Informality Meets Formality

Luanda's Urban Transformation

by

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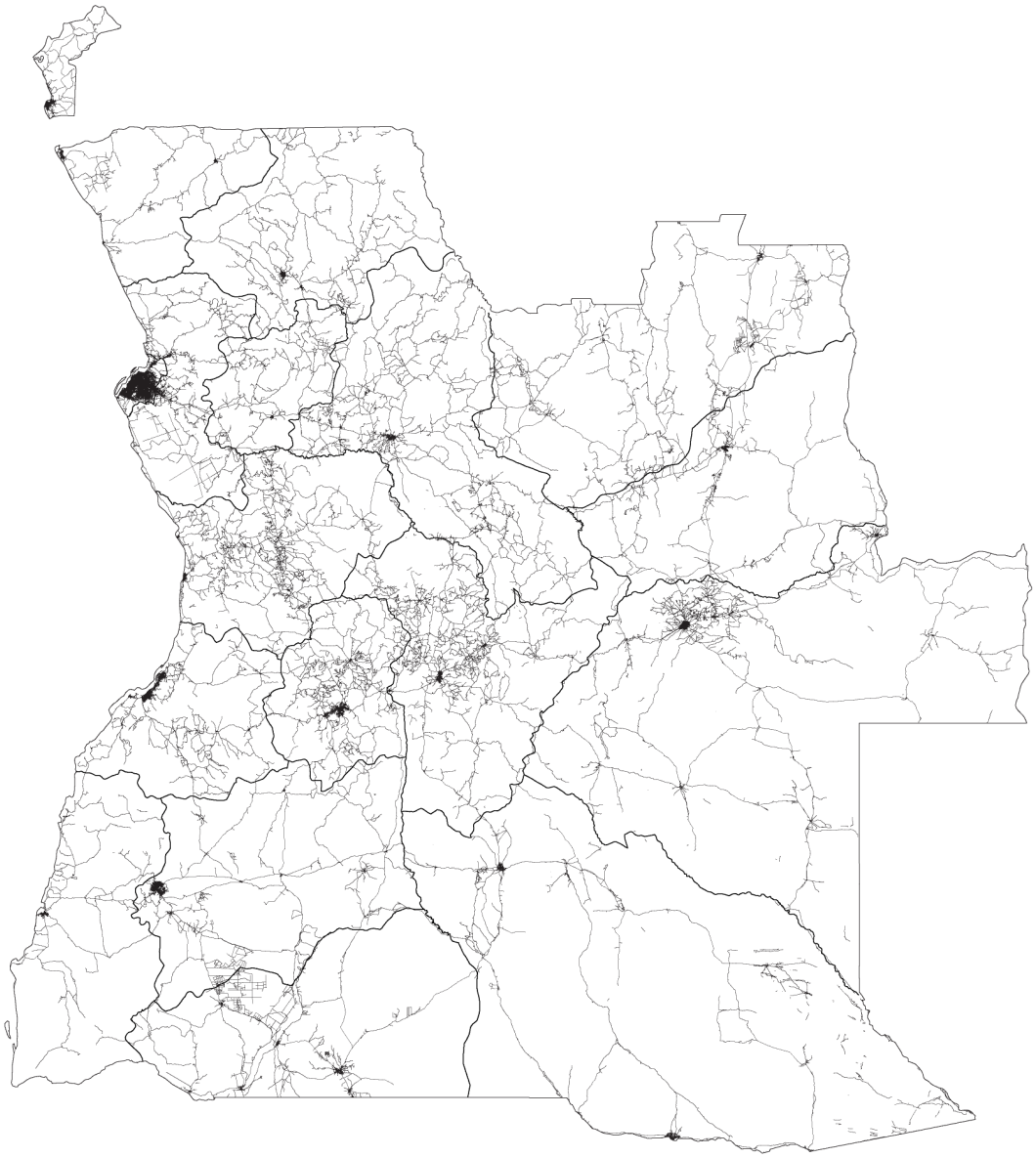

Fig 1: Angola

Abstract

Global urbanization is occurring at an unprecedented rate. While the West is mostly urbanized, the vast majority of urban growth in the next several decades will occur in Africa and Asia. In Sub-Saharan Africa, where 72% of urban dwellers already live in informal settlements, it is crucial that continued urbanization be managed with effective urban planning.

While designed for a population of 500,000, Luanda, Angola is home to 6.5 million people -- and expected to grow to 13 million by 2030. The consequences of rapid, unplanned growth are already acute. Four decades of war pushed people from rural areas into cities, while sapping the resources necessary to construct the infrastructure needed to support them. Most residents of Luanda lack basic services and title to their properties, most of which are self-built, one-story structures. In the absence of effective public transportation, the city is clogged with cars and roads are in extremely poor shape. Building on input from a range of local stakeholders, “Informality Meets Formality” offers an architectural response to the need for housing upgrades by adding density to address Luanda’s extensive slums.

Focusing on the transition from lower- to middle-class households, prototypes for low-rise, higher-density housing were developed to accommodate the evolving needs of individuals and families (e.g., flexible unit layouts, shared public space, self-building, direct street access, reduced common circulation, etc.) Drawing on case studies, built projects, and failed attempts to construct social housing in Luanda and elsewhere, the project proposes an economically and socially sustainable roadmap for the phased redevelopment of Luanda’s Cazenga district.

Acknowledgements

I would like to sincerely thank my thesis advisor, Professor Benjamin Gianni, for his continuous support and constant sharing of extensive knowledge. I am grateful to have been given the opportunity to explore this topic and for the many valuable contacts he made available to me along this journey. Over the past year I have learned more I could have wished for and he has shown me how much, and how little, can be achieved and addressed in a year's worth of research and design. This exercise in learning would not have been possible without the guidance and encouragement of Professor Gianni.

Secondly, I would like to express my deepest appreciation for the many local experts and foreign researchers that helped and supported me along the way. Special gratitude to Mr. Allan Cain, Director of Development Workshop Angola, for his ongoing support from the very beginning of this investigation and for the extensive time and resources he graciously shared. I am grateful to the Development Workshop for allowing me to use its office space and resources during my field research in Luanda. I also wish to acknowledge several individuals who played a crucial role in helping me to understand the current urban conditions in Luanda. Special thanks to Ilidio Daio, lead urban planner for GTRUCS, who guided me through several settlements in Luanda and who generously shared data -- and his extensive knowledge about the areas of focus. Thanks also to Sylvia Croese, urban sociologist and the PEAK Urban Research Officer at the African Centre for Cities, for sharing research papers and allowing me to join on several research trips to Luanda's periphery; Antonio Frank, lecturer at The Hague University of Applied

Sciences, for spending just over a week sharing information while also acting as translator during site visits. Lastly, I would like to thank everyone who contributed from close or from afar to the development and production of this thesis.

This thesis is the culmination of over ten months of research, comprising fieldwork, a review of literature, and extensive design work. Although acting alone in the development of this thesis, I had the privilege of working alongside local stakeholders in Luanda, Angola and a fellow thesis student: Etai Atias. Working on separate sites within the same municipality, Mr. Atias and I developed related and complementary thesis projects working with the same advisor. As Mr. Atias and I were in contact with the same local groups and individuals as well as having travelled together to Angola to undertake fieldwork, the larger frameworks of our projects will be substantially the same. Working collaboratively on aspects of the project has afforded both of us a better understanding of issues at play and has contributed to the development of our respective proposals.

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List of Terms

Slum:

UN-HABITAT defines a slum household as a group of individuals living under the same roof in an urban area who lack one or more of the following:

- Durable housing of a permanent nature that protects against extreme climate conditions.
- Sufficient living space which means not more than three people sharing the same room.
- Easy access to safe water in sufficient amounts at an affordable price.
- Access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people.
- Security of tenure that prevents forced evictions.[1]

"The word 'slum' often can carry derogatory connotations, as well as suggest that a settlement needs replacement through legitimatized eviction of its residents. It is a difficult term to avoid, however, for many reasons. First, some networks of neighbourhood organizations choose to identify themselves with a positive use of the term, mainly to neutralize these negative connotations. Second, the only global estimates for housing deficiencies, collected by the United Nations, are for what they term 'slums. And third, in some nations, there are advantages for residents of informal settlements if their settlement is recognized officially as a 'slum'; indeed, the residents may lobby to get their settlement classified as a 'notified slum'."[2]

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1 UN Habitat. The State of the Worlds Cities 2006/2007: Globalization and Urban Culture. London: Earthscan, 2004.

2 Cain, Allan. "African Urban Fantasies: Past Lessons and Emerging Realities." Environ ment and Urbanization 26, no. 2 (2014): 561-67. http://dw.angonet.org/sites/default/files/online_lib_files/Cain - African urban fantasies past lessons and emerging realities - E&U April 2014.pdf.

Informal Settlement:

The *Organization for Economic Co-Operation and Development* defines informal settlements as being:

- Areas where groups of housing units have been constructed on land to which the occupants have no legal claim, or occupy illegally.
- Unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing).[3]

The terms "slum" and "informal settlement" are frequently used interchangeably. And, although slum carries negative connotation, both terms are used quasi interchangeably throughout this thesis as all definitions apply directly to the case studies and sites discussed. In addition, the word ***Musseque***, the local Portuguese word used to refer to slums or informal settlements, may be used to describe local conditions and/or in citations.

Urbanization:

- The quality or state of being urbanized or the process of becoming urbanized

  Urbanize:

  - To cause to take on urban characteristics
  - To import an urban way of life to

    Urban:

    - Of, relating to, characteristics of, or constituting a city[4]

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3 OECD Statistics Directorate. OECD Glossary of Statistical Terms - Informal Settlements Definition. Accessed March 26, 2019. https://stats.oecd.org/glossary/detail.asp?ID=1351.

4 "Urbanization." Merriam-Webster. Accessed March 26, 2019. https://www.merriam-webster.com/dictionary/urbanization.

Self-build:

- A way of building your house yourself.[5]

Self-building is a common practice among residents of informal settlements. Among other things, it enables residents to expand their dwellings as households grow and/or economic circumstances change.

Tenure:

- Being the legal owner of land, a job, or an official public position, or the period of time during which you own it.[6]

Chain Migration:

In Doug Saunders's book *Arrival City,* chain migration is described as:

- "An activity that "moves sets of related individuals or households from one place to another via a set of social arrangements in which people at the destination provide aid, information and encouragement to new migrants""[7]

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5 "SELF-BUILD | Meaning in the Cambridge English Dictionary." Cambridge Dictionary. Accessed March 26, 2019. https://dictionary.cambridge.org/dictionary/english/self-build.

6 "TENURE | Meaning in the Cambridge English Dictionary." Cambridge Dictionary. Accessed March 26, 2019. https://dictionary.cambridge.org/dictionary/english/tenure.

7 Saunders, Doug. Arrival City: The Final Migration and Our next World. Toronto: Vintage Canada, 2011. P.46

Transit camp:

- A place where refugees stay in tents or other temporary structures when they have nowhere to live permanently[8]

The term *transit camp* is used to describe places to which residents are temporarily relocated to facilitate slum redevelopment. Transit camps can be disadvantageous to the people displaced as, often times, they are subjected to equally poor living conditions for much longer than expected (sometimes permanently) in unfavorable locations.

FSI:

- FSI, which stands for Floor Space Index, describes the ratio between the gross floor area of building on a lot or given site to the area of the site in question. An FSI of 1, for example, means that the entire site has been built out at the equivalent of one story (or half the site has been built out at two stories, etc.). It is also known as Floor Area Ratio (FAR).

UPA (UPH):

- The measure describes number of residential units per acre or hectare of land (UPH or UPA). It is a measure of residential density. It is normally applied to residential areas of cities.

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8 "Transit Camp." Cambridge Dictionary. Accessed March 26, 2019. https://dictionary.cambridge.org/dictionary/english/transit-camp.

PPA (PPH):

- The measure describes the number people living and working on a given acre or hectare of land (PPA or PPH). It is measure of overall density, not just residential density. It is normally applied to mixed-use areas of cities and to commercial centers.[9]

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9 Gianni, Benjamin. "Introduction to Urbanization." Interview. November 6, 2018. The abbreviations used to define urban densities (FSI, UPA, and PPA) were all explained during this interview.

1. Introduction

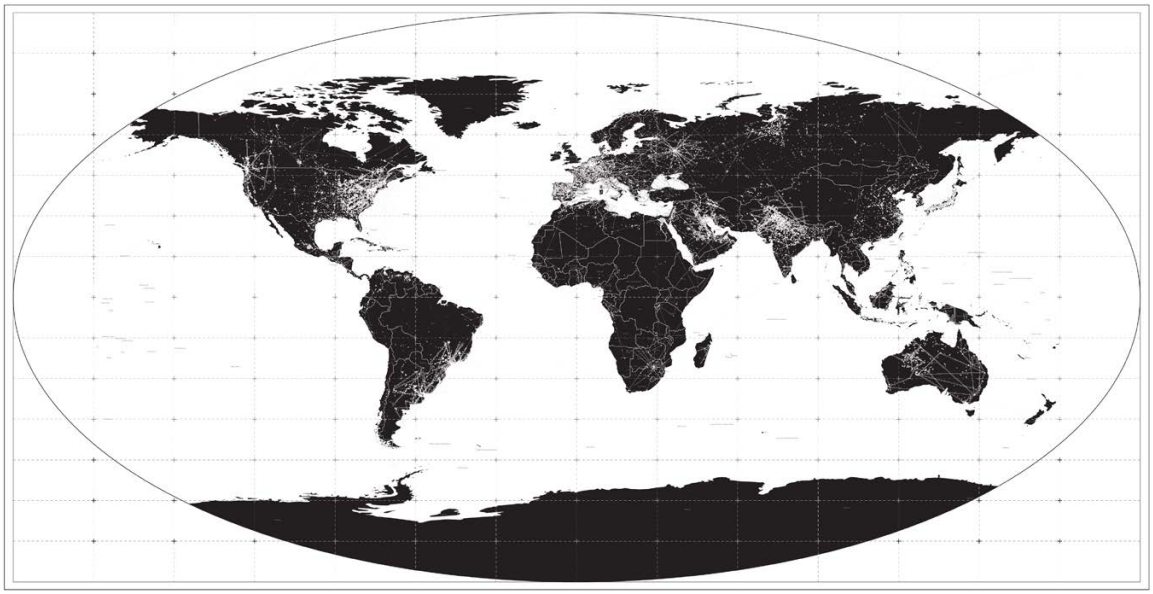

Fig 2: World map; major urbanized areas.

Cities across the globe are facing the challenges of rapid urbanization. Fueled by the search for better opportunities and living conditions – be it fleeing poverty, or escaping climate-change-induced droughts or floodings – millions of people are being pushed out of the rural areas and pulled into cities. Experts estimate that 60% or the world's population will be living in urban centers by 2030,[10] an increase of about 10% -- or some 800 million people -- over the next decade. As the bulk of this rural-to-urban migration will be occurring in the most populated and least urbanized areas of the world, namely Asia and Africa, cities in these regions are facing significant challenges. Local governments will be called upon to provide roads, public

10 "UN-Habitat at a Glance" I Data. Accessed January 06, 2019. https://unhabitat.org/un-habitat-at-a-glance/

transit, water, sanitation, electricity and most pressingly, proper housing. Managed poorly, this rapid growth will contribute to the proliferation of informal settlements, bringing with it a set of deeper health and social challenges.

With an urbanization level of only 39.5%, Sub-Saharan Africa will be the stage for the largest and most rapid urban migration the world has yet to witness.[11] It is estimated that 55% of the urban population in this region already lives in some form of informal settlement,[12] primarily on the periphery of large cities. And with GDPs thirteen times lower than that of North America and a population about three times the size,[13] Sub-Saharan Africa will be facing massive challenges with respect to urban planning and the provision of housing.

Informal settlements are growing at an unprecedented rate in rapidly urbanizing areas of the world. There is a recognized global need to head off additional settlements (e.g., by staying ahead of the curve with respect to the provision of housing and infrastructure), to retrofit and/or redevelop existing slums, and to regularize land tenure. Many redevelopment projects have been conducted with little understanding of, or consideration for, the existing socio-economic fabric of slums, and redevelopment efforts disrupt the networks that are key to the integration

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11 "Urban Population (% of Total)." Data. Accessed March 27, 2019. https://data.worldbank.org/indicator/sp.urb.totl.in.zs?view=map.

12 "Population living in slums (% of urban population)" | Data. Accessed January 06, 2019. https://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS

13 "GDP (current US$)" | Data. Accessed January 06, 2019. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

of rural-to-urban migrants. Many informal settlements are, in effect, transitory networks in which migrants begin the transition from poverty to middle class. They are places through which new arrivals move – after establishing a foothold in the urban economy – both formal and informal. And, despite the poor quality of construction and an acute lack of services, these settlements have been largely successful in helping slum dwellers make this transition.

Any resettlement/redevelopment effort must recognize and respect the social and economic networks of slums. As highlighted in Doug Saunders's book *Arrival City* and Jean-Nicolas Orhon's documentary *Slums: Cities of Tomorrow*, the informal networks – physical, social and economic -- that operate on the periphery of virtually every large city in Asia, Africa and South America should not be viewed as a problem but rather as a solution to the lack of affordable and accessible urban housing, among other things.[14] Both Saunders and Orhon explore the processes that trigger mass migrations of people into cities and, while keeping the human element at the forefront, explore the tragedies and successes that occur within the informal urban fabric. They document systems and strategies used by residents, they reveal layers of important social interactions and hierarchies, and they shed light on how people survive in the informal city. In a similar vein, this thesis attempts to identify and respect the social and economic frameworks at work in the extensive informal settlements of Luanda, Angola as it attempts to define a template for their redevelopment. The goal is to regularize and improve the urban

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14 Orhon, Jean-Nicolas. *Slums Cities of Tomorrow* - Directed by Jean-Nicolas Orhon. 2018

fabric without disrupting the social and economic networks that facilitate rural-to-urban integration.

Through an extensive, two-pronged research approach involving a review of literature (books, journals, articles, precedents, case studies, etc.) in tandem with on-site field research, I've attempted to understand both the global proliferation of informal settlements and the specific historical, social and economic realities of post-war Luanda, Angola, which is the site of the project. In proposing alternatives to the existing, largely informally-built fabric of Luanda's Cazenga District, I've attempted to identify and understand the layers of systems that undergird the lives of its residents. The work builds off of Claudia Gastrow's premise that "quotidian notions of citizenship are mediated through the material and aesthetic worlds of slum housing construction, more specifically the cement-block house. It draws on theories that understand *citizenship* and *belonging* not simply as juridical categories but more substantively produced through shared imaginations and symbolic worlds."[15] Referring to Luanda in her article *Cement Citizens: Housing, Demolition and Political Belonging in Luanda, Angola,* Dr. Gastrow – an American anthropologist working in South Africa[16] – explores the sense of citizenship among slum dwellers in Angola and describes how urban development alienates and disrupts the lives of residents. Expanding on this, while working hand-in-hand with local stakeholders, this thesis attempts to identify key elements

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15 Gastrow, Claudia. "Cement Citizens: Housing, Demolition and Political Belonging in Luanda, Angola." Citizenship Studies 21 (2). Routledge. 2017. 1.

16 Ibid.

of the informal settlements that can be carried over into redevelopment efforts. The goals include increasing the quantity and quality of affordable housing, regularizing the urban fabric, augmenting access to infrastructure and services, addressing safety, and regularizing land tenure while respecting exiting social networks and informal economies – and supporting the transition towards middle class over time.

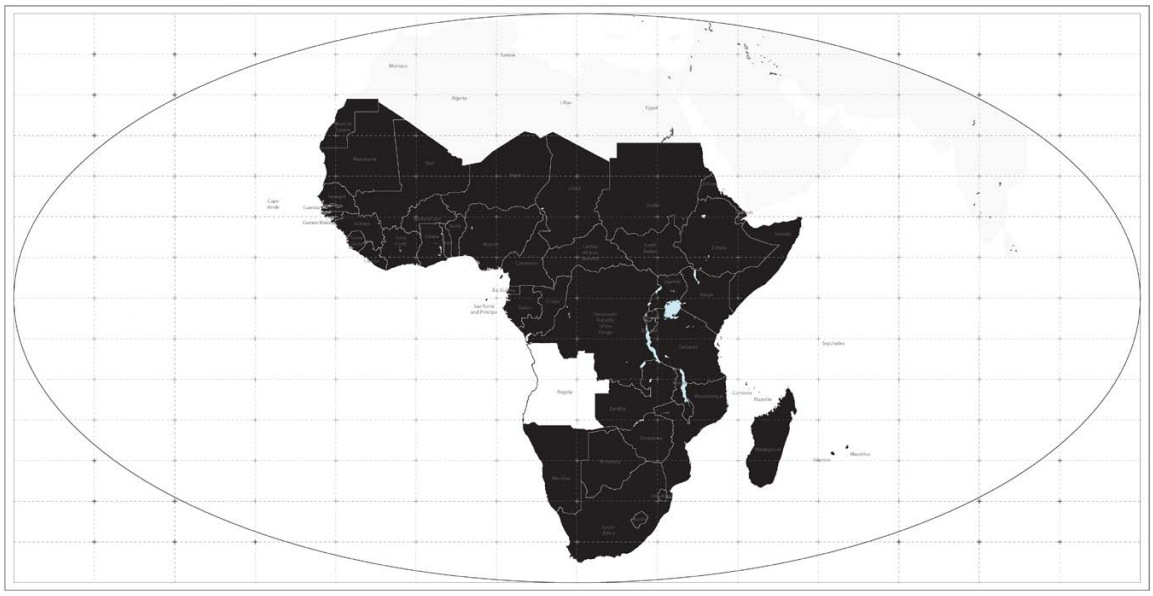

Fig 3: Map of Sub-Saharan Africa.

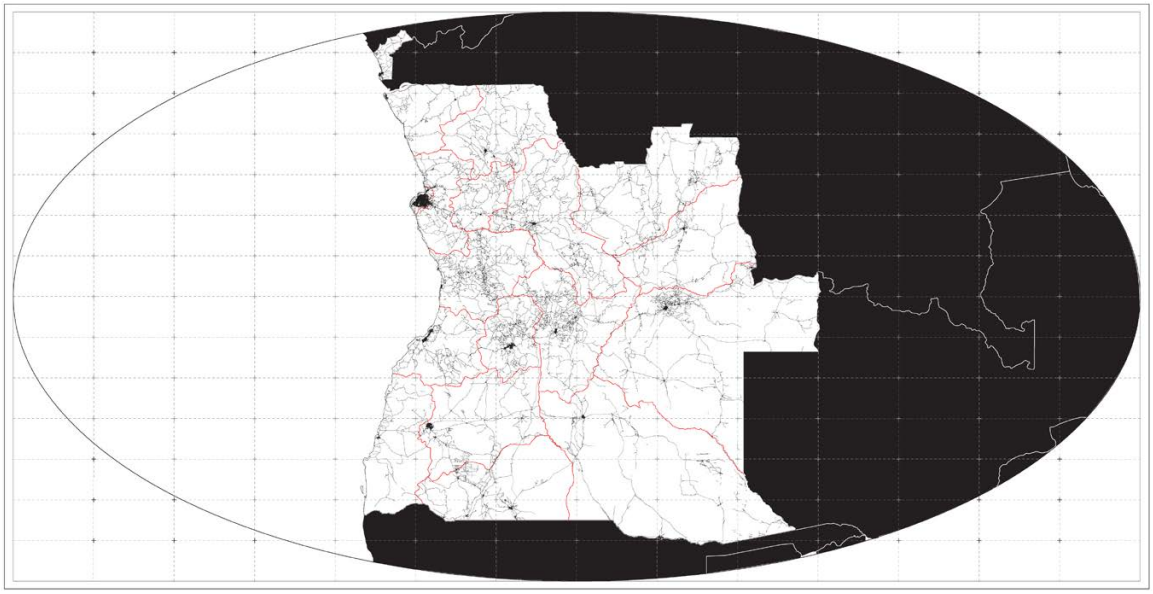

Fig 4: Map of Angola.

2. Background

In his 2010 book, *Arrival City,* Doug Saunders examines the world of slums and shantytowns. He presents an uncharacteristically eloquent and optimistic portrait of this demi-monde, as well of that of its main actor – the slum dweller. Saunders investigates the phenomena of mass migration and rapid urbanization, documenting the transition from lower- to middle-class status that is the basis on which many individuals and families embark on the often-perilous journey towards becoming urban dwellers. Saunders unveils the layers of social interactions that make these fringe worlds "kilns of reverberating energy and optimism."[17] Known variously as slums, favelas, bustees, bidonvilles, musseques, ashwaiyyat, shantytowns, kampongs, urban villages, villages in cities (VICs), gecekondular, and barrios in the developing world, or as immigrant neighborhoods, ethnic districts, banlieues difficiles, Plattenbau developments, Chinatowns, Little India's or Hispanic quarters in the west, Saunders argues that the term "arrival city" is a more accurate term than slums for these neighborhoods.[18] As people migrate from rural to urban areas in an effort to improve their situation, these "arrival cities" play a crucial role in mediating between these two worlds.

Indeed, the predominantly hard-working dwellers of the Arrival City benefit both rural areas and urban centres – contributing to the urban economy while sending money back to and maintaining close social ties

17 Saunders, Doug. *Arrival City: The Final Migration and Our next World*. Toronto: Vintage Canada, 2011.

18 Ibid.

with the areas from which they've come. Saunders argues that we should not view informal settlements (only) as problems to be solved but as dynamic solutions to the complex phenomena of urbanization. When considering slum upgrades or redevelopment, then, we must be cognizant of addressing the physical and infrastructural deficiencies without compromising the important social and economic functions these neighborhoods accommodate. By displacing people, disrupting social networks and limiting the range of activities these communities support, we risk trading one set of problems for another, e.g., transforming the informal settlement into a ghetto.

Fig 5: Luanda's extensive slums.

Angola

Historical Context:

Emerging from two devastating wars in the early 2000s, Angola is now struggling with many of the challenges associated with rapid urbanization. Following a decade-long war of independence from the Portuguese (from 1961 to 1974),[19] the fragile peace quickly degenerated into a protracted civil war. From 1975 to 2002 various political factions (the MPLA, UNITA and the FNLA) battled for power and territory.[20] The effect of more than forty years of conflict – much of which played out in rural

19 Cain, Allan. "Luanda's Post-War Land Markets: Reducing Poverty by Promoting Inclusion." Urban Forum 24 (1). Luanda. August 2012. 11–31.

20 Ibid.

Angola -- was that people were pushed from rural to urban areas at a faster rate than cities could absorb them. Major cities like Luanda and Huambo became safe strongholds for the opposing parties.

With resources largely absorbed by war, governmental authorities had little capacity to deal with mass migration into cities. Informal settlements quickly formed within and around the country's urban centers. Informal communities on the periphery initially resembled refugee camps, which the government assumed would be temporary. While authorities presumed that migrants would return to the countryside after the war, this proved not to be the case. As a rule of thumb, the probability of people returning home or moving elsewhere after two years of living elsewhere due to displacement drops to about 50%.[21]

As social and economic bonds solidify, the probability further diminishes the longer that people stay.

Over the course of the protracted conflict, even established urban neighborhoods lost access to services (water, sewers, electricity, etc.) and existing fabric gave way to warrens of self-built dwellings. With the formal economy crippled and hijacked by war, informal economies took root, accounting for an ever-increasing percentage of the country's overall economy. Following the war, the Angolan government was faced with a country devastated by conflict and an unforeseen number of people living in informal settlements. Lacking in both financial resources and expertise, the country turned to the international community for support.

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21 Cain, Allan. "Introduction to Angola." Interview by author. October 08, 2018.

Fig 6: Informal housing in the city

Post-War Development

With so little planning and building having taken place in Angola between 1960 and the mid 2000s expectations for post-war reconstruction were high. Unfortunately, with the onset of wars in Iraq and Afghanistan, international focus turned to the Middle East and support from the World Bank and the international community never materialized.[22] In the same period, however, Angolans saw new hope for revenue from deep off-shore oil drilling to support rebuilding. While oil had been extracted in Angola since the 1960s, it was only after the war that foreign expertise was able

22 Cain, Allan. “Introduction to Angola.” Interview by author. October 08, 2018.

to capitalize on off-shore reserves with massive deep-water oil rigs.[23] Although the industry employed few local workers, revenue from taxes and land exploitation quickly made Angola one of the wealthiest countries in Sub-Saharan Africa. Indeed, having nationalized all land and resources,[24] the state's coffers filled quickly. Unfortunately for the ones most in need, however, this new-found wealth profited the few, as the country became among the most corrupt in the world.[25]

For all intents and purposes, then, virtually no housing has been constructed in the formal marketplace since independence. Severe shortages in housing, in turn, have led to massive price inflation, further limiting access to housing and contributing to the proliferation of informal housing in Angola. Current estimates suggest that between 70% to 90% of the country's population lives in informal housing.[26] The nationalization of land has all but eliminated private-sector incentives, leaving only the government to address shortages. And as they are not in a position to collect property taxes – a combination of government control of land and lack of formal title and tenure for the majority of residential properties – municipalities have limited revenue to support

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23 Koning, Tako, Tako Koning, and Halfdan Carstens. "Milestones in Angola's Oil History." GEO ExPro. January 21, 2014. Accessed March 27, 2019. https://www.geoexpro.com/articles/2012/10/milestones-in-angola-s-oil-history.

24 Cain, Allan. "Luanda's Post-War Land Markets: Reducing Poverty by Promoting Inclusion." Urban Forum 24 (1). Luanda. August 2012. 11–31.

25 "Angola Vows to Fight 'Cancer' of Corruption as Economy Recovers" Accessed January 06, 2019. https://www.bloomberg.com/news/articles/2018-11-22/angola-vows-to-fight-cancer-of-corruption-as-economy-recovers.

26 Cain, Allan. "Introduction to Angola." Interview by author. October 08, 2018.

investment in infrastructure. The only major foreign investor in Angola has been China,[27] promising aid to build infrastructure and housing for hundreds of thousands of Angolans. As China and its companies do not ask for the level of scrutiny as the World Bank or the United Nations, this has opened the door to corruption and poor planning policies across the country.

Angola Today

In the summer of 2018, I was introduced to the problem of informal settlements in Angola through members of the International Conference on Canadian, Chinese & African Sustainable Urbanization (ICCCASU).[28]. The opportunity presented itself to investigate slum redevelopment in Luanda as a thesis project. As an architect – and in the context of an architectural thesis – I was particularly interested in the opportunity to explore the physical aspects of slum redevelopment, namely urban structure and housing typologies, in partnership with local stakeholders and a team of researchers for whom my expertise and perspective would be complementary. Cities in Angola have recognized the need for significant changes/upgrades to their urban fabric. And, with the new government that came into power in 2017, many of those with a stake in Angola's urban transformation are optimistic that policies will be implemented to

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27 Cain, Allan. "African Urban Fantasies: Past Lessons and Emerging Realities." Environment and Urbanization 26 (2). October 2014. 561–67.

28 My thesis advisor, Benjamin Gianni and Allan Cain, Director of Development for the Development Workshop, Angola, are board members of ICCCASU.

enable the country to move forward. Policy-making, proper investment strategies, and economic partnerships coupled with appropriate architectural interventions, can put the country on the path to a better future.

While the process of chain migration has slowed in Luanda following the wars, the government is facing massive housing shortages that can only be addressed through proper policies and investment. Indeed, as the shortages have pushed housing prices ever upward (in 2018 a 1-bedroom apartment in downtown Luanda cost $1600 per month to rent – commensurate with the income of a middle-class European citizen),[29] it has become virtually impossible for residents to better their living conditions. It is important to understand that, due to nationalization after the war, less than 10% of all land in Angola has proper tenure.[30] Yet, despite this, virtually every piece of land is bought, sold and/or rented in the informal marketplace.[31] It's also estimated that 54% of the country's population lives off informal economies, partially due to the fact that they do not figure within the formal framework of the city (they pay neither income nor property taxes, nor do they appear on formal enumeration lists).

In support of orderly and sustainable urban redevelopment and added density, the Development Workshop Angola is working with numerous local and international partners to leverage local experience and take account of

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29 "Cost of Living in Luanda.". Prices in Brazil. Updated May 2018. Accessed January 06, 2019. https://www.numbeo.com/cost-of-living/in/Luanda?displayCurrency=CAD.

30 Cain, Allan. "Luanda's Post-War Land Markets: Reducing Poverty by Promoting Inclusion." Urban Forum 24 (1). Luanda. August 2012. 11–31.

31 Cain, Allan. "Introduction to Angola." Interview by author. October 08, 2018.

Fig 7: Life in Onze de Novembro

current realities, in order to address the surfeit of informal developments and lack of municipal infrastructure in Luanda and elsewhere. By partnering with DW Angola and its affiliates, this thesis aims to identify appropriate housing types and urban strategies that work hand-in-hand with effective redevelopment policies.

Fig 8: GIS map of Luanda

Luanda

Overview

Initially laid out to accommodate a population of 500 000, Luanda, Angola, is now home to more than 6.5 million residents,[32] over 70% of which live in informal settlements. Expected to grow to more than 13 million people by 2030,[33] the consequences of urban growth and mass migration will be devastating in the absence of effective urban planning and proper implementation of growth strategies. As the country's capital and largest city, Luanda is at the centre of focus for future developments in Angola;

32 Gastrow, Claudia. "Cement Citizens: Housing, Demolition and Political Belonging in Luanda, Angola." Citizenship Studies 21 (2). Routledge. 2017. 1.

