit Architects Sdn Bhd.

This is an electronic product manufacturing factory, the main function is the factory and office space.

The original intention of the design is to integrate the factory with the natural space. The green courtyard separates the factory from the office and connects the office with the factory through a bridge. The public space such as meeting rooms, restrooms and restaurants are distributed along this path, encouraging users to use these green public Spaces for dining and

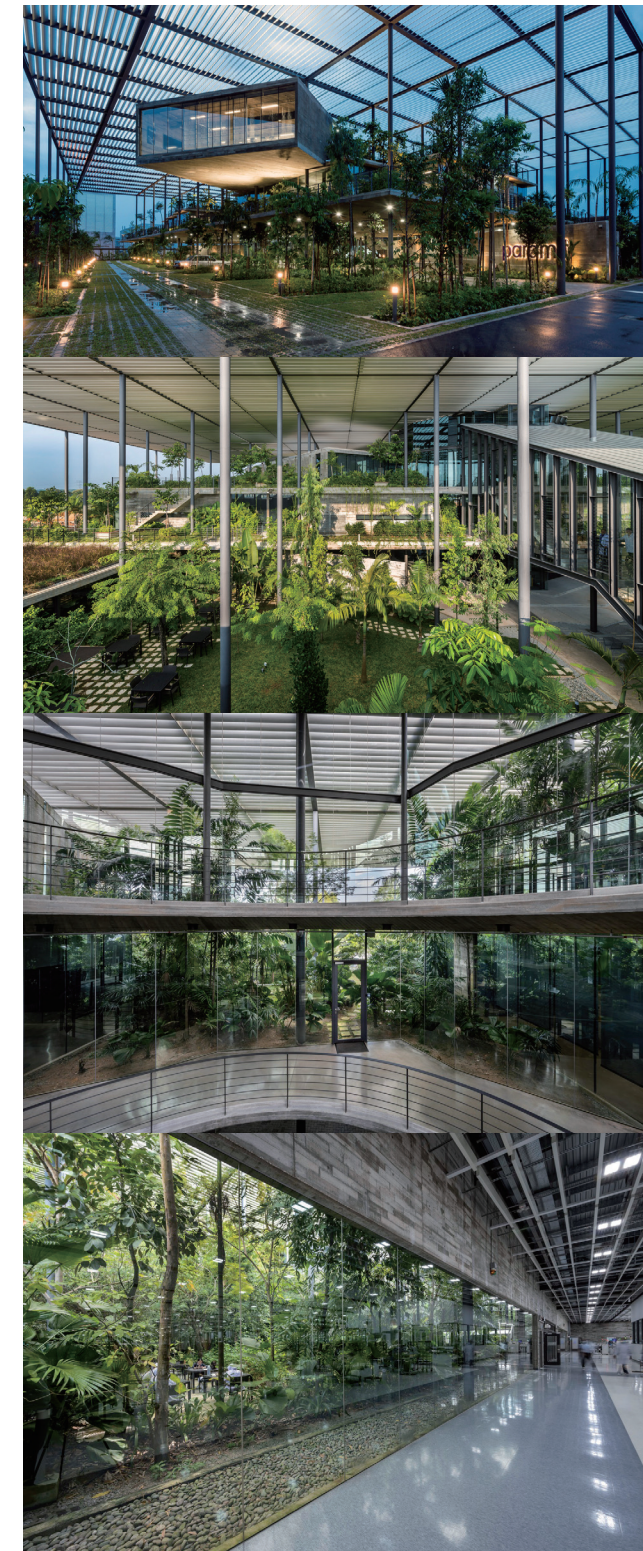


fig.36.37.38.39
Photos ,Factory in the Forest
©Design Unit Architects Snd
Bhd

gathering.

The plant's top grille, in addition to providing shading, also controls the flow of rainwater to the ground for irrigation or collection. Glass walls and a designed curtain wall system are used extensively throughout the factory, encouraging the use of natural light systems.

The designer's aim was to create an exciting and meaningful working environment for all employees, and to make the building an image of the company. To express the importance of environmental protection and the concern of employees' mental health.

The designers have been concerned about the mental health effects of forests from the start. That's what the biophilic theory is after. Therefore, the design of the factory considers the full contact between human and natural space, contact time, contact location and so on, and How natural space is used has a beneficial impact on the users.

Construction of color and the application of the natural material such as wood, and the use of a large number of glass curtain wall to make the employees in every corner of the building can be in contact with the natural space, which makes for the nature of the direct and indirect contact can occur at a time and place and, shading and daylighting systems provide users natural light and the change of rhythm. At the same time, the transparent roof gives the user natural weather changes. The whole factory was surrounded by plants. The deep integration of natural elements and factories enables the factory in the forest to be realized. Even if the function of the factory changes over time, the small forest connected to the ecosystem will remain. And the intensity of biophilicity inside the building space will continue to increase.



PARKROYAL on Pickering / WOHA
Continuous green landscape singapore

fig.40
Photo ,PARKROYAL on
Pickering ©WOHA

PARKROYAL on Pickering was designed as a hotel-as-garden that would double the green-growing potential of its site. Adorned by frangipani and palm trees and draped with tropical plants, curvaceous sky-gardens are cantilevered at every fourth level between the blocks of guest rooms. Greenery flourishes



throughout the entire complex, and the trees and gardens of the hotel appears to merge with those of the adjoining park as one continuous sweep of urban parkland.

The hotel is placed on a platform that lifts up to 5 storeys high. In the tropics, the sun has a great influence on the building's temperature, and most of the rooms are placed on the north side with views of the park to the north.

Corridors and service rooms are on the south side, all in the cool shade of the hot equatorial climate. The base of the platform borrows from the natural rock texture.

The biophilic design of the project is distinctive. The first is the open ground floor space, which is arranged with small landscaping and connected with the surrounding urban green space, greatly increasing the area of green space, increasing the area of green space available, and connecting with the natural system.

fig.41.42
Photos ,PARKROYAL on
Pickering ©WOHA

fig.43
Modle ,PARKROYAL on
Pickering ©WOHA

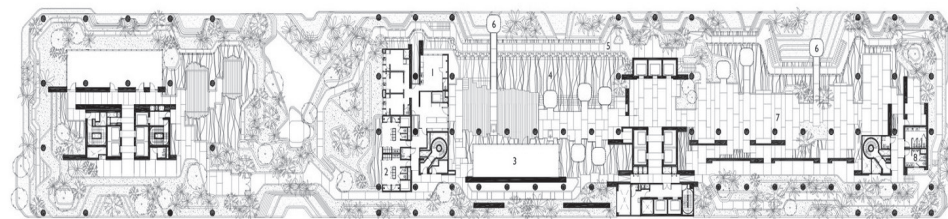
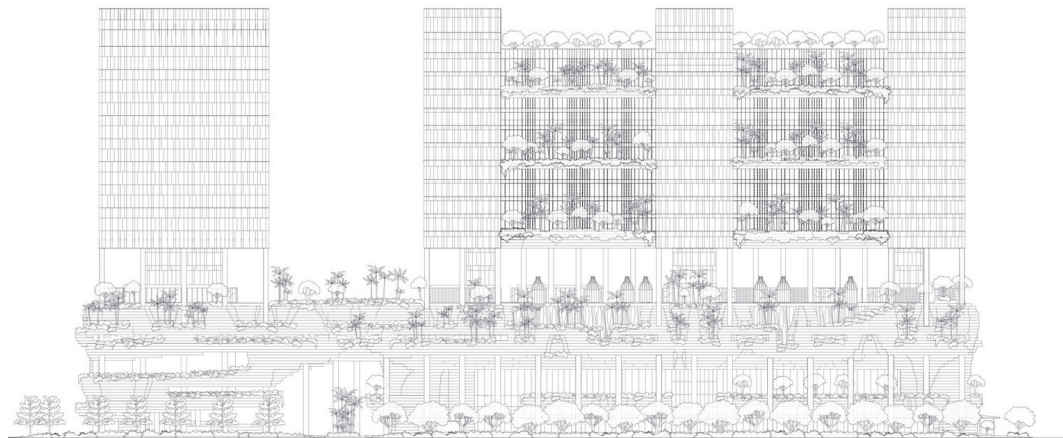
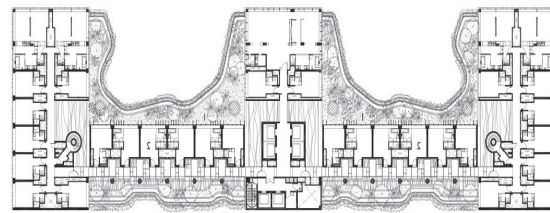


The viewing platform on the fifth floor is designed as an open park, providing a public green space for the building's occupants and establishing a direct connection with nature. The five-story platform also offers a long view of the city. In addition to this is the experience of water, and the abstract mountain elements.

fig.44
10th floor plan
,PARKROYAL on Pickering
©WOHA

fig.45
Elevation,PARKROYAL on
Pickering ©WOHA

fig.46
5th plan,PARKROYAL on
Pickering ©WOHA



Changi Airport, Singapore/Safdie Architects,

As part of the terminal, the project integrates commercial Spaces and gardens into a single entity, forming the heart of Changi Airport. Due to the limited land area of Singapore, the airport serves as a window to the outside of Singapore. The designer aims to build the airport into a landmark building to attract tourists and citizens. Located in the heart of a forested valley, this stepped indoor garden offers plenty of Spaces for interactive experiences, including walking trails, waterfalls, and quiet

fig.47
Rander,Changi Airport,
Singapore, ©Safdie
Architects,

fig.48
Rain vortex ©Safdie
Architects,

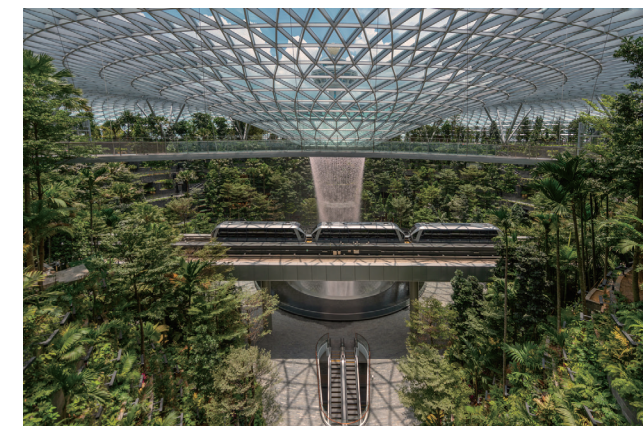


fig.49
Section,Changi Airport,
Singapore © Safdie
Architects,

fig.50.51
Photos of vortes,Changi
Airport, Singapore, ©Safdie
Architects,

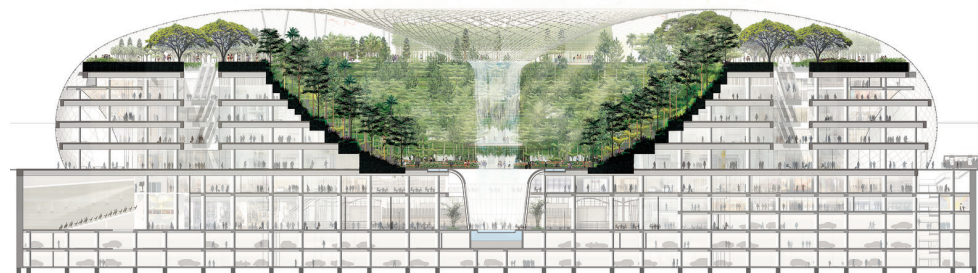
seating areas.

Home to more than 200 different species of trees and plants, there is the world's highest indoor waterfall, which pours down through an eye hole in the domed roof to the seven-story Forest Valley Garden below.Both helping to cool the landscape and collecting large amounts of rainwater for reuse projects around the building.The waterfall, as a landscape with waterfall features that do not exist in nature, is comparable to the natural landscape with its prominent biophilic features in combination with the forest valley.

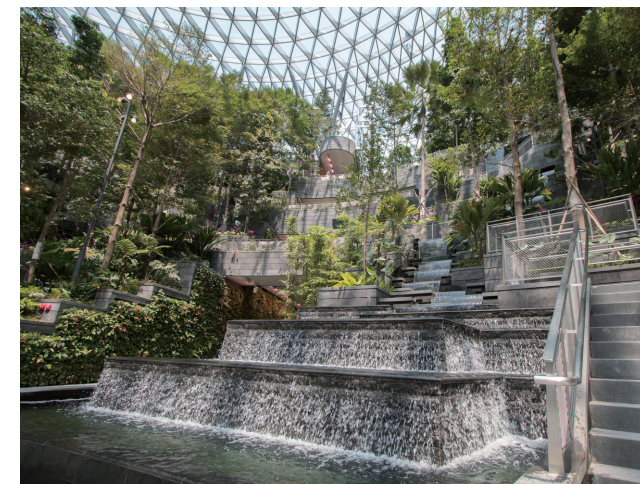
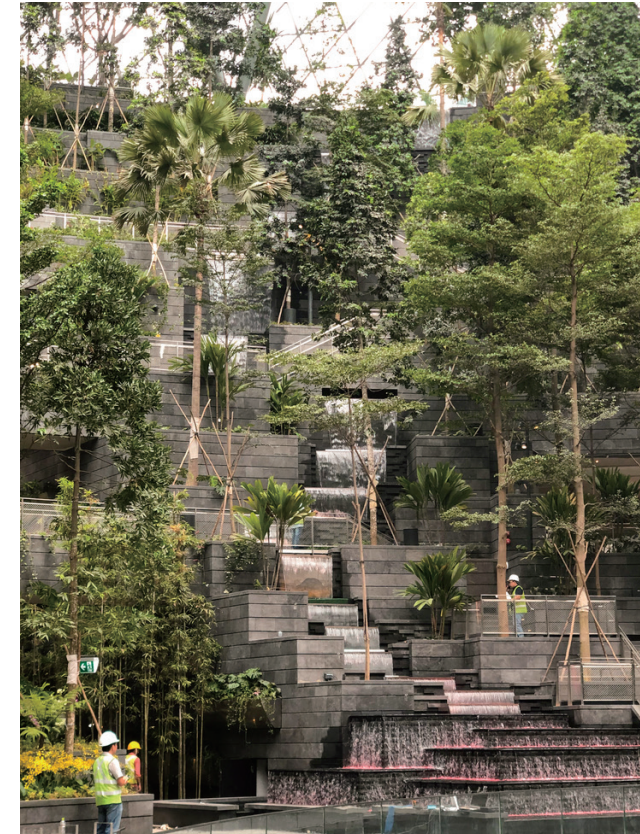
Analysis the landscape , it is the same as the real waterfall landscape structure, with mountain, height difference, plants, and other characteristics.But the water from the waterfall flows in regular rings through the transparent roof.

This is also something nature does not have.The resulting unique landscape also has the mystical character of being biophilic.On the fifth floor is the Tree Canopy Park, which features a network of dangling trees, like vines in a primeval forest, and an exciting catenary glass-bridge walkway that offers a biophilic experience of risk.

