Measuring Physical Density: Implications on the Use of Different Measures on Land Use Policy in Singapore

By

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ABSTRACT

Land use planning policies in Singapore have been driven by the goal to optimize the use of the scarce land resource. Density measures how intensively land has been put to use and is thus a good indicator of how planning policies are performing in relation to this goal of land use optimization. This study looks at how physical density has been measured in Singapore and assesses the suitability of the methods of measurement. It also evaluates current planning practice to determine how successful they have been in achieving the goal to optimize land use. The Development Guide Plan for the Punggol Planning Area was used as the case study.

Thesis Supervisor: Eran Ben-Joseph
Title: Assistant Professor of Landscape Architecture and Planning

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To the many prayer warriors who have remembered me in their prayers, and to my family and friends who have encouraged me, I say thank you. I have been greatly blessed that you have been a part of my life.

Most of all, I thank God for the fullness of His grace. For in Him, I have truly been enriched in every way. To God be the glory!

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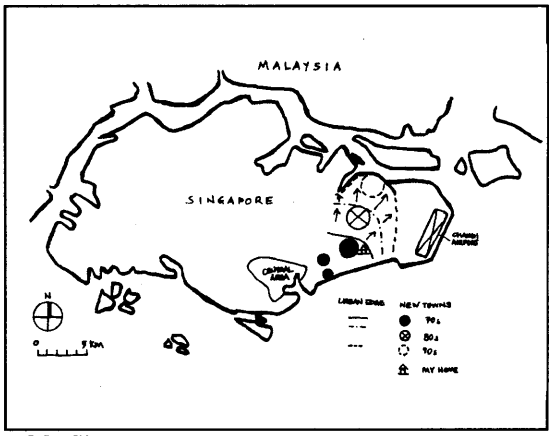
Preface

Before I delve into this study, I feel it is important for me to explain how my interest in the topic developed.

I grew up in the 1970s and 80s when Singapore was experiencing buoyant economic growth. Despite the relative economic prosperity we enjoyed, it was impressed upon young Singaporeans like myself how vulnerable our city-state of Singapore was, and still is. Lacking in natural resources such as land, potable water and mineral deposits, the story of Singapore's economic success in the 30 years since her independence is no short of phenomenal.

The scarcity of land is very real to me. The 1970s and 80s was a period of rapid development. I witnessed landscapes changing frequently before my very eyes. I live in the eastern part of the island. In the 1970s, my home was at the edge of the urban area, and was considered remote in terms of location. Today, it is relatively close to the Tampines regional center and several new towns. As the urban boundary continues to shift further and further away from my doorstep, I sometimes wonder if there will be any land left in time to come.



My Singapore
The growth of the urban area around my home in my lifetime

Economic prosperity brought about many new conveniences. For example, the travel time by car from my home to school was reduced from 45 minutes to 20 minutes with the completion of the East Coast Parkway (expressway) in the early 1980s. Public transportation also became more convenient and travel times were significantly reduced when the MRT came to my neighborhood. I am part of the generation that has grown used to the improvements in the quality of life and certainly expect more.

Over the years, regional economic competition for foreign investment has become keener. Singapore's neighbors have repeatedly expressed their desire to surpass her to become the financial center, and maritime and aviation hub of the region. As the next millennium approaches, Singapore is faced with the challenge of sustaining economic growth, as well as enhancing the quality of life for the increasingly affluent population. The biggest constraint is Singapore's limited land area.

It is in the light of this context that I ask the question how can the use of land as a resource be optimized.

1

Introduction

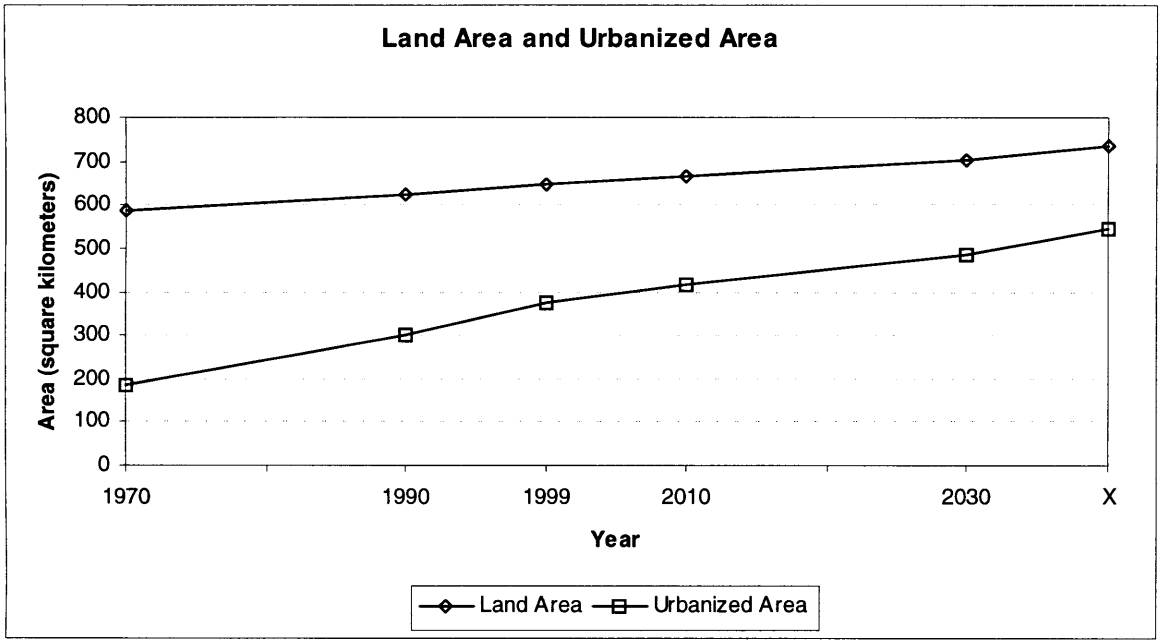
Land is a scarce resource in the city-state[1] of Singapore. With an area of 648 square kilometers[2] (250.2 square miles), the country is merely 3.5 times the size of the District of Columbia. The demand for land is immense. Housing, jobs, infrastructure[3], education and recreation have to be provided for within this finite space to satisfy the basic functional needs of the 3.87 million[4] people. Having enjoyed economic prosperity over the past two decades, Singapore's increasingly affluent population expects their quality of life to continue to be enhanced. This translates into the demand for more living space, wider choice of housing types, and more entertainment and recreation areas. In addition, Singapore is also faced with the challenge of sustaining economic growth in an increasingly competitive global environment. And as a sovereign nation, Singapore has to set land aside for the purpose of national defense and security.

With a population density[5] of 6173 persons per square kilometer, land use is already considered very intensive by world standards (Figure 1-1). Although land reclamation has been aggressively pursed as a strategy to increase the total land area since the 1960s, there are economic, political and environmental limits to the amount of land that can be reclaimed from the sea. The urbanized area has been growing at a faster rate than the territorial land area (through reclamation) (Figure 1-2). This suggests an imbalance between the supply of land with demand. Today, less than a fifth of the existing land area is soft land[6] available for development in the foreseeable future[7]. There seems to be the real danger of land running out at some point if it is not properly managed as a resource. Singapore's planners thus face the unenviable task of having to perform the delicate balancing act of juggling between the various demands for land with its very finite supply

Figure 1-1 Population and Population Density - Singapore and World Cities

Source: The Straits Times (Feb 10 1999 & Mar 20 1999)

Figure 1-2 Growth of Land Area and Urbanized Area (1970 to Year X)



Source: Urban Redevelopment Authority (1991)

Since attaining political independence in 1965, planning policy in Singapore has been driven by the goal of land use optimization. Recognizing that Singapore is a city without a hinterland, the government has actively pursued strategies of land conservation in order to use land efficiently. Allowing development at higher spot[8] densities than ever before has been one of the main vehicles to achieve this goal. Over the last 10 years, developers have readily arisen to the government's call to intensify site density by increasing the floor area ratios[9] (FARs) on individual land parcels upon development or redevelopment. The previously unheard of en-bloc sale phenomenon swept through the property market. This saw individual property owners collectively agreeing to sell their properties to a single developer who would comprehensively redevelop the land at the higher prescribed FAR. Although this policy has proven very successful, it is unclear if it has resulted in the optimization of the use of land.