33 Broadway Malyan, "Metropolitan Plan for Luanda - Vol1 Vision & Strategies 1-49," March 9, 2018, 1–49.

what happens in Luanda will set the tone for the future of the country as a whole. There is widespread consensus among government officials and community stakeholders on the need for investment in infrastructure and urban renewal. The question is how best to achieve this over time. None of the high-profile housing projects undertaken in Luanda over the past two decades has done much to alleviate housing shortages or address affordability. Lacking both in funds and expertise, none of these projects seems to offer much promise as a way forward.[34]

Current and Ongoing Efforts

The past decade has seen both small-scale, localized urban interventions and ambitious, large scale master plans commissioned for Luanda. While none of the master plans has been implemented, several local redevelopment projects have been either partially or fully realized. These first efforts towards infrastructure upgrading were aimed at cleaning up the core and relocating people to areas on the periphery known as "rehousing zones." Others, known as "Satellite cities," consist of large-scale ensembles of multi-unit buildings far outside the urban core, constructed to alleviate housing shortages in the city. While a variety of these initiatives were executed under the aegis of government agencies and private companies, they were never part of a broader urban vision. Claudia Gastrow notes that "What united these projects… was not any single plan or institution but an aesthetic imaginary of what the new city should look like."[35]

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34 Buire, Dr Chloé. "Views of Suburban Luanda: The Move from an Informal Settlement to Social Housing," August 2015, 1–3.

35 Gastrow, Claudia. "Cement Citizens: Housing, Demolition and Political Belonging in Luanda, Angola." Citizenship Studies 21 (2). Routledge. 2017. 1.

Fig 9: Zango housing project

Rehousing Zones - Zango

The Zango housing project (see figure 9) is one of the largest rehousing zones on the periphery of Luanda. Located about 40km outside the city center, this multi-phase development is one of a number of housing projects including Panguila, Sapú and Projecto Morar into which residents were relocated.[36] Comprised of approximately 36 300 homes, Zango was constructed to rehouse residents displaced from areas that Luandan authorities identified as 'high risk.'[37] Mainly, these 'high risk' areas were targeted due to lack of infrastructure and for their proximity to the urban core.

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36 Gastrow, Claudia. "Zango: Plans Unravel." UrbanAfrica.Net. April 01, 2014. Accessed March 27, 2019. https://www.urbanafrica.net/news/zango-plans-unravel/.

37 Ibid.

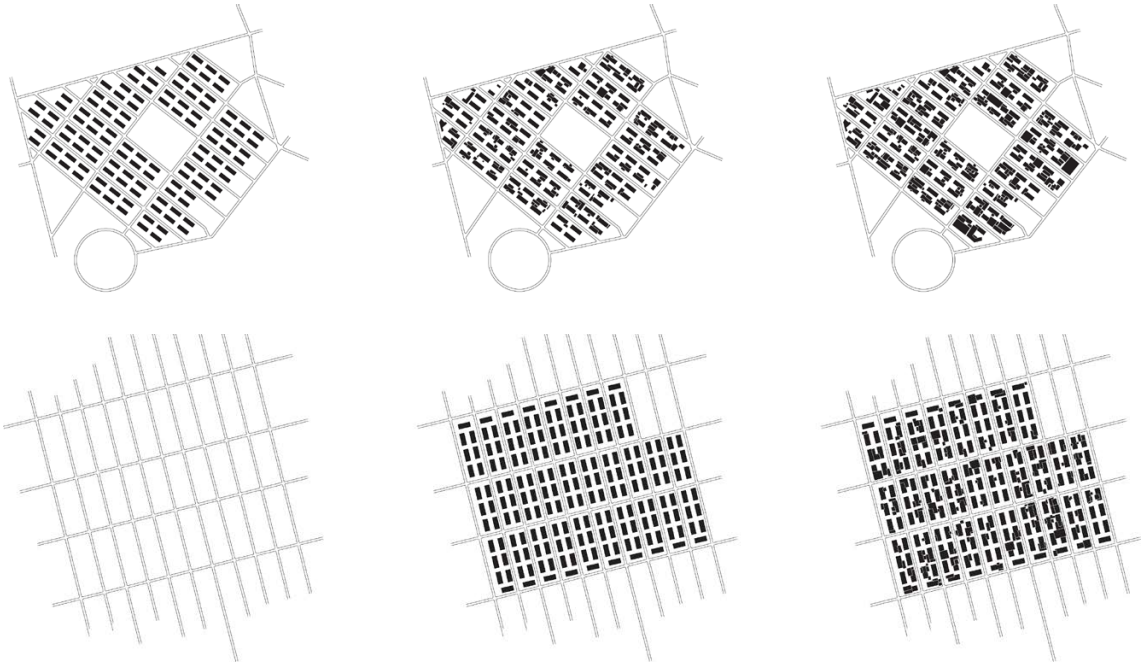


Fig 10: Urban Growth across time in Zango

Built by the state, some homes are sold while others are managed as rental housing. Unfortunately, the government has found it necessary to provide ongoing rent subsidies to facilitate the transition to affordable living outside of the urban centre, placing further financial burdens on the project.[38] While the plan involved giving ownership to Zango's residents when they took possession, only a few have received legal title documents. Yet, the selling and renting of these properties at market value (illegally) is a regular occurrence.[39] Over time, some of these areas have given rise to a new form of informality as people have starting adding to their properties without any guiding framework (see figure 10).

38 Gastrow, Claudia. "Zango: Plans Unravel." UrbanAfrica.Net. April 01, 2014. Accessed March 27, 2019. https://www.urbanafrica.net/news/zango-plans-unravel/.

39 Ibid.

Fig 11: Kilamba

Satellite Cities - Kilamba

Kilamba (see figures 11 & 12), the largest Chinese development in Africa, is the best-known example of an Angolan satellite city. Housing over 200,000 people in buildings ranging from 5 to 14 stories, it is located some 30km out of Luanda's core. Similar to other satellite cities around Luanda such as Capari or Km 44, Kilamba was built in order to alleviate housing pressure in the core.[40] Originally intended for low-income residents, the high purchase cost, despite a publicly subsidized financing program, has led Kilamba to house mostly middle-class citizens attempting to escape the exorbitant downtown rents.[41] In the absence of proper transit links, however, most people commute 2-hrs each way by car into central Luanda to work, contributing to congestion on the city's crowded and poorly maintained

40 Cain, Allan. "African Urban Fantasies: Past Lessons and Emerging Realities." Environment and Urbanization 26 (2). October 2014. 561–67.

41 Ibid.

roadways. Apart from a few schools and convenience stores, employment opportunities and non-residential uses are notable absent from the complex. In many respects the bleak and infamous Kilamba development feels more like an American public housing project of the post-WWII period than a community designed to flourish over time.

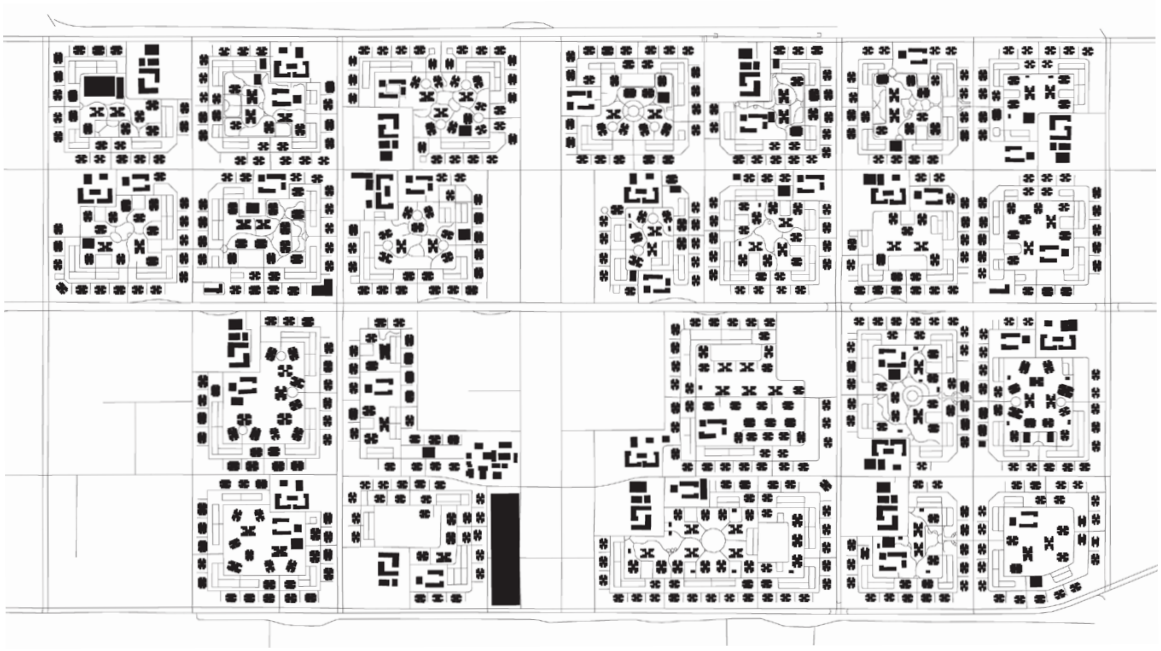


Fig 12: Kilamba site plan

While “rehousing zones” and “Satellite cities,” have been at the forefront of recent redevelopment efforts, several smaller interventions have been undertaken within the city’s core. Upgrading efforts in small neighborhoods like Cariango (discussed in greater detail below), have delivered positive results but little traction to the extent of the intervention is localized and affects a small number of people. Other projects have also attempted to use the guiding principles used in Kilamba and Zango on vacant land closer to the city’s core. Learning from the successes and failures of these efforts will help inform what can be implemented as a thoughtful response to the lack of affordable housing in Luanda.

With respect to master planning efforts, the *Metropolitan Master Plan of December 2015* was the first attempt at a unified proposal for greater Luanda. (See figure 13) Undertaken by British architecture and planning firm Broadway Malyan, the master plan for Luanda is the result of an 18-month study commissioned by the Angolan Government.[42] Comprehensive in its scope, this document includes recommendations for road networks, public transit (taking into consideration both current and future nodes within the city), airports & seaports, the distribution of commercial, industrial and residential uses, along with many other elements, envisioning what Luanda might ultimately become as a world-class city. Although competent and thorough, the plan is currently on hold due to lack of funds.[43] Many also question the practicality of the plan inasmuch as it seems to largely ignore the existing urban fabric. Local

42 Broadway Malyan, *Metropolitan Plan for Luanda - Vol1 Vision & Strategies 1-49*, March 9, 2018, 1–49.

43 Cain, Allan. “Introduction to Angola.” Interview by author. October 08, 2018.

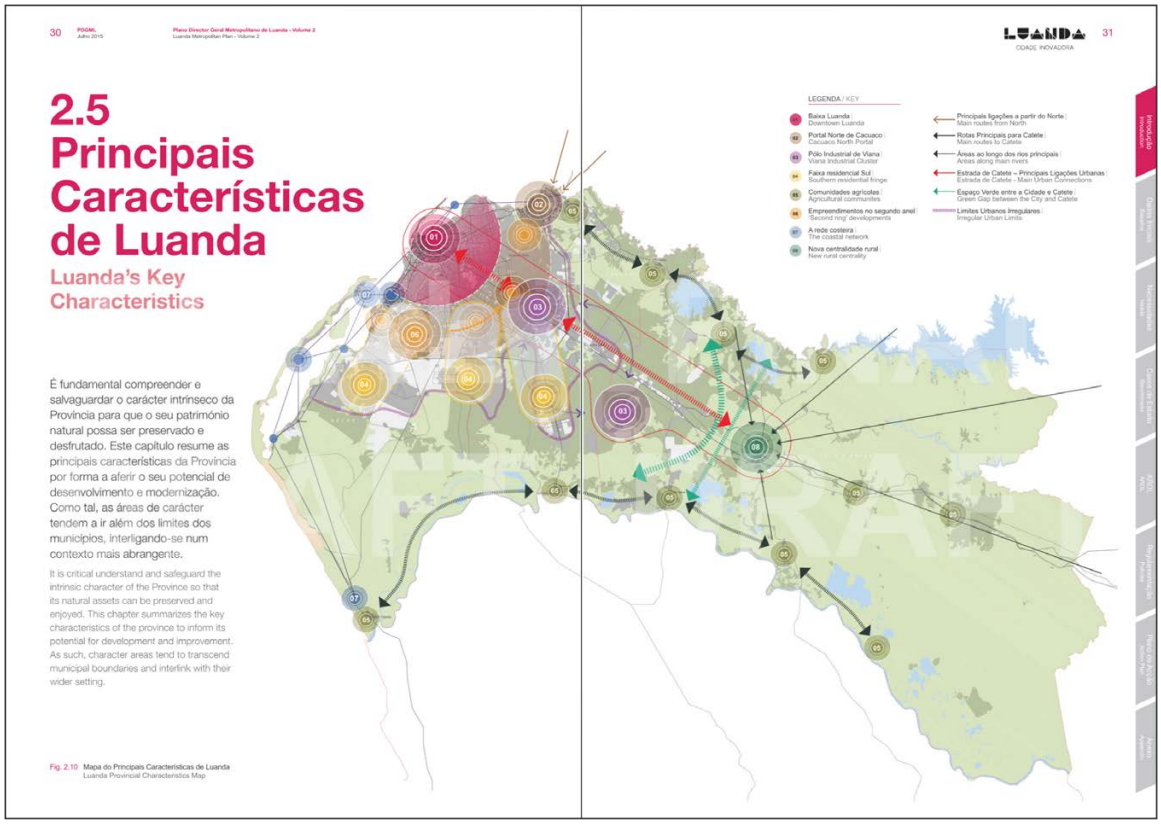


Fig 13: Luanda Metropolitan Master Plan

planners and architects have little faith that a plan of this magnitude can be implemented and are concentrating their efforts on smaller-scale urban development projects.

Introduction to the various settlements and neighborhoods under consideration in Luanda

Municipality of Cazenga:

Metropolitan Luanda – which enjoys provincial status – is divided into seven municipalities. The most densely populated of these, Cazenga, is located immediately west of the city's historical core. (See figure 14) Home to between 800,000 and 1.1 million inhabitants[44], the residential fabric of the municipality consists primarily of informally built structures. Given its favorable location, this mostly flat municipality has been targeted for redevelopment by government officials. In 2011, the GTRUCS Urbanism office was created by the state to develop a master plan for the municipality along with the adjoining areas of Rangel and Sambizanga.[45] (See figure 15) Employing local architects familiar with the area, GTRUCS' mandate was to formulate a redevelopment plan that would accommodate all existing residents while allowing for added density and a greater mix of uses. Using a rule of thumb of eight people per household,[46] planners identified zones for social and market-rate housing, allocated public open space, identified environmentally sensitive areas (e.g., those prone to flooding), and located zones for mixed-use, commercial, business,

44 Cain, Allan. "Introduction to Angola." Interview by author. October 08, 2018.

45 Daio, Ilidio. PLANO DIRECTOR DO CAZENGA SAMBIZANGA E RANGEL. PDF. Luanda: GTRUCS, April 19, 2015.

46 Daio, Ilidio. "Architecture & Planning in Luanda." Interview by author. October 10, 2018.

and industrial activity. Although disregarding most of the existing road and path networks through the area's slums, the plan represents the most thorough and practical attempt to date at understanding how the urban fabric of Cazenga might be reorganized and upgraded.

Fig 14: Luanda map showing city centre and Cazenga

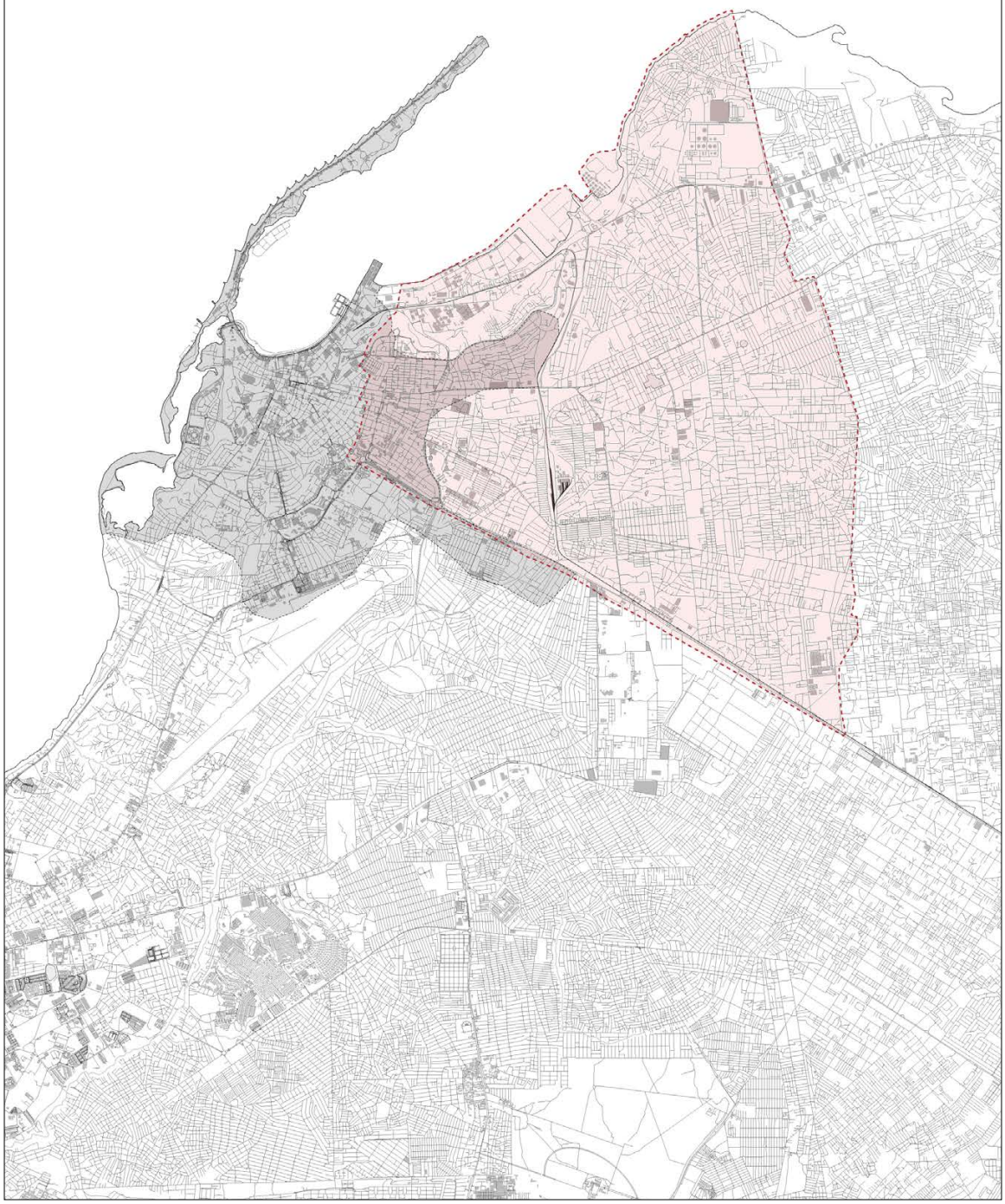
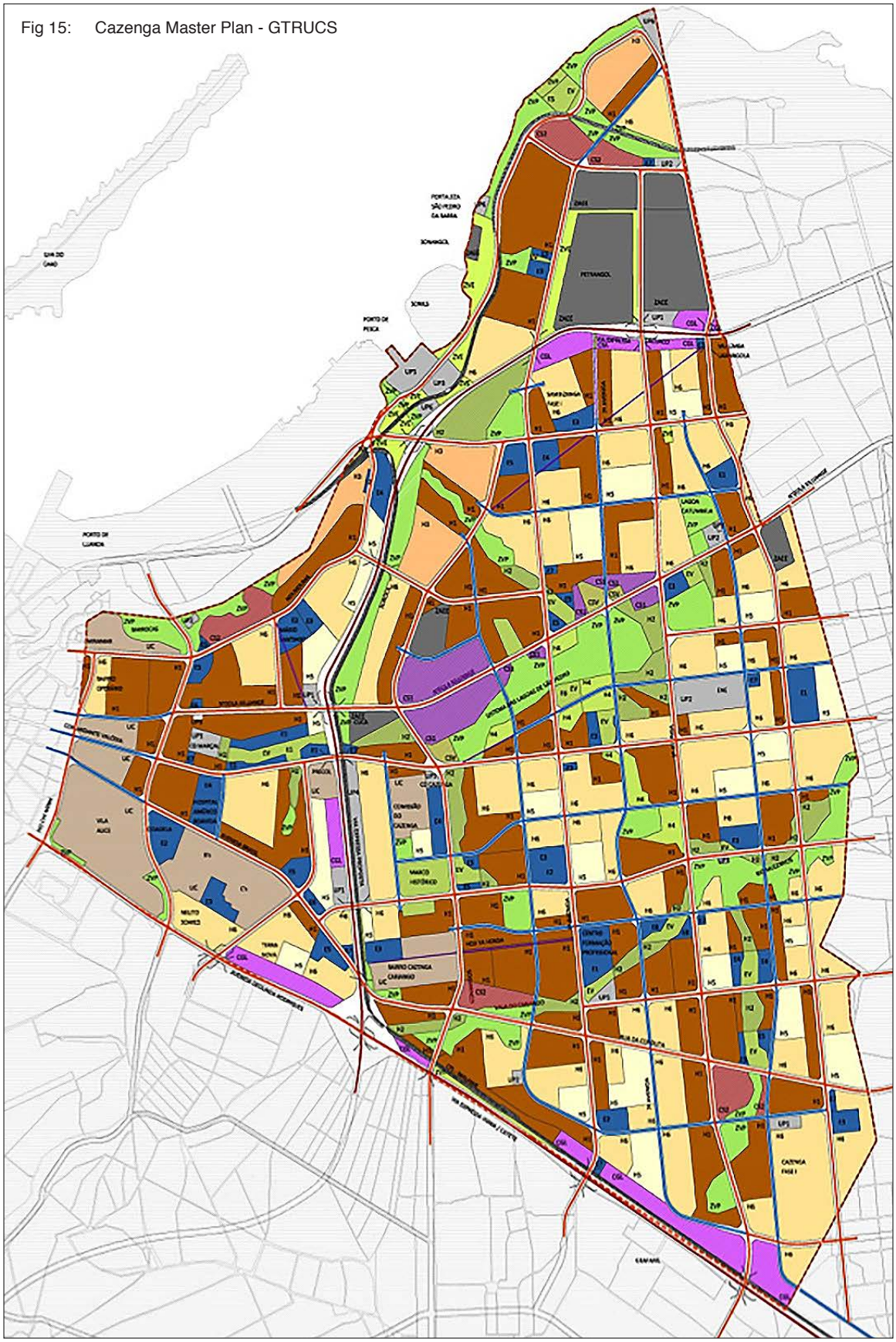


Fig 15: Cazenga Master Plan - GTRUCS



Ilidio Daio, a lead urban planner for GTRUCS, was kind enough to present the project to myself and several other researchers. In addition to giving us access to GIS data and research files associated with the project, Mr. Daio toured us through a number of sites in Cazenga and invited us to the office to share knowledge and ideas. The meeting allowed for the exchange of valuable insights on how projects are conducted in Luanda. As an outcome of these discussions -- and in consultation with the Development Workshop Angola -- I was able to identify specific sites and projects within the municipality of Cazenga on which to focus for my thesis work. The decision about what line of research to pursue was further informed by several secondary case studies within Cazenga. These studies, described below, were instrumental in helping me to understand the varied structure of Luanda's informal settlements (See appendix A), the range of approaches taken to their redevelopment, and, most importantly, what I, as an architect, might contribute to the overall endeavor.

Research into the physical structure of the Cazenga slums falls within the context of the larger, socially oriented research and enumeration work being done by the Development Workshop Angola (DWA). This work, currently focused on Luanda's Cazenga Municipality, has been funded by the International Science Council's LIRA initiative.[47] Project goals include "*Realising the potential of urban*

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47 "The LIRA 2030 programme is run by the International Science Council together with its Regional Office for Africa and in strong partnership with the Network of African Science Academies (NASAC). […] The programme supports collaborative research that explores new approaches to re-thinking urban futures in Africa, in partnership with local authorities, communities, industry and government." See. "What We Do." International Science Council. Accessed March 27, 2019. https://council.science/what-we-do/funding-programmes/leading-integrated-research-for-agenda-2030-in-africa.

density to create more prosperous and liveable informal settlements in Africa" and *"Co-producing urban knowledge in Angola and Mozambique through community-led data collection: towards meeting SDG 11."* While the *urban knowledge* component "aims to generate data on the indicators of the urban sustainable development goals … to inform more inclusive, sustainable and participatory urban planning and policymaking,[48] the former is directly in line with the aspirations of this thesis. In particular this involves determining "how to free up space for the holistic development of informal settlements through land readjustment, promoting tenure security, access to finance … and conditions for multi-story developments."[49] The partnership with the Development Workshop allows me to build upon the data collection in order to propose ways to redevelop and increase the residential density of the informal settlements, which are comprised primarily of one-story dwellings.

To reiterate, then, the phased redevelopment of Cazenga -- including portions of Rangel and Sambizanga -- presented itself as a propitious thesis topic due to the need for infrastructure renewal, its proximity to the city center, the ability to build on and contribute to ongoing LIRA research, and the availability of data gathered by GTRUCS. As noted above, we initially identified three neighborhoods within the municipality for further study. These are, from least to

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48 Croese, Sylvia. "Advancing the Implementation of the Sustainable Development Goal 11 in Africa." 2017.

49 Visagie, Dr Justin. "Realising the Potential of Urban Density to Create More Prosperous and Liveable Informal Settlements in South Africa & Angola." 2018

most developed, 11 *de Novembro*, *Cariango* and *Marconi.* (See figure 16) While I ultimately decided to focus on *Marconi,* these case studies represented different versions of informality and different approaches to slum upgrading/redevelopment.

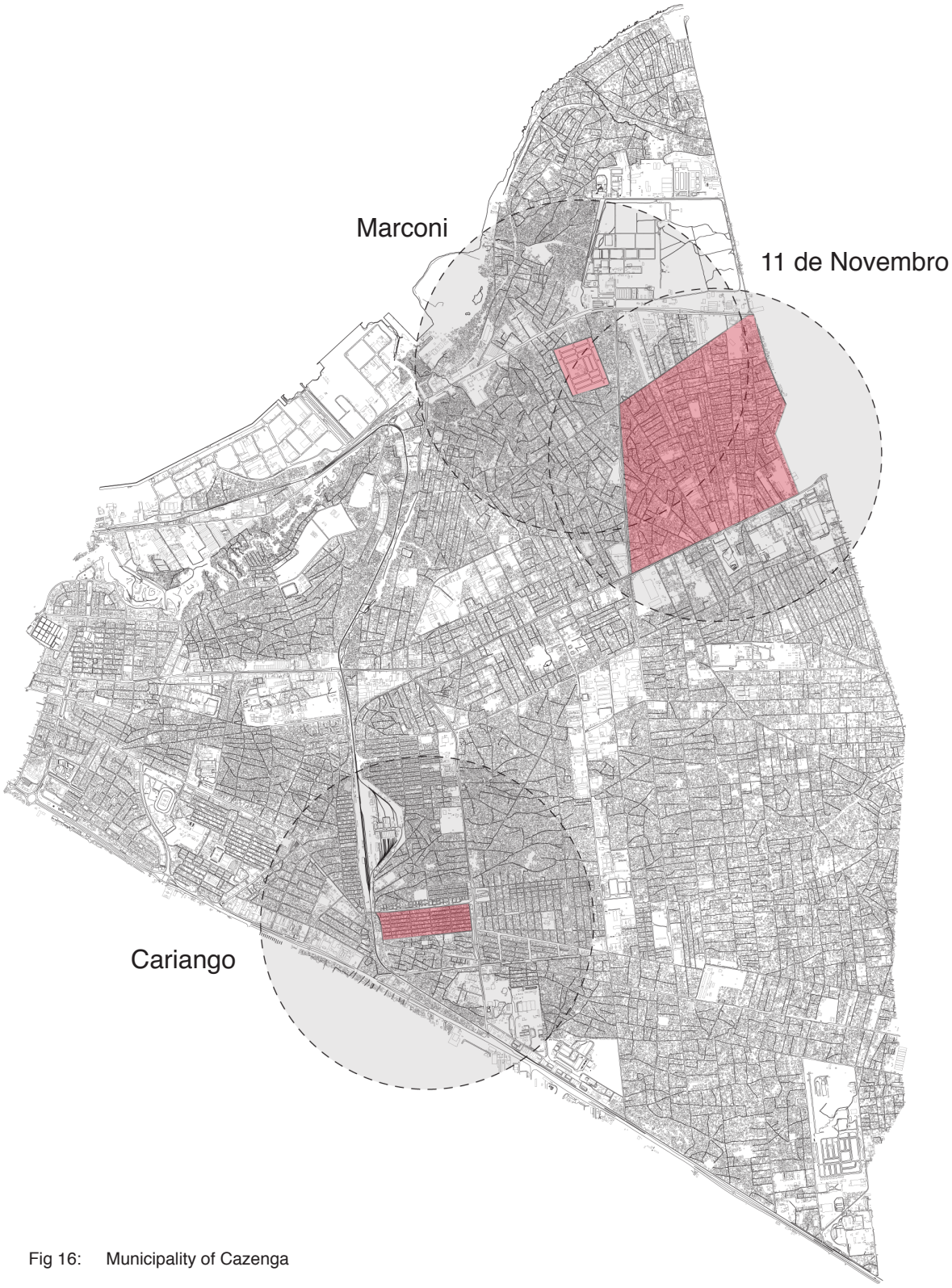

Fig 16: Municipality of Cazenga

Fig 17: Onze de Novembro, typical fabric

Onze de Novembro

Devoid of municipal services, Onze de Novembro presents an interesting case study on how residents within informal settlements organize themselves in the absence of input or support from governing bodies. Not surprisingly, the informal settlement is more structured than it initially appears. Together, visual observations and discussions with locals revealed the numerous layers of organization that make the slum "work." Like the other neighborhoods we visited, Onze de Novembro benefitted from an informally chosen community leader that facilitated discussions and helped resolve conflicts; in some cases, these leaders had links to the municipal administrators and government officials. These social hierarchies seemed highly significant and respected by the community. While built out by residents, there was a larger physical order to the neighborhood that residents respected, including a network of wide, unpaved roads along which cars travelled and business was conducted. Branching off of these main corridors, a tightly organized jumble of self-built homes extends deep into the settlement's fabric, creating narrow passages where crime and sanitation are issues. Understanding the social hierarchies starting with the community leaders and observing the physical construct allows one to comprehend how people actually use the space.

Fig 18: Alley in Onze de Novembro

Fig 19: Public life in Onze de Novembro

Fig 20: Cariango housing condition

Cariango

Cariango is both a “site of interest” and a case study inasmuch the neighborhood has already benefitted from a significant infrastructure upgrade. These upgrades were facilitated by a relatively regular existing street network, within which a few homes had been built in the early 1970s.[50] As conflicts elsewhere in Angola pushed people into Luanda, the area was overtaken by self-building. Whatever municipal services had been originally provided ceased to function, and the poorly maintained roads all but disappeared.

Plans to demolish the inward-sloping, flood-prone neighborhood after the war were abandoned due to opposition from deeply entrenched residents and

50 Cain, Allan. “Introduction to Angola.” Interview by author. October 08, 2018.

Fig 21: Cariango housing & street relationships

the costs associated with relocation.[51] Instead, infrastructure upgrades were made without demolishing the existing homes. In 2014, electricity was re-introduced and new roadways, sewage and water mains were installed about a meter above the existing grade.[52] The neighborhood no longer suffers from flooding (beyond leaky roofs) and the new sewers and municipal water have greatly improved sanitation. That said, the height of the new streets has created an interesting condition, making it necessary for residents to step *down* into their houses. (See figure 21)

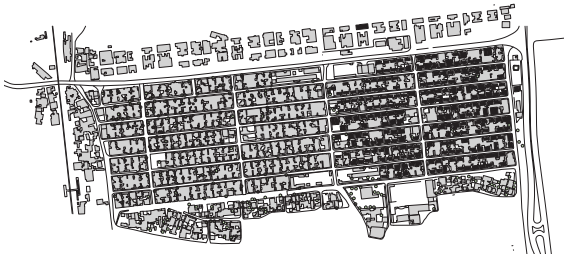

Fig 22: Cariango urban grid

51 Ibid.

52 Daio, Ilidio. “Architecture & Planning in Luanda.” Interview by author. October 10, 2018.

Cariango is a good example of upgrading without disrupting the existing fabric, i.e., slum upgrading as opposed to slum redevelopment. Again, this was largely possible due to the existence of a regular street network. While the availability of municipal infrastructure (water, sewers, electricity, etc.) has improved the lives of residents, the housing is still largely self-built and the residential density is low relative both to the neighborhood's central location and to what the infrastructure can support. Although some efforts were made to give residents tenure where proper structures are built, most people still do not have title to the properties they occupy and incentives to build, upgrade or densify are very low. Over time, however, it is presumed that existing structures will be replaced by taller, multi-unit dwellings.

Fig 23: Marconi housing condition

Marconi

Unfortunately, not all sites can accommodate upgrading without significant disruptions to the existing fabric; more radical solutions are often necessary. Marconi offered the opportunity for a different approach to the challenge of slum redevelopment. Used for (now defunct) radio towers, it was a relatively large, centrally located site surrounded by a dense warren of informal settlements. When the towers were decommissioned and land nationalized after the war, the government decided to build out what amounted to a blank site with replacement housing into which it would shift residents from surrounding slums. Once vacated, housing on adjacent lots could be demolished, roads and servicing could be introduced, and new housing could be constructed at a higher density and

better quality than the predominantly one-story, self-built slum dwellings.

While the project got underway, it has suffered from setbacks. Intended as affordable rental housing, the project was spearheaded by the government, which ran out of funds.[53] For better or worse, less than half of the 77 buildings proposed for the Marconi site were constructed and only two are occupied.[54] None of the adjacent blocks has undergone redevelopment. And while the strategy is fundamentally sound, the new, multi-unit buildings constructed on the site are architecturally banal and don't appear to respond to the needs of those for whom it was constructed. Among other things it's difficult to see if or how the housing, as conceived and executed, could support the range of activities that occur in the adjacent, informally-built blocks. It appears more like a poor-man's Kilamba – eerily reminiscent of some of the worst public housing projects of post-WWII USA. Arguably it's more of a ghetto than a neighborhood. (See figures 23 & 24)

In its current state, Marconi is an excellent example of failed opportunity -- like many others in Sub-Saharan Africa. Learning from Marconi's failures, however, while acknowledging the soundness of the strategies that underpin it, provides strong cues on how one might move forward in the larger redevelopment of Cazenga.