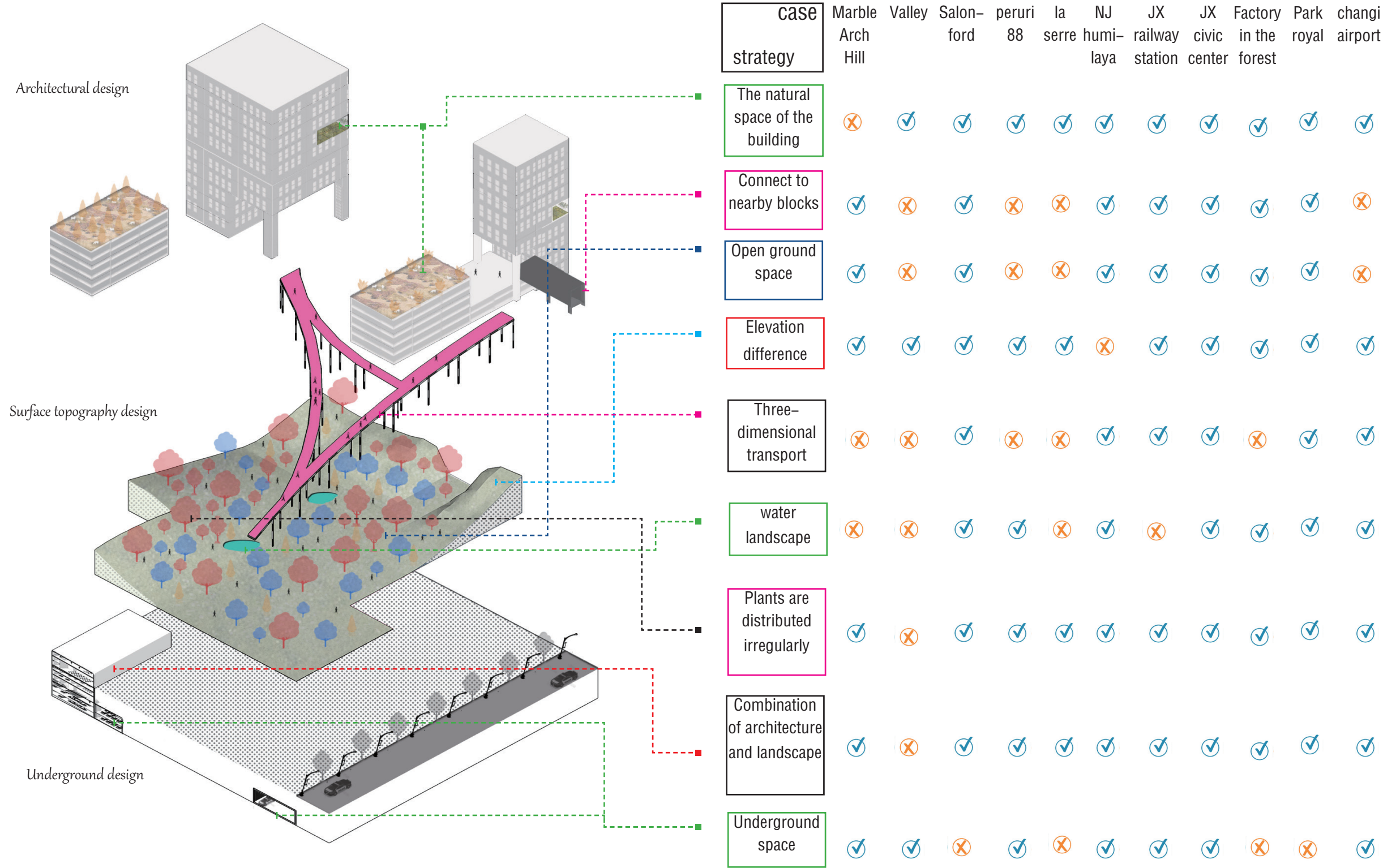
However, the most successful design of Changi



Airport is that the architects have finally turned the building into a man-made natural attraction.



Summarize of case studies



Suggestions for biophilic design

The design of a biophilic building consists of three parts: the surface design, the building design, and the design of the space below the surface.

The design of the surface,

1. Because the soil on the surface connects to the natural system.

It is also the basis for the survival of all living things, so the surface was designed to provide contact with real nature.

The topography mimics the natural mountain landscape, and the changing topography is designed to increase the volume of the land and increase the species richness and content of the site.

2. The design of the site should conform to the natural logic. In addition to providing basic traffic functions, the designed pavement should be used as little as possible and the natural soil should be used as much as possible.

Choose local tree species for ground plants.

Strive to form a truly natural system.

3. The design of waterscape should be based on the actual situation, and water landscape should not be designed for the existence of water.

If there is a water system near the site, a water feature can be designed to connect with the natural water system.

Dynamic water features are better than static water.

4. Consider providing a biophilic experience for your neighborhood, or connecting to nearby natural Spaces.

The architectural design

1. In addition to necessary functions, buildings should not occupy too much ground space and encourage the use of underground space.

Encourage large multi-functional single

buildings to improve the efficiency of land use.

The saved land is returned to natural space and made available to all, promoting the sharing of natural resources.

Encourage three-dimensional transportation.

Separate traffic functions from the surface to avoid taking up too much natural space.

2. Encourage architectural design to be integrated with topographic design, and architecture should also assume the biophilic responsibility of the city.

Biophilic design is most important to the experience, not the stack of biophilic elements.

Choose an appropriate biophilic strategy and avoid simple stacking of biophilic elements.

3. The design of the biophilic building is ultimately to design the building as a large artificial natural landscape with normal functions.

5. Small amounts of greenery can't replace large park facilities because they don't provide more biophilic content and space,

Design unit

Project introduction

Project analysis

The design title for the project comes from the 2020 Hope Architecture Competition - Buildings in Evolution,

background of competition

"A century ago, only about 10 percent of the world's population lived in cities. By 2050, the United Nations predicts, that figure will rise to 75 percent."Beyond abstract macro statistics, the staggering convergence of cities around the world is forcing us to think and try to really understand how we should analyze and understand the interaction between cities, buildings and their inhabitants, given the inevitable impact of excessive growth on people and the environment;

The way we choose to shape our cities, our buildings, and our public Spaces is linked to and ultimately determines a number of facts. More and more cities are becoming alienated. In the high-density urban Space, "Space" is everywhere, while "Place" is nowhere to be found. In the past of the city, people constantly encounter the familiar and unfamiliar "Anywhere", but where is the "Somewhere" that we are unfamiliar but familiar with? In a city like this, what do people really care about? What is the concern of the architecture community?

Competition requirements and suggestions.

The competition venue is located in Tianjin, which has four plots of land. Designers will design multi-purpose buildings for each site, which can be shared by 2,000 residents. The language of multifunctional buildings should

fig.1
map of tianjin

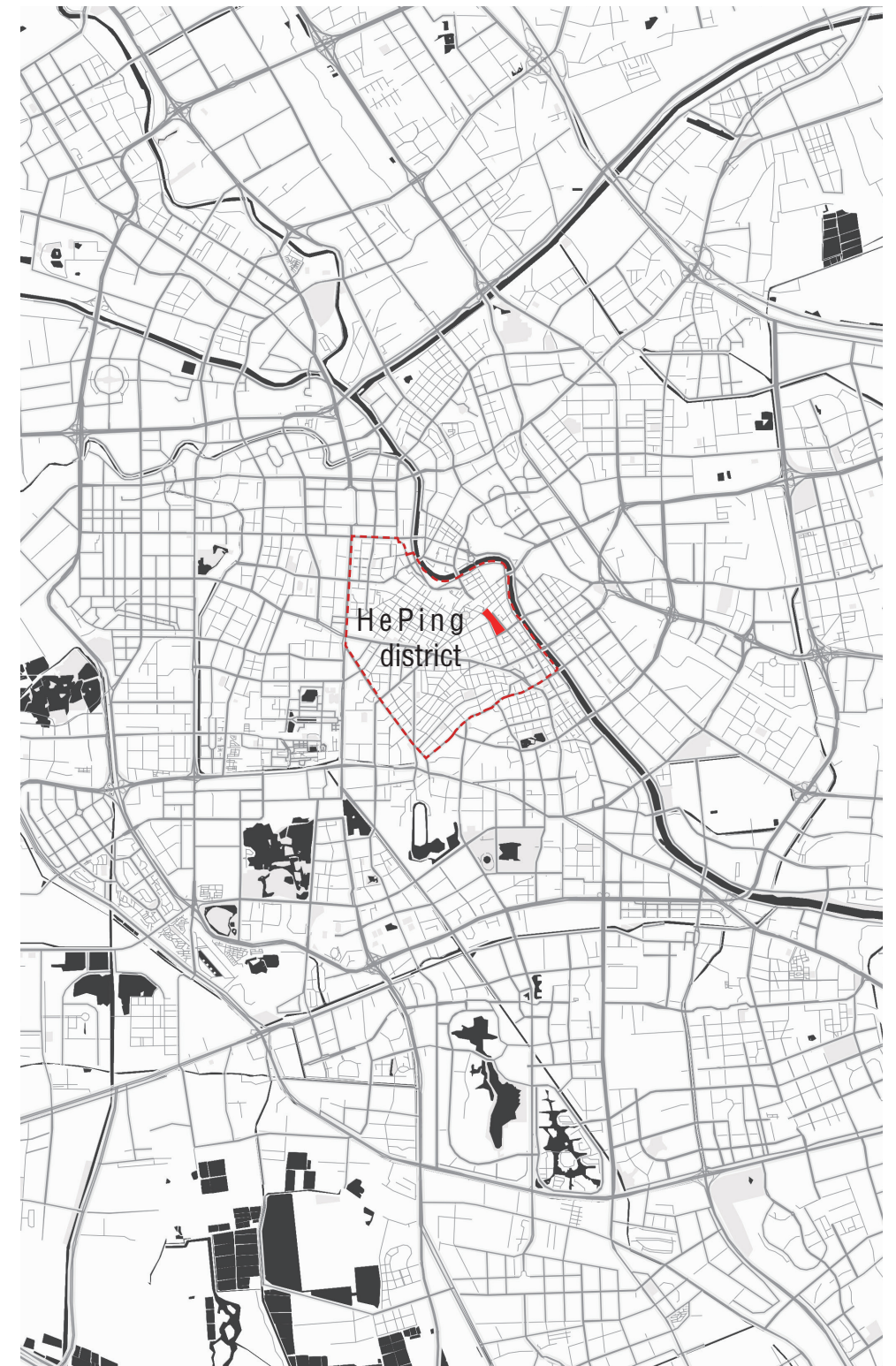


be different. High-rise tower, high density, low density building structure. However, on the tops of buildings, roofs, yards, or any other suitable area, about 30 percent of the green space should be used; Or, by raising a plot of land, you can get 50-60% of the green space. Or, if one site is low-density and another is high-density, it should be a city within a city. At the center of the four square lots is a metro station. Each site has a different function. This also means that one site may have more residential functions, while another site may have other functions...

For example, multi-functional building, commerce, shopping and so on. In other words, a piece of land has a shopping function, and a piece of land has a residential function. However, all sites can be used in a comprehensive manner. The theme of the overall design is the Media Culture Center. It is expected that this topic can be used as an experimental unit to make some contributions to the future urban typology.

However, participants who cannot attend the survey in person due to the epidemic situation can choose the same area of land by themselves. Function according to the above requirements. Other requirements are energy self-sufficiency (the area should produce more energy than it consumes) · Consider solar and wind energy as energy sources · Food self-sufficiency · Water self-sufficiency · Urban environment greenery rate $\geq 30\%$ · Sun-rich (through clever vertical and horizontal layout of the building) · Rares area (an area for recreation, aesthetic appreciation, and regional, sensual and sustainable development) Tianjin, one of the four municipalities directly under the Central Government of China, is also the largest open

fig.2
map of HePing district



city and industrial and commercial city in North China. The development of Tianjin is different from that of traditional Chinese cities. Tianjin's urban development has gone through the feudal empire era, modern and modern times, and a variety of urban planning and architectural ideas have been mixed together.

Due to the concession era of Tianjin in modern times, western planning ideas also greatly influenced the urban development of Tianjin. So far, Tianjin still retains the traces of these urban planning. Various architectural styles and planning ideas have been preserved in Tianjin. Tianjin is like a history book of the city, with each block recording its history. The same problems mentioned in the background also exist in Tianjin, just like the city in confusion mentioned in the title.

Selection of site

That site I chose is an urban center plot in Heping District, Tianjin, which is located at the intersection of Dagou North Road and Tangshan Road. The plot consists of two rectangular plots with a total area of 40,137 square meters. The reason for the selection of the site is to provide a new idea for the reconstruction of the old city, towards a more livable and sustainable development in the future.

Heping District is located in the central part of Tianjin, on the west bank of the main stream of Haihe River. Its administrative area is irregular quadrilateral, starting from Haihe River in the east and facing Hedong District.

It borders Nankai District along Nanmenwai Street and Weijin Road in the west, Xuzhou Road, Machang Road and Jinhe District in the south, Haihe and Nanlu District in the north, 3.72 kilometers in width from east to west, 4.2 kilometers in length from north to south, with a

total area of 9.98 square kilometers.

Before 1945, this block used to be a British concession, so its planning and architectural style were influenced by the British mainland at the same time, and many historic buildings are still preserved.

The site is located in the core of the Heping District, 500 meters away from the river, the west side of the site is the residential area, the east side is the financial district, the north and south side are the office buildings, the east and north side of the site are the main road of the city. Most of the blocks adjacent to the plot are historic protected buildings, and the situation of the blocks will not change greatly in the future.

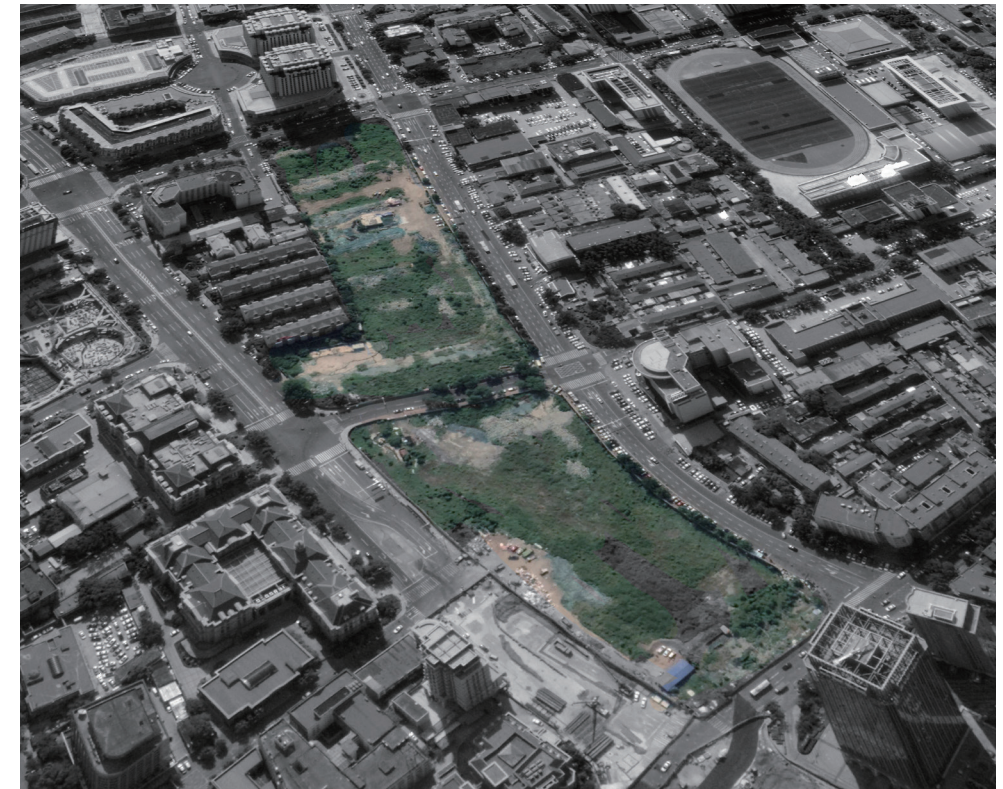


fig.3

The airview of site



fig.4
Satellite of HePing district



The picture shows the map of Tianjin in the 25th year of Guangxu Emperor of the Qing Dynasty. Due to the defeat of the Qing Dynasty in the Second Opium War, the Qing Dynasty signed the Treaties of Tianjin in 1858 and the Treaties of Beijing in 1860.

According to the treaty, Britain and France established concessions in Tianjin.

The concession is located in the south of the old city of Tianjin, on the left bank of Haihe River.

It is also the center of the current peace district.

