



NEGOTIATING THE PERI-URBAN

*Exploring Housing Serves as a Mediator between Local Inhabitants
and Migrant Quarry Workers in Navi Mumbai*

P5 Research & Design Booklet



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Global Housing Graduation Studio 2021/22
Mixing Navi Mumbai

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September 2021 - June 2022



Informal quarry settlements in Navi Mumbai.

Image Source: Valerie Lux, *Informal quarry settlements in Navi Mumbai*, 2008, photograph, Navi Mumbai, https://www.academia.edu/3443723/Navi_Mumbai_Stone_Quarry_Settlements_by_ARCSR.

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Skyline of Navi Mumbai shows the hybrid landscape of the rural-urban interface.

Image Source: Anurupa Chowdhury, Navi Mumbai Skyline, 2011, photograph, Navi Mumbai, https://upload.wikimedia.org/wikipedia/commons/archive/9/95/20140406130944%21Navi_Mumbai_Skyline.jpg.

I. BACKGROUND

This chapter provides an insight to the background of this master project, especially the rural - urban migration issue in India.

I. BACKGROUND

Horizontal Urbanization

India's rapid urbanization has drawn rural migrants to the metropolis for livelihoods, further resulting in urban expansion. In the early twentieth century, the growth of Indian cities was often confined to vertical development within urban boundaries. However, this pattern has changed significantly in the last three decades, especially in metropolitan areas such as Mumbai, Kolkata, and Delhi.¹ They are not only growing in population but also the size of cities.

This horizontal urban expansion to the periphery increases a more complex interaction with its surrounding rural areas, shaping them into a dynamic rural-urban interface termed the 'peri-urban'.² These emerging hybrid landscapes have become a major landing point for rural migrant workers into the city.

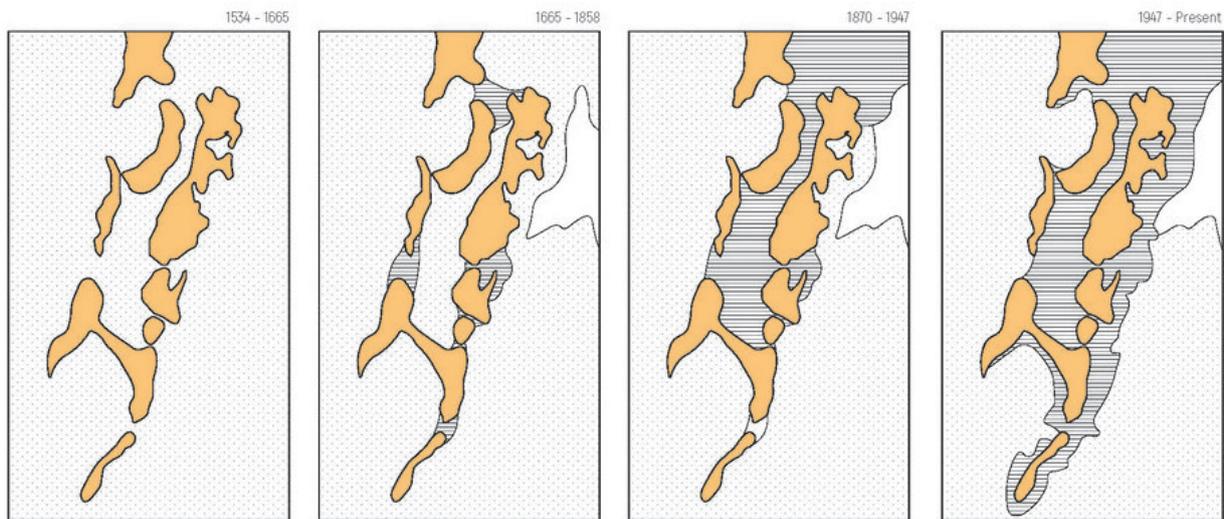


Image Source: Time-line showing Reclamation of Seven Islands. University of Pennsylvania School of Design. "Mumbai Eastern Waterfront Plan". Fall 2015 Studio.

¹ Annapurna Shaw, "Peri-Urban Interface of Indian Cities: Growth, Governance and Local Initiatives," *Economic and Political Weekly* 40, no. 2 (2005).

² Liana Ricci, "Peri-Urban Livelihood and Adaptive Capacity: Urban Development in Dar Es Salaam," *Consilience*, no. 21 (2019).

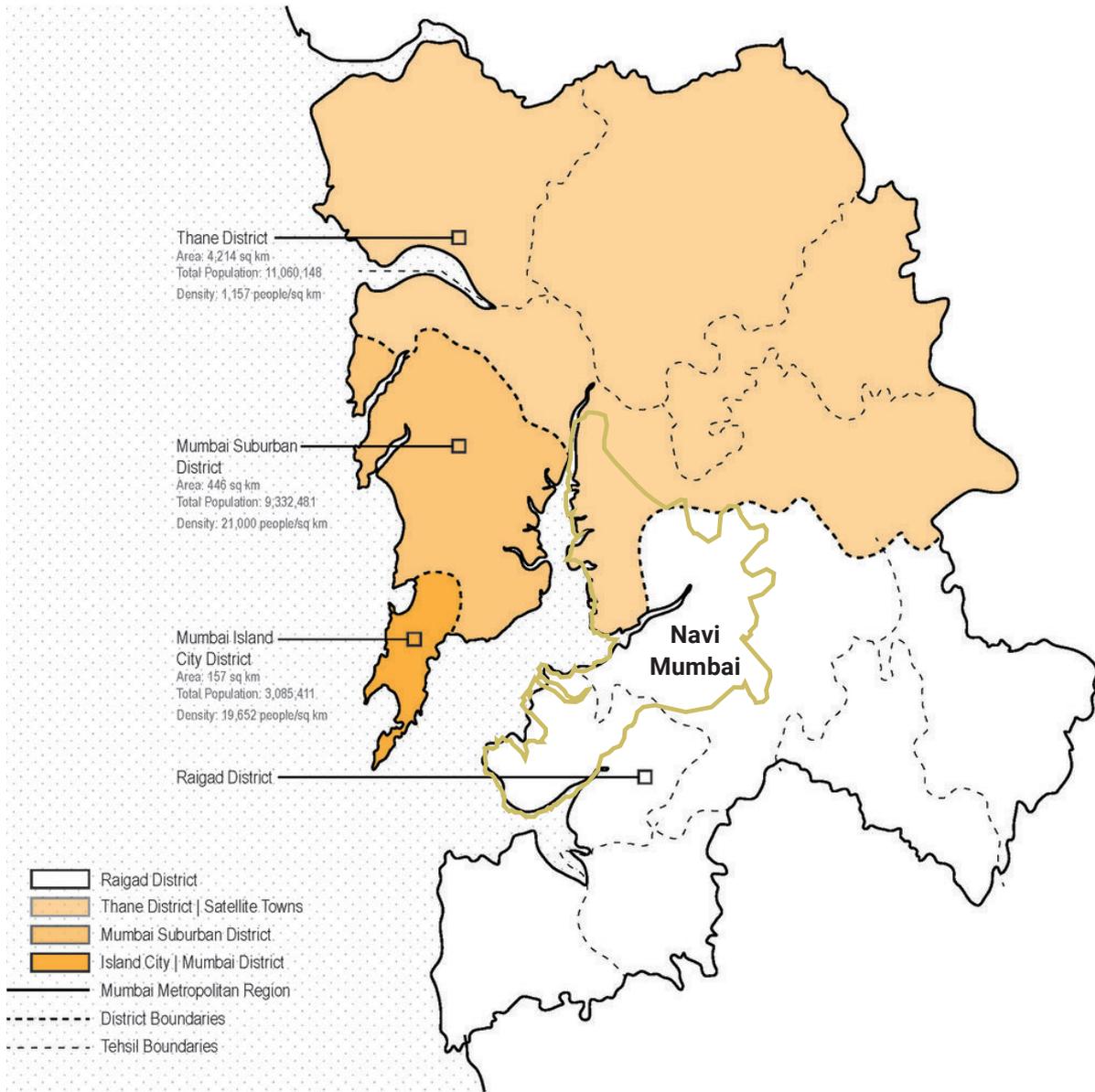
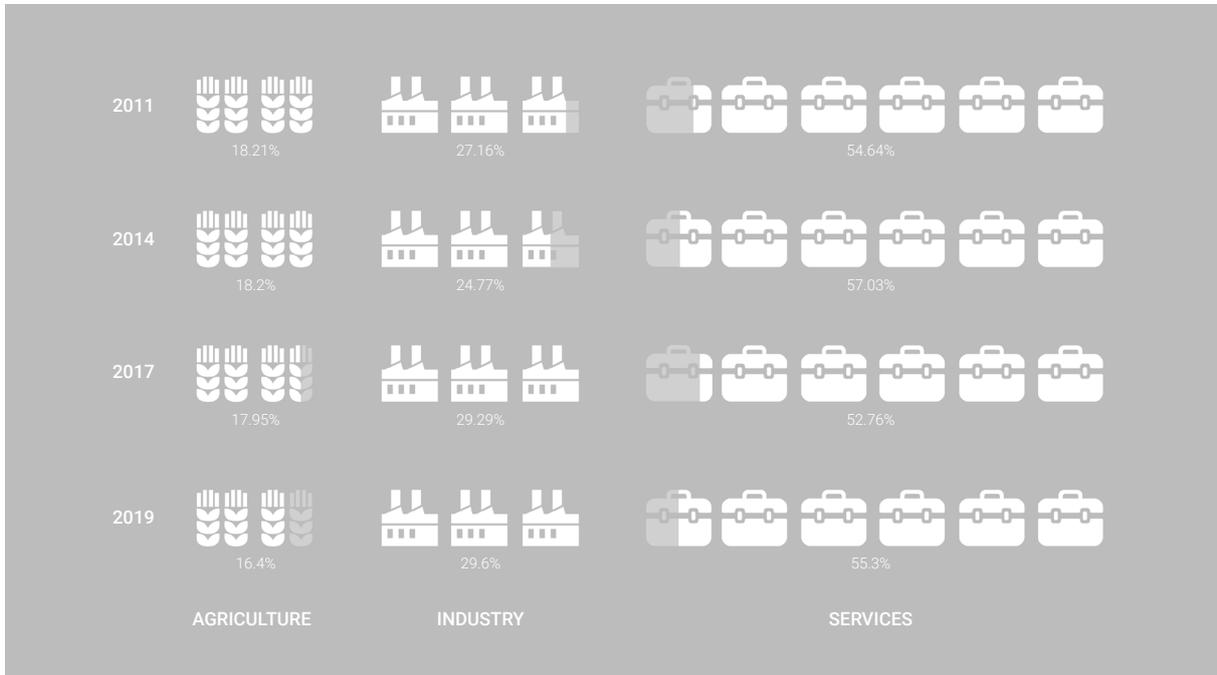


Image Source: Time-line showing Reclamation of Seven Islands. University of Pennsylvania School of Design. "Mumbai Eastern Waterfront Plan". Fall 2015 Studio.

I. BACKGROUND

Local Space Breakdown



*the Agriculture, Industry, and Services Sector's
Composition of India's GVA*

Data Source: Sector-wise GDP of India. Ministry of Statistic and Programme Implementation, https://mospi.gov.in/documents/213904/416359//Press%20Note_31-05-2021_m1622547951213.pdf/7140019f-69b7-974b-2d2d-7630c3b0768d.

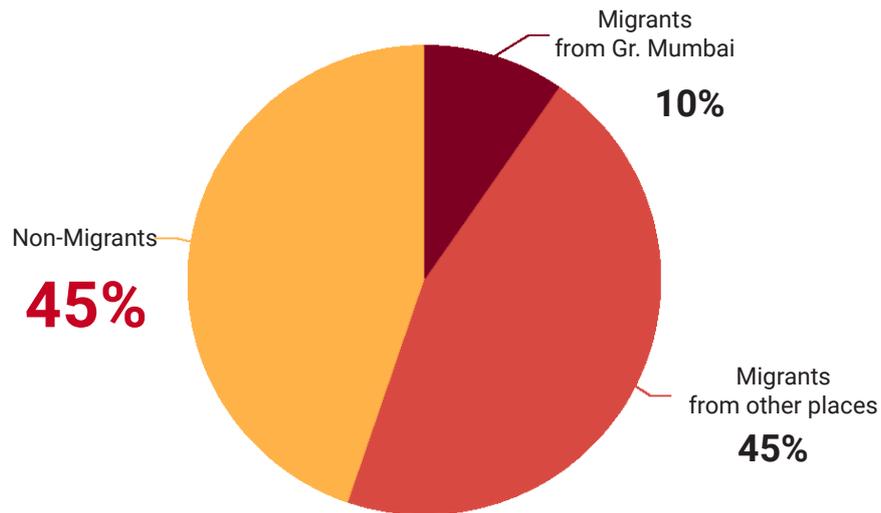


On the one hand, urbanization has profoundly impacted villages within the urban boundaries. There has been a massive breakdown of local space through gradual changes in land use, economy, and social linkage. For example, in Navi Mumbai, agricultural degradation forces local inhabitants to sell their farmland. As a result, the previous agricultural communities were expelled from their original land and moved away, leading to the displacement of local vulnerable social groups.

Image Source: <https://sabrangindia.in/article/pushed-aside-displaced-development-india>

*Distribution of Survey Households
by Place of Migration (Villages)*

1997-survey



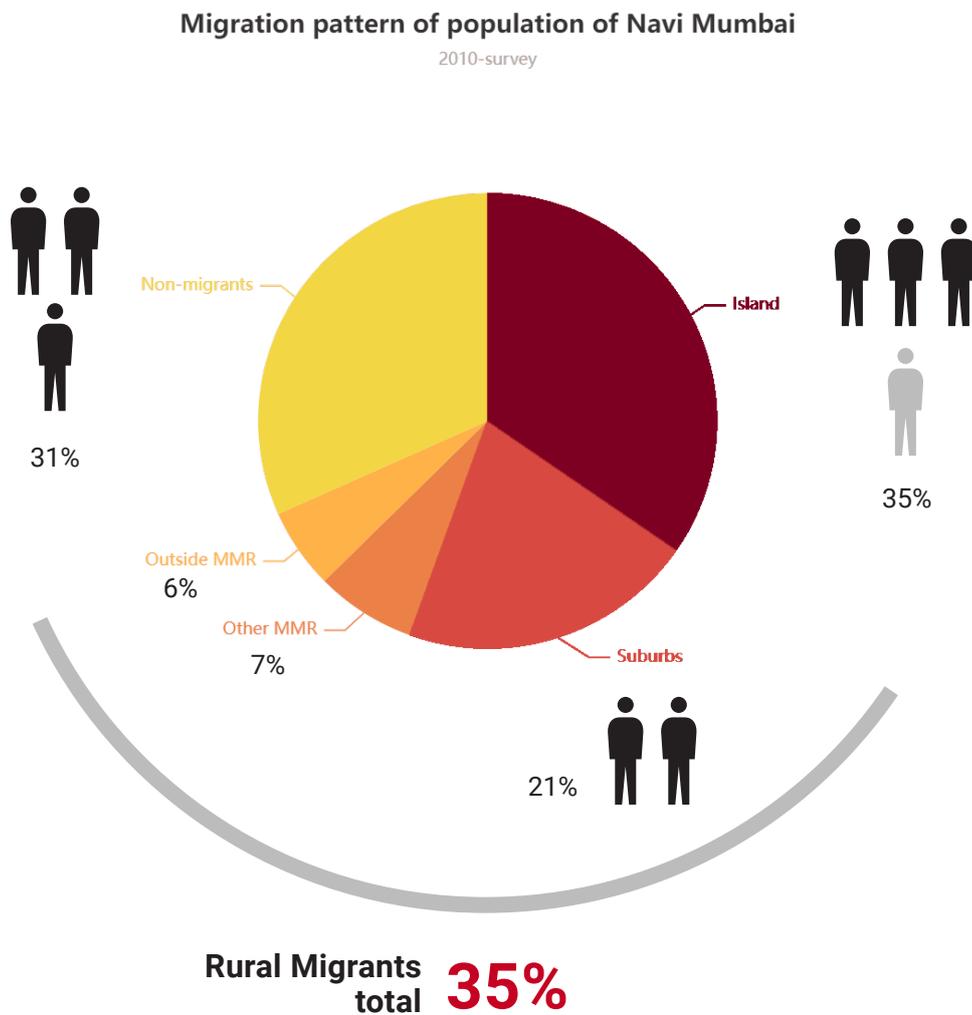
Data Source: Annapurna Shaw, *The Making of Navi Mumbai*, P240

*The **breaking down of agrarian and village systems** and socioeconomic relations of production has induced **displacement of various social groups** like agricultural communities, tribal communities, and landless labourers.*

-- Aparna Phadke

I. BACKGROUND

Labour Migration



Data Source: CIDCO

On the other hand, infrastructure works in the city have provided many job opportunities, attracting poor migrants from surrounding rural areas to move to the city.

Navi Mumbai was planned as a satellite city of Mumbai in 1964, with the original intention to distribute the crowding population of Mumbai and absorb migration.¹ In 2010, about 35% of the

population in Navi Mumbai are rural migrants. Most of its migration were from Maharashtra and the rest of them were from Bihar, Uttar Pradesh, Karnataka, and Andhra Pradesh.² They were mainly working in labour-intensive sectors, such as quarrying.

1 R. Baxter, "New Bombay—the Twin City," *Geography* 59, no. 1 (1974): 51-54. See also Annapurna Shaw, "The Planning and Development of New Bombay," *Modern Asian Studies* 33, no. 4

(1999): 959-60.

2 See *The Making of Navi Mumbai* (New Delhi: Orient Longman, 2004), 235.



Vasai Tehesil

Mira Bhayandar

Thane

Bhiwandi

Dombivli

Kalyan

Badlapur

BOM

Mumbai

Navi Mumbai

Matheran

Rasayani



Source: Alamy Stock Photo, The Dark Sites of Granite, P47

I. BACKGROUND

Stone Quarry Worker



2k Rs.

monthly income



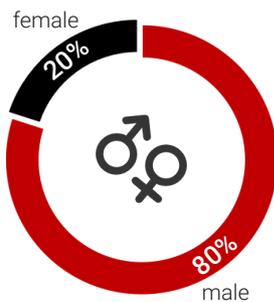
SCs/OBCs

Caste

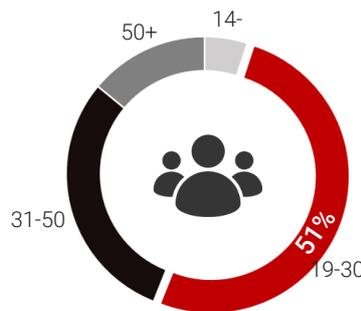


61%

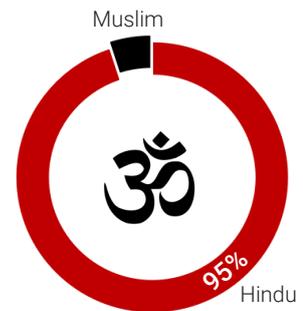
illiteracy



gender



age



religion

Data Source:

Annapurna Shaw, *The Making of Navi Mumbai*, 235.

Alamy Stock Photo, *The Dark Sites of Granite*, 47

Lux, Valerie Saavedra, and Paul Watson. "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces." edited by Bo Tang: London Metropolitan University; Association of Rural People for Health and Educational Needs, 2008.

Before the new city expanded from Mumbai in the early nineteen-seventies, the hills around Navi Mumbai had already been used for quarry work. The emergence of the new city has profoundly impacted the development of quarries.

In 2008, there were more than 200 quarries located between Turbhe and Nerul, employing

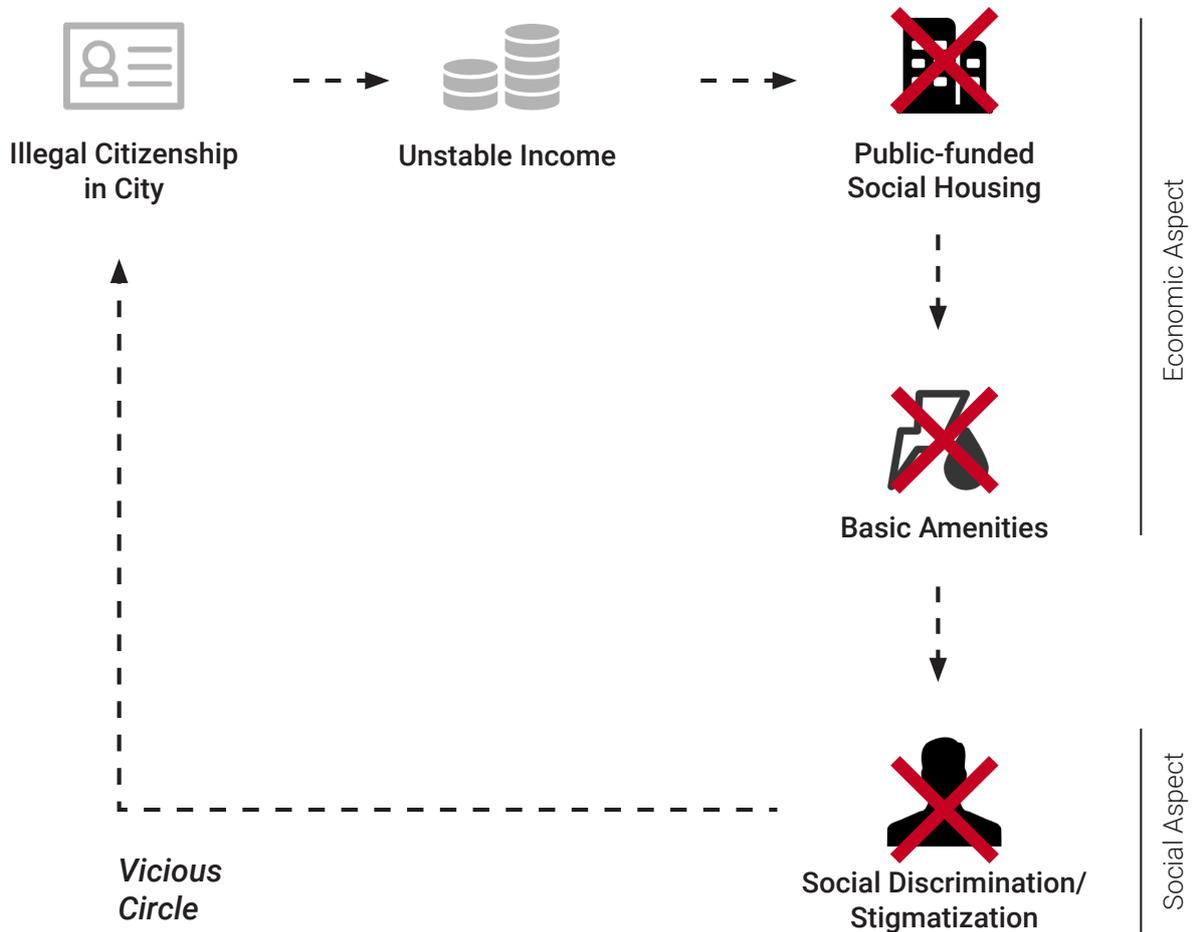
a total of 20,000 workers.¹ Most of them were poor-educated and from the lower caste, including Other Backward Class (OBCs) and Scheduled Caste (SCs).²

¹ Shaw, *The Making of Navi Mumbai*, 234.

² Other Backward Class (OBCs) and Scheduled Castes (SCs) are collective terms used by the Indian Government to classify castes which are economically, socio-culturally and educationally disadvantaged.

I. BACKGROUND

City Exclusion



Unprecedented urbanization in India increased existing inequalities and exacerbated urban exclusion in the context of disability to access social services and formal houses. Government interventions have been unable to respond to the exclusion appropriately, especially in the housing sector.

For instance, under the existing social housing allocation system, most quarry workers are excluded from applying for formal social housing without legal citizenship and stable incomes in the city. They have to live in self-built

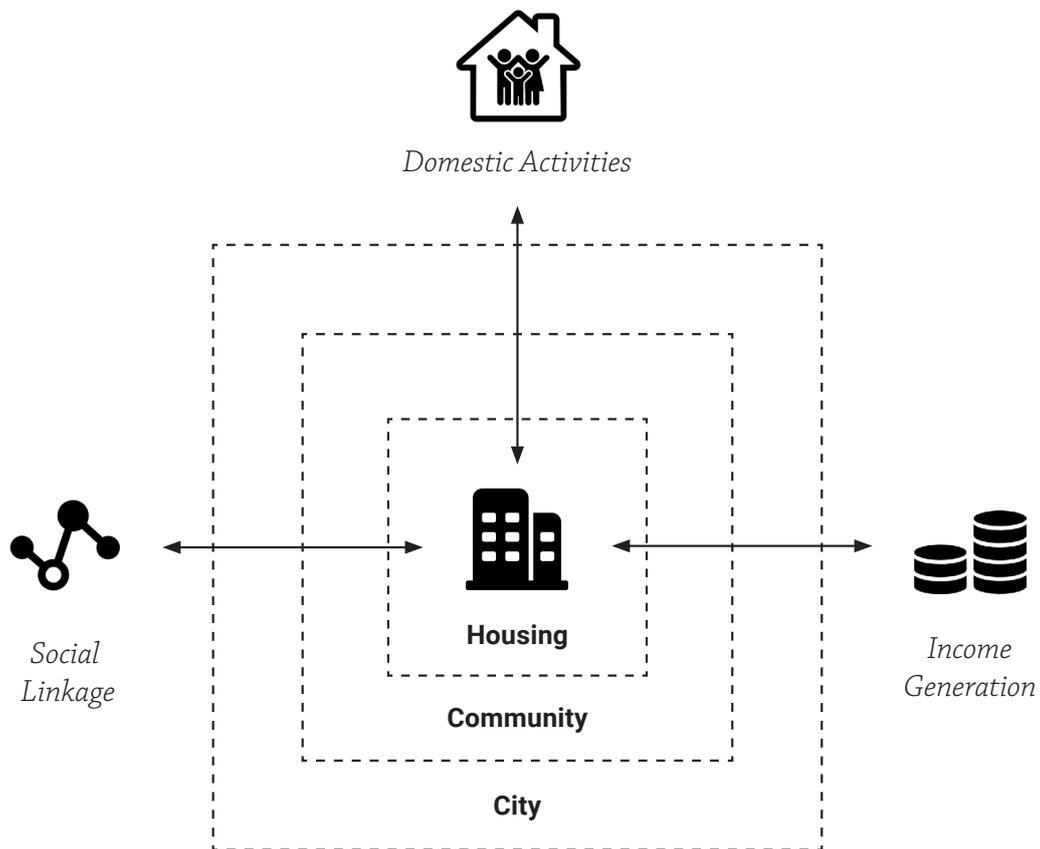
informal shelters which have difficulty accessing basic amenities and are exposed to high levels of risk, including pollution, dynamite blasting, and heavy industrial road traffic.

Also, with a highly centralized structure, public-funded social housing does not fit the needs of quarry workers with a rural background, further pushing migrants away from formal social housing. Therefore, it can be argued that public-funded social housing has been adopted as an institution to exclude and marginalize rural migrants.



From top to down:
Quarry workers sleeping in their collective accomodation.
Flimsy slum-like shelters outside the quarry owner's office.

Image Source:
GlocalResearch, *Migrant workers sleeping in their accomodation*, photograph, 22, https://www.stopkinderarbeid.nl/assets/TheDarkSitesOfGranite_new.pdf
Valerie Lux, *Informal quarry settlements in Navi Mumbai*, 2008, photograph, Navi Mumbai, https://www.academia.edu/3443723/Navi_Mumbai_Stone_Quarry_Settlements_by_ARCSR.



In general, the dynamic socio-spatial spaces in the peri-urban area are full of multidimensional conflicts between villagers, migrants, and government officials. Fortunately, housing is a combination of domestic activities, income generation, and social linkage in the Global South. It is significant for urban development and facilitates social integration. It led me to pursue and challenge an inclusive way to mediate the conflict and complex spaces in peri-urban areas.

Research Question

How can housing serve as a mediator between local inhabitants and migrant quarry workers in order to negotiate the peri-urban area in Navi Mumbai and build an inclusive Indian city?

Approach & Ambition

Background

Problem Statement

Sub questions:

- *How can architects organize the hybrid landscapes in peri-urban Navi Mumbai to provide opportunities for quarry workers to integrate into the city?*
- *Is it necessary and possible to reconstruct the breakdown spaces for local inhabitants at the urban periphery?*
- *How can peri-urban living spaces shared by quarry workers and local inhabitants be negotiated on both economic and social-cultural levels?*
- *How can affordable housing be provided to quarry workers who are excluded from formal public-funded social housing in Navi Mumbai?*
- *How do we build a home for quarry workers in the city based on their traditional rural-related living patterns to provide them with a sense of belonging and clarify their ambiguous citizenship in the city?*

II. DESIGN RESEARCH

This chapter elaborates on how I worked with the design research, which is focused on three fields: stone quarries, quarry settlements, and housing in India.



Stone Quarry

Navi Mumbai's quarry belts are located in two main areas. One is located between the Parsik Mountain Range and the Mumbai highway, and the other is located in the Dapoli Range to the south of the city.

The rock formation in the region is derived mainly from Deccan basalt and also from granites, gneiss and laterite.¹ The conversion of this granite and Deccan basalt into smaller pieces is the main usage of the material due to its poor natural quality.

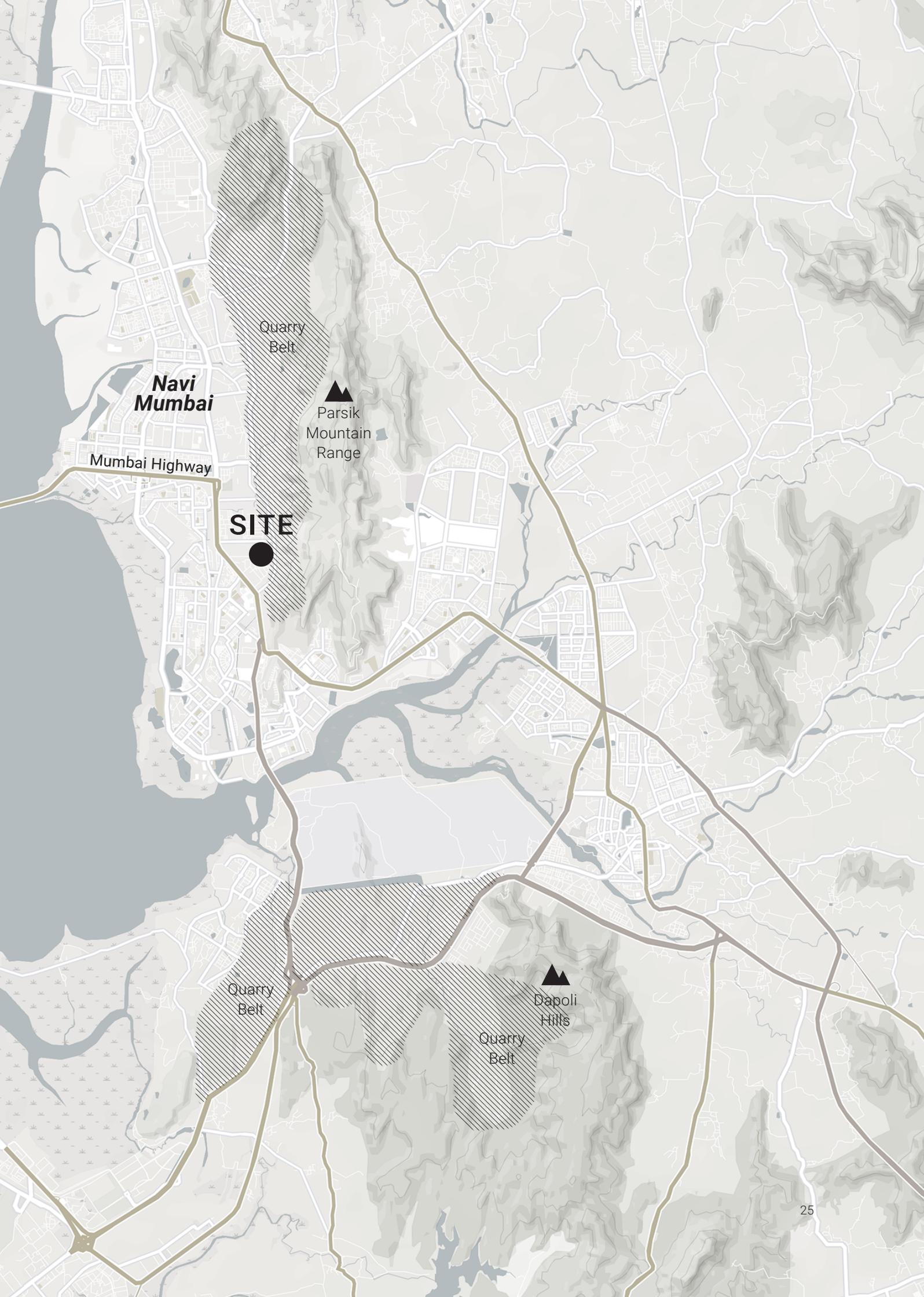
¹ Lux, Valerie Saavedra, and Paul Watson. "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces." edited by Bo Tang; London Metropolitan University; Association of Rural People for Health and Educational Needs, 2008, 10.





Mumbai





**Navi
Mumbai**

Mumbai Highway

Quarry
Belt

▲
Parsik
Mountain
Range

SITE

Quarry
Belt

▲
Dapoli
Hills

Quarry
Belt

II. DESIGN RESEARCH

Stone Quarry

With ongoing resistance from local residents and environmentalists, the authority was under pressure to close the quarries in Navi Mumbai in 2016 temporarily. Despite a decision to reopen the stone quarries in 2021, it is foreseeable that the quarries will eventually close in the future. The planning of this area, therefore, requires a long-term perspective.

11 killed in stone quarry blast in India

4 August 2018 10:36

Share in:   



Maharashtra Reopen 102

After acquiring land for Navi Mumbai, the state government has decided to reopen 102 stone quarries to meet the demand of livelihood.

BY MUMBAI LIVE TEAM • 12 M



SHARES
19

The Mah
quarries

NEW DELHI. KAZINFORM - At least 11 labourers were killed and four others wounded in a dynamite blast inside a stone quarry in southern Indian state of Andhra Pradesh, officials said Saturday, [Xinhua](#) reports.

Source:

https://www.kazinform.kz/en/11-killed-in-stone-quarry-blast-in-india_a3343136

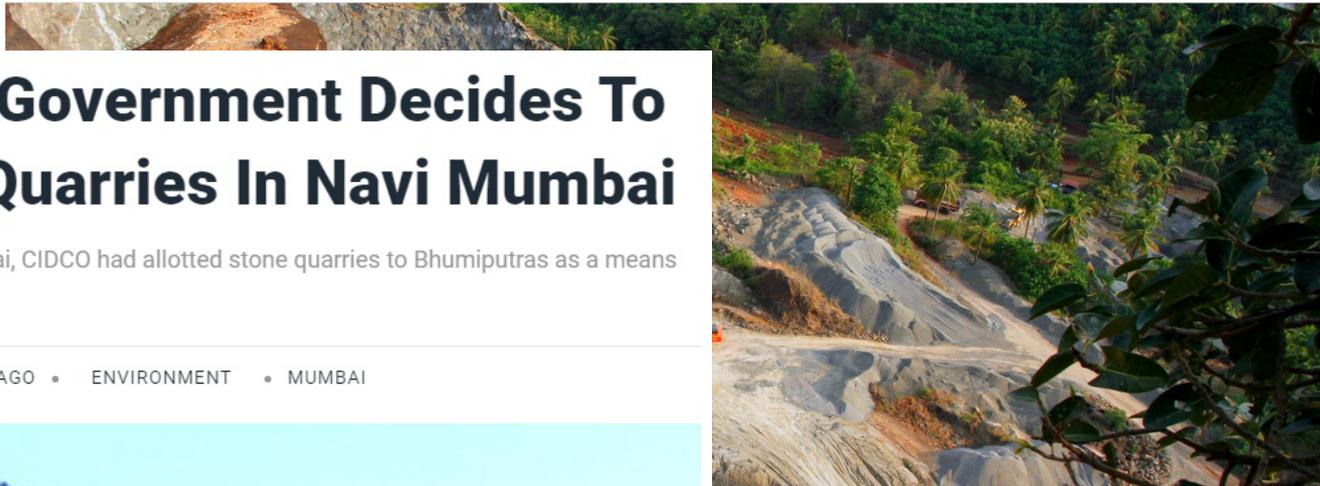
<https://india.mongabay.com/2020/11/quarrying-in-kerala-needs-more-monitoring-indicates-environmental-panel/>

<https://www.telegraphindia.com/west-bengal/illegal-stone-quarries-in-two-blocks-of-purulia-district-cause-pollution/cid/1748342>

<https://www.mumbailive.com/en/environment/state-government-decision-to-reopen-102-stone-quarries-in-navi-mumbai-66086>

Quarrying in Kerala needs more monitoring, indicates environmental panel

by K.A. Shaji on 30 November 2020



State Government Decides To Close 12 Quarries In Navi Mumbai

In Navi Mumbai, CIDCO had allotted stone quarries to Bhumiputras as a means

MONTHS AGO • ENVIRONMENT • MUMBAI



Madhya Pradesh government has decided to close 12 illegal stone quarries in Navi Mumbai.

Illegal stone quarries in two blocks of Purulia district cause pollution

Leaders & mafia in collusion: villagers



One of the illegal stone quarries near the Jharkhand border.
(Biswanath Roy)

Abhijeet Chatterjee | Purulia | Published 24.02.20, 07:17 PM

Several unauthorised stone quarries are operating in two blocks of Purulia district close to Jharkhand border, triggering dust and sound pollution and damage to homes.



Quarry Settlement

Since they could not afford formal housing in the city, most quarry workers lived in collective accommodation provided by quarry owners near the quarries. However, due to the poor living conditions there, some workers chose to leave the accommodation and build their informal houses instead.

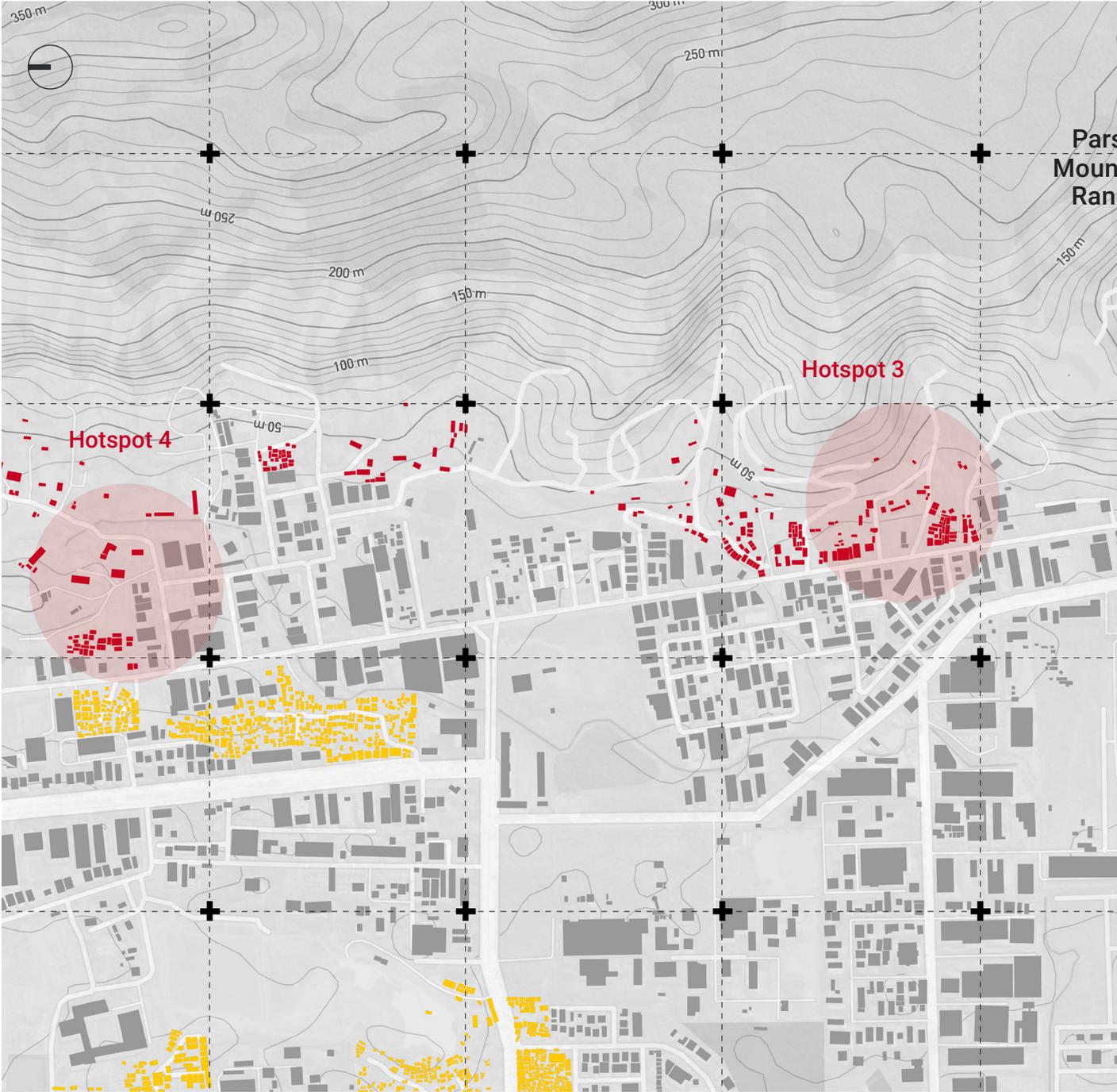
These houses are exposed to high levels of risk, including pollution, dynamite blasting and heavy industrial road traffic. During the monsoons, floods can also endanger residential areas.



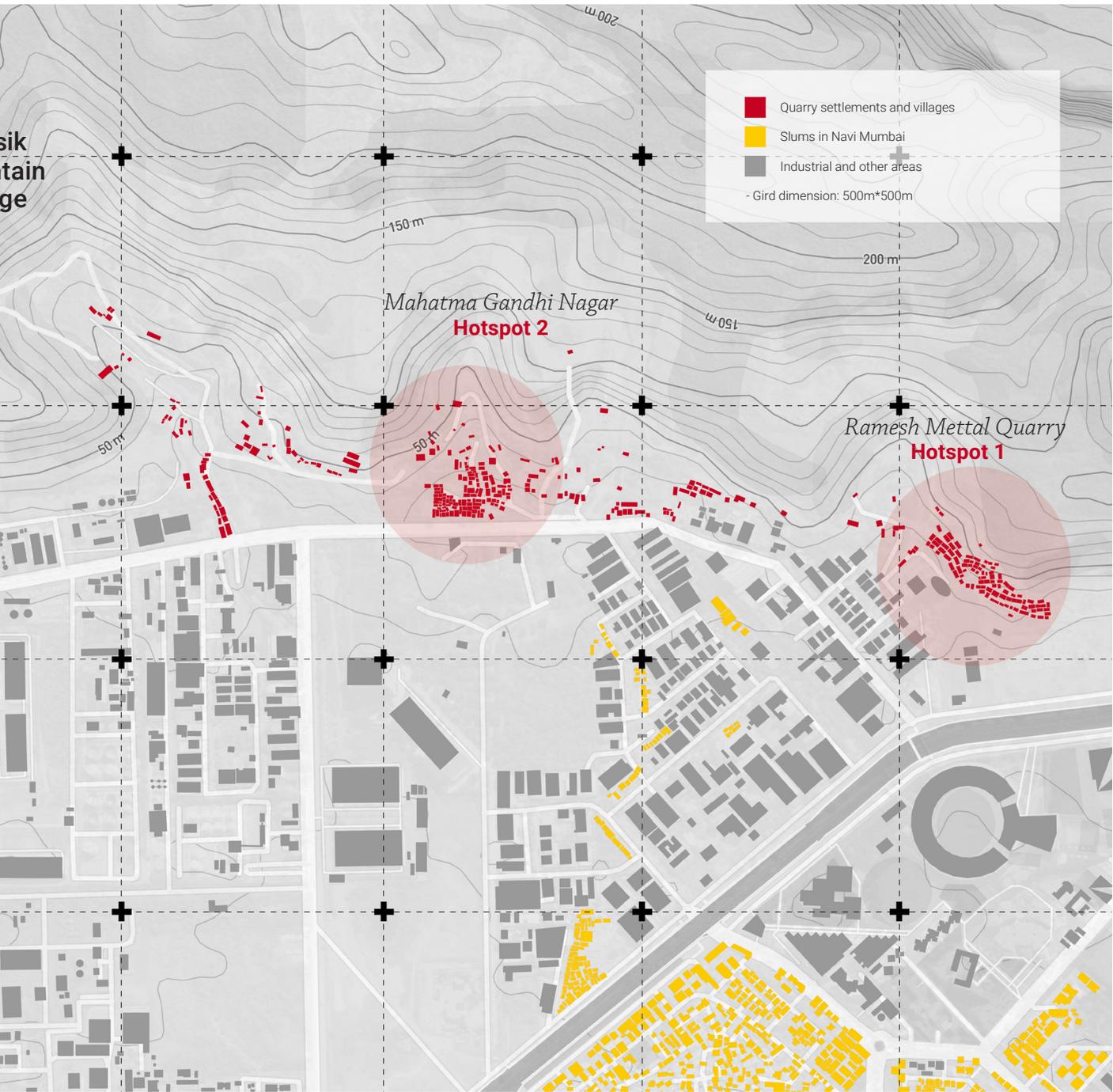
II. DESIGN RESEARCH

Quarry Settlements

The quarry workers' settlements are close to their quarries,. Most of them are extensions of the remained urban villages, gathering in small clusters and each one has a high density. There is an urgency to resettle them into a safer place and upgrade the neighbourhood.



Map of quarry settlements allocation in Navi Mumbai.



II. DESIGN RESEARCH

Quarry Settlements

Hotspot 1

Ramesh Mettal Quarry



Ramesh Mettal Quarry was originally built as a colony for workers at the Ramesh Mettal quarry. It expanded rapidly between 2003-2009 and became a declared slum located on MIDC land in Nerul district of Navi Mumbai. It has an estimated population of 1550 dwellers residing in 310 structures. It covers an area of 10373 sq.mts.

Data Source:
<https://app.shelter-associates.org/dashboard/city::Navi%20Mumbai>

Image Source: <https://www.sutori.com/en/story/ramesh-metal-quarry-nerul-navi-mumbai--oHFsZ9BFTUpkAi9ALsLvnZ5x>



2003



2009



2015



2022

II. DESIGN RESEARCH

Quarry Settlements

Hotspot 1 Ramesh Mettal Quarry



Programme

Data Source: <https://app.shelter-associates.org/dashboard/city::Navi%20Mumbai>

Dwellers: 1,550
Dwellings: 310



Ownership

II. DESIGN RESEARCH

Quarry Settlements

Hotspot 2

Mahatma Gandhi Nagar

Mahatma Gandhi Nagar is a declared slum located on hilly MIDC land in Nerul ward Navi Mumbai. It has an estimated population of 2750 dwellers residing in 550 structures. It covers an area of 13443 sq.mts.

It expanded rapidly between 2015-2022 which makes it very close to a quarry and suffers from high levels of dust pollution.