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53 Cain, Allan. "Introduction to Angola." Interview by author. October 08, 2018.

54 Daio, Ilidio. "Architecture & Planning in Luanda." Interview by author. October 10, 2018.

Fig 24: Urban fabric of Marconi

3. Precedents & Research

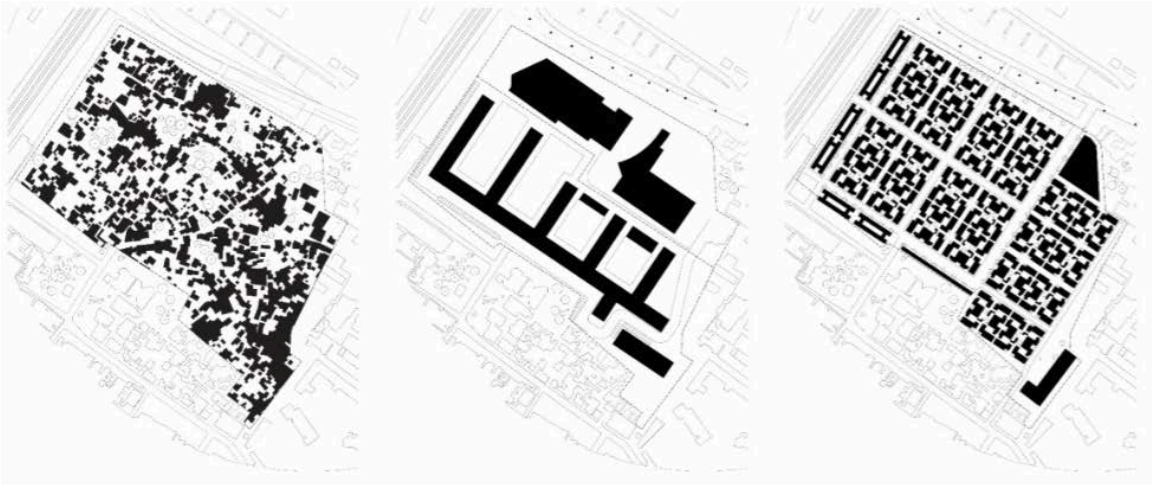


Fig 25: Kathputli Colony current fabric, developer's vision & thesis proposal

This thesis builds on the work of several Carleton students who have used their M.Arch. theses to explore the challenge of informal settlements and housing for rural-to-urban migrants in rapidly urbanizing areas of the world. These include Sara Hormann and Jayla DeKraker, who proposed alternative housing models for China's rapidly-expanding cities,[55] and Gillian Walzak who explored the redevelopment of a slum in Delhi, India (the Kathputli Colony).[56] (See figure 25) Several themes were common to all three theses, namely the need to 1) design market-friendly housing that could transition, along with its residents, over time, 2) design housing that integrated with, rather than standing out from, the adjacent buildings and urban fabric, and 3) organizing housing into communities

55 Hormann, Sarah. "Architecture of Assimilation," Master's Thesis, Carleton University, Ottawa, May 2015. 1–97.

56 Walczak, Gillian. "No Strings Attached," Master's Thesis, Carleton University, Ottawa, April 2017. 1–80.

that accommodated a range of activities – formal and informal -- understanding that the nature of those activities was likely going to change over time. In other words, rather than designing homogeneous ensembles of short-term or “transitional” housing (e.g., subsidized rental housing through which residents were intended to pass en route to establishing themselves elsewhere in the city), the goal was to design flexible, resilient, market-friendly housing to which residents would be given title. In addition to enabling the municipality to include these residents on its tax rolls, title to their properties would provide slum dwellers with an asset in which to accumulate equity and against which to borrow. As such, the replacement housing would play a key role in changing the economic circumstances of those involved. This is the model being used both in China and in India.

In all three of the previous theses, emphasis was also placed in designing housing that both integrated with and contributed to the larger urban fabric. Low-rise solutions were strongly preferred to mid-or high-rise housing, largely because access to the outdoor space at or close to grade was identified as a priority for family-friendly housing. (See figure 26) As with the Kathputli Colony, an emphasis was placed on in-situ redevelopment to minimize the disruption of established social networks.

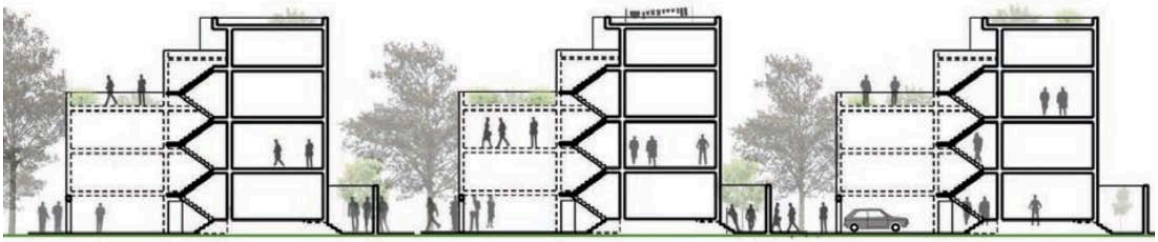


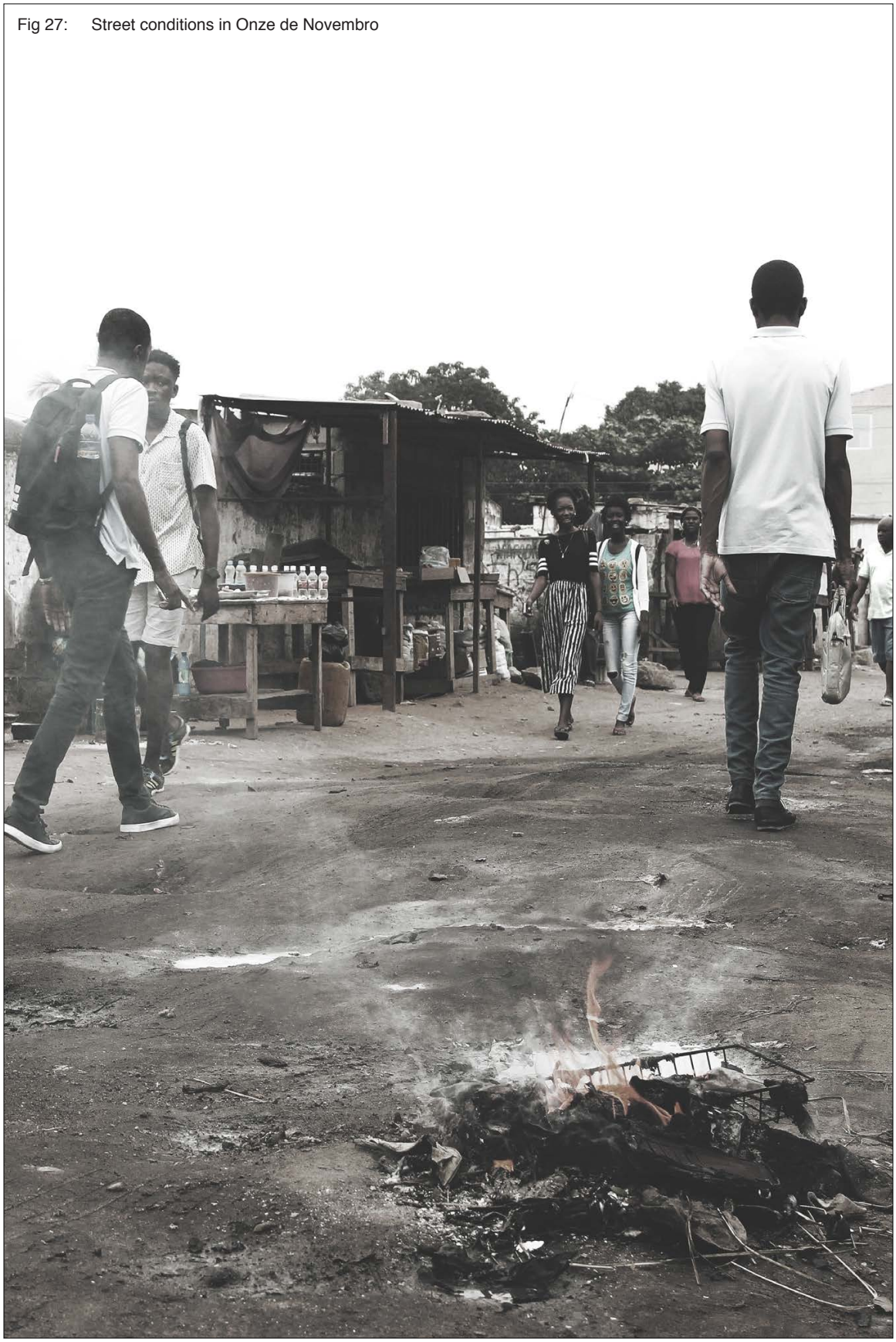
Fig 26: Low-rise apartments for modified Shikumen-type housing, Sarah Hormann.

Finally, as with the previous investigations, it was assumed that the private sector would play a significant role in slum redevelopment. In exchange for the right to build market-rate housing on a portion of the land in question, private-sector proponents would provide expertise, coordinate construction, and contribute to the cost of the replacement housing. Despite the challenges associated with public-private partnerships, it was acknowledged that private-sector involvement (with proper oversight) would increase the likelihood that the redevelopment would move forward and be completed in a timely fashion. As noted above, Marconi is a sad example of what can happen when the government is solely responsible for slum redevelopment. A healthier mix of uses and demographics is also more likely to result when the private sector is involved.

Cultural, political, and economic differences aside, one of the key characteristics that distinguishes Luanda's slums from their counterparts in China and India is the relatively low density at which they've been built. The vast majority of the self-built-housing in Luanda is only one-story. The limited height and density of the existing fabric paves the way for private-sector participation inasmuch as it makes it relatively easy to free up land for market housing without resorting to high- or mid-rise solutions for replacement housing.

Spending time in Luanda provided the opportunity to experience first-hand this urban fabric. Visiting the sites and interacting with local stakeholders was a critical component of the research, contributing to my understanding of the physical, lived structure of space: a tight urban fabric comprised primarily of single-story dwellings with few public spaces other than the streets. Beyond these observations, the fieldwork offered the opportunity to observe how life is conducted,

Fig 27: Street conditions in Onze de Novembro



focusing on the relationship between social interactions and the built environment. As life is mostly lived outdoors and as responsibilities are often shared intergenerationally and among neighbours, individuals spoke of the importance of exterior spaces, of access to the street, and of community cohesion. Having questioned residents about their perceptions of multi-unit housing, I determined that concerns about housing revolve more around the quality of space and the opportunities it offers rather than around specific housing typologies.

Furthermore, the two-pronged research approach, involving a review of literature (books, journals, articles, precedents, case studies, etc.) in tandem with the on-site field research, helped strengthen certain concepts and constructs, while shedding light on important theories of urban design and slum upgrading. Articles such as Claudia Gastrow's *Cement Citizens: Housing, Demolition and Political Belonging in Luanda, Angola,* the document *"They Pushed Down the Houses,"* produced by the African division of Human Rights Watch, and the Development Workshop's numerous resources on Luanda's housing market, were key to understanding the complex issues of displacement, ownership and the sense of belonging in Luanda.[57] They describe the devastating effects that most slum redevelopments have had on displaced residents due to factors such as the location of areas to which residents have been moved, the often poorly organized or even unannounced nature of these displacements, the lack of consideration for the financial well-

57 Africa Division of Human Rights Watch. 2007. "'They Pushed Down the Houses'," May, 1–101

being of individuals and families being moved far from income-generating opportunities, and the loss of all previous investment in their own housing. They reinforced the extent to which slum redevelopment affects the livelihood of the those involved and the largely negative impact it has on the way the city functions and develops over time.

In addition to reviewing literature, examining previous theses, and engaging local stakeholders, I explored a number of precedents, notably slum-replacement housing proposals by architects B.V. Doshi and Elemental. In so doing I identified several key characteristics crucial to successful housing, among which were 1) the including of flexible spaces that could be used for a range of activities (retail, workshops, garages, etc.), 2) clear hierarchies of exterior space (private, semi-private and public), 3) direct street access (and addresses) for all units, and 4) flexible layouts to enable units to be reconfigured as household size, circumstances, composition, and income changed.

In developing prototypes, I decided to focus on multi-unit housing, largely because it is easier to achieve higher residential densities with low-rise, multi-unit housing than with freehold housing. Unlike some of Elemental's row-housing schemes to which owners can add on over time,[58] (See figure 29) flexibility in multi-unit housing translates to units in which partitions can be easily moved to enable portions of the overall floorplate to be re-allocated. Following B.V. Doshi's *Life Insurance Corporation Housing,*[59] efforts were made to design the multi-

58 "Elemental «." Elemental. Accessed March 27, 2019. http://www.elementalchile.cl/en/.

59 Architectmagazine.com. Accessed March 27, 2019. https://www.architectmagazine.com/

story housing such that all units could be accessed directly from the street without resorting to common corridors. (See figure 28)

Ultimately, while the proposed design was informed by research and precedents, design itself was an important component of my research. The design process allowed for the translation of data, standards and targets into form – to assess alternatives and determine what was possible and/or preferable. Indeed, much of my research consisted of an iterative movement between design and analysis, working between the scale of the neighborhood, the building and the unit. It is the ability to visualize and translate ideas, ideals and targets into form which is the architect's greatest contribution to the process.

Fig 28: B.V. Doshi's Life Insurance Corporation Housing

Fig 29: Elemental's incremental housing

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project-gallery/life-insurance-corporation-housing_o.

4. Method & Considerations

Approaches to Redevelopment

Four main redevelopment strategies are applied to the redevelopment of informal settlements[60]:

> ***In-situ redevelopment:*** In-situ translates to "on-site." This strategy offers slum dwellers new housing on or near their existing dwellings. In favorable locations, in-situ redevelopment often leverages land as a resource with which to partner with the private sector, mitigating the financial and logistical burdens placed on the state. In higher-density slums, where phased redevelopment is not possible, in-situ redevelopments may require temporary relocation to transit camps. The nature and duration of these temporary relocations will affect the longer-term effectiveness of the strategy.
>
> ***Relocation:*** This approach shifts people from informal settlements to formal ones, typically at some distance from the original site. Relocation is deployed when informally-occupied land is considered to be of a particularly high value (e.g., in or close to the core, a subway stop, etc.) and/or when the informal settlement occupies environmentally sensitive land (e.g., steep slopes or flood prone areas). While the new housing is typically of a substantially higher quality the location is generally less

60 Gianni, Benjamin. "Introduction to Urbanization." Interview. November 6, 2018. The terms outlining the four urbanization models were all explained during this interview.

favorable with respect to access to employment and transportation. Relocation also puts residents at a disadvantage to the degreed that is disrupts social networks.

***Retrofit**:* Without necessarily reconstructing homes, this strategy introduces infrastructure upgrades in to existing neighborhoods. Fraught with logistical challenges, retrofits are generally only possible when there are regular networks of streets and public rights of way and where informal slums to have not developed on environmentally sensitive areas. Focused on infrastructure (water, sewers, etc.) retrofits generally do not address the quality, density or soundness of informally built structures.

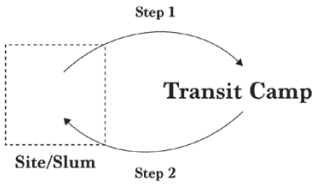
***Slum Clearance**:* This term refers to the act of demolishing the existing informal fabric to make place for new construction. Most often, this strategy is paired with an in-situ or relocation strategy in order to provide for the people affected by the clearance.

While there are advantages and challenges associated with each of these approaches, in-situ redevelopment is typically considered the most desirable – especially when vacant parcels of land adjacent to the slums can be used to kick-start a phased redevelopment. (See figure 30)

1

Redeveloping the Inadequate

- Residents must be displaced to a transit camp
- Land gets redeveloped
- People are then moved back to proper housing



2

Replacing the Inadequate

- Empty land adjacent to slums is developed
- People are moved and more land is cleared
- Process gets repeated

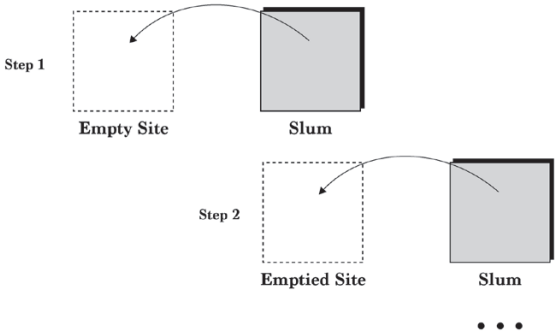


Fig 30: In-Situ redevelopment strategies

Preferred Approach

3

Replacing the Inadequate while Addressing Housing Shortages

- Empty land adjacent to slums is developed with a higher density than the current fabric
- People are moved and more land is cleared
- Process gets repeated

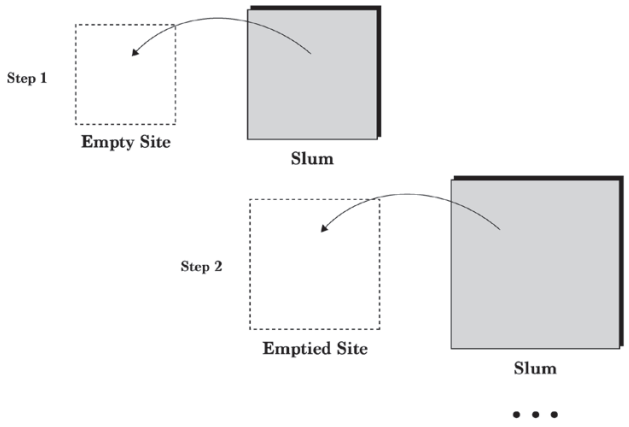


Fig 30: In-Situ redevelopment strategies

In choosing a redevelopment strategy, it is crucial to consider if and how likely that strategy is to be implemented and to identify the indicators and measures of success. While this is often beyond the scope of the architect, the significant cost (social and economic) of slum redevelopment make it imperative that redevelopment strategies be developed in concert with policy experts to understand what is required to assure it is brought to fruition to the optimal benefit of those affected. Be it through municipal bonds or other alternate financing structures, we must assure that the replacement housing finds itself to the slum dwellers for whom it is intended. Among the considerations is that financing be made available to bridge the gap (if any) between the cost/value of the replacement dwelling and the pre-demolition value of the land from which residents are being displaced. Given the severe housing shortages in Luanda is also important to consider the value of the replacement housing as a commodity that can be exchanged on the marketplace -- often for a significant profit. Past examples have restricted residents from selling for the first five years, ensuring the project benefits the ones in need first. While specific policies and regulations are beyond the scope of this thesis, it is important to highlight the need to develop them with a range of experts.

Redeveloping Marconi

Introduction

While it may seem counter intuitive to select a site that has already undergone partial redevelopment, the vacant portions of Marconi offer an ideal starting point for the larger redevelopment of Cazenga. In its current form, Marconi represents a failed financial and social vision. Together the form of the housing and the lack of completion put in question the state's effectiveness in responding to the housing crises in Luanda.[61]

Marconi's lack of completion, however, also represents an opportunity to move forward under new terms of reference. Learning from what was (and wasn't) completed, it's possible to forge a new architectural and urban vision for the community. In moving forward my goal was to meet or exceed the density targets established for the original development, as well as targets for the number of schools and percentage of open space. I also opted to stay with the multi-unit building approach taken with the completed portions of Marconi, rather than introducing row housing or other freehold typologies. The challenge, however, was to do so in a manner that better addresses the disposition of space, supports a broader range of activities and is more responsive to the needs of residents in both the short and longer term.

Following the example of the Kathputli Colony, where the private-sector partner constructed replacement housing in exchange for the right to build market housing on 30% of the

61 Funding for the project dried up with the collapse of oil prices.

land slated for redevelopment, the redevelopment of Marconi presents an opportunity to experiment with public/private partnerships. Properly structured, such partnerships can be benefit all parties and produce healthier mixed-use and mixed-demographic communities. As land and housing in Luanda are in critically short supply, there is little doubt that the private sector would benefit greatly from the opportunity to develop land near the city's core. Moreover, the portion of land allocated to the private sector is likely be built out at higher densities and be aimed at a different demographic than the replacement housing. The end result will be a healthier mix of uses and demographics and a significantly higher overall density than what can be achieved with the replacement housing alone.

In this overall equation, it is assumed that the city would be responsible for organizing the enumeration process, procuring and negotiating with private-sector partners, determining who gets title to what and on what terms, clearing the land (once the appropriate replacement housing has been completed), and for providing roads and infrastructure (hard and soft). As the initial replacement housing requires a significant up-front commitment on behalf of the private-sector proponent, the government could mitigate risk by guaranteeing loans.

Finally, as the built-out of the balance of Marconi is the first step in a larger, phased redevelopment of Cazenga, it also offers an opportunity to consider urban and architectural typologies that can be applied elsewhere, as well as experimenting with various types of collaboration agreements with private-sector partners.

Fig 31: Marconi apartments

Current Marconi Proposal:

47 acres

1184 dwelling units

1 school (lot covering 5200sqm)

Residential density: 24 UPA (38 Net UPA)

FSI: 0.4

PPA (8 persons/unit): 189.4

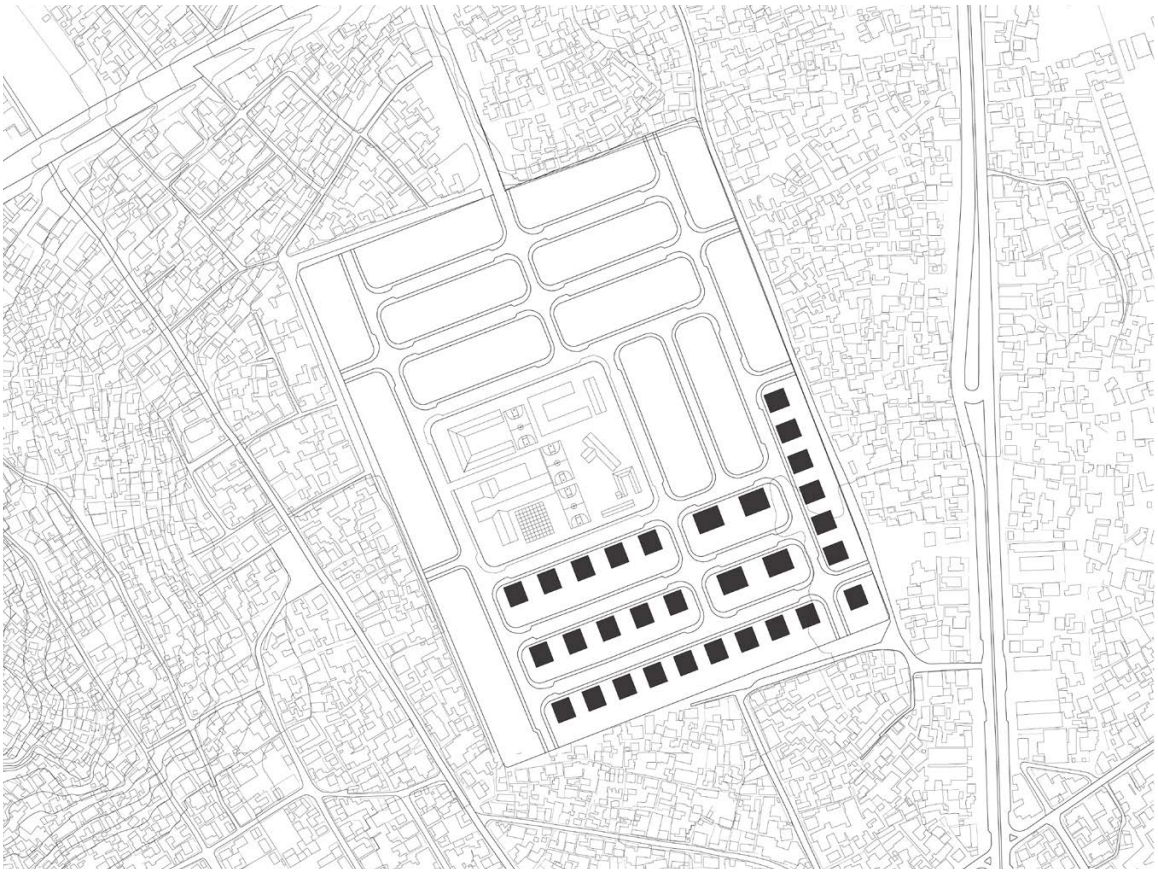


Fig 32: Marconi current urban condition

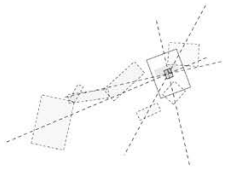
Urban Overview

Having selected the build-out of Marconi as the point of departure for a larger, in-situ redevelopment of the surrounding area, the first step was to understand its place within Luanda. Given the presumption of the private-sector interest/involvement, it was important to understand the economic and social drivers involved. Located only 10km from the city center, Marconi is convenient to many, if not most, services and close to numerous employment opportunities. Figure 33 positions Marconi in relation to the city's main markets, central business district, industrial areas, and other points of interest – by way of demonstrating its potential value for private-sector, market-driven development.

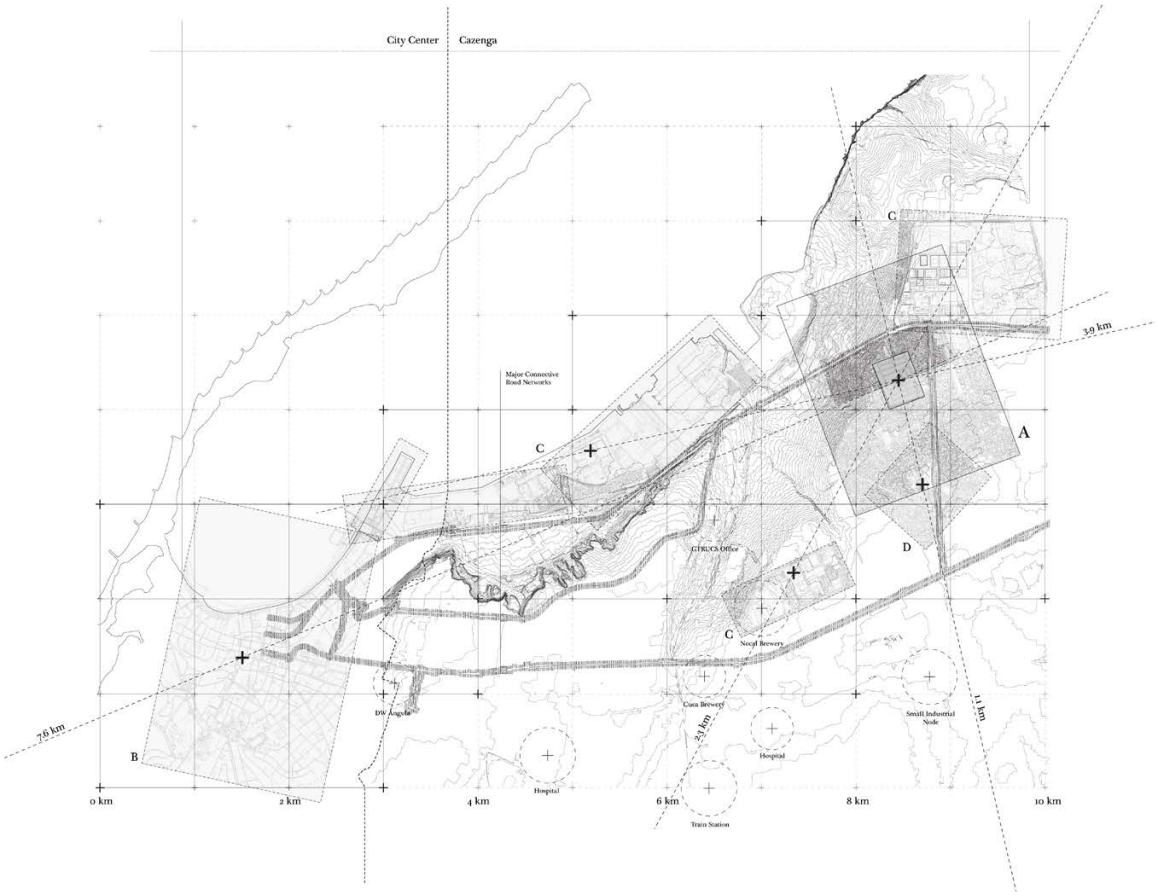
Urban Fragments

Diagram Overview

Urban Economic & Social Drivers / Site Relationship



A - Marconi **B** - Urban Core **C** - Industries **D** - Main Market



Key

Marconi

This Area higlights the main site of focus and its sorroundings. In dark grey is the site: Marconi. The light grey indicated the area from which people will be displaced and the outter box shows the greater context around Marconi.

Main POI

The light grey rectangles with a dashed border highlight the main zones of economic activity. The major points of interest show the proximity of industries, markets and the urban core to the site.

Secondary POI

These minor points of interest show services and minor areas of economic activity. The also indicate locations of institutions propmoting urban growth in Cazenga.

Interactions

The dottes lines connect the site of Marconi with the different economic drivers shown. Each line passing through two main points market by a cross is accompanied with a distance marker showing proximity between these areas.

Fig 33: Marconi urban relationships

Setting the Urban Framework

Given Marconi's favorable location and its potential as a point of departure for a larger, in-situ redevelopment of the surrounding area, it is necessary understand the degree to which the targets for density, open space, schools, etc. might drive the architecture typology. As noted above, I opted to stay with the multi-unit building type, both to be consistent with the approach taken elsewhere on the site and because I suspected it would be easier to meet density targets with multi-unit buildings. That said, my goal was to limit the height of buildings to four stories in order to simplify construction, reduce costs, and obviate the need for elevators. I also attempted to reduce the total amount of common circulation required and to make sure all units had direct access to the street.

To aid in this endeavor I developed an urban density matrix to test out three multi-unit building typologies. (See appendix B) To do so, it was necessary to design typical units that could be arranged into multiple building forms and tested at several density ratios. Only then was it possible to narrow down and identify the most favorable options for further development. Part and parcel of this was experimenting with various block configurations, understanding that the type was likely to be deployed in the redevelopment of areas outside of Marconi proper. (See appendix C for all targets and assumptions)

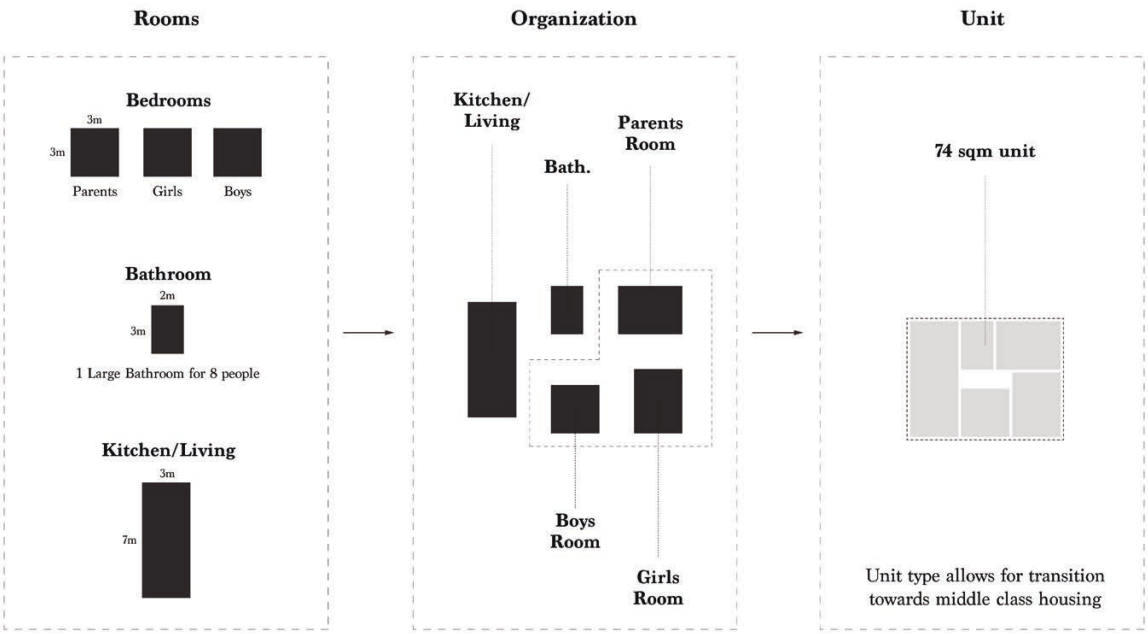
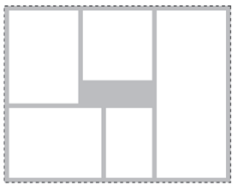


Fig 34: Unit development diagram



The Unit

To develop and test building types it was necessary to design a typical unit. Based on data provided by GTRUCS, the target unit should accommodate a family of eight,[62] be approximately 75 sq. m., and include three bedrooms (1 for the parents, 1 for boys, 1 for girls), one bathroom (on an exterior wall for ventilation purposes) and a kitchen/living space. Keeping in mind that this unit may be called upon to accommodate a smaller household as residents age and/or transition to middle class status, flexibility was important. I also attempted, in further iterations, to design units such that portions could be hived off and rented out should space needs change and/or should the owners wish to generate income. The following diagram explains how units were initially configured.