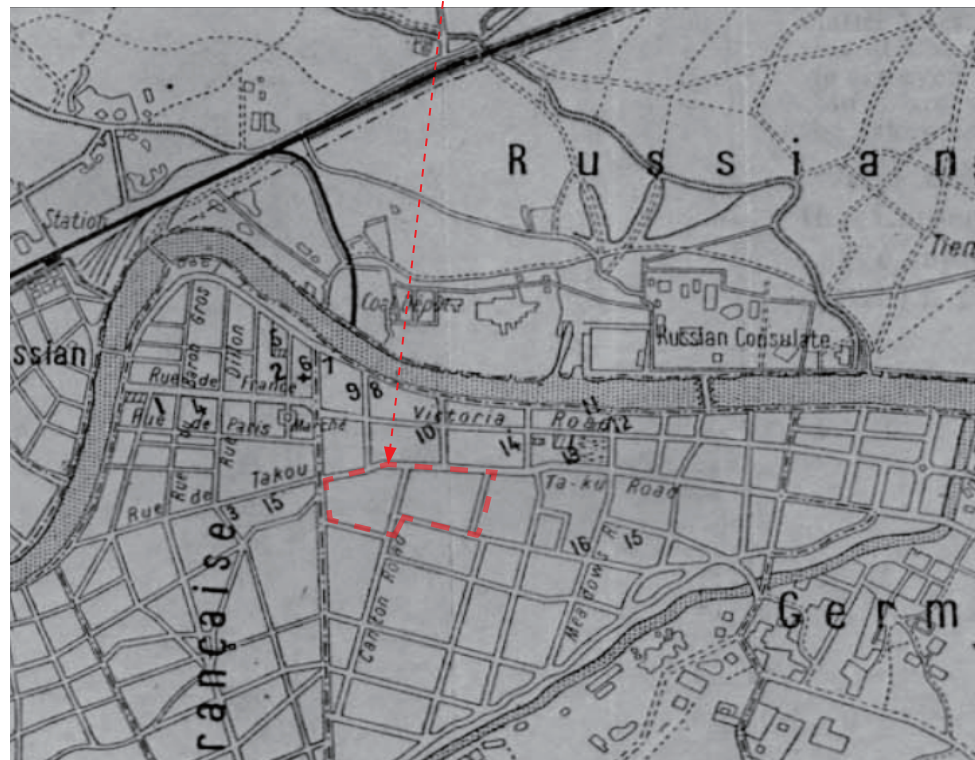
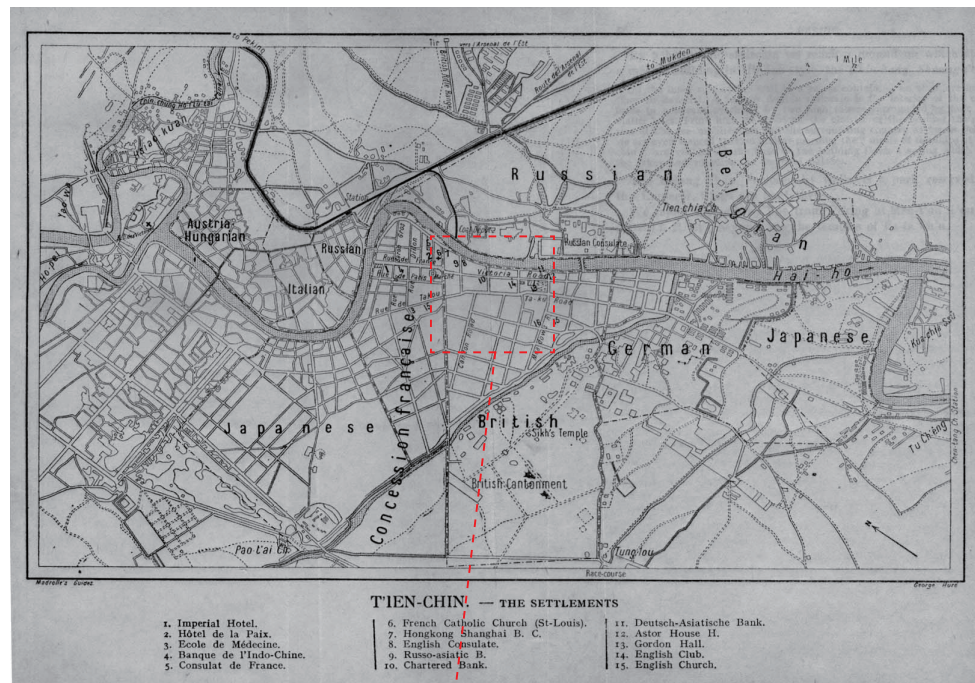
According to the information on the map, the architecture in the concession is different from that in China. The buildings in the concession are three-story Western-style residences.

Grid streets were not yet formed.



fig.5
Tianjin cheng xiang bao
jia quan tu, 天津城厢
保甲全图, This map is
available from the United
States Library of Congress's
Geography & Map Division
under the digital ID g7824t.
ct002306.

fig.6
partial enlarged detail, The
British and French
Concession



The map was drawn in 1912, when China ended the feudal dynasty and entered the Republic of China.

From 1860 to 1945, nine countries established concessions here.

The longest British Concession lasted 75 years. The British Concession of Tianjin was small at first;

There are only three roads running north and south, Victoria Road in the middle, River Dam Road on the east and Haida Road on the west.

After the settlement was expanded in the late 19th century, more than 70 streets were built.

Combined with the Haihe River dredging project, the British Municipal Council and Engineering Bureau of Tianjin reclaimed part of the dredged area into urban parks, such as the Victoria Park, the earliest garden landscape in the British Concession in Tianjin.

The block where the design site is located is located at the junction of Dagu Road and the French Concession, surrounded by three other unnamed streets, but the area of the whole block is much larger than the current area.

fig.7
The map of foreign settlements (concessions) in Tianjin, as of 1912. Originally titled "T'ien-chin - The Settlements 1912", From "Madrolle's Guide Books: Northern China, The Valley of the Blue River, Korea." Hachette & Company, 1912.

fig.8
partial enlarged detail



This map was drawn in 1942, when the planning and construction of the area near the Hai River in the British Domain was completed. The street shape is stable, and the area where the site is located, the block and the street shape have been formed as they are now. The site is surrounded by Bristow Road (the border between the British and French Concessions), Daven Port Road and Daku Road.

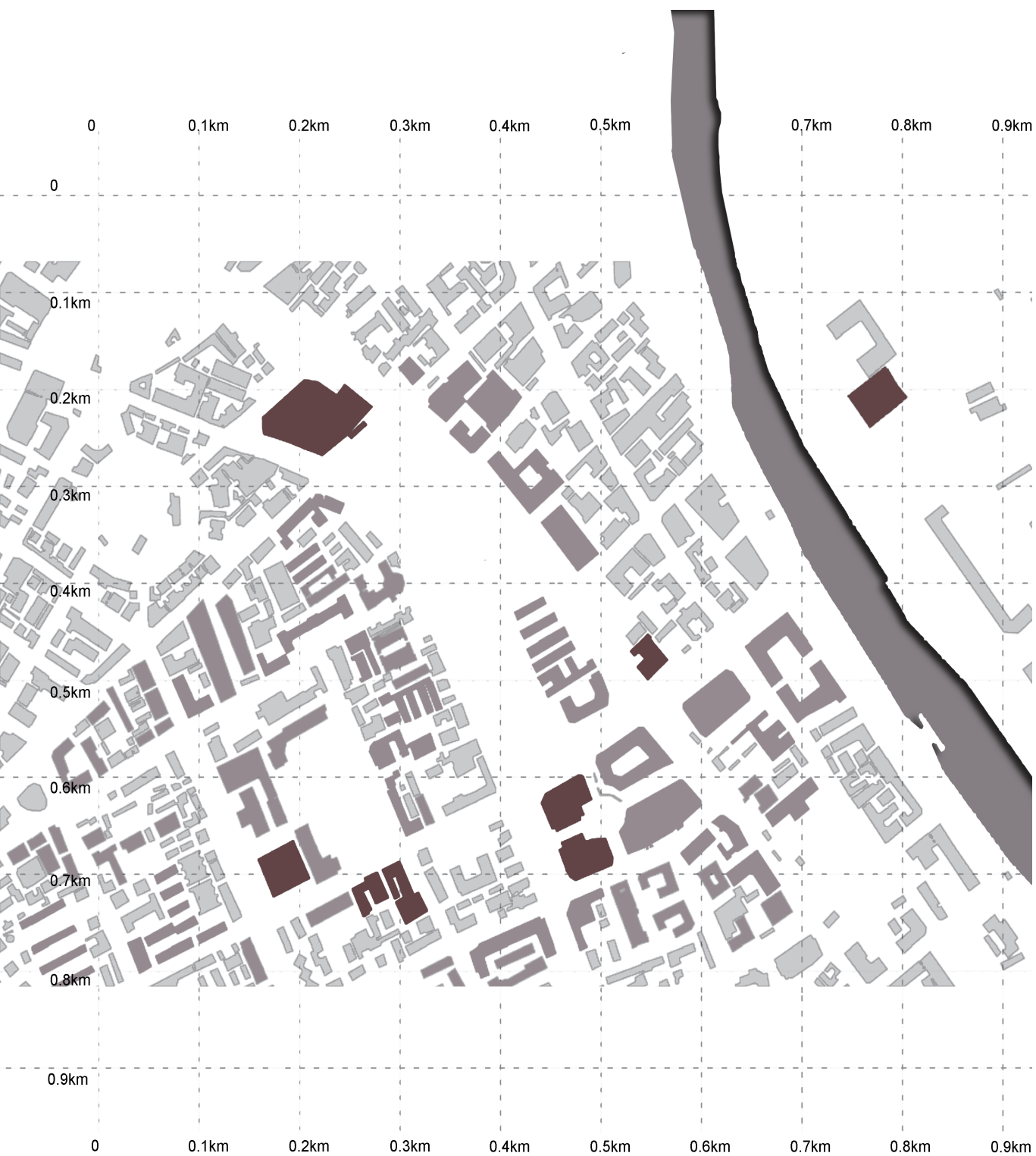
fig.9
Map of Tientsin 1942
Source University of Texas
Perry-Castañeda Library Map
Collection [http://www.lib.
utexas.edu/maps/ams/china_
city_plans/](http://www.lib.utexas.edu/maps/ams/china_city_plans/)
Author United States Army
Map Service



fig.10
Victoria Road 1930
University of Bristol -
Historical Photographs
of China©2012 Historical
Photographs of
China reference number 1930

fig.11
Meadows Road, Tientsin,
China, 1904, Chandless,
Robert Henry, 1880-1951

fig.12
Victoria Park 1930s
©2012 Historical Photographs
of China



TPOLOGY OF ARCHITECTURE

- High-rise building
- Medium height
- Low-rise building

fig.13 XinHua Center
34 Yingkou Road, Heping
District, Tianjin, China.

fig.14
167 Dagu North Road

wfig.15 Renji bank
129 Jiefang North Road

baidumap.com



 *historical building*



fig.16
Jing Yuan Garden in Anshan
Dao No. 70, Heping District,
Tianjin .
Author :TJArchi-Studio

fig.17
The Astor House Hotel in
Tianjin,
Author:Xrdtj

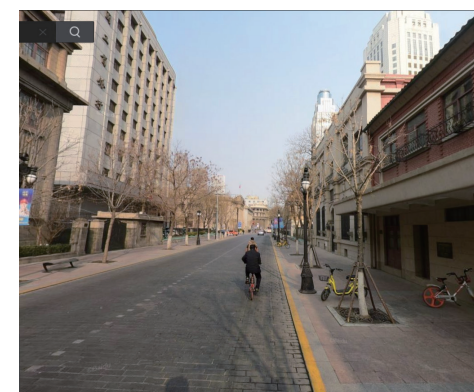
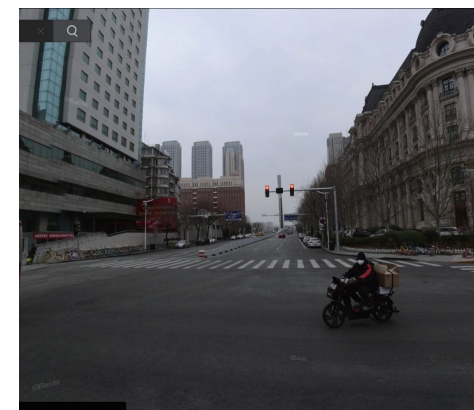
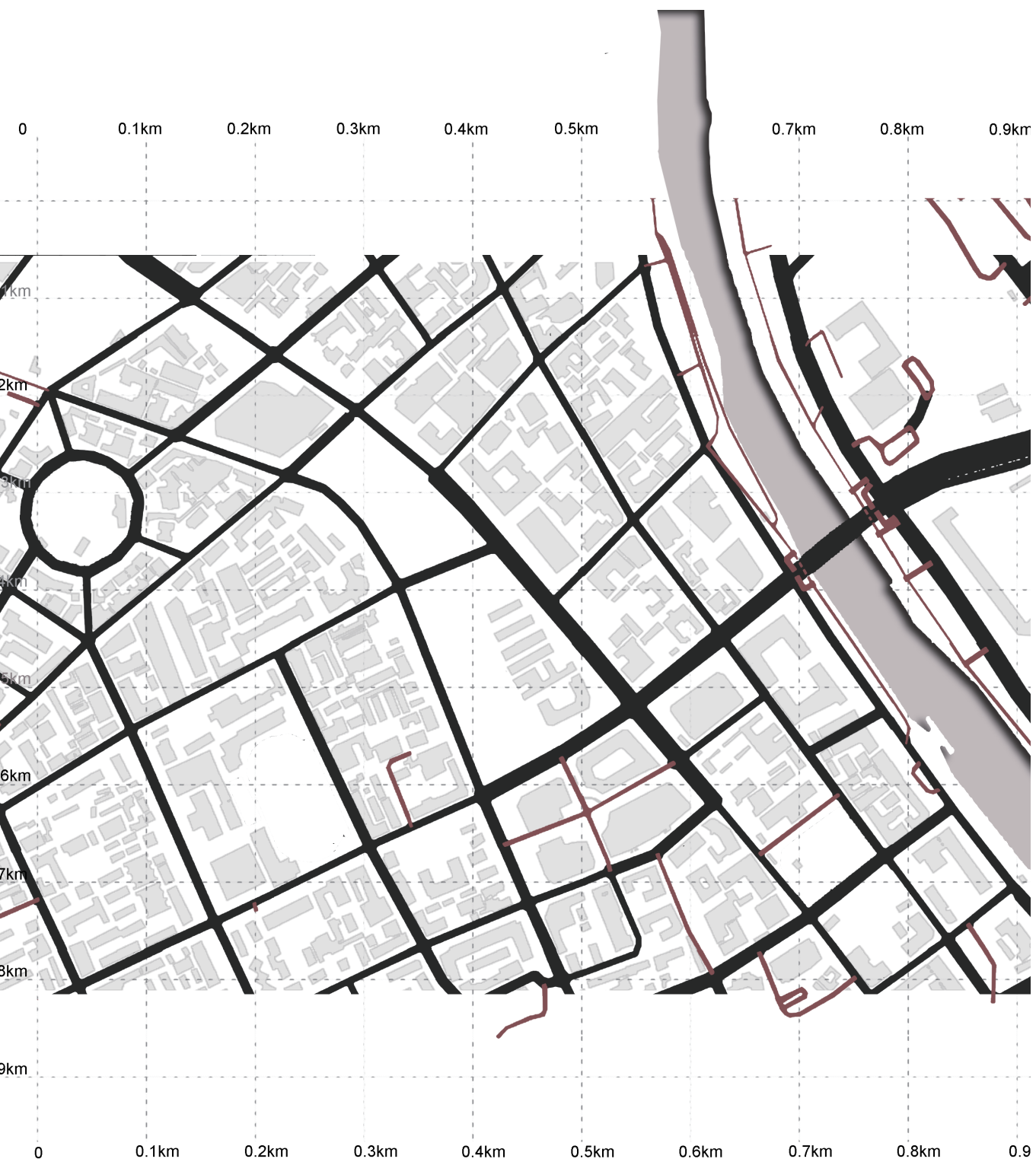