Data Source:

<https://app.shelter-associates.org/dashboard/city::Navi%20Mumbai>



2003



2009



2015

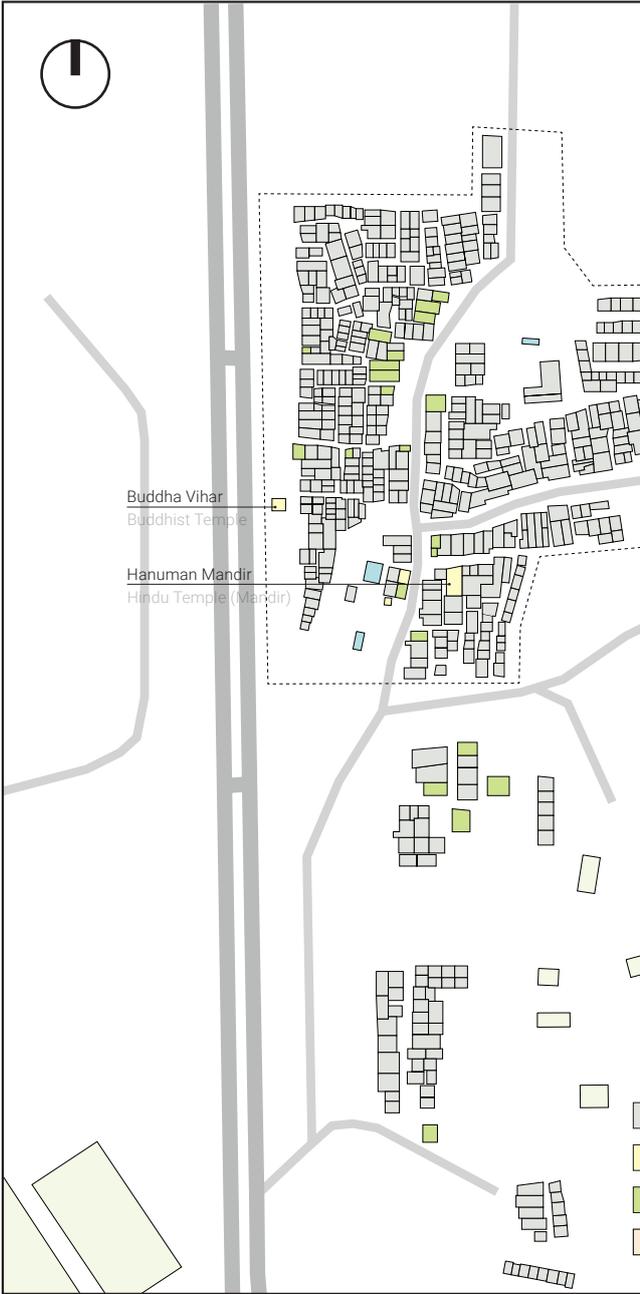
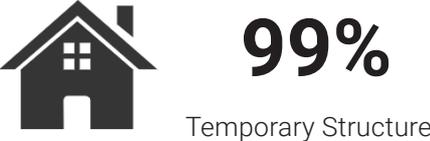


2022

II. DESIGN RESEARCH

Quarry Settlements

Hotspot 2 Mahatma Gandhi Nagar



Programme

Data Source: <https://app.shelter-associates.org/dashboard/city::Navi%20Mumbai>

Dwellers: 2,750
Dwellings: 550

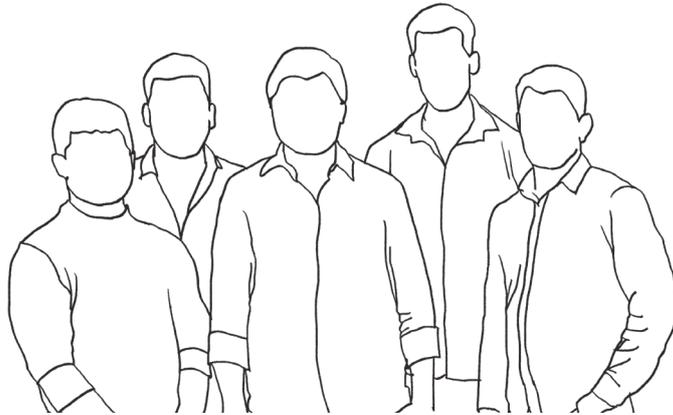


Ownership



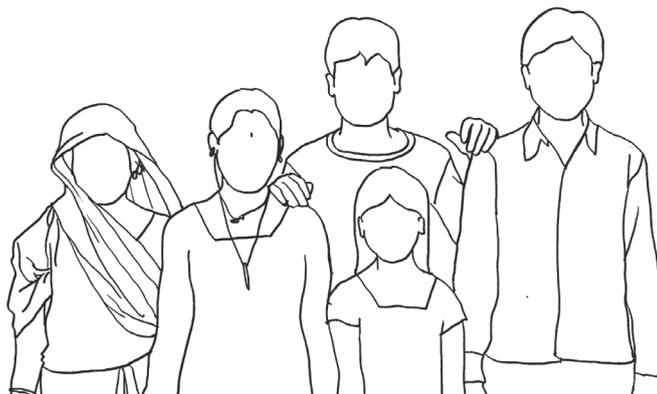
Quarry Worker

Single



Quarry Worker

Group



Quarry Worker

Family

Avg. Size 4.5 person

II. DESIGN RESEARCH

Living Pattern



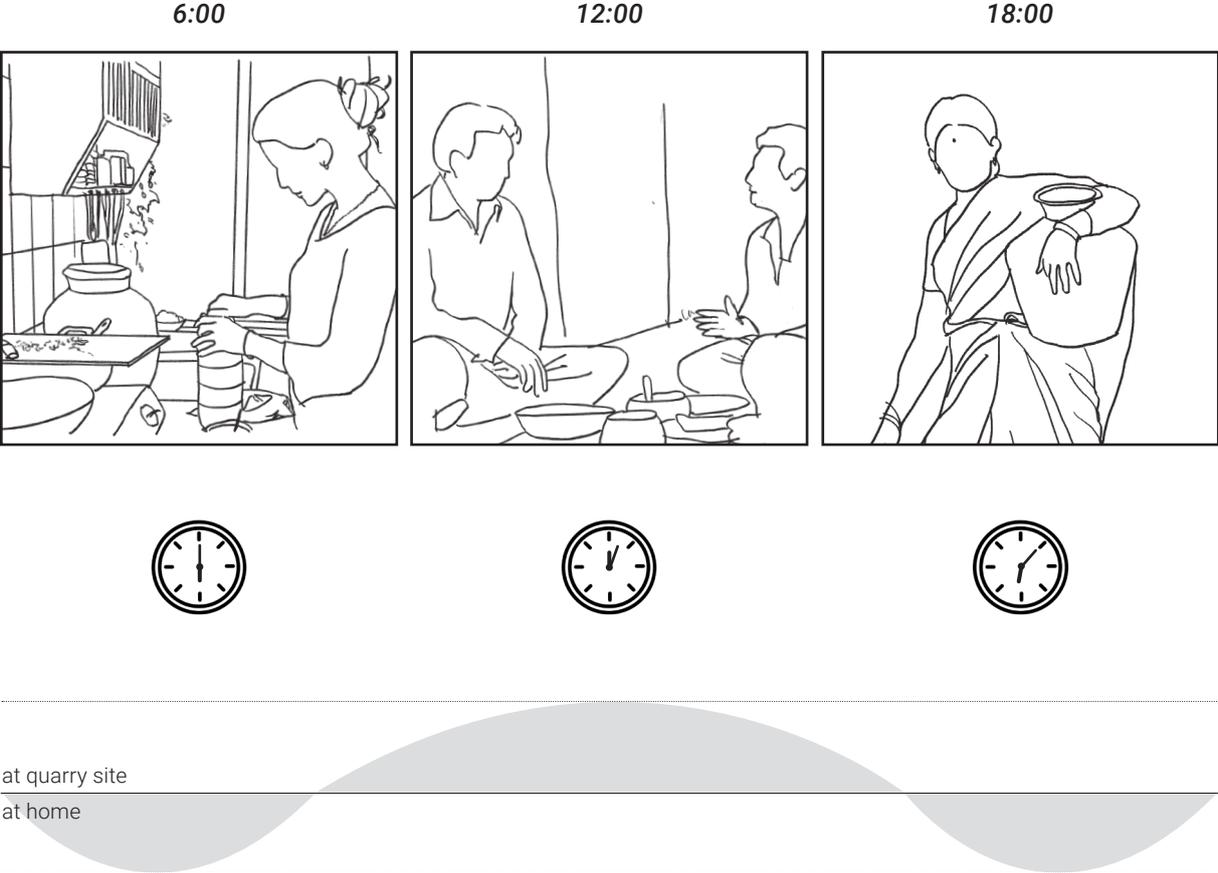
Source: GlocalResearch. "The Dark Sites of Granite: Modern Slavery, Child Labour and Unsafe Work in Indian Granite Quarries - What Should Companies Do?". Utrecht, The Netherlands: India Committee of the Netherlands, 2017.

*" In Andhra Pradesh 80% of the migrant accommodation consists of a semipucca houseix, roofed with tin or asbestos sheets with one lamp and one fan, where **12 to 15 persons are accommodated**. The ventilation of the rooms is so poor that one can barely see without light during daytime."*

-- <The Dark Sites of Granite>

II. DESIGN RESEARCH

Living Pattern



Source:
 Lahiri-Dutt, Kuntala. Gendered Livelihoods in Small Mines and Quarries in India: Living on the edge, 25.
 Raj, Sanjay. Budhpura Ground Zero Standstone quarrying in India, 20.
 The Dark Sites of Granite, Utrecht, India Committee of the Netherlands, 2017.

A typical day for quarry workers' families starts at 6 a.m. when the wife packs her and her husband's lunch boxes, and bring them to the quarry. They set off on foot for the mine site.

At the site, they work continuously till noon, after which they take an hour's break (usually have lunch). Then return to work till 4 p.m.

After that, quarry workers have to take a long walk back home. Women basically take care of all the household chores, including cooking for families, collecting water from the village well, washing and cleaning up.

During off-day, they travel at least 2-5 km to get firewood from the forest. Most families entirely depend on firewood for cooking.

Creche 'House Mother'



Source: Lux, Valerie Saavedra, and Paul Watson. "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces." edited by Bo Tang: London Metropolitan University; Association of Rural People for Health and Educational Needs, 2008.

Women generally go in groups for work in quarries, or the family is involved. In the absence of family support or the ability to send children to school, women have to take their children along to the quarry site where there was a 'creche' and one 'house mother' to look after everyone's children. Sometimes they also take along one of the older children to take care of siblings.

II. DESIGN RESEARCH

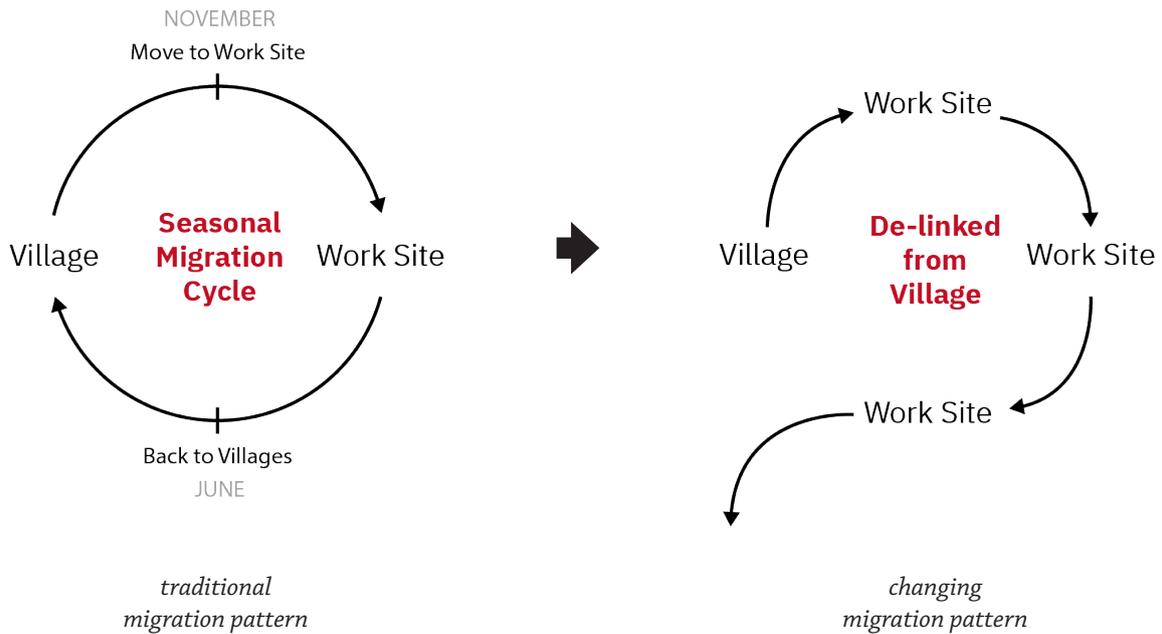
Living Pattern

MAY 2022

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 <i>International Worker's Day</i>	2	3 <i>Ramzan Id/ Eid-ul-Fitar</i> 	4	5	6	7
8	9	10	11	12	13	14
15	16 <i>Buddha Purnima/ Vesak</i> 	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				
		April 2022 Su M Tu W Th F Sa 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	June 2022 Su M Tu W Th F Sa 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	Calendars by Vertex42.com © 2018 Vertex42 LLC. Free to print.		

There is no marked holiday system in the quarrying area. However, they celebrate Amavasya (the monthly no-moon day) and the two yearly prime Hindu festivals Holi (festival of colours) and Diwali (festival of lights).

*Migration Pattern Transition
of Quarry Workers in India*



As the stone quarry sector is now losing its seasonal character, some quarry workers' families may no longer move back to the rural area.¹ They are isolated from their original rural communities and lose their citizen identities.

On the one hand, migrant workers are cut off from all their basic entitlements in villages where they have previously registered, including public education for children, free services in public health centres, and Public Distribution System (PDS) grains. On the other hand, they are not

¹ For example, in Maharashtra, stone quarries have begun to work round the year. See Smita, 7.

allowed to access city facilities.² As a result, living in the informal settlements in the city, quarry workers are forced to give up their rights and entitlements, becoming further disenfranchised.³

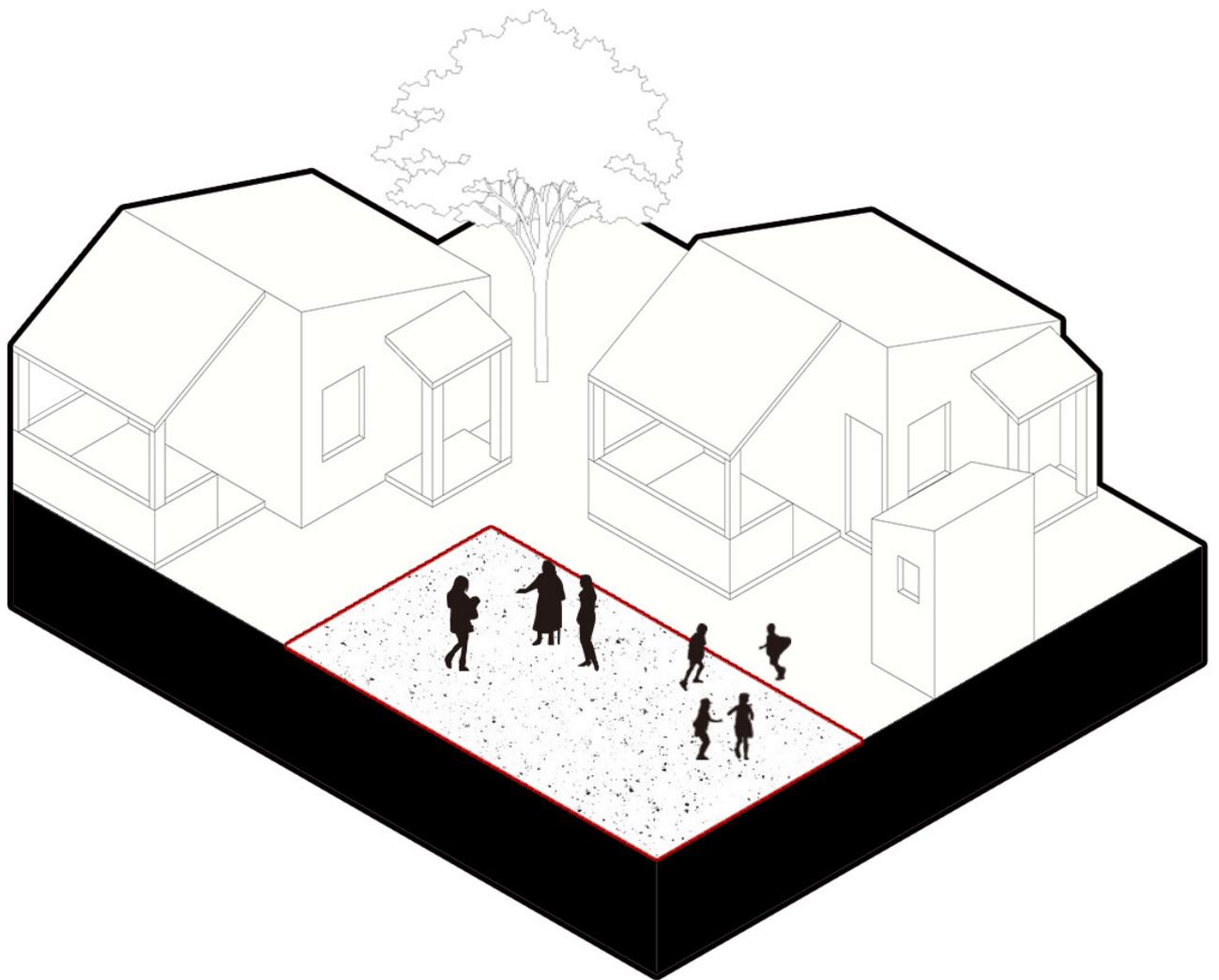
This transition has further contributed to the solid social linkages between migrant workers' communities and sets up their sense of dependency on the communities in the city.

² Lux and Watson, "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces," 13.

³ Smita, 19.

II. DESIGN RESEARCH

Social Linkage



Open-to-sky Space

in Quarry Settlement & Traditional Indian Villages



Source: Lux, Valerie Saavedra, and Paul Watson. "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces." edited by Bo Tang: London Metropolitan University; Association of Rural People for Health and Educational Needs, 2008.

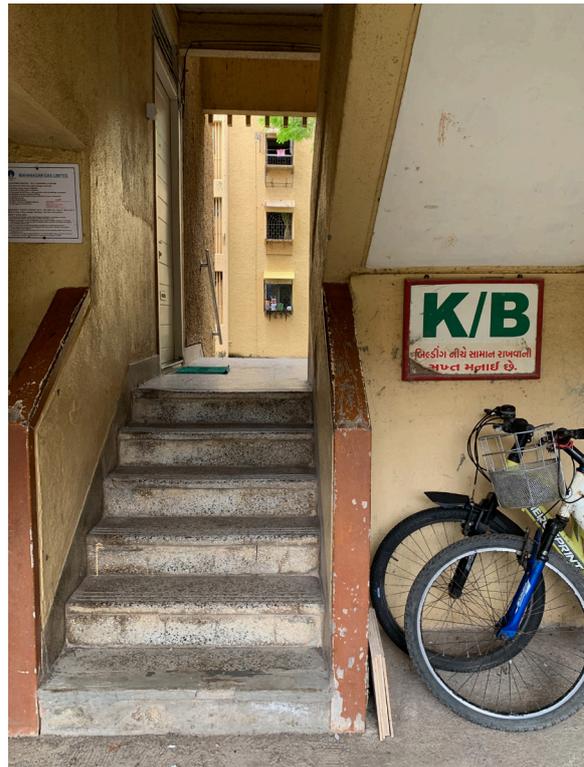
II. DESIGN RESEARCH

Housing in India

Based on its cultural and religious context, Indian housing usually presents a focus on building a social linkage. The Versova Aga Khan Baug project is located in Mumbai's suburban district. It received 344 needy families in Mumbai and most of them came from the economically weaker sections of the Ismaili community. Therefore, considering its religious background, the project was planned as a closed community to create a central open space for community gatherings, especially for the celebration of religious festival.

There are 10 blocks clustered around the peripheries of the site and create a central open space which is divided into several gardens and paved for walking. With paving on the outer edges, some internal space is delineated for service areas like the underground water tanks. Besides, at the western boundary of the property is a Jamatkhana, or community center, and a play area for children. With the dwellers' daily recreation activities in these spaces, the project gains its vitality. The pedestrian and vehicular circulation are separated.

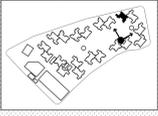
For each block, two buildings are structurally connected to create a housing block while each building is functionally independent. The plan is impact, with 4 houses on each floor and a walk-in staircase. This staircase separates the houses on two different levels. The ground floors are generally open, with space for bicycle parking and mailboxes.



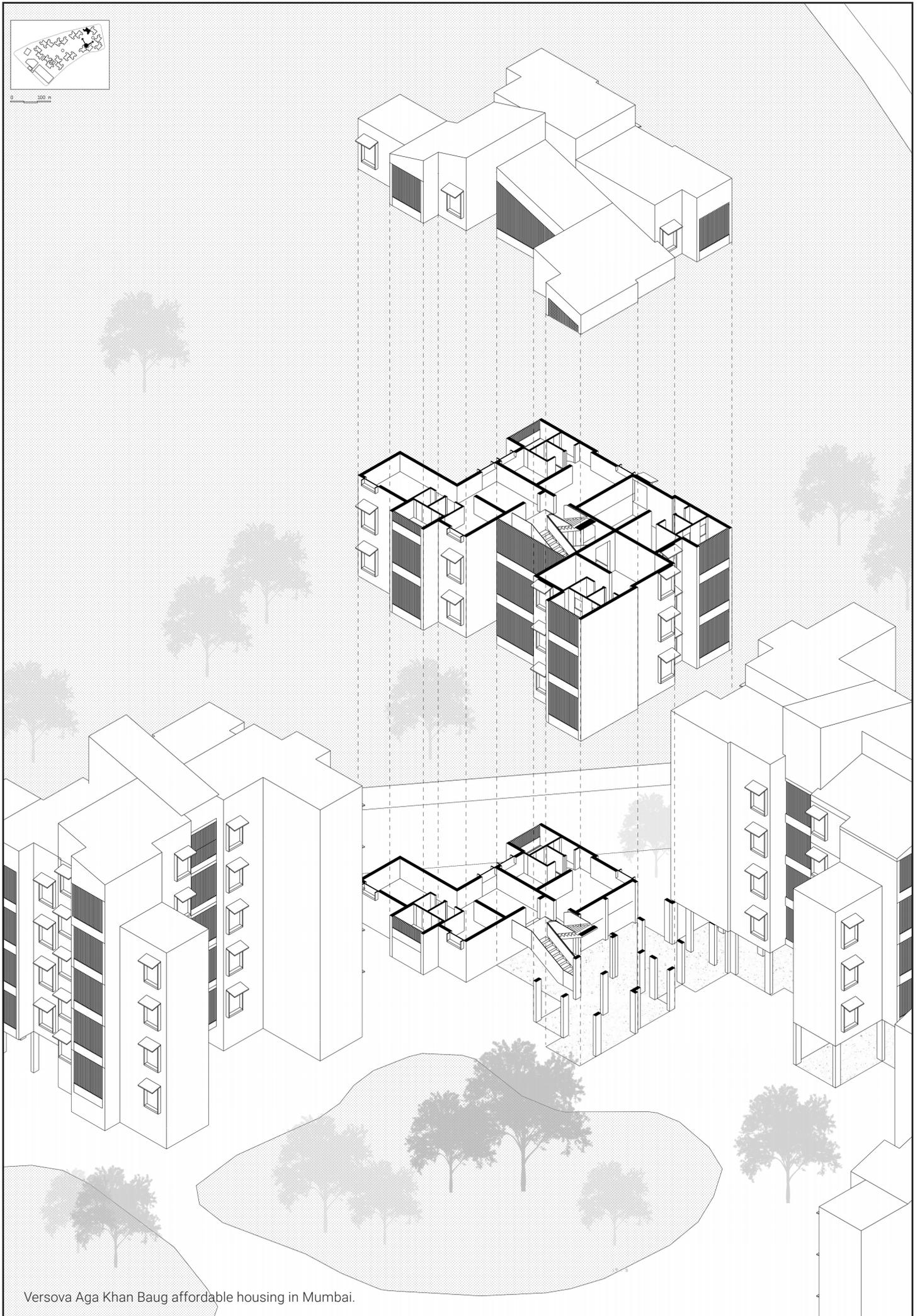
From top to down:
The open staircase works as a doorstep place.
The central open space (courtyard) for community gatherings.



Residents celebrate the religious festival in the central open space.



0 200 m

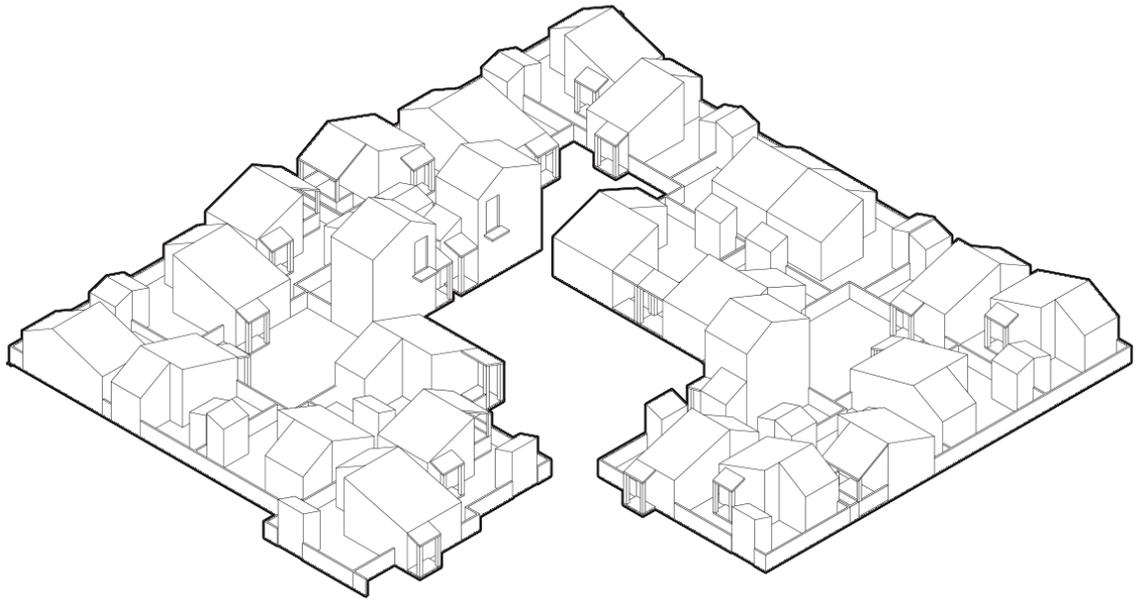


Versova Aga Khan Baug affordable housing in Mumbai.

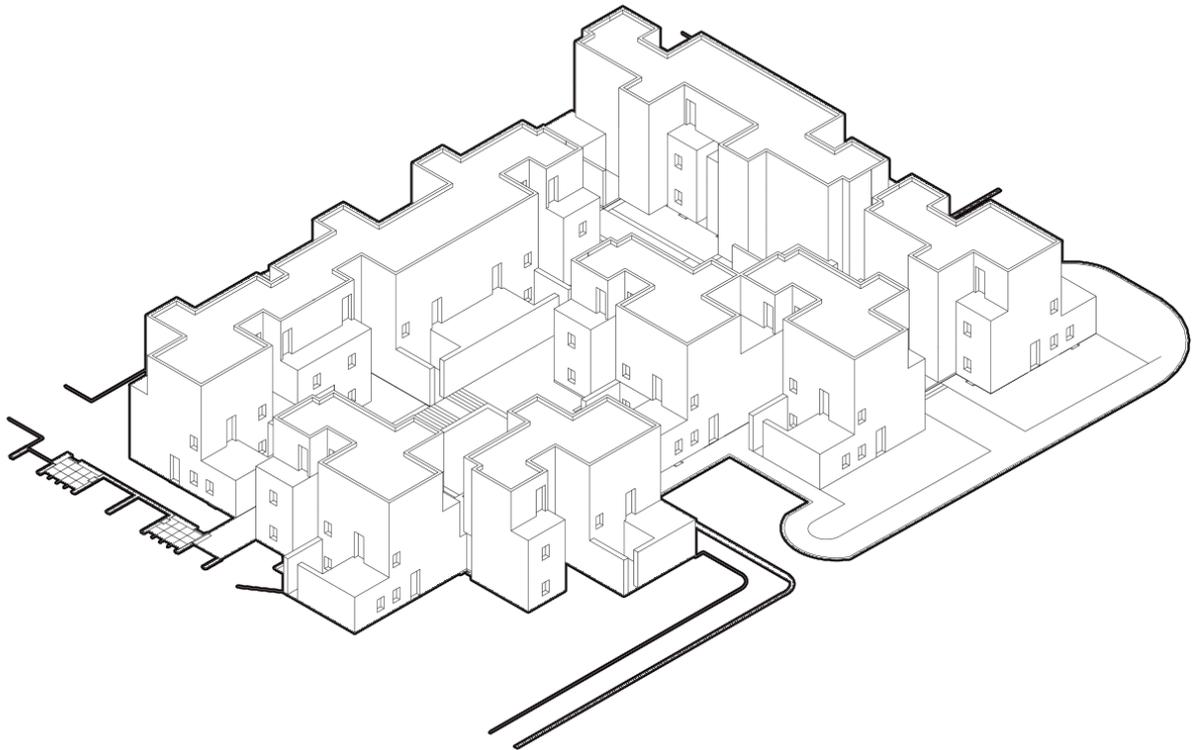
II. DESIGN RESEARCH

Housing in India

Low-rise Housing



Cluster layout of Artist Village.



Cluster layout of Raj Rewal CIDCO Housing.



Open-to-sky Space



Incrementality



Pluralism and Equity



Social Linkage

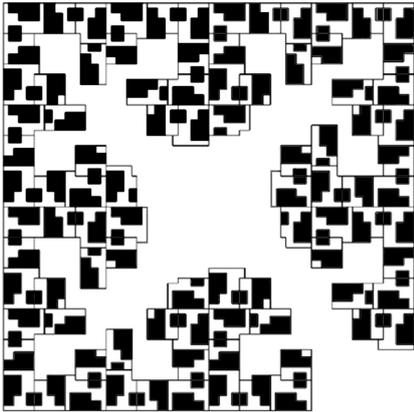


Materiality and
Climate Respond

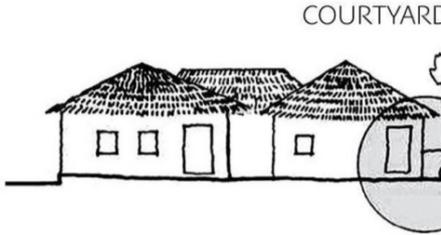
II. DESIGN RESEARCH

Housing in India

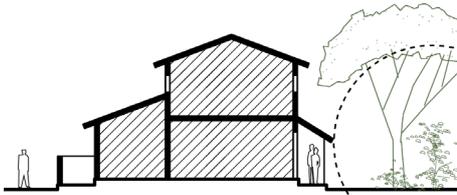
Low-rise Housing



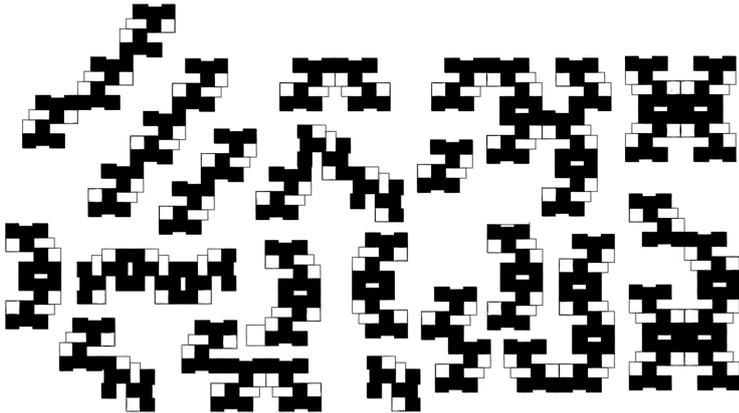
Cluster layout of Artist Village



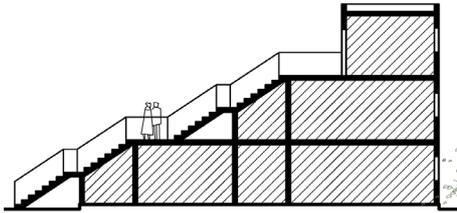
COURTYARD



DOORST

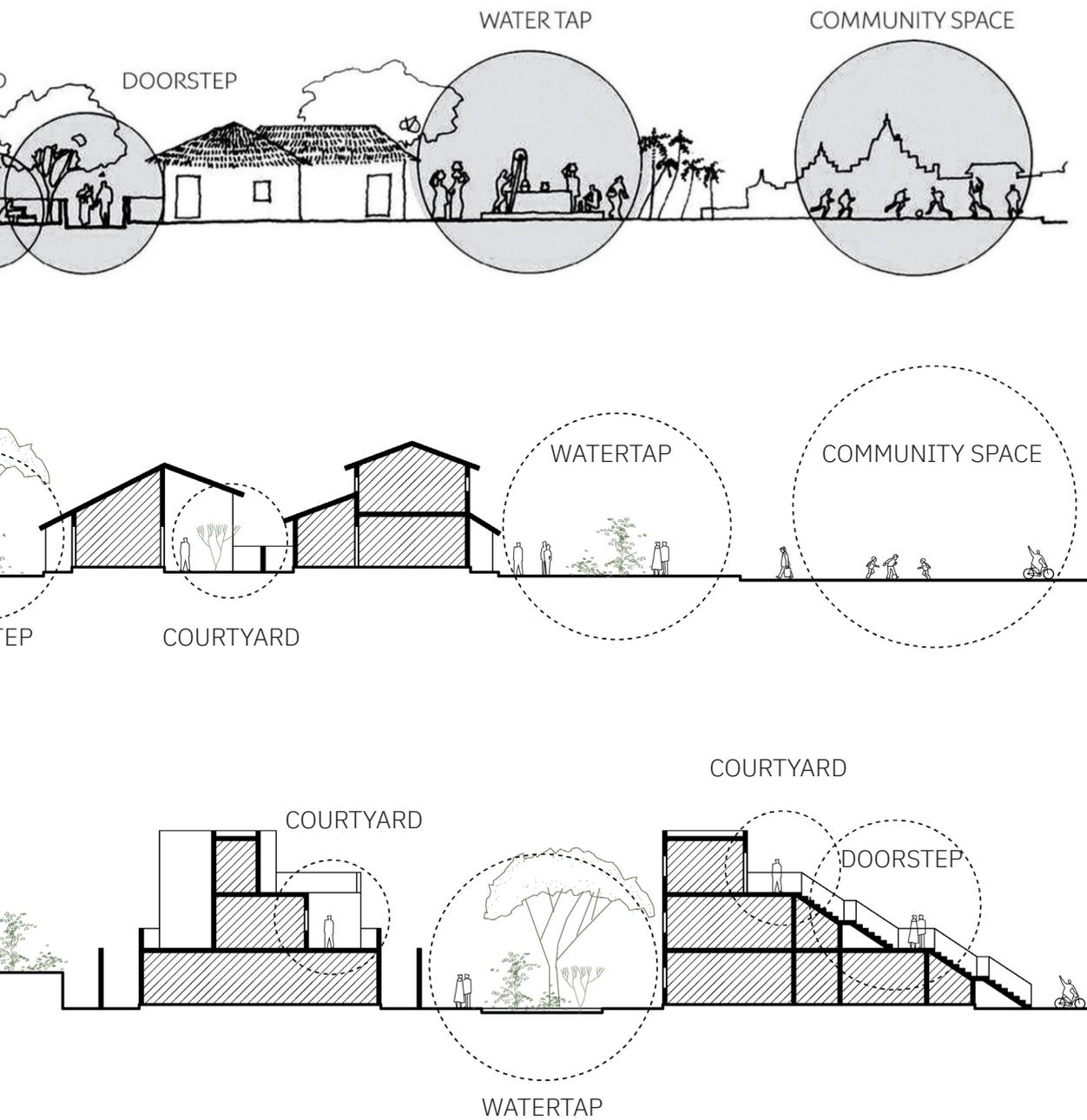


Cluster layout of Raj Rewal CIDCO Housing



0 5 10 15m

A horizontal scale bar with markings at 0, 5, 10, and 15 meters.



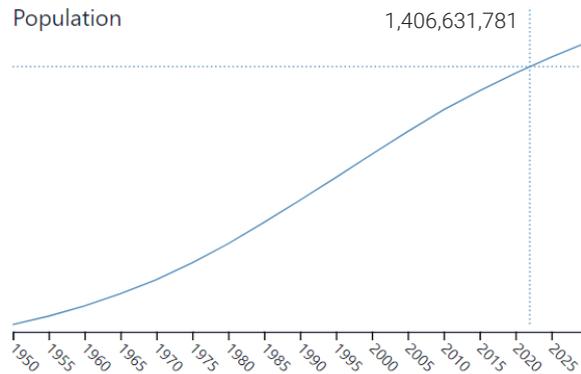
Comparison of Charles Correa's spatial hierarchy section with Artist Village and Raj Rewal CIDCO Housing.

II. DESIGN RESEARCH

Housing in India

Since 1980s, India has been under the age of population boom. It requires to accommodate more population in the housing sector. As a result, India's housing experiment has also seen a move from low-rise housing to the high-rise housing.

CIDCO Mass Housing Scheme is a government funded project to create roughly 90,000 apartments at several nodes of Navi Mumbai, aiming to address the urban housing shortage among the EWS/LIG and MIG categories. The design concept of the mass housing scheme consists of a repetition of one unit, an EWS or LIG single person unit. This unit is repeated on every floor 6 times, all connecting to the same circulation of the building. The units fit together like a puzzle piece and every building complex can be connected to its neighbouring building. All together creating an mass housing scheme.



Data Source:
<https://www.populationpyramid.net/india/2022/>

Navi Mumbai Marches Ahead
With 'HOUSING FOR ALL'
89,771 HOUSES AT SEVERAL NODES
OF THE CITY BASED ON TRANSIT ORIENTED DEVELOPMENT

Ground Breaking Ceremony of
CIDCO'S MASS HOUSING SCHEME-2018
 by
NARENDRA MODI
 Prime Minister

ON TUESDAY, 18TH DECEMBER, 2018 AT 01:30 PM
 AT: VASUDEV BALWANT PHADKE GROUND, LAL CHOWKI, ADHARWADI ROAD, KALYAN (W)- 421 301.

PROJECT HIGHLIGHTS

- 89,771 Houses
- 13,483 for Economically Weaker Section (EWS) and 36,288 for Lower Income Group (LIG) categories.
- Houses in vicinity of Bus Depots, Truck Terminals and Railway Stations enabling Transit Oriented Development.
- Bus Depots and Truck Terminals covered: Vashi, Kharghar, Kalmamboli and New Panvel in addition to a Project at Talaja Node.
- Railway Stations Forecourt Areas covered: Sarnpada, Jaitnagar, Kharghar, Barnandwerg, Kharghar, Mananagar and Khandeshwar.

Eligibility for Subsidy for EWS under PMAR: Ru. 2.5 Lakh for LIG under C.I.S.S. upto Ru. 2.07 Lakh.

DEVENDRA FADNAVIS
 Chief Minister, Maharashtra

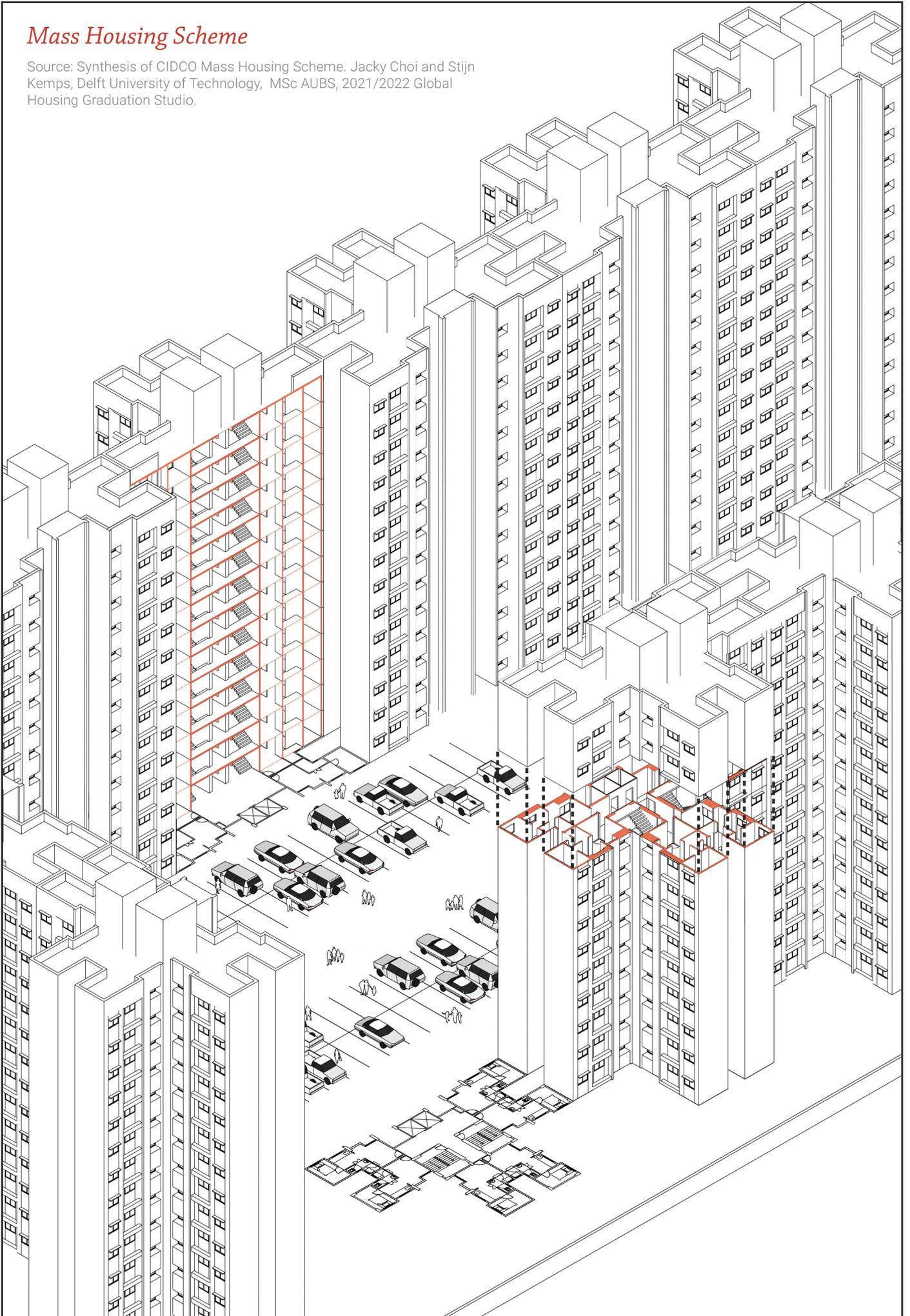
CITY AND INDUSTRIAL DEVELOPMENT CORPORATION OF MAHARASHTRA LIMITED.

REGD. OFFICE: Nirmal, 2nd Floor, Nariman Point, Mumbai - 400 021 | Phone: +91 22 4650 8900 | Fax: +91 22 2282 2089
 HEAD OFFICE: CIDCO Bhavan, CBD Belapur, Navi Mumbai - 400 654 | Phone: +91 22 4791 8100 | Fax: +91 22 4791 8166
www.cidcoindia.com | CIN: U50909 MH 1976 BOC-04574 | CIDCOIN3000002576

Source: CIDCO Mass Housing Advertisement. Admin, W. (2020, 22 juli), Sarkari Yojana Latest News, <https://pmil.in/maharashtra-govt-scheme/cidco-mass-housing-scheme/>.

Mass Housing Scheme

Source: Synthesis of CIDCO Mass Housing Scheme. Jacky Choi and Stijn Kemps, Delft University of Technology, MSc AUBS, 2021/2022 Global Housing Graduation Studio.



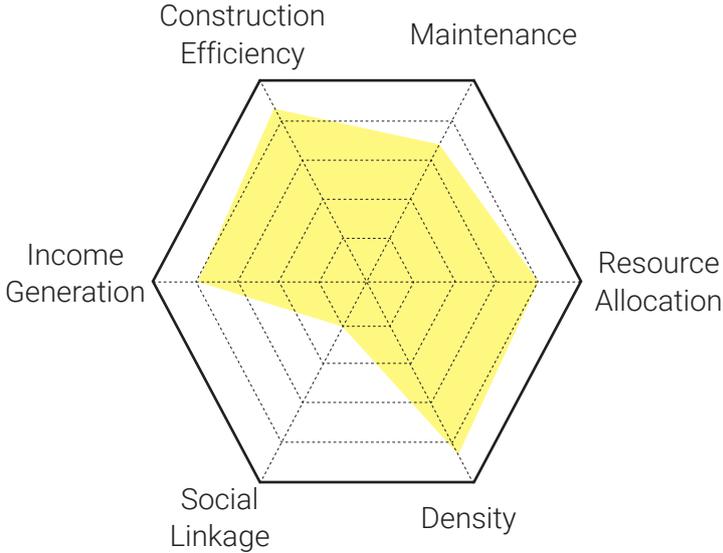
II. DESIGN RESEARCH

Housing in India

URBAN



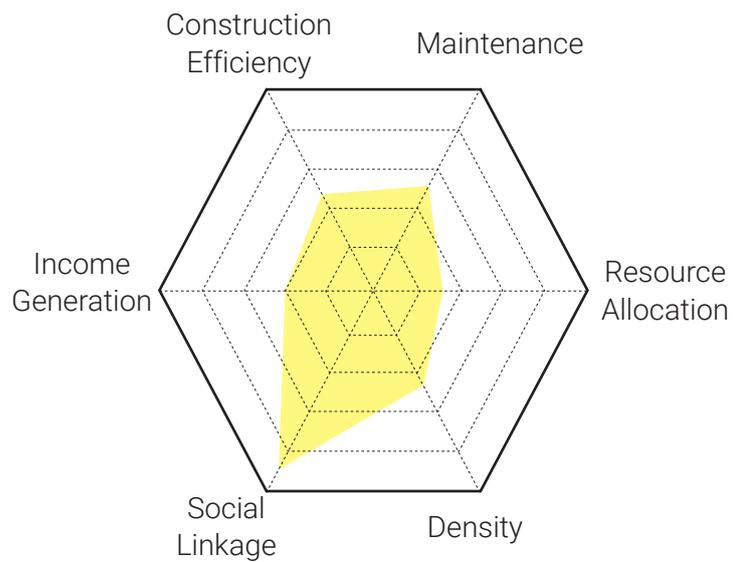
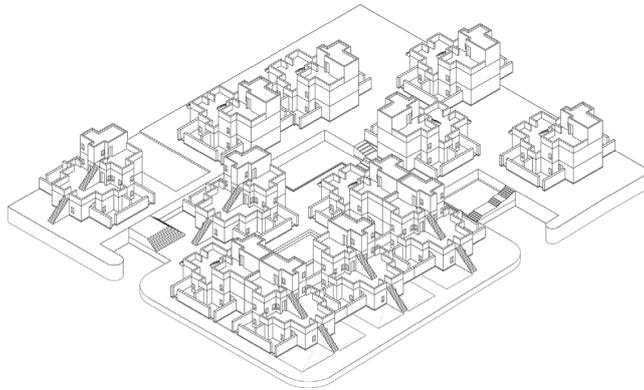
Source: Jacky Choi and Stijn Kemps, Delft University of Technology, MSc AUBS, 2021/2022 Global Housing Graduation Studio.



?