At this juncture, it is critical for planners and policy makers to question how effective these strategies and policies have been in optimizing land use. Singapore's total population will reach 4 million in mid-1999, owing to the government's pro-talent immigration policy. Thus the population has now reached the milestone figure[10] for Year X in the Concept Plan[11] although planners thought it would be reached only after the Year 2010. This Concept Plan which was prepared in 1991 is currently being reviewed, and will be replaced in the Year 2001 by the new Concept Plan.

1.1 Land Use Optimization and Density

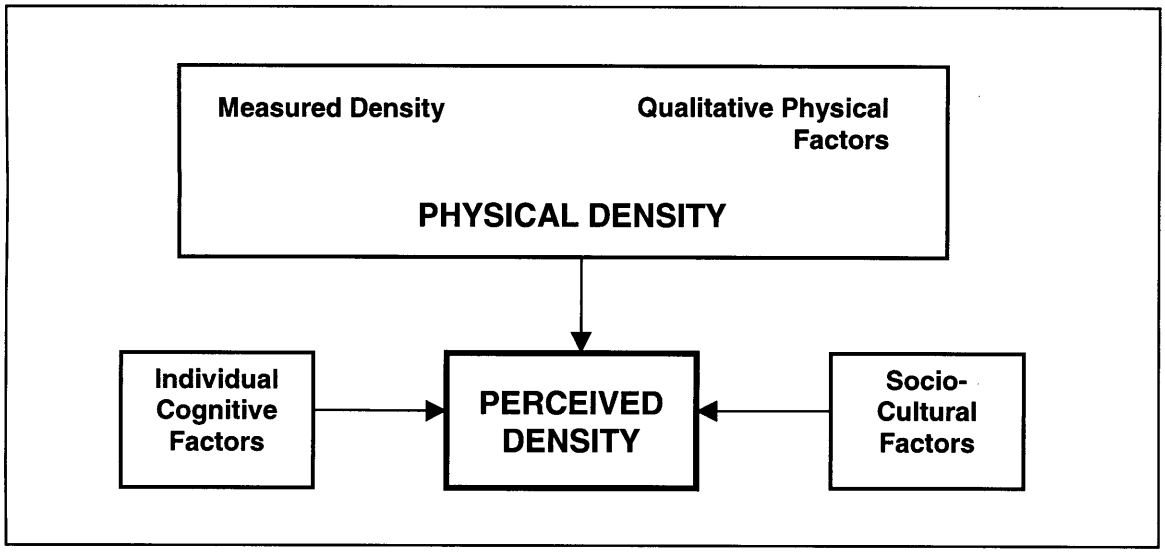
Land use optimization has always been understood as putting land to the highest and best use. The first question which arises is how is usage of land measured? The next question that comes to mind is what constitutes "highest" and "best"? These are relative terms which suggest that the performance of the policies and strategies to achieve the goal of optimization is a key consideration. The answer to both these questions is density.

Density as a construct measures the degree to which a space or area has been filled. It is also an indicator of the performance of planning policies. Density provides a measure of the efficient use of urban resources and the effectiveness of investment in these resources. Density expressed as policy has a great impact on land prices, which is an important concern of the government, especially in light of the current economic crisis affecting Asia.

1.2 Scope

There are three different types of density, perceived density[12], physical density and measured density[13]. Each represents different phenomena and appears in different contexts. However they are intimately linked to one another (Figure 1-3).

Figure 1-3 Relationship between different types of density



Source: Alexander & Reed (1988)

Density is a perceived experience[14]. Physical density, combined with socio-cultural and individual cognitive factors, produces perceived density. Planners and designers strive to create environments which will positively affect people's perception of densities, stimulating positive evaluation on the part of users.

Physical density is made up of both objective and physical characteristics of the built environment that are perceived by people in an actual setting. Qualitative measures of physical density include height, spacing between buildings, scale and color. These attributes are usually not included in the quantitative measurement of density. Quantitative measures of physical density try to capture the degree to which a space is filled by people, structures, housing or even built-up floor space.

This study focuses on the quantitative measures of density, which are widely used to regulate the built environment and impact urban form. It looks at physical density in two ways. Firstly, density is recognized as a planning tool to capture the intensity of land use. Secondly, density is a performance indicator of the successes or failures of planning

policies. The study will concentrate on residential density, which itself is a complex notion. Worker (employment) densities and commercial densities will not be discussed.

1.3 Aim

The aim of this research is twofold. Firstly the study seeks to find an appropriate set of quantitative density measures for Singapore given its unique development goals. The conventional approach of using FAR alone to measure density will be questioned in order to detect if the existing measures of density are appropriate and effective. It is also hoped that this work will help planners and policy makers in evaluating the current planning practice and determining its success in optimizing land use.

The study will contribute to the body of research on measured physical density. These studies have been primarily confined to developed countries of the west. The applications of this study may be useful in countries with similar development constraints and goals as Singapore.

1.4 Methodology

The study methodology can be divided into two broad steps, background and analysis.

Background

The background research involved the following steps:

- Cataloguing of land use planning policies in Singapore and relating them to the development goals of land use optimization and improvement in the quality of life;
- Establishing an exhaustive list of generic quantitative density measures; and
- Researching the quantitative measures of density used and planning standards used in Singapore.

The research was primarily library-based, although information on the Singapore situation was also obtained through the interview process. Several planners in the Urban Redevelopment Authority[15] (URA), Singapore's national planning agency, were consulted for background information for this study.

Analysis

In this portion of the study, the performance of planning policies was analyzed in order to assess their success in optimizing land use. A case study, the Development Guide Plan (DGP) for the Punggol Planning Area, was be used to do this. From the analysis, conclusions will be drawn on the effectiveness of the existing set of density measures, and how planning policies have performed in relation to the goal to optimize land use.

1.5 Overview of the Thesis

Chapter 1 Introduction

The problem of development pressure on land in Singapore and the importance of managing the finite land resource are introduced in this first chapter. It briefly deals with the subject of this thesis, defines the scope of the study and highlights the methodology used.

Chapter 2 Land Use Policies and Physical Planning in Singapore

This chapter provides the background by examining the key issues presented in the introductory chapter. Firstly, Singapore's planning and land use policies will be examined in relation to development goals and strategies. Performance indicators to assess the success and failure of policies are introduced and elaborated upon. Secondly Singapore's approach to physical planning will be discussed.

Chapter 3 Measuring Physical Density

Chapter 3 focuses on quantitative measurements of density. An exhaustive list of the generic quantitative measures of density will be provided. The different ways density is

being measured in Singapore and how planning (provision) standards are used will also be discussed.

Chapter 4 Analyzing Land Use Planning Policies

This chapter shifts to the analysis of the performance of land use planning policies. The case study, the Punggol Development Guide Plan (DGP), is introduced in this chapter. The planning policies will be evaluated against the set of performance indicators discussed in Chapter 2 to assess their successes and failures.

Chapter 5 Strategies to Optimize the Use of Land

Chapter 5 explores the important issues related to the optimization of land use that have not been addressed by the policies given in the case study. It looks in detail at two issues – the classification of housing variety and the pattern of land consumption. In relation to the latter, additional strategies to optimize land use will be proposed and evaluated to assess their feasibility.

Chapter 6 Findings and Recommendations

In this final chapter, the suitability of density measurement methods used in Singapore and how successful the current planning practice has been in optimizing land use will be discussed. Recommendations will be made on alternative strategies to put land to more optimal use. The potential areas for further study are highlighted and the shortcomings of this exercise is discussed.