fig.18
DaGu North Road

fig.19
JieFang North Road

baidumap.com

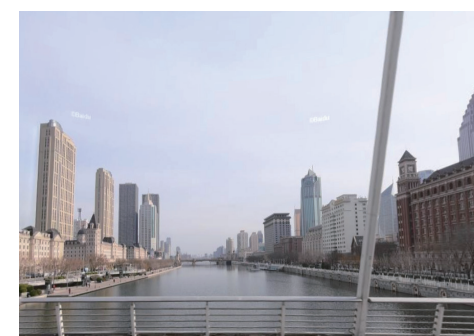
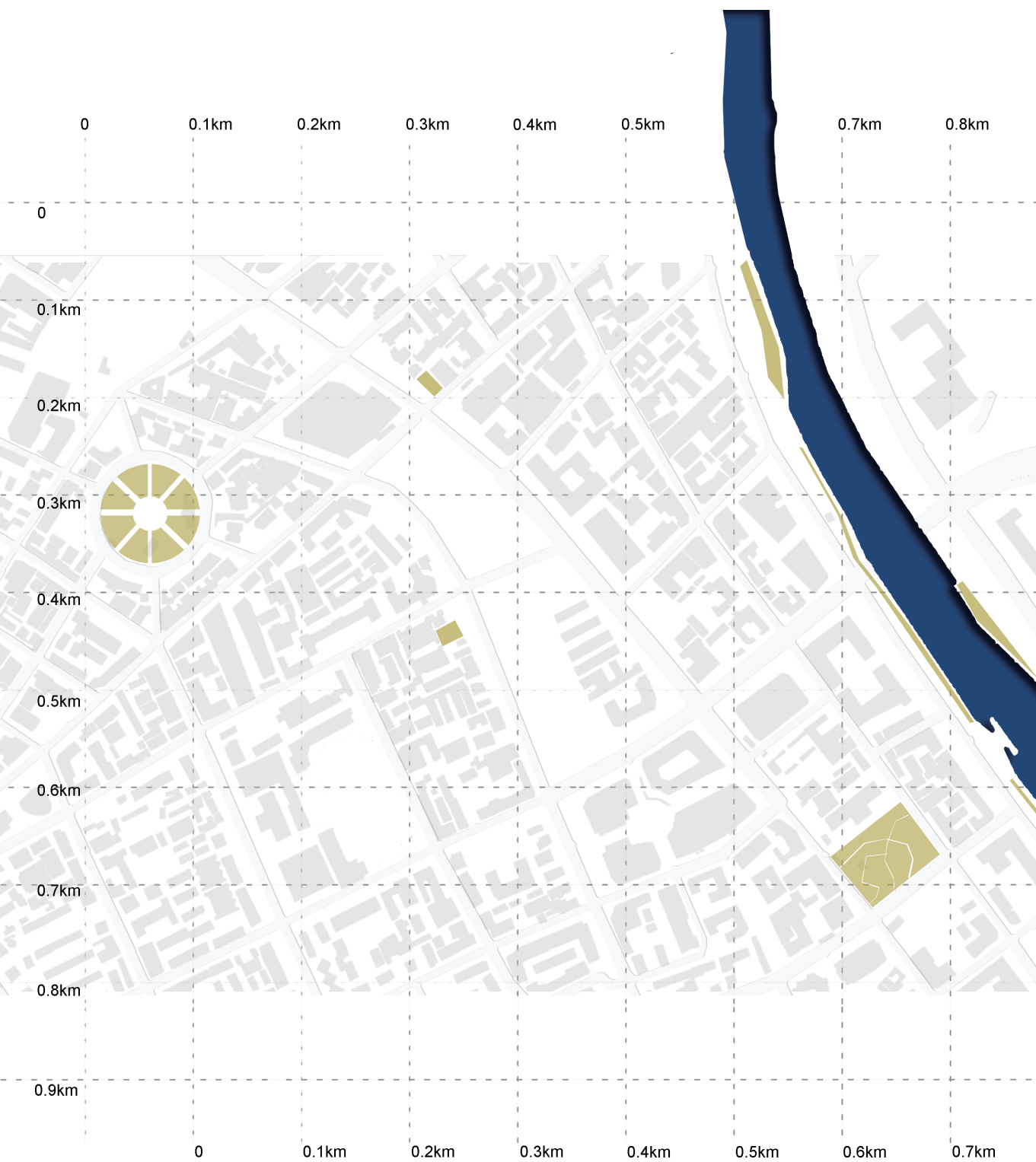
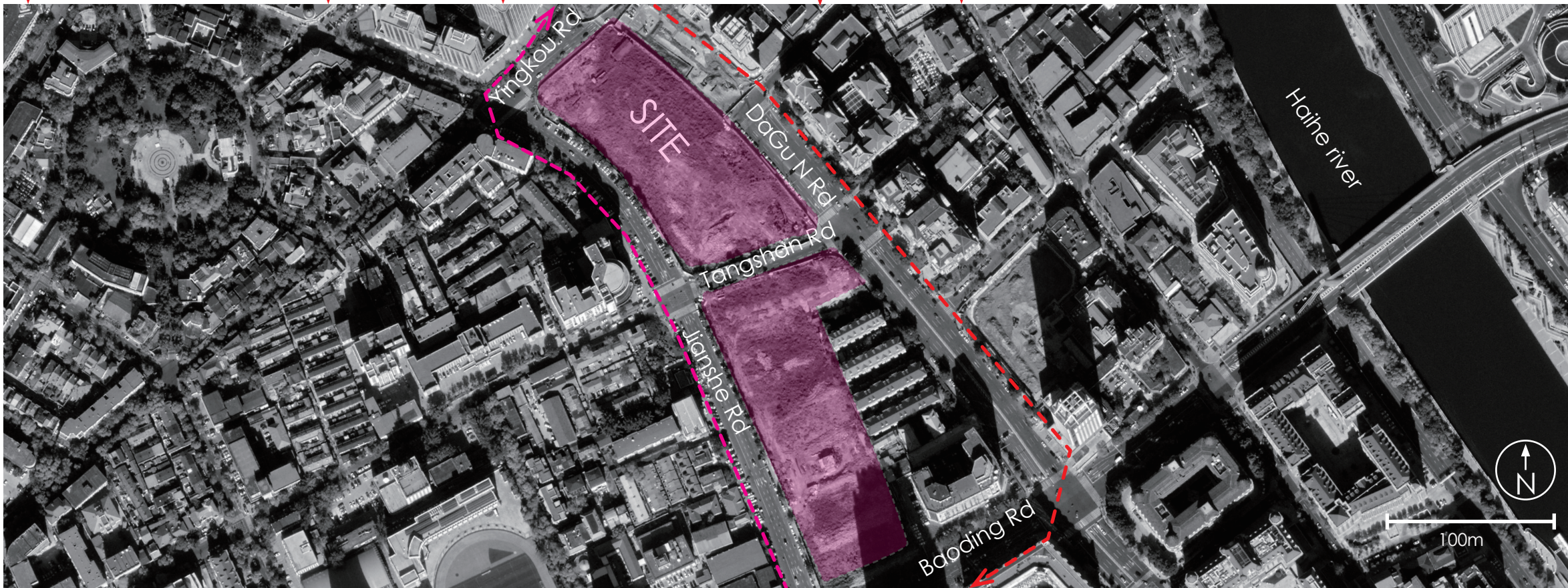


fig.20
ZhongXing park

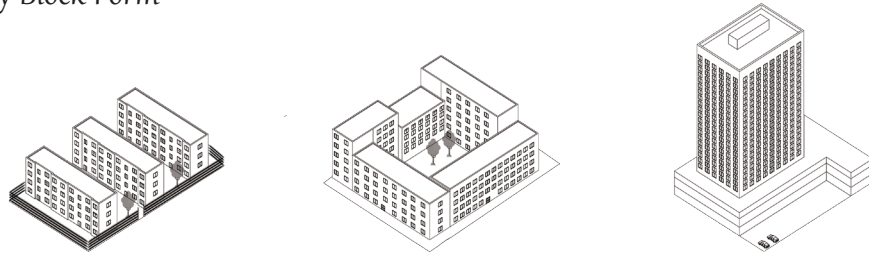
fig.21
Hai He River

baidumap.com

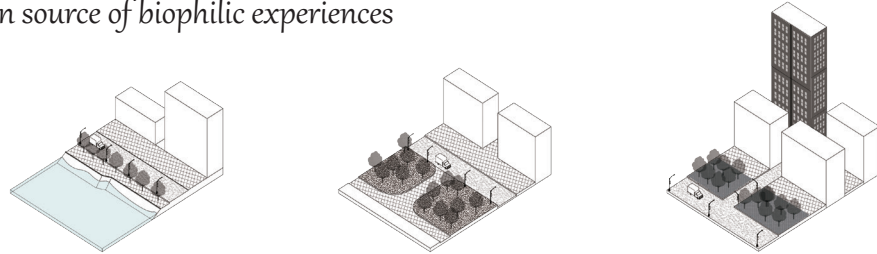
Site surrounding



Nearby Block Form



Main source of biophilic experiences



Biophilic experience analysis

The biophilic experience of residents in this area mainly comes from two kinds of Spaces. The first is the riparian space and small park located on the banks of Haihe River, which mainly provides visual and non-visual contact with plants, water, landscape and other biophilic elements.

The second is located in a high-rise building, providing visual contact with nature and rich visual information through a distant view.

The former is the real experience of the real natural space, while the latter relies mainly on the vision.

Other sources of biophilic experience in urban space are street trees and some historical buildings, but these biophilic experiences are far lower than the first two.

After analyzing the biophilic biological experience in the nearby blocks, it is found that the natural space of urban park and river

bank is insufficient and can only satisfy the daily biophilic experience of the residents in the nearby blocks.

The building form of blocks is mostly closed and community. Some large communities have miniature landscapes, but these landscapes cannot be shared due to property rights, security and other reasons due to the closed nature of the community.

Making the residents of these neighborhoods less biophilic. While some of the high-rise buildings on the block offer a biophilic experience from a distance, with few natural or biophilic elements within visible range, their biophilic experience is only superior to that of gated communities.

In the biophilic theory, the greatest degree of biophilic experience can be created by being in nature. Or it can be considered that the artificial area tends to zero while the natural area tends to infinity. Therefore, in order to improve the biophilic experience of the site and the nearby blocks, the most necessary thing to do in the design is to provide the maximum natural space.

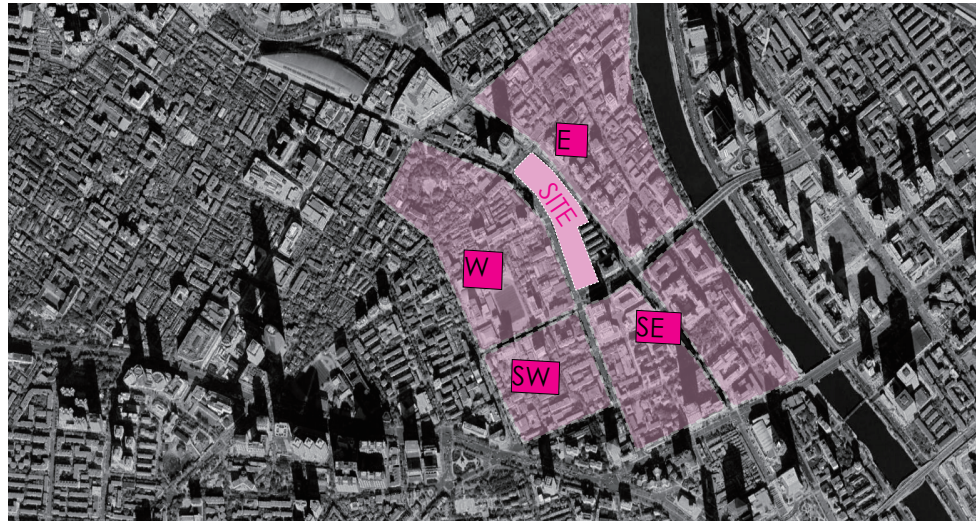
Principles for this project

1. In the Biophilic theory, the maximum biophilic experience is in nature, or it can be considered that the artificial area tends to zero while the natural area tends to infinity. Therefore, in order to improve the biophilic experience of the site and the nearby blocks, the most important thing to do in the design is to provide maximum natural space.

2. As the surface is the space that mainly carries the natural system, the surface space should be preserved to the maximum extent.

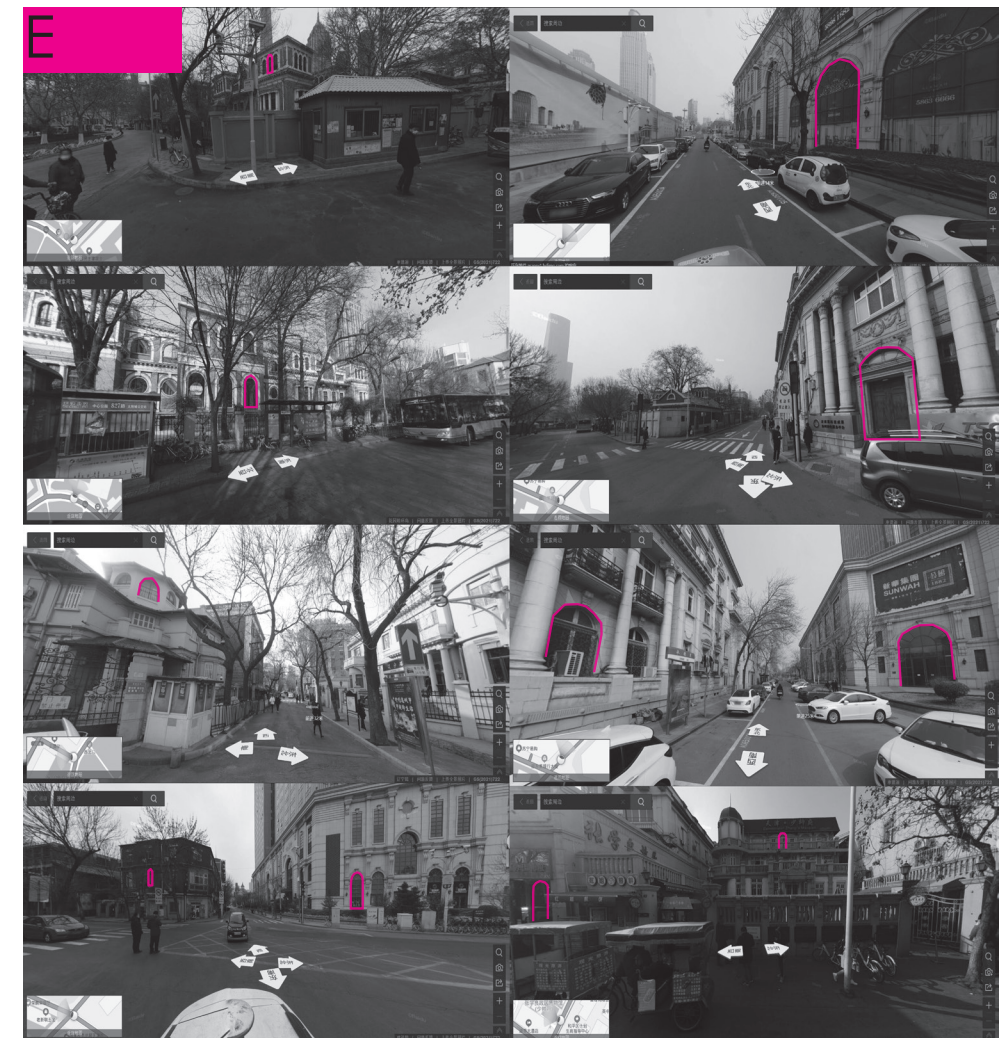
3. "Open up" gated communities to share the natural Spaces mentioned above.

Traces of history



The blocks around the site are all historical blocks, where a large number of historical buildings and modern buildings are mixed together, spanning from the 19th century to the present. The principle for the protection of historic buildings in Tianjin is not only to protect the buildings themselves, but also to protect the blocks where the buildings are located to maintain historical continuity so as to achieve the purpose of extending the historical context. As a result, the road planning of the block is dominated by history, and most of the new buildings are similar to the style of the block they are in. Therefore, both old and new buildings have similar architectural elements, among which the most frequent element is the arched window.