Negot
Peri-U

RURAL



?
Differentiating
Urban



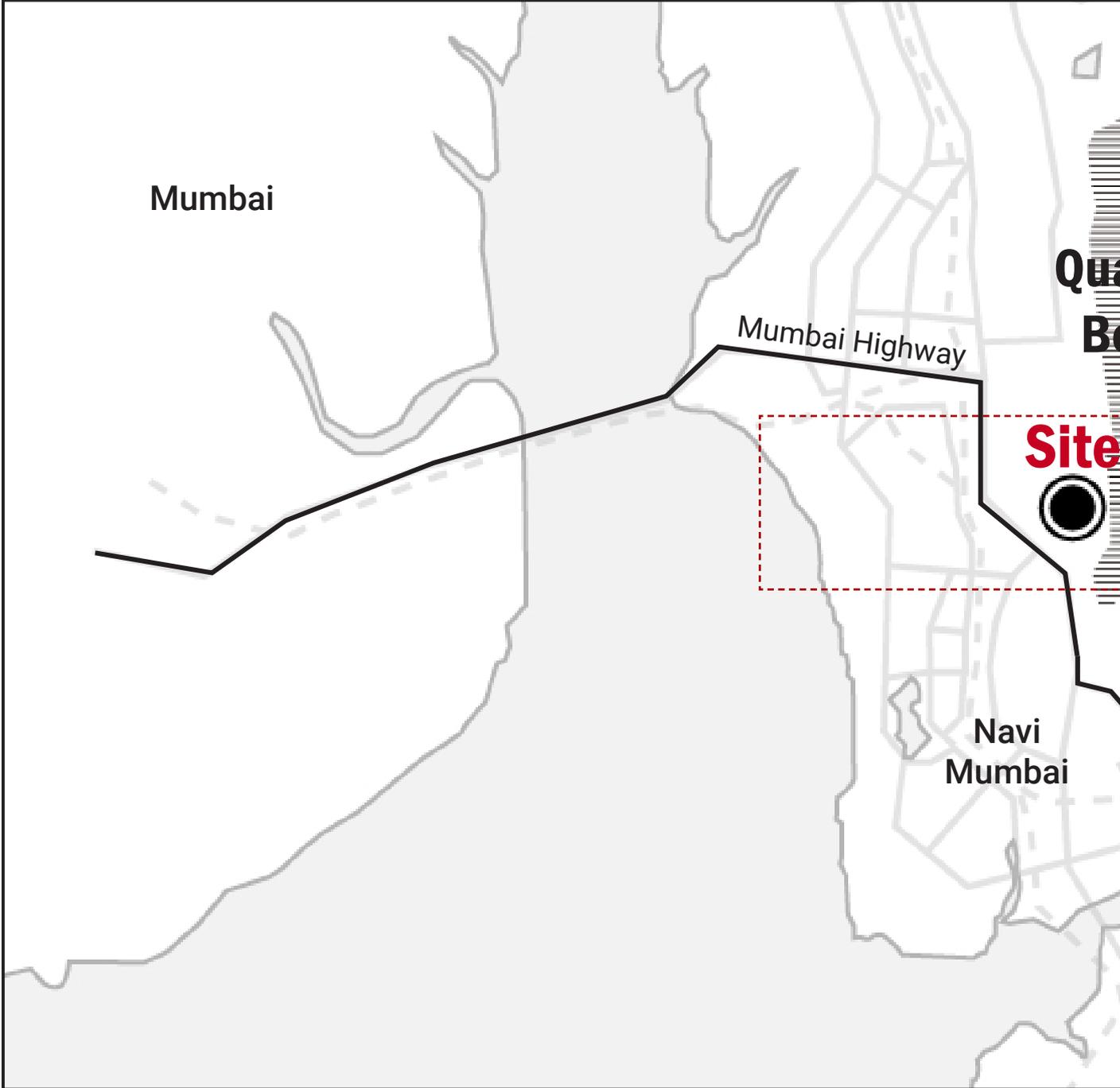
**socio-ecological
urban resilience**

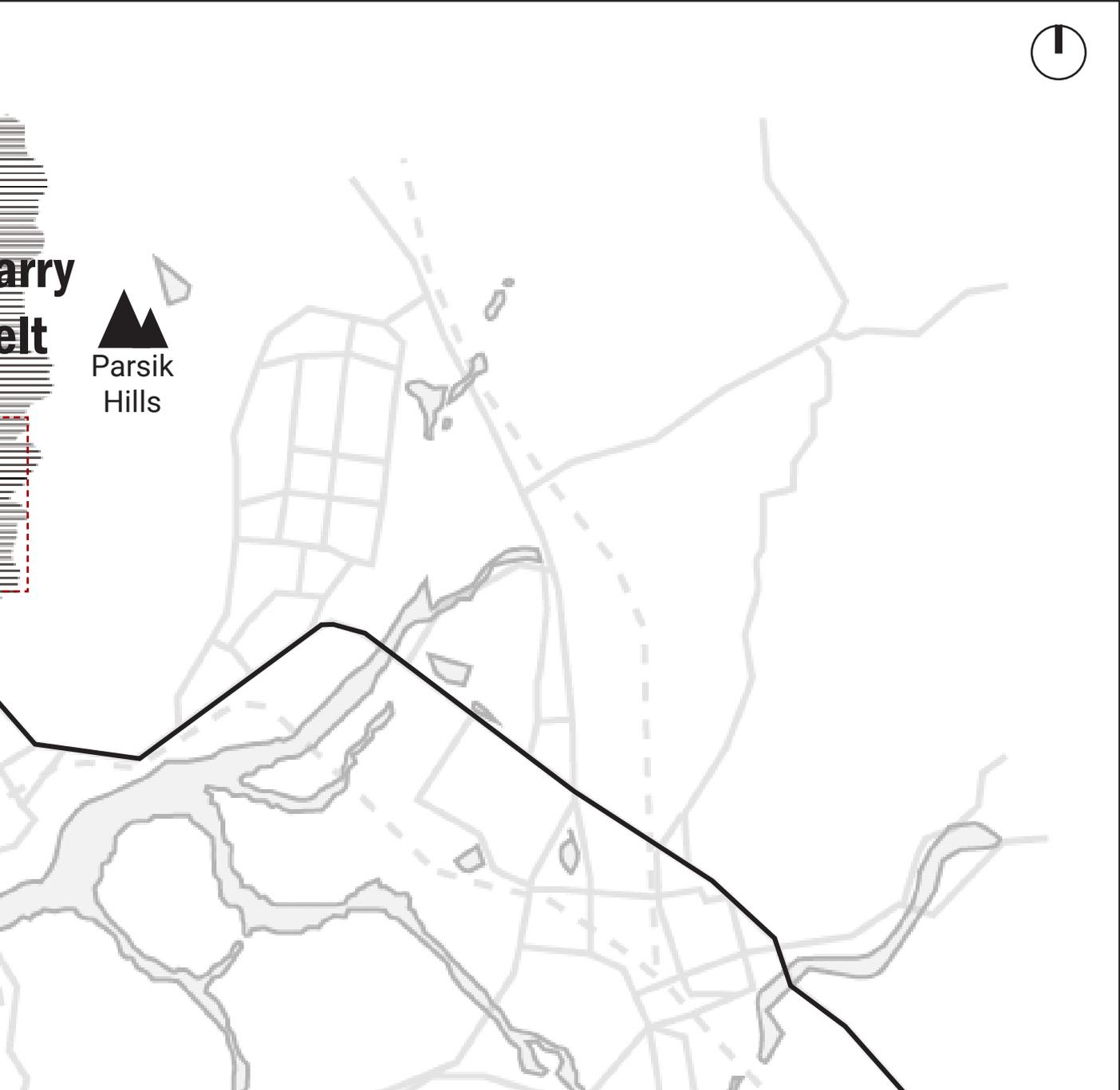
III. URBAN STRATEGY

Based on the previous research, this chapter presents the design hypothesis for the research question from an urban perspective.

III. URBAN STRATEGY

Selected Site Location



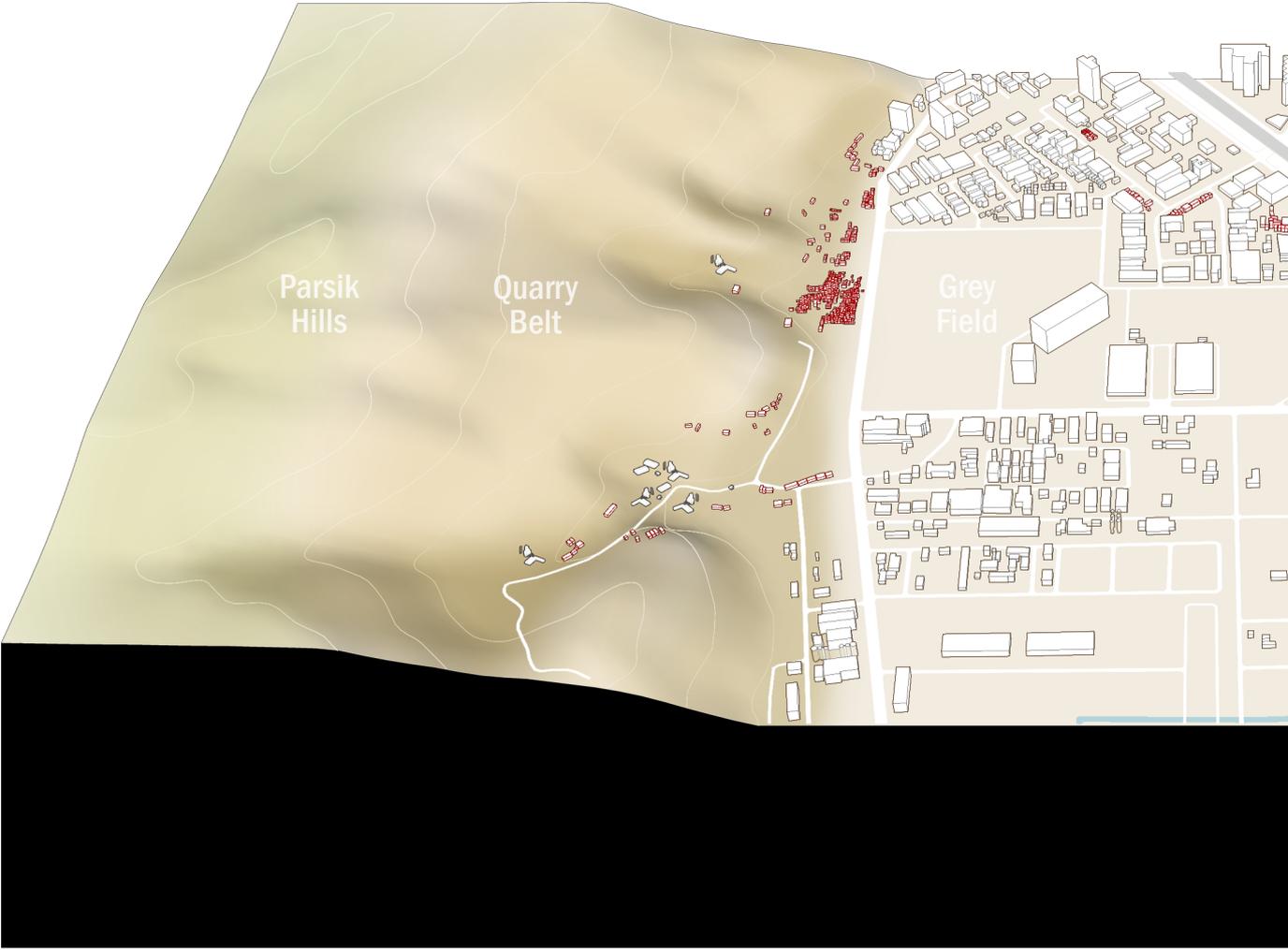


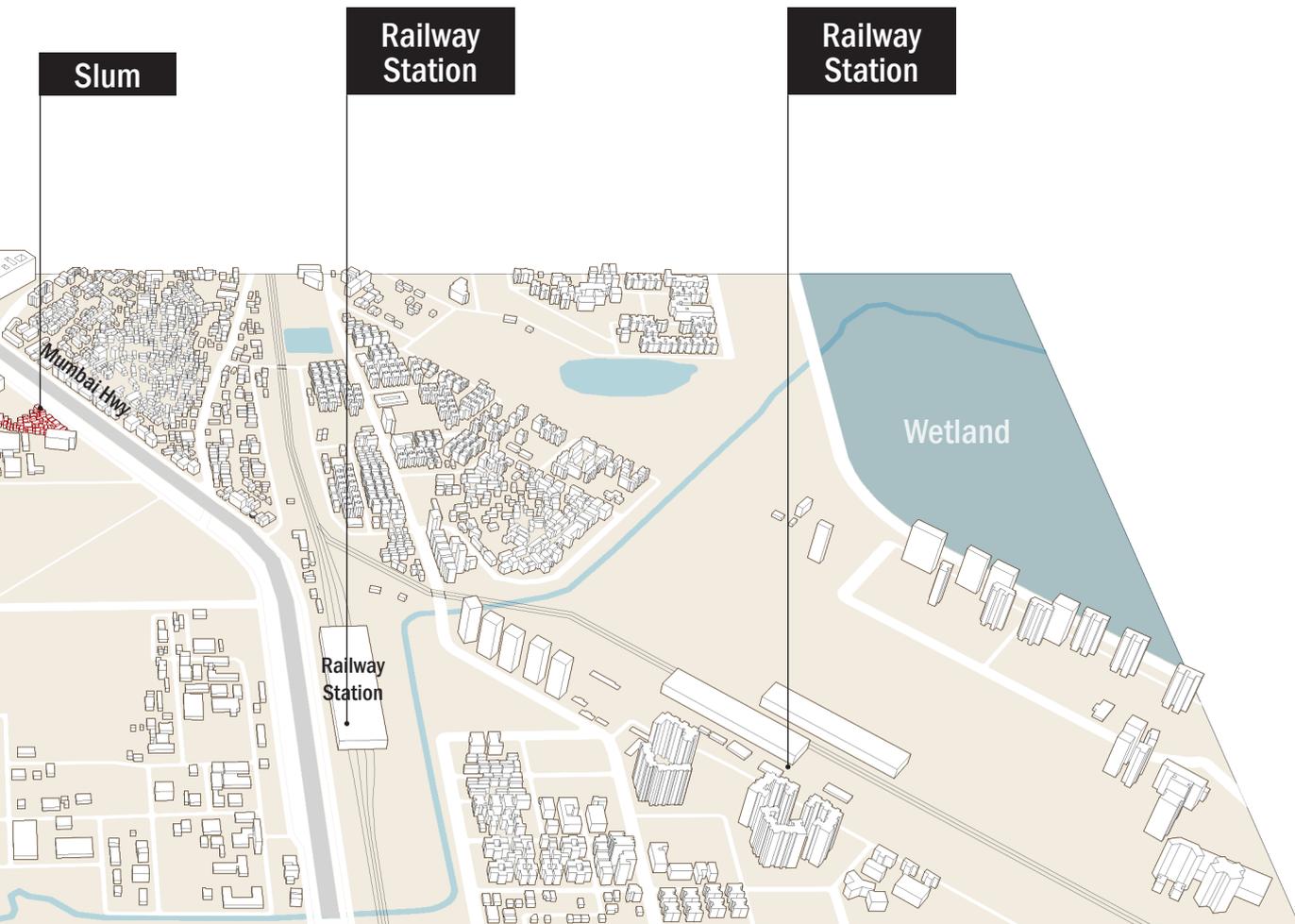
III. URBAN STRATEGY

Current Situation

The original situation of the selected peri-urban area which is located between the Parsik Hills and Mumbai highway, is exposed to safety risks from quarries. In addition, it suffered from a lack of urban infrastructure and amenities.

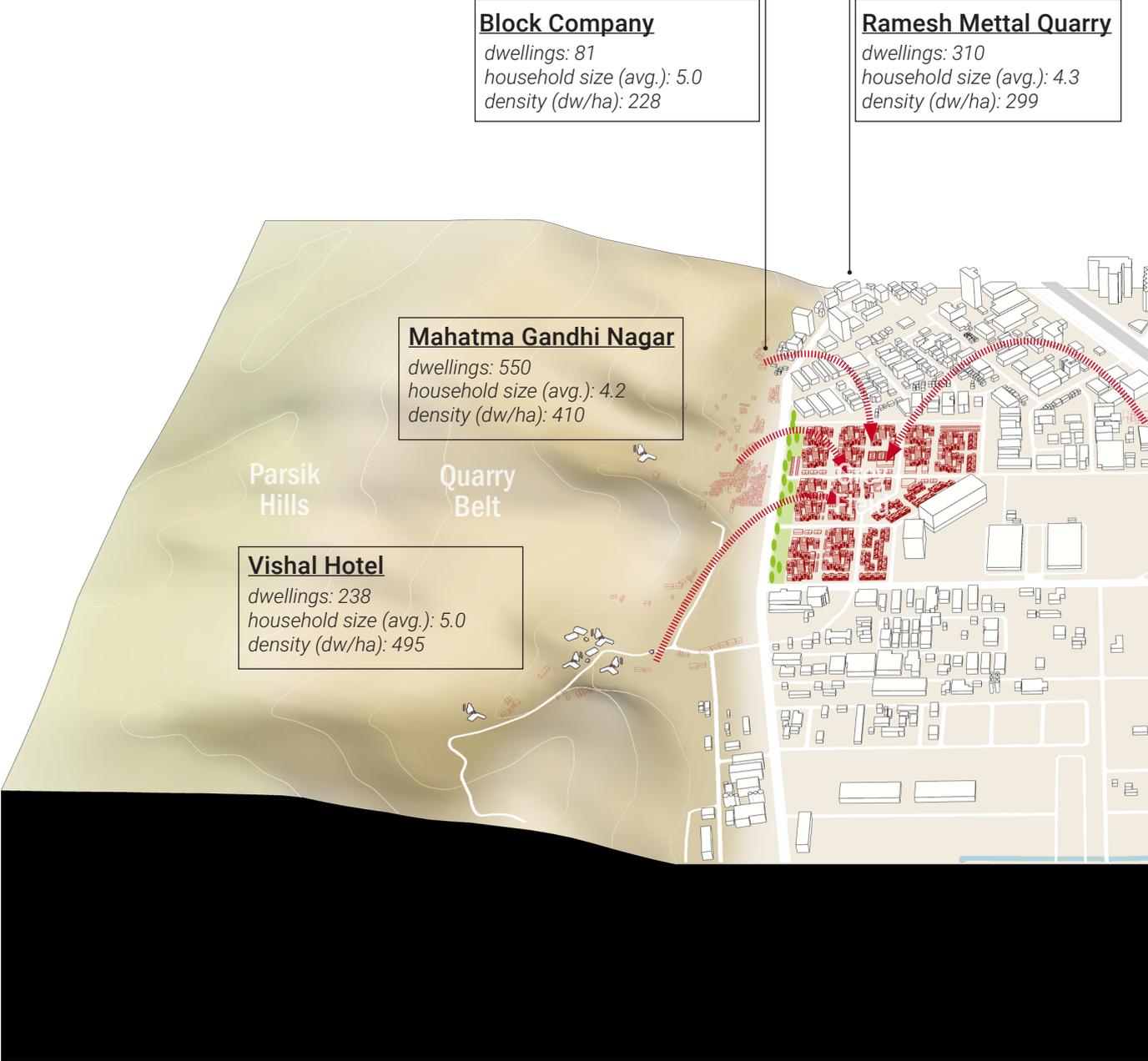
The upgrading will be divided into three phases: firstly, to resettle workers to a safer place to live; secondly, to upgrade urban facilities; and finally, to restore the ecology of the quarry area and create a green corridor from the peri-urban to the city center.





III. URBAN STRATEGY

Phase 1: Resettlement



Data Source: <https://app.shelter-associates.org/city::Navi%20Mumbai>.



P1: resettlement

P2: urban

Shivaji Nagar

dwellings: 676
household size (avg.): 4.3
density (dw/ha): 450



resettlement
units

1855 + **800**

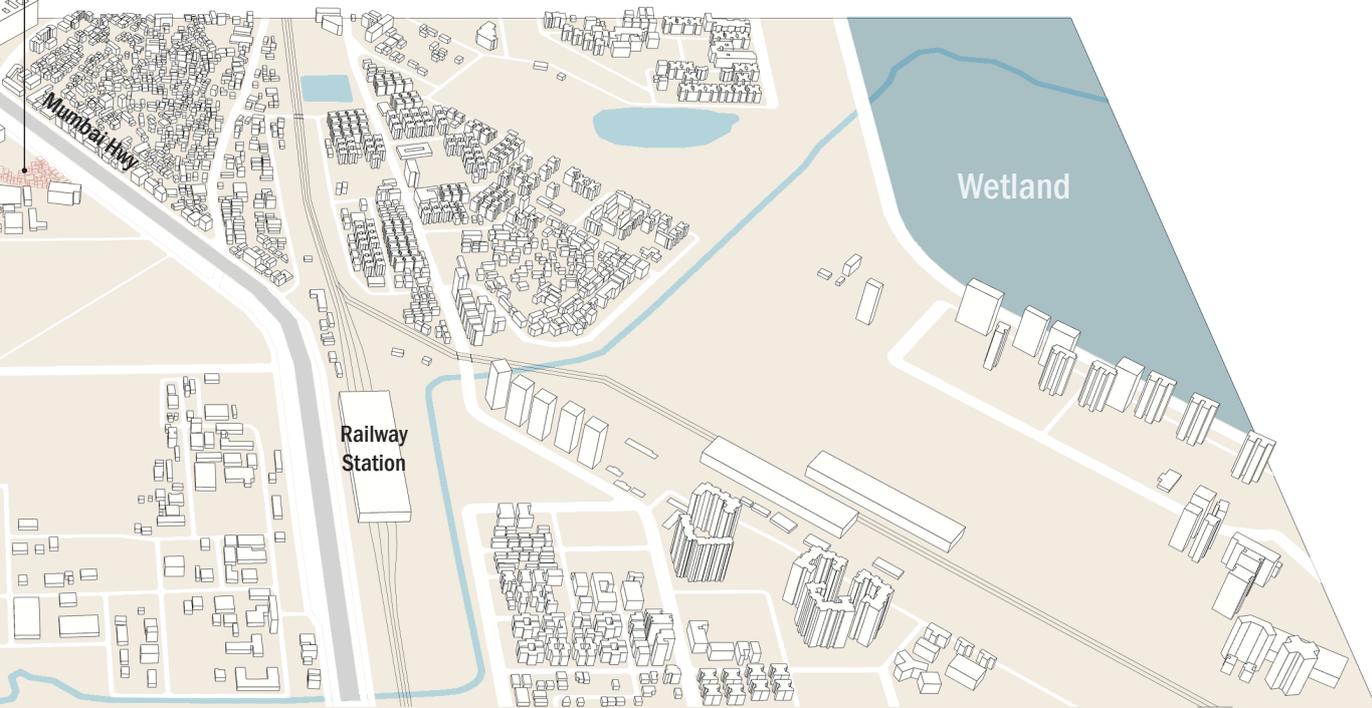
future
development

EWS **LIG**

LIG **MIG**

Migrant
Workers

Other Local
Inhabitants



h upgrade

P3: ecological restoration

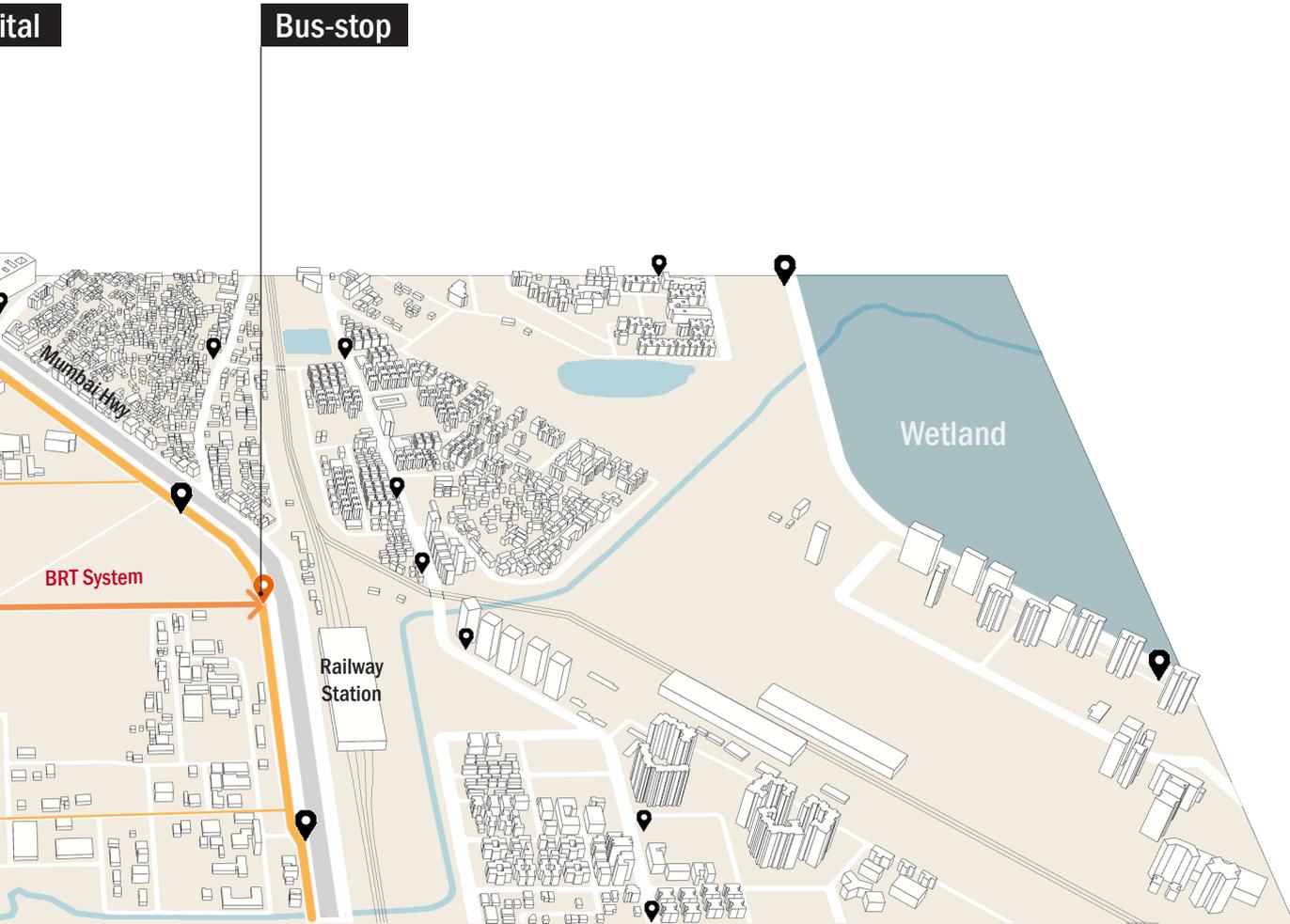
III. URBAN STRATEGY

Phase 2: Urban Upgrade



P1: resettlement

P2: urban



h upgrade

P3: ecological restoration

III. URBAN STRATEGY

Phase 3: Ecological Restoration



P1: resettlement

P2: urban

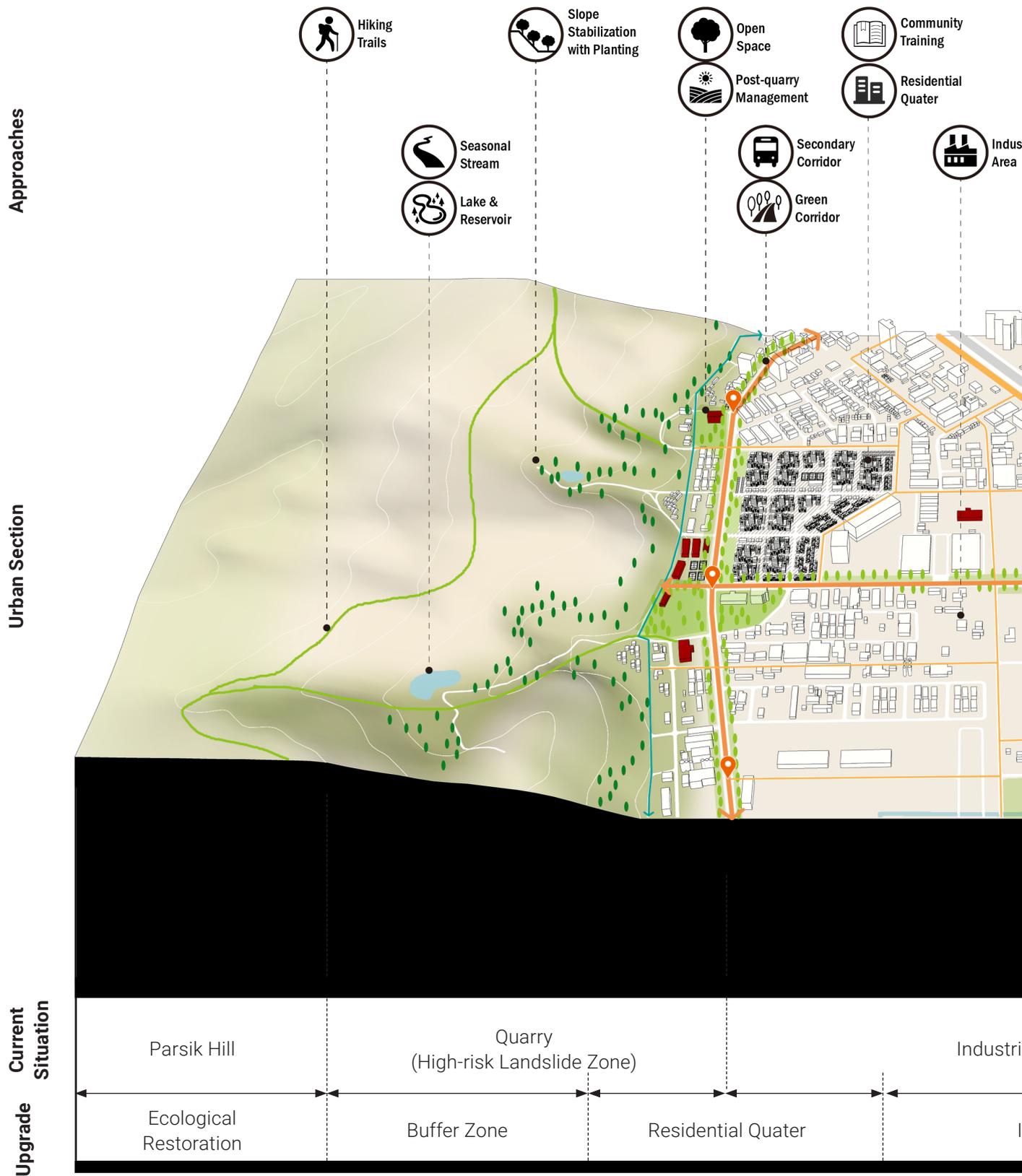


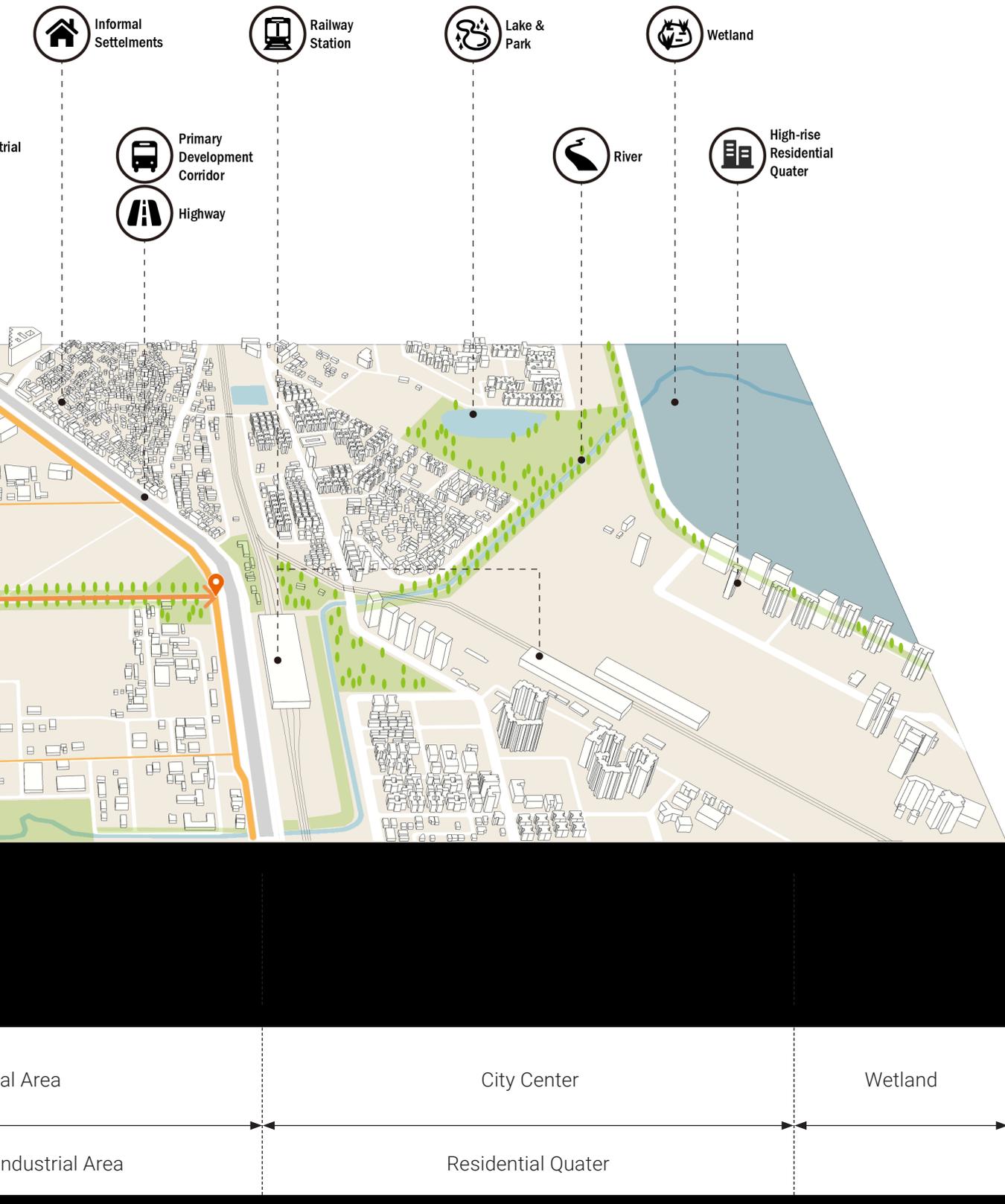
h upgrade

P3: ecological restoration

III. URBAN STRATEGY

Conclusion





III. URBAN STRATEGY

Focus Area

P1: resettlement

P2: urban





IV. RESIDENTIAL DESIGN

This chapter focuses on residential design and further develops the project's urban strategies.

IV. RESIDENTIAL DESIGN

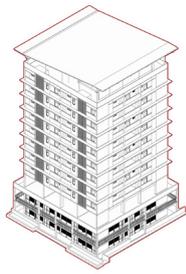
Concept



Quarry workers' collective and mutual-help lifestyle brings about the proposal of the residential cluster concept. This cluster will be a combination of domestic activities, income generation and social linkage. The core is a collective space as well as the income generation space. It will serve as a cluster

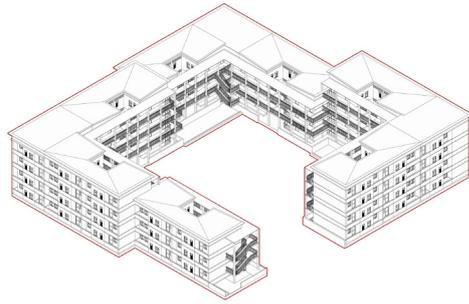
booster and be closely connected to the upstairs collective accommodation for quarry workers.

Low-rise apartments surround the core space and the courtyards in-between will link the cluster together.

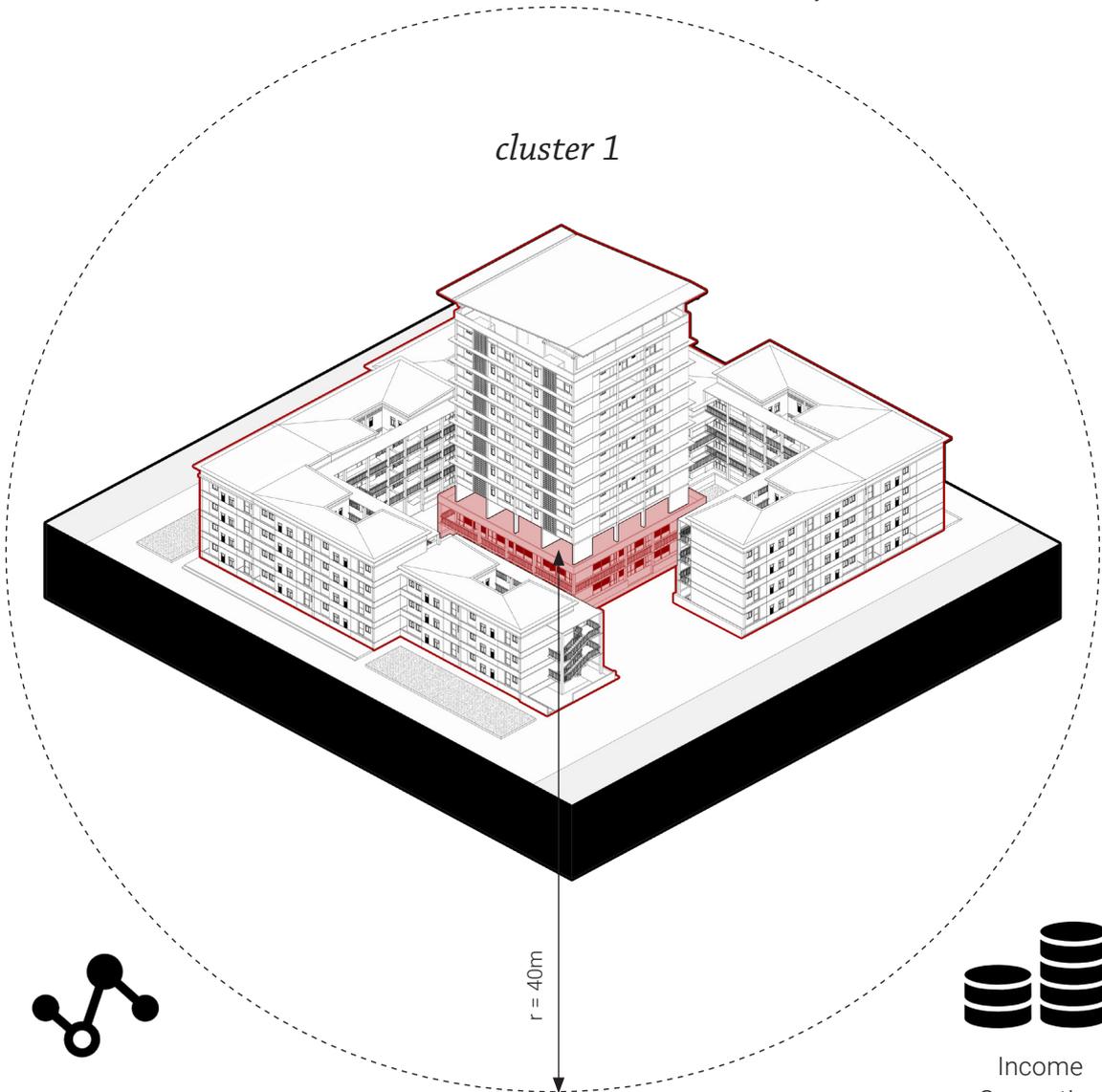


tower

+



courtyard



cluster 1



Social linkage



Income Generation



Domestic Activities

IV. RESIDENTIAL DESIGN

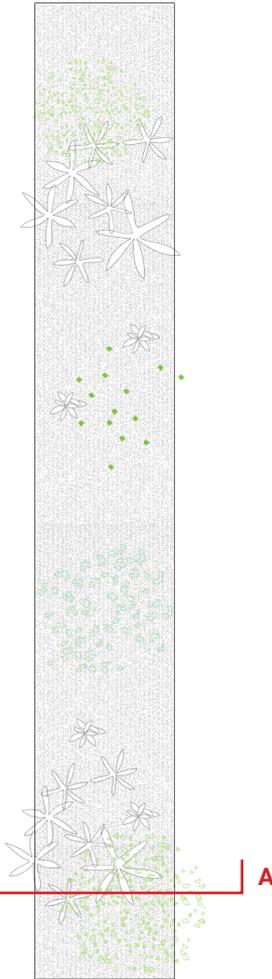
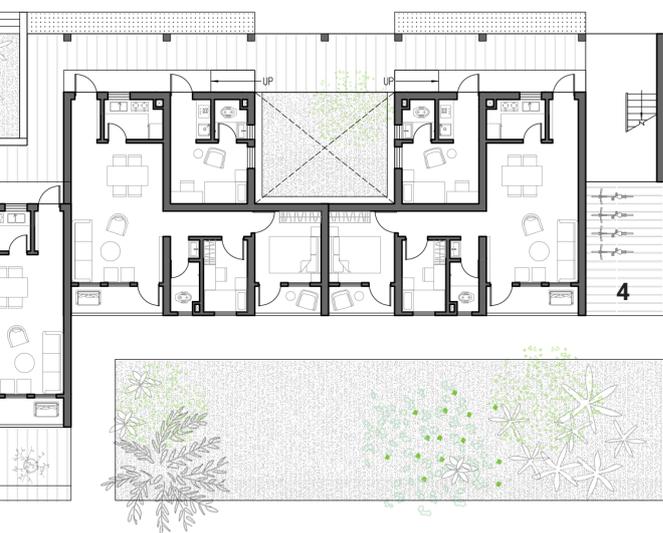
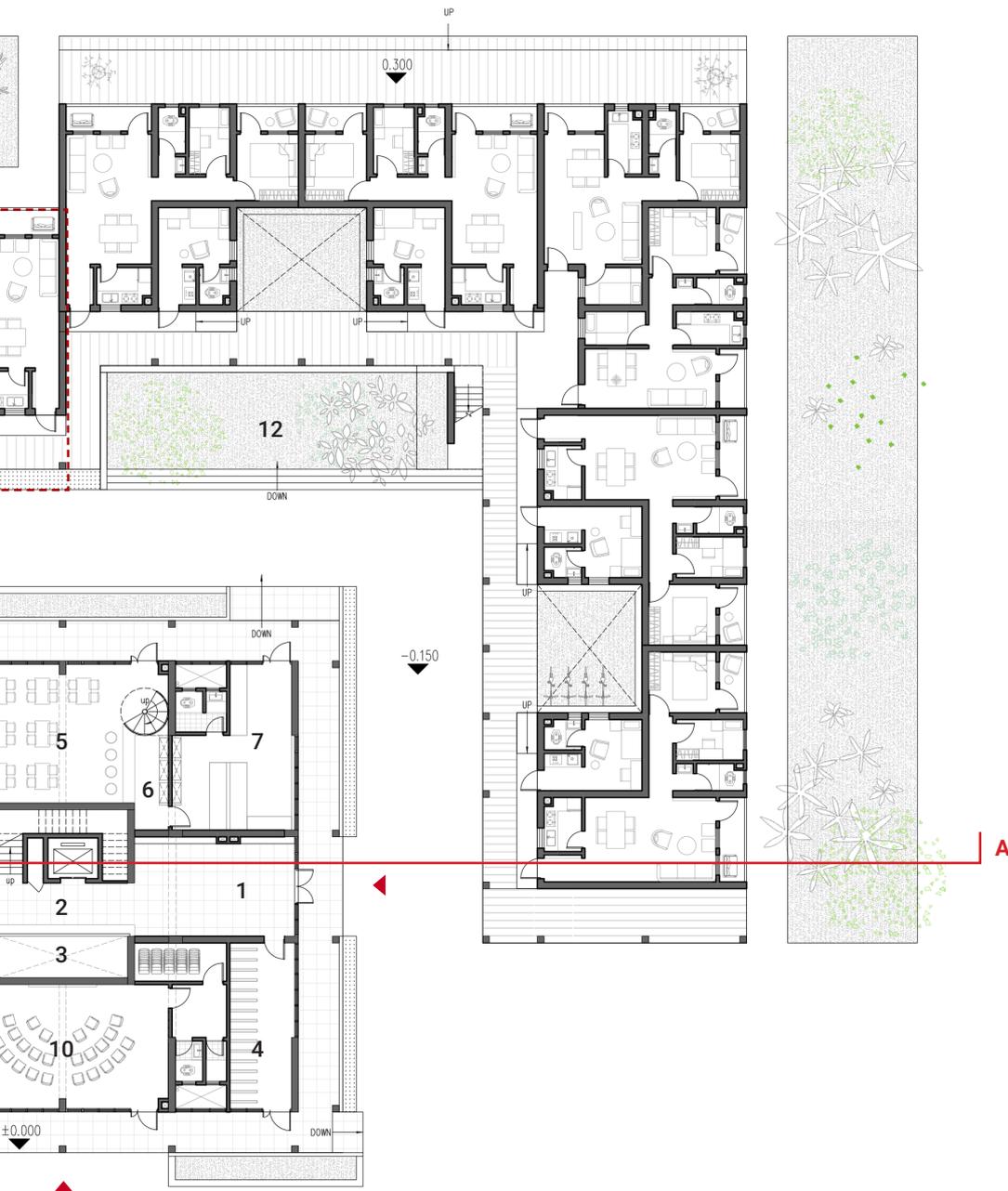
Cluster 1



- 1 foyer (tower)
- 2 lobby
- 3 courtyard
- 4 bicycle parking
- 5 canteen
- 6 servery

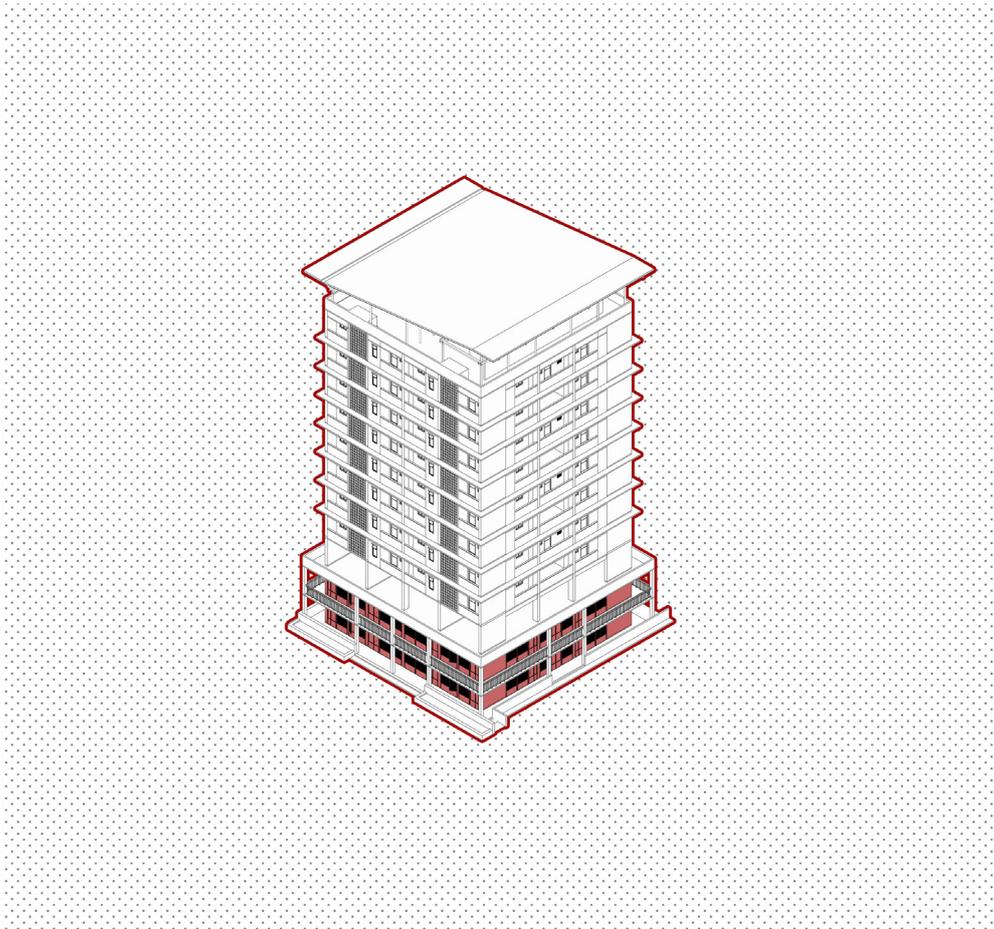
- 7 kitchen
- 8 puja room
- 9 bridge school
- 10 community classroom
- 11 gallery
- 12 sunken courtyard

Ground Floor Plan



IV. RESIDENTIAL DESIGN

Building Typologies: Tower



With the ambition to improve the professional skills of migrant workers, the first two floors of the building will be used for communal space which includes income-generated programmes. These programmes will be supported by the NGOs.

The housing typologies provided by **Tower** are mainly collective accommodation which will be rent to workers. The design takes into account the temporality of the quarrying industry and proposes the possibility of converting the collective accommodation in the future after the closure of the quarry.



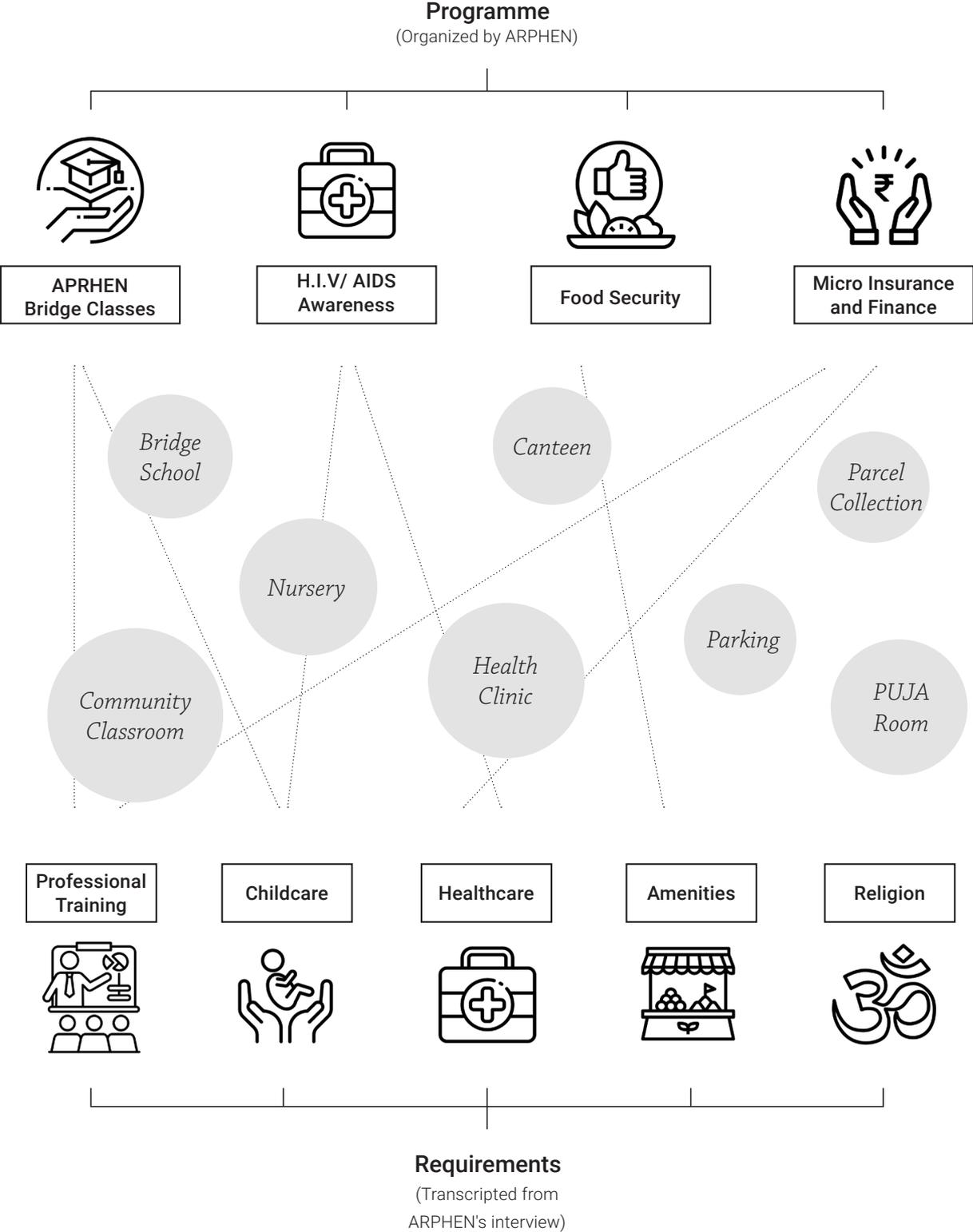
- | | |
|---------------------|------------------------|
| 1 mail room | 7 kitchen |
| 2 lobby (for tower) | 8 puja room |
| 3 courtyard | 9 bridge school |
| 4 bicycle parking | 10 community classroom |
| 5 canteen | 11 storage |
| 6 servery | 12 flower bed |

Ground Floor Plan 1:150

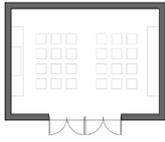


IV. RESIDENTIAL DESIGN

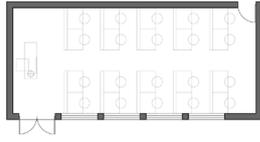
Building Typologies: Tower



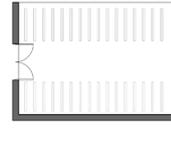
Source: Lux, Valerie Saavedra, and Paul Watson. "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces." edited by Bo Tang: London Metropolitan University; Association of Rural People for Health and Educational Needs, 2008.