62 Daio, Ilidio. “Architecture & Planning in Luanda.” Interview by author. October 10, 2018.

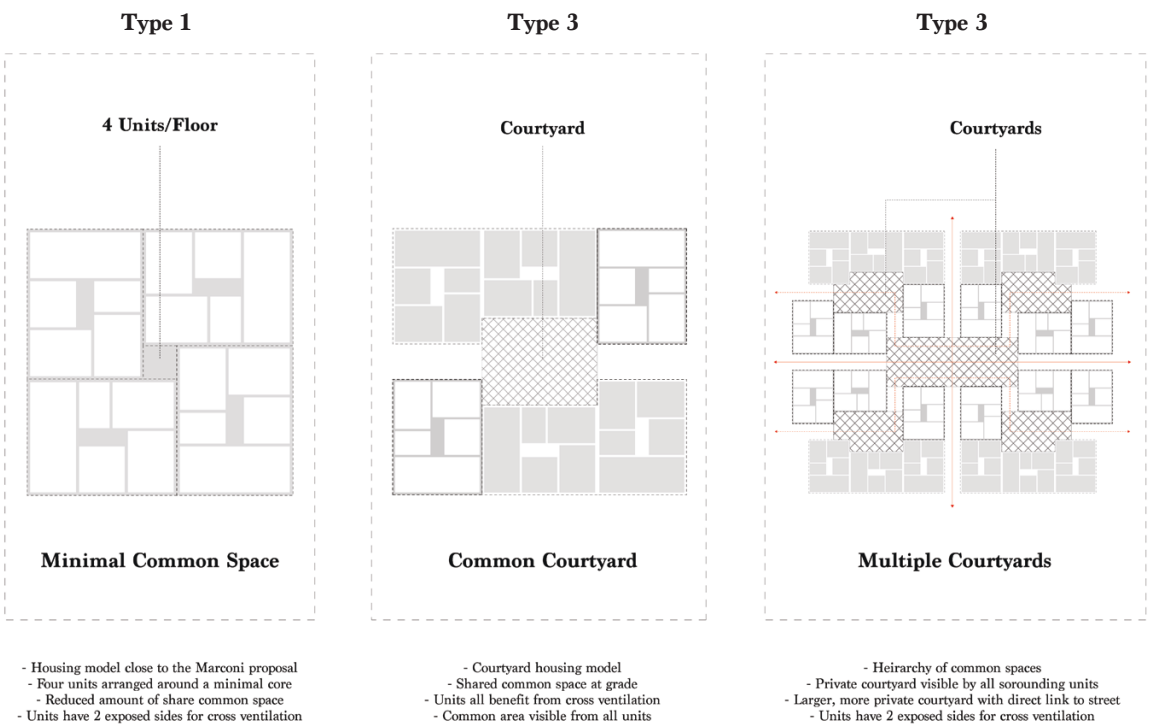
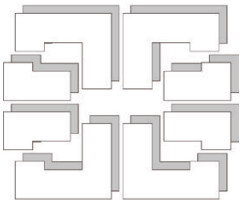


Fig 35: Building typologies diagram



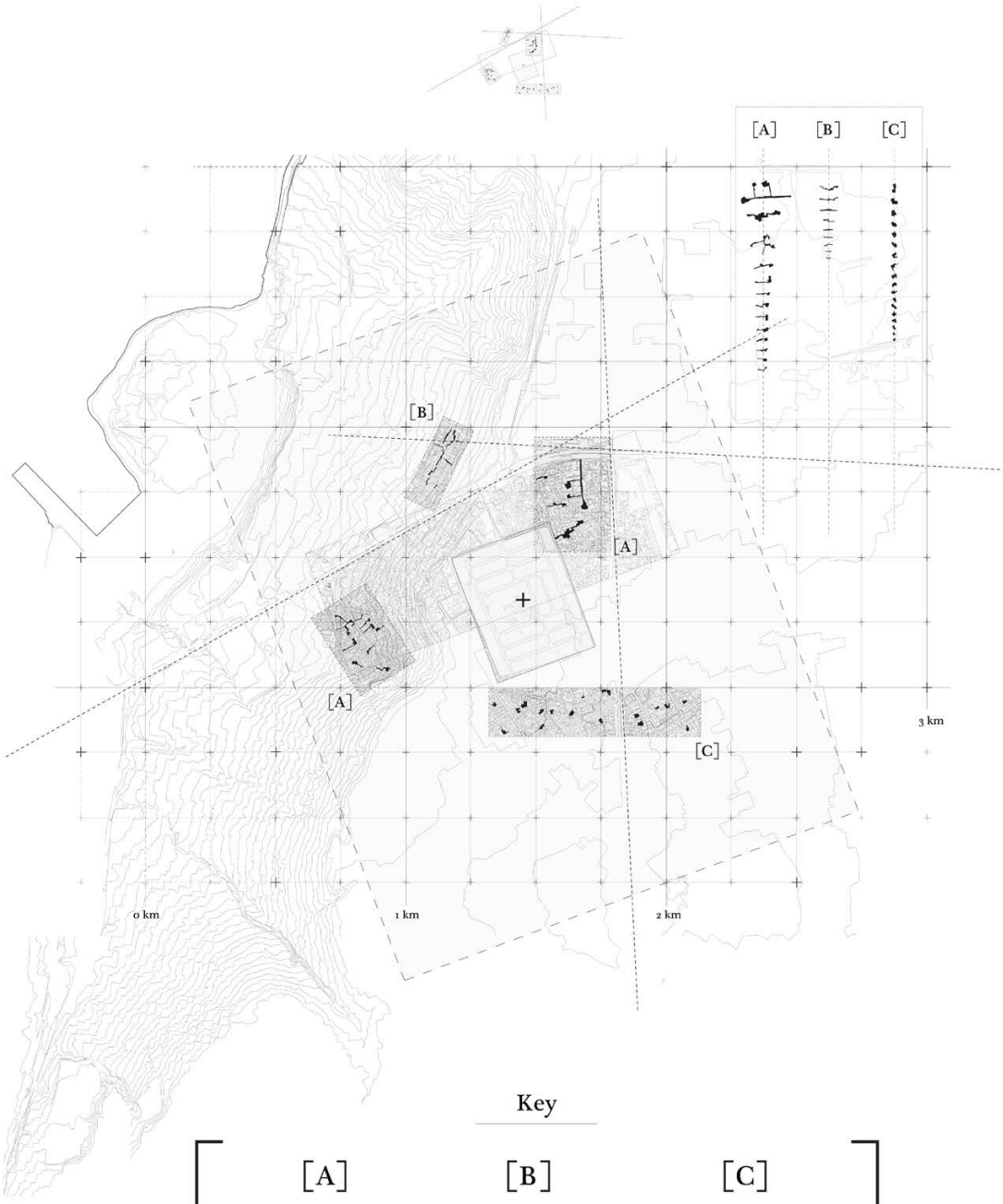
Building Typologies

The three building typologies tested were inspired by the existing portions of the Marconi development. Organizing base units into three different configurations enabled me to explore various distributions and hierarchies of public and private space. The first of the three types is a simple square that closely resembles the existing multi-unit buildings on Marconi; it was intended as a “base model” against which to compare more complex building forms. The second and third types reflect urban patterns found in the adjacent informal settlements. As shown on the map on the following page (See figure 36), the “Courtyards” and “Gardens” of the informal fabric have been transposed into communal courtyards around which units are organized.
To generate and compare aggregate densities, each of the three building types was tested in the density matrix at 1, 2, 3 and 4 stories.

Urban Fragments

Diagram Overview

Recuring Urban Typologies / Housing and the Public Realm



Key

[A]

The "Courtyard"

People have kept open courtyards in the center of deep blocks of informal housing. These are shared among several households and are accessible from the streets and paths leading to homes.

[B]

Street Link

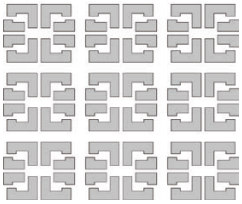
Where lots are deep, some hoseholds have as only link to the street narrow alleys. These poorly maintained passageways are problematicfor crime and sanitation but provide the opportunity for people to inhabit deep blocks.

[C]

The "Gardens"

Despite the hard living conditions and lack of space, many homes also have small exterior enclosures. Sometimes shared between a few homes, these are inside some type of threashold.

Fig 36: Recurring urban typologies



Urban Layout

The next step was to organize each of the iterations on the full Marconi site, separating buildings by at least 9m to accommodate rights of way. (See figure 37) The goal was to determine how many buildings were required (in what configurations and at what heights) to meet density targets – by way of determining how much space might be left over for schools, public spaces, and private-sector development.

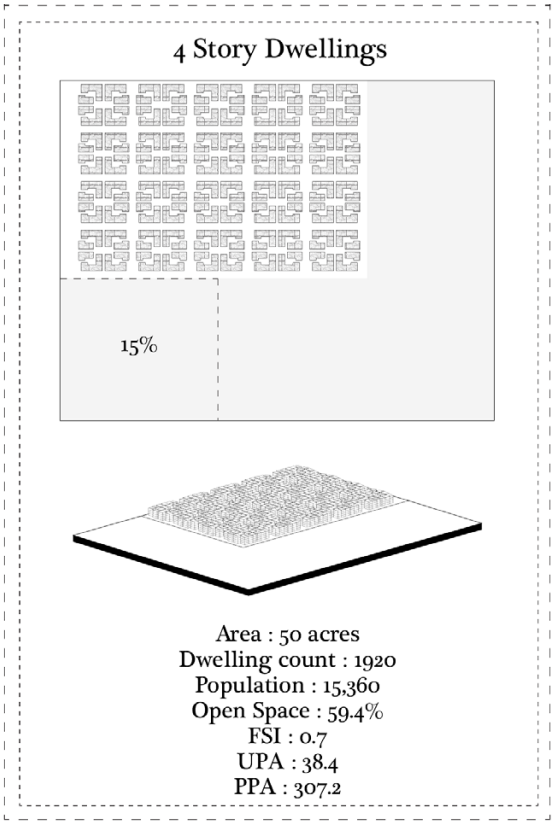


Fig 37: Density matrix urban layout example

Density Matrix

Deploying the three building types at 1-, 2-, 3- and 4-stories, each organized on the constraint of four different FSI values, resulted in forty-eight different urban layouts. The FSI values were evaluated against the FSI of the adjacent informal settlements (0.4) (See figure 38), the target FSI for the original Marconi development (0.7), and FSI values approximately 50% (1.0) and 100% higher (1.5) to assess the implications of increasing the density beyond what was originally planned.

As a result, the following set of preliminary rules was developed to identify which of the permutations were worth pursuing further:

- The study must include a minimum of 1184 dwelling units
    - This was the target unit count for the original Marconi development
    - Matching or exceeding this target is mandatory

- The study must achieve an overall density of 190 persons per acre (PPA) and a residential density of 24 units per acre (UPA) (38 net)
    - These were the targets of the original Marconi development
    - Matching or exceeding these targets is mandatory

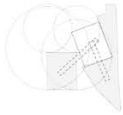
- The required number of units must fit into no more than 55% of the available space.
    - 15% of the land must be set aside for outdoor public space
    - 30% of the land must be set aside for private-sector, market-driven development.
    - Any remaining area will be considered for public infrastructure (schools, roads, etc.)

- Replacement housing must be no higher than four stories.

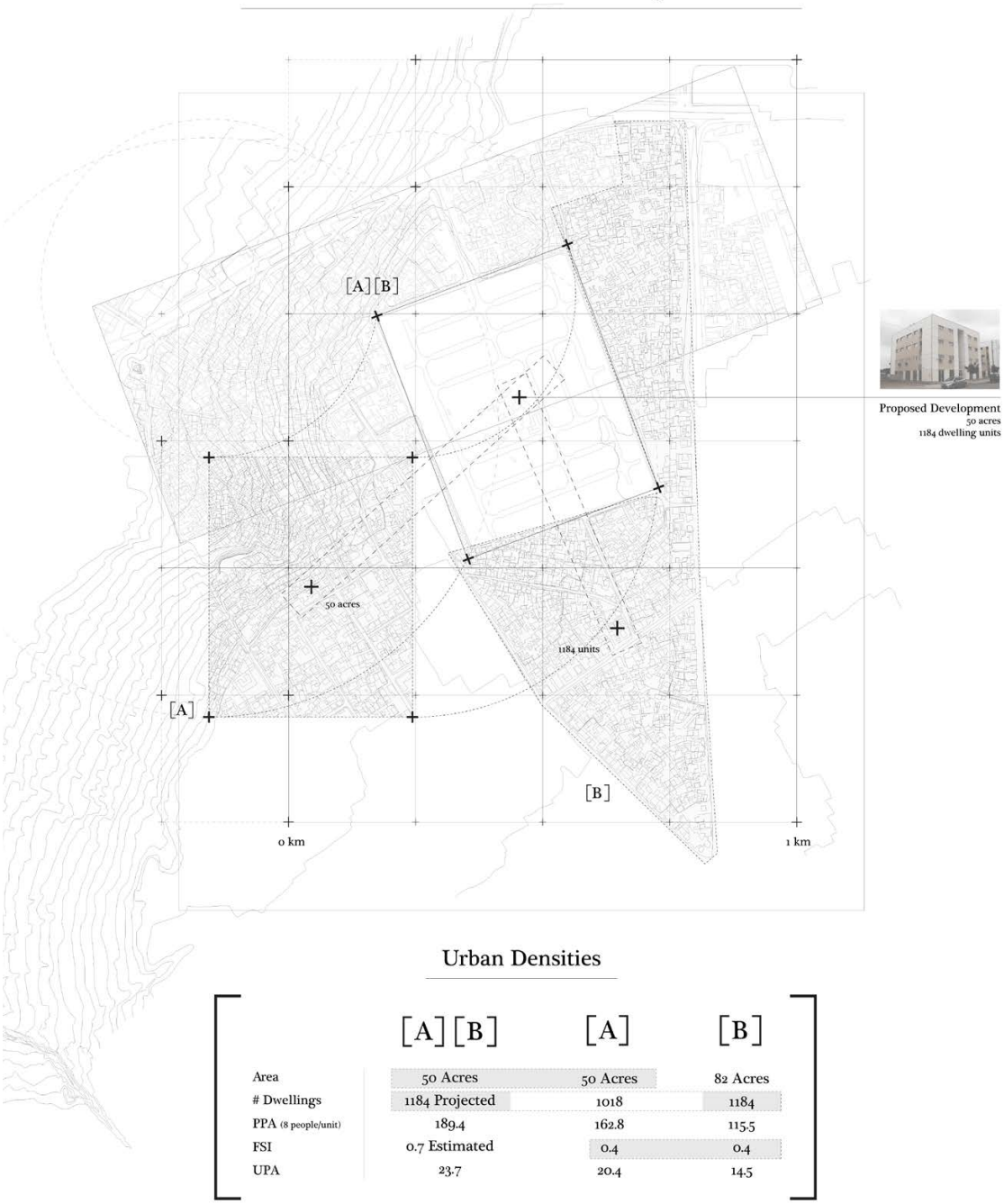
Urban Fragments

Density Overview

Proposed Development & Informal Networks



A - Marconi size **B** - Marconi dwelling count



Urban Densities

	[A][B]	[A]	[B]
Area	50 Acres	50 Acres	82 Acres
# Dwellings	1184 Projected	1018	1184
PPA (8 people/unit)	189.4	162.8	115.5
FSI	0.7 Estimated	0.4	0.4
UPA	23.7	20.4	14.5

Fig 38: Current and projected urban densities around Marconi

Most Efficient Variations:

Based on these guidelines, only six of the permutations met all requirements. I further analyzed each of these six to determine which could also accommodate additional density, schools, and public rights of way (roads, paths, etc.)

Based on the ratio of units to schools included in the original design for Marconi, it was determined that one school is required per about 500 dwellings, broken down as follows:

- *One school is required per about 500 dwellings*
    - 4 classrooms per grade15% of the land must be set aside for outdoor public space
    - At 30 students per classroom = 120 students per grade
    - Using an 8-grade system, a total of 960 students
    - Assuming 2 children per household attend school, 480 households would fill a school

- *One school covers 5200sqm*
    - The footprint of the school constructed for the completed portion of the Marconi including the school yard is 65m x 80m = 5200 sqm

Based on the additional considerations, only two of the six permutations satisfied all of the criteria. (See figure 39).

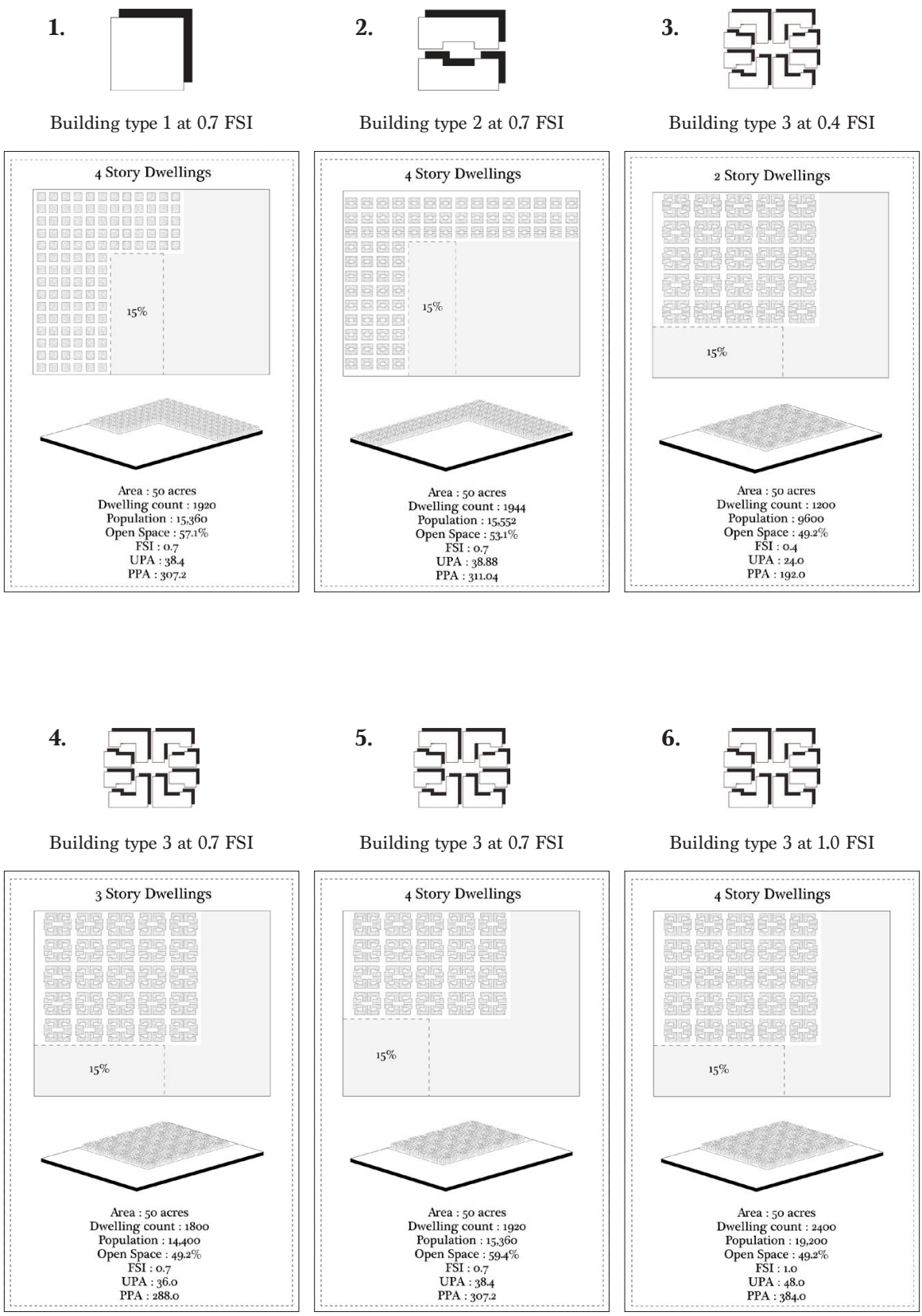
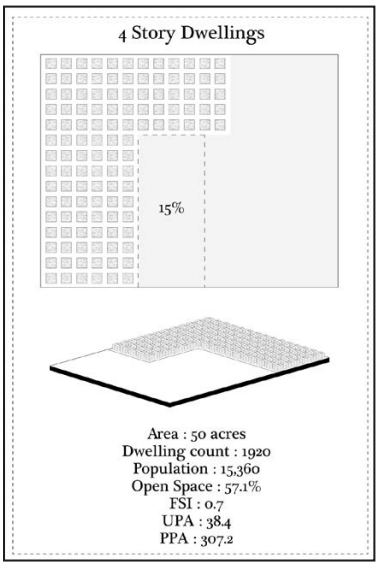


Fig 39: Isolated urban layouts from density matrix – 1

1. **Schools**
Amount: 3.8
Area: 4.9 acres (10%)
Total Open Space Needed: 55%

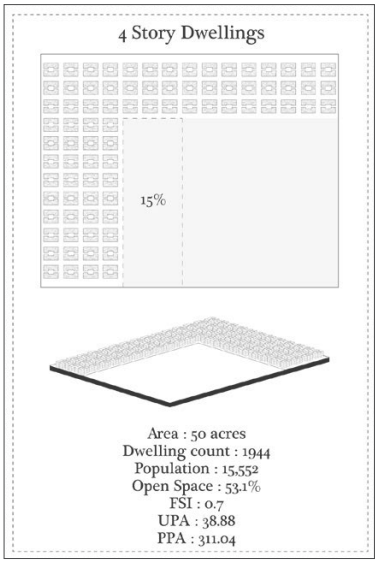
Building type 1 at 0.7 FSI



2,1% Excess Open Space

2. **Schools**
Amount: 3.9
Area: 5 acres (10%)
Total Open Space Needed: 55%

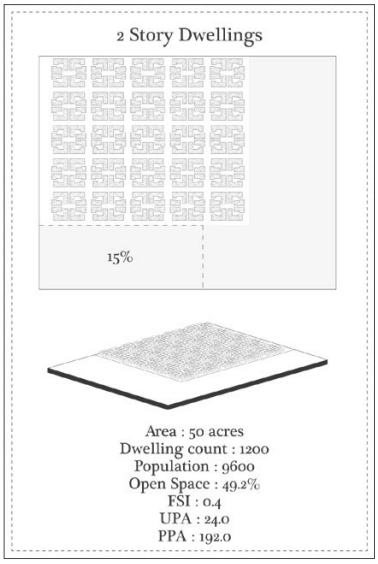
Building type 2 at 0.7 FSI



1.9% Open Space Missing

3. **Schools**
Amount: 2.4
Area: 3.1 acres (6.2%)
Total Open Space Needed: 51.2%

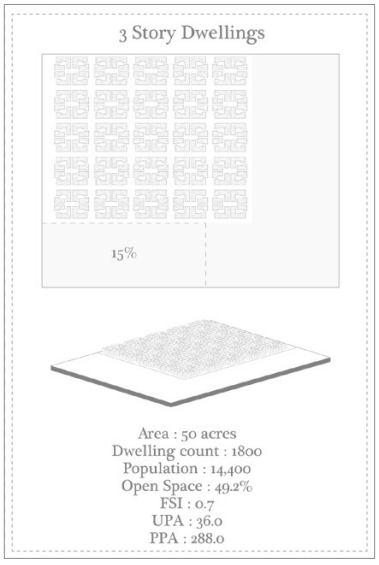
Building type 3 at 0.4 FSI



2% Open Space Missing

4. **Schools**
Amount: 3.6
Area: 4.6 acres (9.2%)
Total Open Space Needed: 54.2%

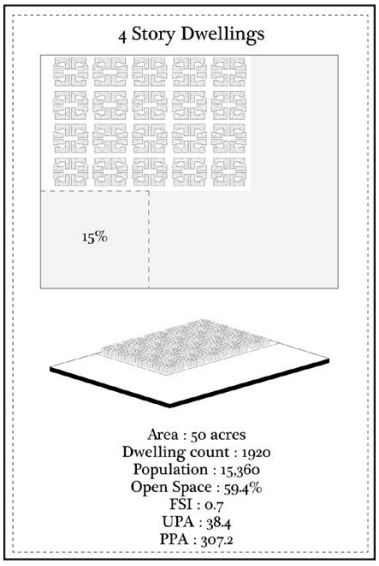
Building type 3 at 0.7 FSI



5% Open Space Missing

5. **Schools**
Amount: 3.8
Area: 4.9 acres (10%)
Total Open Space Needed: 55%

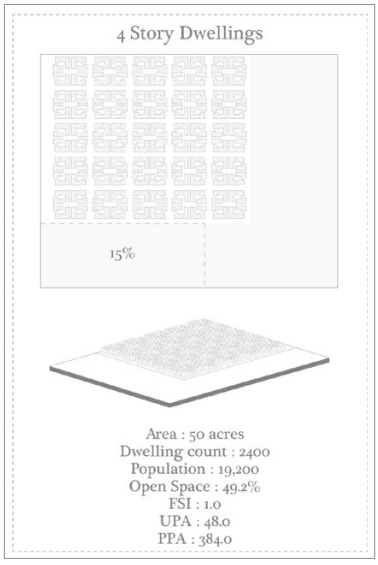
Building type 3 at 0.7 FSI



4.4% Excess Open Space

6. **Schools**
Amount: 4.8
Area: 6.2 acres (12.4%)
Total Open Space Needed: 57.4%

Building type 3 at 1.0 FSI



8.2% Open Space Missing

Fig 40: Isolated urban layouts from density matrix – 2

Best Match – A Starting Point for Design

While both the first and fifth permutations met all targets, the latter achieved this using the third building typology, which incorporated more of the characteristics of the adjacent fabric of informal settlements. By reorganizing the diagram generated by the density matrix, it was possible to accommodate all sectors, i.e., replacement housing, private-sector development, schools and open spaces (See figure 41). Using this modified diagram as a starting point, I returned to and refined the unit designs. Further attention was also given to establishing a hierarchy of public and private exterior spaces, and to assuring that unit layouts were flexible enough to transform over time.

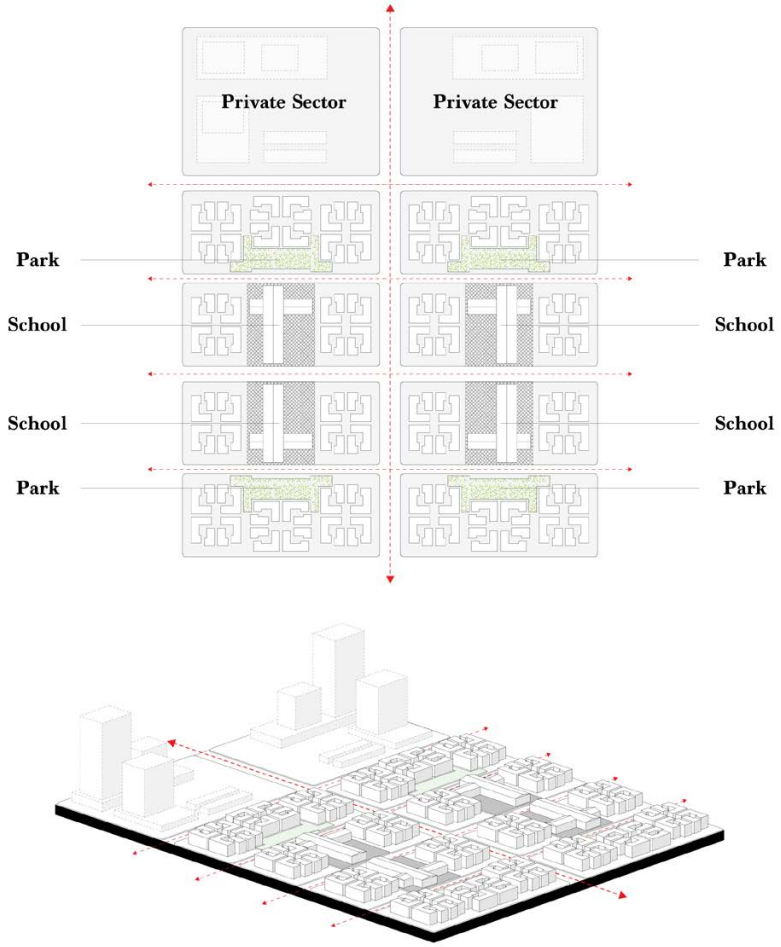


Fig 41: Preliminary urban layout diagram

5. The Proposed Design

Unit

As noted above, the base unit developed for the density studies was a 75 sq. m. flat consisting of three bedrooms, a bathroom, a laundry room, a kitchen and dining area, and a living space that could be partitioned off to create a sleeping alcove for extended family members. All rooms benefited from natural light and both the bathroom and laundry room were located on exterior walls for ventilation purposes. Each unit also benefited from multiple orientations and cross ventilation. (See figure 42) In addition, these units were designed with long term transformations in mind. As household composition changes and/or as families transition from lower to middle class, units can be modified accordingly. For example: a 3-bedroom /1-bathroom unit that once accommodated up to ten family members could be reconfigured into a 2-bedroom/2-bathroom unit with larger rooms for a middle-class family of four. (See figure 43) While it was necessary to anticipate what changes might be made, efforts were made not to make permutations overly prescriptive.

75 sq.m.
3 bedroom Unit

73 sq.m.
3 bedroom Unit Variation

62 sq.m.
2 bedroom Unit Variation

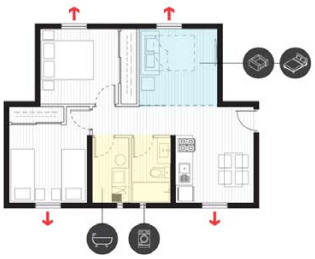
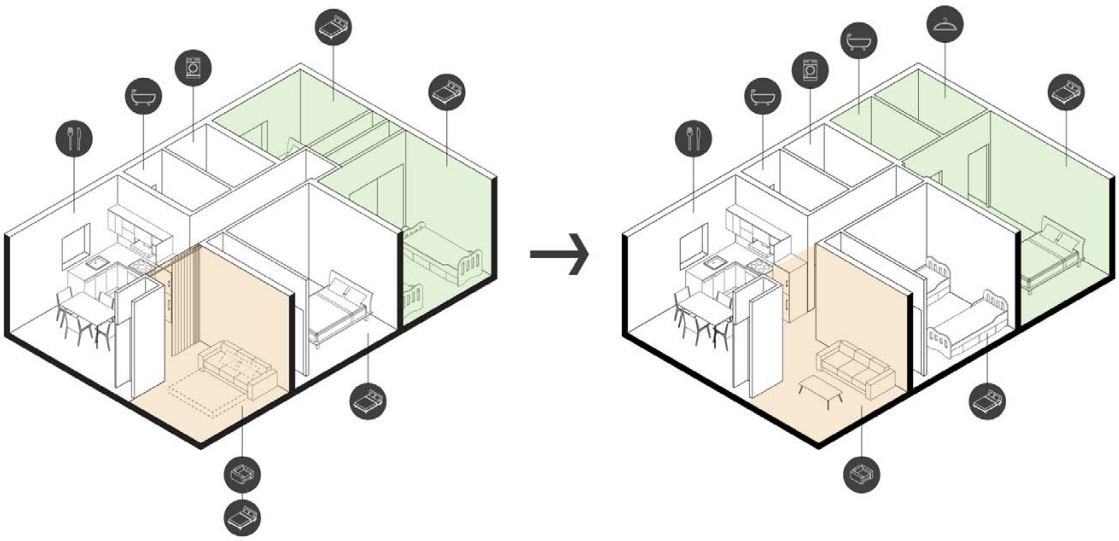


Fig 42: Base Unit Explorations

Base Unit Concept Diagram

Transformation across time



75 sq.m.
3 Bedrooms
Living room / Sleeping alcove
Kitchen
Bathroom
Laundry room

75 sq.m.
2 Bedrooms
Living room
Kitchen
2 Bathroom
Laundry room

Fig 43: Base units variations

As the design of the buildings evolved, however, most units were divided between two floors. (See figure 46) While the addition of stairways within units increased the square footage to an average of 86 sq. m., it allowed me to simplify and reduce the total amount of common circulation. The only shared horizontal circulation is an exterior corridor -- or “street” – facing the courtyard on the 3rd-level. In some cases, the 2-story unit configuration also made it easier to hive off and rent out a portion of the unit. (See figures 47 & 48) While the revised unit square footages are larger than the initial targets, it is important to understand that additional space within each unit produced a better net-to-gross ratio for the building as a whole, due to a significant reduction in the amount of common circulation. And, although units would be more expensive on a cost-per-square-foot basis, the added cost to the owners would be partially offset by a reduction in overall common area fees (condo fees). In the long run, the additional square footage will benefit owners as it will add to the value of their asset.

Following common construction methods used in Angola, units were designed using concrete-block bearing walls spaced every 3 meters. (See figure 45) As per local conventions, pre-cast concrete beams span between bearing walls to support floors[63] (See appendix D for material charts) and efforts were made to stack kitchen and bathroom plumbing. Water would be gravity fed from storage tanks on the roof (into which municipal water is pumped). And, while each unit has access to a private terrace, portions of the common roof will be accessible to residents for drying of laundry.

The ensemble of stacked 2-story units (4 stories in total) includes a mix of 2-bedroom flats and 3-bedroom duplexes. (See figures 47 & 48) Two parking bays were also added at grade for every four units – with the understanding that these bays could be used for other purposes (storage, workshops, etc.). Elsewhere on site, off-street surface parking was provided to achieve the ratio of one parking space per unit.