1.6 Limitations

Before delving into the study proper, it is appropriate to establish the limitations of this study. They are with regards to the data used in this study, and the opinions and views expressed here.

Data

The data used for analysis is not the most recent, and may have been superseded by events. Nevertheless they are sufficient for the purposes of this study because they give an idea of the processes behind planning in Singapore.

Views and Opinions

Having worked as an urban planner in Singapore for several years, I have gained a valuable insight and an appreciation of the inside view of the planning practice. Being at MIT has permitted me to view this practice from an outside perspective. In researching the questions raised in this academic exercise, I have hoped to synthesize these diverse experiences. I wish to qualify that the views and opinions expressed in this piece of work are solely my own. They do not in any way reflect the official position on the issues raised in the study.

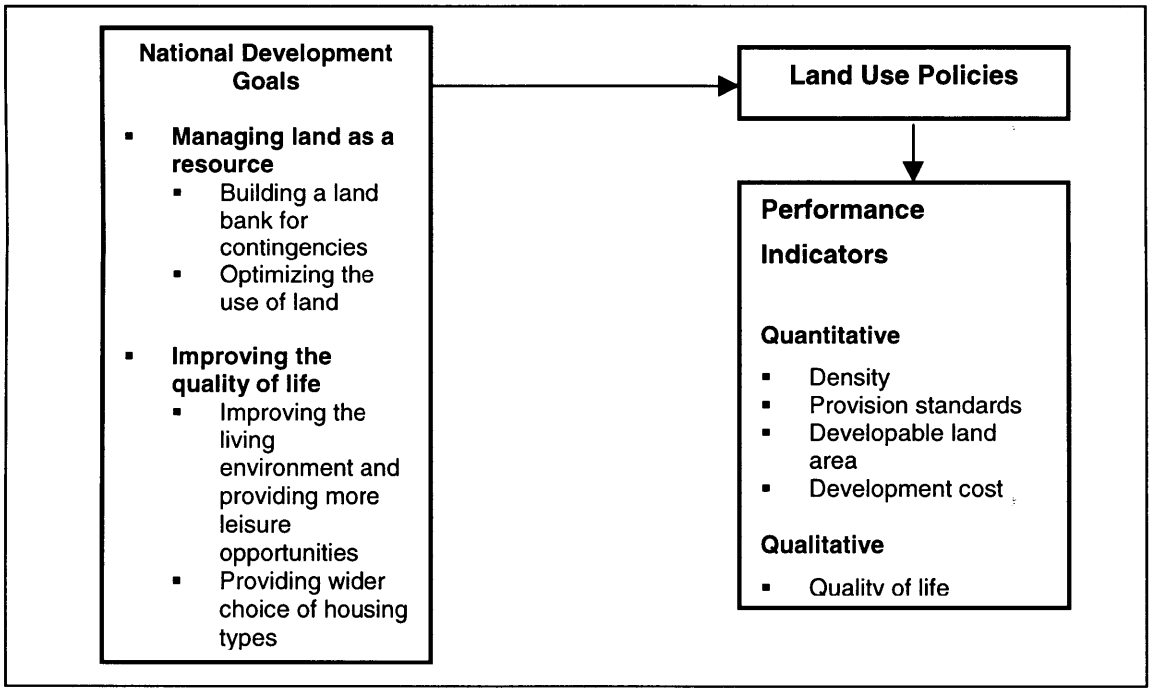
[1] In this document, city-state is used interchangeably with city, country and nation.
[2] Singapore Facts and Pictures, 1997. The main island itself has an area of 585 square kilometres.
[3] Includes transportation, water, power and sewerage
[4] Department of Statistics, Singapore (published in the Straits Times, Feb 10 1999). This is the total population figure as of mid-1998, and includes both residents and foreign workers.
[5] Total population density, which is different from resident population density
[6] Soft land can be defined as land available for development in the next 30 years.
[7] Urban Redevelopment Authority, 1996
[8] i.e. on individual sites
[9] The equivalent term used in Singapore for Floor Area Ratio (FAR) is Plot Ratio (PR). It is defined in Section 1.1.11 of the Master Plan Written Statement 1998 as the ratio between the floor area of the building and site area.
[10] This planned milestone population figure of 4 million considers the resident population (Singapore citizens and permanent residents) only. With the pro-talent immigration policy, the resident population has increased at a faster rate than projected in the 1991 Concept Plan through migration.
[11] The 1991 Concept Plan, *Living the Next Lap*, is Singapore's blueprint for long-range physical development up to the target planning year "X", where resident population will reach 4.4 million. It articulates the vision for land use and transportation in 3 stages – Year 2000, Year 2010, and Year X. At the time of preparation of this plan, foreign workers were mainly employed in the construction industry or as domestic maids. Their housing needs did not have to be catered to because they live on construction sites or with their employers respectively.
[12] Rapoport, 1975
[13] Alexander & Reed, 1988
[14] Rapoport, 1975
[15] The Urban Redevelopment Authority (URA) is a statutory board under the purview of the Ministry of National Development (MND). This Ministry is responsible for Singapore's physical development through long-term land use planning, public housing, public works, urban redevelopment, parks and recreation and other aspects of the physical development of Singapore. URA has a crucial role in planning the Singapore's future. It prepares long-range, as well as more detailed, local area plans for physical development and then co-ordinates and guides efforts to bring these plans to reality.

2

Land Use Planning Policies and Physical Planning in Singapore

This chapter sets the stage for the rest of the study by developing the key ideas presented in the introductory chapter. Singapore's planning policies will be examined in relation to development goals, and the performance indicators to assess the success and failure of policies will be introduced. Figure 2-1 gives an overview of the relationship between the development goals, planning policies and performance indicators. In later part of this chapter, an overview of Singapore's approach to physical planning will be given.

Figure 2-1 Relationship between Goals, Policies and Performance Indicators



2.1 Development Goals and Planning Policies in Singapore

The first chapter briefly introduced the primary physical planning challenges faced in Singapore, namely land scarcity and people's expectations for an improved quality of life. These central issues have shaped the nation's physical development goals, and planners have formulated strategies and policies in order to achieve these goals.

2.1.1 Managing land as a resource

Land use planning policies related to managing land as a resource are guided by two goals:

- Building up and safeguarding a land bank for contingencies as well as to maintain flexibility in responding to future changes in land demand pattern; and
- Optimizing the use of land.

2.1.2 Quality of life

Policies related to quality of life issues are also guided by two goals:

- Enhancing the quality of life through improvements to the living environment and provision of adequate leisure opportunity; and
- Achieving a private : public housing mix of 25 : 75 by 2010 in order to realize the vision of providing greater choice and variety of housing and to meet the housing aspirations of a better educated population.

Table 2-1 gives a catalog of the planning policies related to the development goals articulated above.

2.2 Performance Indicators

Performance indicators help us evaluate and measure the successes and failures of planning policies. The list of proposed indicators that can be used to assess the performance of the policies is given in Table 2-1. They are divided into two categories, namely quantitative and qualitative indicators.

2.2.1 Quantitative Indicators

Quantitative indicators measure the various attributes related to the built environment. Four indicators are proposed.

- *Density*

Density indicates how intensively land is being used for development. It is a very important indicator of performance and the subject of study of this thesis. Density will be discussed in greater detail in the following chapter.

- *Planning standards*

Planning standards fall into three categories, namely provision standards, site area standards and spacing standards. Provision standards are set at the macro level. Some examples include park space per person, living space per person and road length per person are examples of provision standards. An absolute minimum threshold is determined for each land use in the attempt to quantify variables of the natural and built-environment which impact the quality of life. This would ensure an acceptable quality of life for the city's inhabitants. Provision standards have a profound impact on density as they determine the acceptable baseline governing the use of land and built space. For example, if the minimum size of a dwelling unit is reduced (while every other variable is held constant), then overall density can be increased as the same land area will generate a higher net yield of dwelling units.