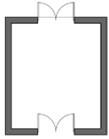
PUJA ROOM
a religious space for Hindu Rituals



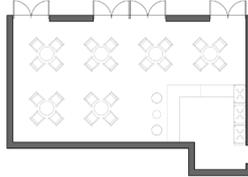
BRIDGE SCHOOL
an educational space for pre-school children



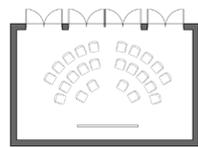
BICYCLE PARKING
amenities for bicycle and motorbike parking



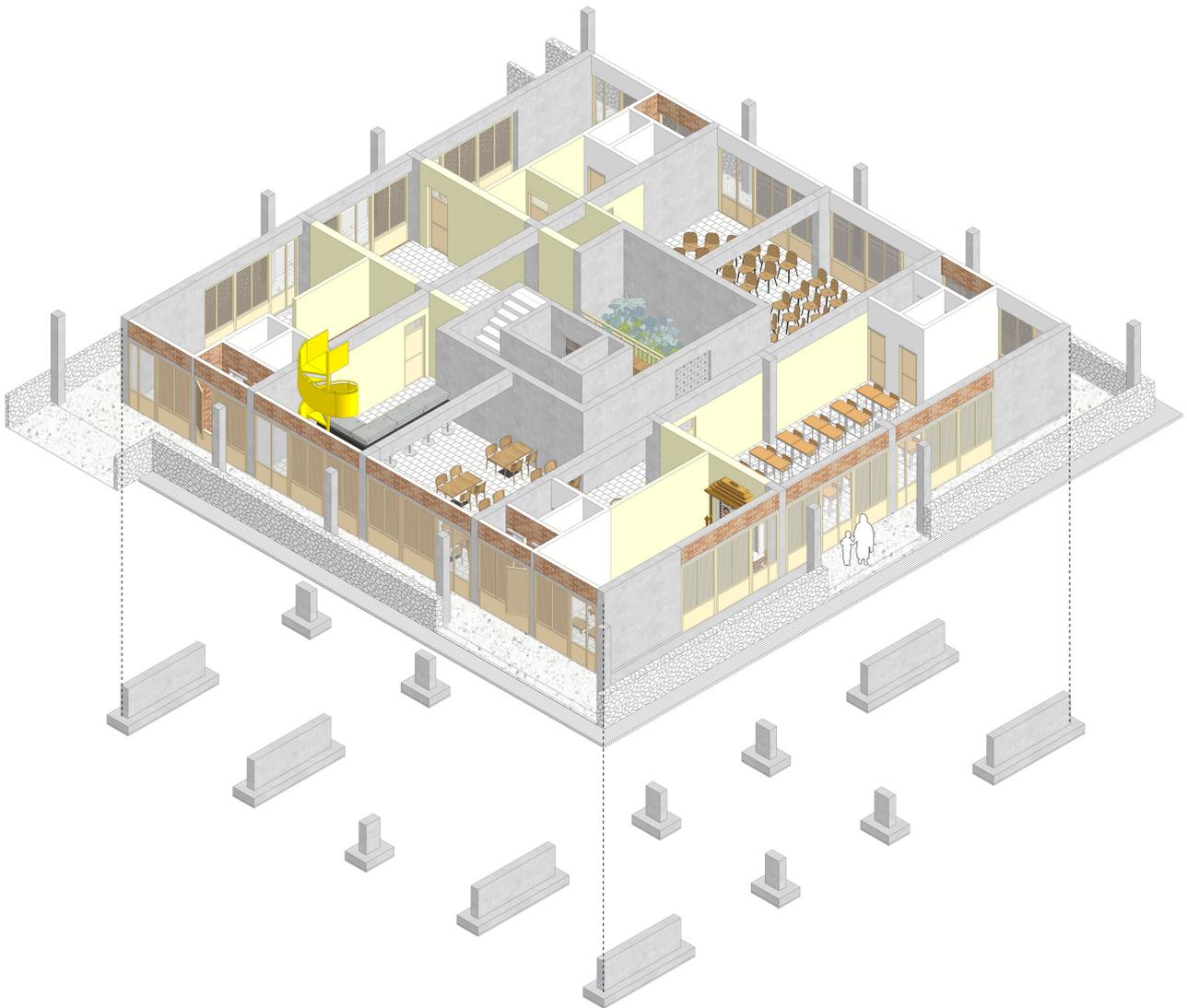
LOBBY (for tower)
a space for tower's entrance



CANTEEN & KITCHEN
a dining space for busy migrant workers



COMMUNITY SCHOOL
an educational space for the unemployed



 partition walls

Ground Floor Axonometry

IV. RESIDENTIAL DESIGN

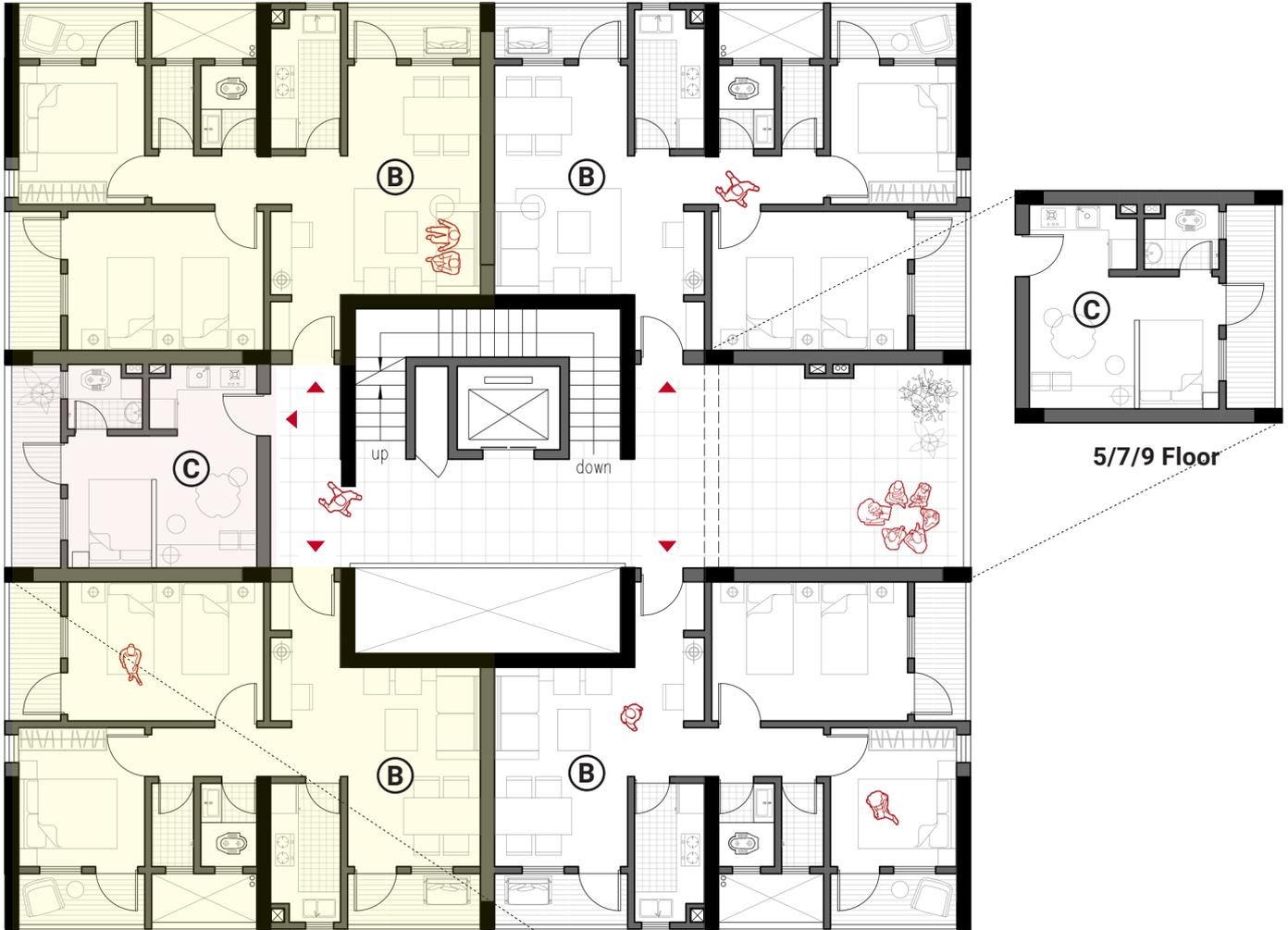
Building Typologies: Tower



Typical Residential Floor Plan
(Before)

Type A

collective accommodation
area: 160 sq.m.
group: quarry workers



Typical Residential Floor Plan
(After)

80%

Type B

2 BHK
area: 65 sq.m.
group: MIG

20%

Type C

1 BHK
area: 25 sq.m.
group: LIG

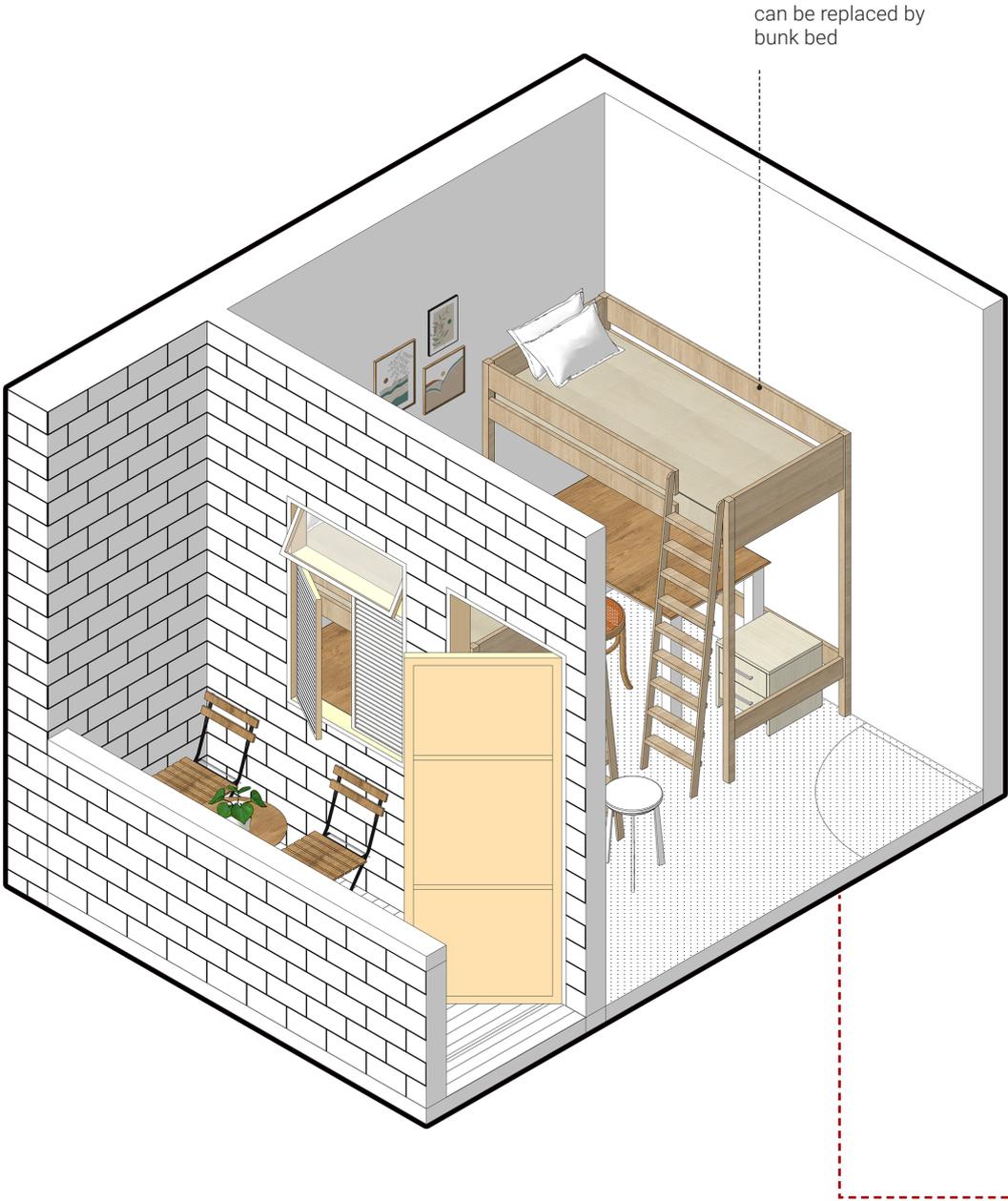
5/7/9 Floor

5/7/9 Floor

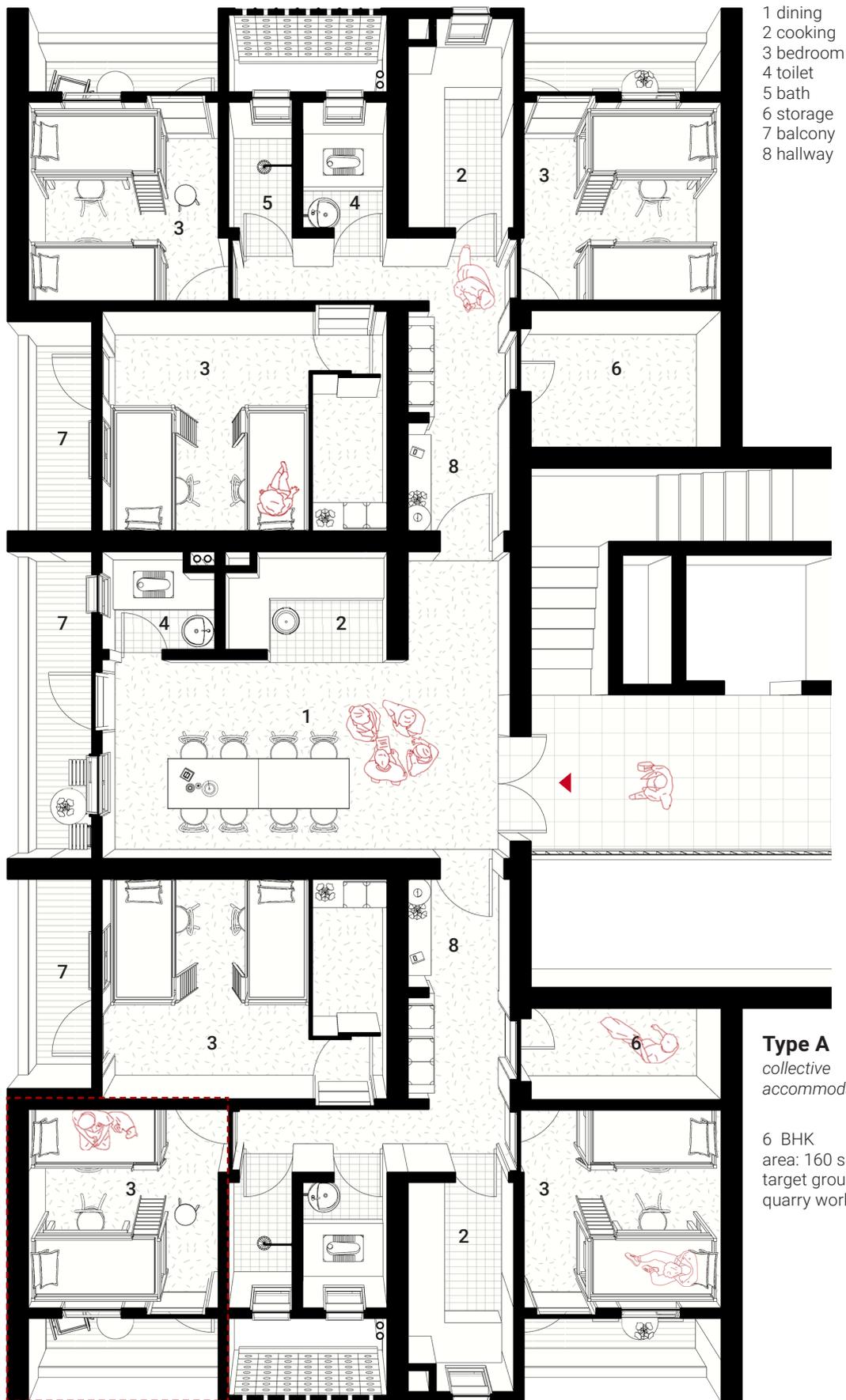


IV. RESIDENTIAL DESIGN

Building Typologies: Tower



Accommodation Unit Axonometry



- 1 dining
- 2 cooking
- 3 bedroom
- 4 toilet
- 5 bath
- 6 storage
- 7 balcony
- 8 hallway

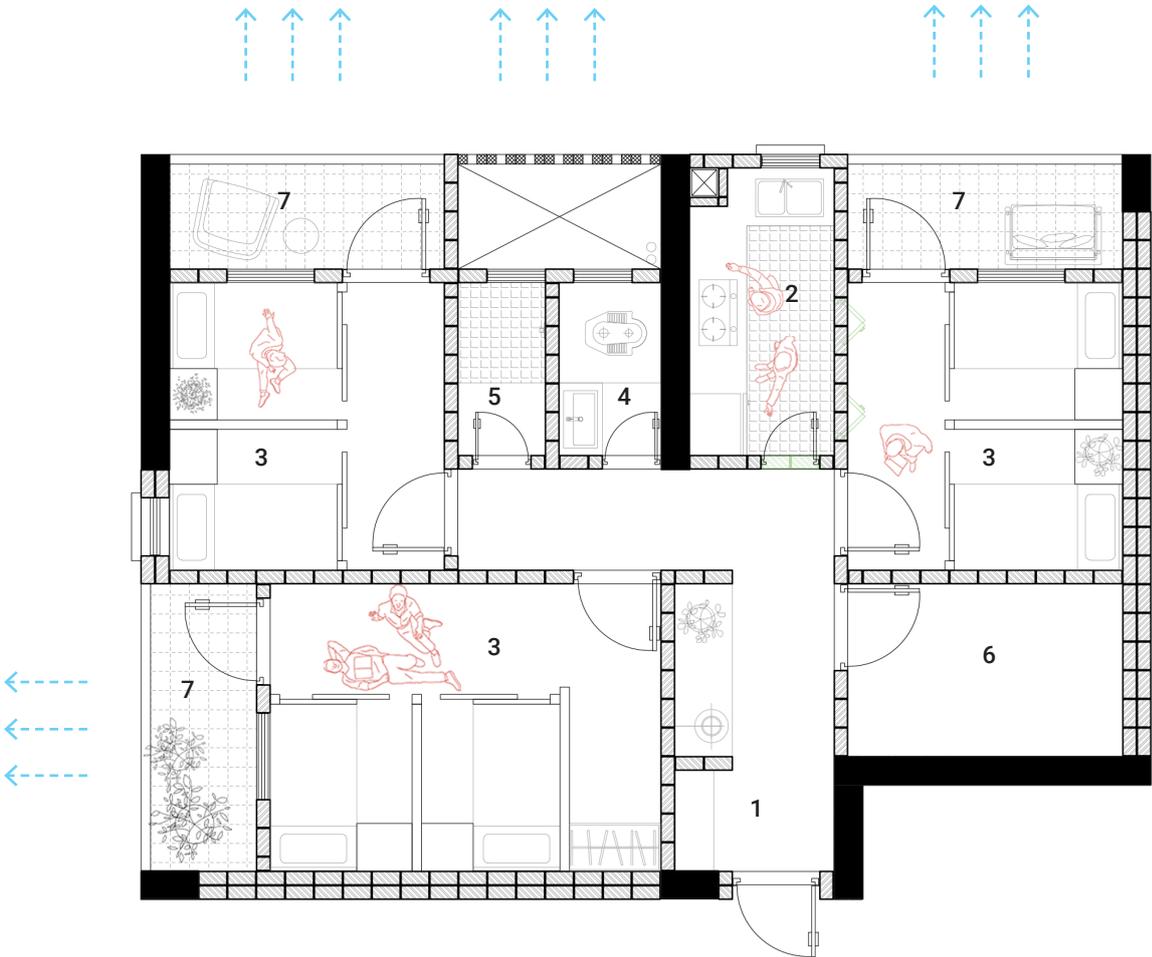
Type A
*collective
 accommodation*

6 BHK
 area: 160 sq.m.
 target group:
 quarry worker

typical accommodation unit

IV. RESIDENTIAL DESIGN

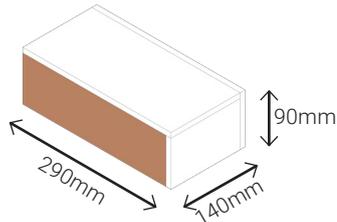
Building Typologies: Tower



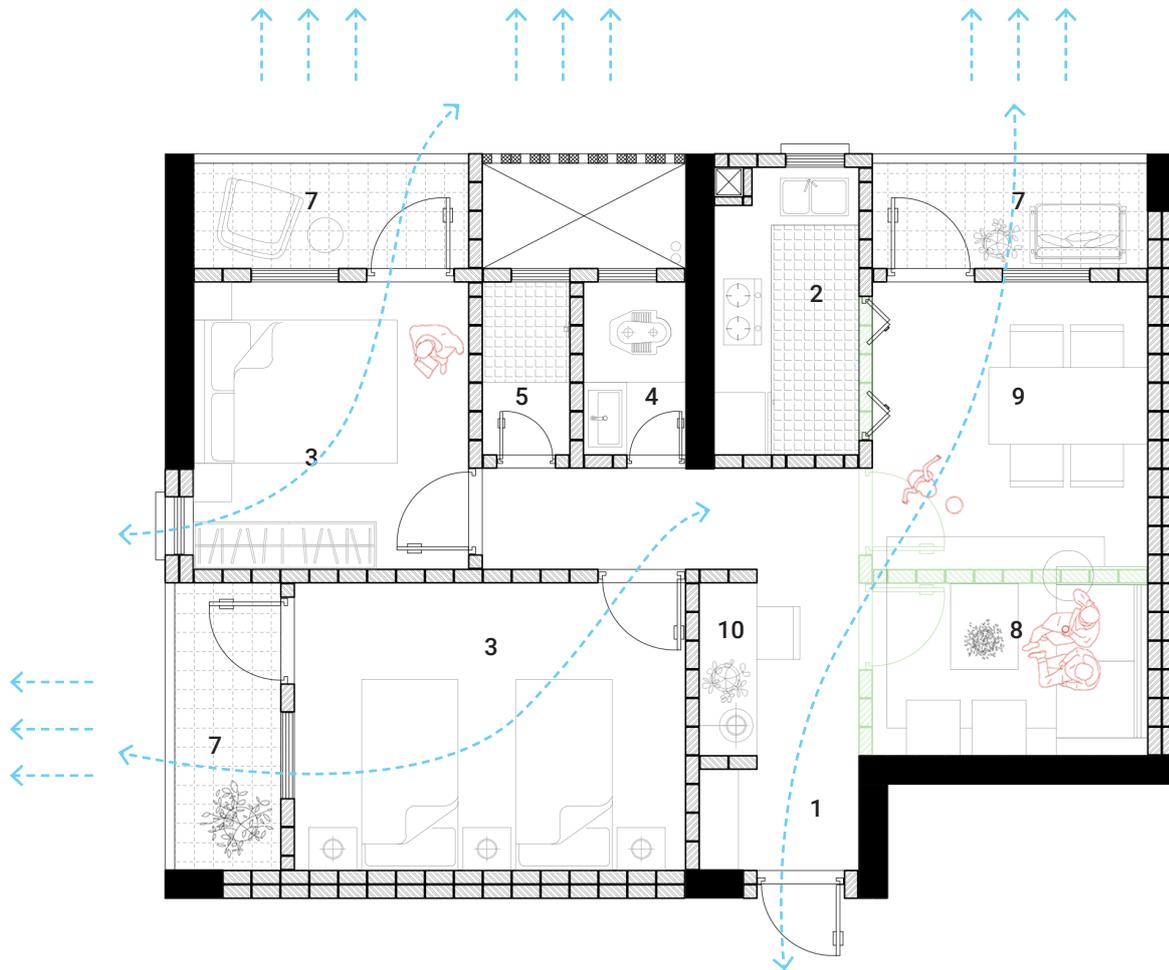
Type B (Before)

collective accommodation

The temporality of the quarry industry requires a long-term perspective. These collective accommodations will be converted into apartments for LIG & MIG in the future. The precast concrete skeleton and compressed earth block partition walls provide the flexibility to be refurbished.



(10mm mortar joint)



Type B (After)

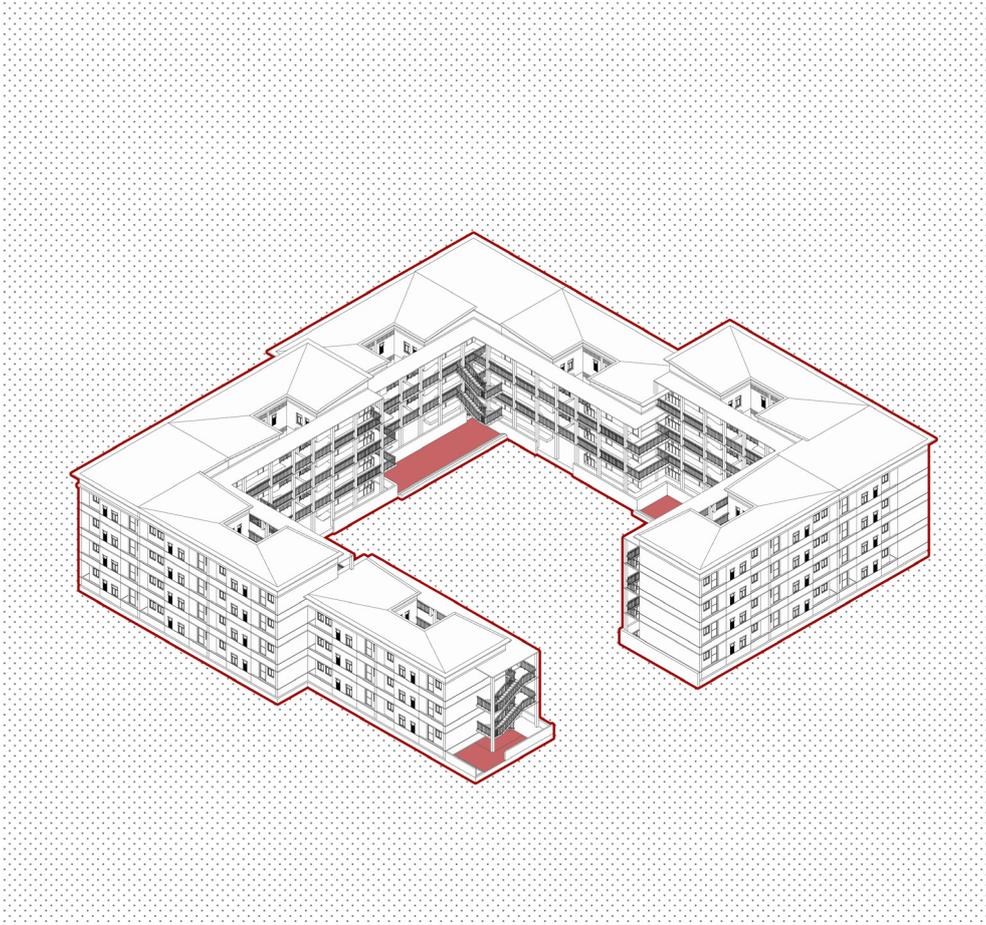
2 BHK
 area: 65 sq.m.
 group: MIG

- | | |
|-----------|---------------|
| 1 hallway | 6 storage |
| 2 cooking | 7 balcony |
| 3 bedroom | 8 living room |
| 4 toilet | 9 dining room |
| 5 bath | 10 study |



IV. RESIDENTIAL DESIGN

Building Typologies: Apartment



Another building typology in the cluster is the low-rise apartment. It is designed for both individual workers and families with small housing units for sale. Therefore, building a social connection with the neighbourhood is important in this building typology.

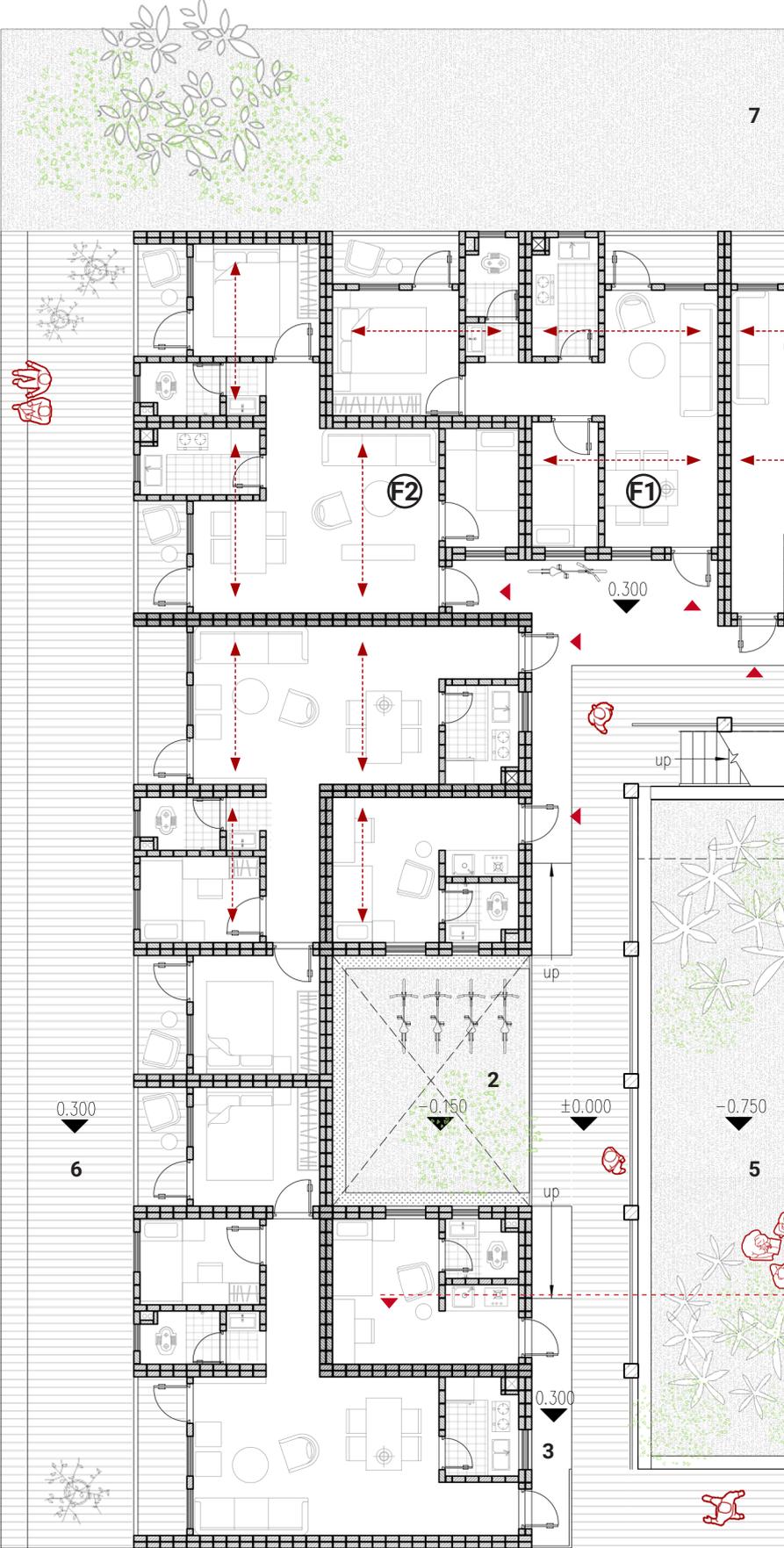
An open gallery system with doorstep areas will link all the house units together. It is designed as a lively space where social connections can take place. In addition, the courtyard located between the low-rise building and the tower can be used for outdoor activities. It can also serve as a buffer area for flooding during the rainy season.

View of Gallery



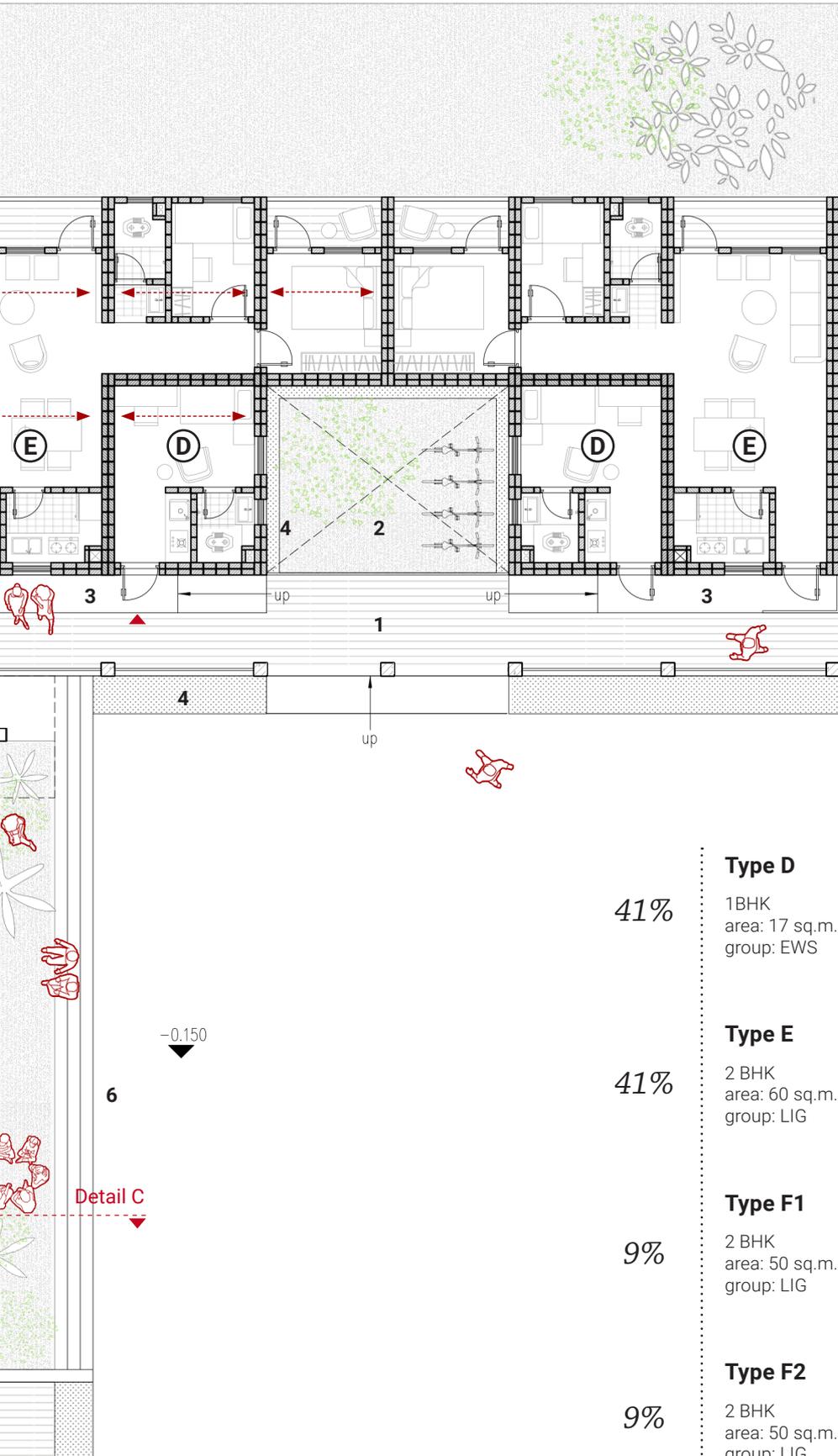
IV. RESIDENTIAL DESIGN

Building Typologies: Apartment



- 1 gallery
- 2 bicycle parking
- 3 doorstep area
- 4 drain
- 5 sunken courtyard
- 6 landscape steps
- 7 sound-buffer courtyard

Ground Floor Plan 1:150



- 41%**

Type D
 1BHK
 area: 17 sq.m.
 group: EWS
- 41%**

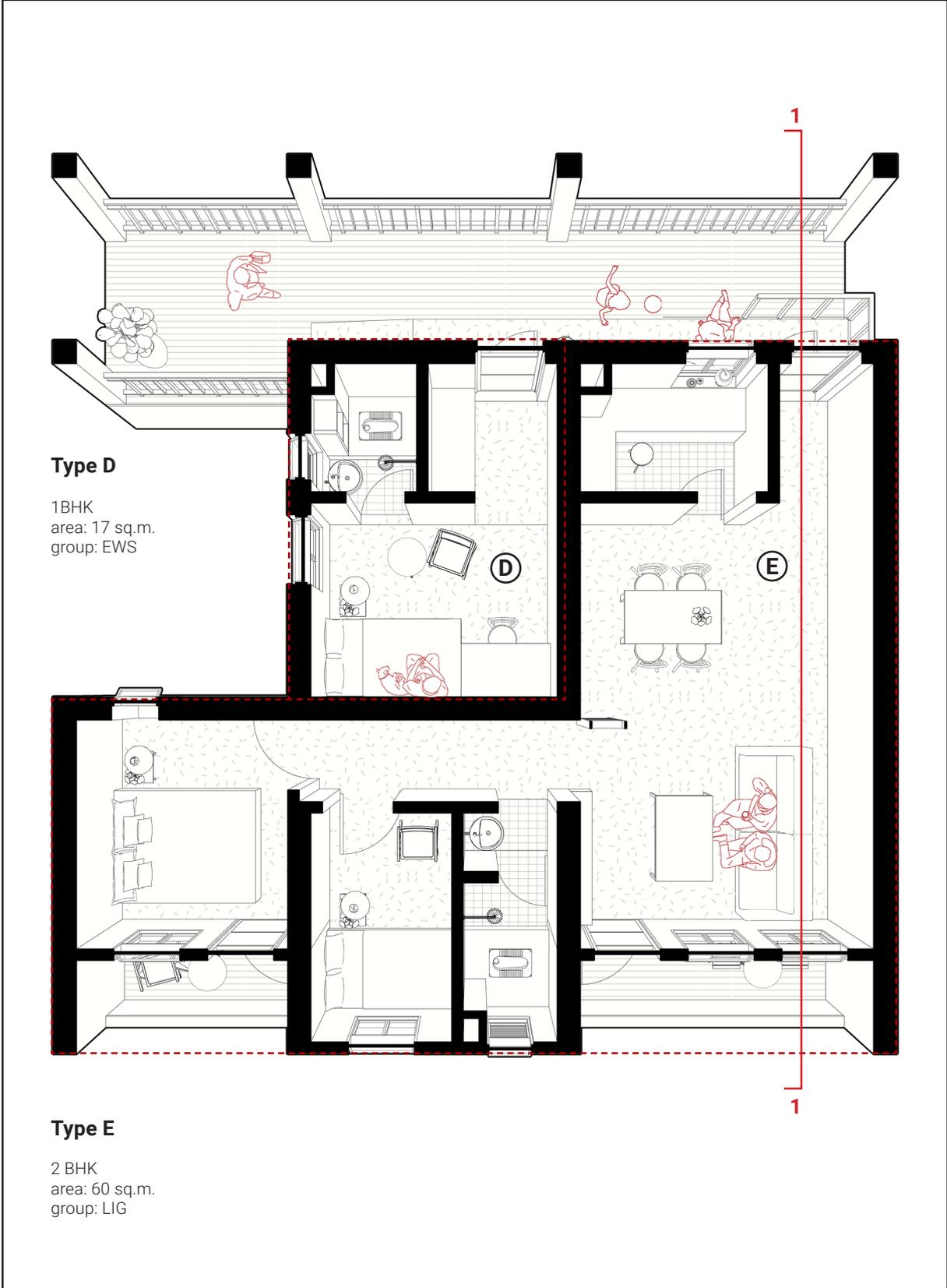
Type E
 2 BHK
 area: 60 sq.m.
 group: LIG
- 9%**

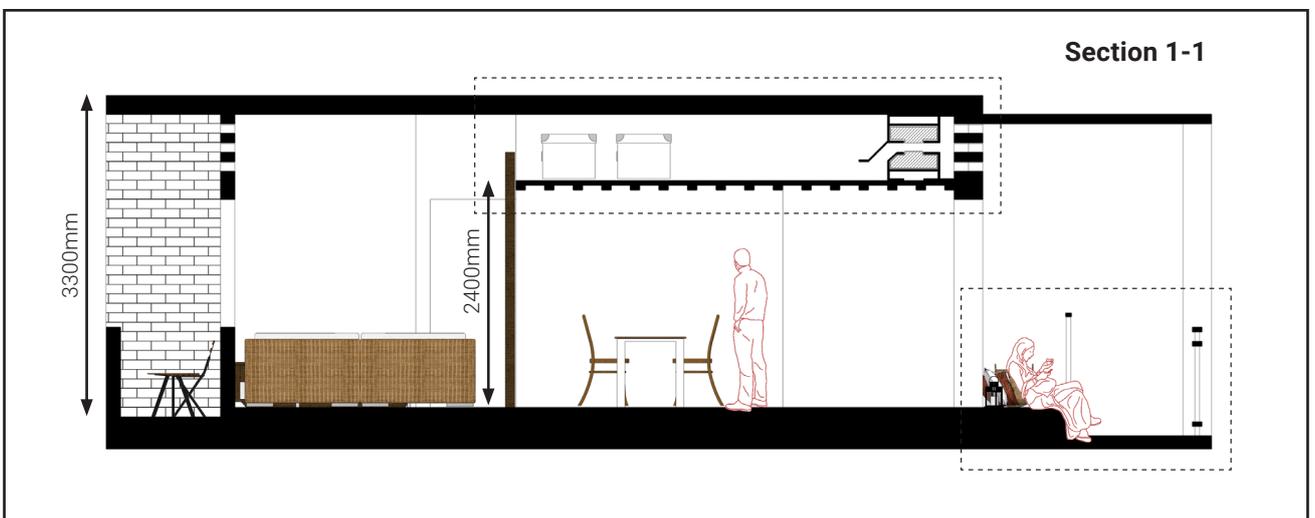
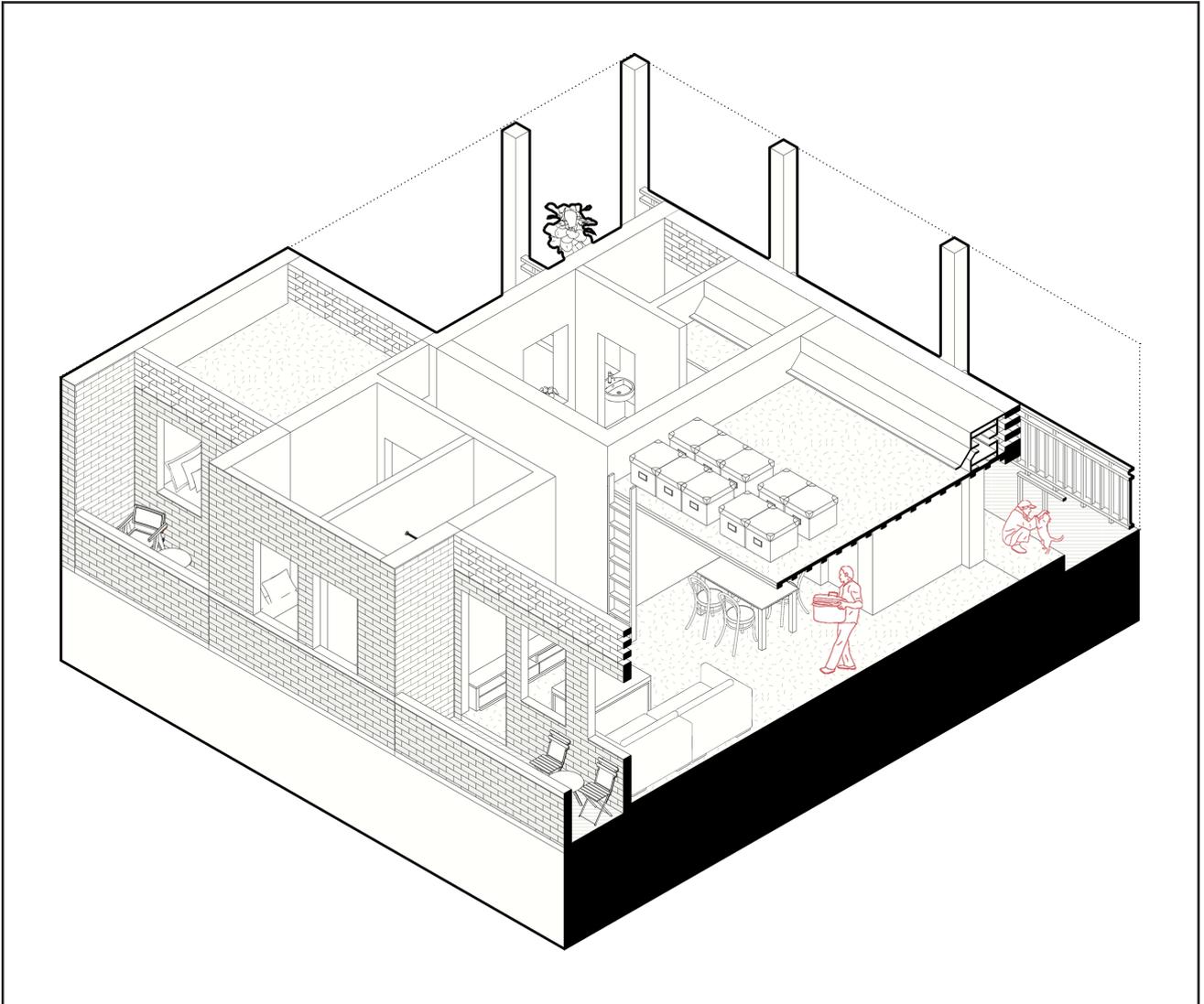
Type F1
 2 BHK
 area: 50 sq.m.
 group: LIG
- 9%**