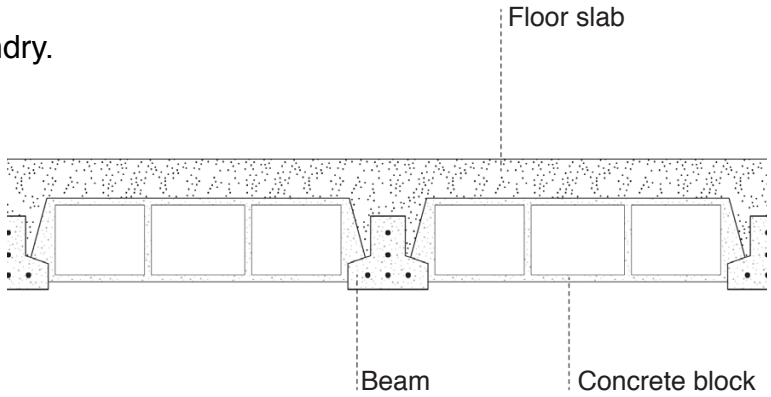


Fig 44: Floor slab construction detail

63 Daio, Ilidio. “Architecture & Planning in Luanda.” Interview by author. October 10, 2018.

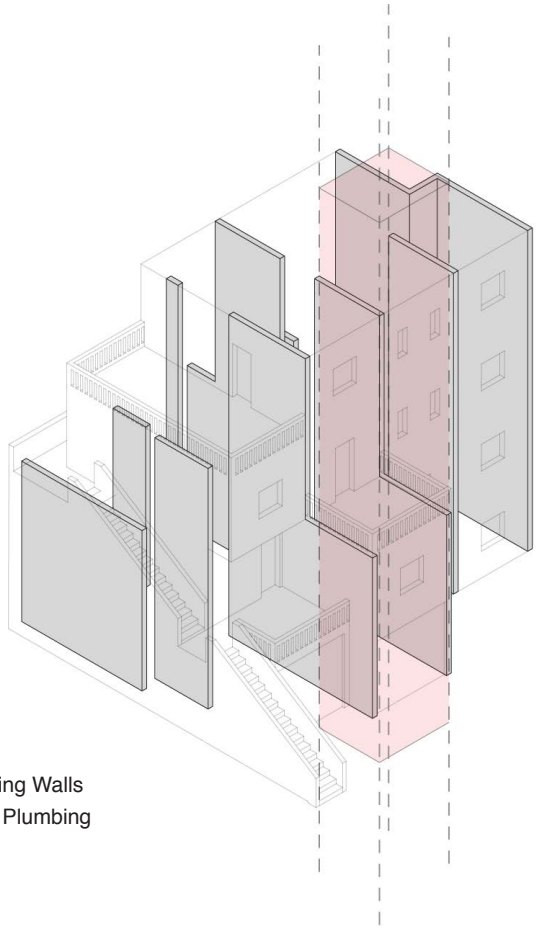


Fig 45: Load Bearing Walls
& Stacked Plumbing

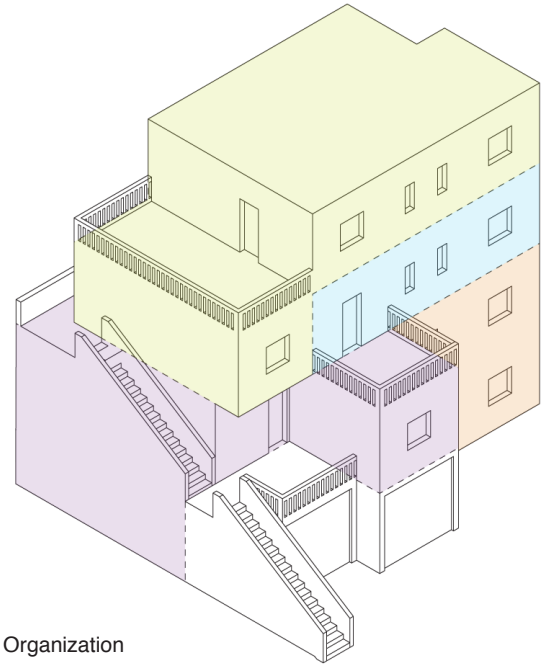
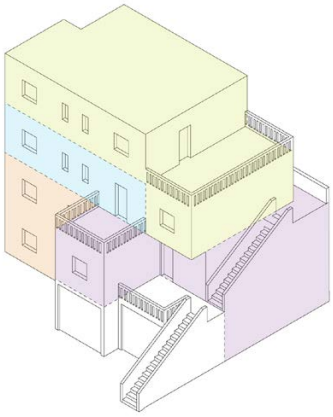


Fig 46: Stacked Unit Organization

Unit Plans



Base Unit Plans

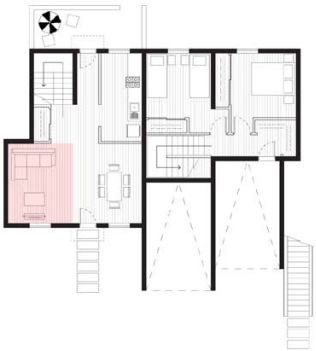
Ground Floor

Second Floor

98 sq.m.
3 Bedrooms
Living room
Kitchen
Bathroom
Laundry room

102 sq.m.
3 Bedrooms
Living room
Kitchen
Bathroom
Laundry room

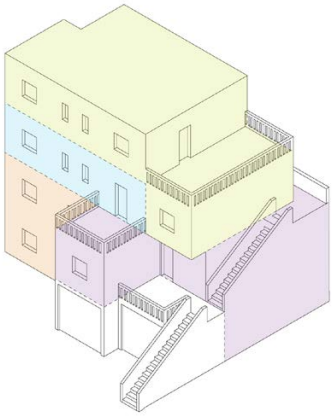
Unit Variations



Bedroom walls can be deleted to add living space. Portions can be hived-off for as rental units.

Fig 47: Unit plans - 1

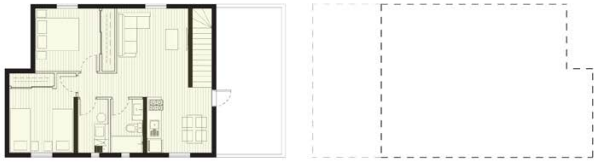
Unit Plans



Base Unit Plans

Unit Variations

Ground Floor



Second Floor

62 sq.m.
2 Bedrooms
Living room
Kitchen
Bathroom
Laundry room

89 sq.m.
2+1 Bedrooms
Living room
Kitchen
1 Bathroom per Level
Laundry room

Bedroom walls can be deleted to add living space. Portions can be hived-off for as rental units.

Fig 48: Unit plans - 2

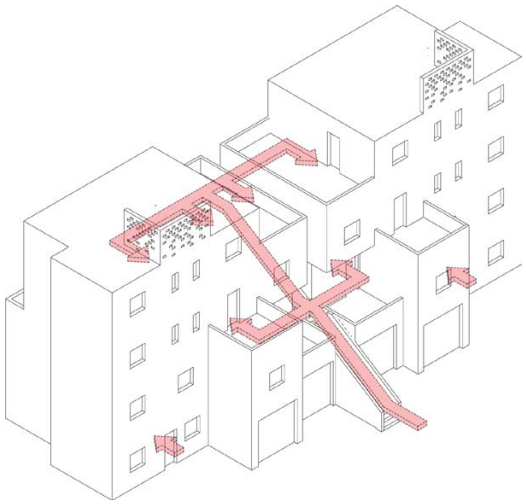


Fig 49: Central access point

Efforts were made to assure that each unit had access to a generous private exterior patio or terrace directly accessible from the kitchen. By mirroring the four stacked units and providing a central access point, the common vertical circulation area is kept to a minimum. (See figure 49) One of the two lower-level units in each 4-unit module is accessed directly at grade, while the other is entered at the 2nd level from the shared central stair. Upper-level units are accessed from exterior corridors at the 3rd level, which are configured to minimize the need to pass in front of another unit en route to one's own. The overall configuration of the mirrored module enabled me to provide a single, exterior point of access from the street for all eight units. These 8-unit pairs were then organized around a central, mid-block courtyard into which secondary egress stairs connect from the 3rd level.

Given the courtyard configuration, efforts were made to minimize the negative effects of living in close proximity – i.e., next to, above or below, and across from one's neighbors. Although residents would be given title to their units, the buildings (and ensembles of buildings) would be structured as condominiums or co-ops, with restrictions to what modifications could be made to common spaces and private exterior spaces (e.g., terraces). Portions of the roofs would be equipped with solar arrays while other portions would be designated as common areas (e.g., for line-drying laundry). (See figure 50)

Roof Usage

Autonomy, resilience, sustainability;
water tanks, solar arrays & roof access

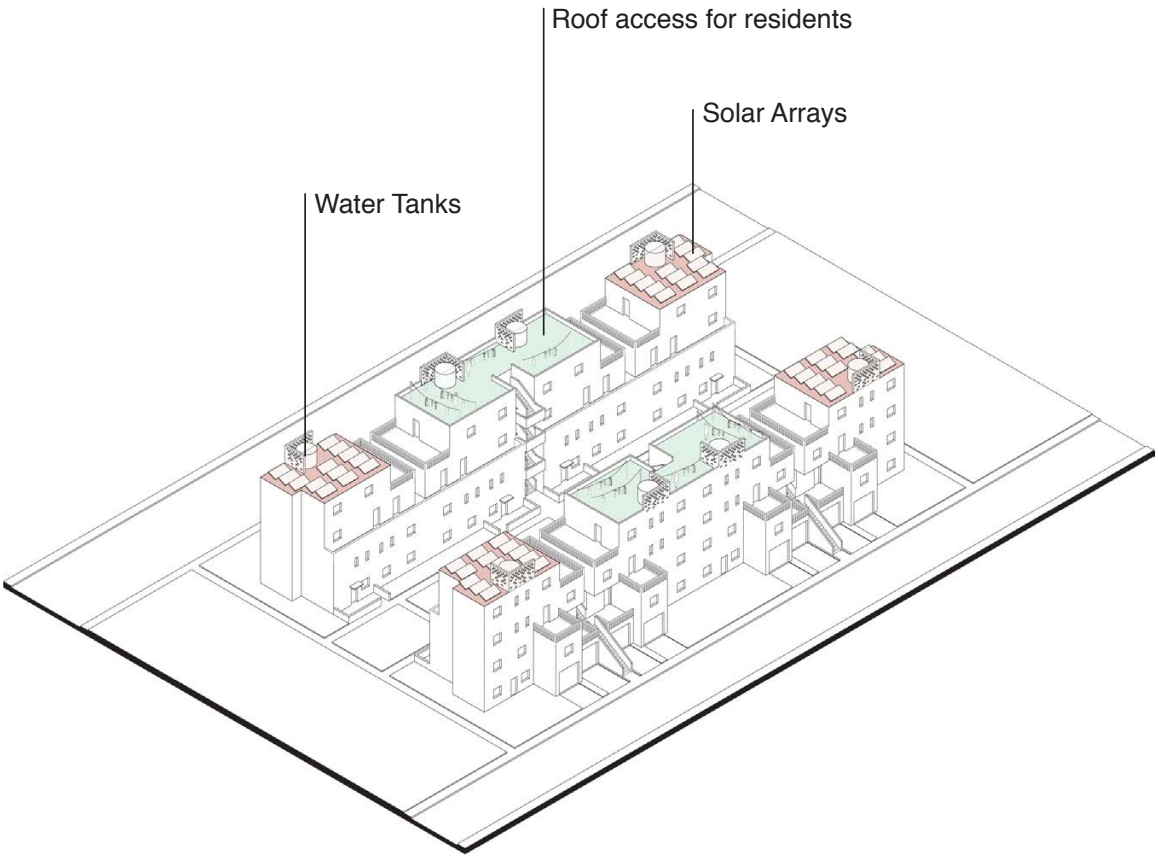


Fig 50: Portions of the roof are available for drying laundry; accessible from common stairs connecting the courtyard, the street in the sky and portions of the roofs. Also, this provides for additional means of egress.

The overall plan also accommodates a range of non-residential uses at grade. As noted above, garage bays along the east/west streets could initially be used as workshops or warehouses, while those on north/south streets could be combined into larger commercial or retail spaces. (See figure 51) Additional space at corners and certain key points have been left open for non-residential uses such as day care facilities, community rooms, clinics, or other social or community-oriented services.

Corners & key points have been left open for non residential uses such as churches, daycares, kindergarten, retail or other community oriented building.

Corners & key points have been left open for non residential uses such as churches, daycares, kindergarten, retail or other community oriented building.

Fig 51: Flexible uses

Flexible bays may be used for small neighborhood oriented commercial use. Over time, it is expected that the small neighbourhood commercial uses transition to parking bays for residents.

Fig 52: Street view render

Fig 53: Courtyard render

Urban level

A variety of courtyard typologies are possible using the 8-unit base building module. (See figures 55 & 56) Four of these modules -- a total of 32 units -- fit into an area of roughly 40m x 60m. Copied and mirrored, different configurations of modules can fit into blocks ranging in depth from 40 to 45 m and between 120 and 200 m in length. While single, double and three-courtyard configurations were developed (see figure 57), I opted to use a standard 45m x 190 m block, divided into three courtyards wherever possible. (See figure 54) Comprised of 12 modules, this block accommodates a total of 96 units. Blocks are oriented east/west so that all units enjoy northern exposure. Single- or double-courtyard configurations were used on smaller and more irregular blocks. When blocks are mirrored, spaces are created for off-street parking, and accessible through laneways. (See figure 58) North/south pedestrian paths cut through each block, dividing the major courtyards. The narrow ends of blocks face onto wider, north/south streets which, as noted above, accommodate commercial activity and more public, institutional uses. Space at alternate corners is set aside for non-residential buildings.

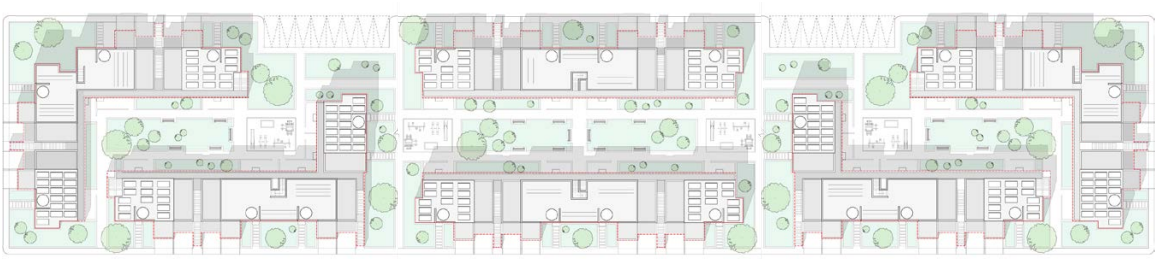


Fig 54: Full Marconi block

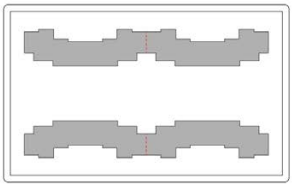
Mid-Block Courtyard Layout

Fig 55: Mid-block courtyard

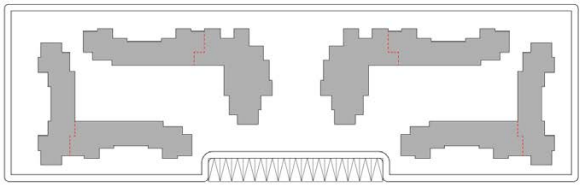
End-Block Courtyard Layout

Fig 56: End-block courtyard

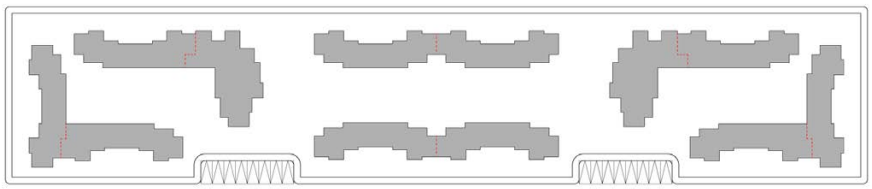
Block Organization



Single courtyard



Two courtyards



Three courtyards

Fig 57: Block organization diagram

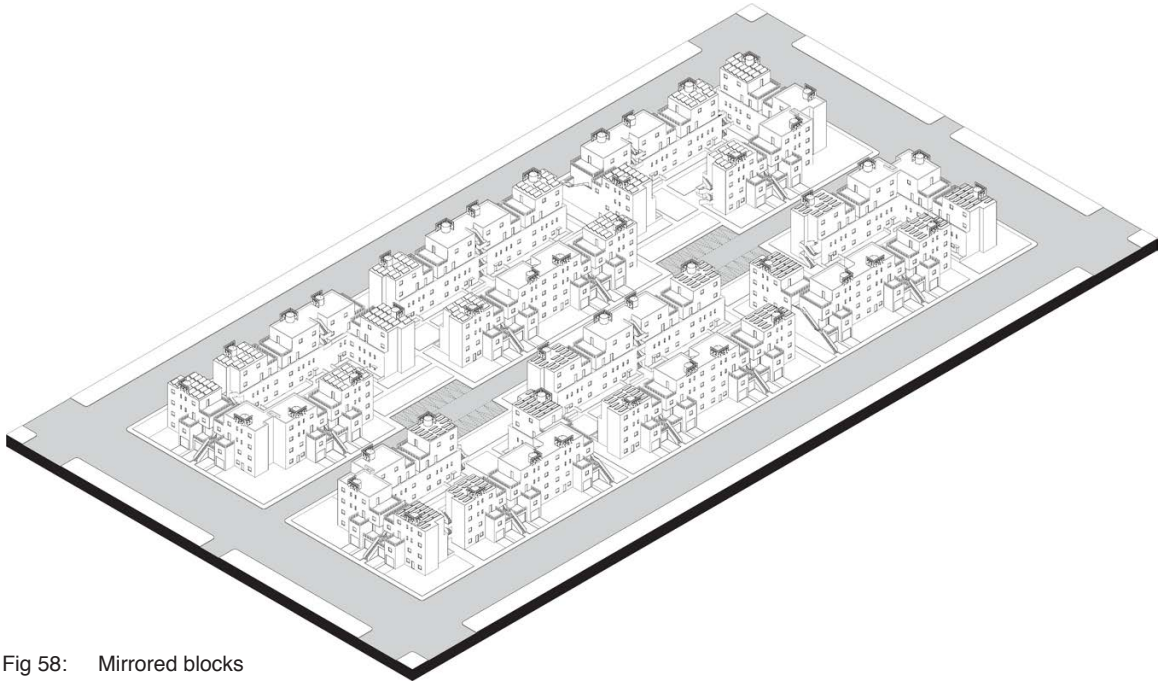
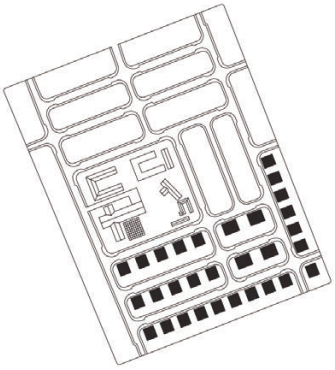


Fig 58: Mirrored blocks

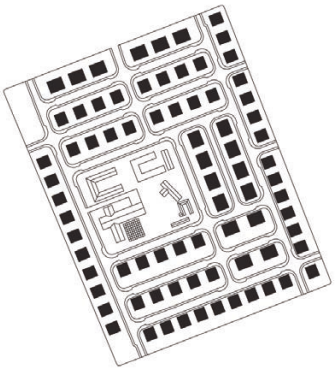
Two mirrored Marconi blocks with 3 courtyard type buildings on each, separated by a 6m lane-way.

Fig 59: Birds eye view render

Corner Lot Courtyard Building



Current State
480 Units in 30 Buildings
Only 2 are currently occupied



Original Proposal
1184 Units in 77 Buildings

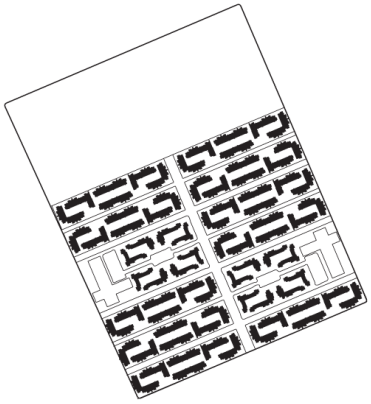
Fig 60: Marconi Development

Understanding that a mixture of one-, two- and three-courtyard blocks would be used for the build-out of Marconi (See figure 63), a number of questions arose:

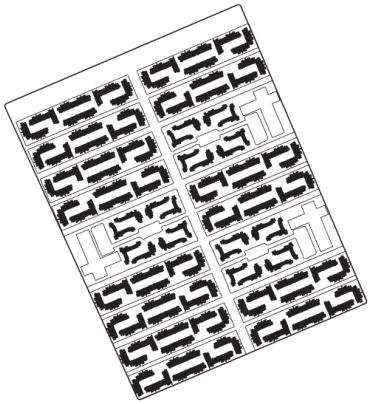
1. Should I leave or demolish the existing buildings on Marconi, understanding that most of the buildings remained un-occupied? Demolishing the buildings would enable me to treat the redevelopment as a blank slate.

2. Should 30% of Marconi be set aside for private-sector development or should the site be built out entirely with replacement housing, with the understanding that land for the private sector would be allocated elsewhere (e.g., closet to a major road) in a subsequent stage of redevelopment?

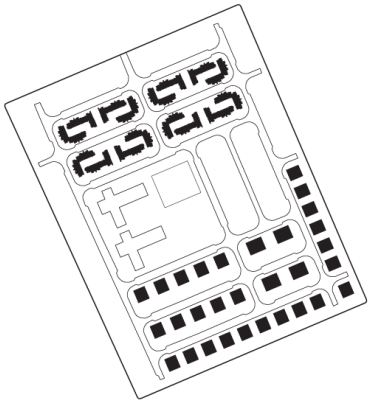
Marconi Redevelopment Options



Redeveloped disregarding current conditions while allocating 30% of land to the private sector.

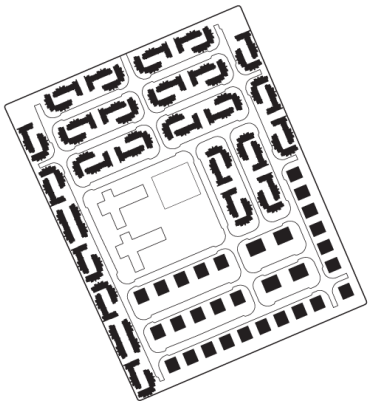


Redeveloped disregarding current conditions with housing on full site. 30% to be allocated to the private sector in phase 2.



Redeveloped while keeping existing buildings and allocating 30% of land to the private sector.

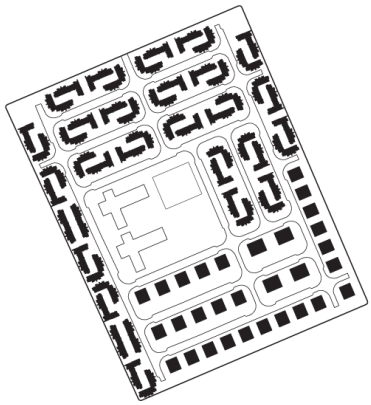
Preferred Option



Redeveloped while keeping existing buildings. 30% to be allocated to the private sector in phase 2.

Fig 61: Marconi redevelopment options

Having assessed the various alternatives (see Figure 61), I opted to leave the existing buildings and to build out the full balance of the site – approximately 13 blocks – with replacement housing. This meant addressing the issue of land for private-sector development in a subsequent phase. This layout enabled me to reach a total residential density, including the existing apartment blocks on the site, of 28 UPA (38 net), an FSI of 0.8 (excluding schools and open spaces), and an overall density of 223 PPA (based on 8 people per household but not including people who may come from elsewhere to work on site). The overall residential density is higher than what was originally planned for Marconi (a gross density of 24 UPA) and significantly higher than that of the abutting areas (20 UPA).



Redeveloped while keeping existing buildings. 30% to be allocated to the private sector in phase 2.

Fig 62: Marconi development strategy

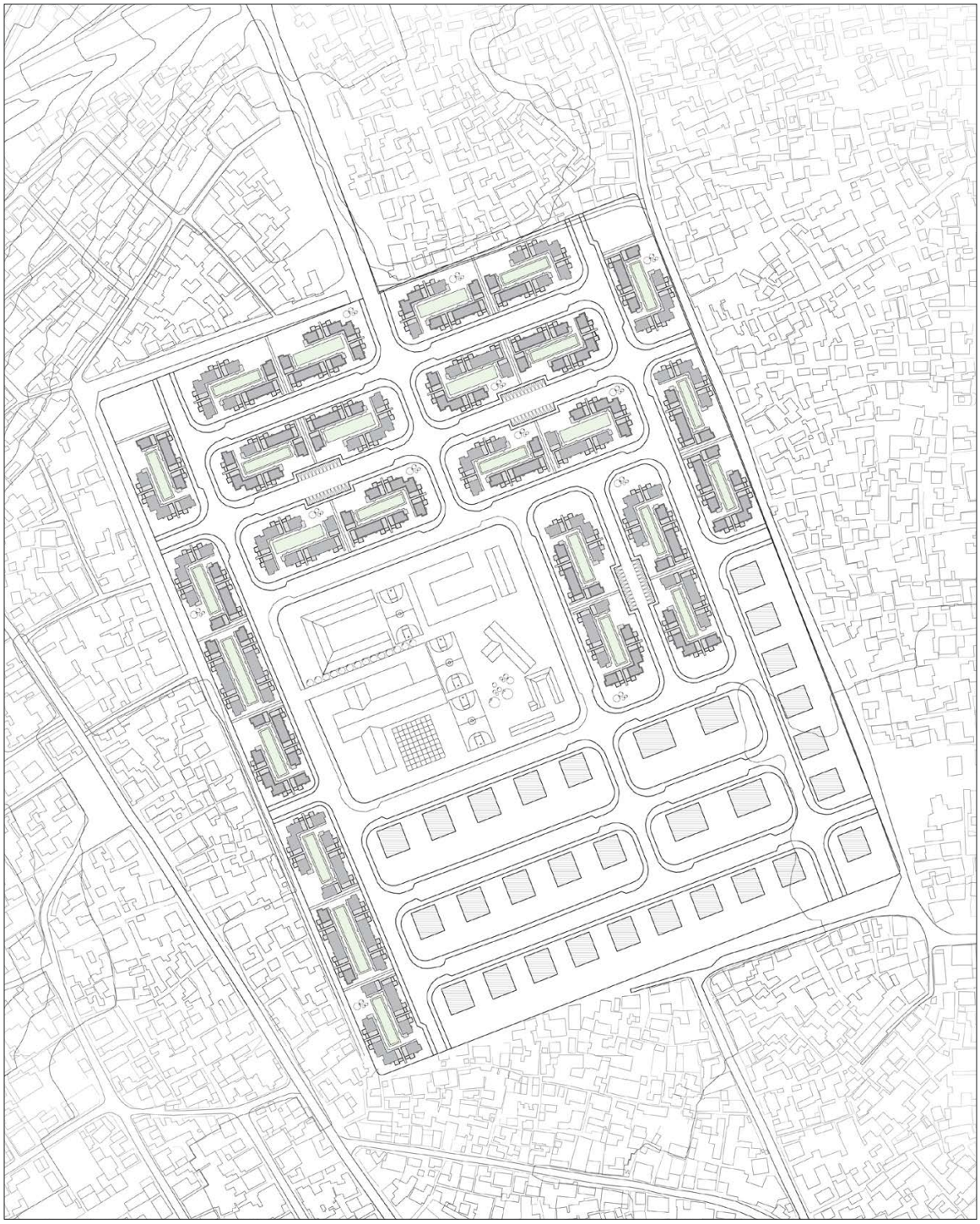


Fig 63: Marconi Master plan

Marconi Proposed Master Plan

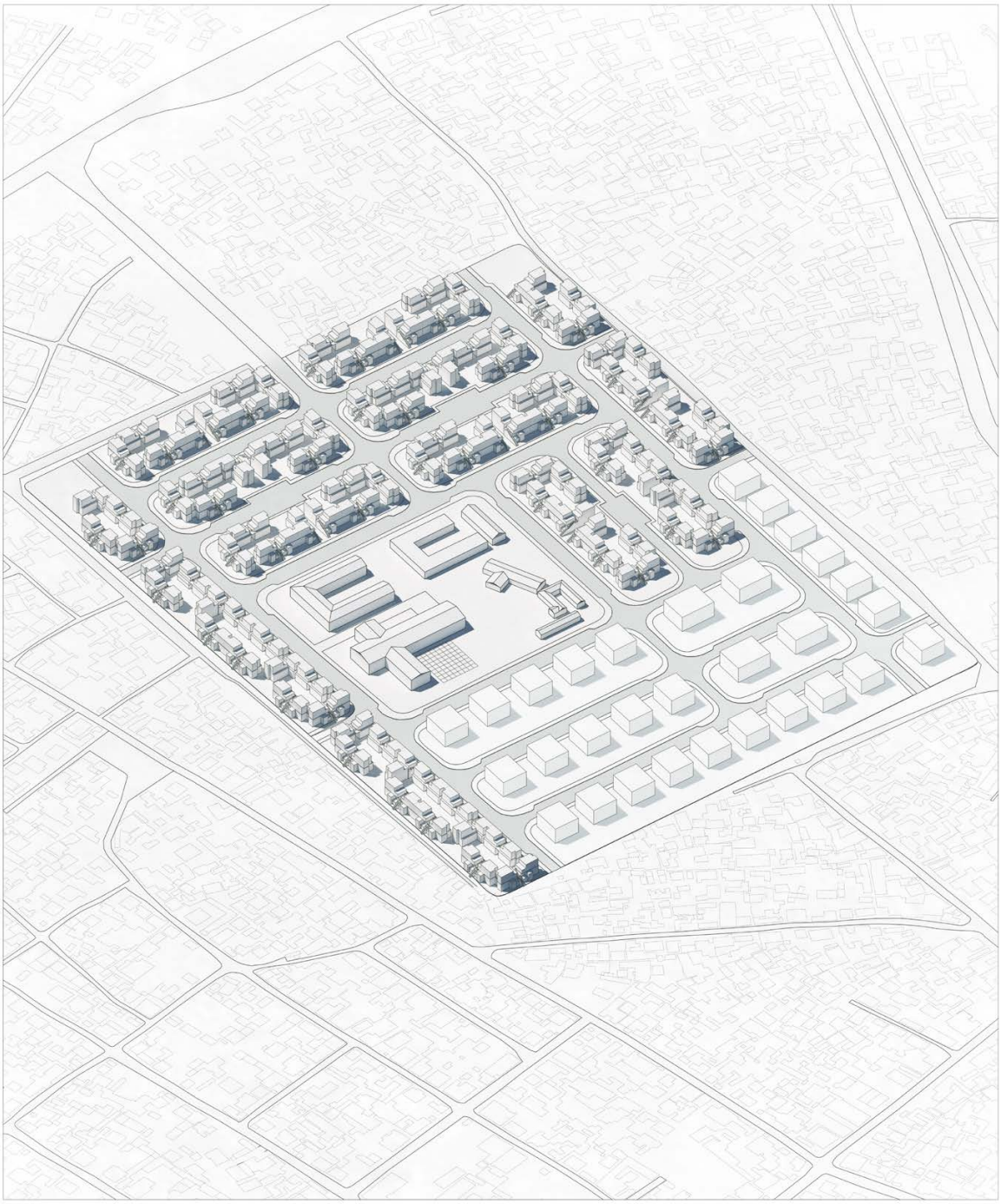


Fig 64: Marconi master plan axonometric view

Marconi Proposed Master Plan

In addition to providing housing at a higher quality and density than the adjacent informal settlements, the goal is to regularize the urban fabric, working outwards from Marconi. Such regularization, would respect, wherever feasible, the existing urban structure so that redevelopment can proceed incrementally, in phases. (See figure 65) Existing main roads and passages will be kept, with new roads and blocks connecting into them. Wherever necessary, main roads will be widened to a minimum width of 15m, not including sidewalks, while minor streets will be at least 9m in width. Where they are introduced, mid-block laneways that accommodate vehicles will be no narrower than 6m. As formulated, this strategy can be applied to the redevelopment of adjacent neighborhoods. Residents from these areas can be moved into – and given title to – newly constructed units in Marconi, opening the way for the phased redevelopment of the surrounding neighborhoods as shown in figure 65.