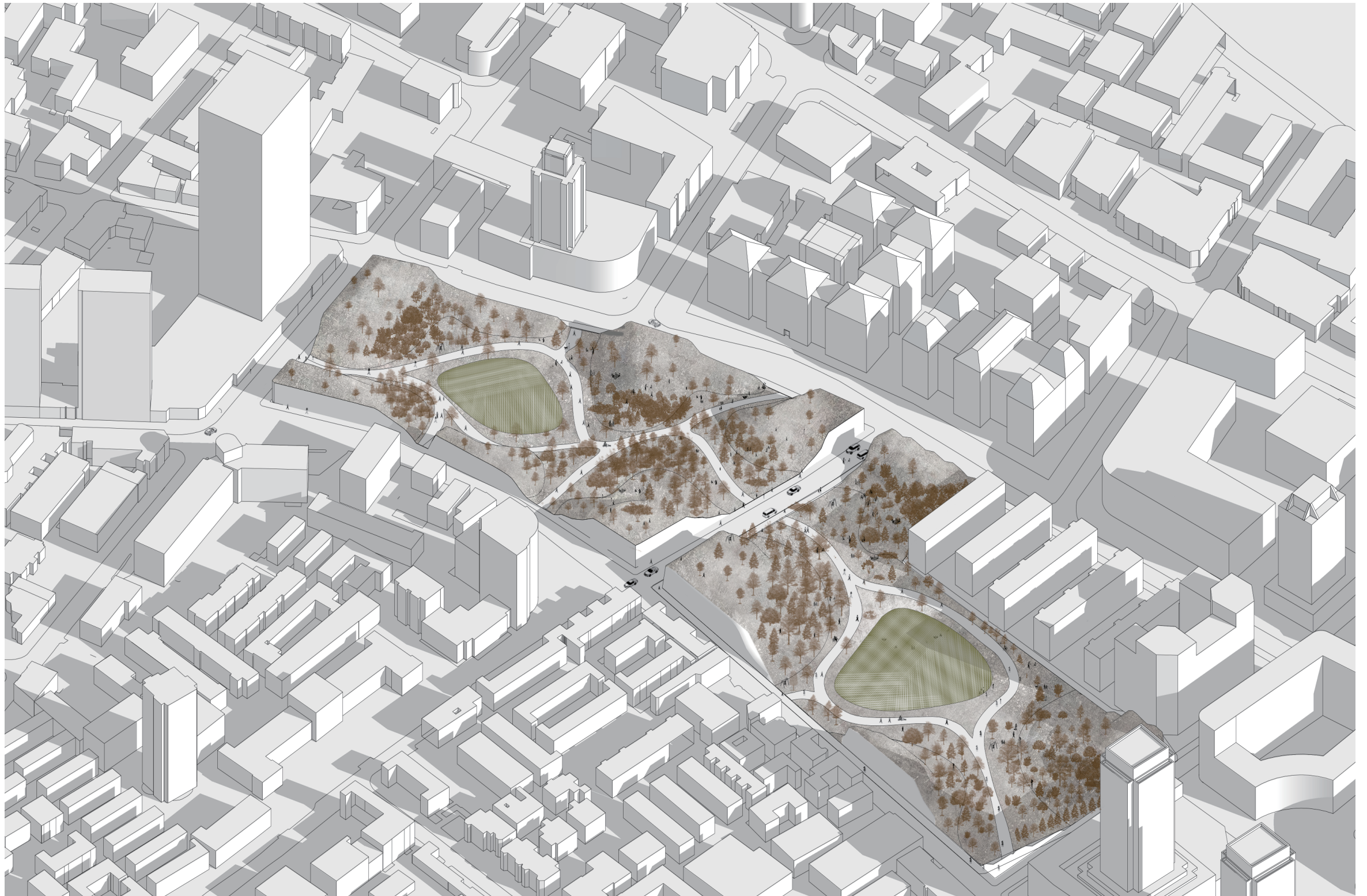


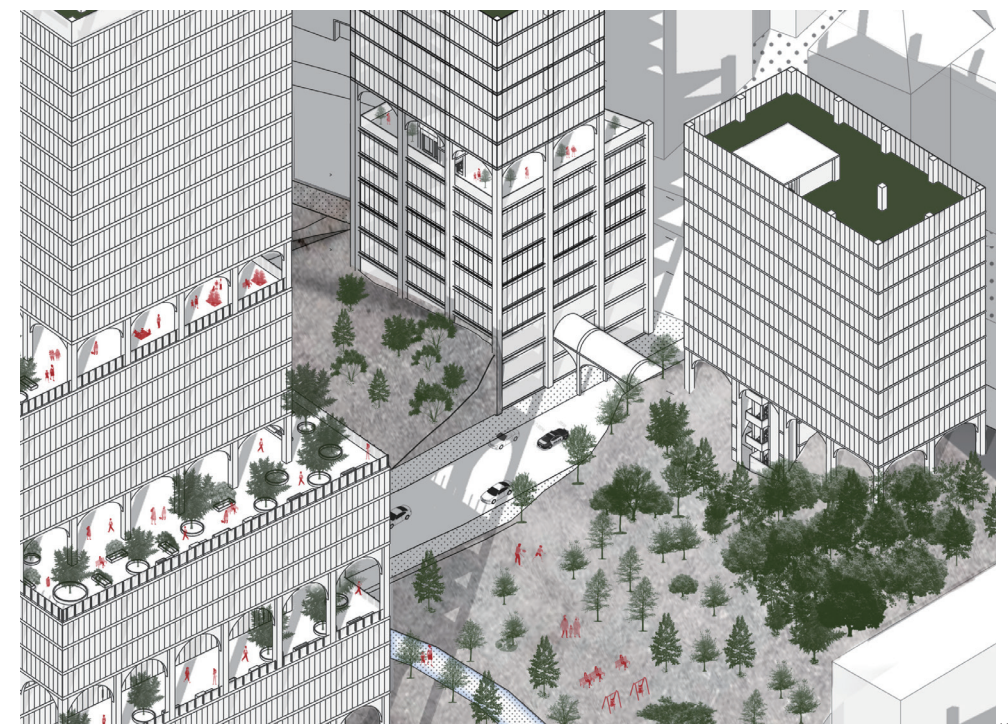
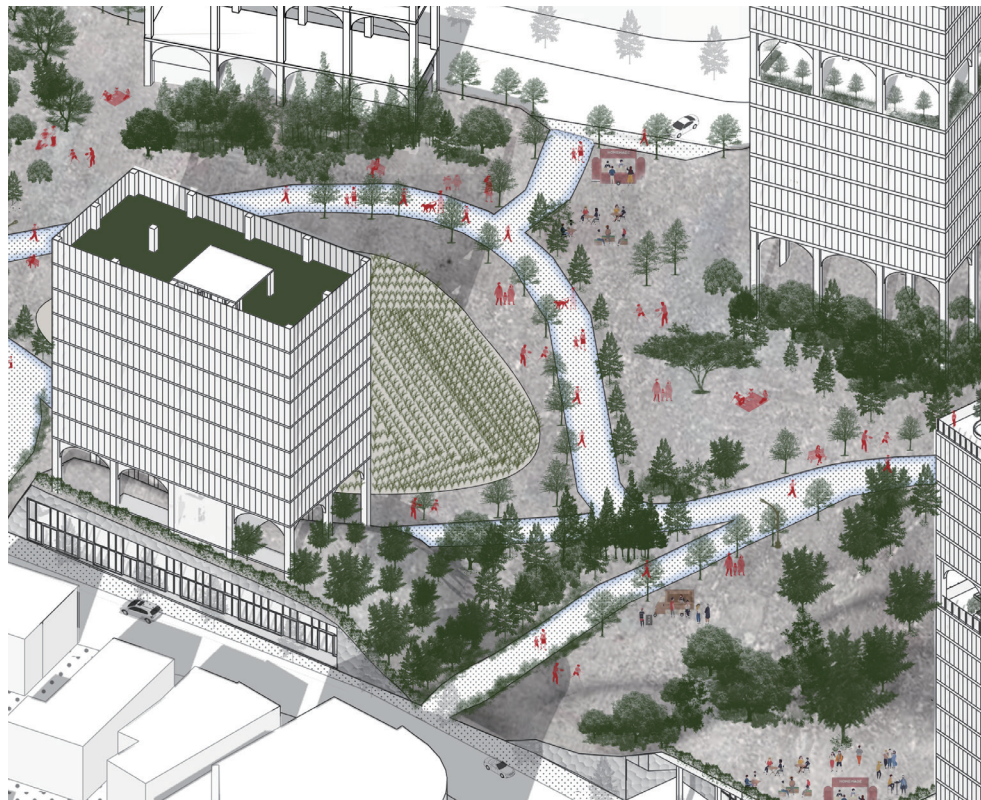
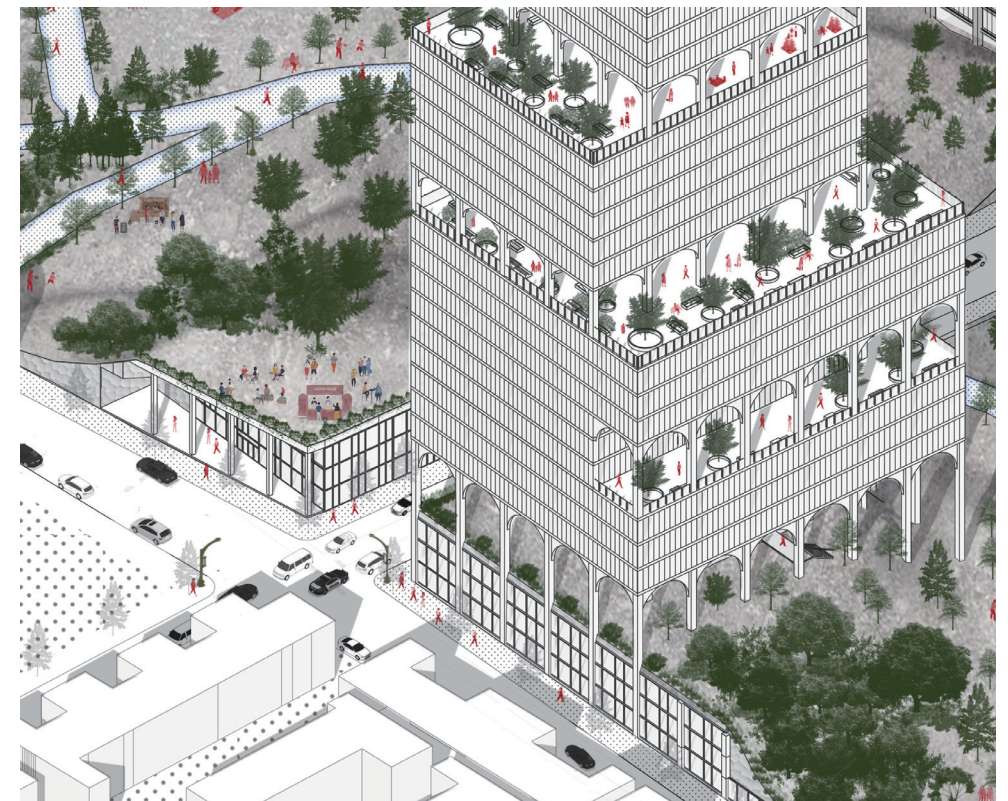
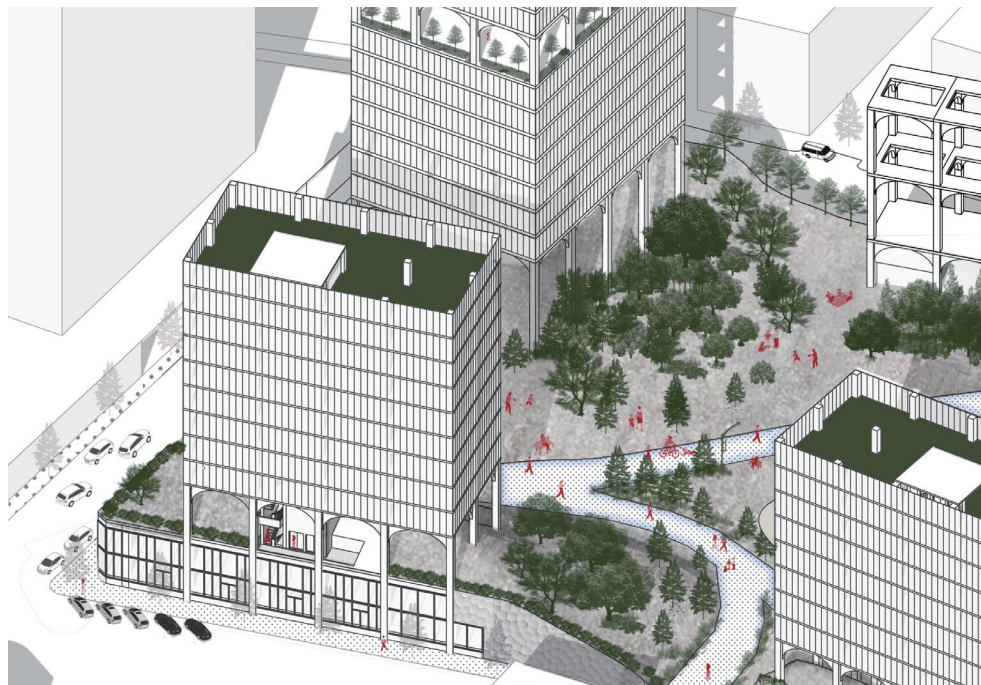