Site area and spacing standards relate to the individual site. They ensure that the built environment has an acceptable environmental quality. Like provision standards, they also affect density.

- *Land take*

This measures how much land has been freed up or saved for development owing to policy changes, e.g. locating compatible library and community center facilities together on one plot of land rather than separate plots.

- *Development cost (monetary)*

It is important to quantify the monetary cost incurred in the pursuit of certain policies such as land reclamation, i.e. unit cost per hectare. This will help to determine the uses programmed onto reclaimed land. The high cost of land usually warrants a high-value use on the land, i.e. high-density housing or commercial development.

The first three indicators, density, planning standards and land take are related to one another. The relationships are briefly explained.

- *Planning standards (independent variable) and density (dependent variable)*

When planning standards change, density will also follow suit. If provision standards become more stringent, then density will increase (this assumes that there is no change in land take). Hence provision standards are positively correlated with density. With regards to site area and spacing standards, when these standards become stricter, density will decrease. These two variables have a negative relationship.

- *Planning standards (independent variable) and land take (dependent variable)*

Planning standards also have an impact on land take. If provision, site area or spacing standards are raised, more land is usually consumed, though the rate may differ depending on the degree to which the standards are modified. The correlation between these two variables should be relatively high, and they have a positive relationship.

- *Density (independent variable) and land take (dependent variable)*

Density and land take are negatively correlated with each other. When density falls, we expect more land to be consumed. For example, low-density housing takes up more land than high-density housing. How well correlated these two variables are will depend on a number of factors.

2.2.2 Qualitative Indicators

Qualitative Indicators deal with human perceptions of the built environment and tend to be more difficult to measure. Nevertheless they are very significant because they contribute to people's overall satisfaction with their living environment.

- *Quality of life*

Although it is possible to measure the number of sports, recreation, leisure and cultural facilities provided, it is difficult to determine how they actually contribute to enhancing the overall quality of life. Besides individual perceptions as to the definition of the quality of life may differ vastly from one another. This depends on individual experience as well as socio-cultural factors.

- *Environmental quality*

Although this is a very important variable, it is difficult to measure its impacts for several reasons. The impact of development may not be fully felt till several years after completion. The signs to look out for may not even be known. Finally nature may be able to adapt and respond to changes in the environment, e.g. migratory birds nest at the vacant reclaimed land at Marine Parade and Marina East as their traditional habitats elsewhere on the island have been destroyed.

- *Time Sensitivity*

It is important to assess if policies can adapt to changing demands for land over time especially in the light of the aging population. However there is no clear- cut way to measure if a policy incorporates an in-built mechanism to respond to changes brought about by the passage of time.

Table 2-1 Development Goals and Planning Policies

National Development Objectives	Planning Policies	Performance Indicators
LAND SCARCITY		
Planning strategy	Conserve land in the following ways: -safeguarding large land banks	Land take; Environmental quality
	-developing substantial pockets of high-density areas	Density; Environmental quality
	-intensifying developments in other areas	Density; Environmental quality
	Select sites for implementation of creative and economic uses	Land take; Density
	Draw up planning guidelines for underground development	Planning standards; Land take; Development cost; Density; Environmental quality
	Reclaim land from the sea for development	Development cost; Environmental quality
	Study ways to improve the flexibility for private sites to respond to changes in the demand for land	Land take
Optimization of land use	Maximize development potential Sites around MRT/LRT stations	Density
	Spaces above roads	Land take; Density
	Minimize development constraints, e.g. height constraints, nuisance buffers around utility sites	Land take; Density; Planning standards; Environmental quality
	Integrate community facilities such as community centers, cultural institutions, schools, parks etc.	Land take; Density; Planning standards
	Identify new ideas to optimize land use with conservation buildings	Land take; Density
	Identify soft land for suitable interim uses	Land take; Environmental quality; Time-sensitivity
	Come up with incentives for new developments and redevelopment which the government wants to encourage	Land take; Density; Time-sensitivity
	Make use of incidental space, i.e. space under roads	Land take

QUALITY OF LIFE ISSUES		
Housing Mix by Year 2010 (25:75)	Review target housing mix	Quality of life; Land take; Density
Quality of life improvement	Create an entertainment district to add vibrancy to night life	Quality of life
	Introduce more street life to historic districts	Quality of life
	Develop Seaside recreational areas	Quality of life; Environmental quality
	Encourage river activities	Quality of life; Environmental quality

2.3 Physical Planning in Singapore

2.3.1 Background

Sir Stamford Raffles of the British East India Company founded Singapore in 1819. During the colonial era, land use planning was largely ad hoc, with the exception of the 1822 Jackson Plan[1]. Since independence in 1959, it has evolved to become a systematic programmed exercise[2]. The government initially adopted a blueprint approach[3] in planning resulting in the development first of the Master Plan in 1958. This was followed by the process planning approach[4] which gave rise to the Concept Plan in 1971.

2.3.2 Evolution of the Planning System

The Master Plan

The Master Plan is a statutory plan which governs how land should to be used and the intensity of its development. It comprises a set of land use/density maps and an accompanying Written Statement[5]. In accordance with the Planning Act (Number 3) 1998[6], the Master Plan has to be reviewed once every 5 years by the competent authority[7]. The plan functions primarily as an instrument of control to manage the growth and development of the city. Inevitably, it also has a significant impact on the land values.

The first Master Plan was adopted in 1958, the last year of colonial rule. The Master Plan has since undergone seven revisions, in 1965, 1970, 1975, 1980, 1985, 1990 and 1998. Singapore's eight Master Plans have been prepared under the auspices of three different national governments. The first was prepared under Colonial rule, the second under the Federation of Malaysia[8], and the other six under the Republic of Singapore[9], an independent state. The plans under the different governments reflected their different ideologies and political agendas.

Post-independence land use planning is characterized by its orientation towards goal achievement[10]. It was not confined to influencing spatial development alone. Planning policies were underpinned by a specific set of principles: a vision of Singapore as a global city, and the notions of national survival and achievement. Land use planning was integrated into a wider national policy which saw massive public investment in the pursuit of goals that were egalitarian and aimed at ensuring the optimal use of land. Land was treated as a scarce resource, land use was prioritized and the overall planning goals were expressed in national rather than communal or individual terms. In the planning process, nothing was left to chance. The preparation of the Master Plan involved exhaustive studies and surveys being carried out to test various feasibility scenarios and cater to contingencies.

During the period following independence, the government realized the shortcomings of the Master Plan. Being a blueprint for land development, the primary problem was its rigid prescriptive nature. There was the danger of strictly adhering to the blueprint rather than adapting to the day to day changes brought about by the dynamic conditions affecting the economy. In addition, the silent assumptions of slow and steady rate of urban growth and social change were overthrown by the high rate of population growth. Rapid changes made the Master Plan obsolete as soon as it was completed. The government also realized that it could not rely on private sector initiative in physical development to provide massive infrastructure requirements in the early days of independence. To overcome the weaknesses of the Master Plan, Singapore undertook the

State and City Planning project[11] in 1967 to prepare a long-range comprehensive physical development plan. The result was the Concept Plan.