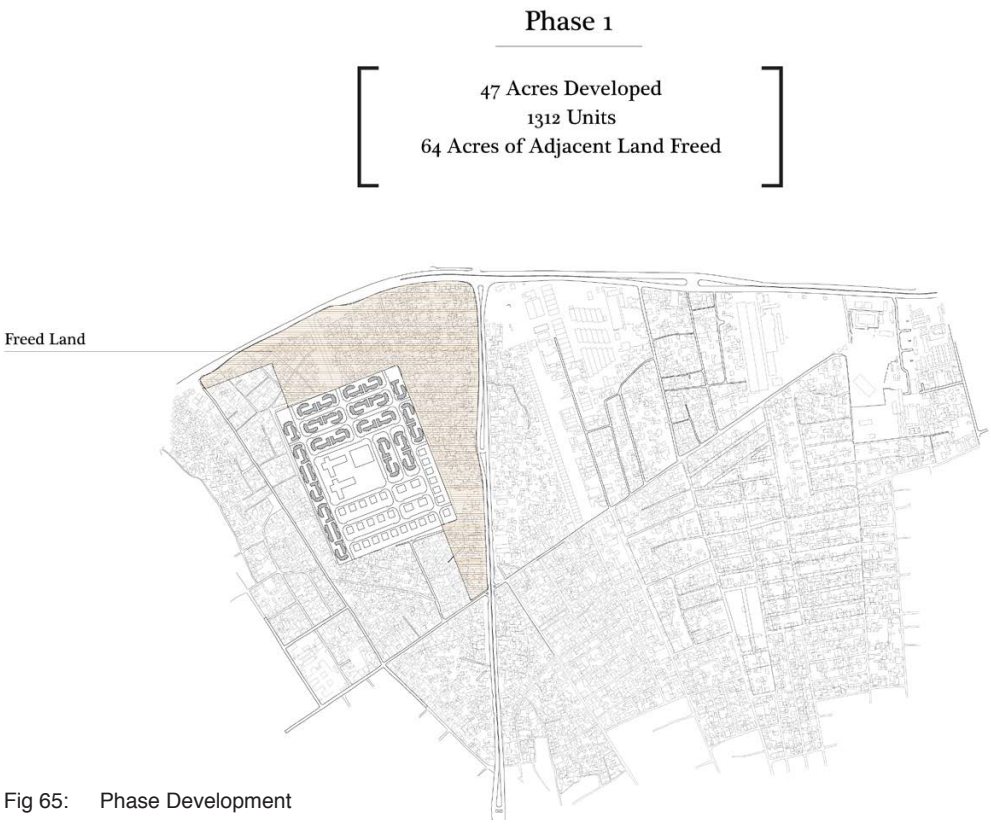
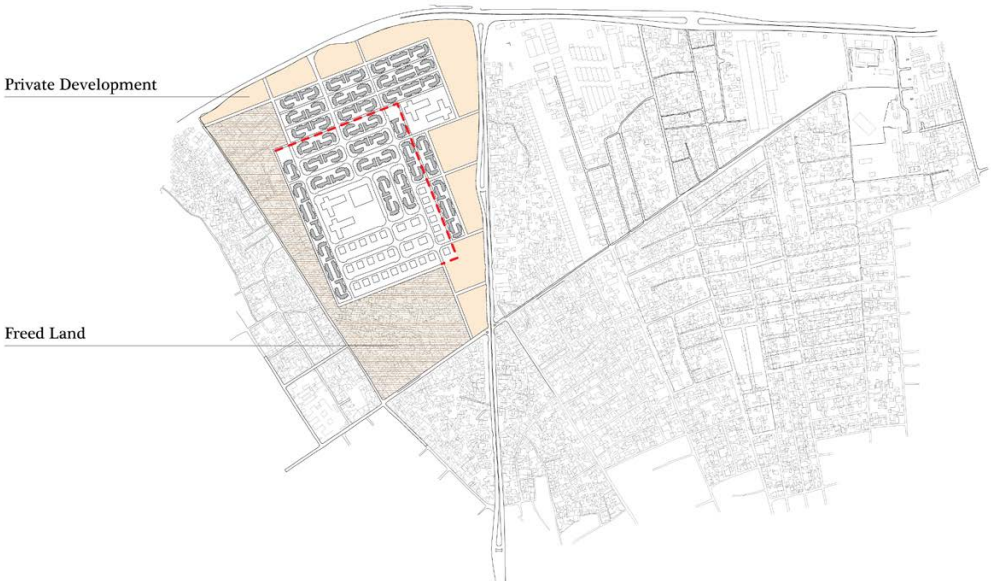


Fig 65: Phase Development

Phase 2

64 New Acres Developed (111 total)
832 Added Units (2144 total)
37 Acres Allocated to Private Sector (34% of 111 acres)
40 Acres of Adjacent Land Freed



Phase 3

40 New Acres Developed (151 total)
992 Added Units (3136 total)
12.5 Acres Allocated to Private Sector (32% of 40 acres)
52 Acres of Adjacent Land Freed

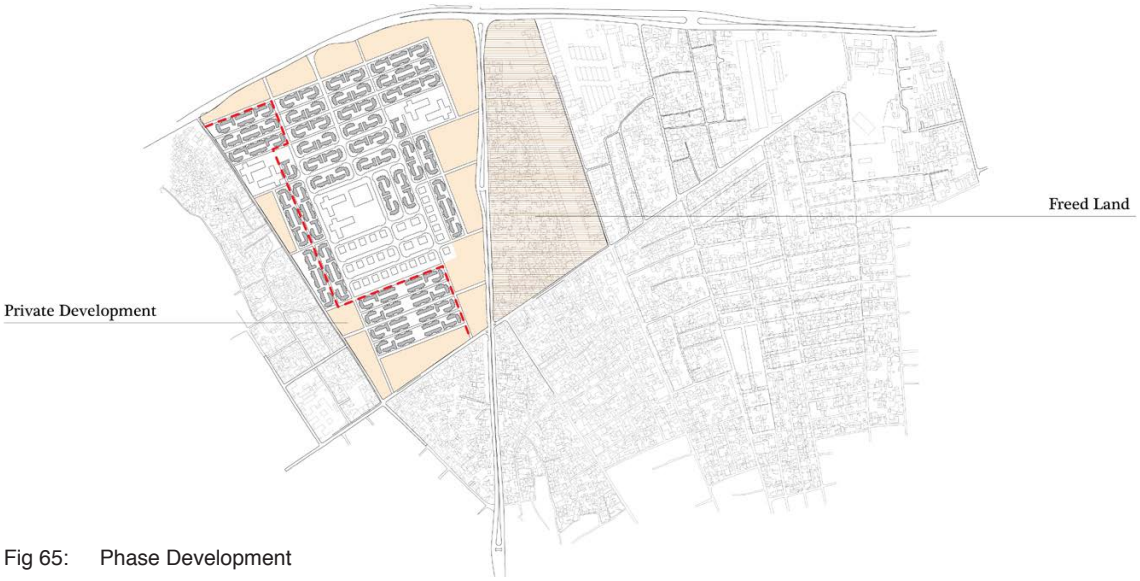
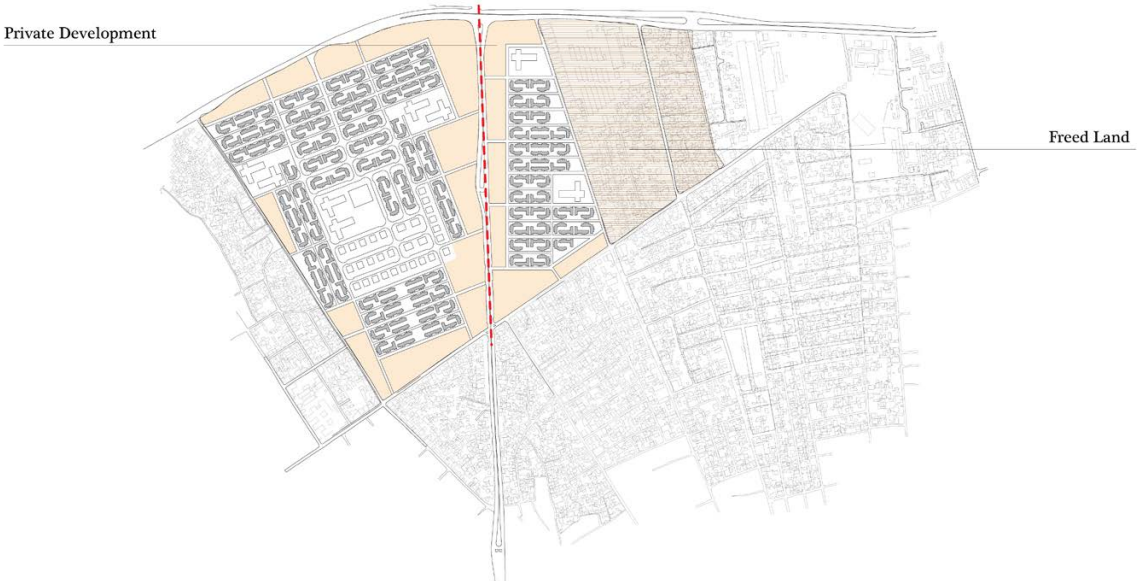


Fig 65: Phase Development

Phase 4

52 New Acres Developed (203 total)
1024 Added Units (4160 total)
10 Acres Allocated to Private Sector (35% of 52 acres)
55 Acres of Adjacent Land Freed



Phase 5

55 New Acres Developed (258 total)
1248 Added Units (5408 total)
19 Acres Allocated to Private Sector (35% of 55 acres)
63 Acres of Adjacent Land Freed

Fig 65: Phase Development

Phase 6

63 New Acres Developed (321 total)
1216 Added Units (6624 total)
22 Acres Allocated to Private Sector (35% of 63 acres)
Would Free 61 Acres of Adjacent Land

Fig 65: Phase Development

6. Conclusion

Ongoing rural-to-urban migration in Angola has resulted in extensive numbers of informal settlements in major cities like Luanda; these low-density, self-built settlements account for some 80% of the urbanized area.[64] The approaches taken to the upgrading and/or redevelopment of these settlements will have a profound effect on the long-term health – physical, social and economic – of the country as a whole.

In their limited efforts to address housing shortages, local authorities have too often resorted to partnerships with foreign companies. The result has been poor urban and architectural responses based on unsustainable financial formulae. As such, Angola now finds itself at a crossroads, in search of new, viable architectural and urban solutions in the midst of difficult financial times. With a newly elected president promoting innovative and sustainable approaches to housing reform, however, there is an opportunity to revisit past approaches to housing shortages and slum redevelopment. The work presented here both recognizes the need for change and demonstrates the feasibility of sustainable solutions. The claim of sustainability is based on sound economic principles, greater social integration, higher densities in support of more efficient use of infrastructure, land tenure reform in support of a stable municipal tax base, orderly and flexible urban fabric, and, most importantly for me as an architect, housing that meets the

64 Gastrow, Claudia. “Cement Citizens: Housing, Demolition and Political Belonging in Luanda, Angola.” Citizenship Studies 21 (2). Routledge. 2017. 1.

current and future needs of families in transition. As stated above, title to market-friendly housing will greatly facilitate the growth of Angola's middle class.

My research and analysis of conditions in Luanda have reinforced the assertion that informal settlements are a solution rather than a problem. They support a multitude of networks and frameworks that facilitate the transition from rural to urban life, from poverty to prosperity. All aspects of life – personal, social, and economic -- take place within the slum. In addressing the need for redevelopment, then, it is crucial not to "throw out the baby with the bathwater," i.e., improve the quality of housing at the expense of other aspects of life (e.g., economic opportunities and social mobility). Identifying and understanding the "successful" aspects of informal settlements is key to developing successful communities of replacement housing – communities that can change and evolve along with their residents. On-site field work and direct interaction with concerned parties is crucial to the process. The knowledge gained in Luanda, paired with research and data gathered prior to the site visit, has helped me to contextualize and conceptualize issues of ownership and citizenship in the city's informal settlements. This was key to formulating an urban and architectural response that addresses both short-term needs and long-term viability.

The proposal for the phased redevelopment of Marconi and its environs is the result of a highly iterative process, testing targets and assumptions at the scale of the unit, the building and the neighborhood. While specific in many aspects, the response is intended to be generic enough to withstand the inevitable challenges involved with bringing it

to fruition. The proposal should be understood as a series of principles and strategies more than an overly specific or prescriptive vision for the redevelopment of Marconi and the surrounding neighborhoods. At a meta level, the exercise was intended as a proof-of-concept for a way forward. And while many aspects of the design are key to the proposal's success, the buildings should be seen as placeholders. Rather than "Architecture with a capital A," the housing represents an attempt to test assumptions against constraints to prove the feasibility of the project. And, while the multi-unit building typology was preferred in this exercise, it should be noted that the greater vision for the phased redevelopment could include a wide range of housing typologies, leading to a diverse, flexible and resilient urban fabric.

My proposal for Marconi and its environs is based on current needs and on assumptions about the future. It is a product of its own rigid structure, which is a function of the limited research I've been able to undertake in the limited time I've been able to dedicate to the undertaking. This is not to say that the proposed framework won't or can't lend itself to new ideas, strategies and paradigms but rather that it must be put to the test. Ultimately, it's the residents that will shape the building and determine its success. An independent, long-term study would likely raise a whole new set of issues and ideas. The investigation of how livelihoods change over the course of the transition from lower to middle class would cycle back and inform ways in which living spaces could be optimized.

Next steps

Moving forward, more time should be spent on understanding urban

relationships and realities. Ideally this would be done by presenting the proposal to -- and receiving feedback from -- key stakeholders (community representatives, politicians, city officials, developers, planners, architects, etc.). While the design portion of the thesis focuses on replacement housing for slum dwellers and formalizing the informal, largely self-built urban fabric, the proposal also addresses private-sector, market-driven housing, mixed-use development, institutional buildings, commercial activity and public space. All of these must be supported by proper infrastructure (roads, utilities, public transportation, etc.) and all are key to the long-term health of Cazenga and Luanda as a whole. Across the board the high-price of housing is an indication of severe shortages in all markets. As such, it is crucial to consider the provision of market housing in tandem with slum redevelopment.

Private investors, government officials, community associations, lending institutions, architects and urban planners must come together to determine how best to address the challenges and leverage the opportunities associated with urban transformation. Redeveloping informally built areas of the city at a higher density will not only enable the residents of Luanda to re-imagine what their city might become, but opens the door to a more sustainable urban future.

Reflecting upon the work produced, it is evident that the project would have benefitted from a better distribution of design and research efforts. Developing the design strategy earlier while continuously researching would have most likely fostered more ideas and may have steered the project in a different direction. Furthermore, visiting and spending time on site proved to be one of the most valuable

ways to gain insight into the nature of the challenge and the needs of residents. The opportunity to have spent more time in Luanda earlier in the process would have been an undeniable advantage. Nonetheless, the process I followed has allowed me to formulate a comprehensive redevelopment strategy and to design a flexible housing prototype whose ultimate success can only be proven through implementation and monitoring over time. To a great degree all architectural projects are subject to the same limitations.

Appendix A

Photographic Catalogue of Sites

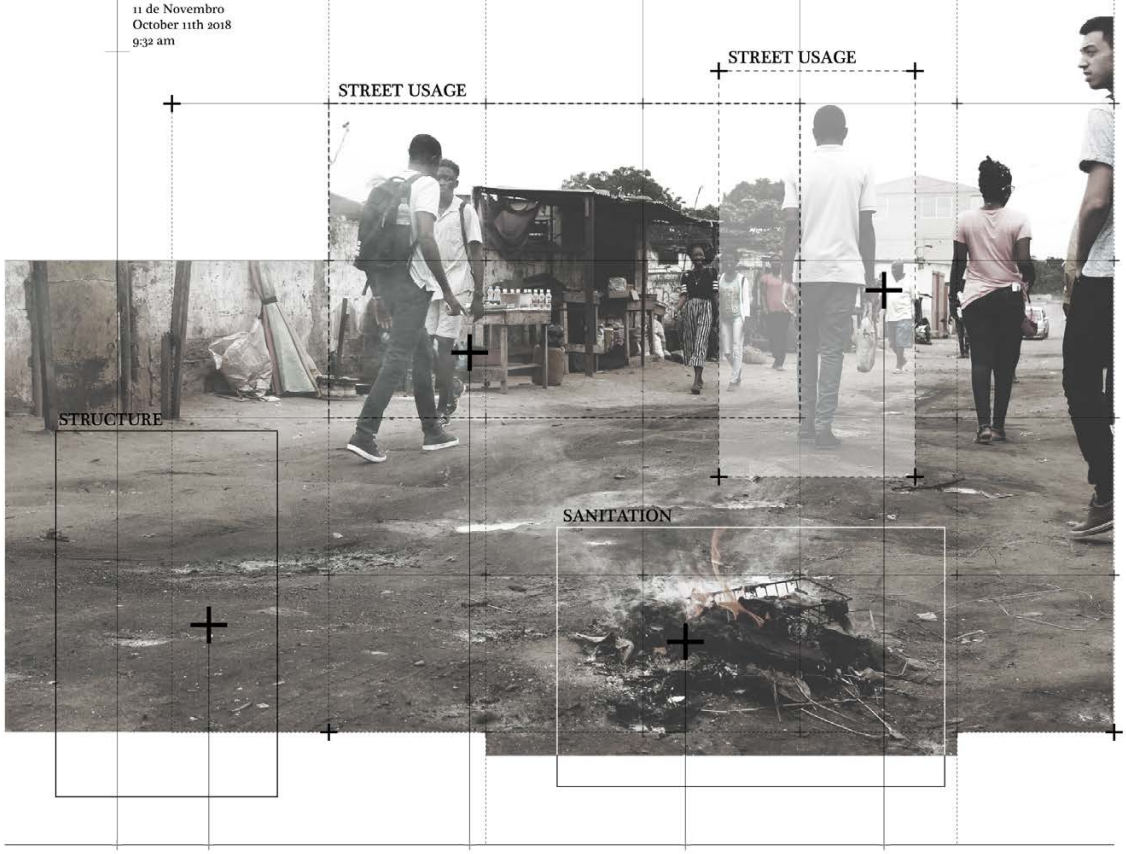
Street Fabric

Street Fabric

11 de Novembro

The lack of infrastructure in this area is reflected in its streets yet they are the site of economic growth and social life.

11 de Novembro
October 11th 2018
9:32 am



Analytic Breakdown

All streets are unpaved, have no sidewalks and but up directly to the homes.

Street edges have been appropriated by locals for business purposes.

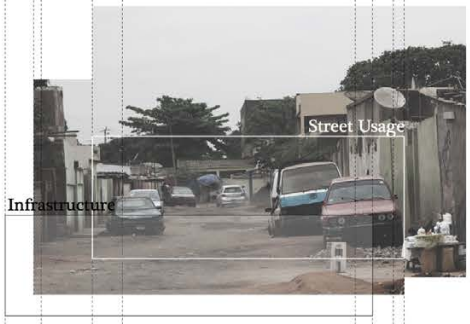
No sanitary infrastructure is in place. Streets become site of garbage dumping and burning.

Streets are the main zones where public life takes its course

11 de Novembro

Street Fabric

1



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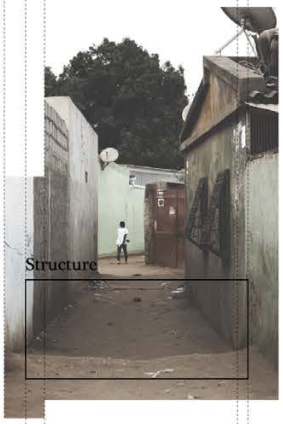
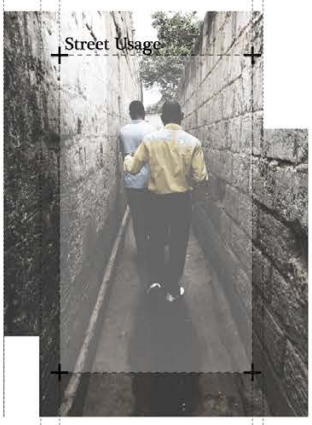


3

4

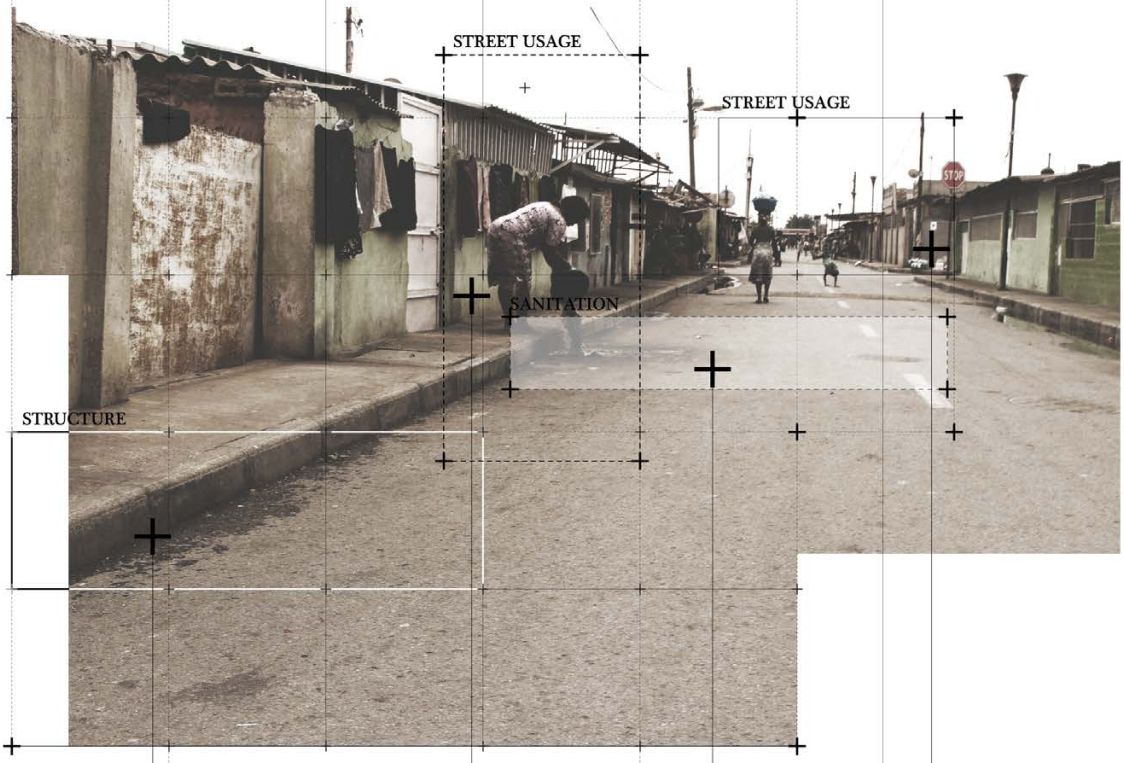


Cariango

The state has come in and introduced proper infrastructure. Without touching the homes, streets were paved above the existing grade along with water mains, sewage and electricity.

Street Fabric

Cariango
October 12th 2018
11:26 am



Analytic Breakdown

All streets are paved, have sidewalks and were built above existing grade

People make use of sewage networks outside of the home.

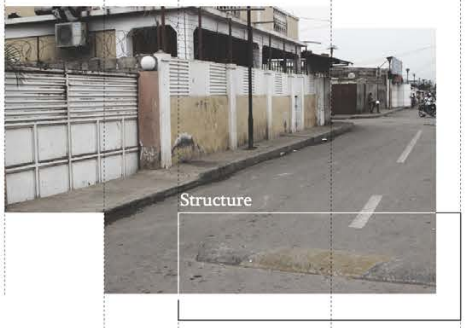
Both water mains and sewage lines were incorporated in the rebuilding of the street.

Business and social life is conducted mostly on the street and sidewalks.

Cariango

Street Fabric

1



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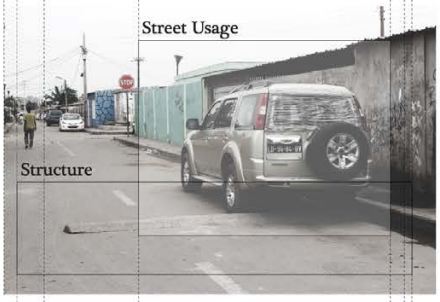


3

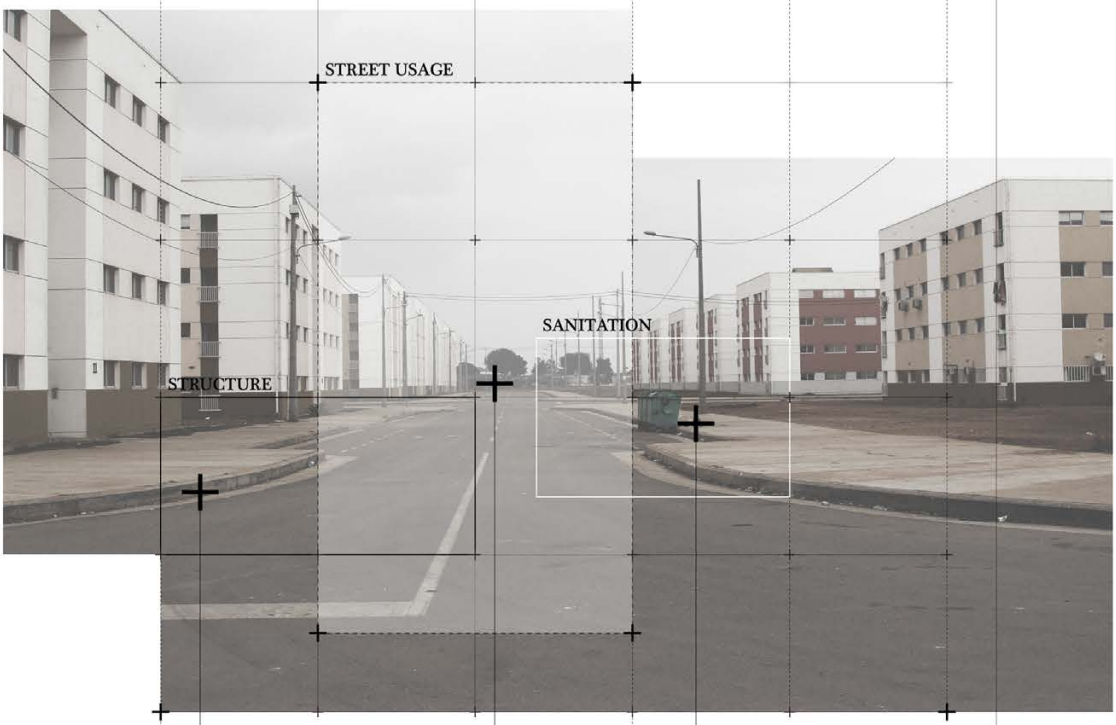
4

Marconi

The partially redeveloped site is virtually empty and the small number of residents have not taken ownership of open spaces.

Street Fabric

Marconi
October 9th 2018
10:06 am



Analytic Breakdown

Streets are fully paved. Wide sidewalks separate the street from the apartment buildings and carve out parking spaces on each side.

Street activity seems non existent in all of Macroni.

Sewage and water mains are functional under the street. Government garbage bins have also been installed in the streets for pick up.

Marconi

Street Fabric

1

2

3

4

Housing Typologies

11 de Novembro

Housing takes many forms within this area; from unstable metal structures to brick and concrete homes. All housing is single story constructions.

Housing Typologies

11 de Novembro
October 11th 2018
9:14 am

Analytic Breakdown

Boundaries between public and private realm are ofter blurry or ill-defined.

Streets butt up directly against homes. Water & contaminants coming from the street often affect homes.

Corrugated metal panels are used as building material for both roofs and walls.

Clay bricks and concrete are also used. This is a cheap building material in Angola and allows for better structural support.

11 de Novembro

Housing Typologies

1

2

3

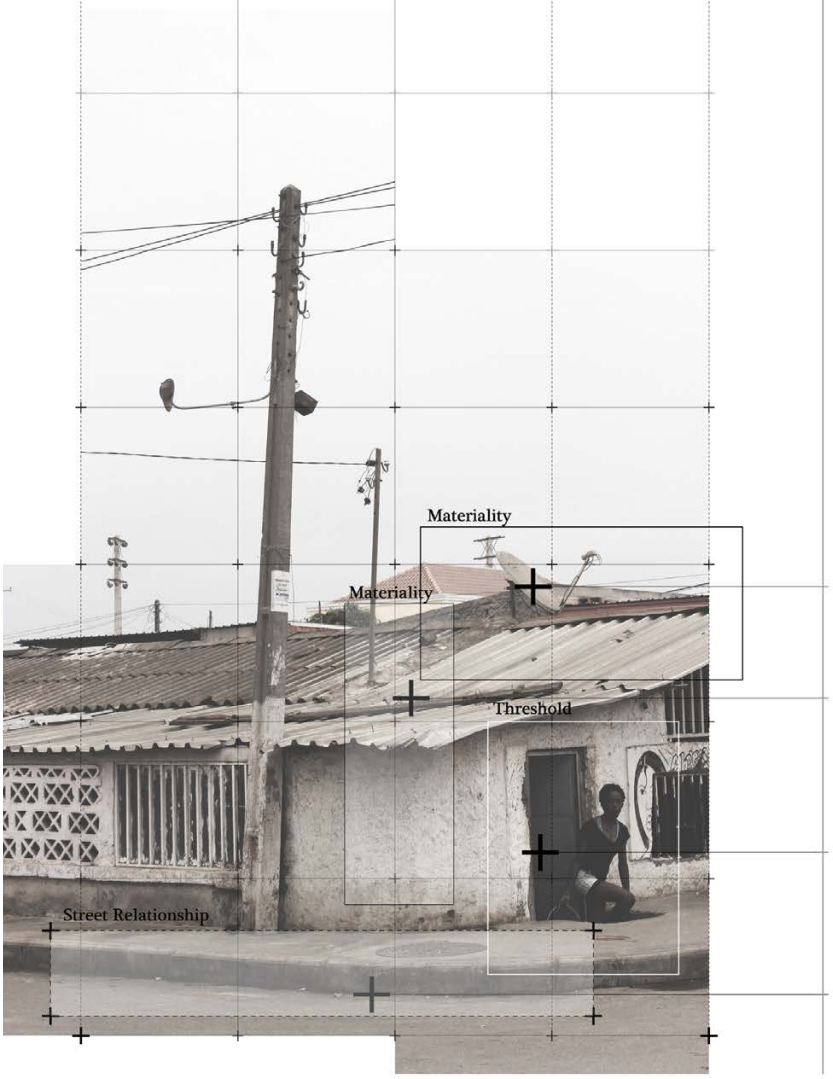
4

Cariango

Housing is better developed in this area than in most Musseques. One story brick & concrete homes with a metal roof is the norm in Cariango.

Housing Typologies

Cariango
October 12th 2018
11:10 am



Personal upgrades have been made. Electricity being present in Cariango, several homes have satellite dishes and even air conditioning.

Masonry walls with corrugated metal roof is the norm in Cariango.

Homes are set lower than the street, creating a unique entrance condition where one must go down to enter the dwelling

Boundaries between public and private realm is very defined. A sidewalk separates homes from the streets.

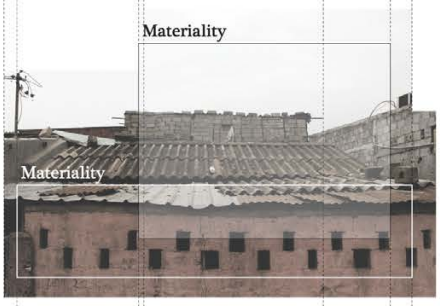
Analytic Breakdown

Cariango

Housing Typologies

1

2



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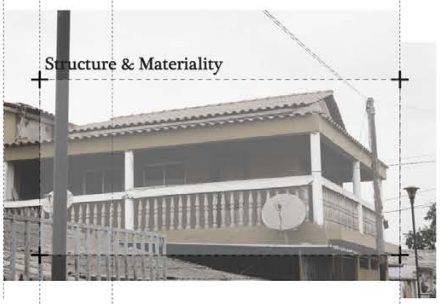

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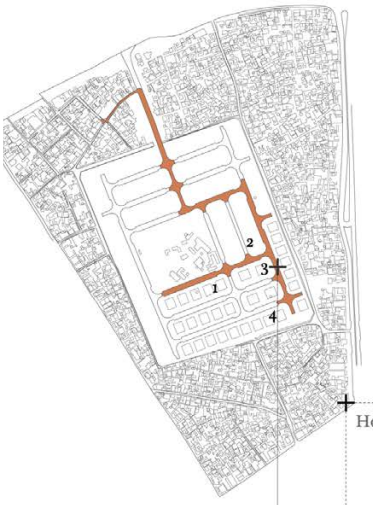
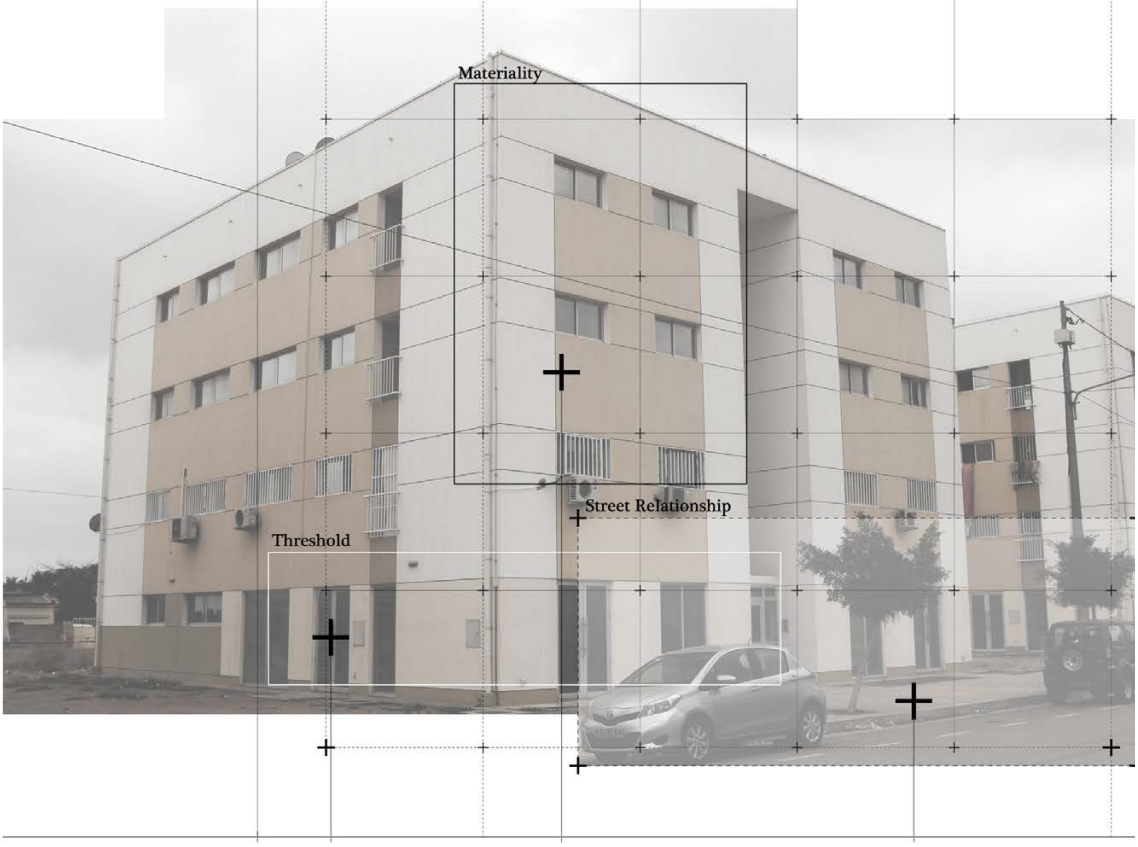


Marconi

The once empty area was redeveloped with state funds to accommodate for families from the informal settlement directly north of the site.

Housing Typologies

Marconi
October 9th 2018
10:13 am



Analytic Breakdown

The ground floor of the buildings is both the residential access and home to commercial spaces. Commercial bays are currently all empty.

All buildings in Marconi are concrete frame constructions. They are four story apartments with 4 units per floor. Each unit is either 2 or 3 bedrooms.

Large sidewalks separate the buildings from the street. Street parking is also located in front of all buildings.