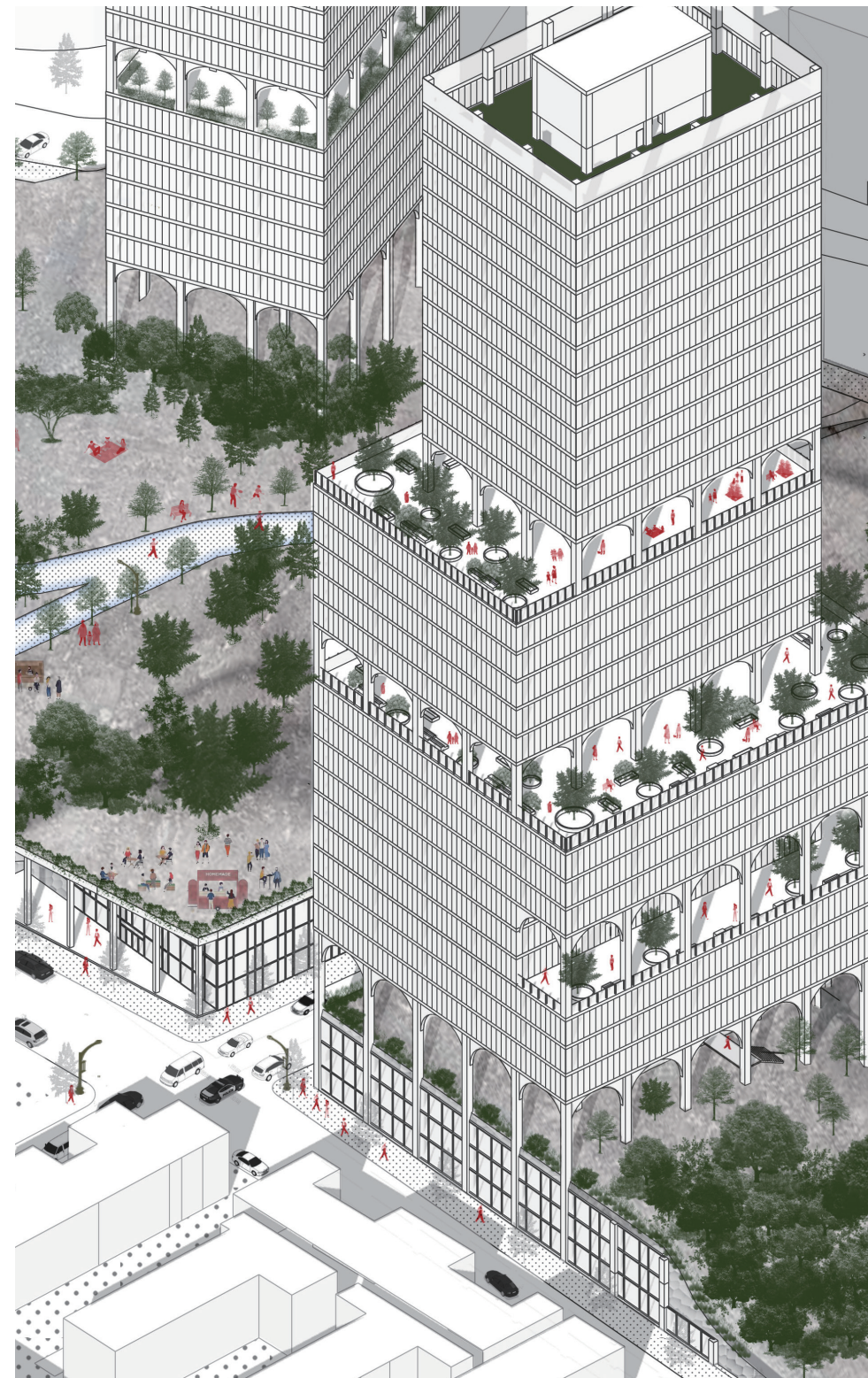
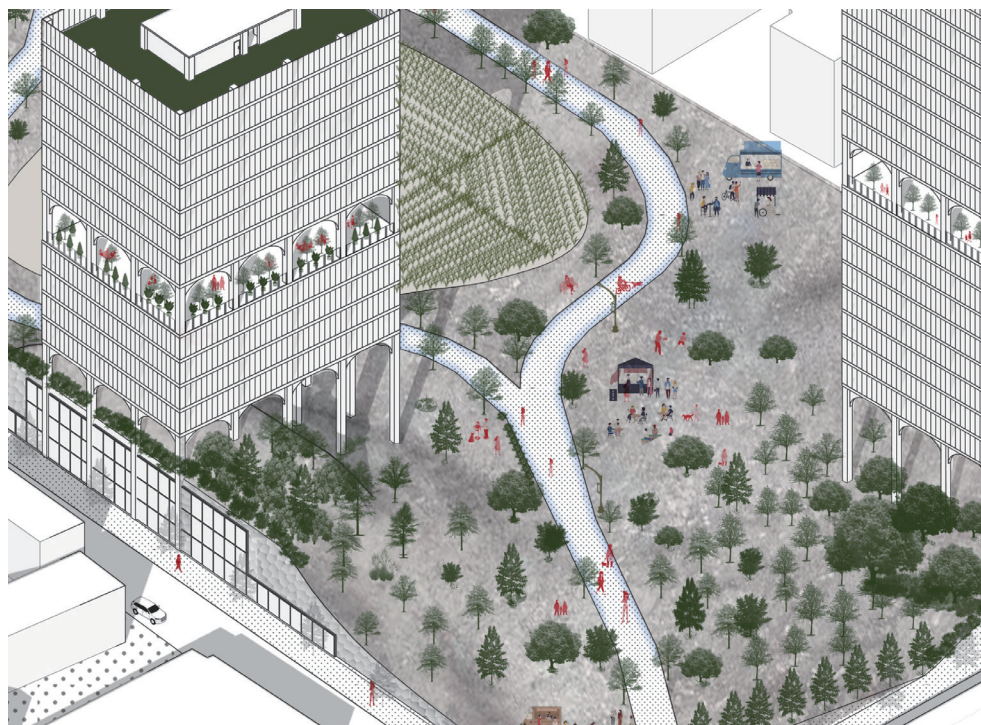
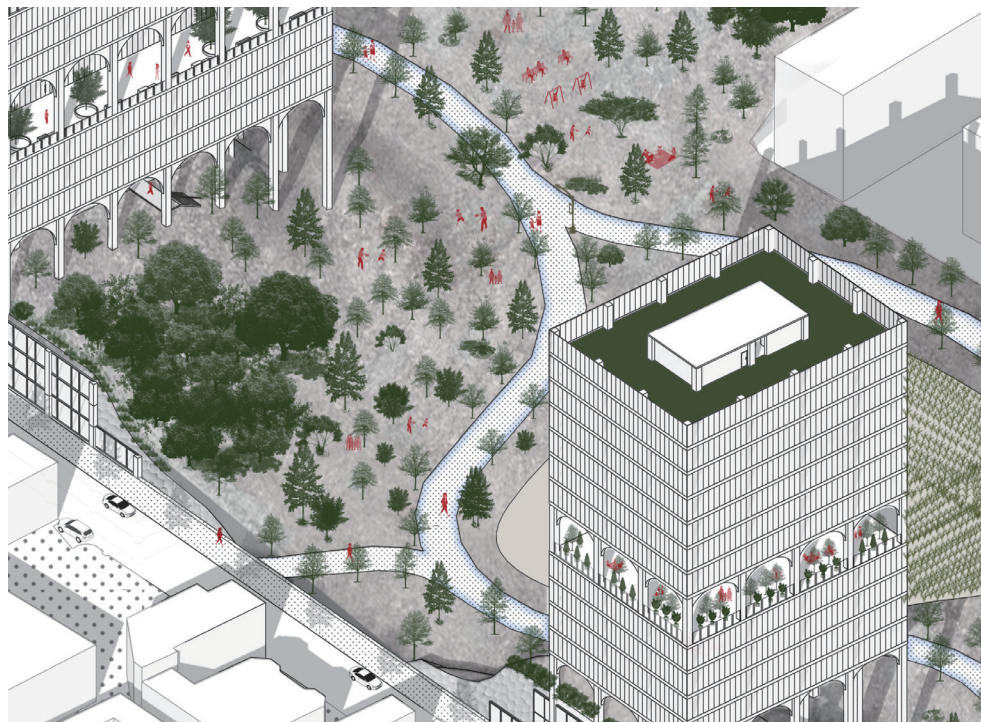


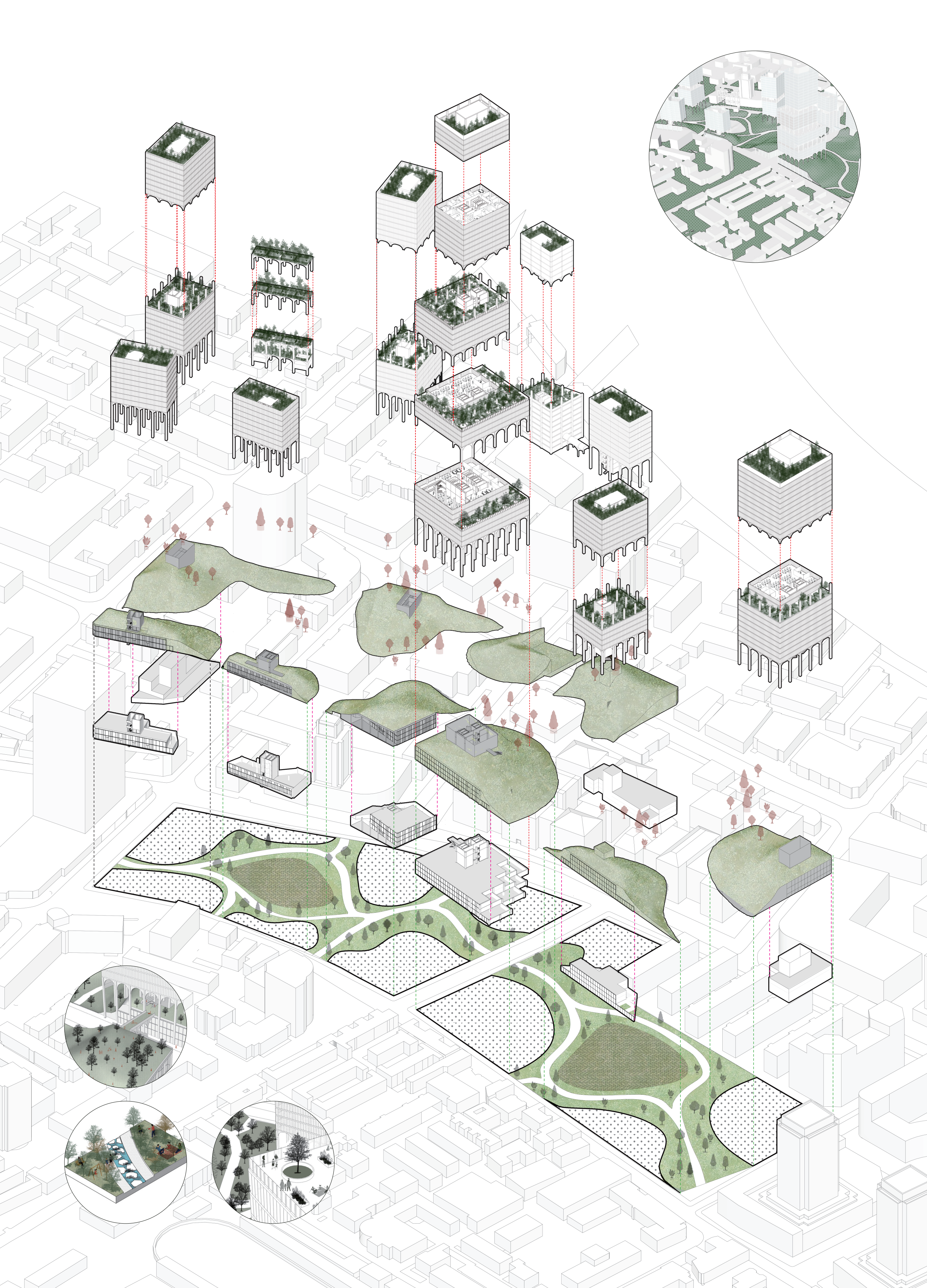


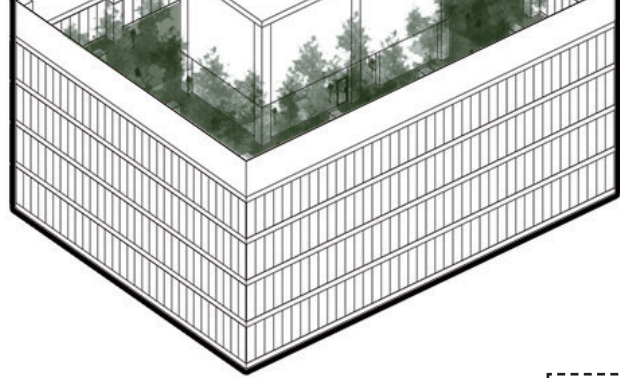




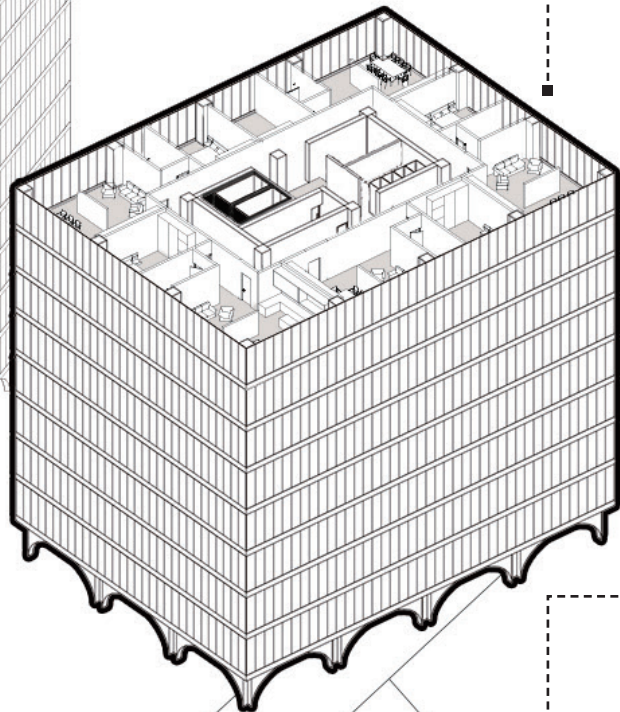
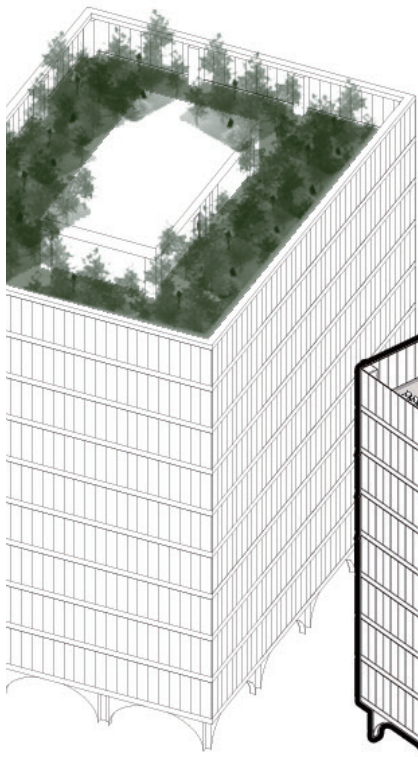
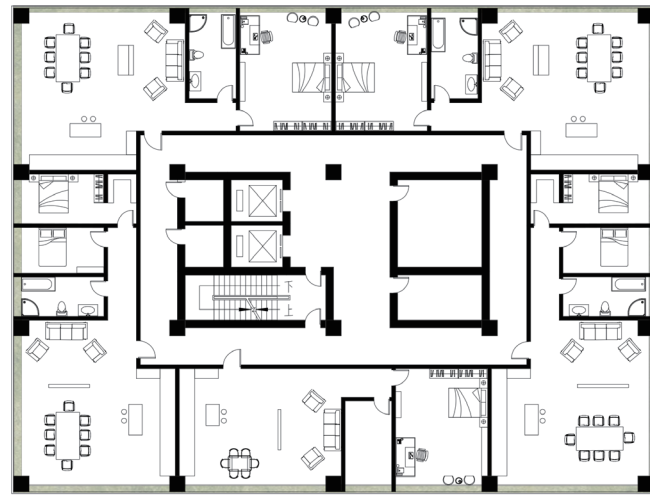




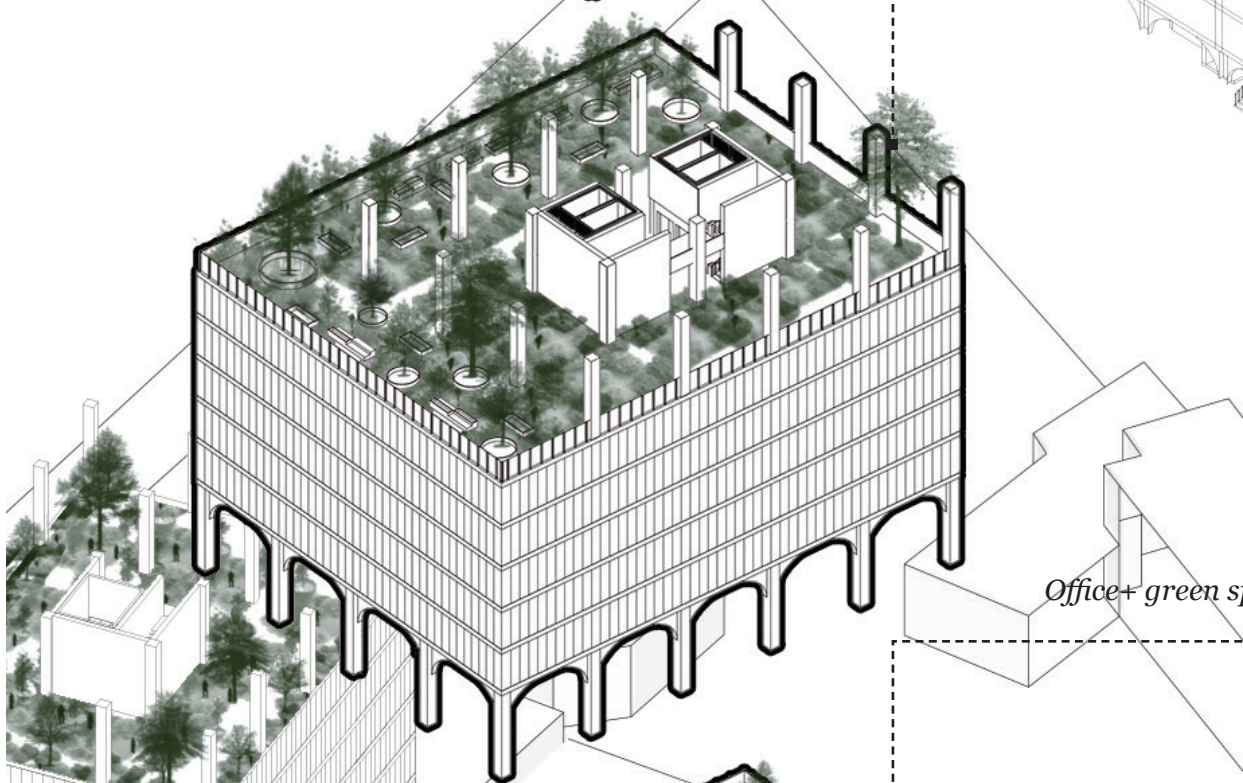
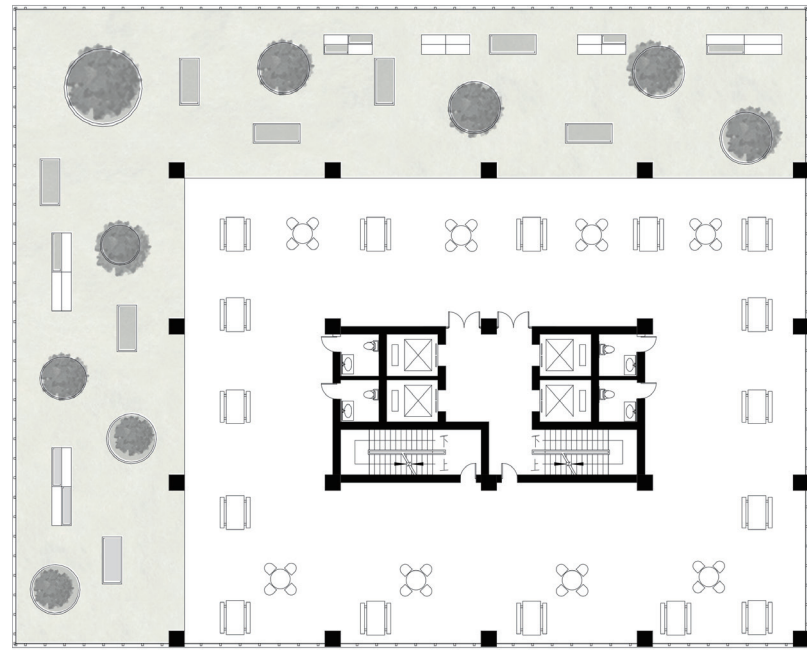