The Concept Plan

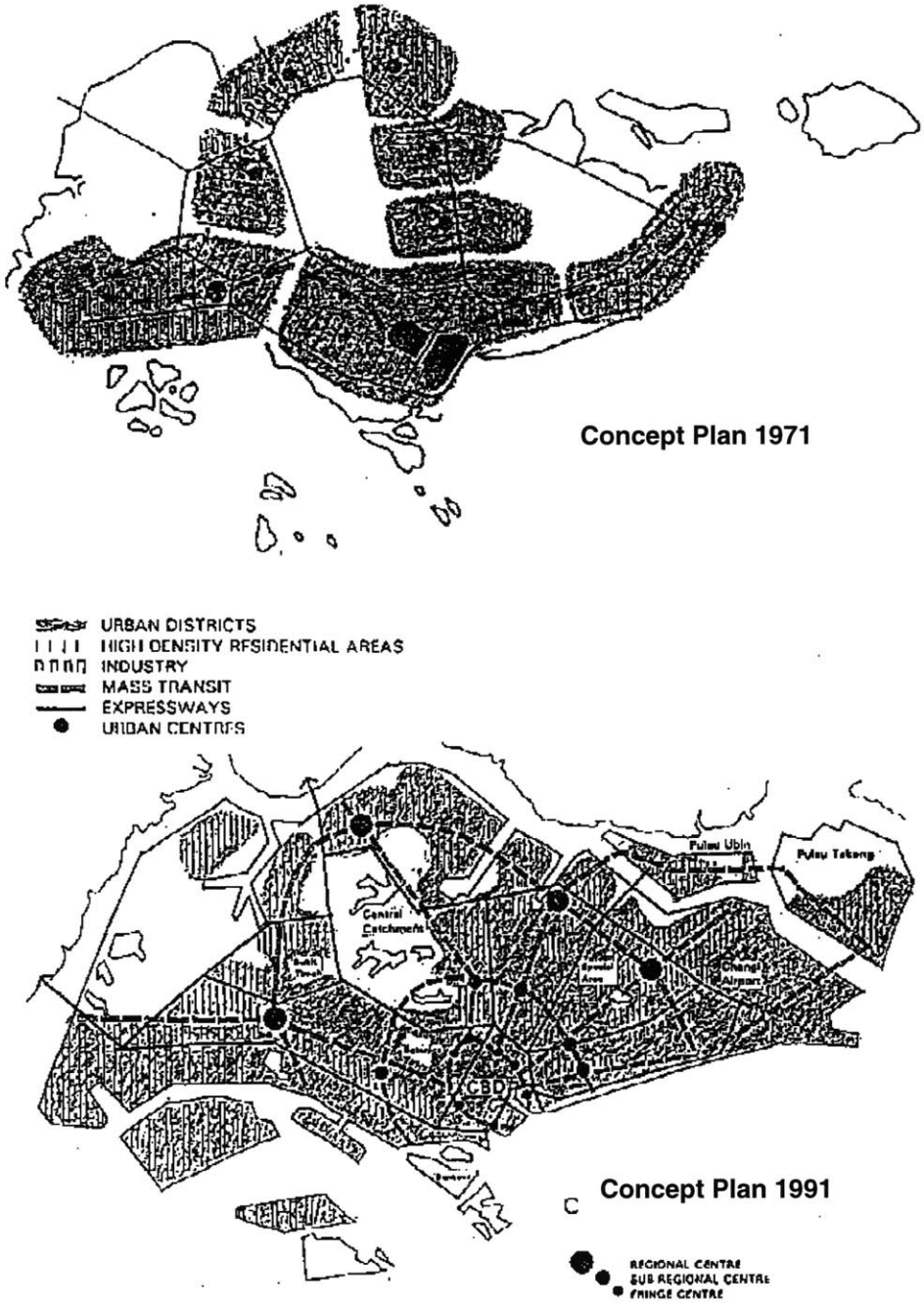
The Concept Plan serves as a comprehensive physical development policy expressing how land should be used in the long-term. It sets out guidelines for the optimum spatial distribution of major activities, a framework for integrating land use, infrastructure provision and transportation planning, and the provision of a rational basis for which the Master Plan is to be revised periodically in order to regulate urban development. Unlike the Master Plan, it is advisory in capacity.

The first concept plan, the *Ring Concept Plan* was a far-sighted plan for industrialization and economic growth (Figure 2-2). It focused on the key infrastructure to be developed, primarily the new airport at Changi, new residential towns, a network of expressways, and the Mass Rapid Transit[12] (MRT) system. The target planning population was 4 million, which was expected to be reached by the early part of the 21st century.

The second concept plan (1991), *Living the Next Lap*, is more comprehensive in nature (Figure 2-2). It spells out how economic growth can be sustained, how best to plan the transportation system, how to maintain the Asian character of the city and how to improve the quality of life. The target population for this plan was also 4 million, which planners thought would be reached after the Year 2010.

The Urban Redevelopment Authority (URA), Singapore's national planning agency, is currently preparing the third Concept Plan, which they expect to complete in 2001.

Figure 2-2 Singapore's Concept Plans



Source: Waller (1998)

2.3.3 The Plans

The Concept Plan is the macro-level plan which sets the strategic directions for all subsequent plans. All the growth needs of the future are identified, and typology studies and standard setting have to be carried out to prepare the plan.

The Layer Plans are macro-level plans which look at various important elements of the Concept Plan. There are six Layer Plans, namely the strategic transportation plan, natural environment plan, leisure plan, culture plan, sports plan and science habitat plan.

The Development Guide Plans (DGP) are detailed plans which begin where the broad Concept Plan ends. Singapore island is divided into 55 planning areas, each with its own DGP. The development quantum in the Concept Plan for each land use type is programmed into the DGPs, and the details on land use and floor area ratio for individual land parcels are worked out. Complementing DGPs are urban design and conservation plans. All these plans incorporate the visions and new ideas for Singapore and form the basis for facilitating the development of land. The 55 DGPs together form the statutory 1998 Master Plan.

2.4 Planning Approaches

Planning approaches guide the preparation of plans to achieve the vision and goals articulated for a city. Singapore has always adopted a quantitative approach to land use planning (Figure 2-3). To match land supply against demand still remains the starting point of any planning exercise. This approach ensures that there is land at the right places to meet long-term growth needs. Apart from demand and supply, the variable third element in the approach is density[13]. The three elements in the quantitative approach will be elaborated upon in greater detail.

Element 1: Determining the demand for land

In Singapore's case, the city is considered a receptacle, in which all the needs of the people will be contained. The size of the receptacle is small and fixed. To cater for every need, planners have to carefully pack in all the land uses at relatively high densities within the tiny space. The floor space quantum for every major need, with ample contingencies, have to be projected so that adequate land is safeguarded for every known and anticipated need.

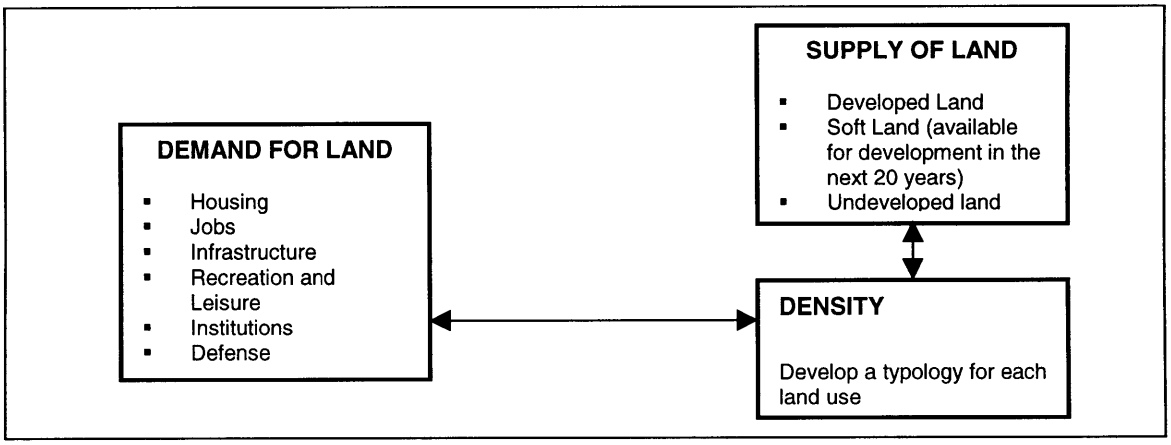
Element 2: Determining the supply of land

The size of the container needs to be defined to test the ultimate holding capacity of the land and sea. Land for urbanization is the net of the natural areas to be conserved from the total land area (includes land to be reclaimed from the sea within practical limits).