Type F2
 2 BHK
 area: 50 sq.m.
 group: LIG

IV. RESIDENTIAL DESIGN

Building Typologies: Apartment





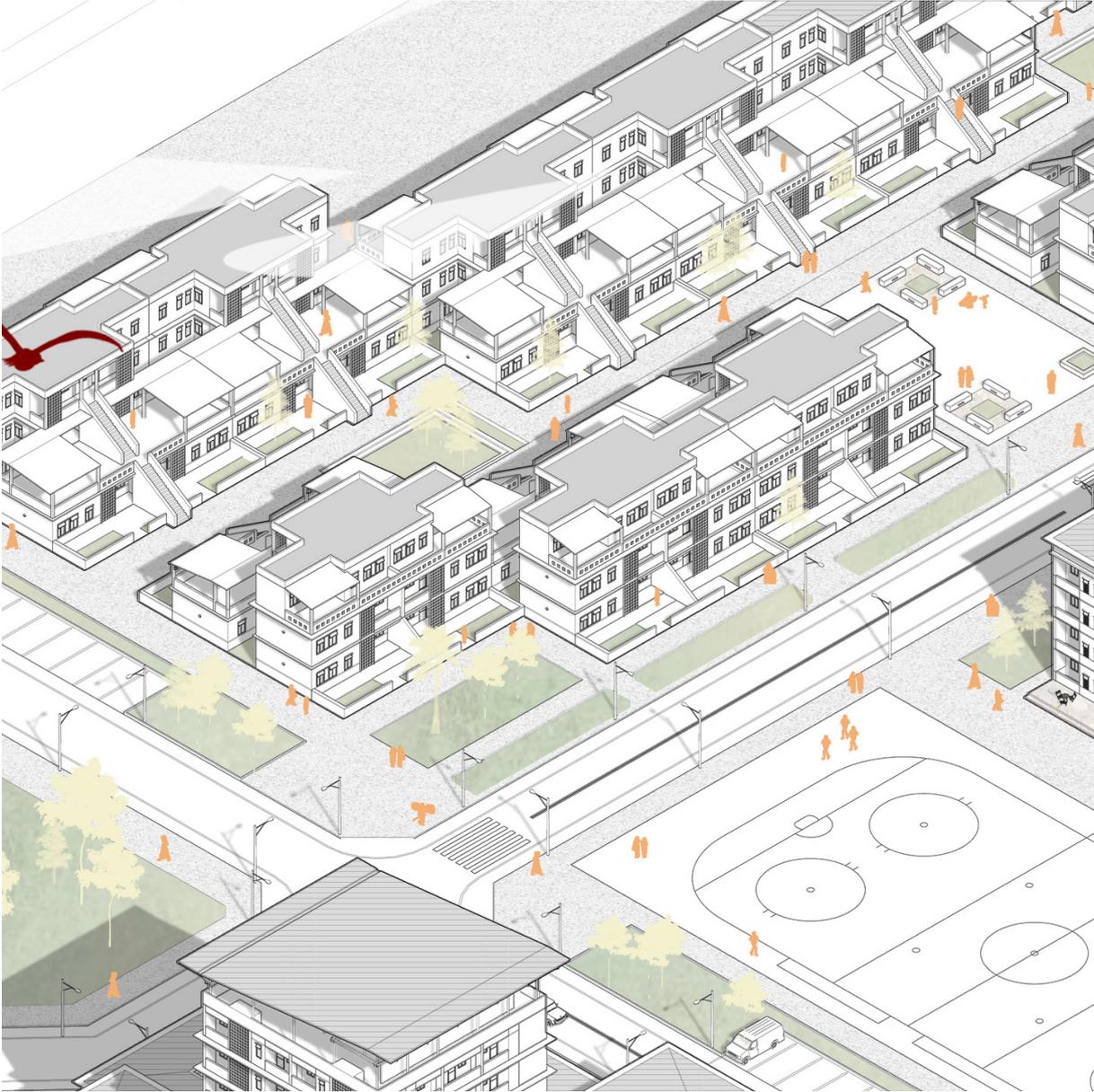


View of Courtyard

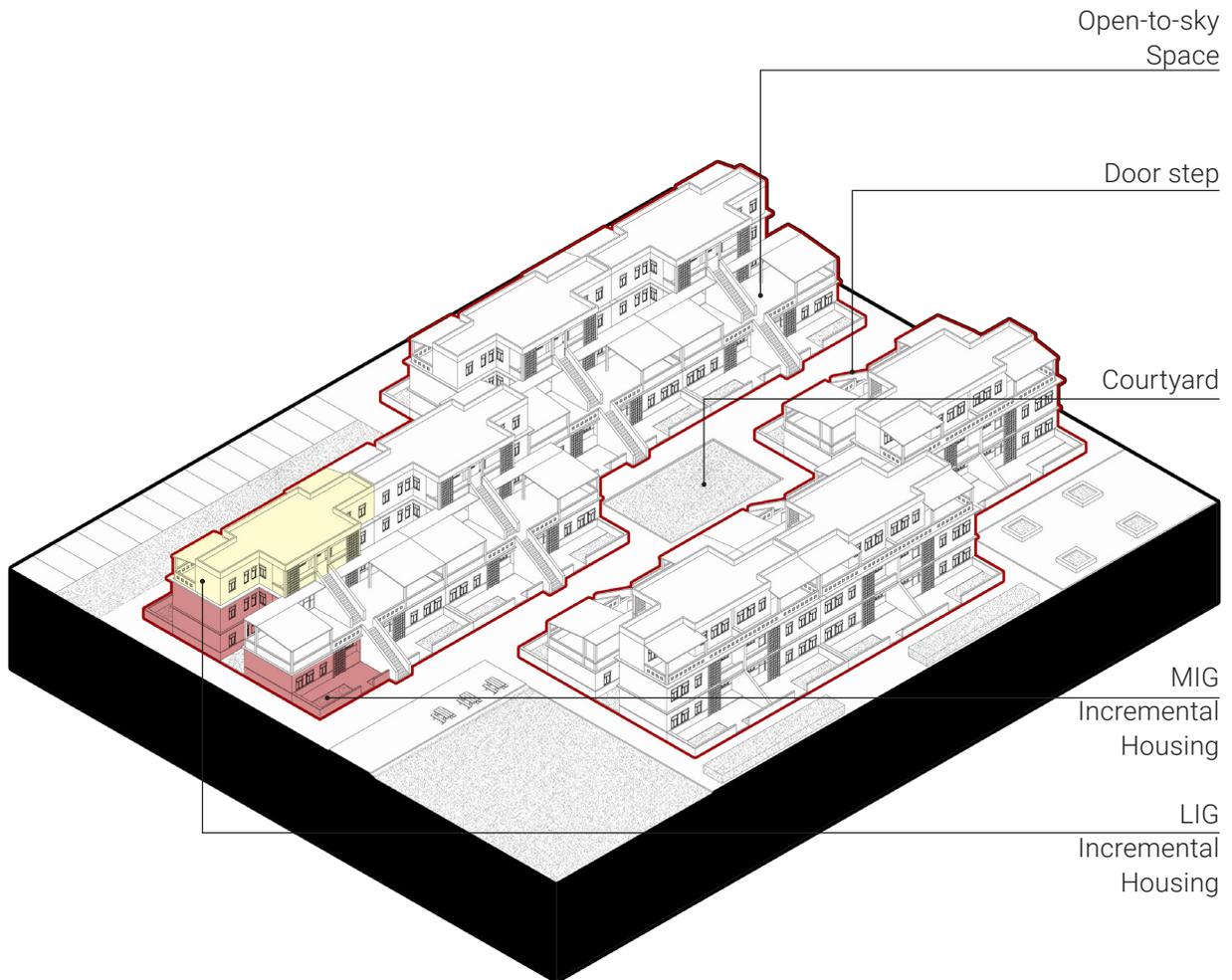


IV. RESIDENTIAL DESIGN

Concept



cluster 2

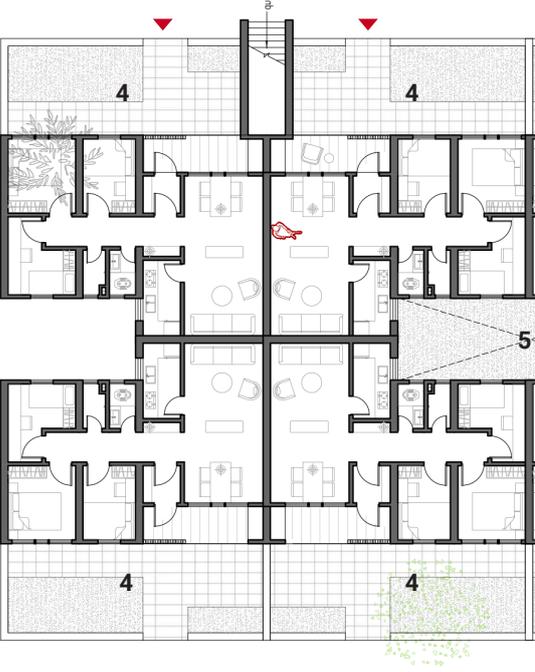
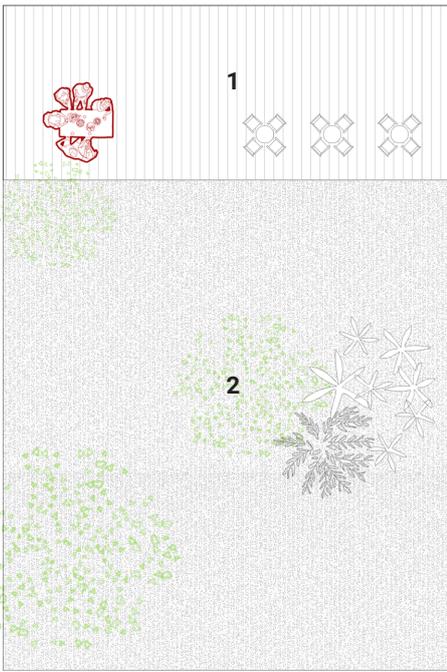
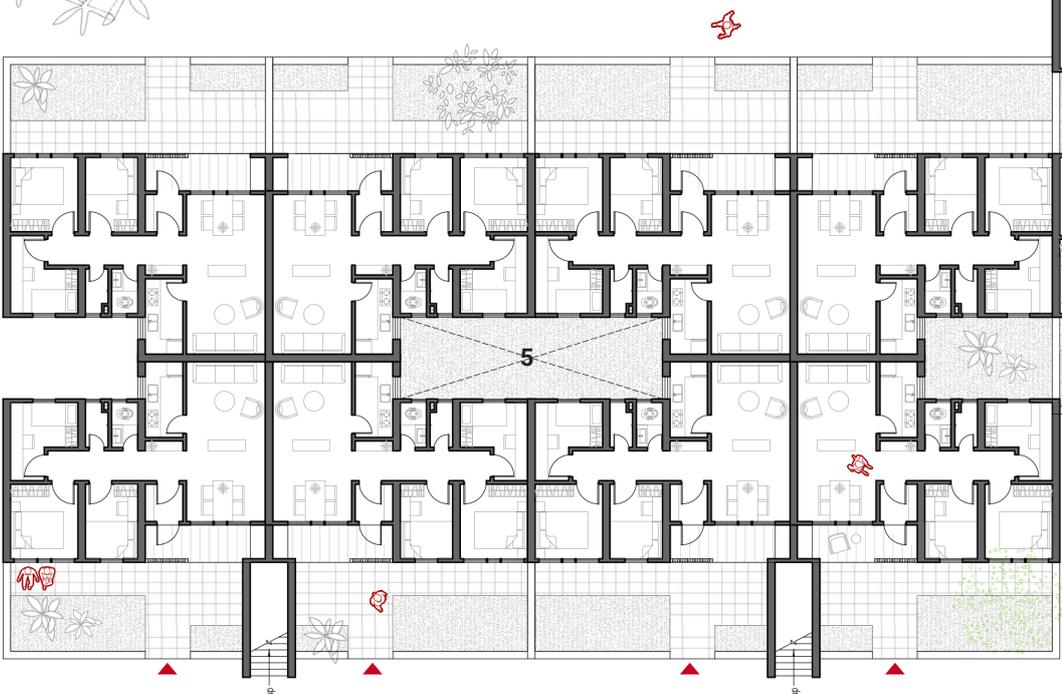


Another cluster with more connection with the ground will be provided to those who are willing to spend more budget on their houses, especially those local inhabitants. This cluster emphasizes

the social linkage with communities, with a lot of setback open-to-sky space to encourage residents' incremental development.

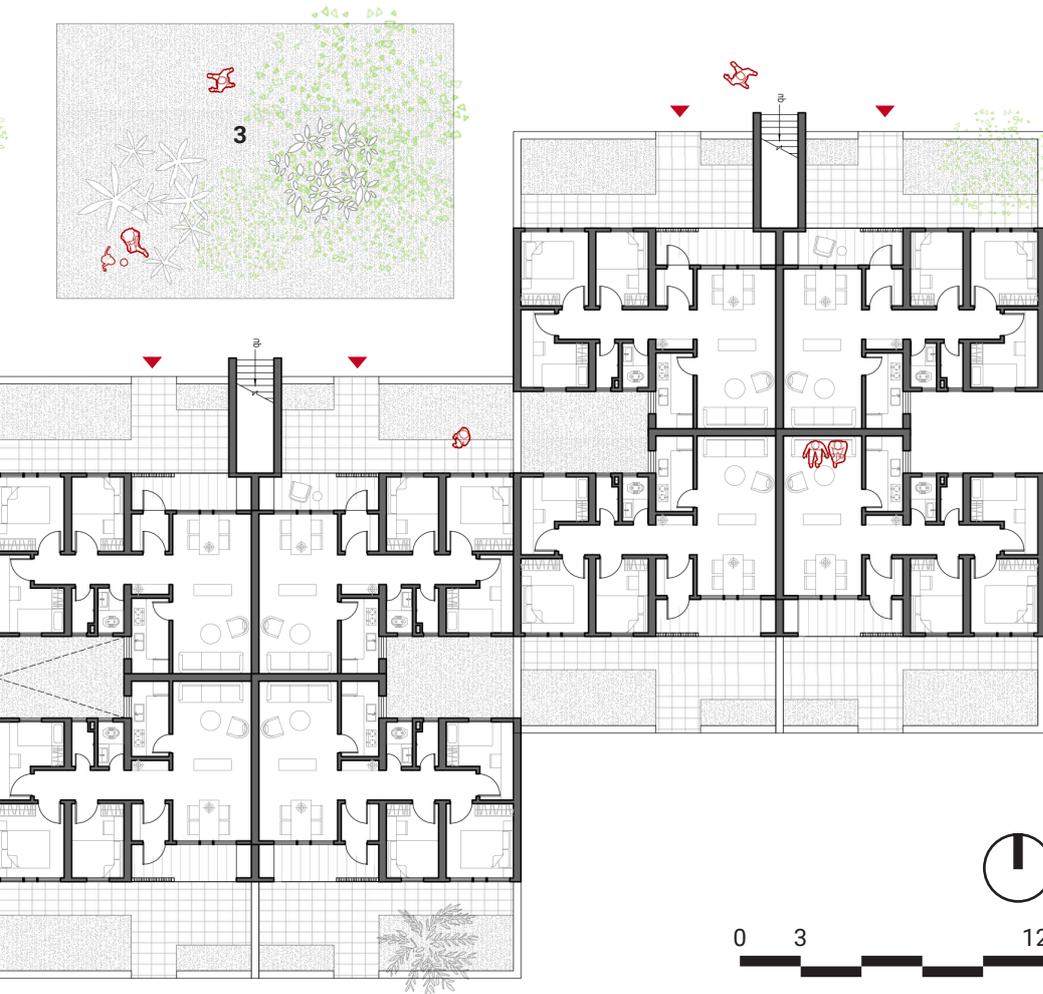
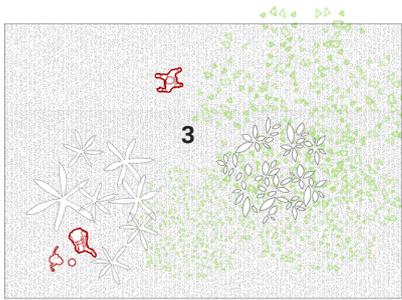
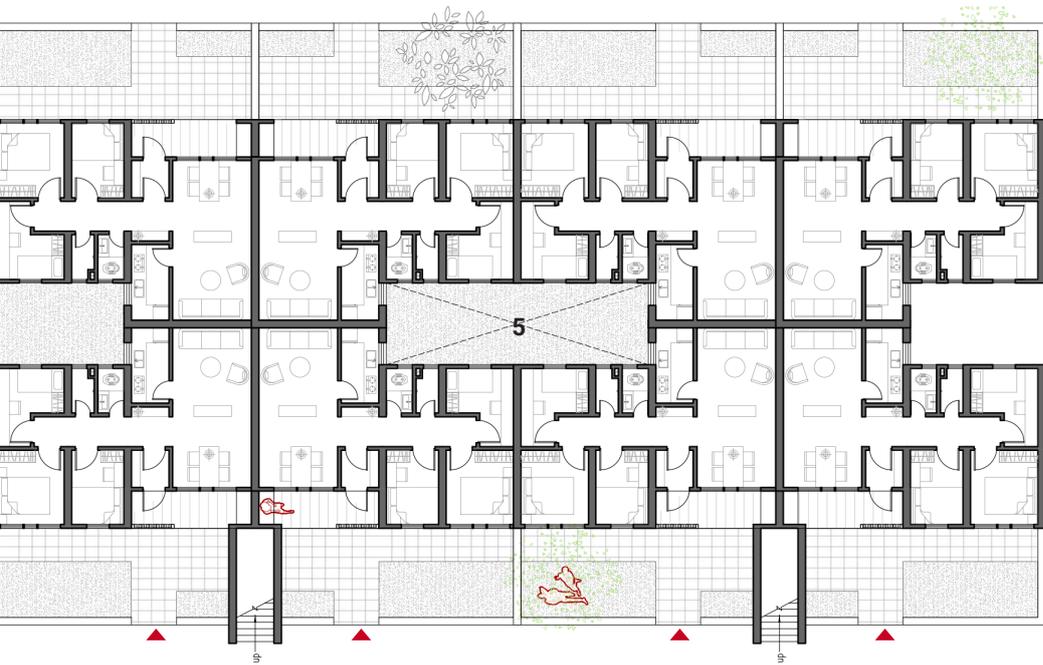
IV. RESIDENTIAL DESIGN

Cluster 2



- 1 gathering platform
- 2 lawn
- 3 central courtyard
- 4 private garden
- 5 patio

Ground Floor Plan



IV. RESIDENTIAL DESIGN

Building Typologies: Row House

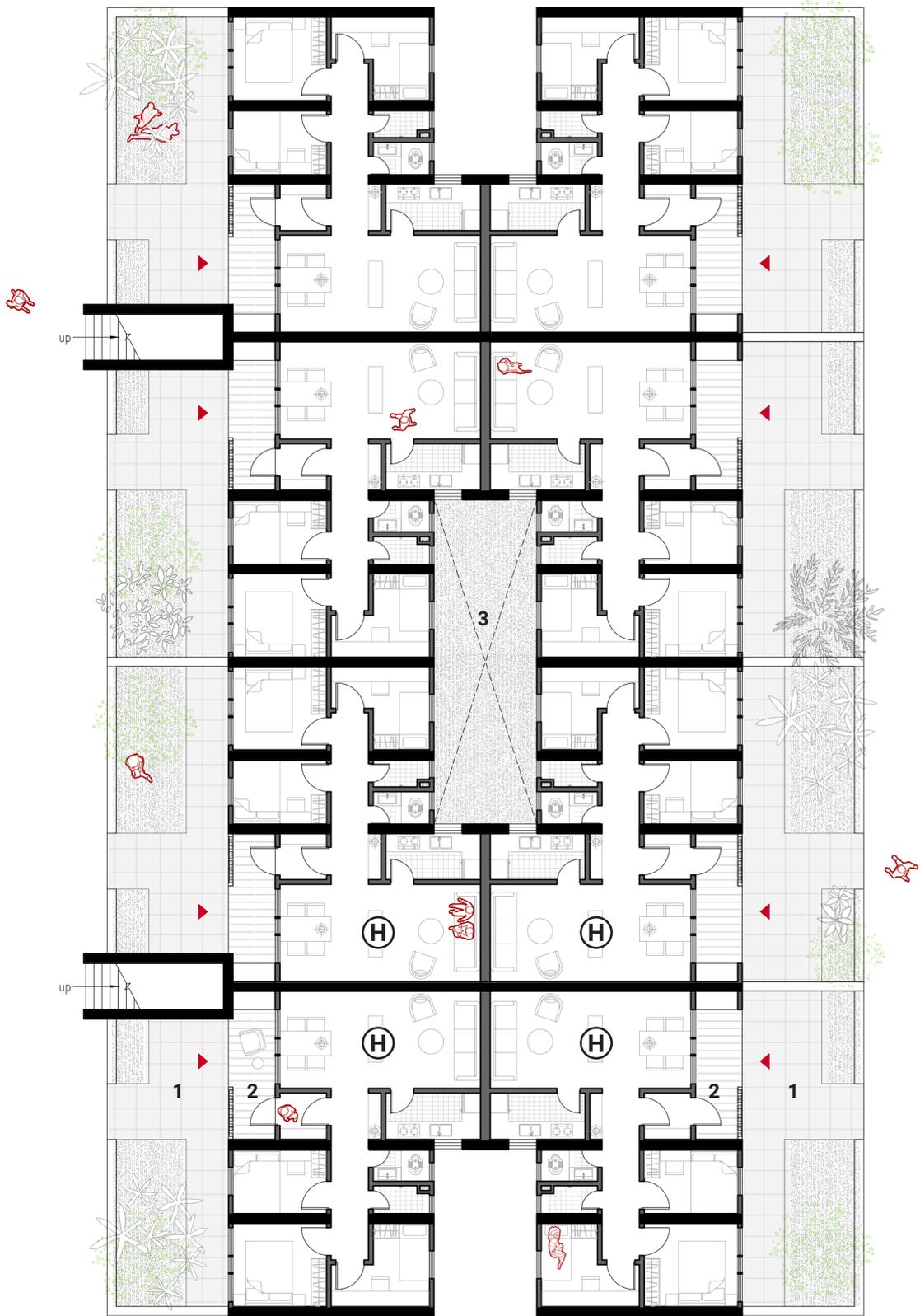


Type H (before)

3 BHK
area: 70 sq.m.
group: MIG

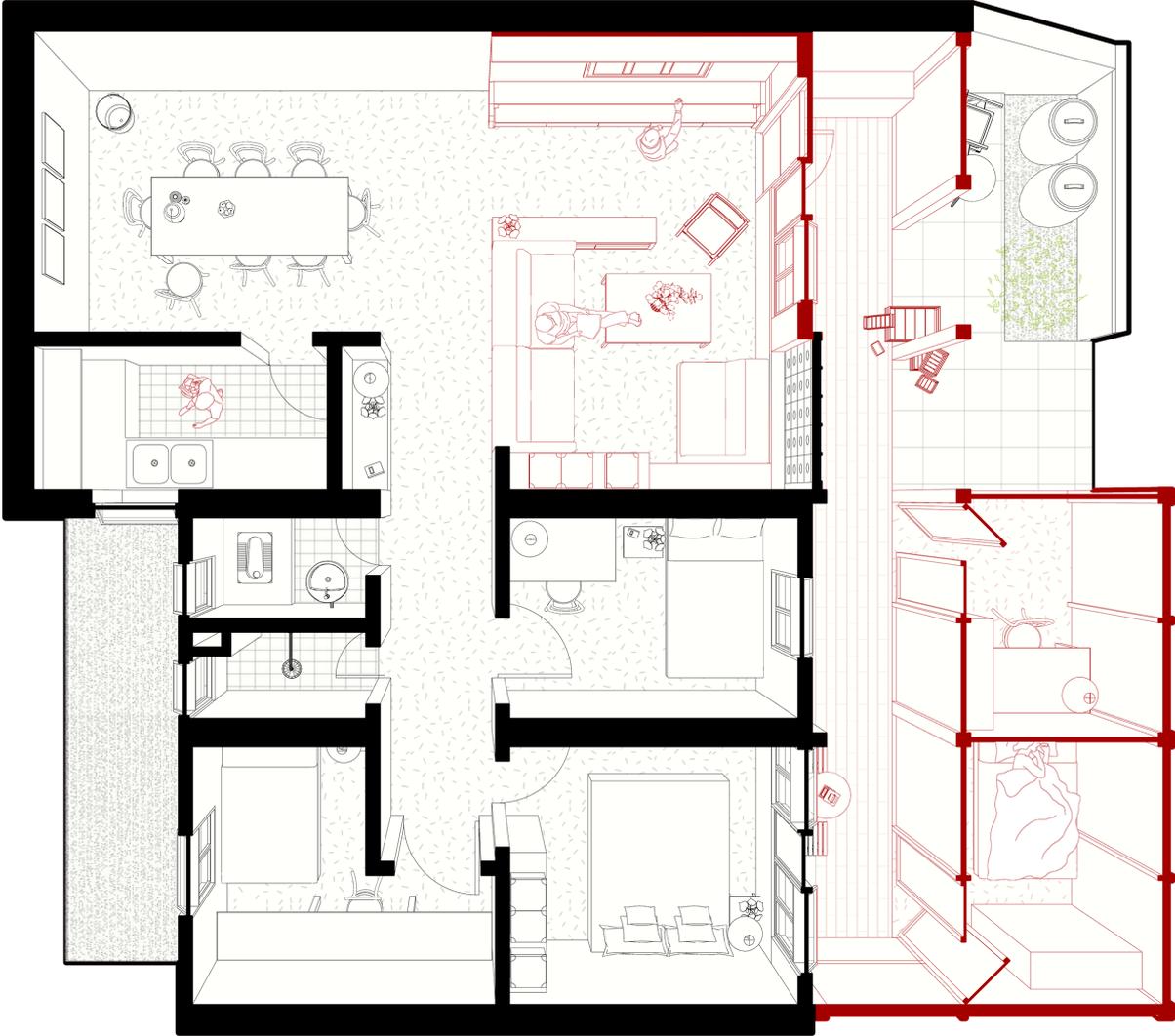
A typical unit is 70 sq.m. with 3 BHK. It is suitable for large Indian families of 4-5 people. The house is divided into two main areas for living and resting. Relatedly, the garden is also divided into two areas. One is connected to the entrance of the house with more pavement and is an outdoor activity area; the other is connected to the bedrooms and is a planting area that provides better sound buffer through vegetation.

Ground Floor Plan 1:200



IV. RESIDENTIAL DESIGN

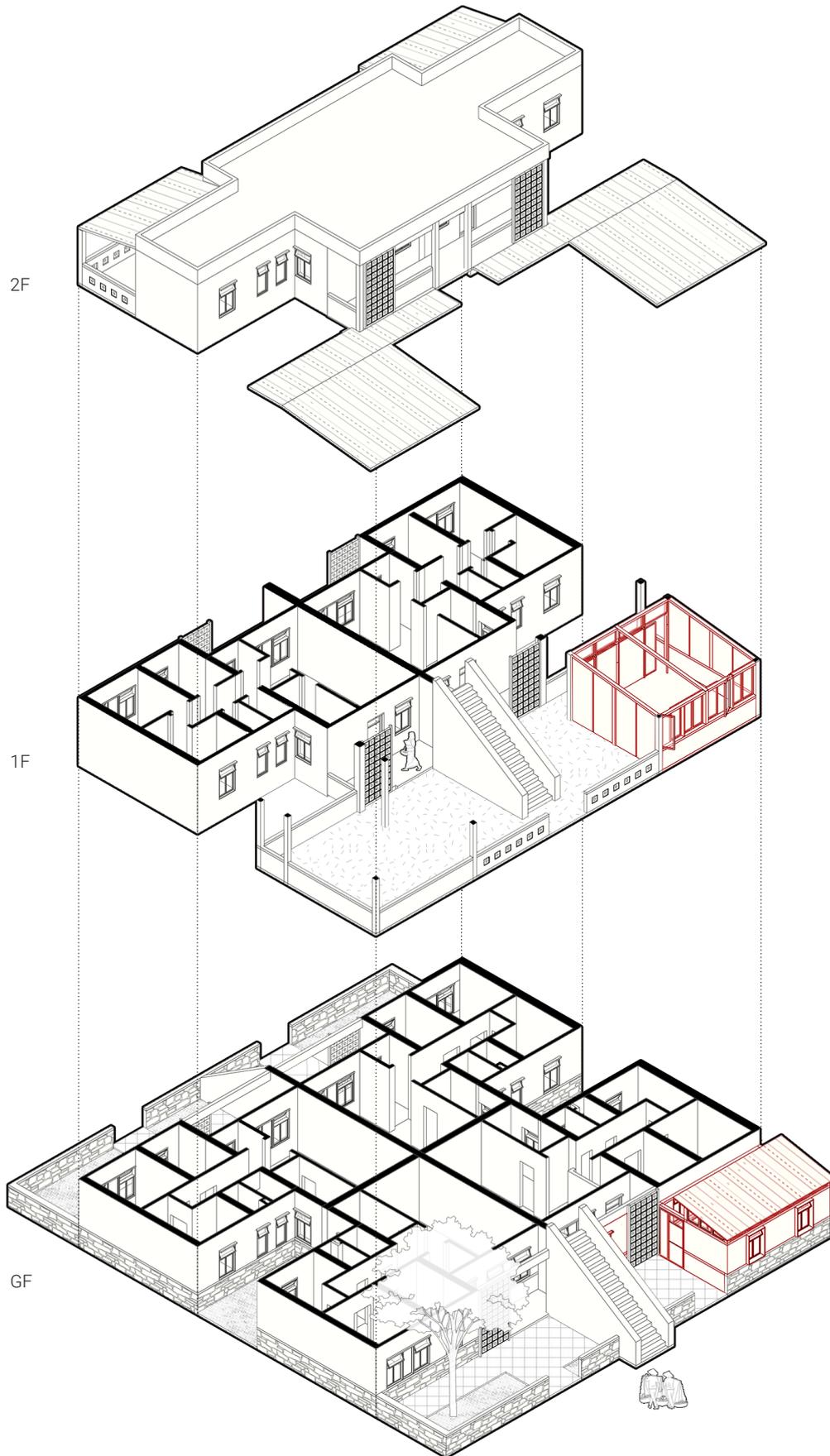
Building Typologies: Row House



Type H (after)

3+2 BHK
area: 70+20 sq.m. (+22%)
group: MIG

The garden can be used as an incremental area when the size of the family becomes larger. A possible incremental plan is shown in the diagram: the original doorway will be included as part of the living room, and parts of the garden will be used to build additional bedrooms.

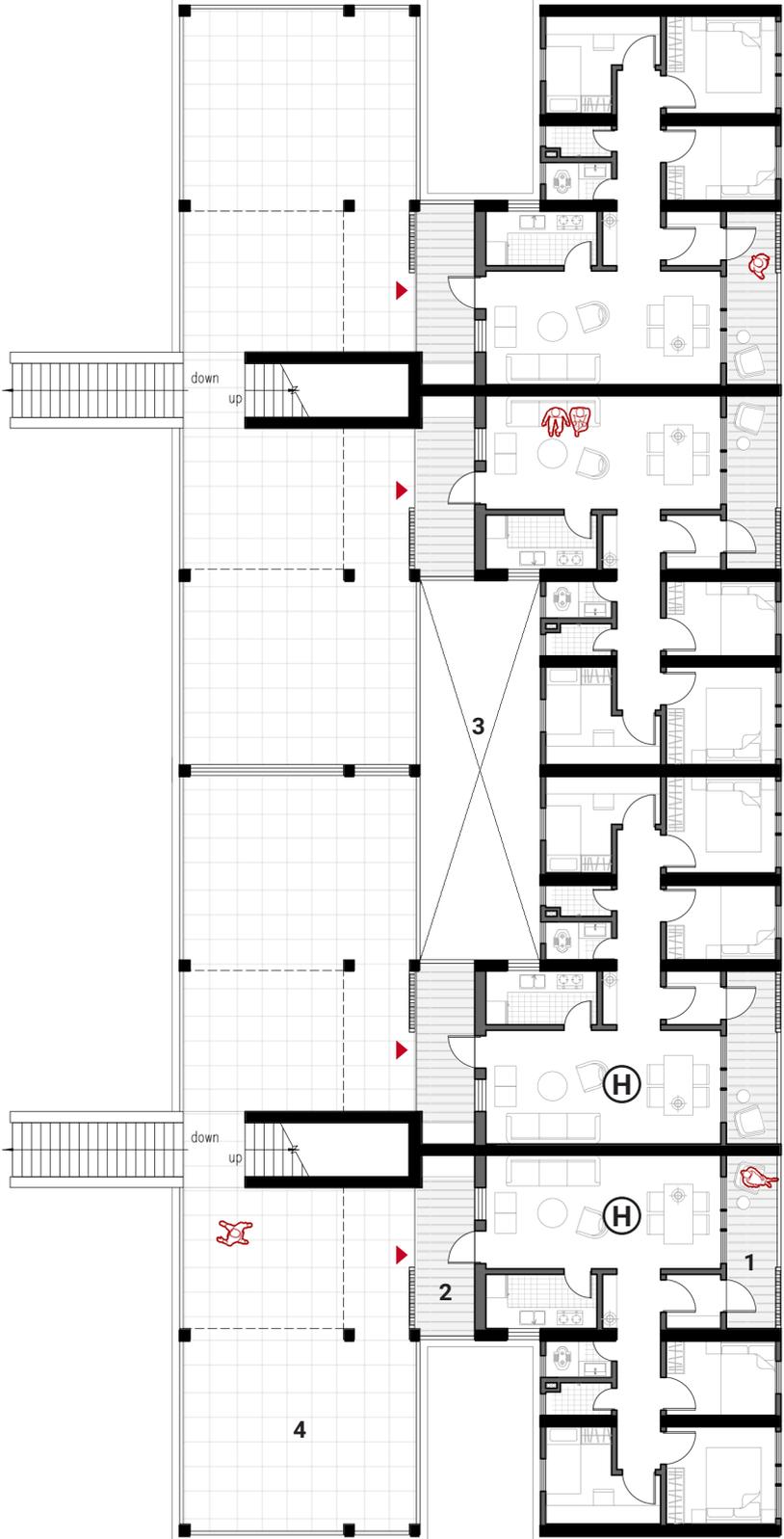


 incremental parts

Row House Axonometry

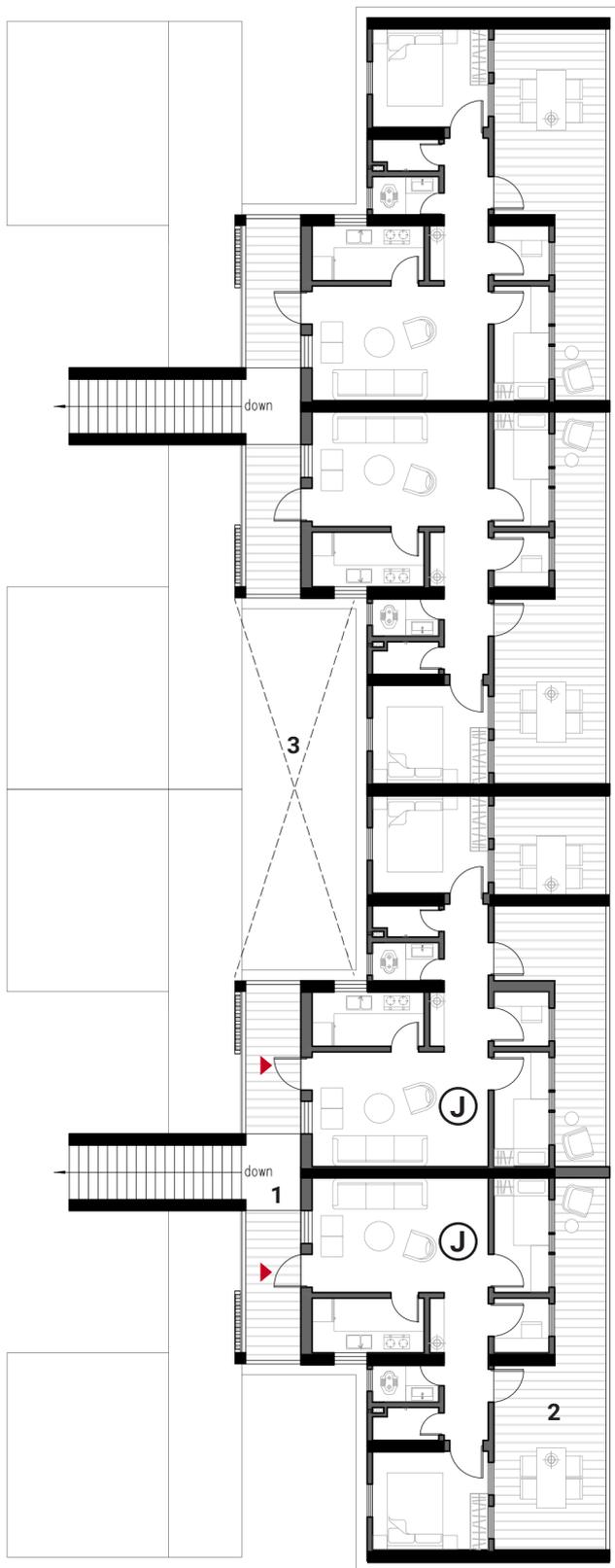
IV. RESIDENTIAL DESIGN

Building Typologies: Row House



- 1 balcony
- 2 doorstep area
- 3 patio
- 4 incremental area

First Floor Plan 1:200



- 1 doorstep area
- 2 incremental area
- 3 patio

Second Floor Plan 1:200



View of Rowhouses (before incremental phase)





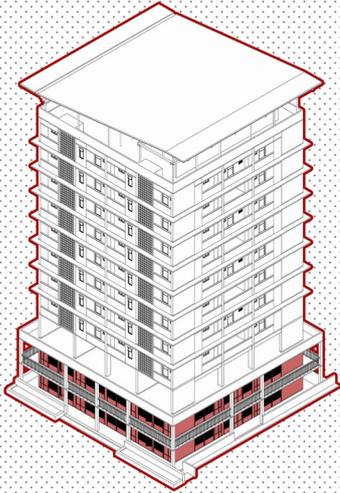
View of Rowhouses (after incremental phase)

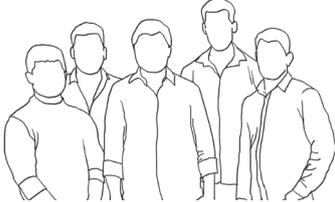


IV. RESIDENTIAL DESIGN

Typologies Conclusion

TOWER





Quarry Worker
Group

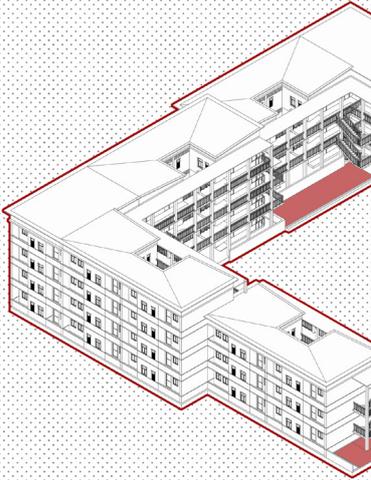


160 m²

Accommodation

 **RENT**

APART





Quarry Worker
Single

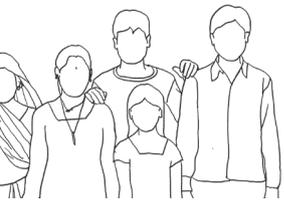
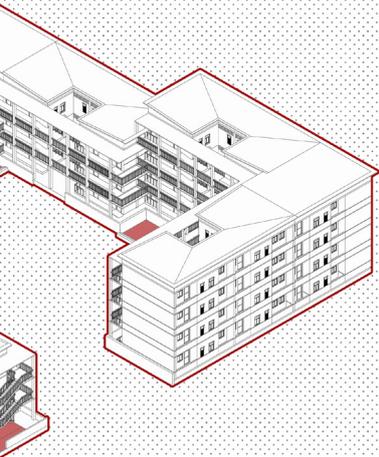


16 m² 

Apartment

 **RENT**

MENT



Quarry Worker
Family

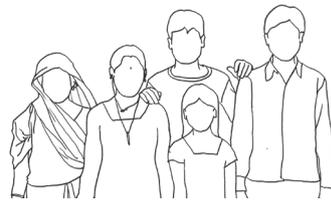
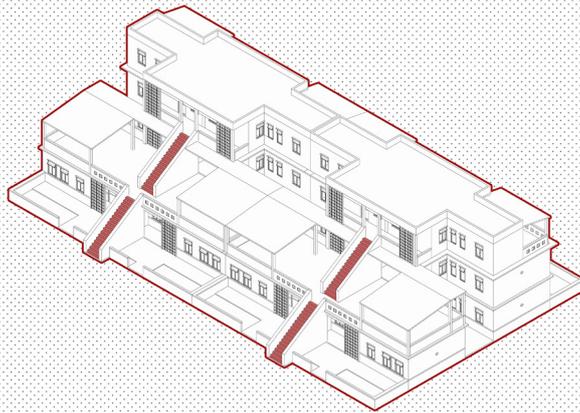