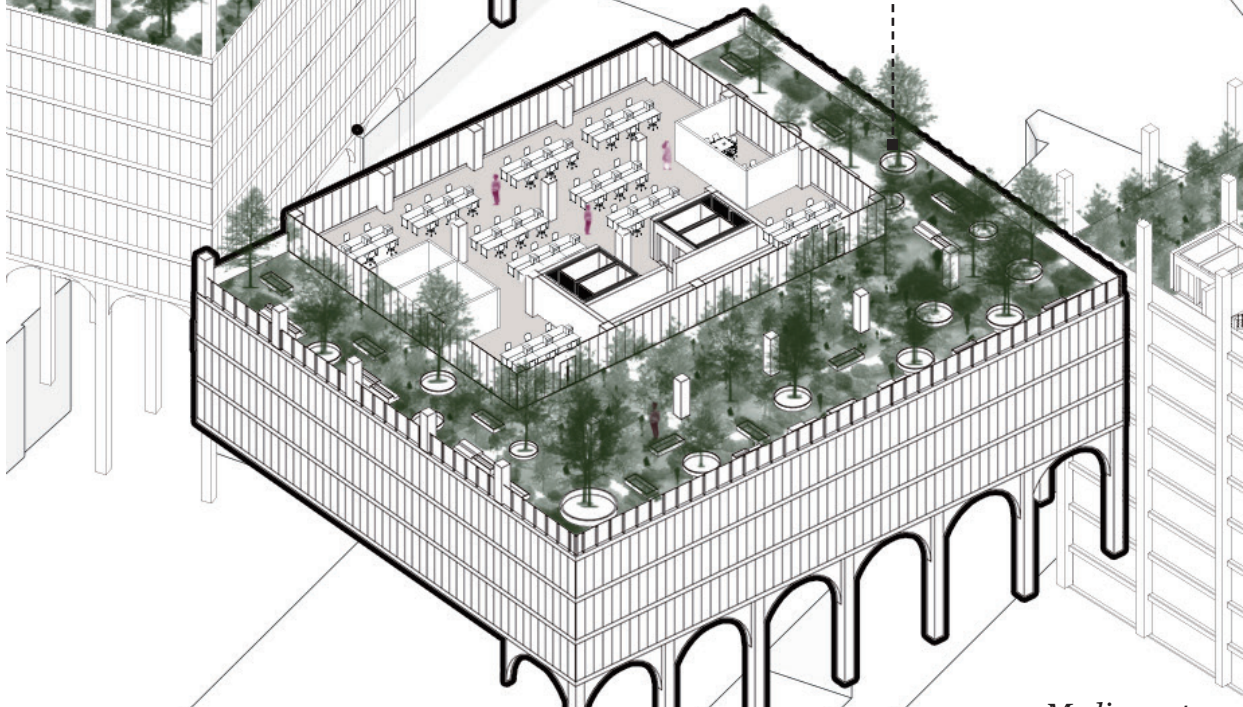
Apartment



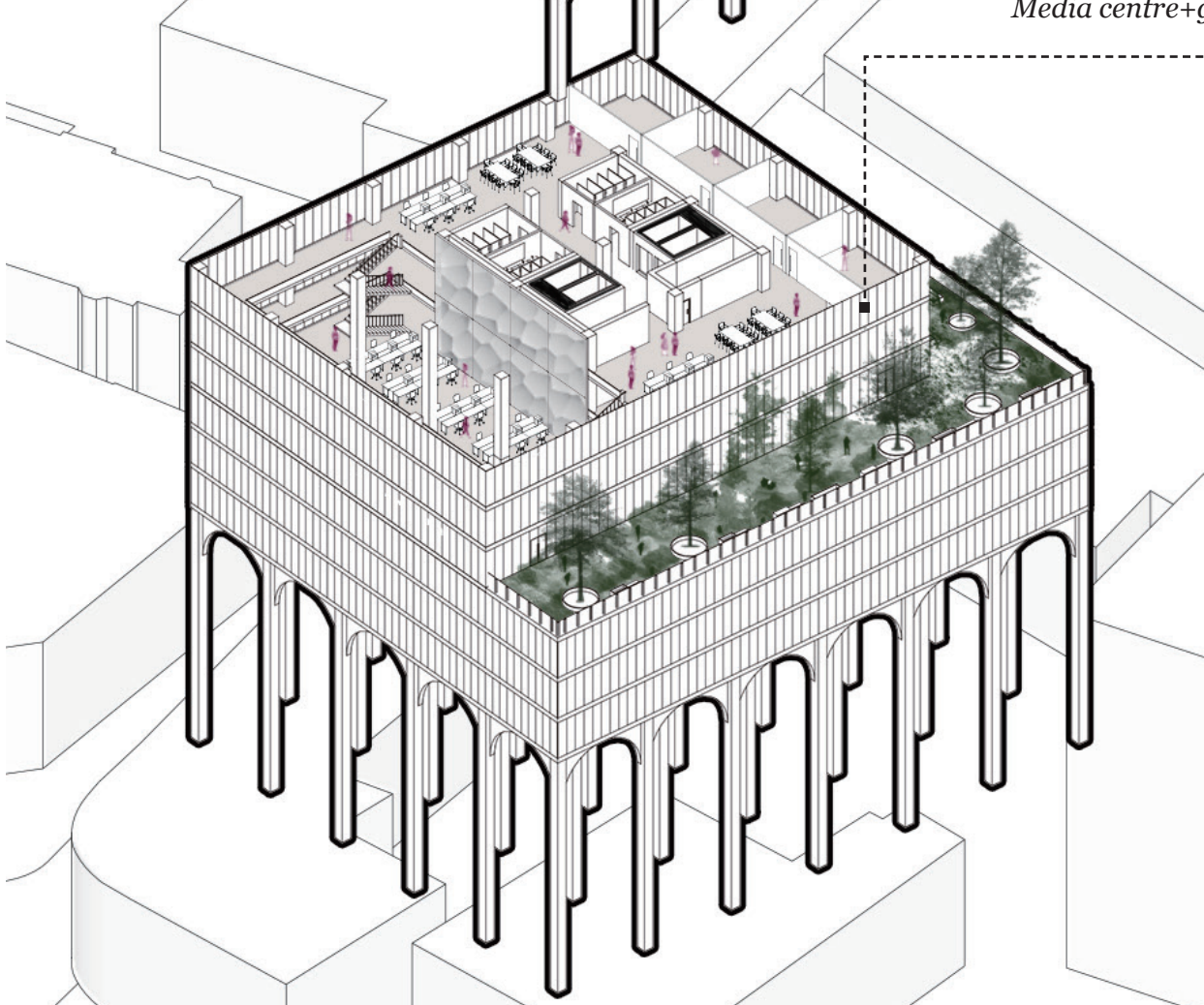
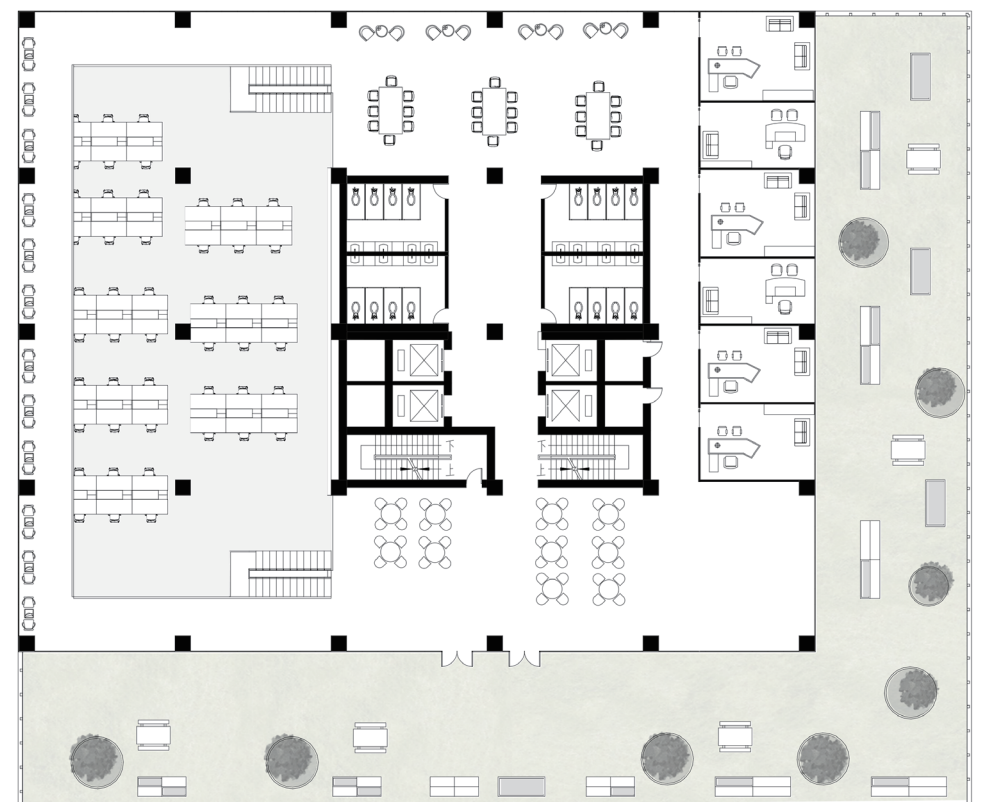
Public green space