Marconi

Housing Typologies

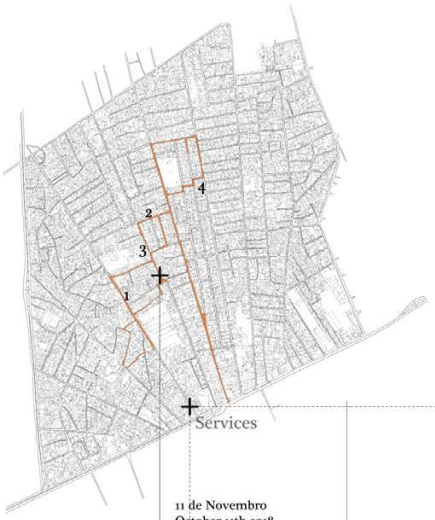
1

2

3

4

Services



11 de Novembro

Services are one of the primary concerns in 11 de Novembro. Although electricity and water once serviced the area, such amenities seem to no longer be available.

Services

11 de Novembro
October 11th 2018
9:49 am

Analytic Breakdown

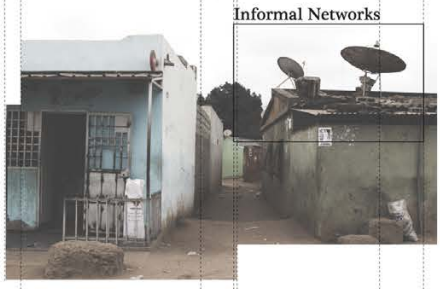
Sewage is inexistent. According to locals, water pipes are present in certain areas but mostly dysfunctional.

Electric wires and lights are present but do not provide any electricity to the area. They are reminders of functioning services from the 80's.

Services such as internet and cable TV are often tapped into illegally. Satellite dishes are often found on roofs of informal dwellings.

11 de Novembro

Services



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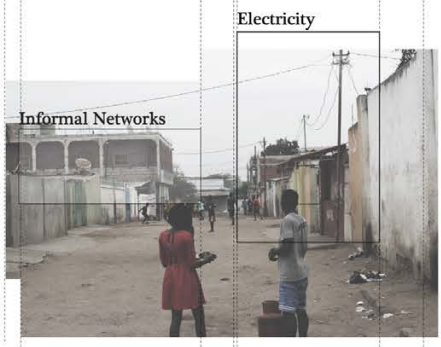
3



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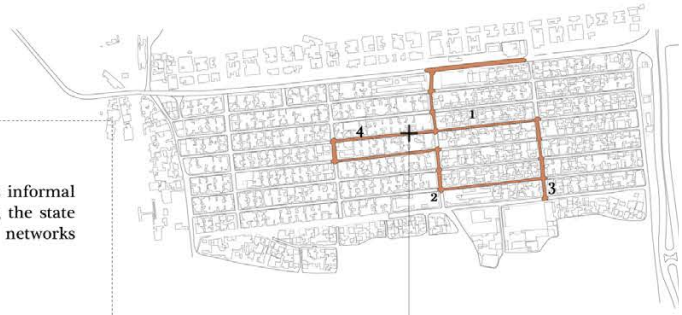


Cariango

Cariango is most likely the best services informal area of Luanda. When roads were paved, the state implemented water services, electricity networks and even public wifi.

Cariango
October 12th 2018
11:29 am

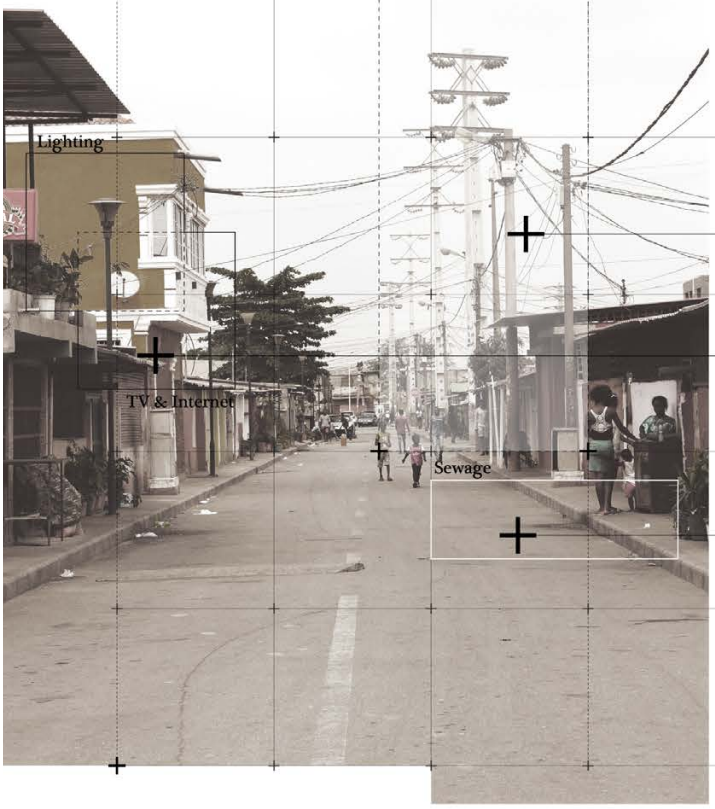
Services

Electricity

Lighting

TV & Internet

Sewage



Neighborhood is fully serviced with electricity.

Street lighting, public wifi and satellite services are all in place throughout the neighborhood.

Sewage and water mains were installed when the road was built. Homes can now be services with water and flooding in the area is no longer a problem.

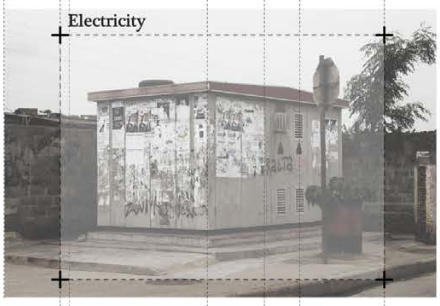
Analytic Breakdown

Cariango

Services

1

2



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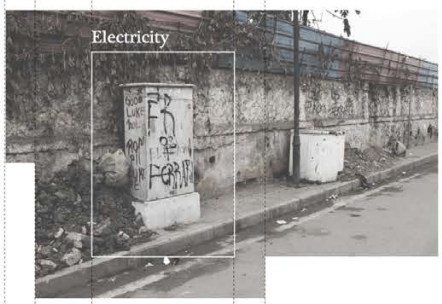

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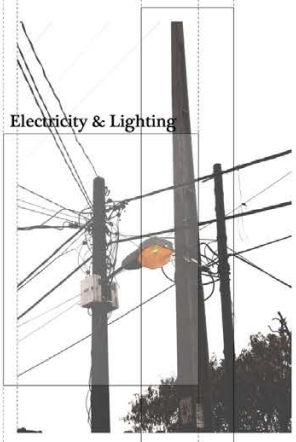
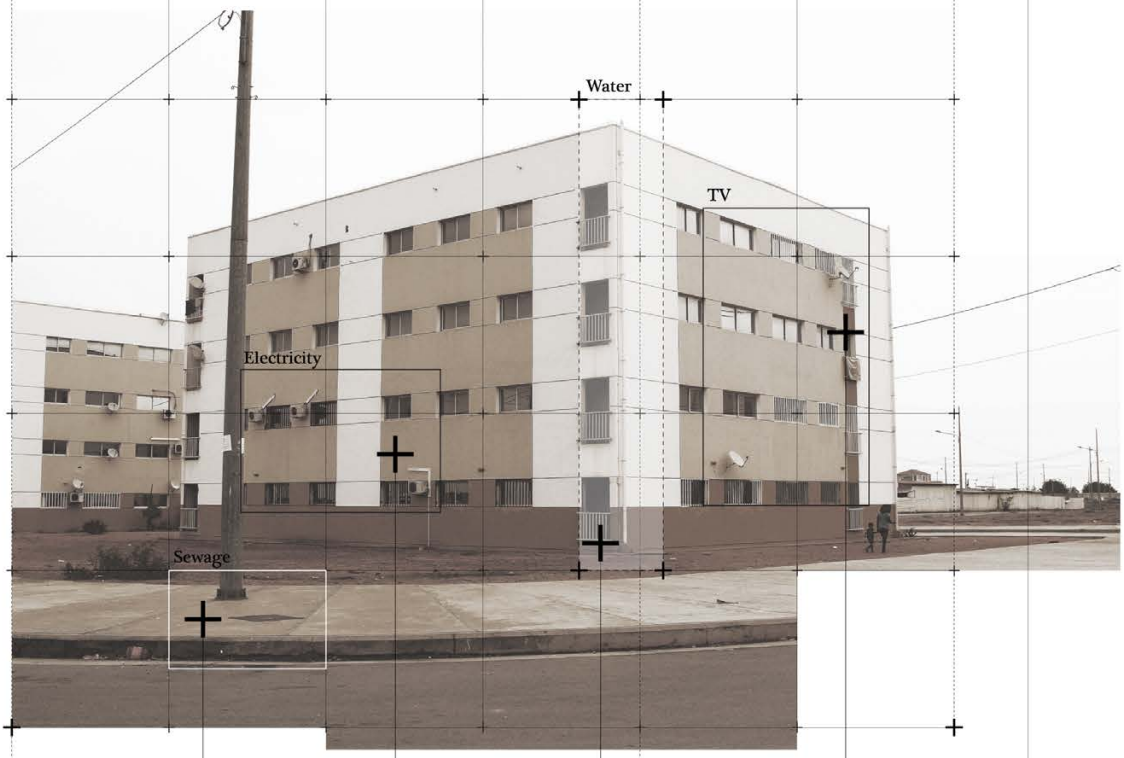


Marconi

Alike Cariango, this newly developed area is fully services with water mains, sewage and electricity.

Marconi
October 9th 2018
10:10 am

Services



Analytic Breakdown

Sewage and water are an integral part of the Marconi redevelopment efforts.

Every apartment is wired with proper connection to the city's electrical grid. This has allowed residents to install air conditioners

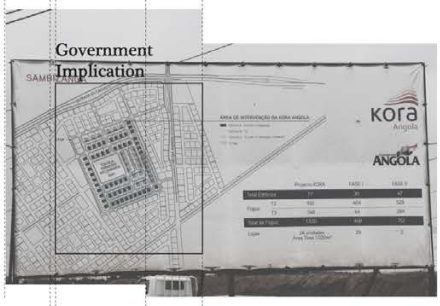
Storm water management systems have been integrated in the housing projects.

Services such as internet and cable TV can be connected to legally since all homes are connected to the grid.

Marconi

Services

1



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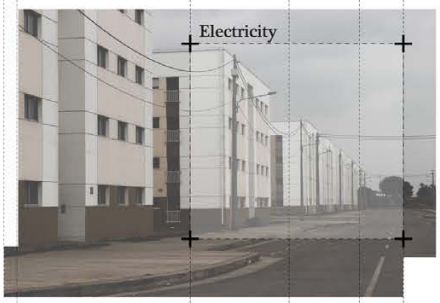
3

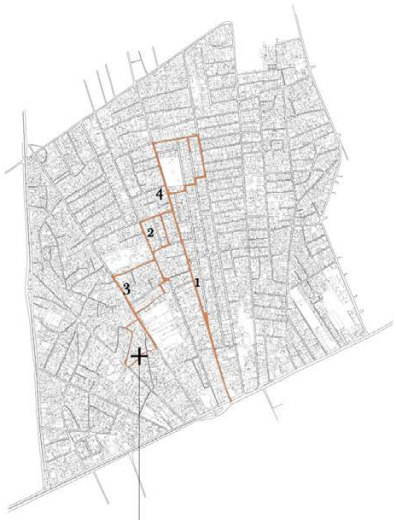
4

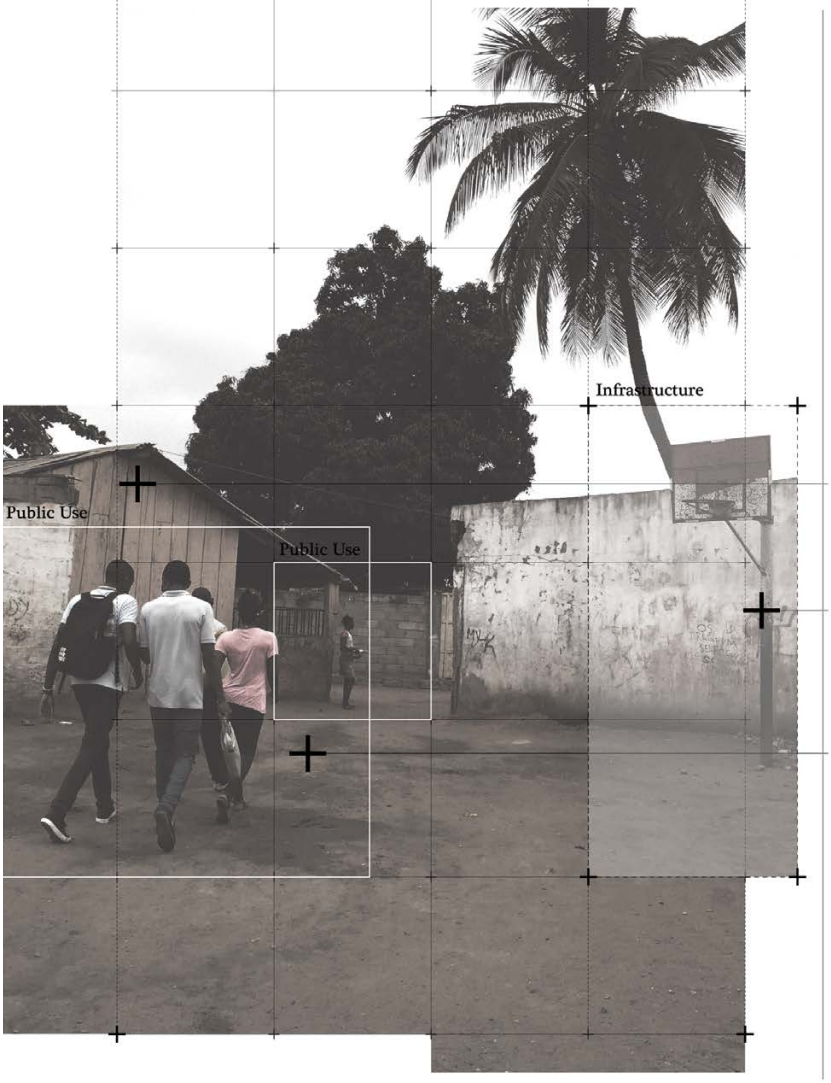


Public Spaces

11 de Novembro

Pockets of public space are rare and almost solely self built by locals. The infrastructure often lacks and these spaces seem underutilized





11 de Novembro
October 11th 2018
9:40 am

Lack of infrastructure such as lighting reduces the use of most public spaces.

The sole piece of infrastructure is poorly maintained and the rest of the lot is void of any other infrastructure.

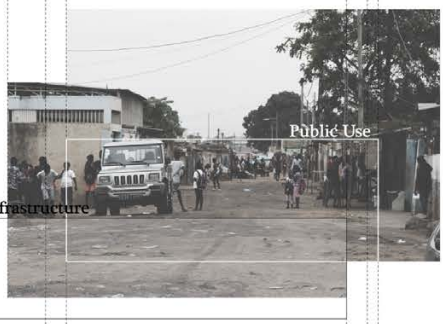
Most people here seemed to by bystanders and people simply walking through. As public life is along the major streets, these pockets of public space are mostly empty.

Analytic Breakdown

11 de Novembro

Public Spaces & Public Life

1



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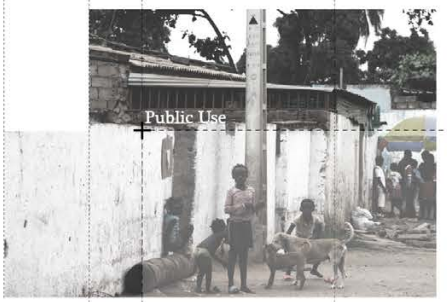


3

4

Cariango

As streets were paved and the whole area upgraded, no designated public space was created. Public activity happens on the streets.

Cariango
October 12th 2018
11:15 am

Public Spaces

Analytic Breakdown

Public spaces strive where infrastructure has been provided. Electricity, sewage and water runs in this area where all streets are paved.

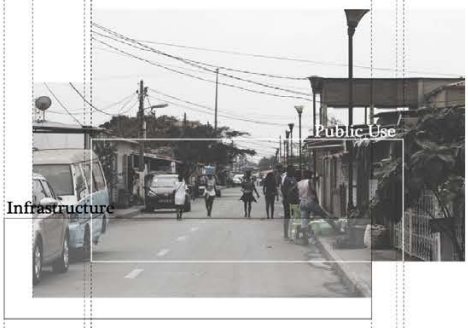
Infrastructure such as street lights and public wifi has made the street a constant public gathering place.

Large sidewalks are the primary space for public interaction. Business and leisure happens along the newly paved streets.

Cariango

Public Spaces & Public Life

1



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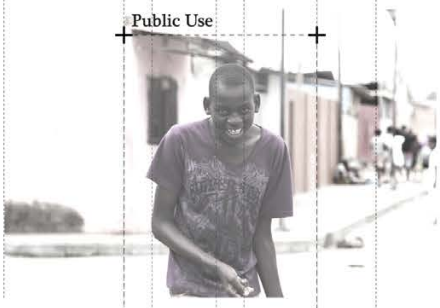
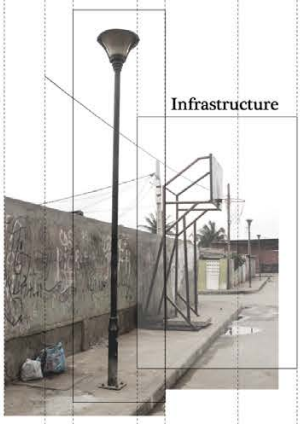
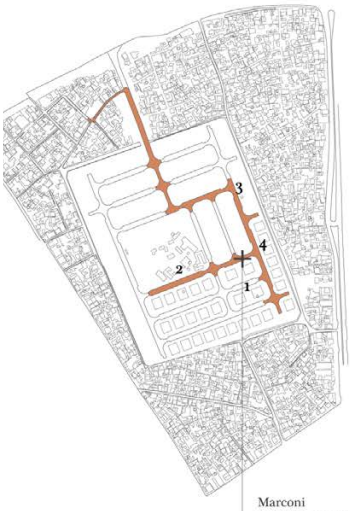


3

4

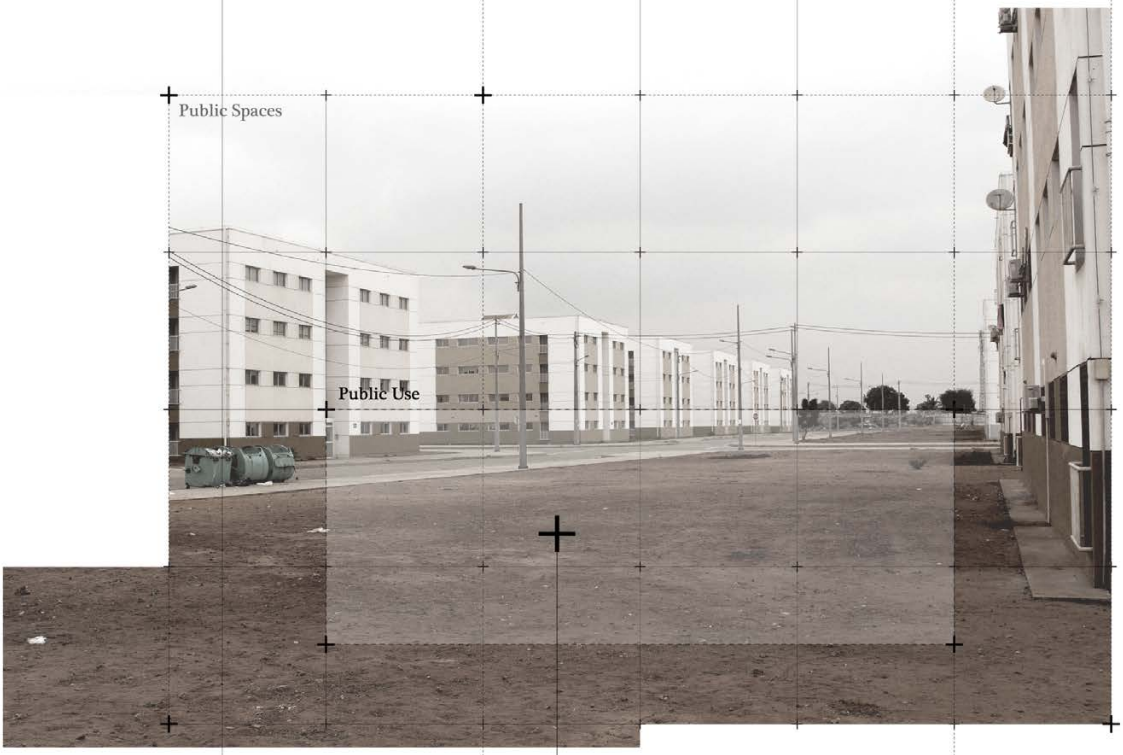




Marconi

Large areas of empty space were left open in the redevelopment of this area. These spaces aren't programed and their future use is ambiguous.

Marconi
October 9th 2018
10:10 am



Analytic Breakdown

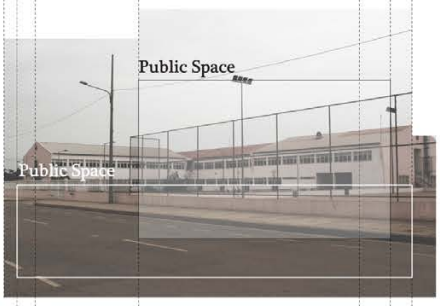
The large empty plots of land between buildings are unprogrammed and have not been used by the inhabitants. Whether these were left in this state on purpose or simply a result of the project being on hold is unknown but this currently resembles a failed use of space or an unfinished development.

Marconi

Public Spaces & Public Life

1

2



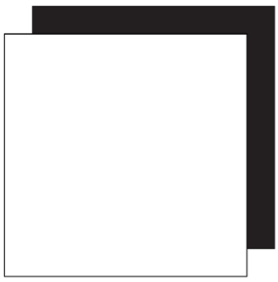
3

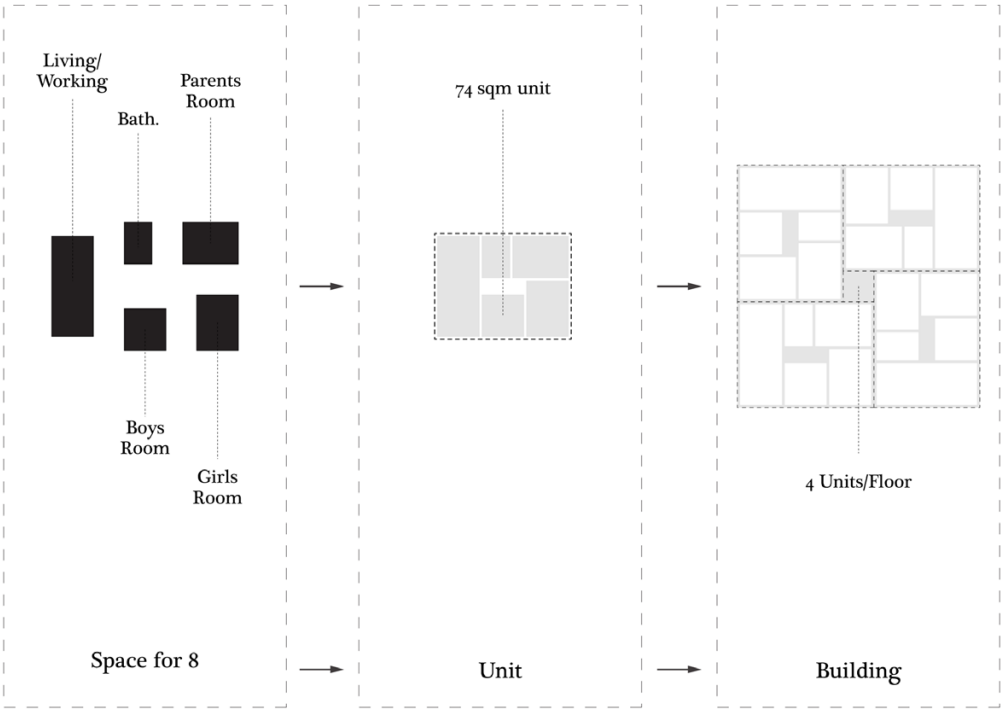
4

Appendix B

Density Matrix

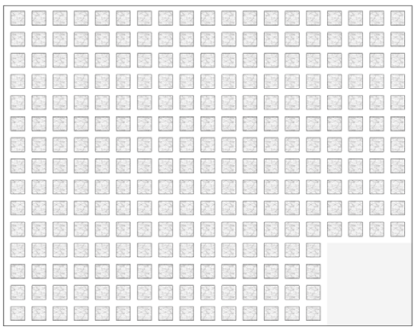
Building Type 1

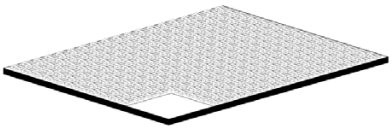




Building Type 1 - FSI 0.4

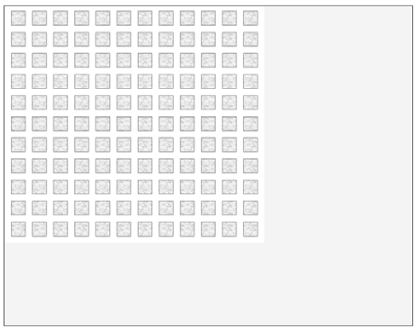
1 Story Dwellings

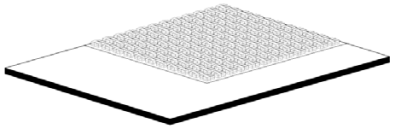




Area : 50 acres
Dwelling count : 1076
Population : 8608
Public Space : 5.4%
FSI : 0.4
UPA : 21.52
PPA : 172.16

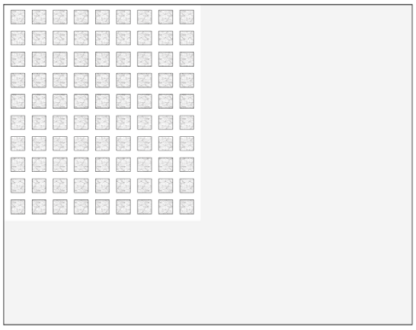
2 Story Dwellings

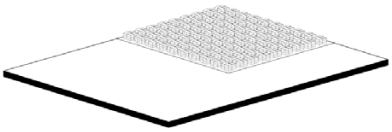




Area : 50 acres
Dwelling count : 1056
Population : 8448
Public Space : 53.3%
FSI : 0.4
UPA : 21.12
PPA : 168.96

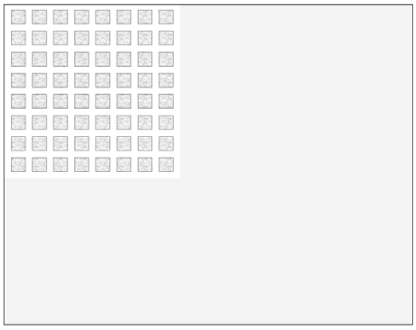
3 Story Dwellings

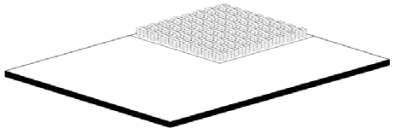




Area : 50 acres
Dwelling count : 1080
Population : 8640
Public Space : 68%
FSI : 0.4
UPA : 21.6
PPA : 172.8

4 Story Dwellings

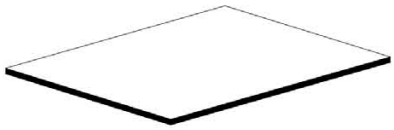




Area : 50 acres
Dwelling count : 1024
Population : 8192
Public Space : 77.4%
FSI : 0.4
UPA : 20.48
PPA : 163.84

Building Type 1 - FSI 0.7

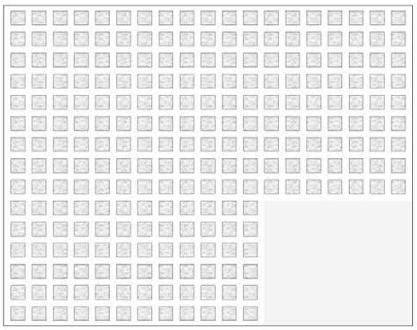
1 Story Dwellings

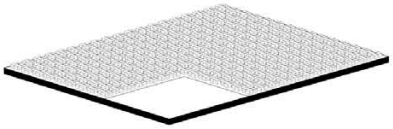


Area : 50 acres

At 1 Story with an FSI of 0.7, the site cannot accommodate for the building typology to be spaced 9m apart.

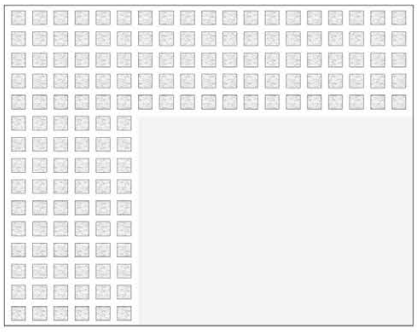
2 Story Dwellings

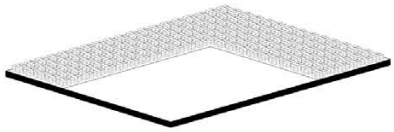




Area : 50 acres
Dwelling count : 1944
Population : 15,552
Public Space : 14.3%
FSI : 0.7
UPA : 38.88
PPA : 311.04

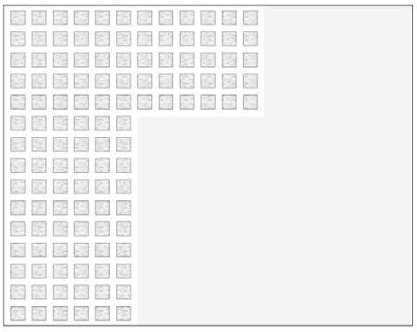
3 Story Dwellings

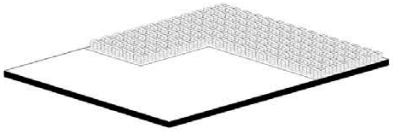




Area : 50 acres
Dwelling count : 1860
Population : 14,880
Public Space : 44.4%
FSI : 0.7
UPA : 37.2
PPA : 297.6

4 Story Dwellings

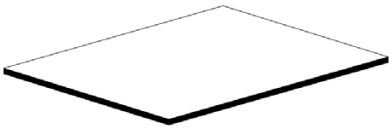




Area : 50 acres
Dwelling count : 1920
Population : 15,360
Public Space : 57.1%
FSI : 0.7
UPA : 38.4
PPA : 307.2

Building Type 1 - FSI 1.0

1 Story Dwellings



Area : 50 acres

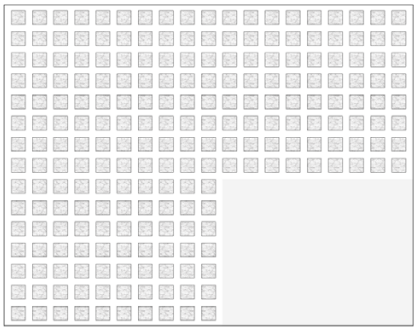
At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

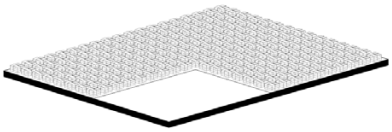
2 Story Dwellings

Area : 50 acres

At 1 Story with an FSI of 1.5,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

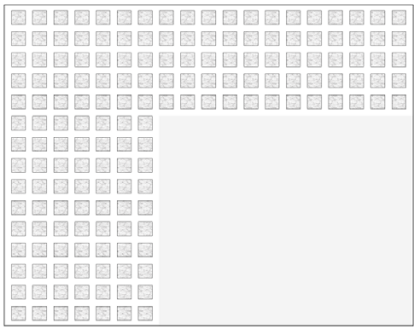
3 Story Dwellings

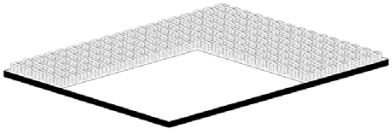




Area : 50 acres
Dwelling count : 2664
Population : 21,312
Public Space : 21.4%
FSI : 1.0
UPA : 53.28
PPA : 426.24

4 Story Dwellings

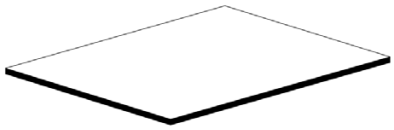




Area : 50 acres
Dwelling count : 2640
Population : 21,120
Public Space : 41%
FSI : 1.0
UPA : 52.8
PPA : 422.4

Building Type 1 - FSI 1.5

1 Story Dwellings



Area : 50 acres

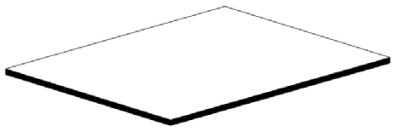
At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

2 Story Dwellings

Area : 50 acres

At 1 Story with an FSI of 1.5,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