Element 3: Determining the intensity of development or density

Land use typologies and their hierarchies have to be established. Typological studies, in terms of developmental forms, intensities and heights, are carried out to examine the range of development prototypes for Singapore. Planners have to see how much of each type of development we can afford to have, from the lowest to highest development intensities within the urbanized area. This allows the maximum the range of environmental variations without fear of facing land shortage.

Figure 2-3 Singapore's Planning Approach

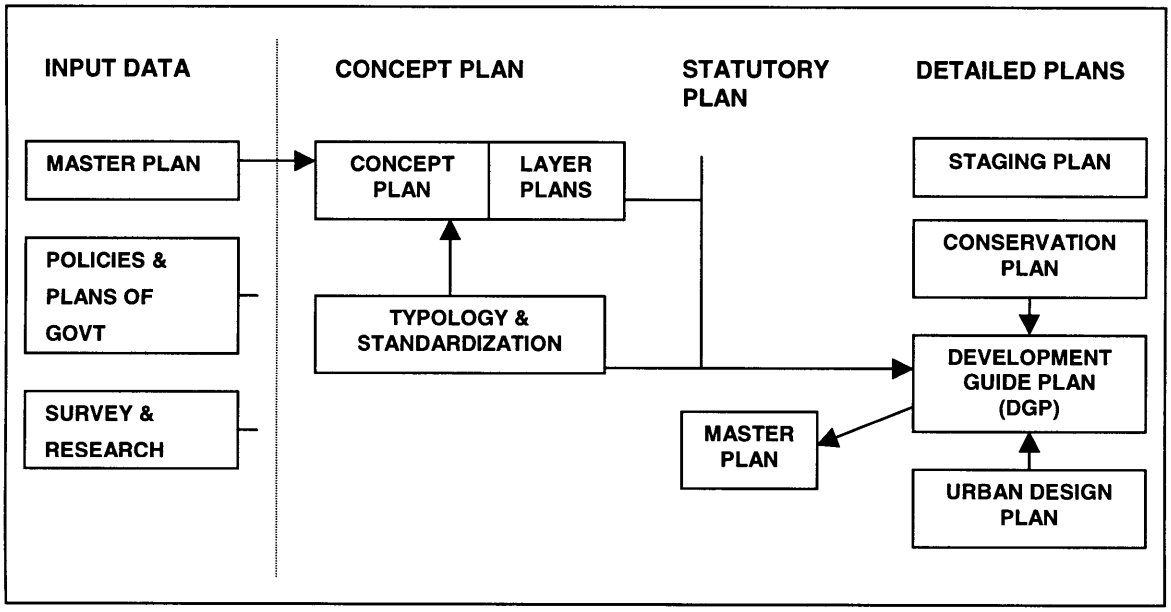


2.5 The Planning Process and the Plans

2.5.1 The Process

In order to understand how density is measured, it is necessary to understand how the planning process works. Figure 2-4 illustrates briefly Singapore's planning process.

Figure 2-4 The Planning Process



2.5.2 The Plans

The Concept Plan is the macro-level plan which sets the strategic directions for all subsequent plans. All the growth needs of the future are identified, and typology studies and standard setting have to be carried out to prepare the plan.

The Layer Plans are macro-level plans which look at various important elements of the Concept Plan. There are six Layer Plans, namely the strategic transportation plan, natural environment plan, leisure plan, culture plan, sports plan and science habitat plan.

The Development Guide Plans (DGP) are detailed plans which begin where the broad Concept Plan ends. Singapore island is divided into 55 planning areas, each with its own DGP. The development quantum in the Concept Plan for each land use type is programmed into the DGPs, and the details on land use and floor area ratio for individual land parcels are worked out. Complementing DGPs are urban design and conservation plans. All these plans incorporate the visions and new ideas for Singapore and form the basis for facilitating the development of land. The 55 DGPs together form the statutory 1998 Master Plan.

Next Chapter

With an idea of the background of physical planning in Singapore, the next chapter proceeds to deal with density, the subject of this study.

[1] This plan envisioned a strict regularity in the layout of the streets and incorporated provisions for the separation of indigenous and European inhabitants along racial and social lines. Its aim was to achieve an ordered pattern of growth, given that Singapore was designated as a commercial and administrative center soon after its founding. The legacy of this plan is still evident today in the street pattern in the Central Business District (CBD), and the existence of the historic districts of Chinatown, Kampong Glam and Little India which were based on ethnic lines.

[2] Teo, 1992

[3] Faludi, 1973. The blueprint approach works towards a predetermined, desired end state.

[4] *Ibid.* The process approach is inherently a response-oriented, monitoring and reactive ad hoc approach to planning decisions.

[5] The Written Statement amplifies planning definitions and proposals and describes the general intent of the Master Plan.

[6] Section 8(1) of the Planning Act (Number 3) 1998 edition

[7] The competent authority for the operation of the Planning Act is the Chief Planner, Urban Redevelopment Authority, who has been appointed by the Minister of National Development under Section 3(2) of this Act.

[8] Singapore was part of the Federation of Malaysia between 1963 and 1965.

[9] Singapore separated from Malaysia on 9 August 1965.

[10] Teo, 1992

[11] This project was under the auspices of the United Nations Development Program (UNDP).

[12] The MRT is Singapore's urban rail transit system, which forms the backbone of public transportation.

[13] Liu, 1991

3

Measuring Physical Density

The focus of this chapter is density. Generic quantitative measures of density are introduced to give a picture of how density is being measured in different places. The focus then shifts to Singapore, and the different ways density is being measured and how planning standards are used will be discussed.

3.1 Measured Density

Density as employed in land use planning and related applications appears to be a simple concept. However the complex reality to which it is applied – the three dimensional city – cannot be fully captured by any given density measure. Although a useful construct, density is inadequate to describe what the existing urban environment is like, what future development will be like, or prescribing what it should look like. Hence there are many measures of physical density, each trying to capture different aspects of reality as precisely as possible. However, in view of the numerous technical complexities involved in coming up with these measures, they are frequently misunderstood and misused. Which measure is the most appropriate to use in a given context needs to be further examined.

Density measures the degree to which a space or area is filled by people, residential structures or built-up floor area. Many measures exist to express density.

3.1.1 Ratios

Density is most commonly measured in the form of ratios. Occupiers of space, such as persons, rooms, households and dwelling units, or built-up area are found in the

numerator. The denominator generally comprises a unit of area, such as plot area, residential land area, neighborhood area or city area. Examples of density expressed in ratios include persons per hectare, number of dwelling units per hectare and Floor Area Ratio (FAR). Density measured in ratios will be elaborated upon in this chapter.

3.1.2 Surrogate density measures

Density can also be reflected in terms of the physical form and volume of buildings. The envelope of a building on a site is often determined by building coverage, height and setbacks, which are classes of measures that are surrogates for density.

3.2 Measuring Density with Ratios

This section looks at the components of density expressed in the form of a ratio.

3.2.1 The Numerator

Numerator units can be group into three categories:

Population Units

- Residential Population
  - Persons
  - Families or Households

- Working Population
  - Workers

Housing Units

- Number of housing units or dwelling units
- Number of habitable rooms
- Number of bedrooms
- Number of bed spaces

Built Floor Area (Square meters / Square feet)

- Gross Floor Area (GFA) – the area within the envelope of the building, including the thickness of its external walls;
- Net Floor Area (NFA) – the area within the envelope of a building after circulation areas (e.g. atrium, lobby and staircases) and thickness of walls is excluded.