60 m2

ment

**MENT &
ALE**

ROW HOUSE



Quarry Worker
Family



50 m2

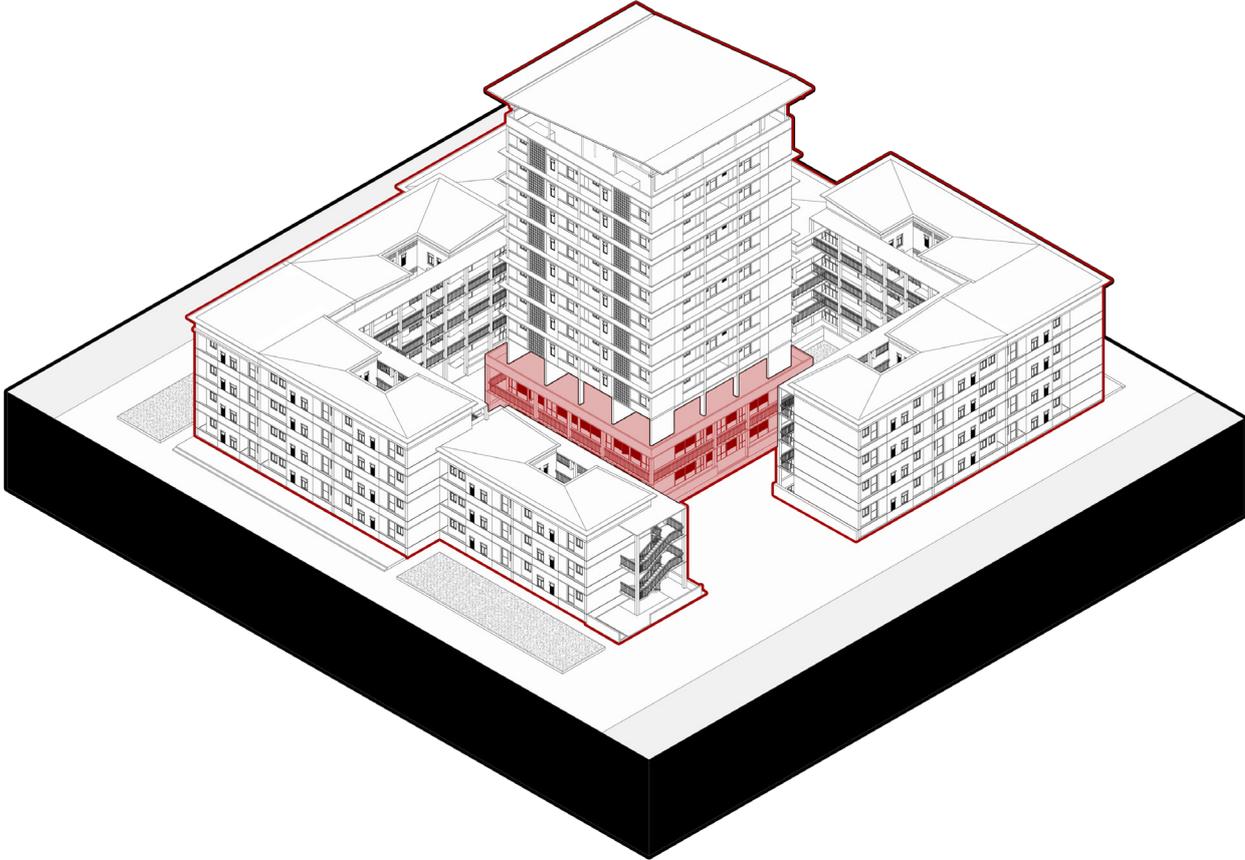
70 m2

Duplex

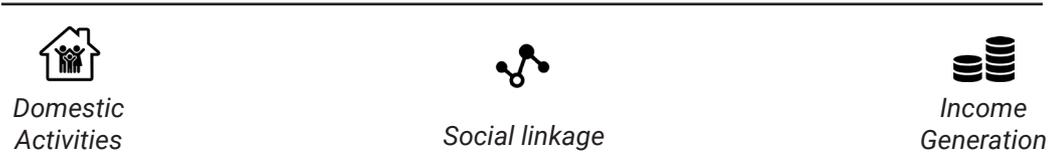


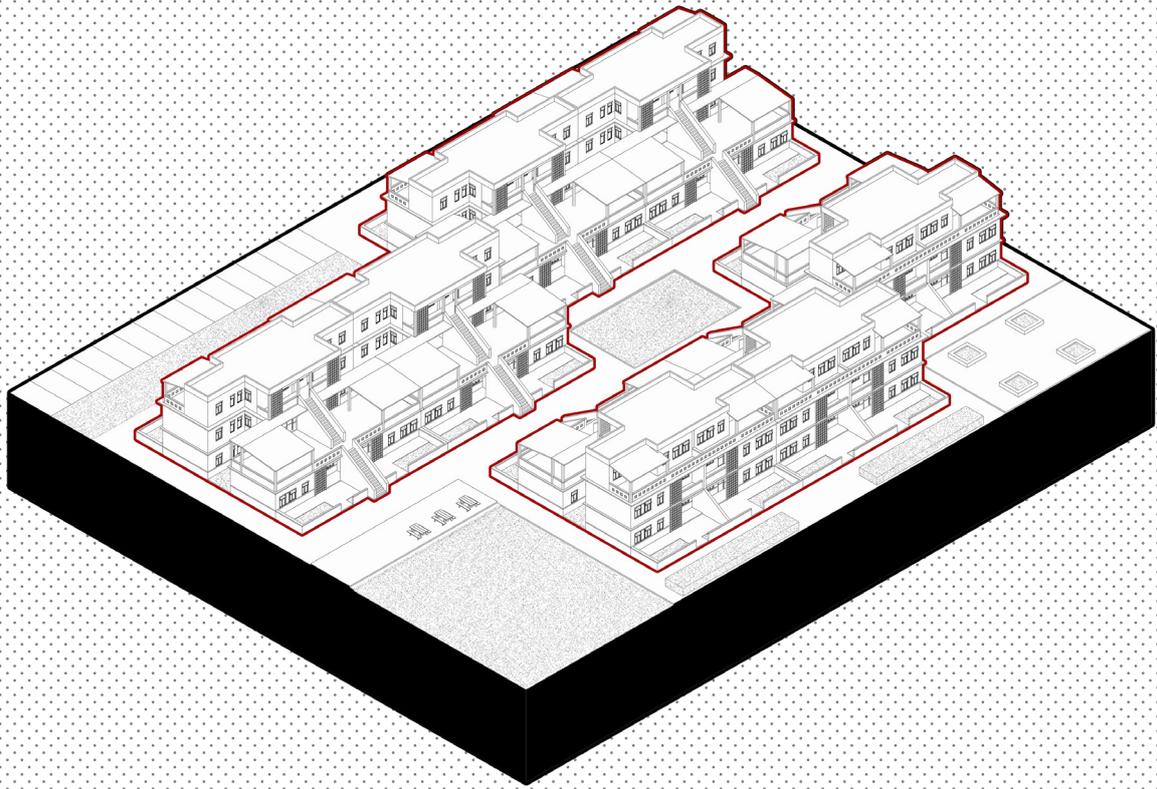
IV. RESIDENTIAL DESIGN

Typologies Conclusion



CLUSTER 1





CLUSTER 2



*Domestic
Activities*



Social linkage

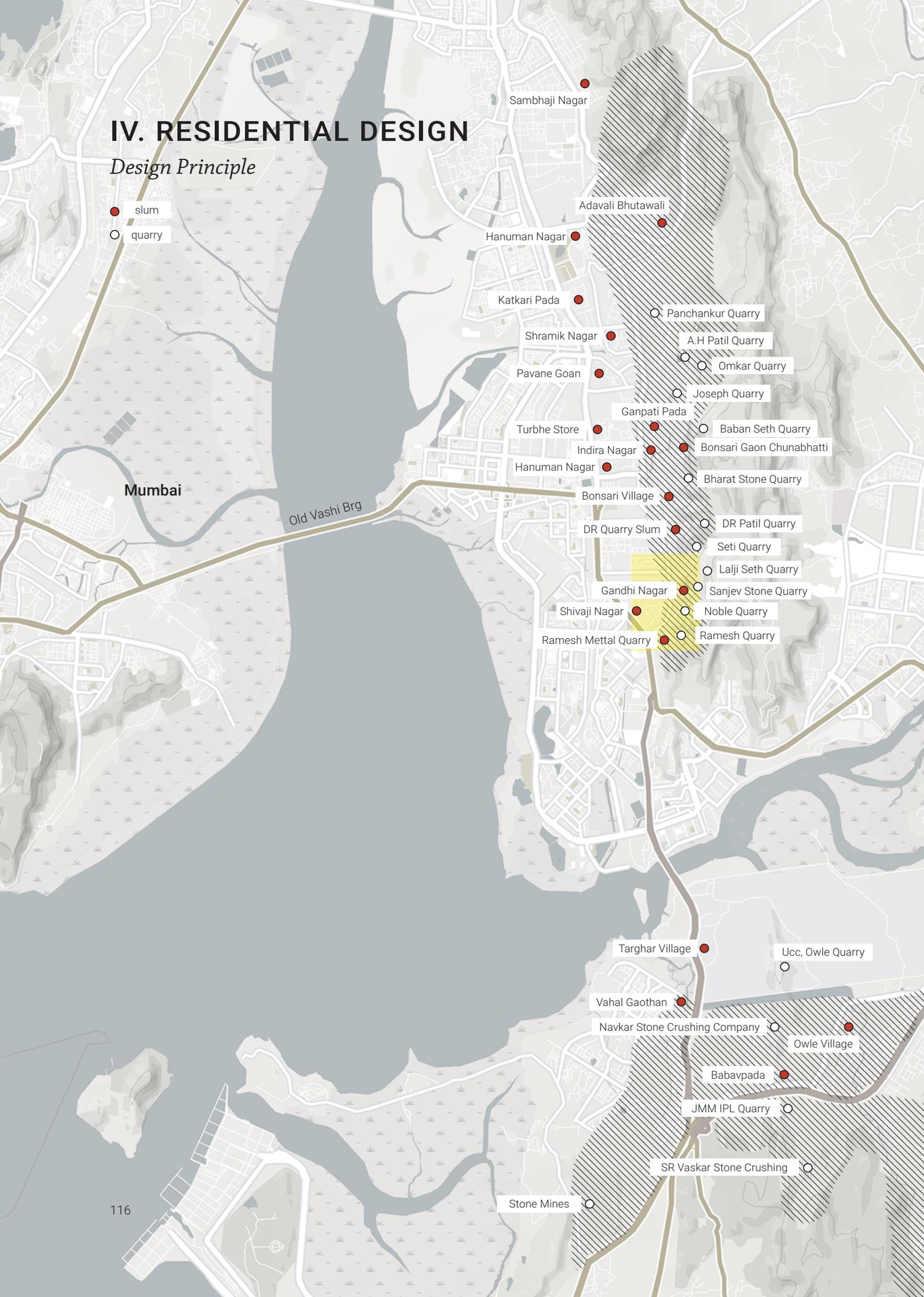


*Income
Generation*

IV. RESIDENTIAL DESIGN

Design Principle

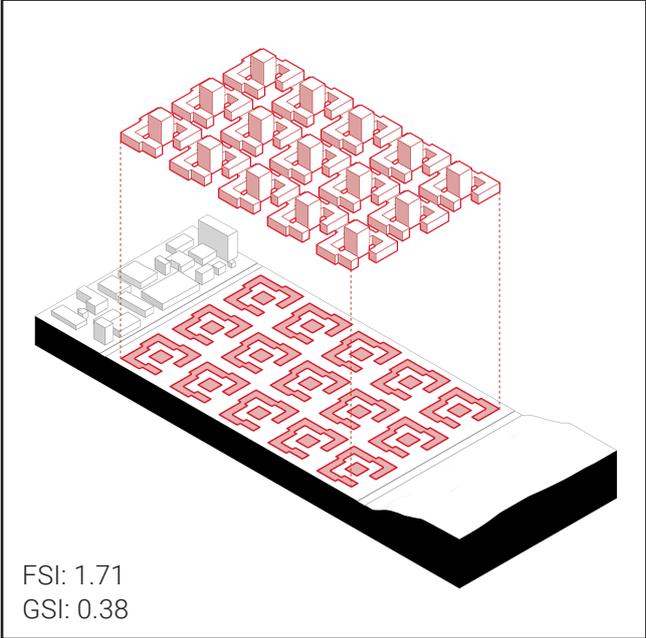
- slum
- quarry



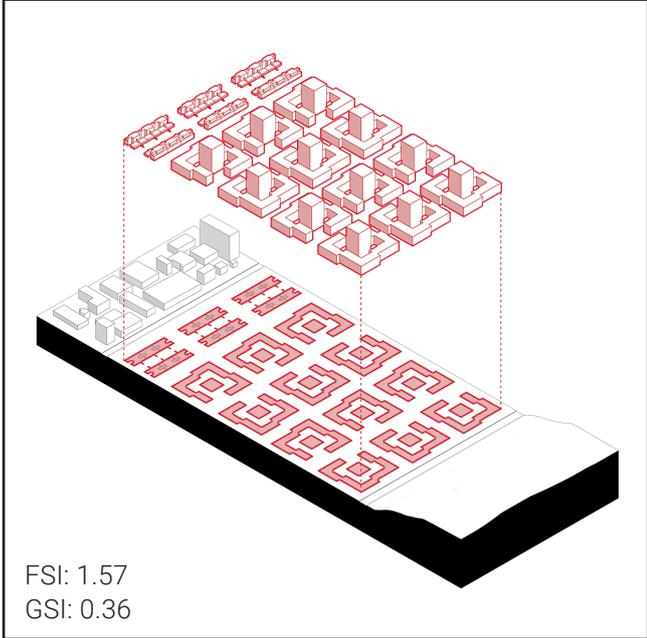


IV. RESIDENTIAL DESIGN

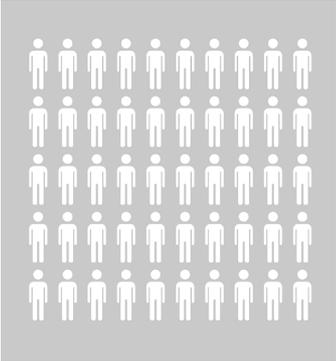
Design Principle



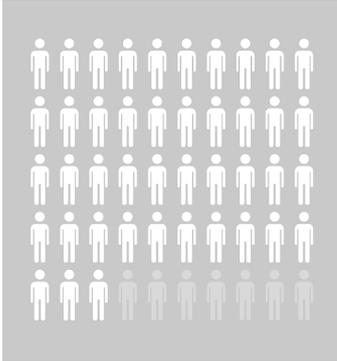
POSSIBILITY 1



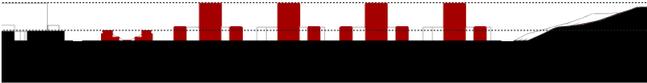
POSSIBILITY 2

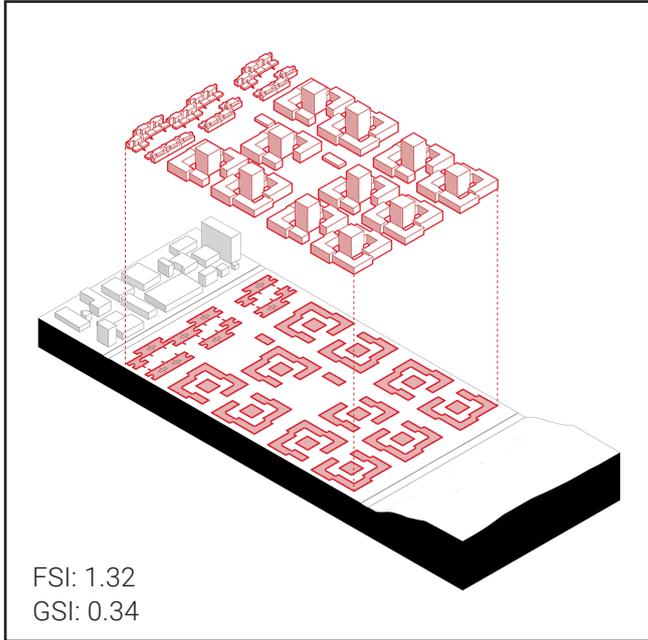


density:
261 dwellings/hectare
1000 dwellers/hectare

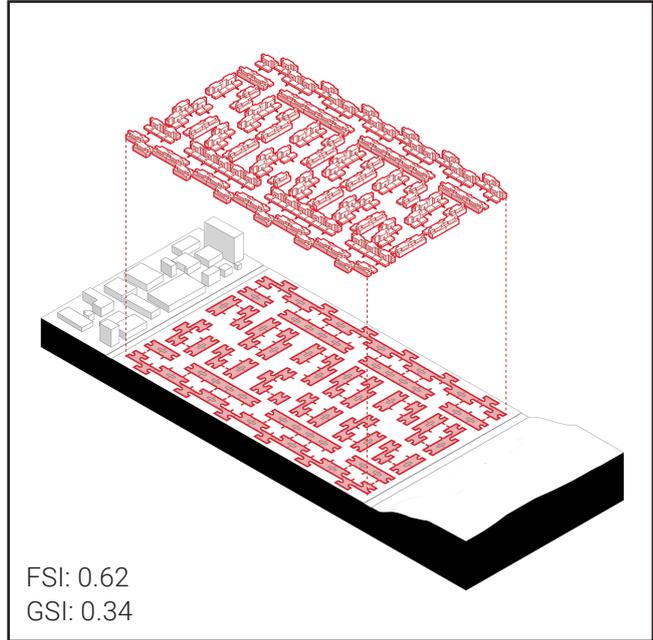


density:
223 dwellings/hectare
863 dwellers/hectare

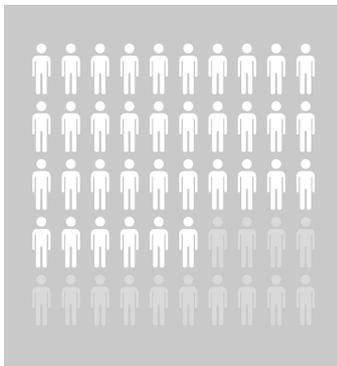




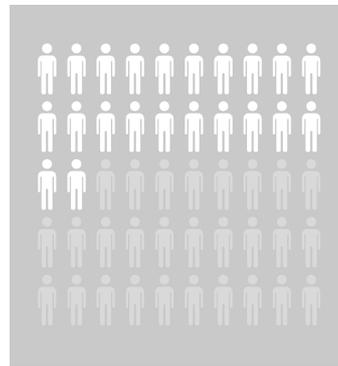
POSSIBILITY 3



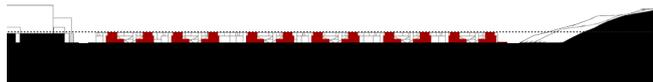
POSSIBILITY 4



density:
188 dwellings/hectare
716 dwellers/hectare

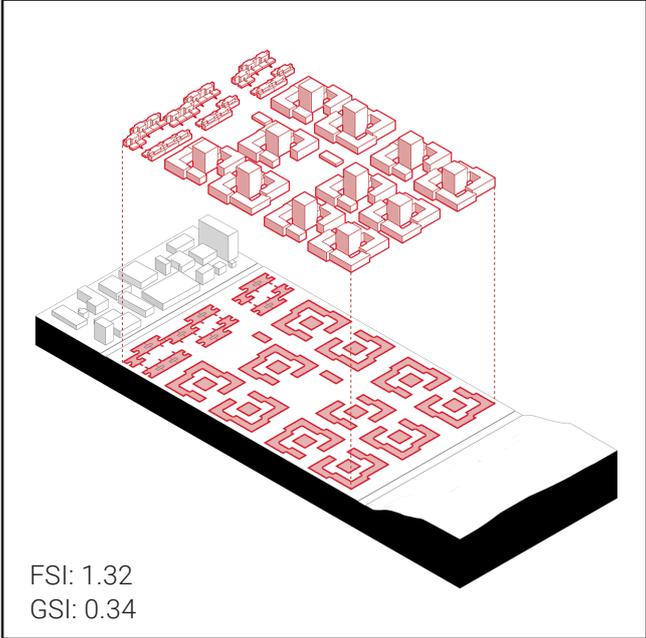


density:
98 dwellings/hectare
431 dwellers/hectare

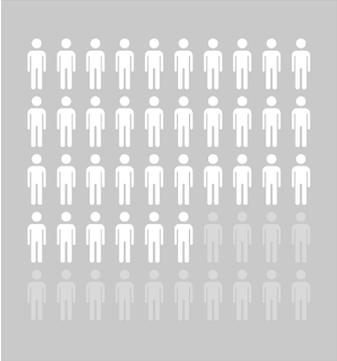


IV. RESIDENTIAL DESIGN

Design Principle



POSSIBILITY 3



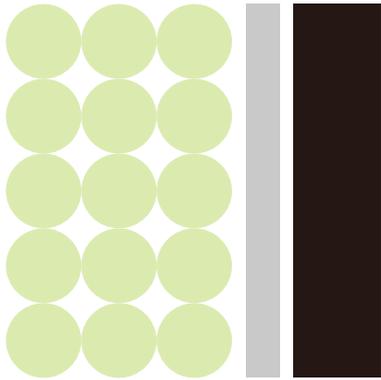
density:
188 dwellings/hectare
716 dwellers/hectare



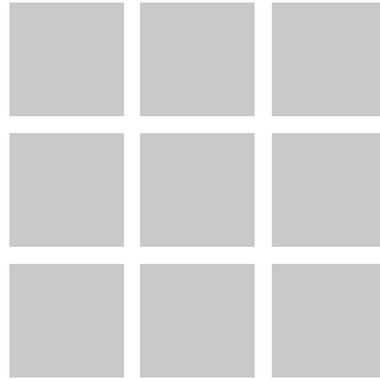
local labour



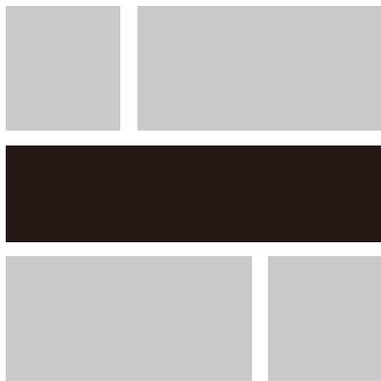
skilled labour



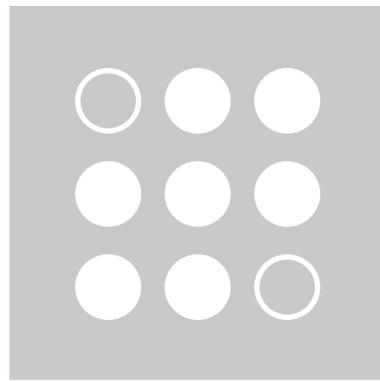
Principle 1
Green Buffer



Principle 2
Traffic Loop



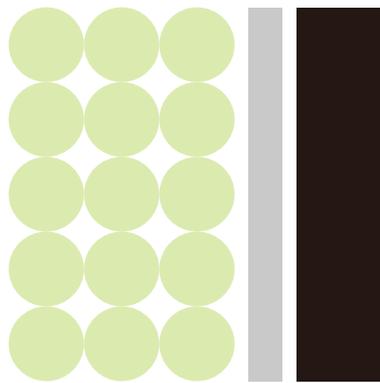
Principle 3
Vendor Street



Principle 4
Communal Space

IV. RESIDENTIAL DESIGN

Street Profile



Principle 1

Green Buffer



IV. RESIDENTIAL DESIGN

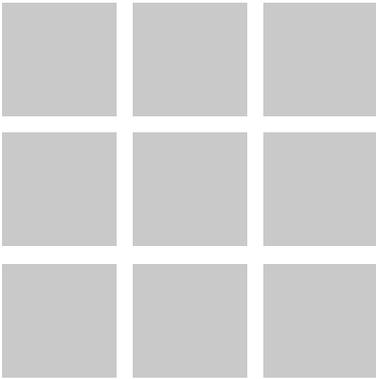
Street Profile





IV. RESIDENTIAL DESIGN

Street Profile



Principle 2
Traffic Loop



IV. RESIDENTIAL DESIGN

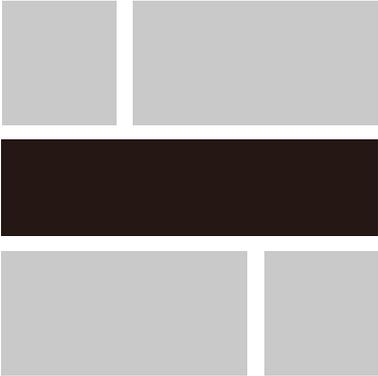
Street Profile



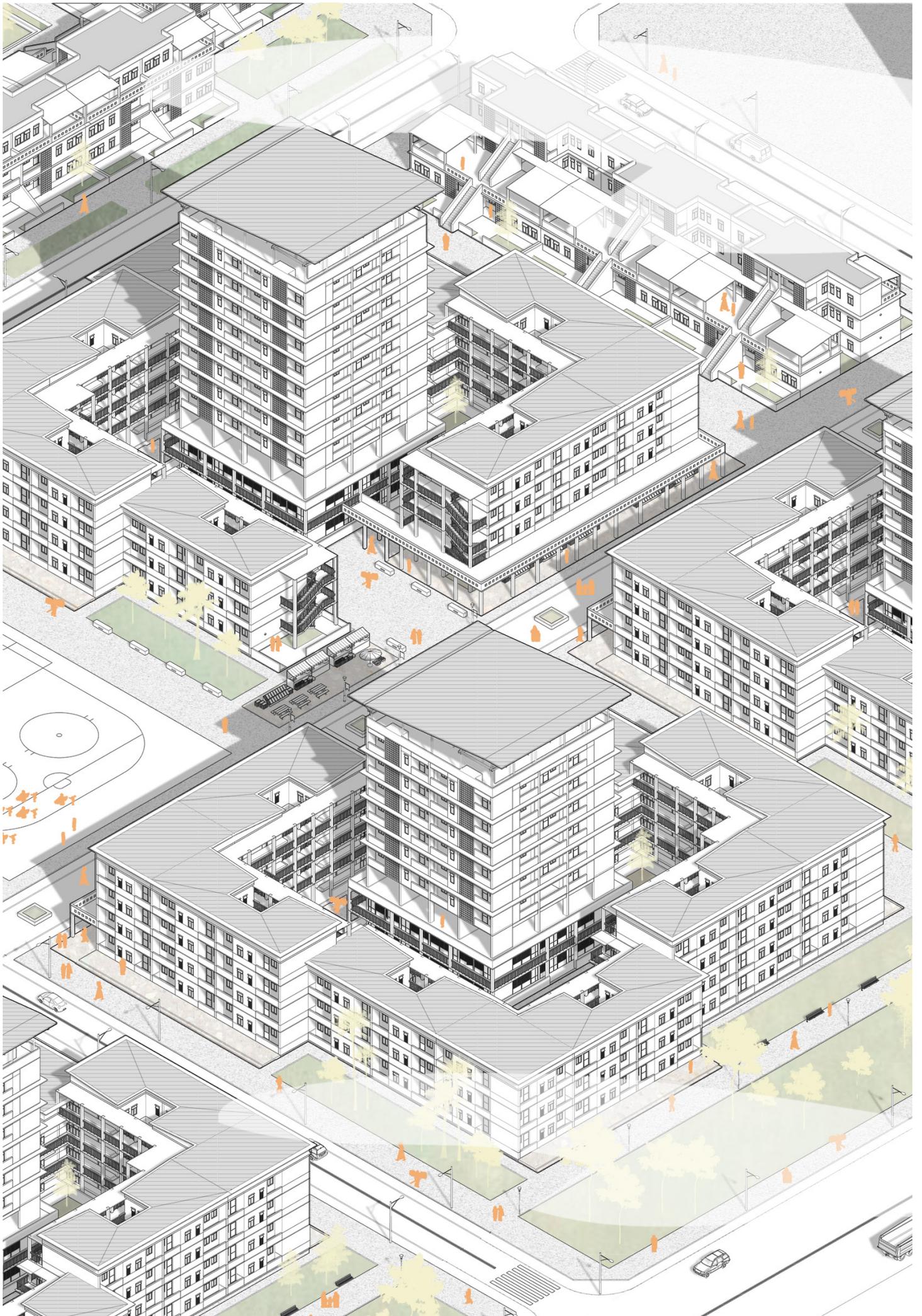


IV. RESIDENTIAL DESIGN

Street Profile



Principle 3
Vendor Street



IV. RESIDENTIAL DESIGN

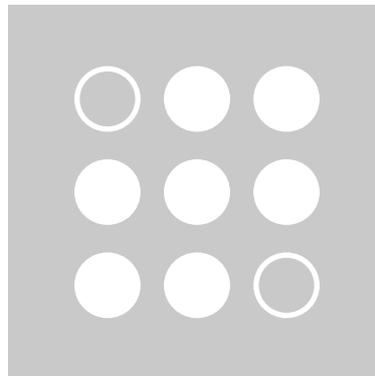
Street Profile





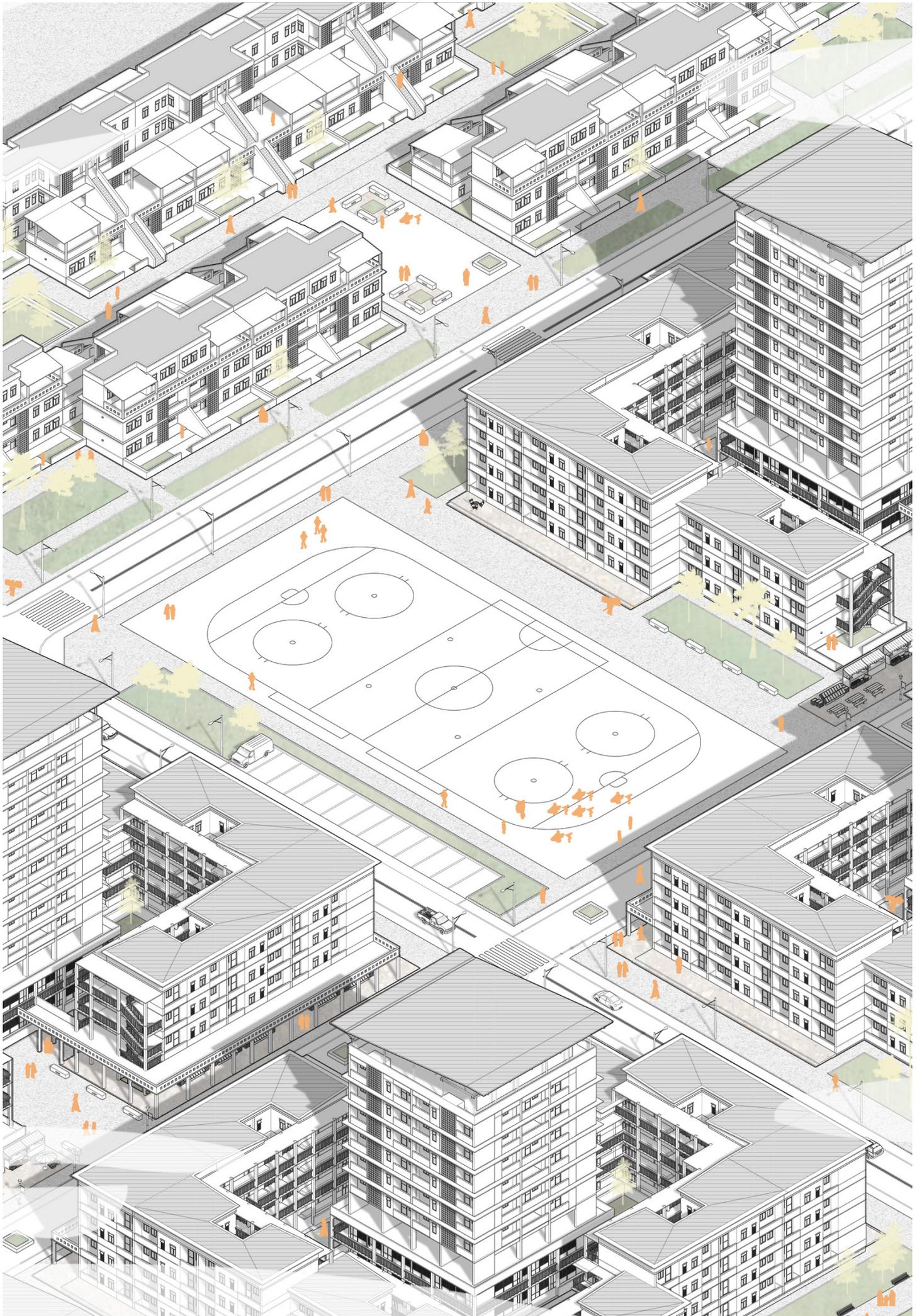
IV. RESIDENTIAL DESIGN

Street Profile



Principle 4

Communal Space



IV. RESIDENTIAL DESIGN

Street Profile

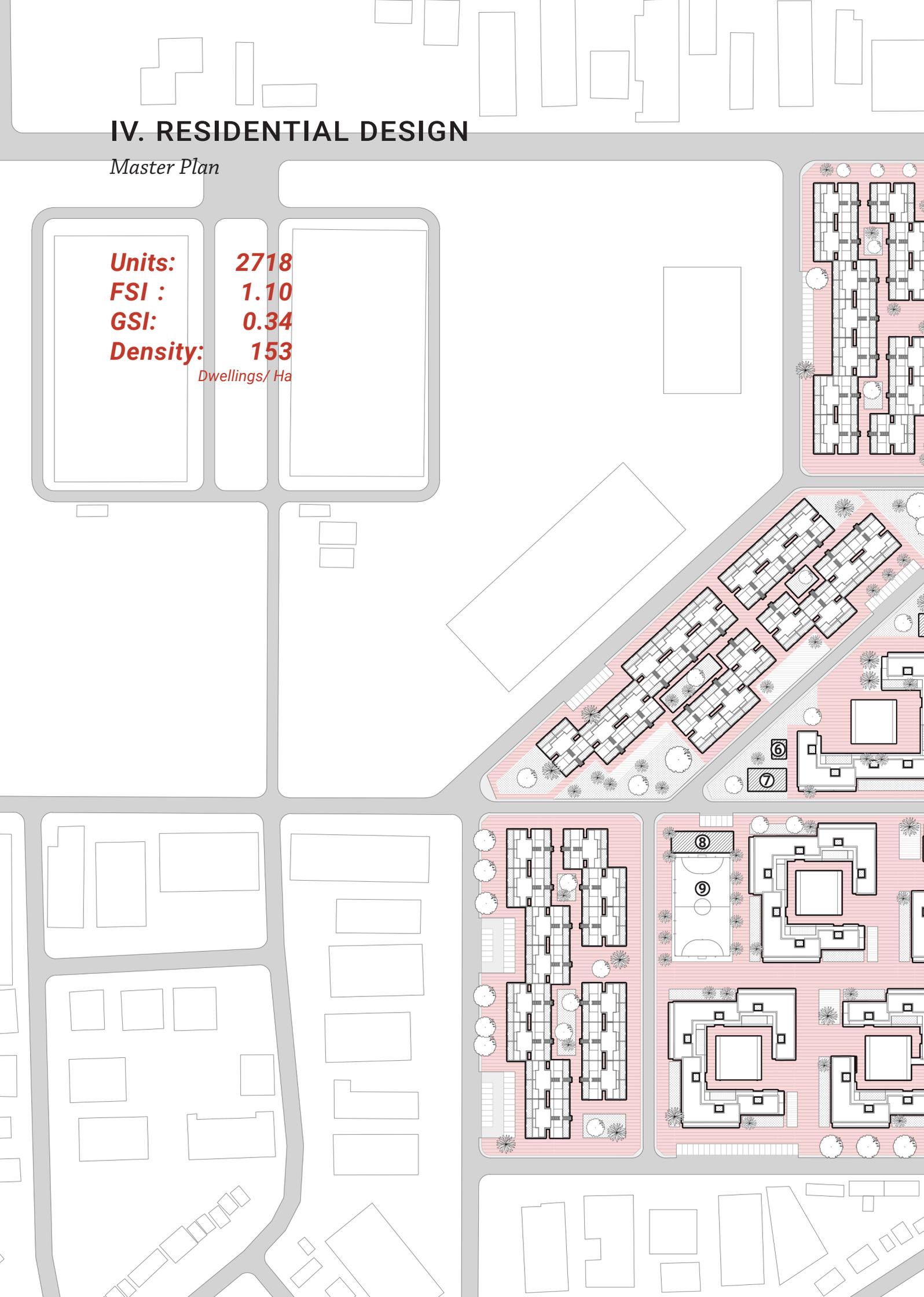


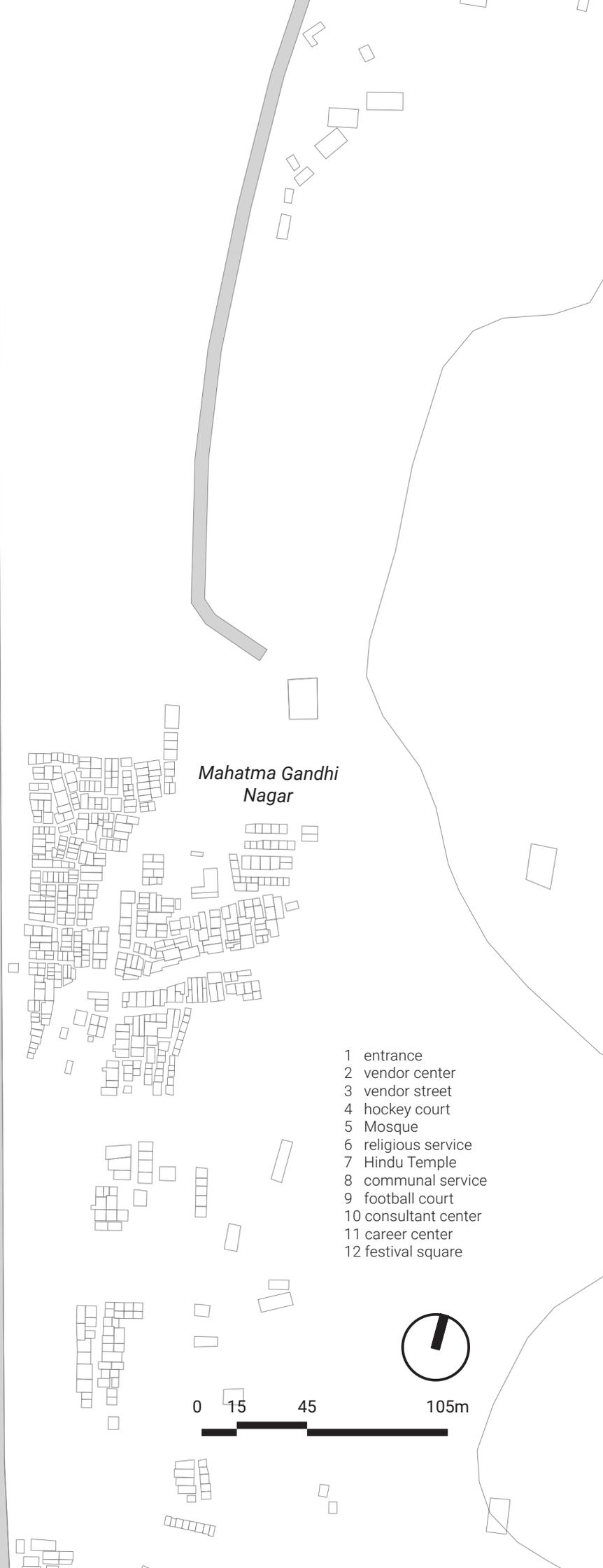
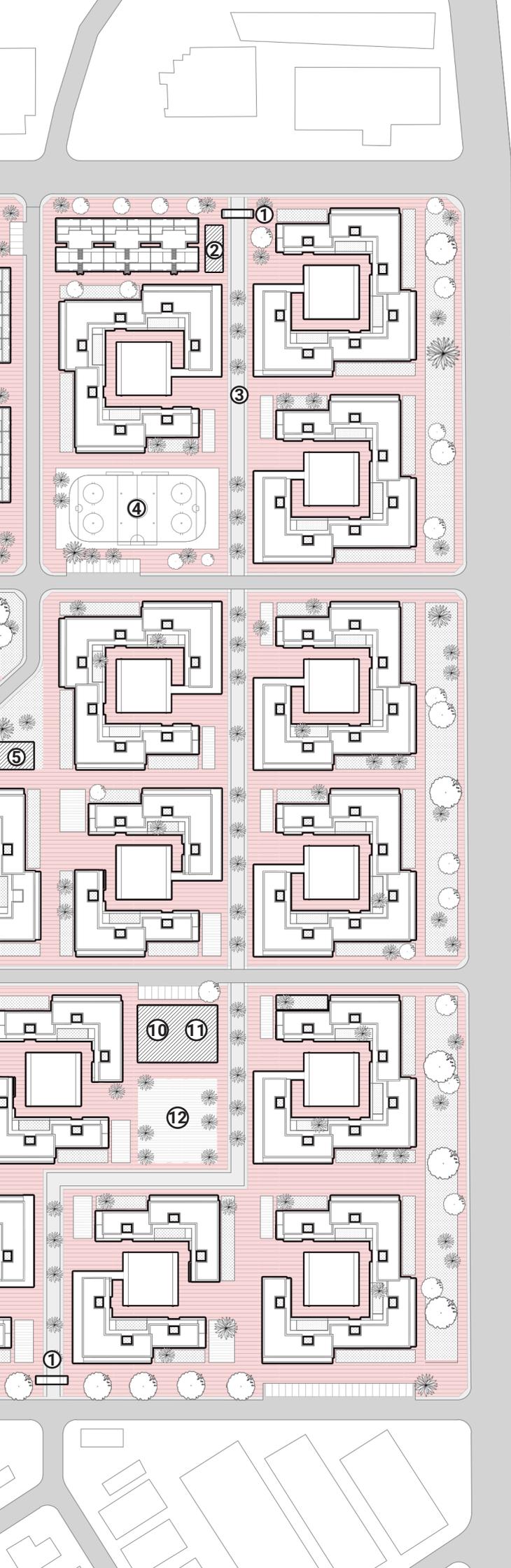


IV. RESIDENTIAL DESIGN

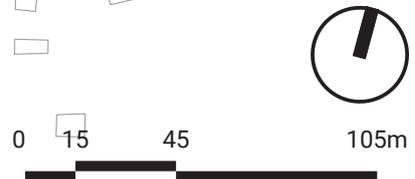
Master Plan

Units: 2718
FSI : 1.10
GSI: 0.34
Density: 153
Dwellings/ Ha



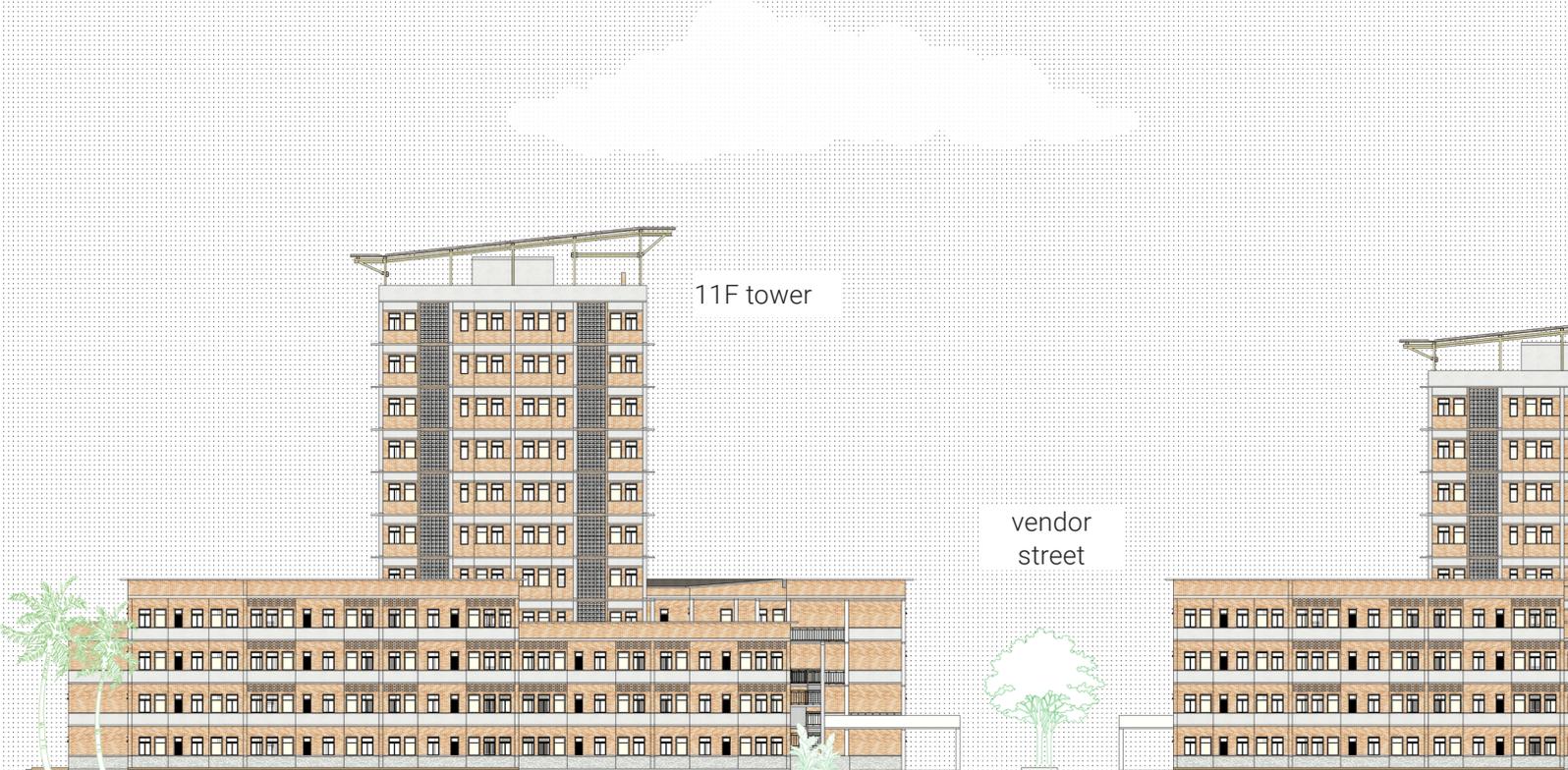


- 1 entrance
- 2 vendor center
- 3 vendor street
- 4 hockey court
- 5 Mosque
- 6 religious service
- 7 Hindu Temple
- 8 communal service
- 9 football court
- 10 consultant center
- 11 career center
- 12 festival square



IV. RESIDENTIAL DESIGN

Urban Section





9F tower

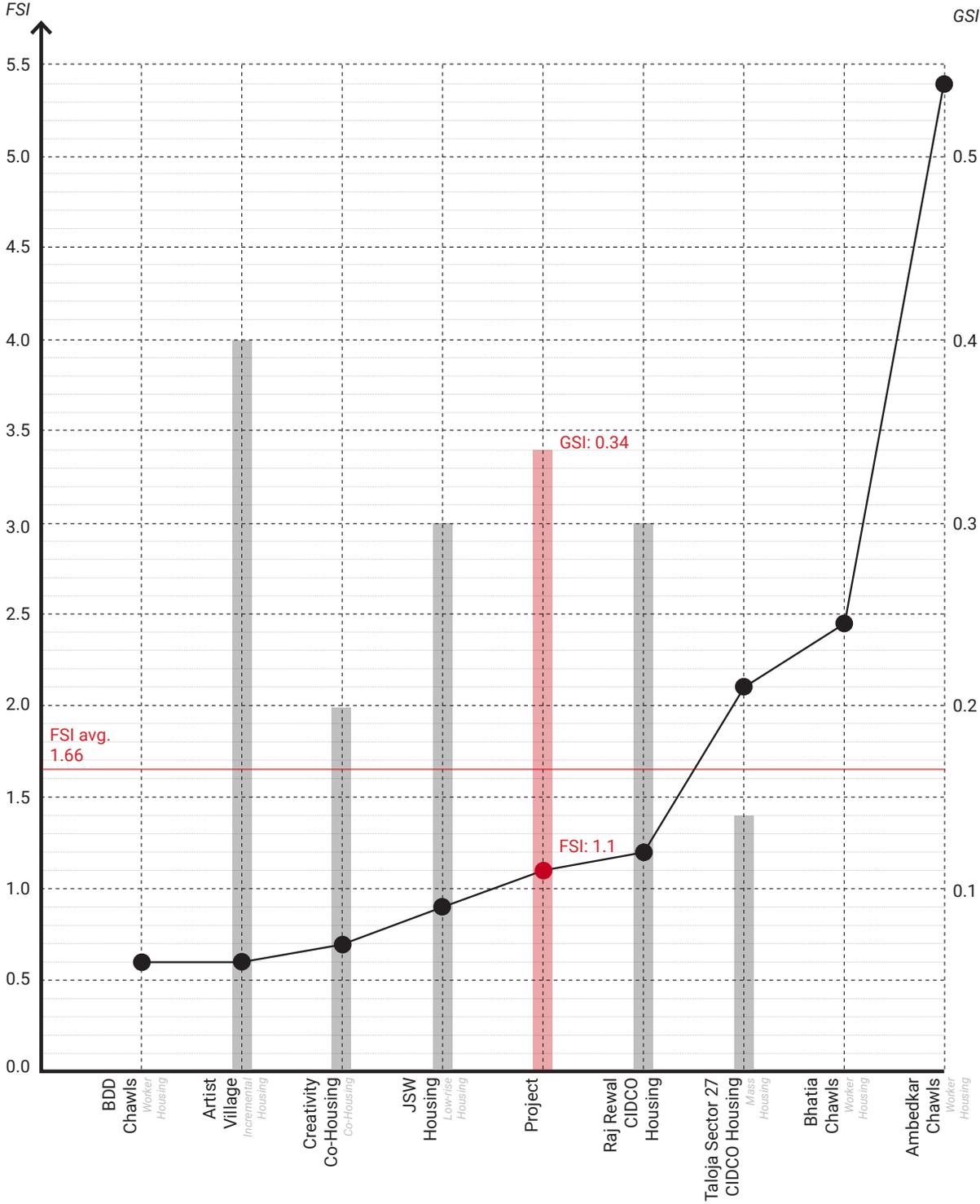
green
buffer

main
road

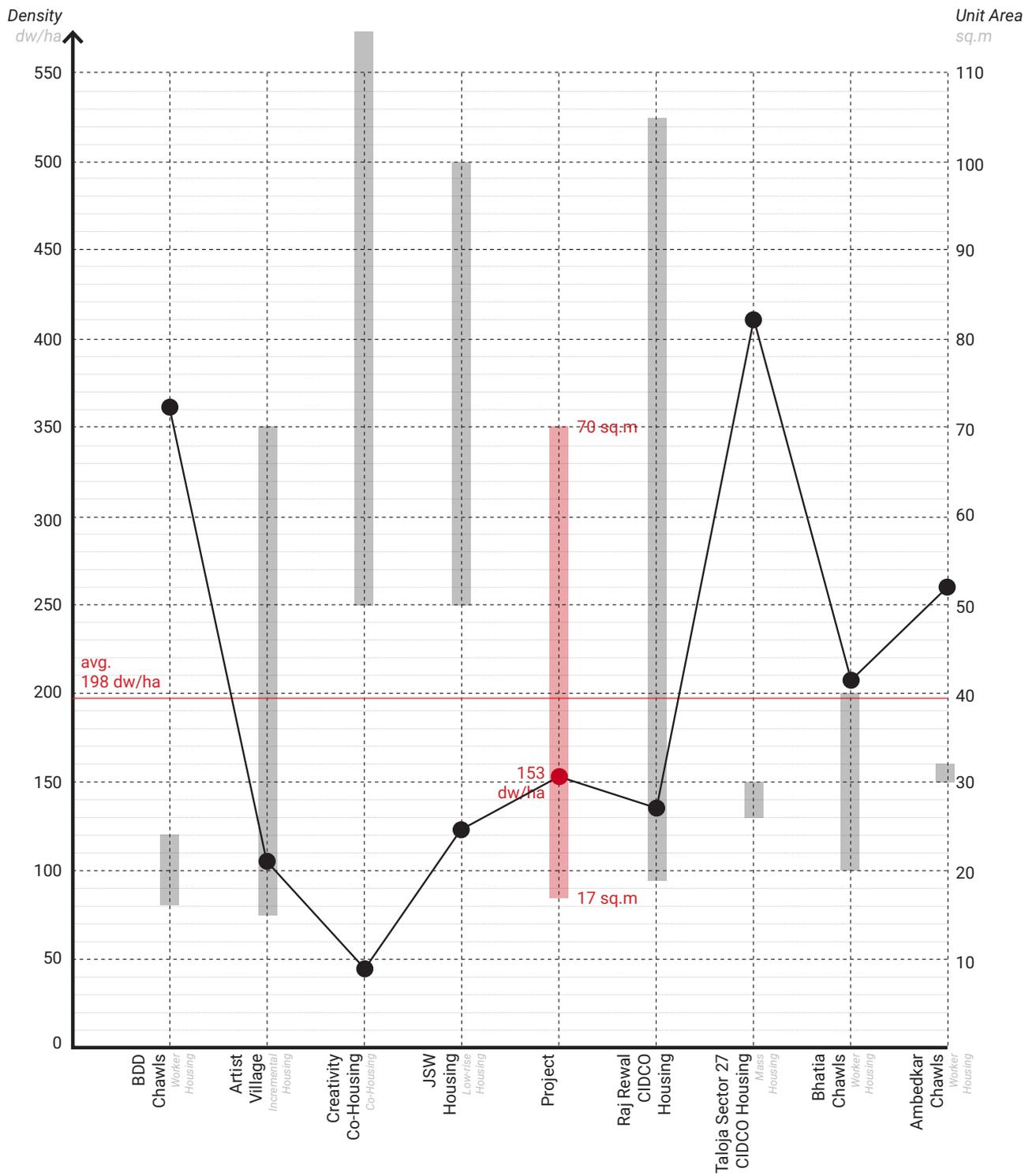
quarry
restoration

IV. RESIDENTIAL DESIGN

Comparative FSI & Density



Data Source: Padora, Sameep. How To Build An Indian House: The Mumbai Example. Reprint, Rotterdam: nai010 publishers, 2020.



IV. RESIDENTIAL DESIGN

Upscaling and Replicability

- slum
- quarry

Mumbai

Old Vashi Brg

Sambhaji Nagar

Adavali Bhutawali

Hanuman Nagar

Katkari Pada

Shramik Nagar

Pavane Goan

Ganpati Pada

Turbhe Store

Indira Nagar

Hanuman Nagar

Bonsari Village

DR Quarry Slum

Gandhi Nagar

Shivaji Nagar

Ramesh Mettal Quarry

Panchankur Quarry

A.H Patil Quarry

Omkar Quarry

Joseph Quarry

Baban Seth Quarry

Bonsari Gaon Chunabhatti

Bharat Stone Quarry

DR Patil Quarry

Seti Quarry

Lalji Seth Quarry

Sanjev Stone Quarry

Noble Quarry

Ramesh Quarry

Targhar Village

Ucc, Owle Quarry

Vahal Gaothan

Navkar Stone Crushing Company

Owle Village

Babavpada

JMM IPL Quarry

SR Vaskar Stone Crushing

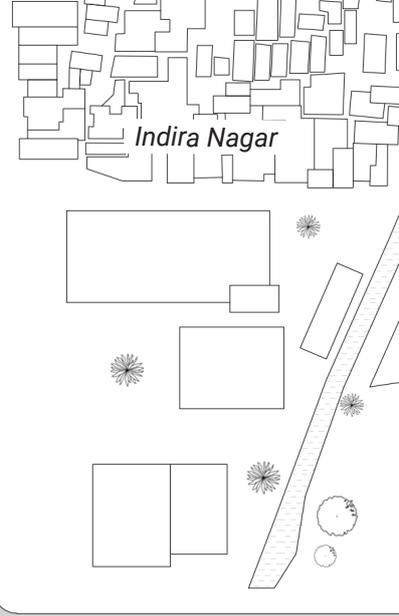
Stone Mines

In Navi Mumbai, many quarry settlements are waiting for an improvement in their living conditions. These settlements are under a similar urban context. They are close to the quarries, with heavy traffic passing through and close to slums. The previous design principles can use for upscaling and replicability.



IV. RESIDENTIAL DESIGN

Master Plan



Units: 1278
FSI : 0.98
GSI: 0.30
Density: 135
Dwellings/ Ha

- 1 entrance
- 2 vendor center
- 3 vendor street
- 4 hockey court
- 5 Mosque
- 6 religious service
- 7 Hindu Temple
- 8 communal service
- 9 consultant center
- 10 career center
- 11 festival square





Bonsari
Village

V. BUILDING TECHNOLOGY

This chapter focus on the building technologies that based on local climate , geographical conditions and ecology system.

V. BUILDING TECHNOLOGY

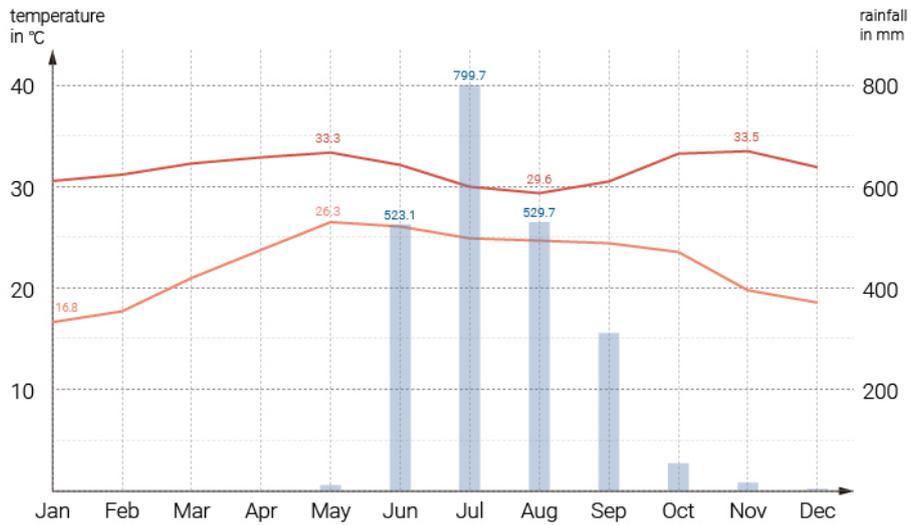
Climate and Materiality



Image Source:
Lux, Valerie Saavedra, and Paul Watson. "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces." edited by Bo Tang; London Metropolitan University; Association of Rural People for Health and Educational Needs, 2008.