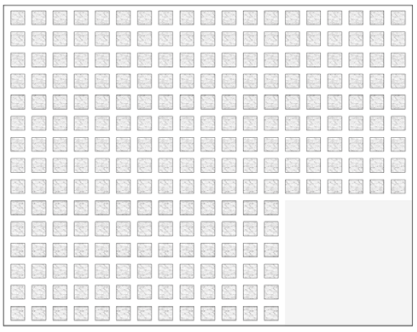
3 Story Dwellings

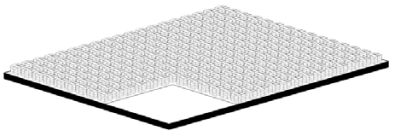


Area : 50 acres

At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

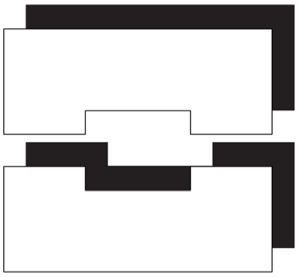
4 Story Dwellings

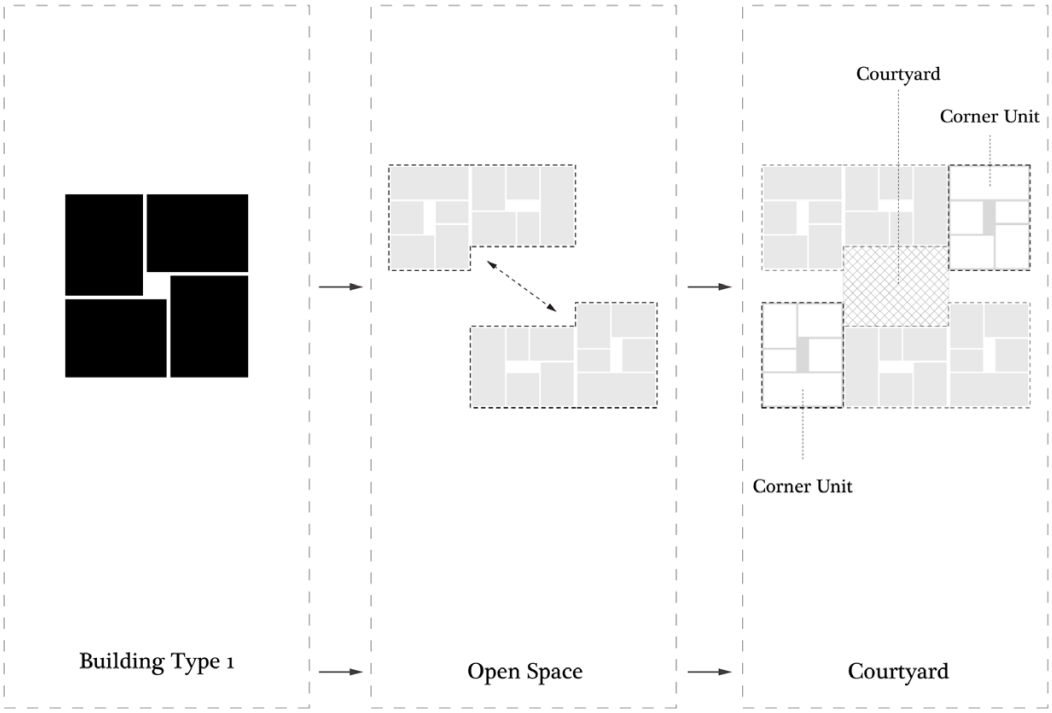




Area : 50 acres
Dwelling count : 3984
Population : 31,872
Public Space : 12.2%
FSI : 1.5
UPA : 79.68
PPA : 637.44

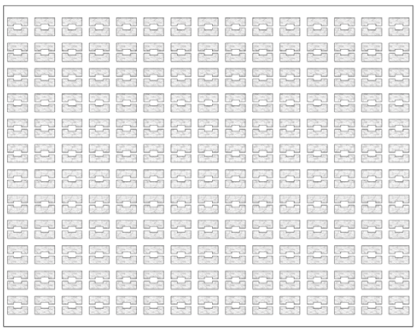
Building Type 2

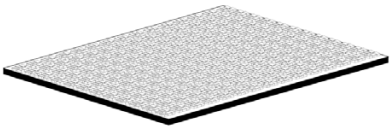




Building Type 2 - FSI 0.4

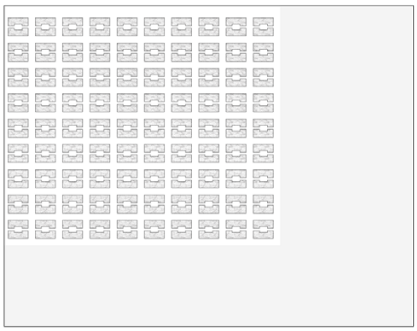
1 Story Dwellings

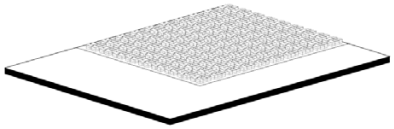




Area : 50 acres
Dwelling count : 1080
Population : 8640
Public Space : 0%
FSI : 0.4
UPA : 21.6
PPA : 172.8

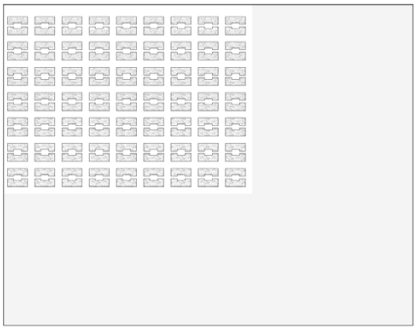
2 Story Dwellings

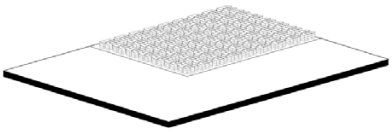




Area : 50 acres
Dwelling count : 1080
Population : 8640
Public Space : 50.0%
FSI : 0.4
UPA : 21.6
PPA : 172.8

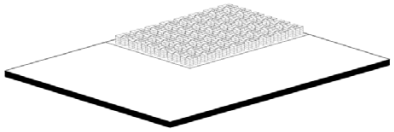
3 Story Dwellings





Area : 50 acres
Dwelling count : 1134
Population : 9072
Public Space : 64.8%
FSI : 0.4
UPA : 22.68
PPA : 181.44

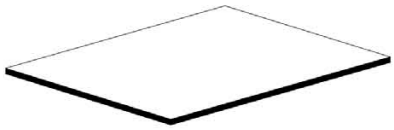
4 Story Dwellings



Area : 50 acres
Dwelling count : 1152
Population : 9216
Public Space : 73.1%
FSI : 0.4
UPA : 23.04
PPA : 184.32

Building Type 2 - FSI 0.7

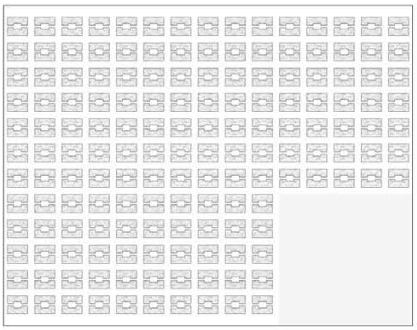
1 Story Dwellings

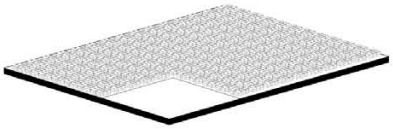


Area : 50 acres

At 1 Story with an FSI of 0.7, the site cannot accommodate for the building typology to be spaced 9m apart.

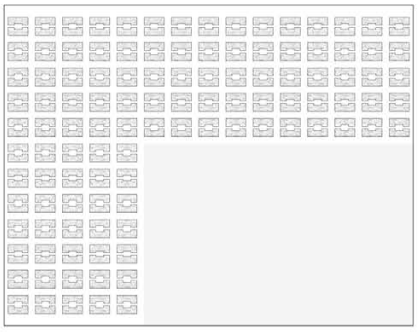
2 Story Dwellings

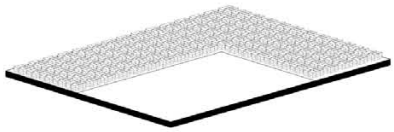




Area : 50 acres
Dwelling count : 1860
Population : 14,880
Public Space : 13.5%
FSI : 0.7
UPA : 37.2
PPA : 297.6

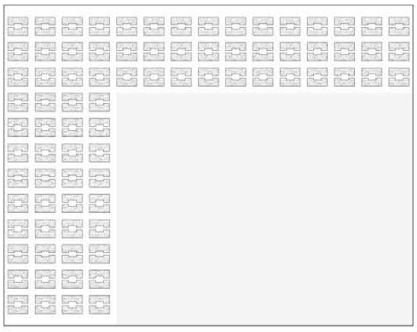
3 Story Dwellings

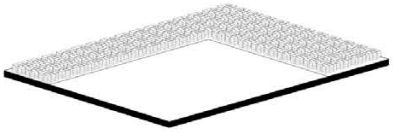




Area : 50 acres
Dwelling count : 1980
Population : 15,840
Public Space : 37.7%
FSI : 0.7
UPA : 39.6
PPA : 316.8

4 Story Dwellings

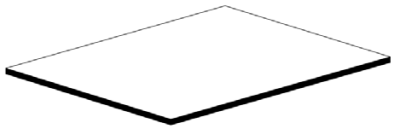




Area : 50 acres
Dwelling count : 1944
Population : 15,552
Public Space : 53.1%
FSI : 0.7
UPA : 38.88
PPA : 311.04

Building Type 2 - FSI 1.0

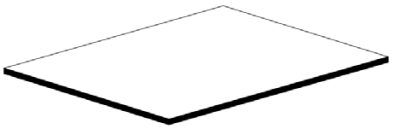
1 Story Dwellings



Area : 50 acres

At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

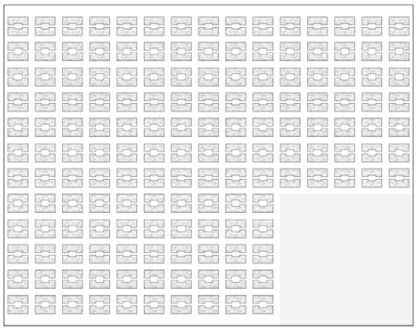
2 Story Dwellings

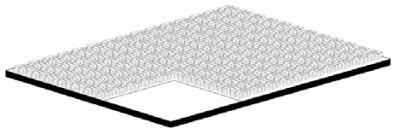


Area : 50 acres

At 1 Story with an FSI of 1.5,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

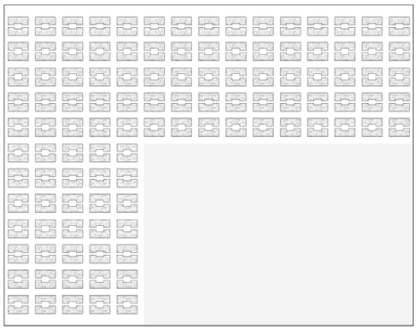
3 Story Dwellings

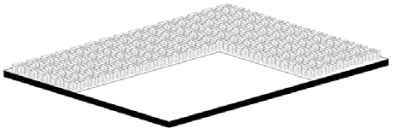




Area : 50 acres
Dwelling count : 2790
Population : 22,320
Public Space : 13.5%
FSI : 1.0
UPA : 55.8
PPA : 446.4

4 Story Dwellings

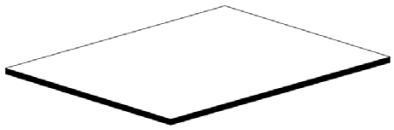




Area : 50 acres
Dwelling count : 2640
Population : 21,120
Public Space : 37.7%
FSI : 1.0
UPA : 52.8
PPA : 422.4

Building Type 2 - FSI 1.5

1 Story Dwellings



Area : 50 acres

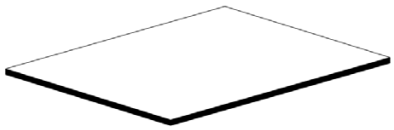
At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

2 Story Dwellings

Area : 50 acres

At 1 Story with an FSI of 1.5,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

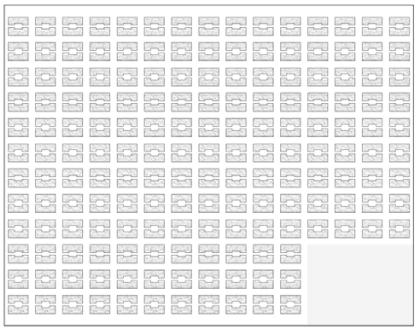
3 Story Dwellings

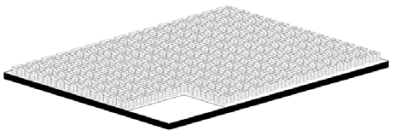


Area : 50 acres

At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

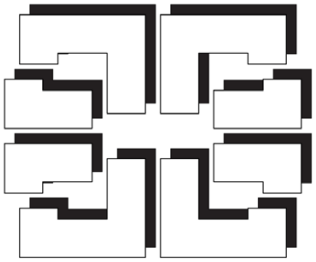
4 Story Dwellings

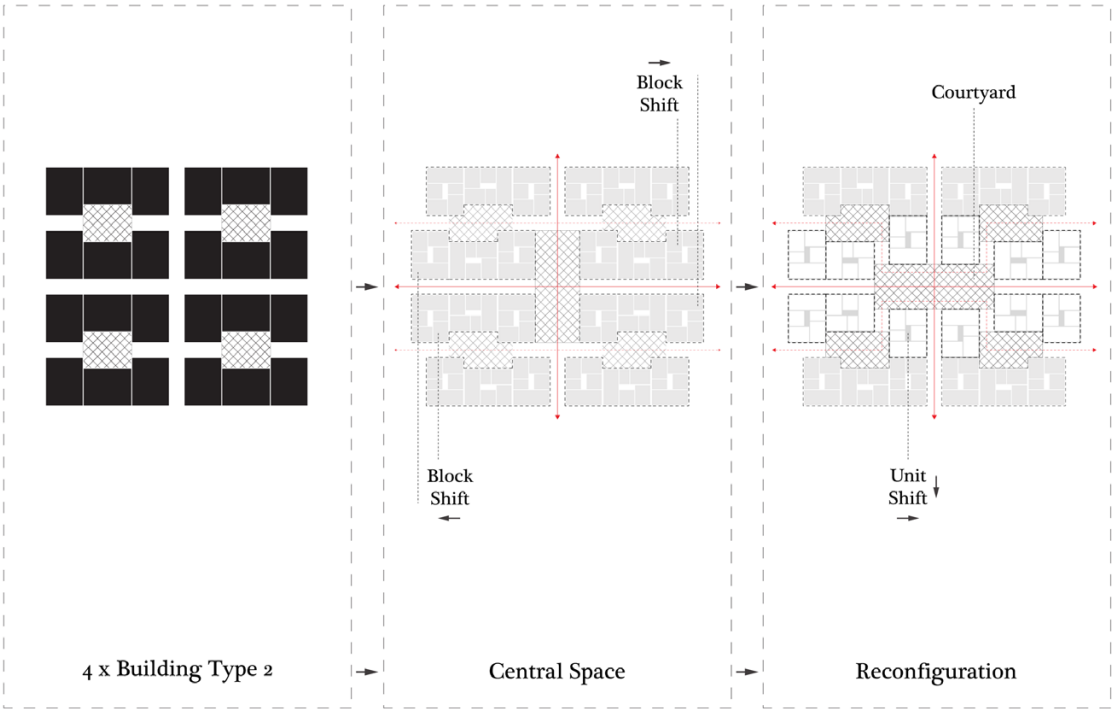




Area : 50 acres
Dwelling count : 4032
Population : 32,256
Public Space : 6.5%
FSI : 1.5
UPA : 80.64
PPA : 645.12

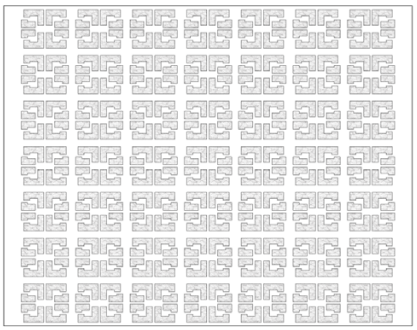
Building Type 3

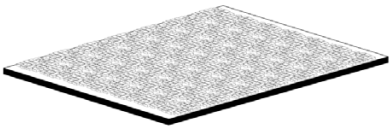




Building Type 3 - FSI 0.4

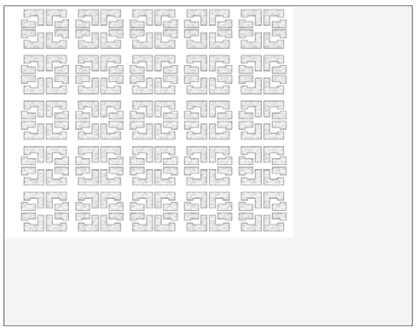
1 Story Dwellings

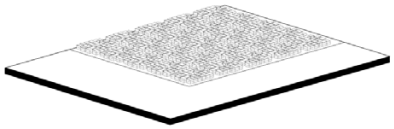




Area : 50 acres
Dwelling count : 1176
Population : 9408
Public Space : 0%
FSI : 0.4
UPA : 23.52
PPA : 188.16

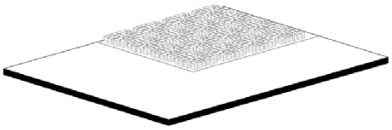
2 Story Dwellings





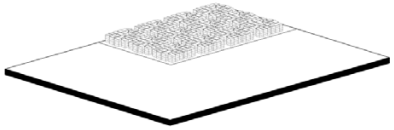
Area : 50 acres
Dwelling count : 1200
Population : 9600
Public Space : 49.2%
FSI : 0.4
UPA : 24.0
PPA : 192.0

3 Story Dwellings



Area : 50 acres
Dwelling count : 1152
Population : 9216
Public Space : 67.2%
FSI : 0.4
UPA : 23.04
PPA : 184.32

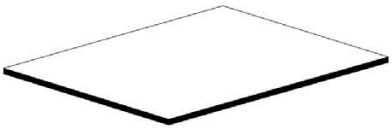
4 Story Dwellings



Area : 50 acres
Dwelling count : 1152
Population : 9216
Public Space : 75.6%
FSI : 0.4
UPA : 23.04
PPA : 184.32

Building Type 3 - FSI 0.7

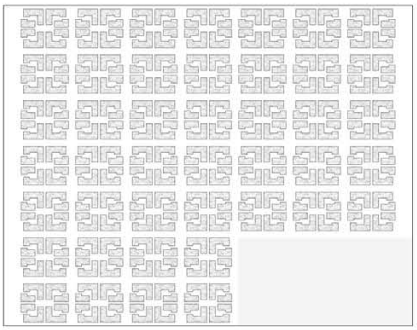
1 Story Dwellings

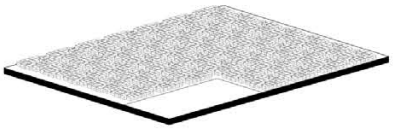


Area : 50 acres

At 1 Story with an FSI of 0.7, the site cannot accommodate for the building typology to be spaced 9m apart.

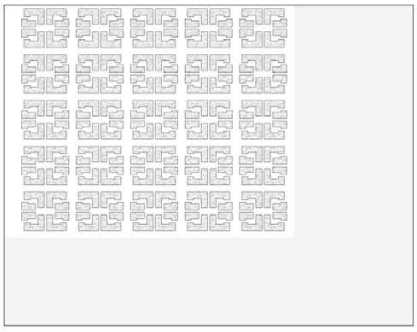
2 Story Dwellings





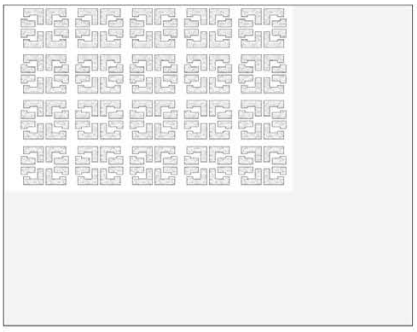
Area : 50 acres
Dwelling count : 2064
Population : 16,512
Public Space : 11.8%
FSI : 0.7
UPA : 41.28
PPA : 330.24

3 Story Dwellings



Area : 50 acres
Dwelling count : 1800
Population : 14,400
Public Space : 49.2%
FSI : 0.7
UPA : 36.0
PPA : 288.0

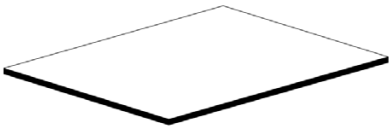
4 Story Dwellings



Area : 50 acres
Dwelling count : 1920
Population : 15,360
Public Space : 59.4%
FSI : 0.7
UPA : 38.4
PPA : 307.2

Building Type 3 - FSI 1.0

1 Story Dwellings



Area : 50 acres

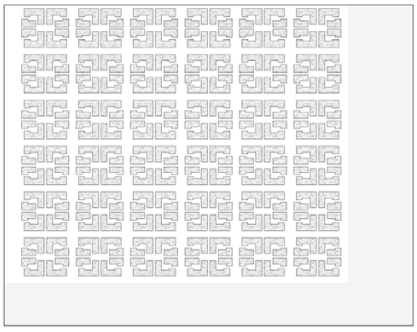
At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

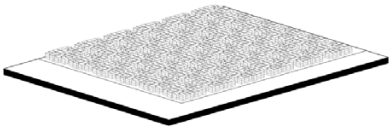
2 Story Dwellings

Area : 50 acres

At 1 Story with an FSI of 1.5,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

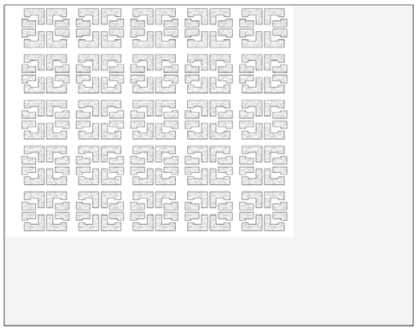
3 Story Dwellings

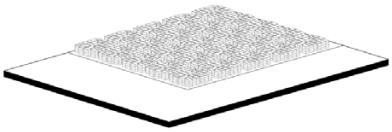




Area : 50 acres
Dwelling count : 2592
Population : 20,736
Public Space : 27.2%
FSI : 1.0
UPA : 51.84
PPA : 414.72

4 Story Dwellings

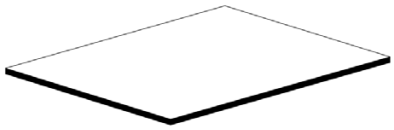




Area : 50 acres
Dwelling count : 2400
Population : 19,200
Public Space : 49.2%
FSI : 1.0
UPA : 48.0
PPA : 384.0

Building Type 3 - FSI 1.5

1 Story Dwellings



Area : 50 acres

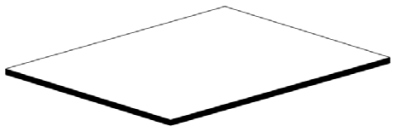
At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

2 Story Dwellings

Area : 50 acres

At 1 Story with an FSI of 1.5,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

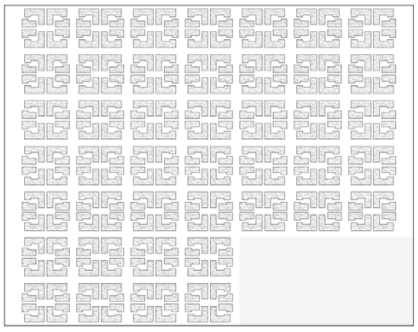
3 Story Dwellings

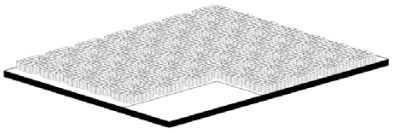


Area : 50 acres

At 1 Story with an FSI of 1.0,
the site cannot accommodate
for the building typology to
be spaced 9m apart.

4 Story Dwellings





Area : 50 acres
Dwelling count : 4128
Population : 33,024
Public Space : 11.8%
FSI : 1.5
UPA : 82.56
PPA : 660.48

Appendix C

Targets & Considerations

*All targets and assumptions were validated by local architect and urban planner Ilidio Daio

General:

Existing residential densities will be at least doubled but in no case would necessitate building more than four-story-high dwellings.

- Existing gross residential density1 for Marconi housing (current development): 24 UPA
- Existing gross residential density for informally built neighborhood around Marconi: 20 UPA
- Target residential density for replacement housing proposed for Marconi: 38 UPA

Redevelopment will produce the following in terms of land use:

- 50% residential as replacement housing for existing neighborhoods residents (at target densities listed above)
- 33% for private sector development
- 17% for schools and open spaces (not including streets, private yards, etc.)

The private sector would take primary responsibility for the construction of replacement housing in exchange for the right to build market housing on approximately 1/3 of the redeveloped land.

The city would cover the cost of demolition, roads and utilities for all areas, except those set aside for private-sector housing

Redevelopment would be handled in a phased fashion, as follows

- Replacement housing would be built on a parcel of serviced, vacant land.
- When the new housing is completed, residents from abutting blocks would move into the new housing.
- The land vacated by those moving into the new housing would then be redeveloped. The land would be serviced and the urban grain would be adjusted in the process
- As new housing will be built at a higher density than existing housing, the areas available for redevelopment would increase with each successive phase. Thus, each phase would enable:
    - Larger and larger amounts of replacement housing to be built
    - Areas to be opened up for schools
    - Areas to be opened up for recreation (with priority given to space adjacent to schools and to flood prone and other environmentally sensitive land).
    - Areas to be opened up for private sector development.

Urban:

In addition to providing housing or a higher quality and density, the goal is to regularize the urban fabric.

Such regularization, would respect, wherever possible, the existing urban structure so that the transformation can be done incrementally, in phases.

Typical blocks should be between 40 and 60 meters deep and no longer than 240 m long.

Blocks will generally run east west.

East/west streets will generally be more residential in nature (with the exception of major east/ west arteries which will occur approximately every 1.5 km) while north/south streets will be more commercial in nature and support a greater variety of building types and uses.

Major, commercial-oriented streets will be a minimum of 15 m wide, not including sidewalks.

Minor streets will be a minimum of 9 m wide, not including sidewalks.

Mid-block laneways will be a minimum of 6 m wide (but need not include sidewalks).

All units will have a street address – and direct access from a street.

Except for areas designated as open space, none of the targets will be met by building on flood prone or other environmentally sensitive areas.

Private-sector, market-oriented development be given priority for land adjacent to major arteries – largely because this housing is likely to be constructed at higher densities than the replacement housing and because this housing is likely to include commercial at the base.

Unit:

The average dwelling unit will include 3 bedrooms and 1 bath

Housing will be designed to transition from lower-income to middle-class housing, with a corresponding drop in the number of residents per unit.

Wherever possible, portions of the units will be able to be hived off and rented out to generate income for owners/primarily residents.

All units will benefit from cross ventilation

All units – whether individually or through a home owners association – will benefit from solar energy (i.e., will be able to tap into a solar array).

In the design of individual units, aggregations of units, and in the overall urban plan, accommodations will be made for a range of non-residential uses. These would include:

- Ground-floor commercial on units fronting on north/south streets.
- Flexible ground-floor spaces on units facing east/west streets. Such spaces could be used as workshops or warehouses in the short term but transition to private garages as the neighborhoods mature and the demographic profile of the residents improves

Common circulation would be kept to a minimum

Attempts are to be made to provide a dedicated, off-street parking space for every unit of replacement housing.

All units benefit from private outdoor space, either in the form of balcony, terrace or ground floor space linked to the courtyard

Construction:

Construction will be reinforced masonry block load-bearing walls with concrete beams supporting the floor slabs

3m wide bays will be used where possible and extend through all four levels to allow load bearing walls to stack

Efforts will be made for bathrooms and kitchens to stack to allow for plumbing efficiency

Bathrooms will be placed on exterior walls for ventilation purposes.

Appendix D

Material Charts

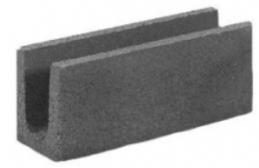
FICHA TÉCNICA PRODUTO

LINTEL

EN 771 – 3: 2010 - Especificações para Unidades de Alvenaria. Parte 3: Blocos de Betão de Agregados.

DESCRIÇÃO/ APLICAÇÃO

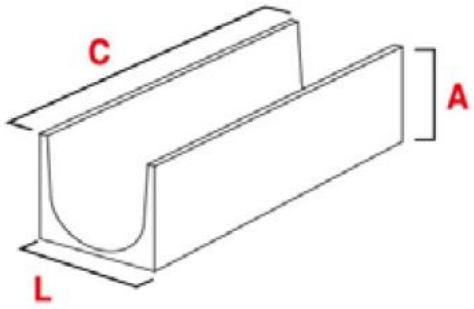
1. Elementos de betão, de baixo custo, usados na execução de alvenarias estruturais;
2. Permitem maior rapidez de execução em obra;
3. A classe mínima do betão é C20/ 25;
4. Bom comportamento térmico e acústico.



CARACTERÍSTICAS

Tipo	Dimensões (cm)			Peso (kg)	Uni/ Palete
	L	C	A		
40 x 20 x 20	20	40	20	12,5	75

Resistência ao fogo	Classe A1
Categoria dimensional	D1



Construção Sustentável Com a solução de Pré-Fabricados de Betão, o consumo de matérias primas e energia é bastante reduzido, contribuindo para a proteção dos recursos naturais do planeta.

FT nº LT01 | Edição nº 01 | Revisão nº 01 | 26-08-2014

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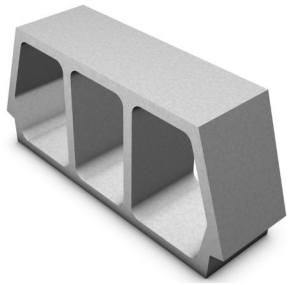
FICHA TÉCNICA PRODUTO

ABOBADILHA

EN 13369 – Regras Gerais para Produtos Pré-Fabricados de Betão

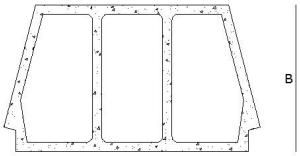
DESCRIÇÃO/ APLICAÇÃO

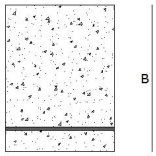
1. Elementos estruturais de betão, de baixo custo, com consumo reduzido de matérias primas e energia contribuindo assim para uma construção sustentável;
2. Utilizam-se como cofragem e aligeiramento de lajes com vigotas de betão pré-esforçado;
3. Permite maior rapidez de execução em obra;
4. A classe mínima do betão é C20/25;
5. Bom comportamento térmico e acústico.



CARACTERÍSTICAS

Tipos	Dimensões (mm)			Peso (Kg)
	A	B	C	
48x20x12	480	120	200	13,0
48x20x20		200		17,0
48x20x24		240		19,0
40x20x12	400	120		11,0
40x20x15		150		12,0
40x20x20		200		18,5
40x25x24		240	250	17,0
40x20x30		300	200	18,0
32x20x20	320	200		10,5
24x20x24	240	240		10,0





Construção Sustentável Com a solução de Pré-Fabricados de Betão, o consumo de matérias primas e energia é bastante reduzido, contribuindo para a proteção dos recursos naturais do planeta.

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FICHA TÉCNICA PRODUTO

BLOCO VAZADO

EN 771 – 3: 2010 - Especificações para Unidades de Alvenaria. Parte 3: Blocos de Betão de Agregados.

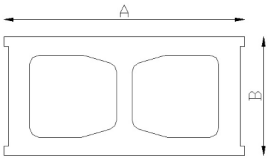
DESCRIÇÃO/ APLICAÇÃO

1. Elementos estruturais de betão, de baixo custo, usados na execução de alvenarias revestidas, simples ou duplas;
2. Permitem maior rapidez de execução em obra;
3. A classe mínima do betão é C20/25;
4. Bom comportamento térmico e acústico.

CARACTERÍSTICAS

Tipo	Dimensões (cm)			Peso (kg)	Uni/ Palete
	A	H	B		
50 x 20 x 10	50	20	10	12,5	100
50 x 20 x 15			15	16,0	84
50 x 20 x 20			20	20,5	70
50 x 20 x 25			25	25,0	40
40 x 20 x 10	40		10	9,0	120
40 x 20 x 12			12	12,5	100
40 x 20 x 15			15	12,0	90
40 x 20 x 20			20	14,5	72

Resistência ao fogo	Classe A1
Categoria dimensional	D1
Tensão de rutura média (Mpa)	≥ 4,0
Tensão de corte (Mpa)	0,15



Topo

Lateral

Construção Sustentável — Com a solução de Pré-Fabricados de Betão, o consumo de matérias primas e energia é bastante reduzido, contribuindo para a proteção dos recursos naturais do planeta.

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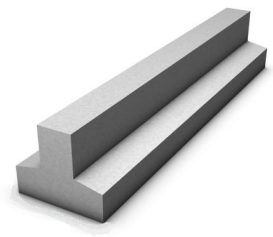
FICHA TÉCNICA PRODUTO

VIGOTA

EN 15037:1 – Produtos Pré-Fabricados de Betão — Pavimentos com Vigotas e Blocos de cofragem

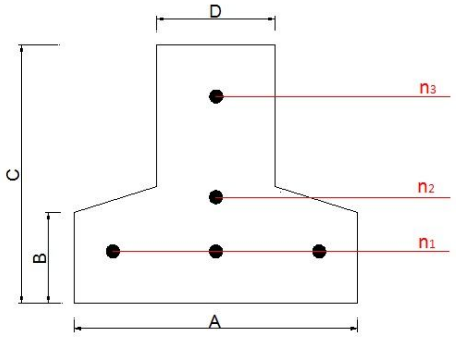
DESCRIÇÃO/ APLICAÇÃO

1. Elementos estruturais de betão pré-esforçado;
2. Pré-esforço na origem de 1100 Mpa;
3. Betão de classe C30/ 37;
4. Comprimentos variáveis, conforme especificações do cliente/ projecto;
5. Constituem as nervuras resistente das lajes aligeiradas unidirecionais.



CARACTERÍSTICAS

Dimensões (mm)		Peso (kg/ ml)
A	115	20
B	37	
C	105	
D	50	



Tipo Vigota	Armaduras (mm)			Estados Limites	
	n1	n2	n3	Mrd (kN.m)	Vrd (kN)
V3	3Ø4	---	1Ø4	2,38	4,73
V4	3Ø4	1Ø4	1Ø4	2,88	4,73
V5	4Ø4	1Ø4	1Ø4	3,38	4,73
V6	5Ø4	1Ø4	1Ø4	4,00	4,73

Construção Sustentável — Com a solução de Pré-Fabricados de Betão, o consumo de matérias primas e energia é bastante reduzido, contribuindo para a proteção dos recursos naturais do planeta.

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Thank you!

Thesis submission produced by M.arch candidate David Anderson. In consultation with thesis advisor professor Benjamin Gianni. Issued on May 9th 2019.