Population and housing units used in the numerator are related to one another, and their relationships can usually be inferred. We can convert density measures from one population unit to another, or from population units to household units and vice versa. For example, to convert density measures from number of persons to number of households, we need to know (or assume) the average household size. Likewise, to convert density measured in population units to household units, we need to make assumptions about the occupancy rates, i.e. one household occupies one dwelling unit or 5 persons occupy one dwelling unit.

3.2.2 The Denominator

The denominator unit in density ratios is a unit of area. According to Alexander and Reed (1988), units of area can be classified into 2 categories:

Molecular

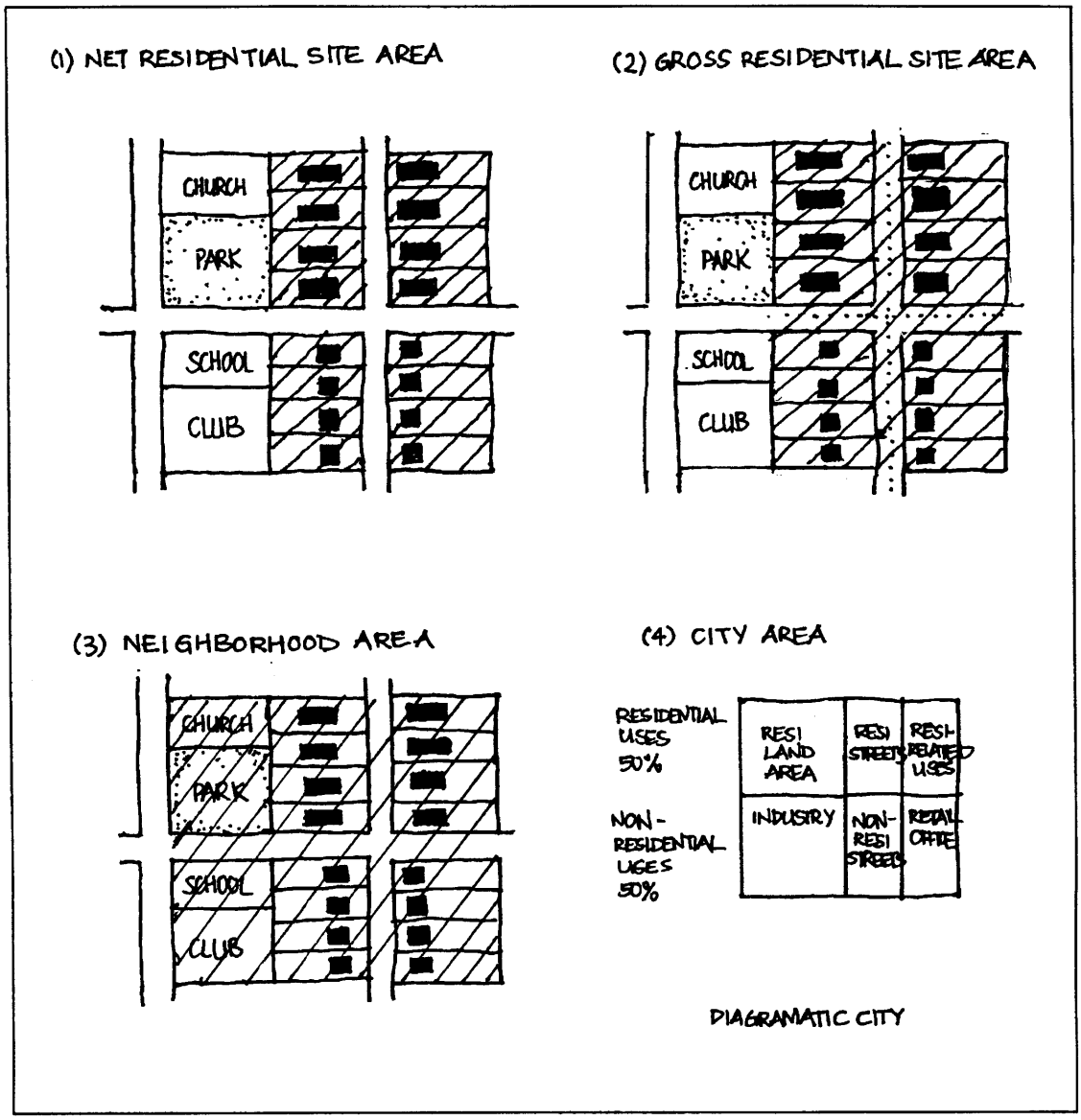
Space within the dwelling unit (not a commonly used denominator), i.e. room, area of dwelling unit

Molar

Land base, i.e. site (net and gross), neighborhood area, suburban area, city area. This is the commonly used denominator in determining density, and will be discussed further. The unit of area varies in two respects. Firstly, it varies in the unit of measurement, i.e. acres, hectares, square miles or square kilometers. Simple arithmetic conversions allow us to convert one unit of measurement to another. More importantly, the land base as a

unit of area varies in the definition of its boundary (Figure 3-1). Land area boundaries are defined differently in practice, resulting in a major source of ambiguity in the vocabulary and makes comparisons difficult. Table 3-1 shows the definition of land area boundaries, from the level of the residential site to the city scale.

Figure 3-1 The Land Base (Molar measure)



Source: Hitchcock (1994)

Table 3-1 Defining the Boundary of Land

Boundary of the Land Base[1]	***Source and Definition***
Net Residential Site Area	▪ APHA (1960) ▪ Hoffman (1967) ▪ Martin & March (1969) ▪ Keeble (1971) ▪ Alexander & Reed (1988) ▪ Loder & Bayly (1994) ▪ Hitchcock (1994) ▪ Cardew (1996) The total land area devoted to residential dwellings, including private driveways, yards, parking areas, and gardens. ▪ FHA (1965) Ambiguous about whether street and parking areas are included
Gross Residential Site Area	▪ APHA (1960) ▪ Stevens (1960) ▪ Martin & March (1969) ▪ FHA (1971) ▪ Cameron (1980) ▪ Alexander & Reed (1988) Net Residential Site Area plus half the area of the perimeter of roads plus one-quarter the area of the intersections ▪ Hitchcock (1994) Net Residential Site Area plus one-half rights of way which abut residential parcels ▪ James (1967) Net Residential Site Area plus 20' of peripheral roads ▪ Loder & Bayly (1994) ▪ Cardew(1996) Net Residential Site Area plus unspecified pro-rated area of local and collector roads
Neighborhood Area	▪ APHA (1960) ▪ Gibberd (1967) ▪ James (1967) ▪ Corvallis (1977) ▪ Cameron (1980) ▪ Alexander & Reed (1988) ▪ Mcloughlin (1991) ▪ Hitchcock (1994) ▪ Loder & Bayly (1994) ▪ Cardew (1996) The total land area devoted to neighborhood uses, including residential land, streets, neighborhood community uses such as schools, recreation and religion culture, and neighborhood retail shopping.

Suburban Area	▪ Cardew (1996) The total land area devoted to neighborhood uses, inclusive of land used for local and collector roads, all non-residential uses (e.g. local open space, drainage reserves, community facilities, schools), and regional uses (regional open space, environmental protection areas, larger scale commercial, community and education uses)
City Area	▪ APHA (1960) ▪ Jensen (1966) ▪ James (1967) ▪ Keeble (1971) ▪ Cameron (1980) ▪ Alexander & Reed (1988) ▪ Mcloughlin (1991) ▪ Hitchcock (1994) ▪ Loder & Bayly (1994) ▪ Cardew (1996) The entire area of the city, regardless of land use. This tends to be ambiguous as this could mean the city's political boundary (vacant and undeveloped land may be included), or only the urbanized or contiguous built-up areas.

3.3 Generic Density Measures in Ratios

3.3.1 Population and Housing Units

Density measures primarily relate to residential areas, or to the residential population of a city or region. From a review of the literature on density measures, it has been found that authors are in agreement that there are several generic definitions though there is no standardization in the terminology used by the different authors. For the purpose of this study, Alexander & Reed's (1988) definitions of density measures will be used as they tend to be general and encompass most of the definitions made by other authors.