Office+ green space

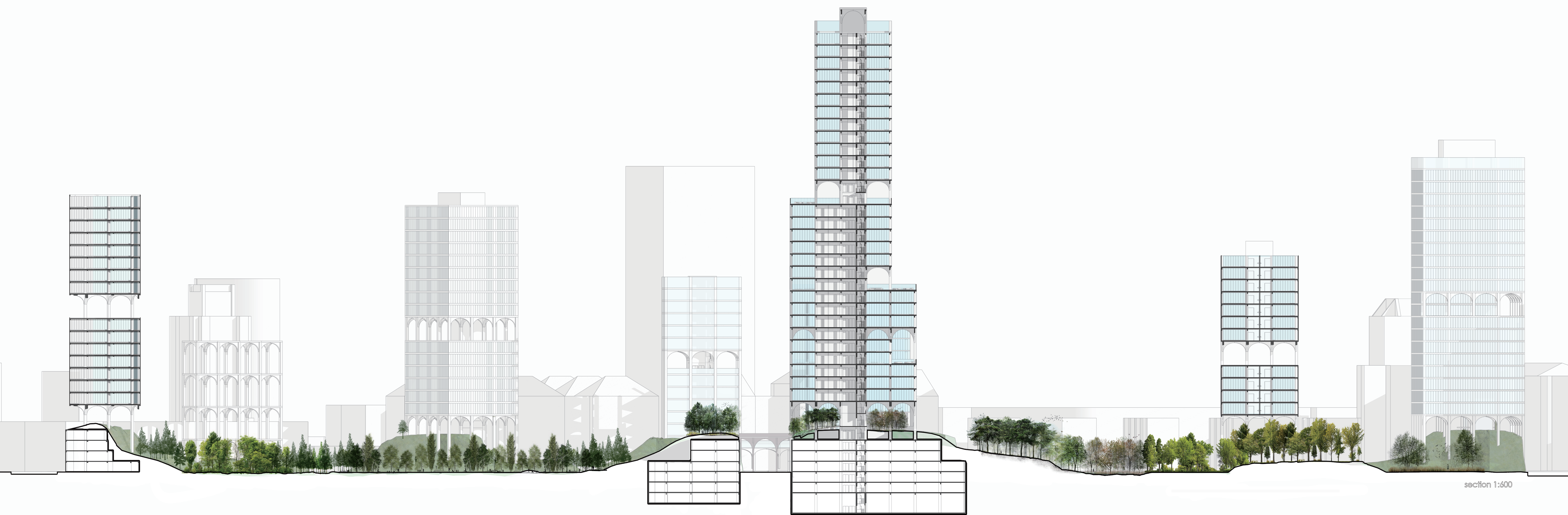


Media centre+green space

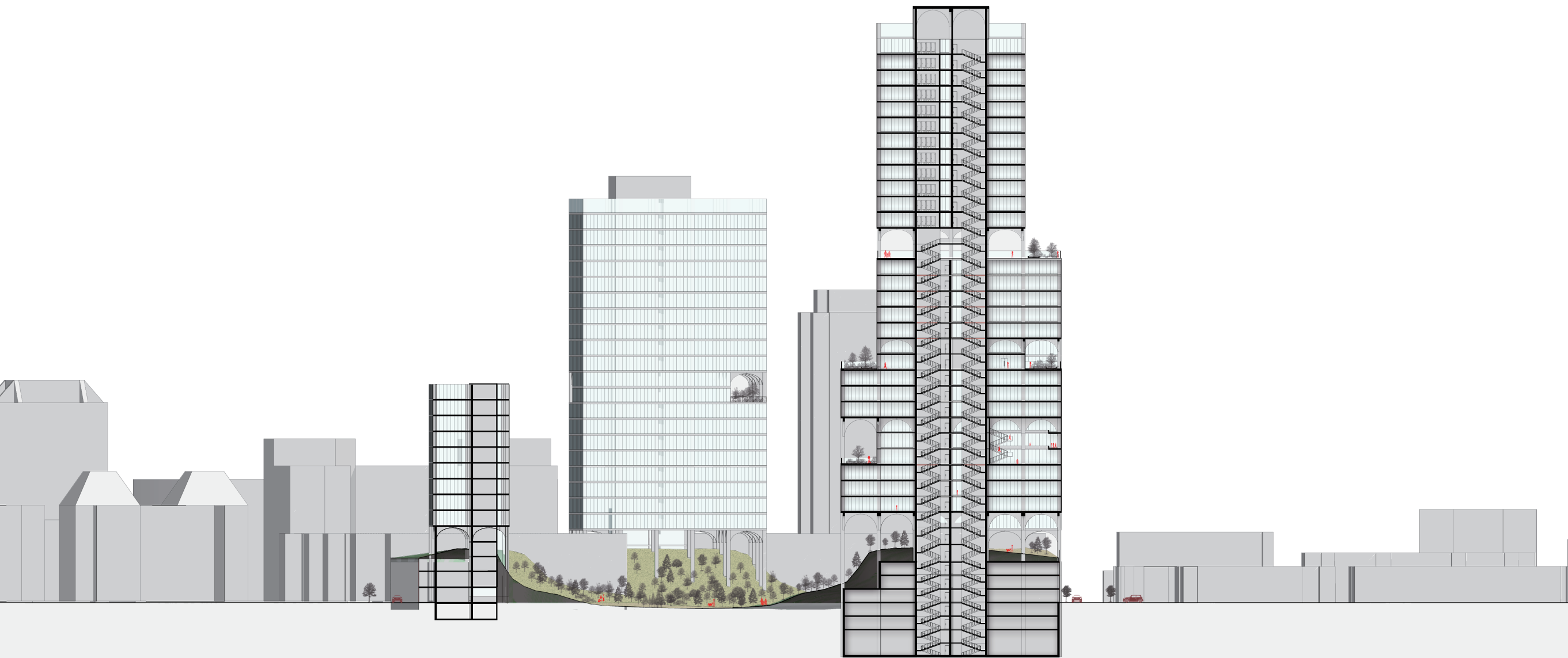




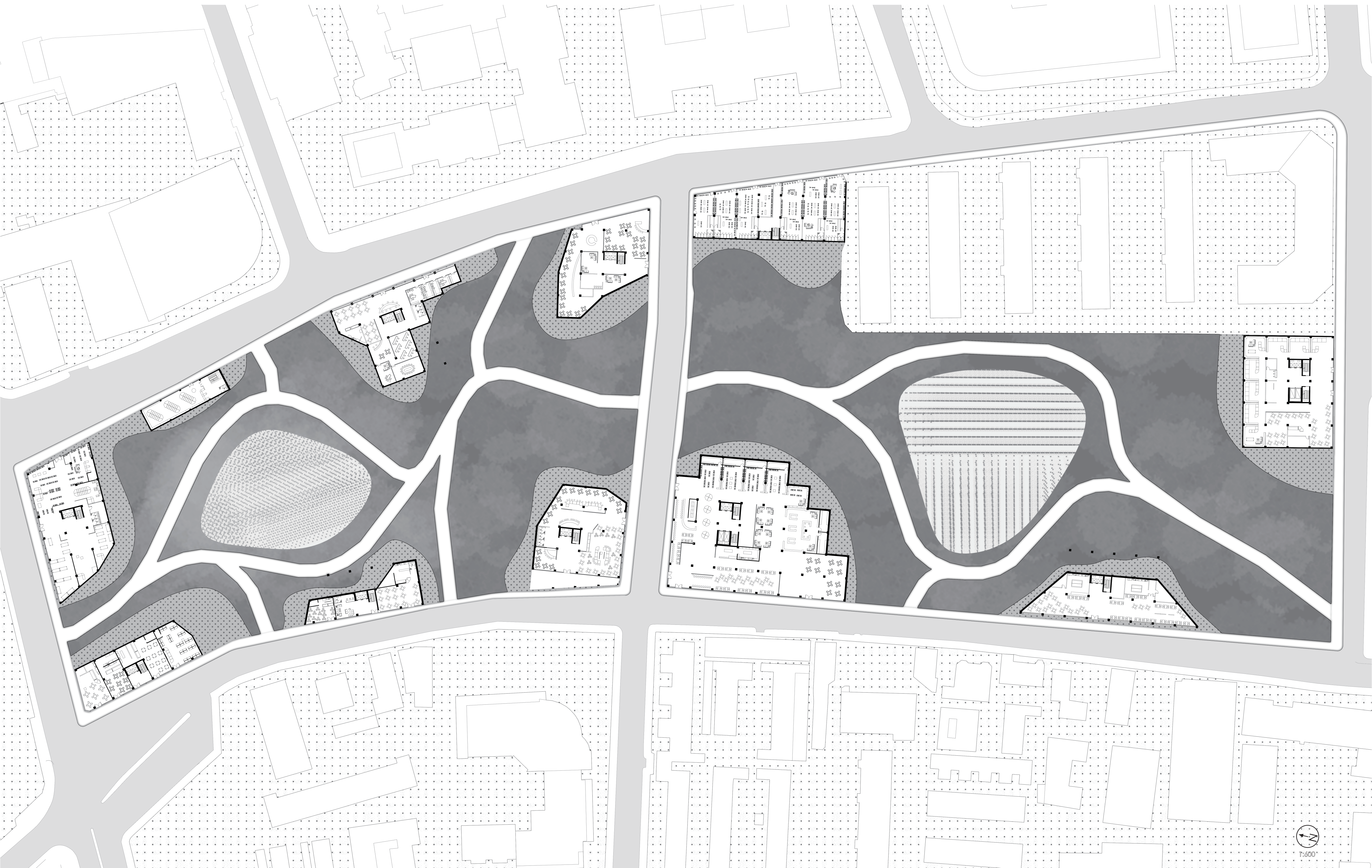
elevation 1:600



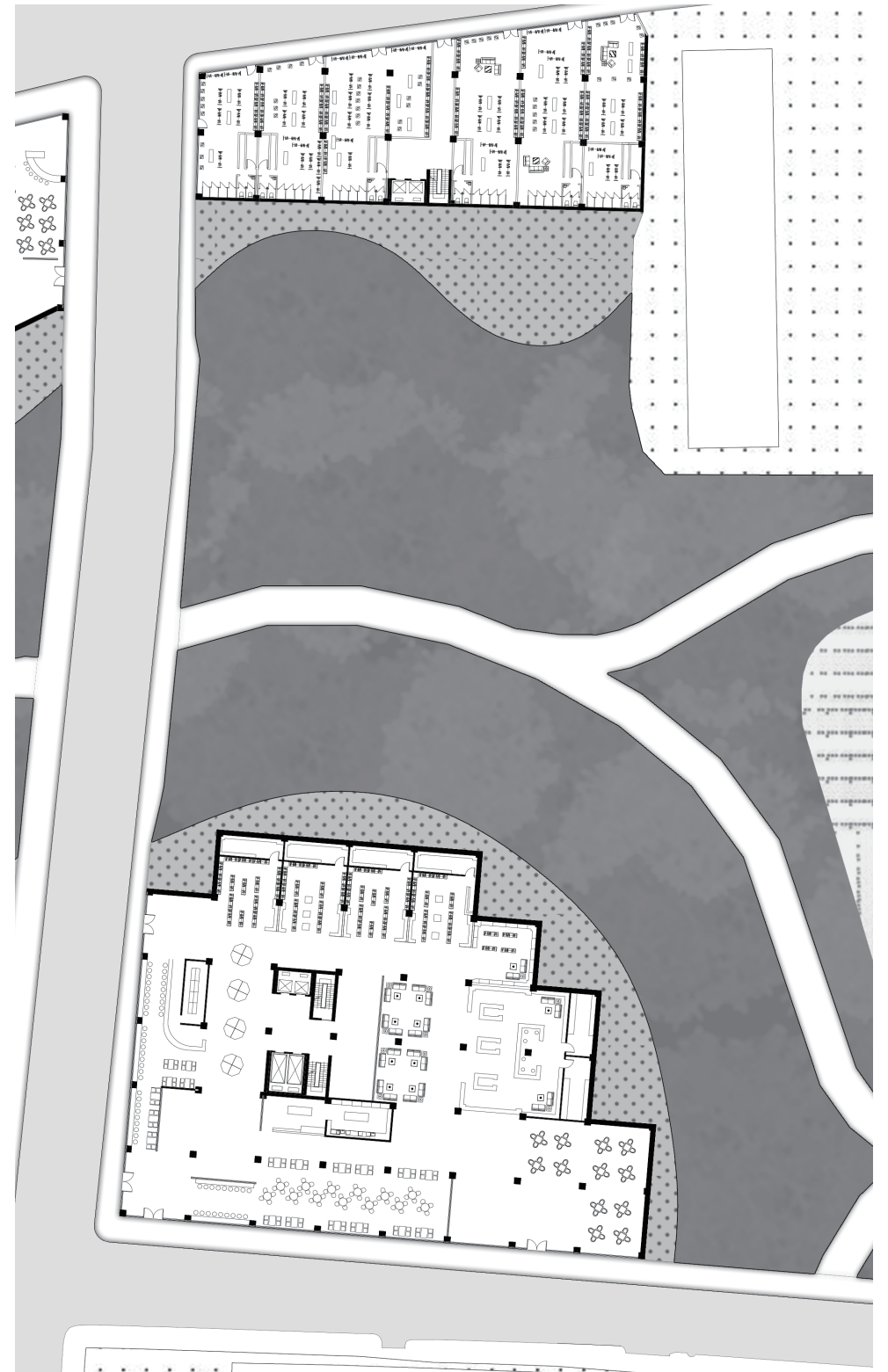
section 1:600

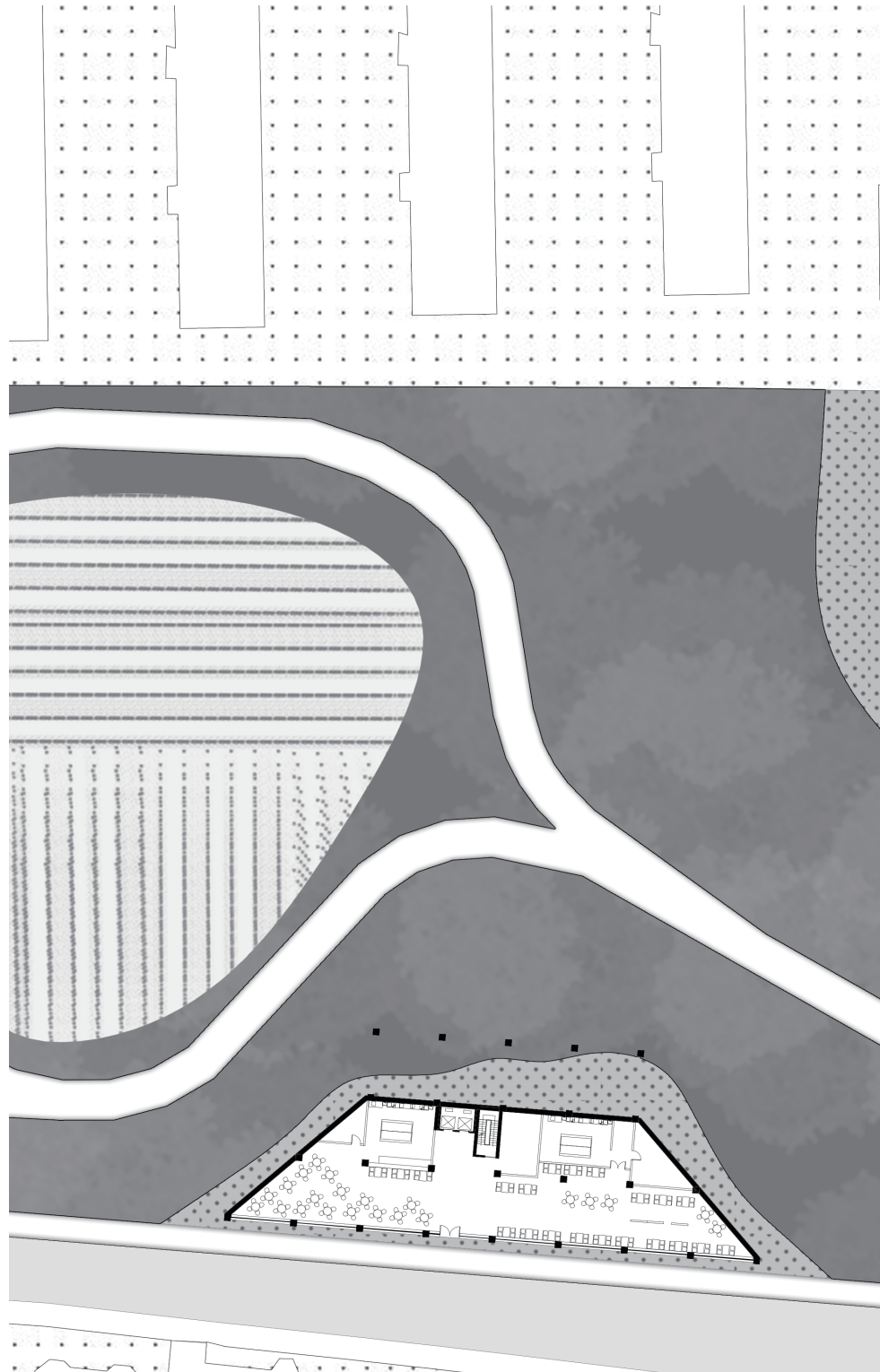


section 1:800









DesignDescription

The design is different from previous residential designs, where buildings and natural Spaces share the surface space, but the design seeks to provide the surface space completely to nature under the principle of biophilic design. By elevating the ground and building on stilts, the natural space on the surface is preserved to the maximum extent possible, providing a solid foundation for biophilic design. As for the design of the bottom commercial space, on the premise of meeting its required functions, it provides support for the mountain terrain and achieves the effect of simulating the natural mountain. With the random distribution of plants, the mountain ecological landscape in nature is perfectly restored, creating a new amusement space for the boring city.

For the landscape design of the surface, the principle of maximizing the natural space is also implemented. Roads occupy as little surface space as possible, and all the surface is dedicated to the soil. The random distribution of plants conform to the logic of nature, the order in disorder. The road, in conjunction with rainwater harvesting, enables a secondary design of natural water, and exists as dynamic water, without the need for external water support. It also occurs with rainy weather, consistent with the natural non-rhythmic stimulation in biophilic design. A large number of plants on the ground provide users with opportunities to connect with nature, both visually and non-visually. The plants that change with the climate and the terrain also produce a mysterious dynamic sense, he has

no fixed form, it is always changing. This is a kind of dynamic man-made natural space.

For buildings, the former buildings occupied a large amount of land on the ground, and nature was just a decoration, which was filled in the blank between buildings. Under the biophilia theory, the status of natural space is the same or even higher than that of buildings, so only the most basic transportation space between buildings and the ground is reserved, which also meets the demand for privacy. The building is no longer a complete entity but is divided into several parts connected by breathing Spaces (open parks in the building). This breathing space with a small botanical garden provides very close contact with nature, while also providing a view of the entire surface space. The description of overlook by biophilic design is realized. There is no clear boundary between architecture and landscape, and it is impossible to distinguish between nature in the built environment or architecture living in nature. For the application of high-rise buildings, the small green space of each residential unit is released into the public space, so that everyone can share this large landscape, and different heights have a different visual experience. Our pursuit of biophilic design lies in its contribution to the health of citizens, all based on natural Spaces. By sacrificing the space of the surface buildings for a large amount of natural space, the transaction is consistently profitable for the city and its citizens.

conclusion

This paper studies a design method that is beneficial to the health of urban residents (biophilic design), which provides a reference for the design of high-density urban spaces in the future. This article analyzes the relationship between the urban built environment and the mental health of urban residents through literature research and reports issued by authoritative organizations, as well as the benefits of biophilic design to the mental health of urban residents, and provides theoretical support for the biophilic design of urban residential areas. It also provides the application method of biophilic design in the process of investigation, analysis, and design. This result helps to promote the application of biophilic design in contemporary urban design.

The logical relationship between biophilic design and the mental health of urban residents.

First, starting from the health data of urban residents, using the stress reduction theory and attention recovery theory of Ulrich and Kaplan as a bridge, the urban built environment is connected with the health of urban residents. Then through the beneficial effects of biophilic design on human mental health, it is finally concluded that the building environment with biophilic design is beneficial to the mental health of urban residents. For the application of biophilic design in the project design process. This article proposes how to conduct site analysis and project design from the perspective of biophilic design. And through case analysis, some feasible and applied biophilic methods have been obtained.

The shortcomings of this research and

suggestions for improvement

- 1. It only studies the biophilic design patterns in urban residential or commercial areas, while ignoring the biophilic design patterns in special areas such as industrial zones. This needs to be re-analyzed to meet the needs of special areas such as industrial zones to determine a suitable biophilic design model.*
- 2. The biophilic of the project is also restricted by the size and location of the site. The project only occupies a block in the city. If there is a project close to a large natural area or a large park design, the degree of intervention required for the biophilic design also needs to be re-analyzed and determined.*
Multiple adjacent blocks adopt biophilic design together, which may double the advantage of biophilic.
- 3. The extent of benefits that can be generated by a biophilic design also requires continuous follow-up investigation during the use phase of the project.*

Biophilic design brings new hope to urban residents. This is a new design method that can reduce stress and improve mental health. This design has played a role in improving mental health and even physical health in some special architectural spaces. The residential area design in this article is an attempt at biophilic design in residential area design, and it is expected to be helpful to the research on the design of new-type residential areas in China. Although this project only focuses on the design of residential areas, this theory is not limited to architecture, it can be applied to every inch of man-made space. It can be roads, bridges, gas stations, water plants, or entire cities that citizens use every day, or it can be a space station, a spaceship, or even a Mars base.

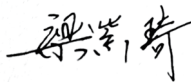
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This article was completed under the guidance of Professor Mauro Berta, who patiently discussed with me from the topic selection to the final draft. This is the first time FOR me to write an article with so much content. I had no experience before this. The difficulty of the topic was far beyond my expectation, and I spent a lot of time and energy in the writing process of the paper. It tested me physically and mentally. Fortunately, I finished the work in the end. At the same time, I have a deeper understanding of the biophile theory, which I believe will be an important direction of future architectural design. I will continue to study this.

Finally, I would like to express my gratitude to Professor Mauro Berta for his guidance and help to me. I couldn't have finished the article without the professor's help.

I would also like to express my deep gratitude to my father and mother for their unconditional love for me. Thank them for supporting all of my choices.

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