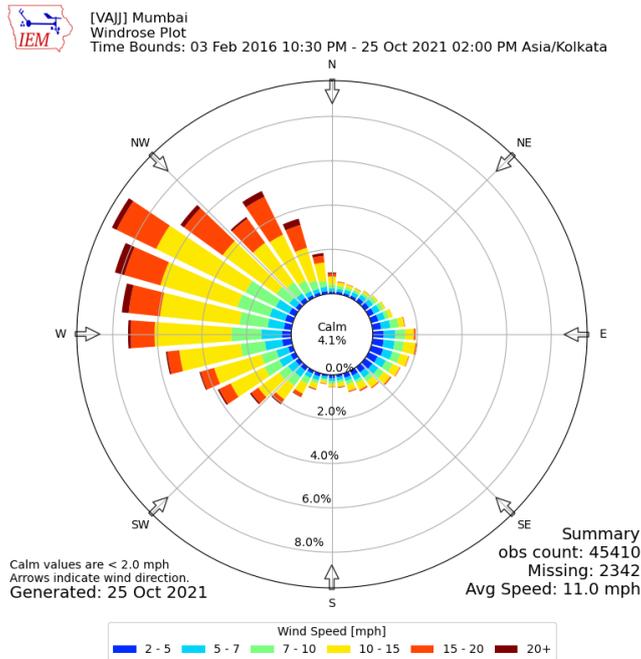
Rainfall/ Temperature

Yearly Climatology

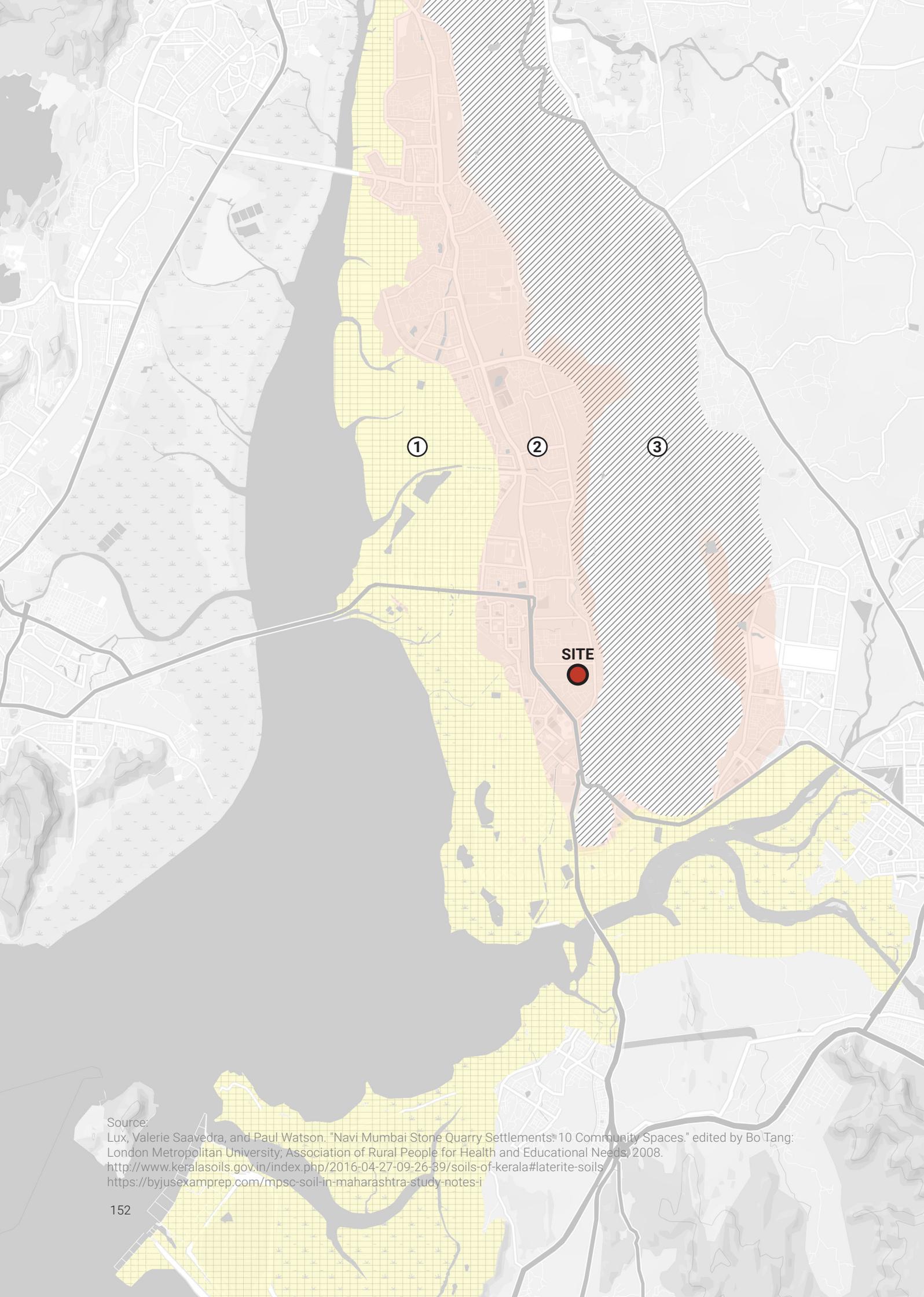


Wind Direction

Yearly Climatology



Data Source:
<https://www.weather-atlas.com/en/india/mumbai-climate#rainfall>
https://mesonet.agron.iastate.edu/sites/windrose.phtml?station=VAJJ&network=IN_ASOS



①

②

③

SITE



Source:
Lux, Valerie Saavedra, and Paul Watson. "Navi Mumbai Stone Quarry Settlements: 10 Community Spaces." edited by Bo Tang:
London Metropolitan University; Association of Rural People for Health and Educational Needs, 2008.
<http://www.keralasoils.gov.in/index.php/2016-04-27-09-26-39/soils-of-kerala#laterite-soils>
<https://byjusexamprep.com/mpsc-soil-in-maharashtra-study-notes-i>

V. BUILDING TECHNOLOGY

Climate and Materiality



Alluvial Soil

1. Coastal Area

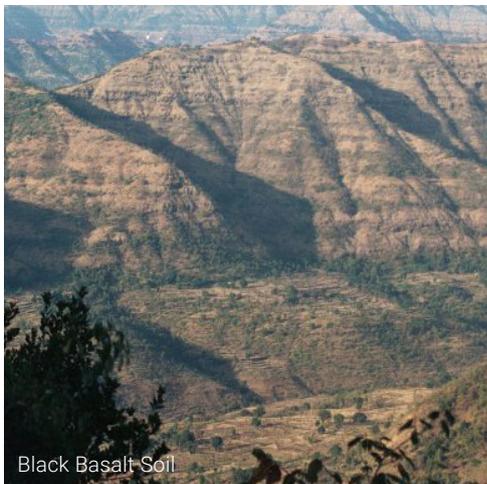
This region are mainly **alluvial soils**. They are **clayey**, with high amount of bases and have **high water holding capacity** (200-250 mm/m). The ground water table of these soils is generally high and it reaches above the surface during rainy season.



Lateritic Soil

2. Laterite Area

The soils located on moderately sloping residual hills are **lateritic** in nature. Laterite soil cannot retain moisture, so it is unsuitable for irrigation. It is less fertile for agriculture but generally suitable for orchards.



Black Basalt Soil

3. Hills

Rock is the most abundant material source with the quarry area. It is mostly **black basalt soil**. This type of soil is **clayey**, retains moisture. The quarry's land was used to produce paddy during rainy season. Some mango and coconut orchards was also practised by locals.

V. BUILDING TECHNOLOGY

Ecology



mango



coconut



mango



paddy

Image Source (from left to right):
<https://indianexpress.com/article/cities/rajkot/cyclone-impact-kutch-mangoes-get-a-boost-as-orchards-in-saurashtra-suffer-major-damage-7346912/>
<https://www.yearofthedurian.com/2013/07/indias-mango-belt.html>
<https://www.indiancooperative.com/co-op-news-snippets/india-takes-giant-strides-in-coconut-production-govt/>
<https://www.deccanchronicle.com/business/in-other-news/180620/indias-rice-production-could-hit-record-high-as-farmers-expand-area.html>



jackfruit



pinapple



pinapple

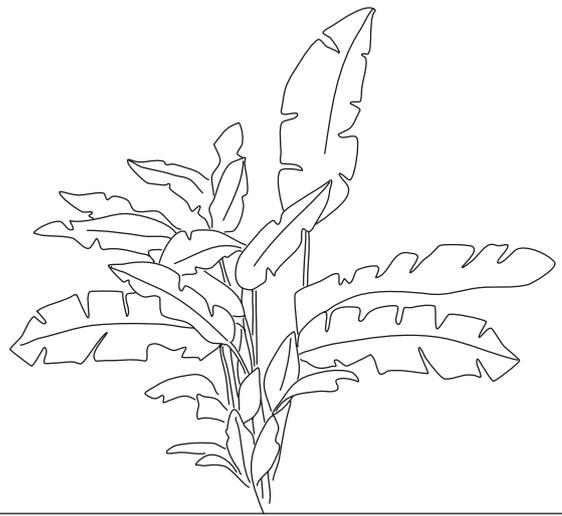
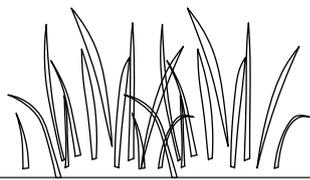


tapioca

Image Source (from left to right):
<https://www.deccanherald.com/national/south/indias-superfood-jackfruit-goes-global-839001.html>
<https://numerical.co.in/numerons/collection/6057f48be3f05b244c654c91>
<https://www.thenewsminute.com/article/vazhakulam-pineapple-fruit-has-brought-prosperity-kerala-town-87671>
<https://www.dreamstime.com/heap-tapioca-cassava-tree-heap-tapioca-cassava-tree-agriculture-prepair-image102316699>

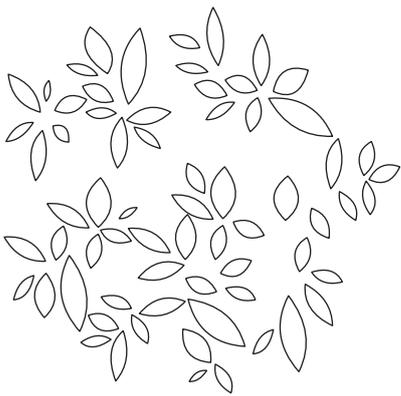
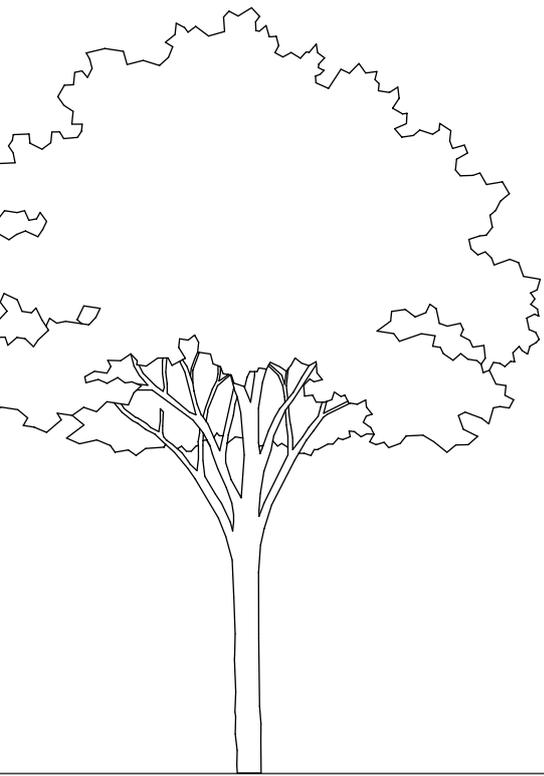
V. BUILDING TECHNOLOGY

Ecology

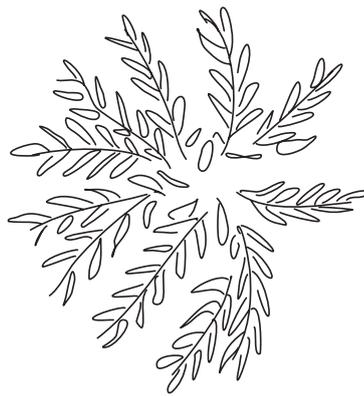


Lemon Grass

Banana Tree



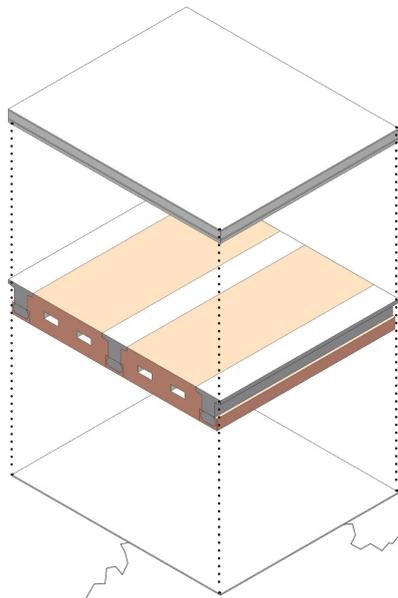
Mango Tree



Coconut Tree

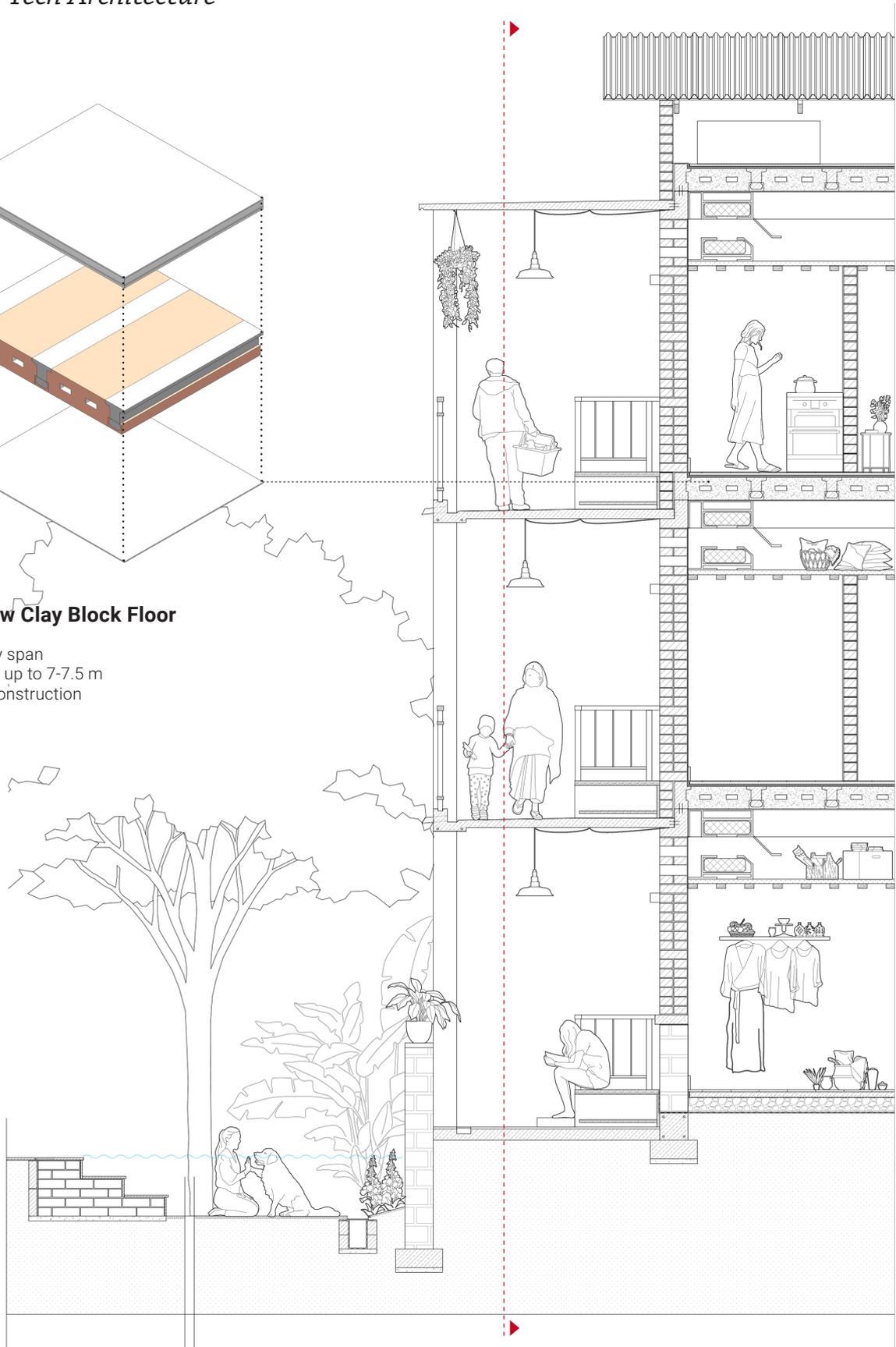
V. BUILDING TECHNOLOGY

Low Tech Architecture



Hollow Clay Block Floor

- 1-way span
- Span: up to 7-7.5 m
- Dry construction





CSEB Load Bearing Wall



Precast Concrete Beam



Hollow Clay Block floor



Marine Plywood Doorstep



Rubble Stone Retaining Wall

V. BUILDING TECHNOLOGY

Low Tech Architecture

Detail A 1:30

1 Floor Construction (interior)

- limestone floor covering	10mm
- screed	25mm
- seperated layer (1mm plastic sheet)	
- impact sound insulation	20mm
- hollow clay block floor	240mm
- plaster to soffit	10mm

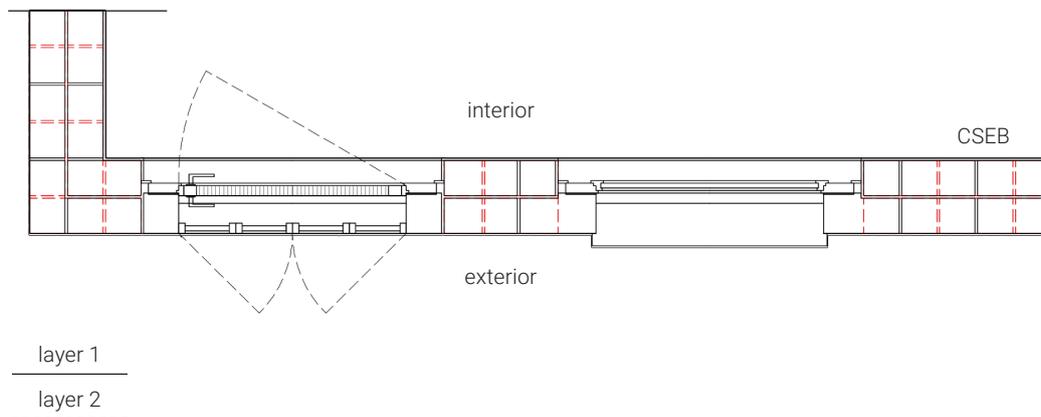
2 Ceiling

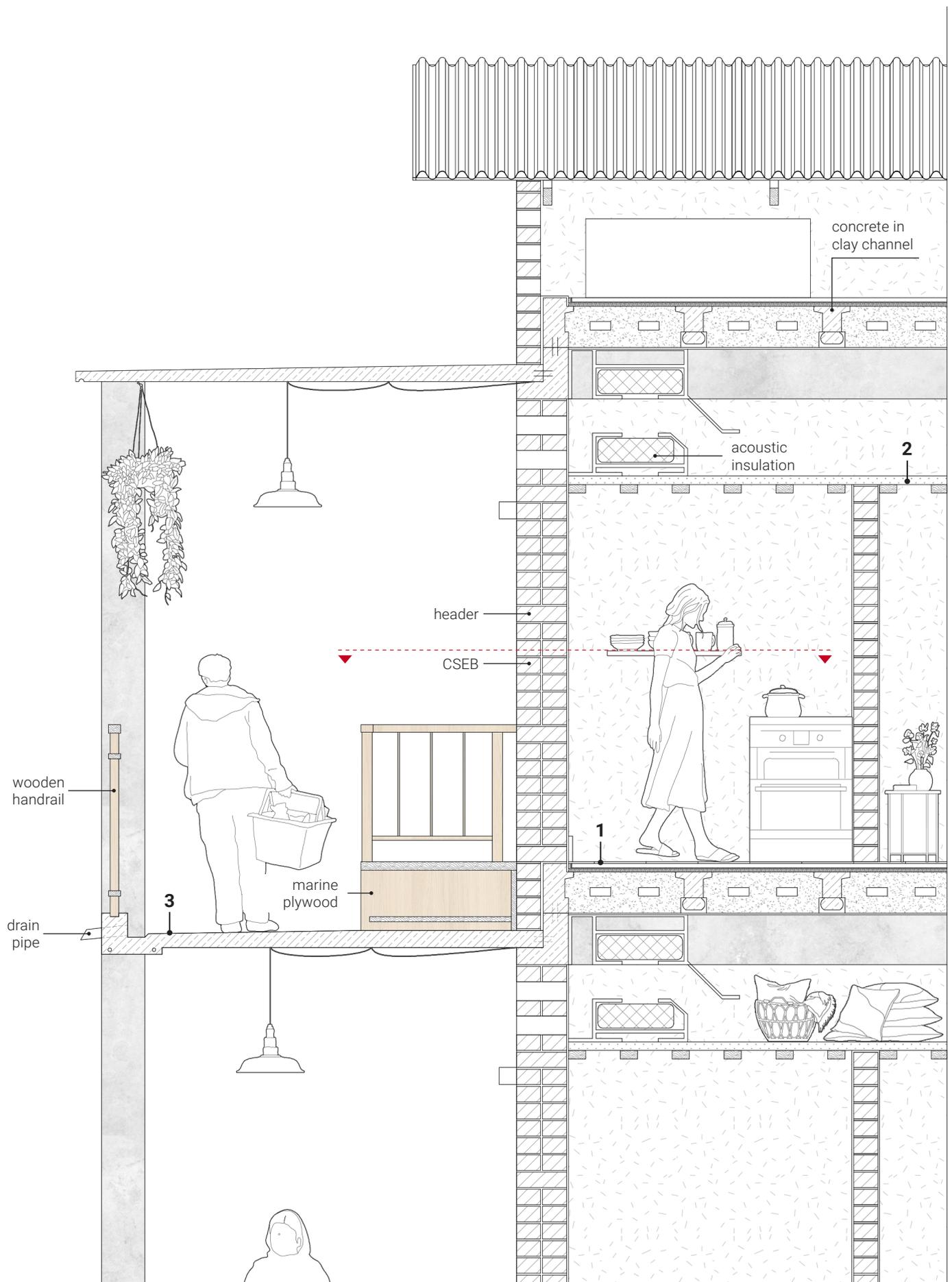
- plasterboard	50mm
- wooden beam	

3 Floor Construction (gallery)

- precast concrete floor	80-100mm
--------------------------	----------

Detail B 1:30

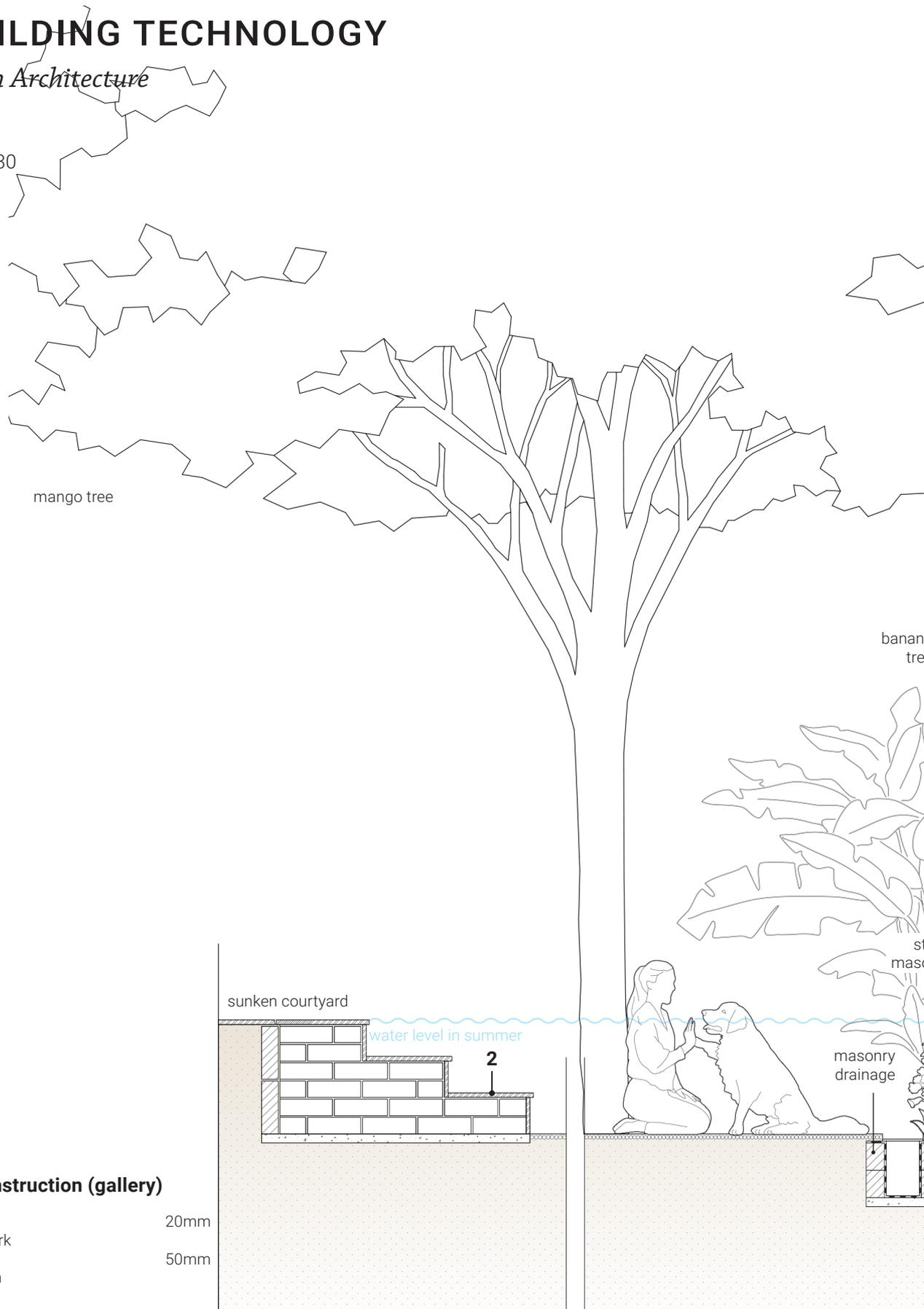


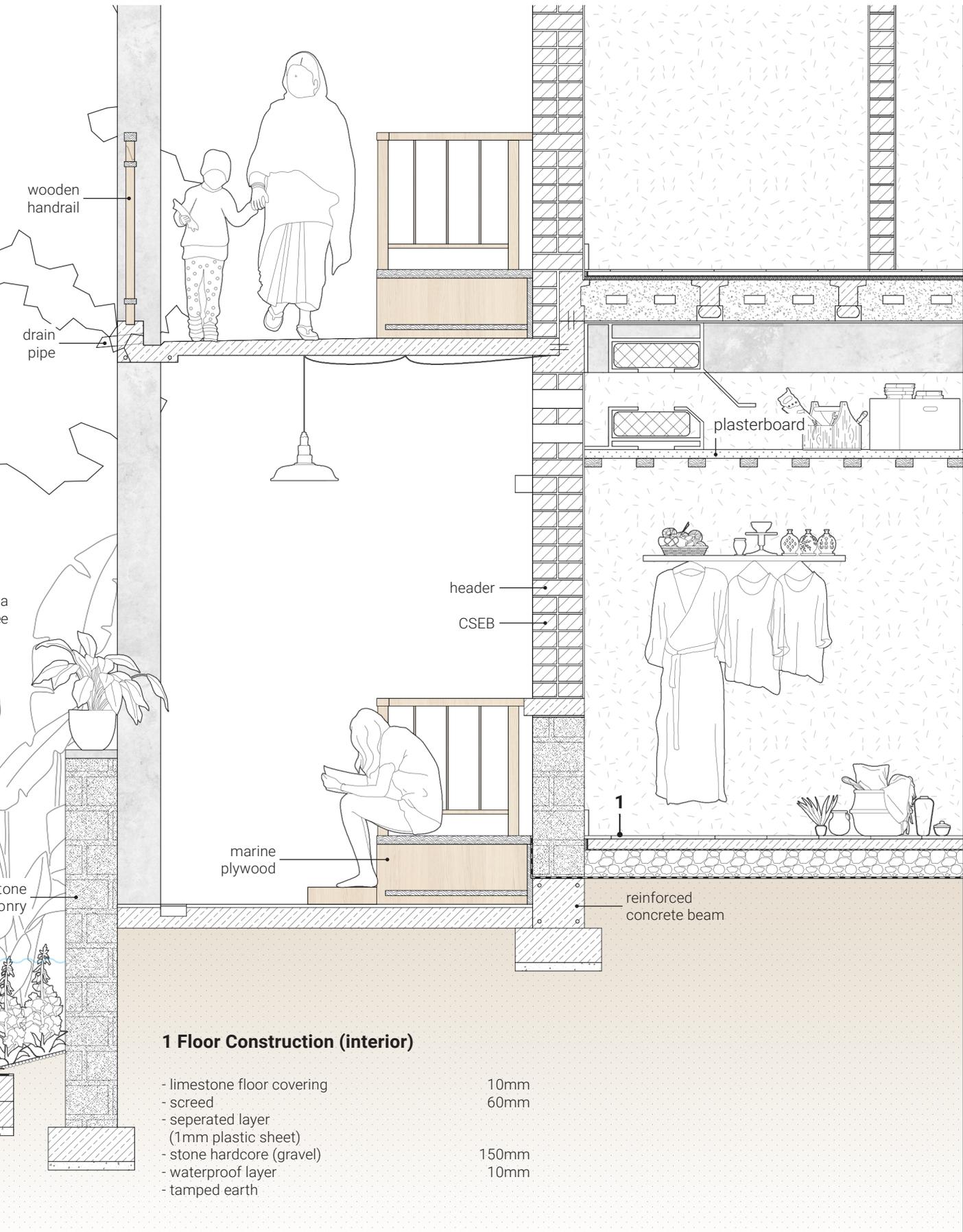


V. BUILDING TECHNOLOGY

Low Tech Architecture

Detail C 1:30





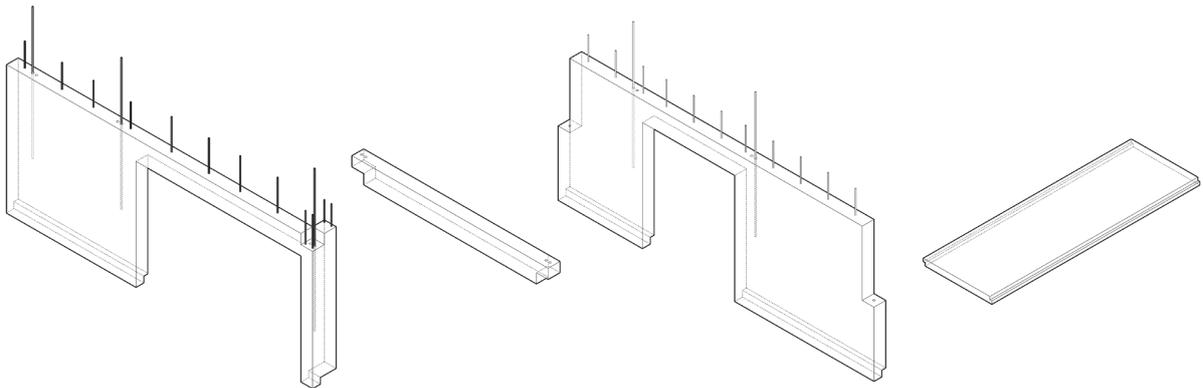
1 Floor Construction (interior)

- | | |
|--|-------|
| - limestone floor covering | 10mm |
| - screed | 60mm |
| - seperated layer
(1mm plastic sheet) | |
| - stone hardcore (gravel) | 150mm |
| - waterproof layer | 10mm |
| - tamped earth | |

V. BUILDING TECHNOLOGY

Precast Architecture

1. Components



① Structural Wall 1

Dimension:
7.8m * 3.3m * 0.3m

② Beam

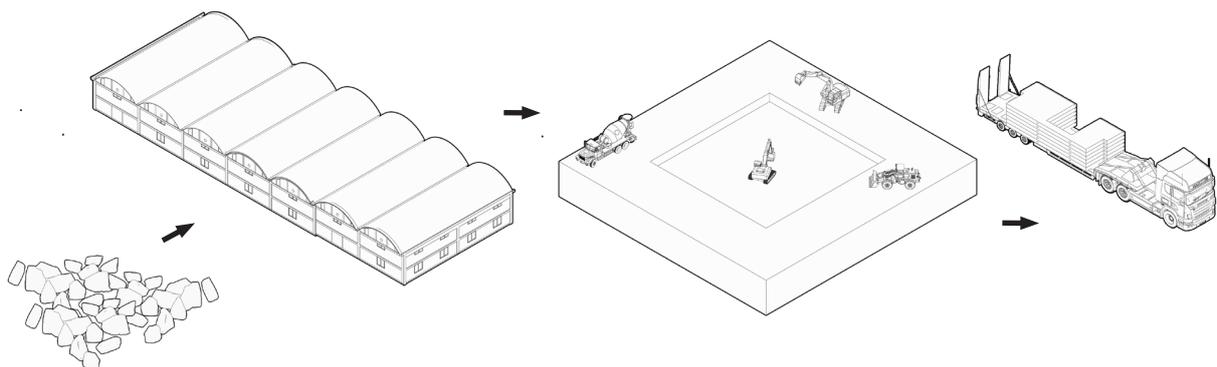
③ Structural Wall 2

Dimension:
8.1m * 3.3m * 0.3m

④ Floor Slab

Dimension:
1.8m * 0.15m * 5.4m

2. Process



① Material

Rock is the main and most abundant material source with the quarry area.

② Factory

In the factory, the concrete will be made into previously designed components.

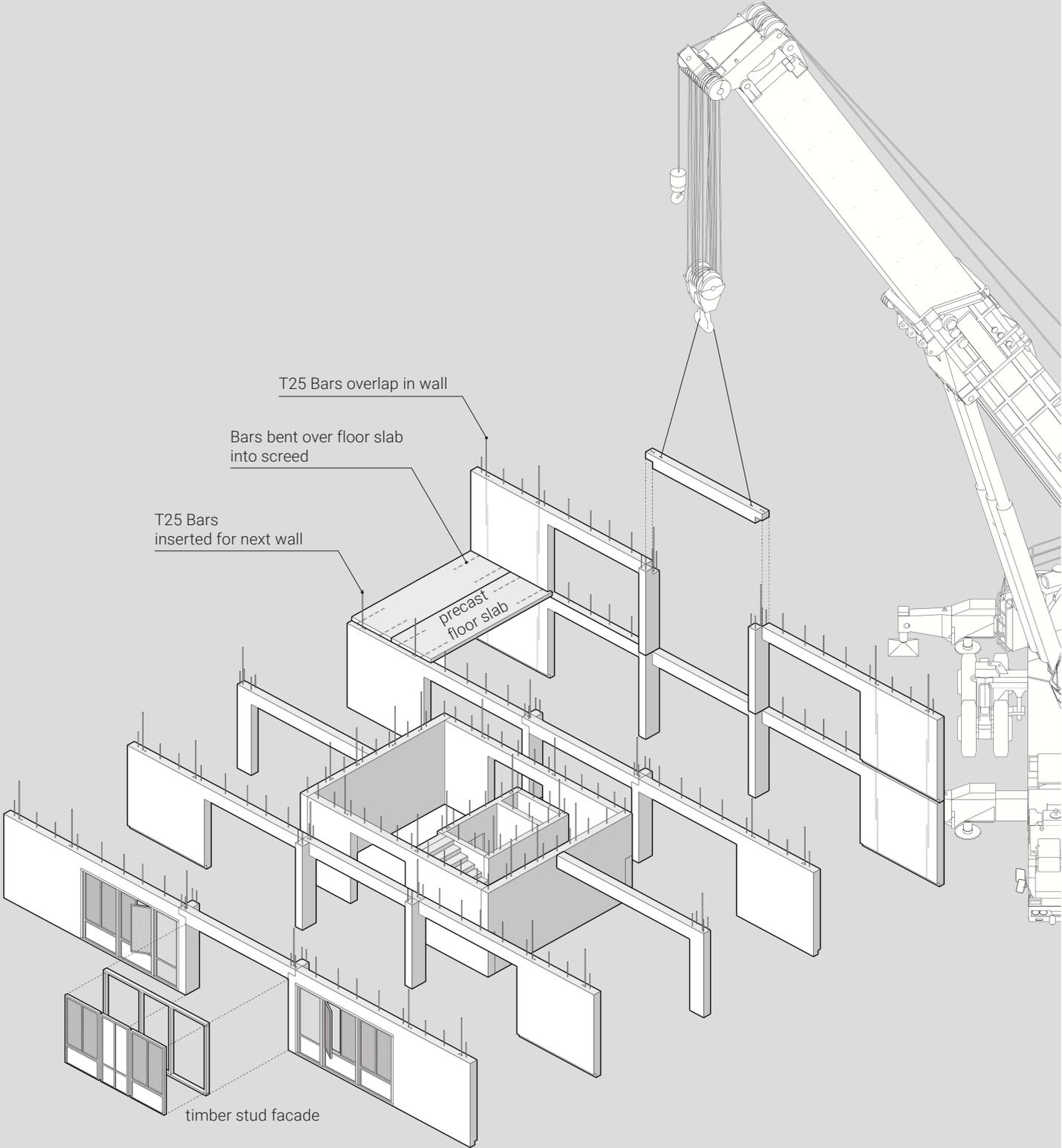
③ On-site Foundation

The foundation will be excavated on site.

④ Transportation

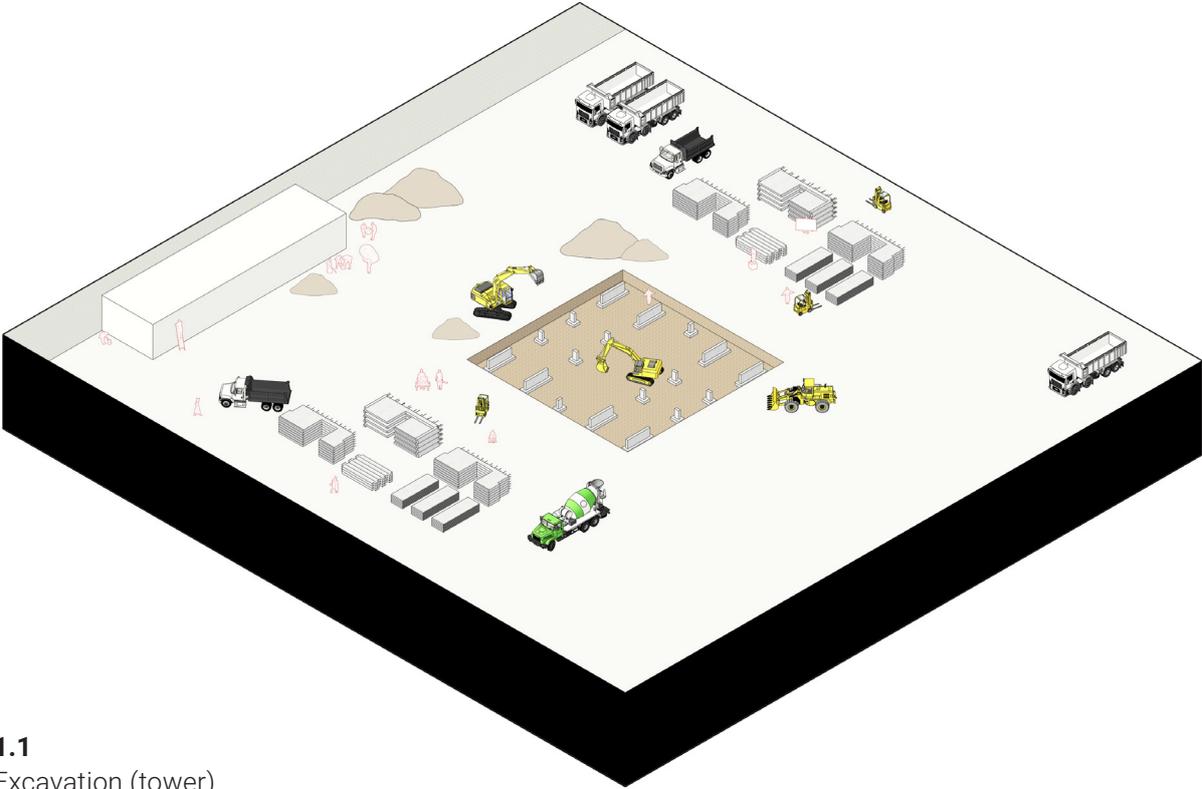
The precast components will be transported to the construction site.

3. On-site Installation

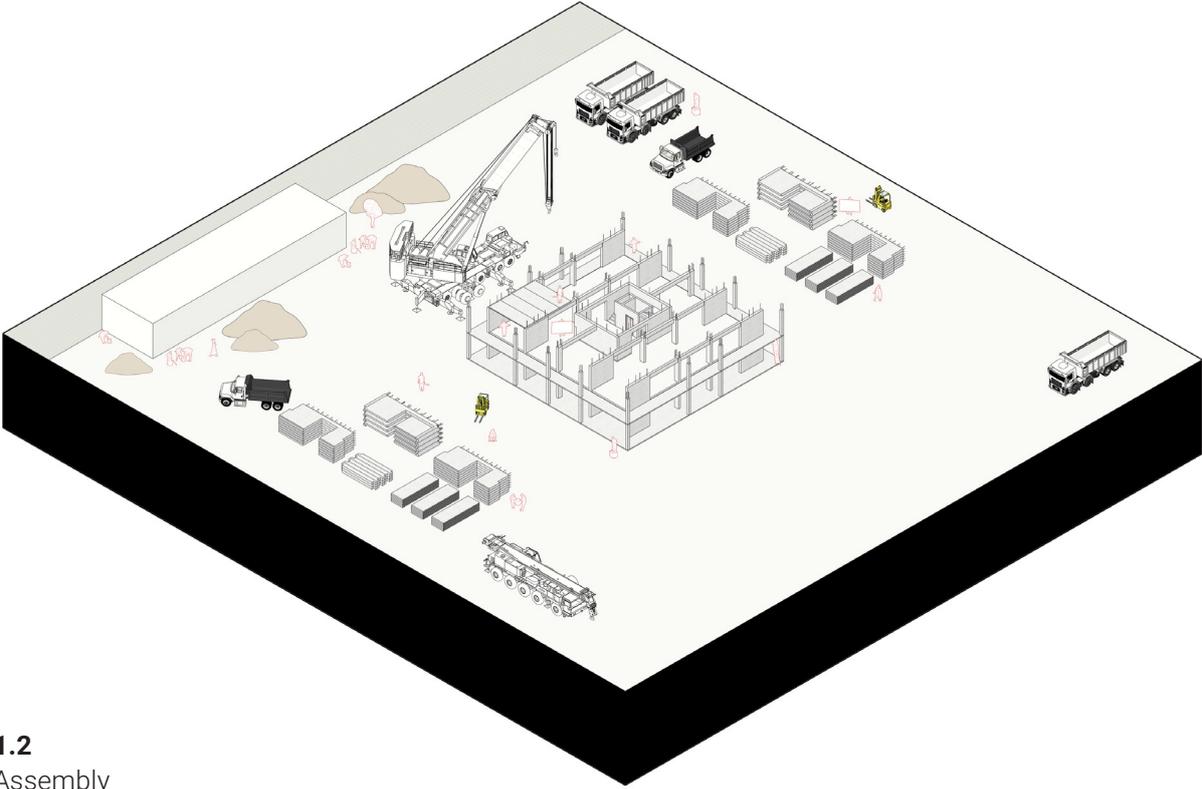


V. BUILDING TECHNOLOGY

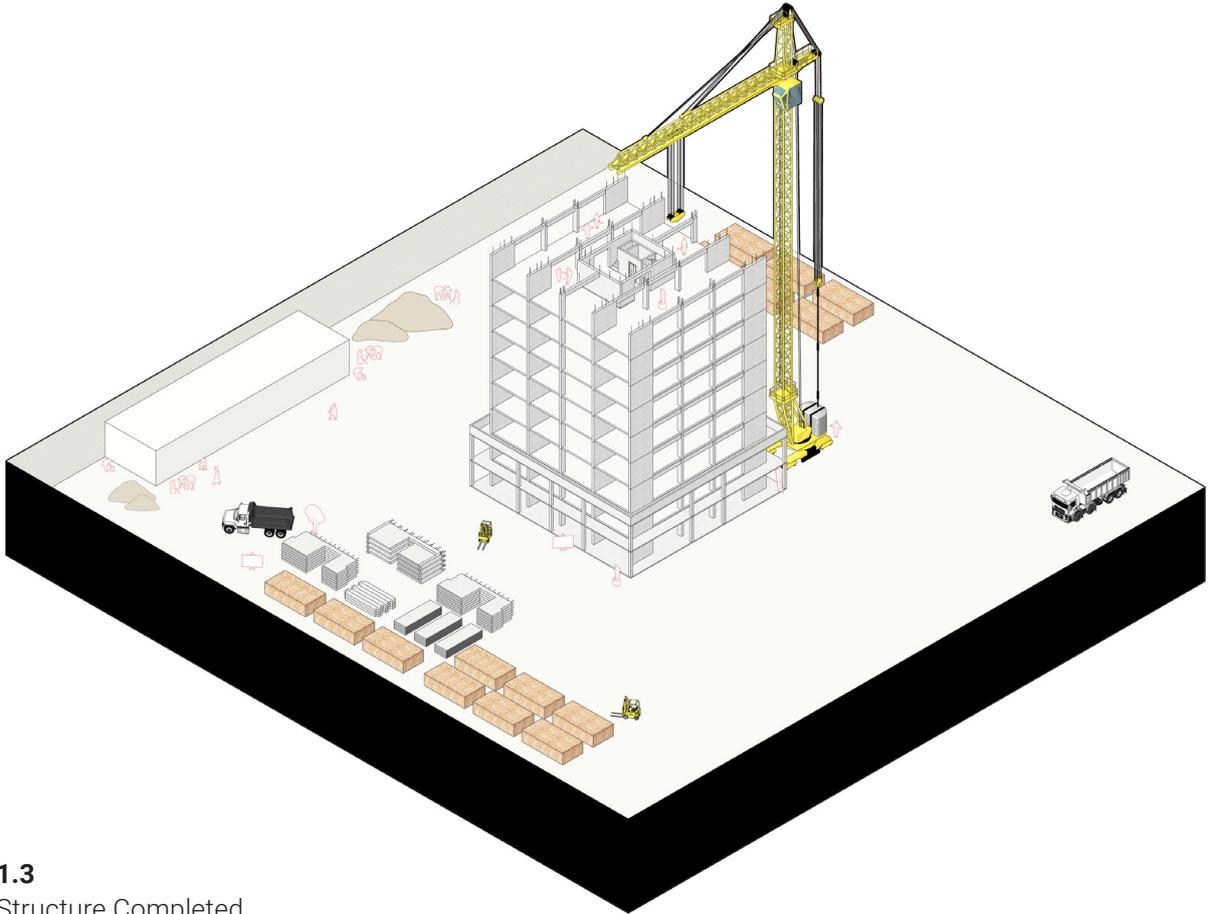
Construction Process



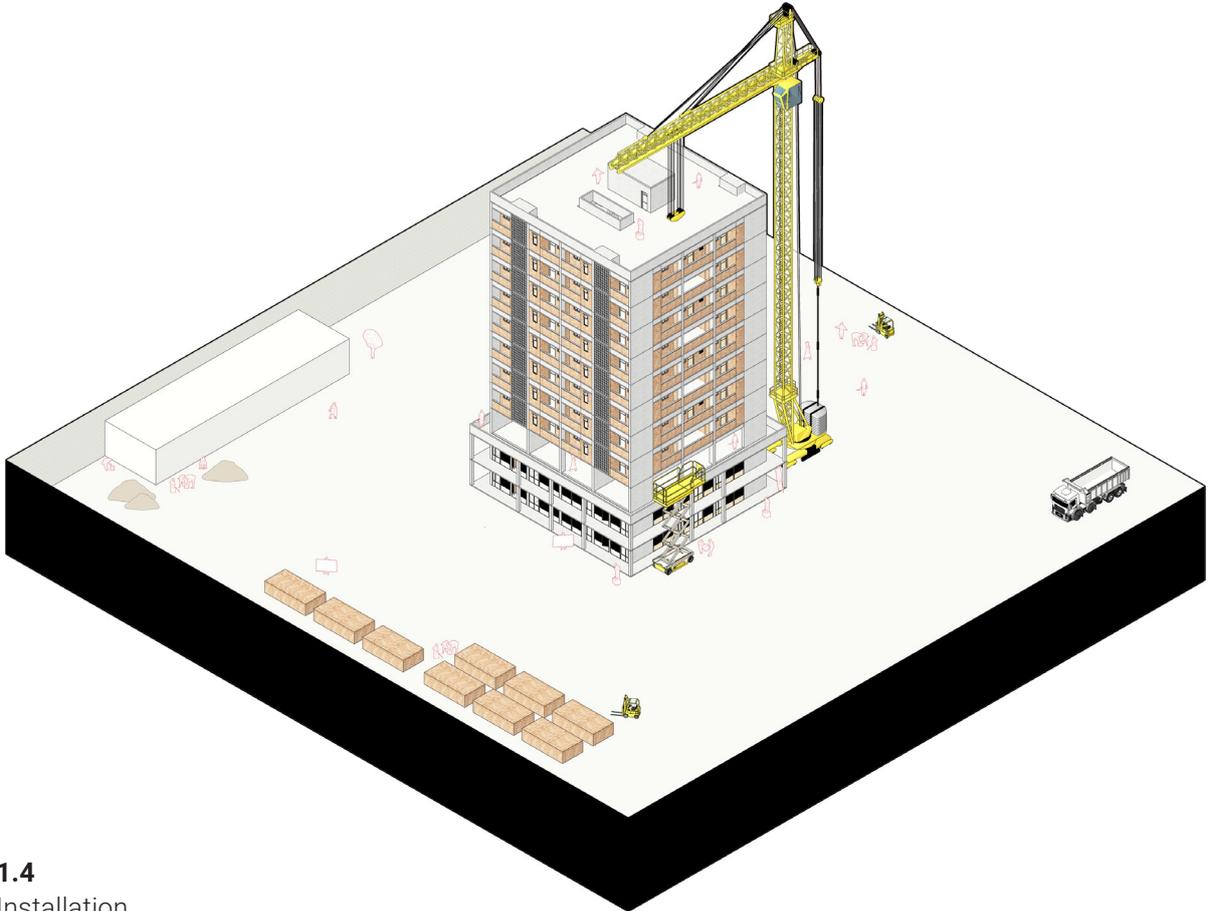
1.1
Excavation (tower)



1.2
Assembly



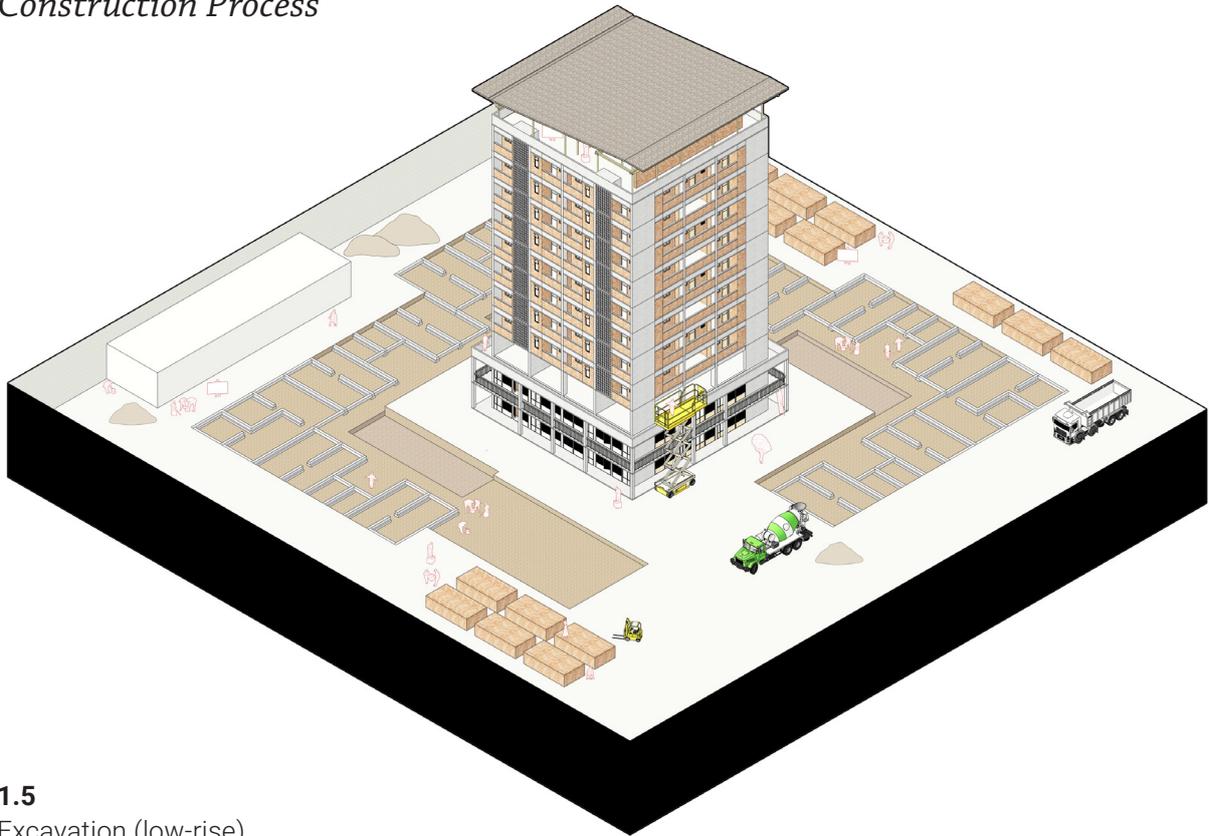
1.3
Structure Completed



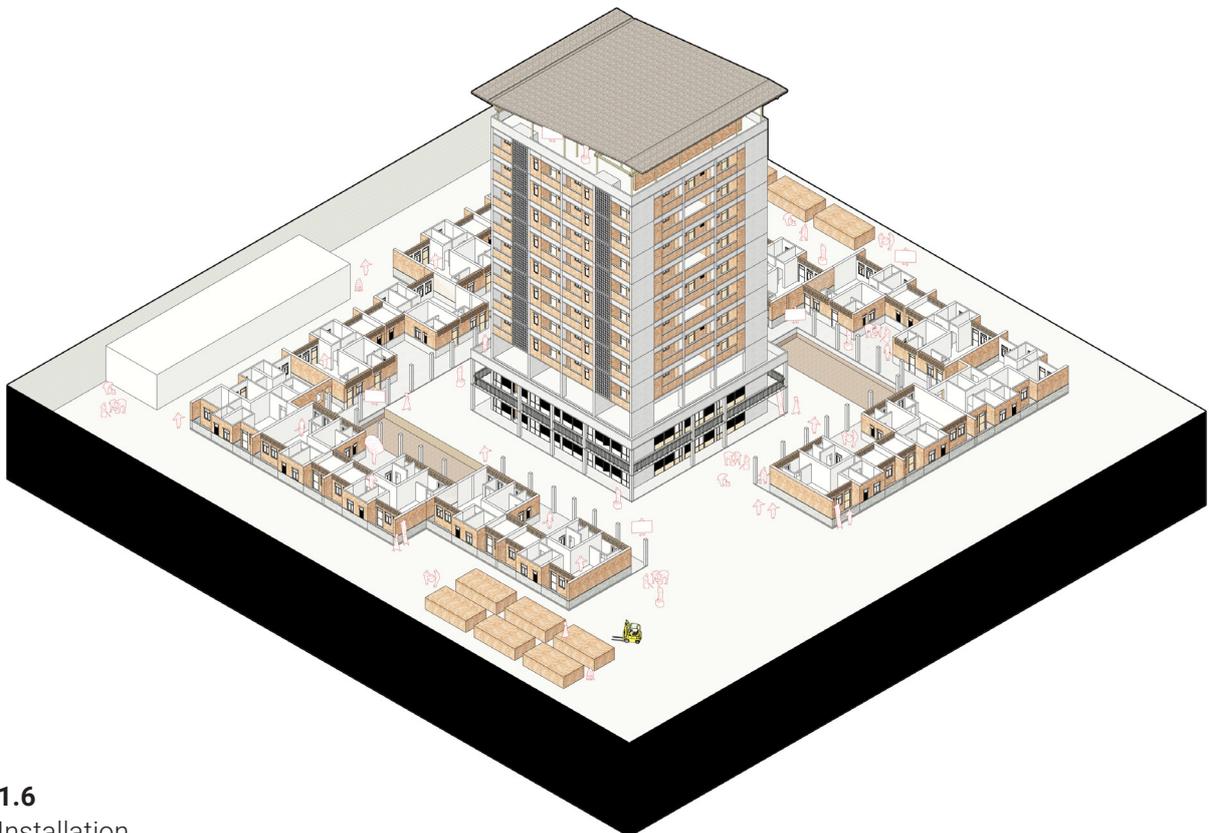
1.4
Installation

V. BUILDING TECHNOLOGY

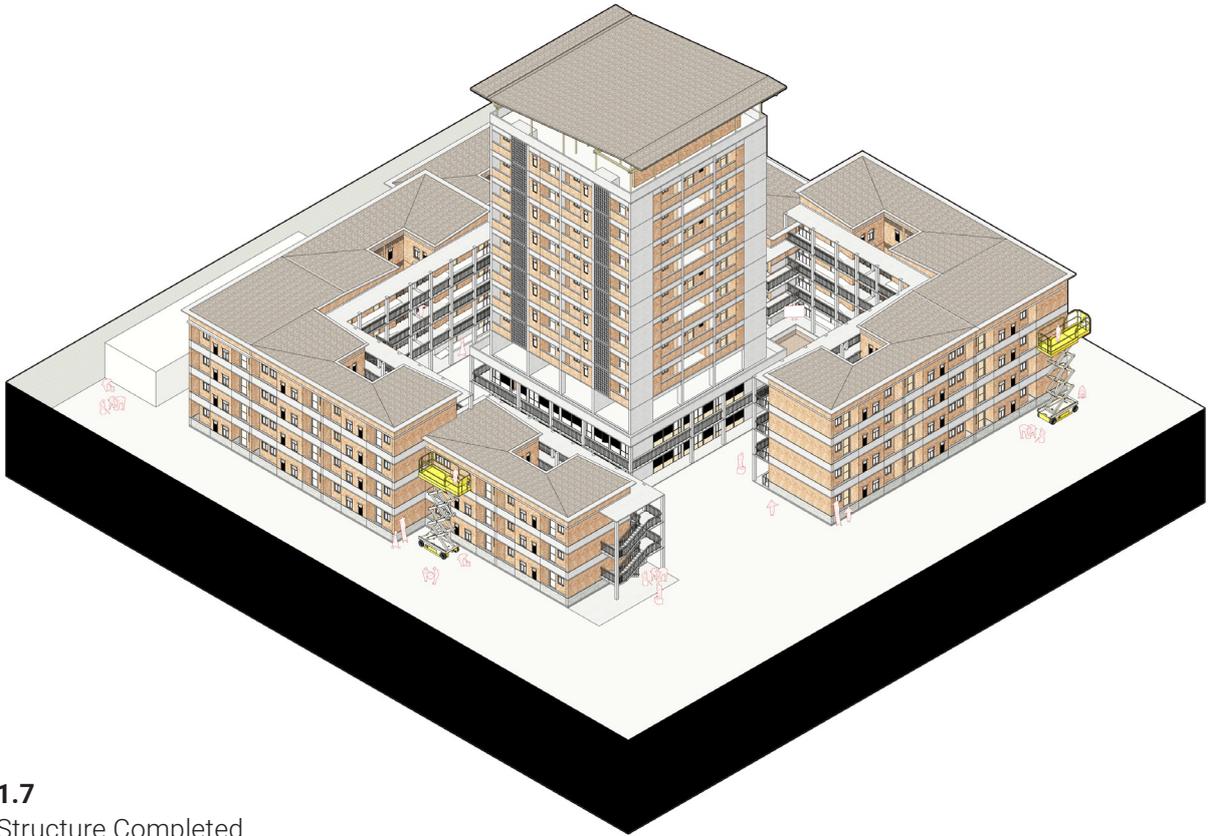
Construction Process



1.5
Excavation (low-rise)



1.6
Installation



1.7
Structure Completed

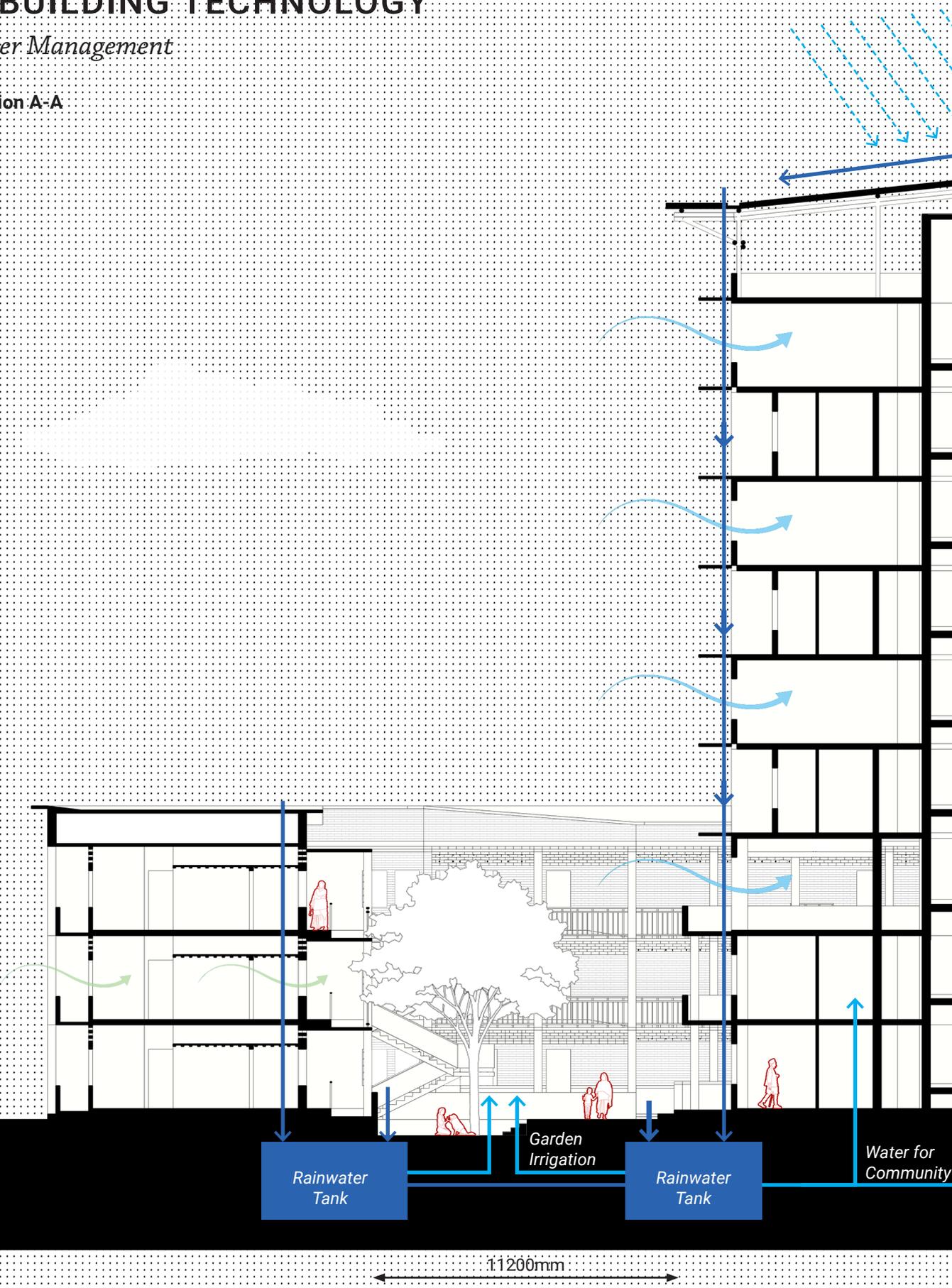


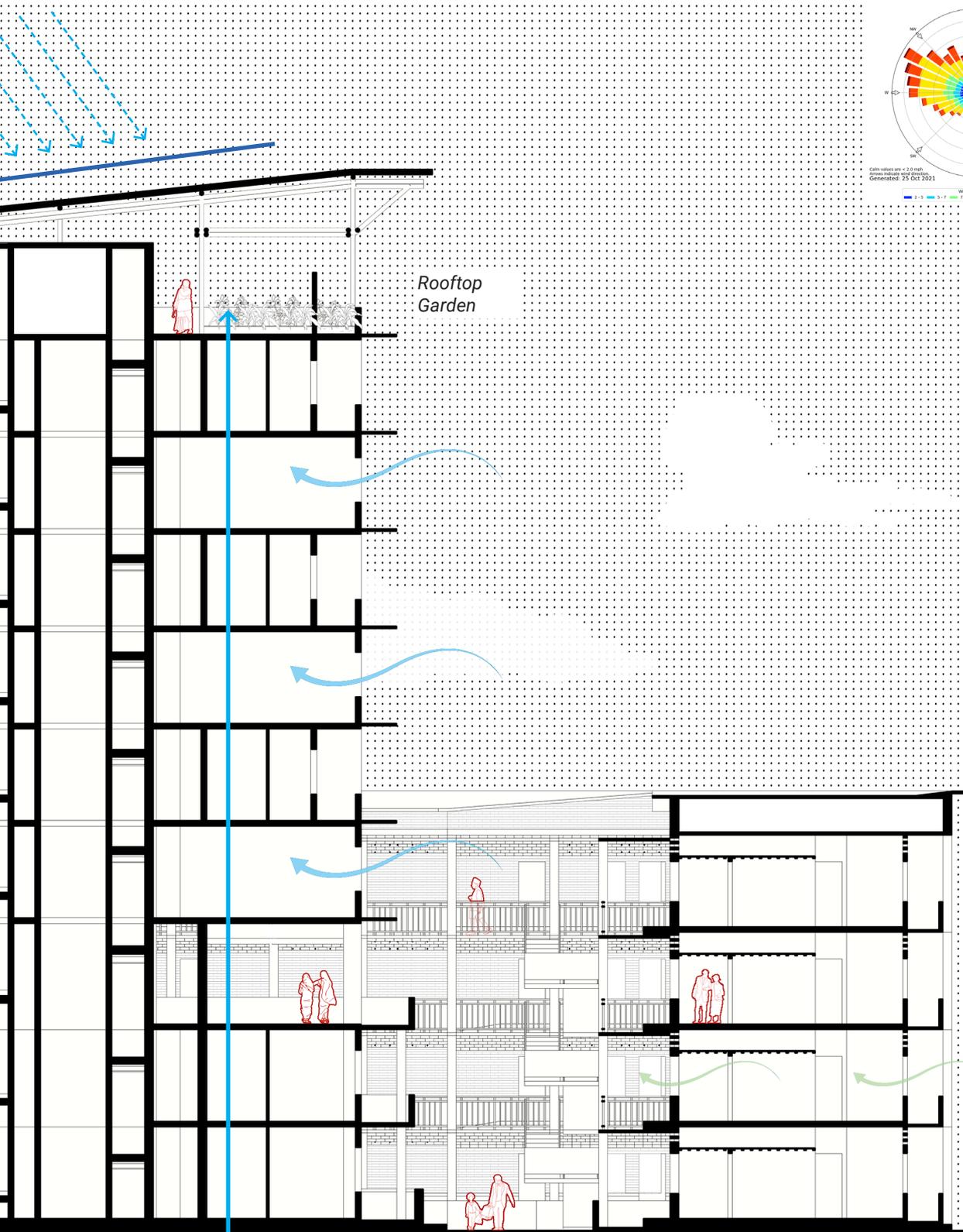
1.8
Environmental Construction

V. BUILDING TECHNOLOGY

Water Management

Section A-A



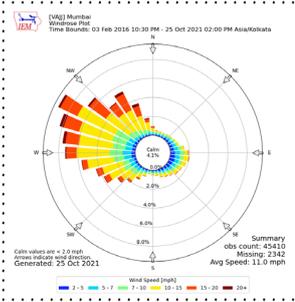


Rooftop Garden

Garden Irrigation

Toilet

6600mm



V. BUILDING TECHNOLOGY

Stakeholder Analysis



Subsidies from government enable a below-market prices from the housing to the poor.



Risk is shared between the Government and the developer.



Project can access to convenient transportation and other infrastructure, which guarantee more job opportunities and better living environment for migrant workers.



V. BUILDING TECHNOLOGY

Stakeholder Analysis

ARPHEN

Association of Rural People for Health and Educational Needs

The organisation works for the development of about 50,000 quarry workers , Tribals, Industrial workers and slum dwellers in Navi Mumbai and Mumbai. It along with net working organisational partners Facilitates the provision of basic health care and education for the community along with exciting govt support, the focus is on capacity building and empowerment of the people through groups and assisting them in developing access to basic facilities.



Bridge
Classes



H.I.V/AIDS
Awareness



Micro Insurance
and Finance



Food
Security

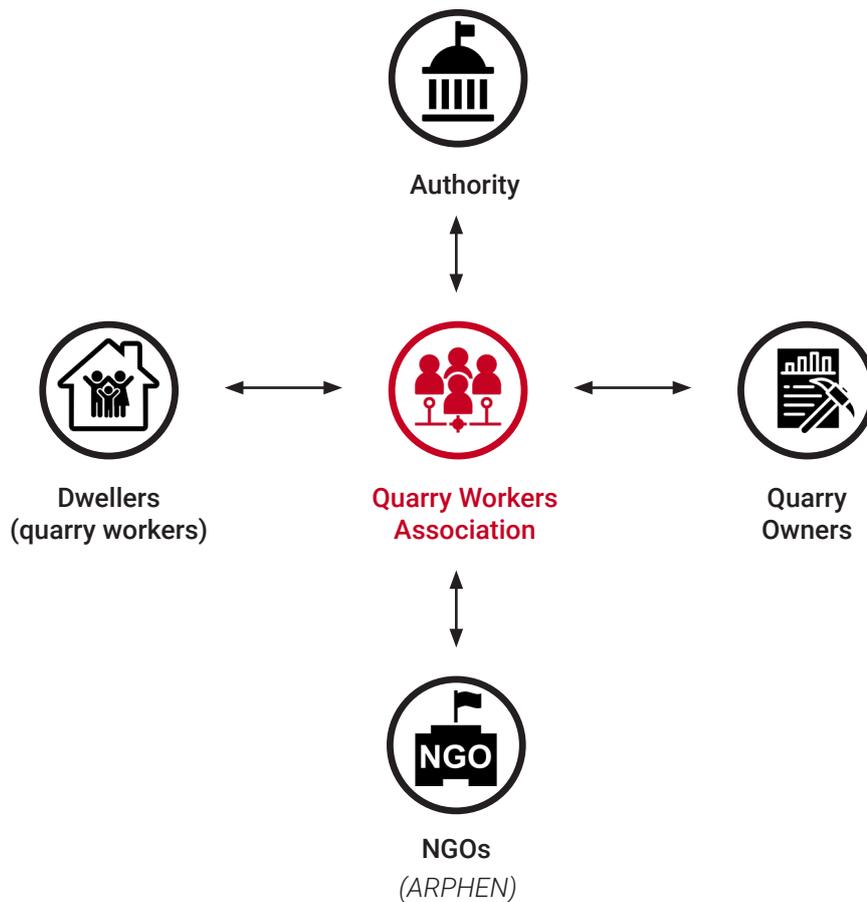
QOA

Quarry Owner's Association

Quarry Owners Association is a platform for all the quarry owners and it's stakeholders to exchange their technical knowledge & assisting each others

Existing Stakeholder in India
NGOs and QOA

Quarry Workers Association



The association will be organized by 10-15 representatives of quarry workers. It will negotiate with the government and quarry owners to express their requirements for improved living conditions. At the same time, it will work together with NGOs to run the income-generated projects.

Proposed new organization
Quarry Workers Association

V. BUILDING TECHNOLOGY

Stakeholder Analysis

Phase 0

Urban Strategies

- 1 Predetermined number of units(density)

Phase 1 & 2

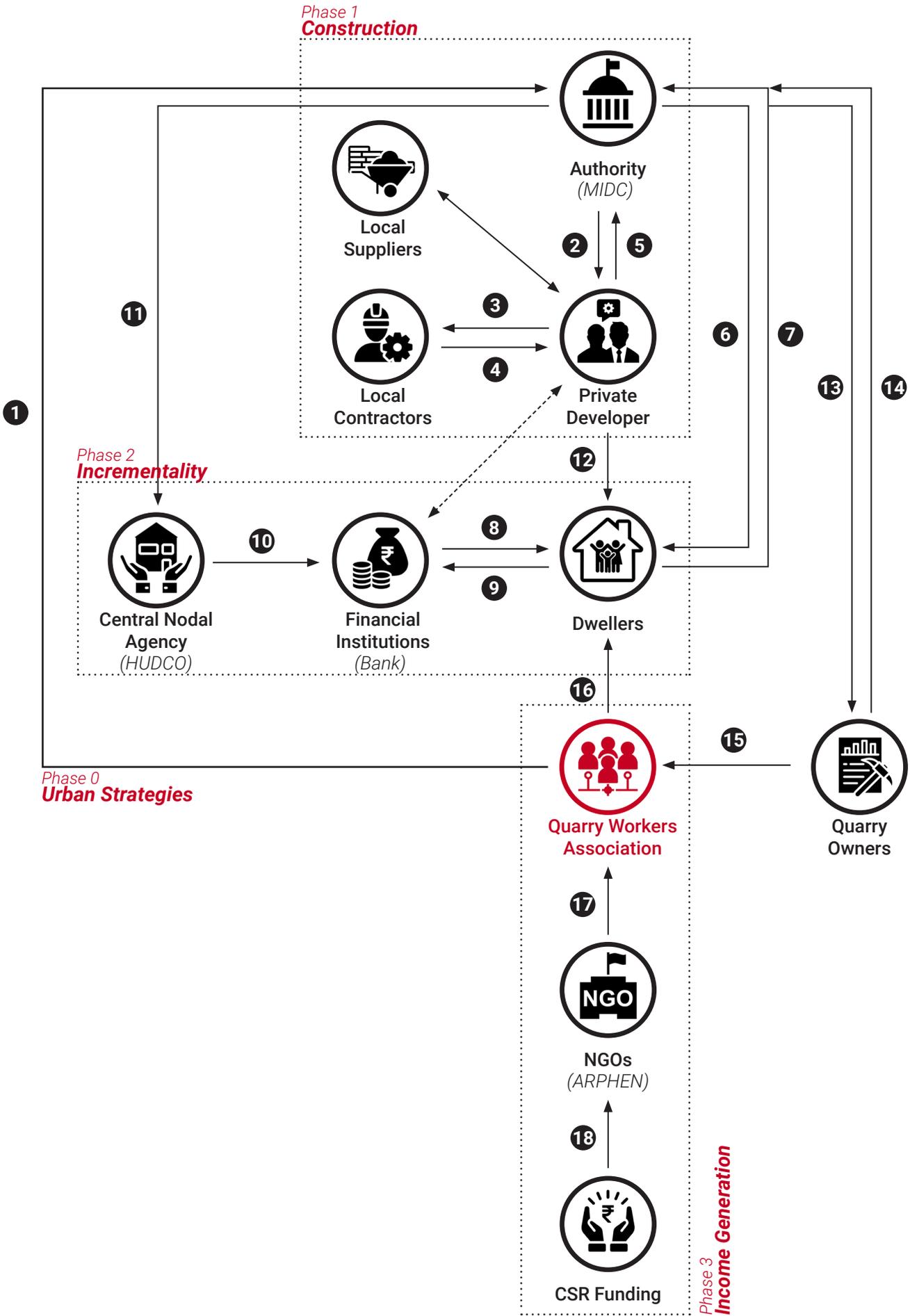
Construction & Incrementality

- 2 Call the bid & select Private Developer;
Provide land for development;
Milestone based payment (50%);
Long-term annuity for up to 10 years (50%);
- 3 Recruit local contractors for construction;
- 4 Be recruited by developer;
- 5 Design, build & finance by Private Developer;
Distribute housing units to Authority
- 6 Handover housing units under an allottee pre-identification
- 7 Pay the cost of housing unit
(lump-sum payment or equated monthly installment)
- 8 Provide subsidized loan
- 9 Pay the loan
- 10 Interest subvention
- 11 Complete ownership
- 12 Maintance
- 13 Provide accommodation to selected quarry owners to rent;
Provide subsidy/ compensation;
- 14 Pay the rental cost annually
- 15 Provide accommodation
- 16 Organize Free training;

Phase 3

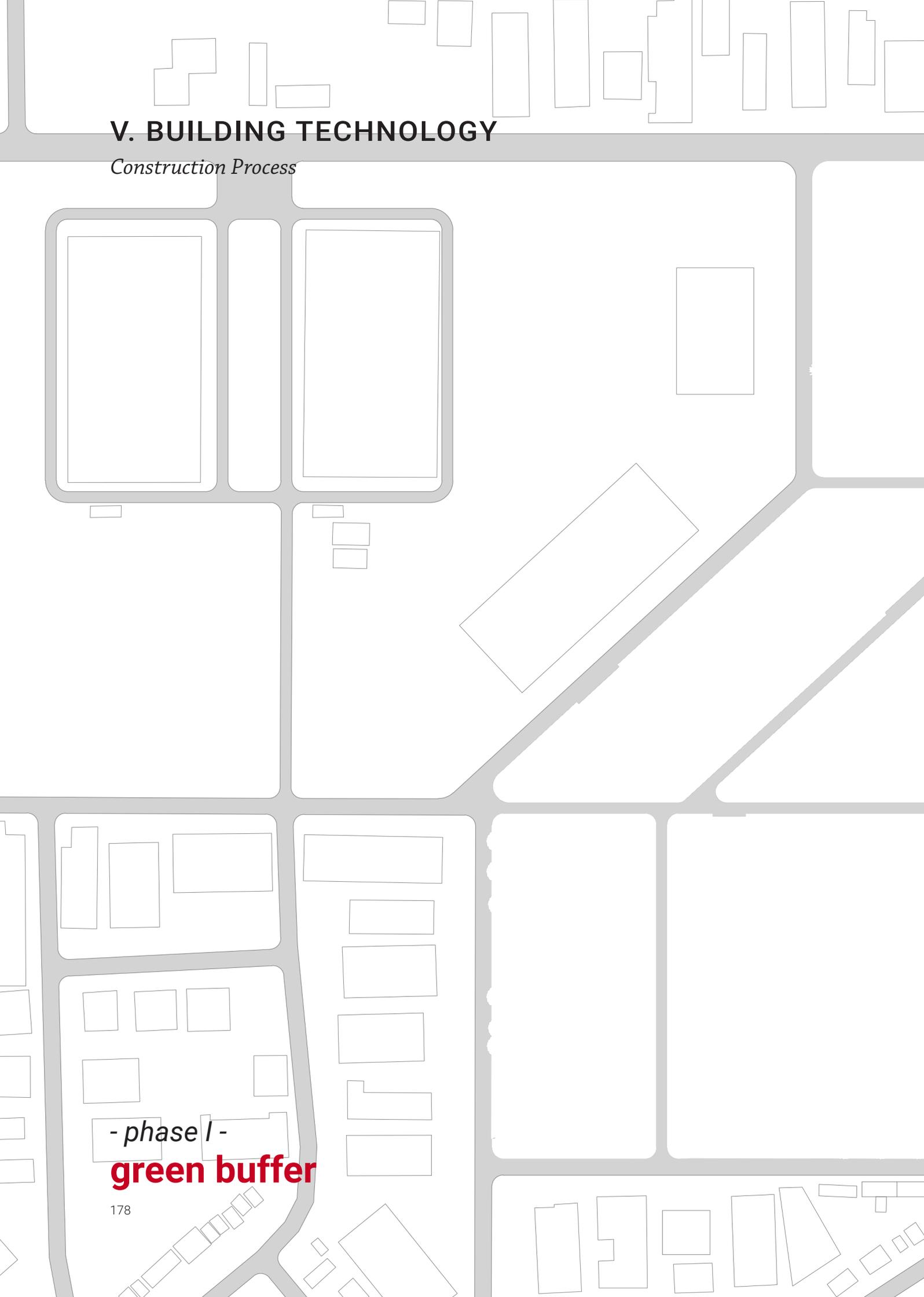
Income Generation

- 17 Organize Free training;
Pay the community workers;
- 18 Funding



V. BUILDING TECHNOLOGY

Construction Process

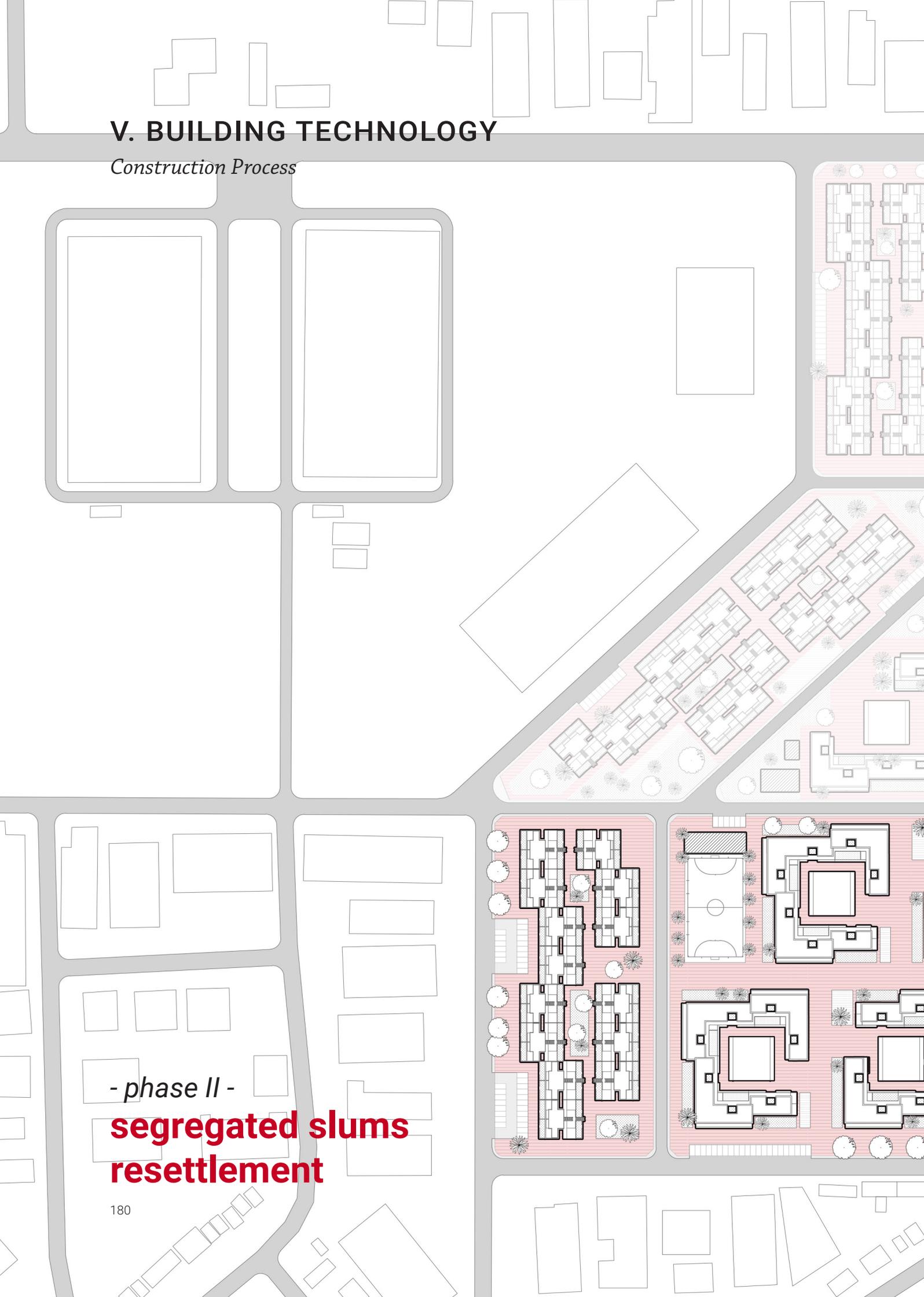


- phase I -
green buffer



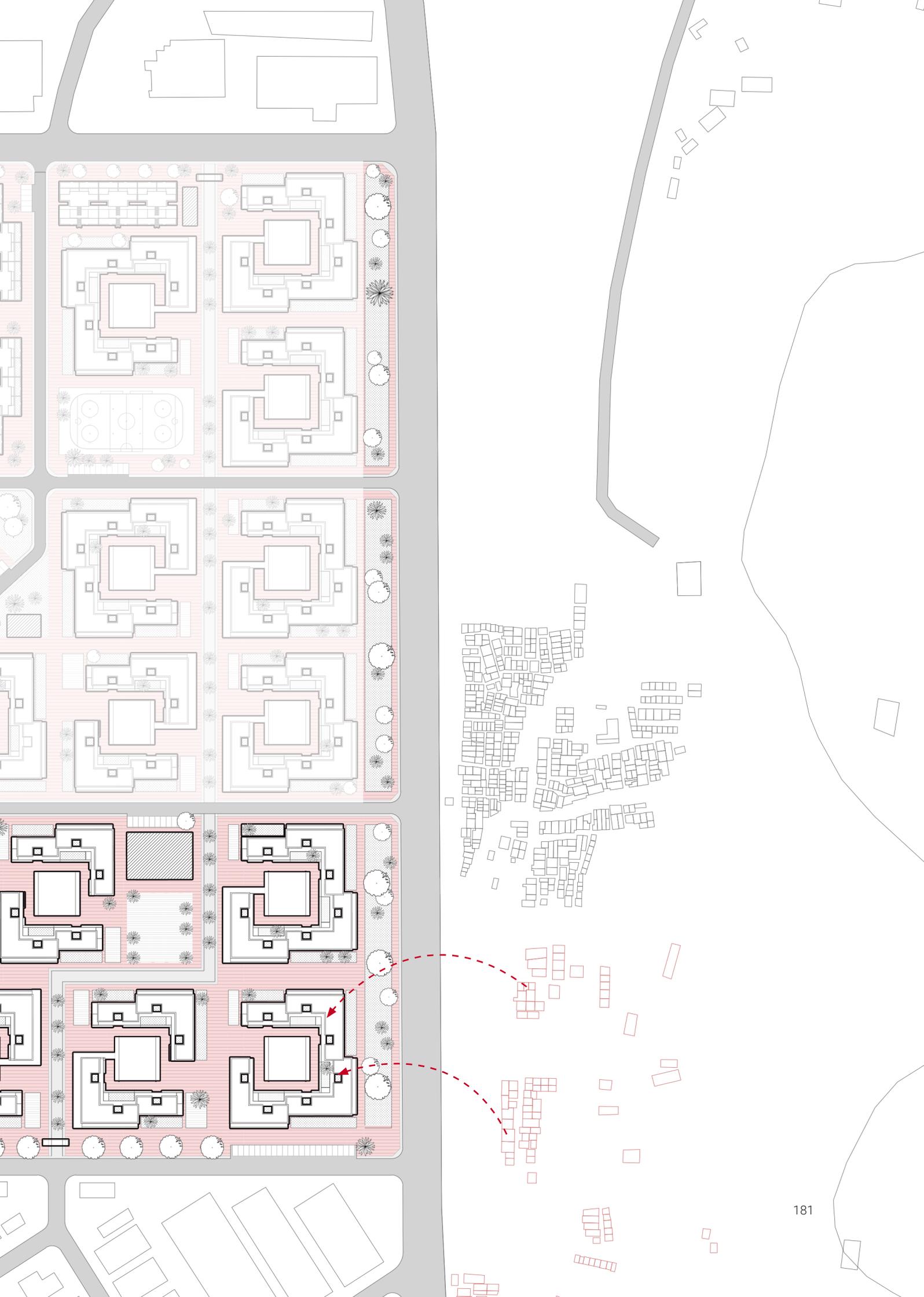
V. BUILDING TECHNOLOGY

Construction Process



- phase II -

**segregated slums
resettlement**

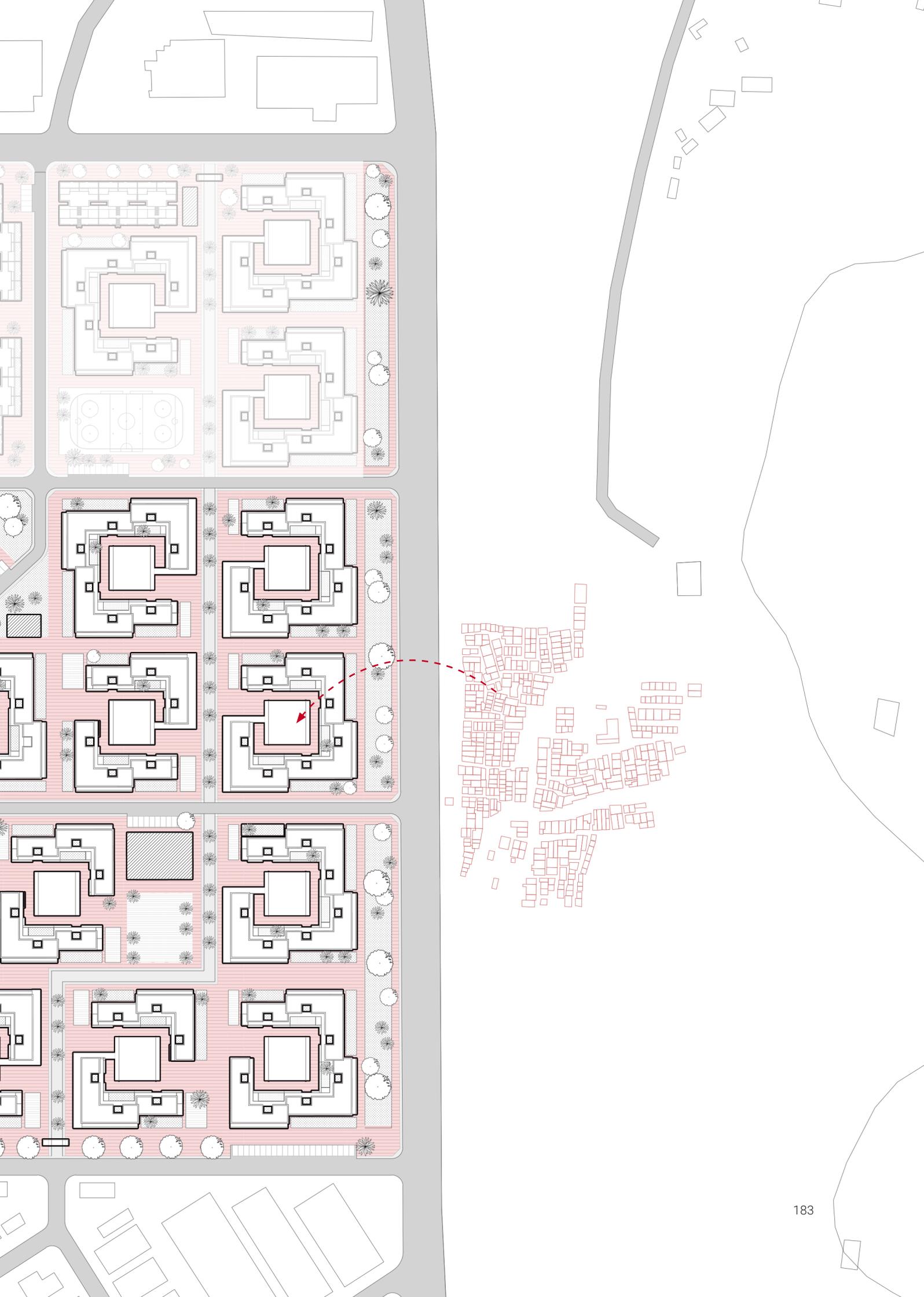


V. BUILDING TECHNOLOGY

Construction Process



- phase III -
**hotspot
resettlement**

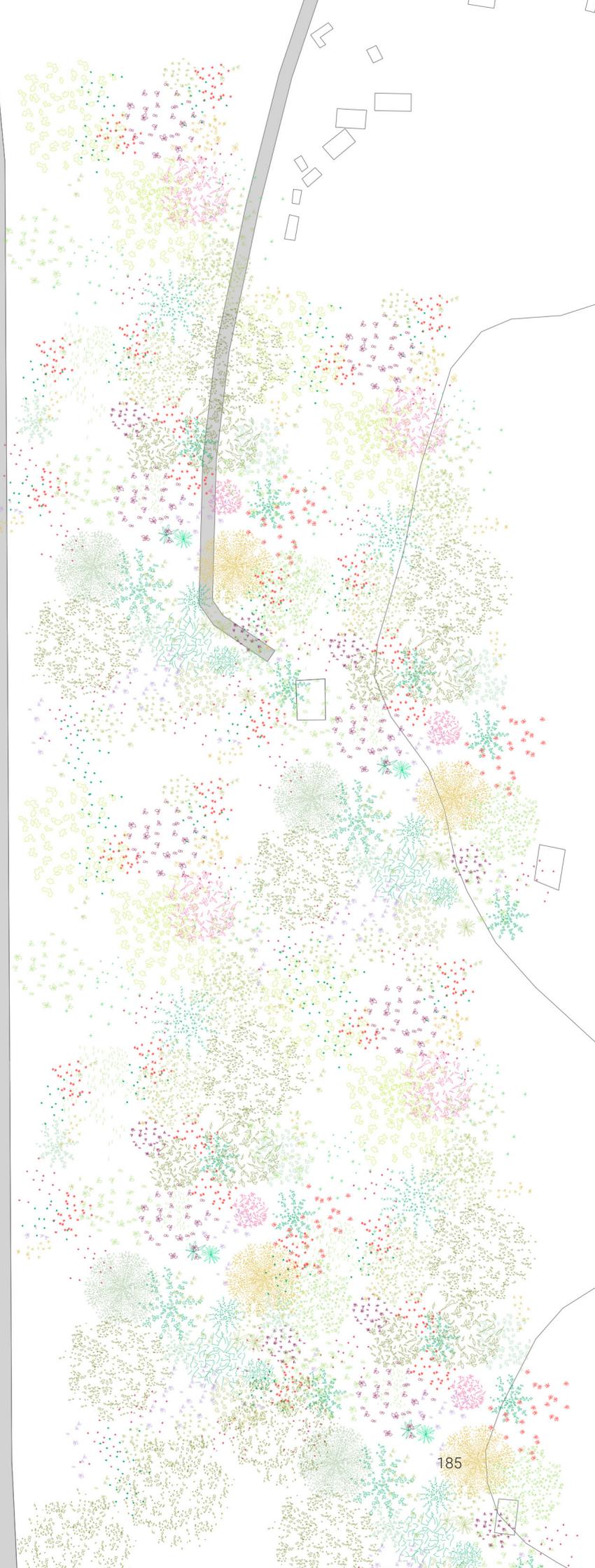
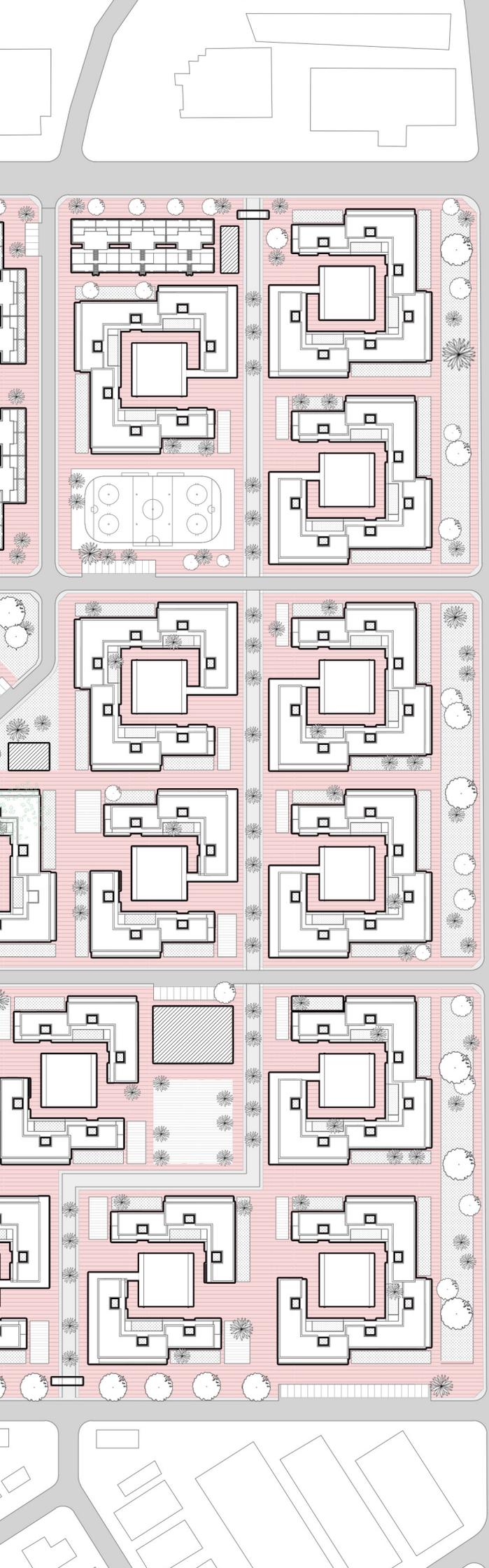


V. BUILDING TECHNOLOGY

Construction Process



- phase IV -
**ecological
restoration**







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