Net Dwelling Density

Numerator	Population (persons, households) or housing (dwellings) units
Denominator	Net residential site area (see Table 3-1)

Gross Residential Density

Numerator	Population or housing units
Denominator	Gross residential area (see Table 3-1)

Neighborhood Density

Numerator	Population or housing units
Denominator	Neighborhood land (see Table 3-1)

City Density

Numerator	Population or housing units
Denominator	Entire of area of the city

Table 3-2 illustrates the density measures that have been developed over the years. They are categorized according to the density measures used by Alexander & Reed (1988).

3.3.2 Built-Up Floor Area

Floor Area Ratio[2] (Figure 3-2)

Floor Area Ratio (FAR) measures density at the net site level. It expresses the built-up floor area[3] of a structure in relation to the net site area which the buildings sits on, both in the same unit of measurement (i.e. square meters, square feet). FAR is usually expressed as a decimal fraction, i.e. 0.5 which means that the built-up area is half that of the site area.

FAR can be used to define the nature of development of an area comprising many land parcels, or to control the intensity of development permitted on any given parcel of land especially when the impact of large buildings on the surrounding environment is a planning concern. It is a particularly useful measure of density where non-residential uses are concerned, or where there is a combination of residential and non-residential uses on the same parcel of land. It can also be used to measure density on residential sites.

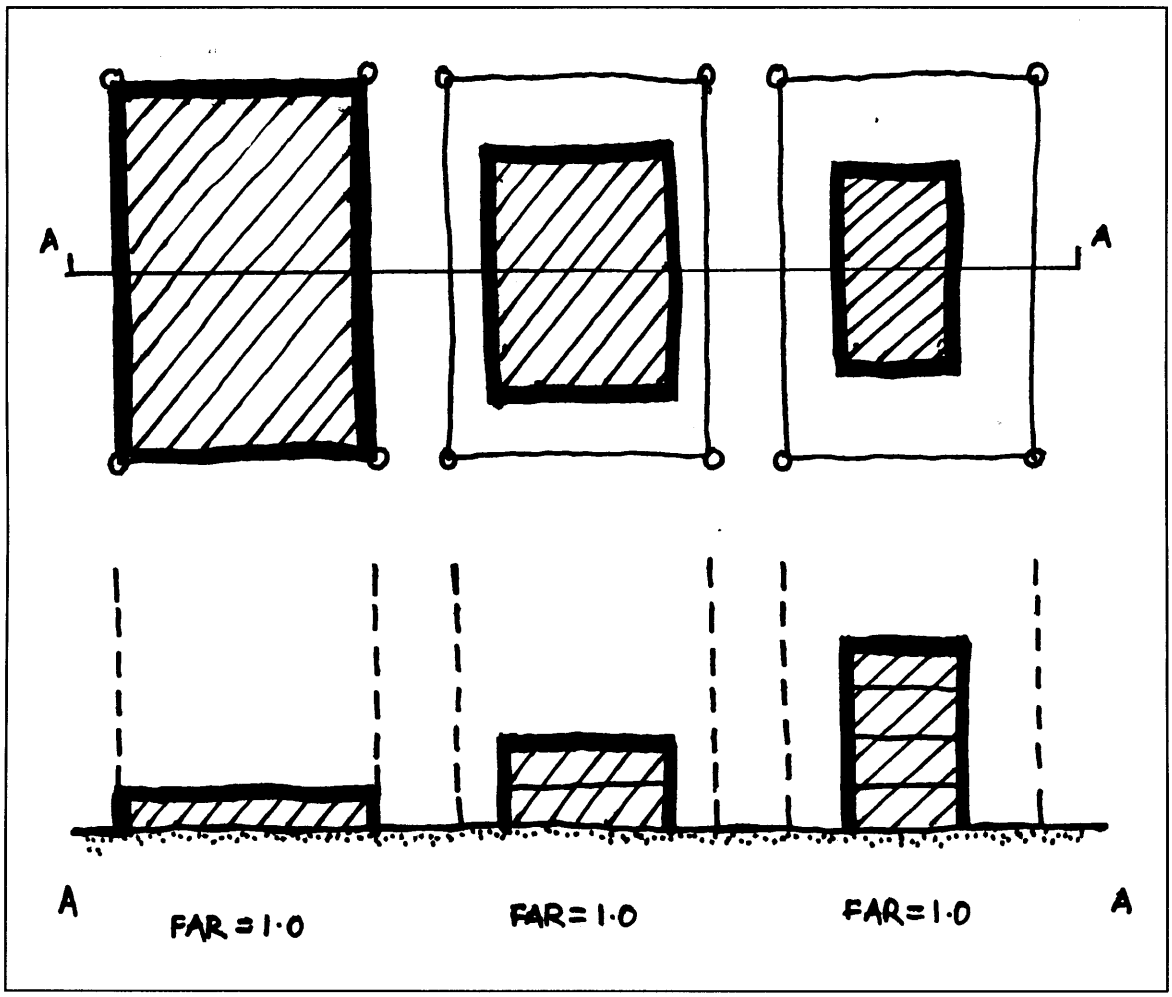
Table 3-2 Comparative Density Measures reflecting Population and Housing Units

	Denominator Units			
	Net Residential Site Area	**Gross Residential Site Area**	**Neighborhood Area**	**City Area**
	Density Measures			
	Net Dwelling Density	**Gross Residential Density**	**Neighborhood Density**	**City Density**
Numerator Units				
POPULATION				
Persons		APHA (1960) Stevens (1960) *Housing Area Density* Gibberd (1967) *Net Neighborhood Density* James (1967) *Net Density* Jensen (1967) *Net Density*	Gibberd (1967) *Gross Neighborhood Density* James (1967) *Gross Density* Jensen (1966) *Gross Population Density* Keeble (1969) *Gross Population Density*	APHA (1960) *District Density* Jensen (1966) *Town Density* James (1967) *Town Density* Cameron (1980)
HOUSING				
Households		APHA (1960)		APHA (1960) *District Density*
Rooms			Corvallis (Oregon League of Cities 1977)	
Dwelling Units	APHA (1960) FHA (1971) *Net Density* Keeble (1966) *Net Residential Density* Hoffman (1967) Martin & March (1972) Hitchcock (1994) *Parcel Density*	APHA (1960) *Gross Dwelling Density* Gibberd (1967) *Net Neighborhood Density* FHA (1971) *Gross Density* Martin & March (1972) Cameron (1980) *Net Housing Density*	APHA (1960) *Net Density* Gibberd (1967) *Gross Neighborhood Density* Hitchcock (1994) *Gross Residential Area Density* Loder & Bayly (1994) *Neighborhood Dwelling Density*	APHA (1960) *District Density* Keeble (1969) Hitchcock (1994) *Gross Municipal Area Density* Loder & Bayly (1994) *Urban Center Dwelling Density* Cardew (1996) *Metropolitan Density*

	Loder & Bayly (1994) *Site Density* Cardew (1996) *Site Density*	Hitchcock (1994) *Street Density* Loder & Bayly (1994) *Net Dwelling Density* Cardew (1996) *Net Residential Density*	Cardew (1996) *Gross Residential Density*	

Source: Alexander & Reed (1988), modified

Figure 3-2 Floor Area Ratio (FAR)



3.4 Surrogate Measures of Density

These measures will be explained in brief because they are not part of the focus of this study.

3.4.1 Building Coverage (Figure 3-3)

The building coverage is the ratio of the area occupied by the building on the ground floor, i.e. its footprint, to the area of the site. It is expressed as a percentage or a decimal fraction.

3.4.2 Height and setbacks (Figure 3-4)

The combination of building height and setbacks (minimum distances between the building and boundaries of the site) determine the mass or envelope of the building.

Figure 3-3 Building Coverage

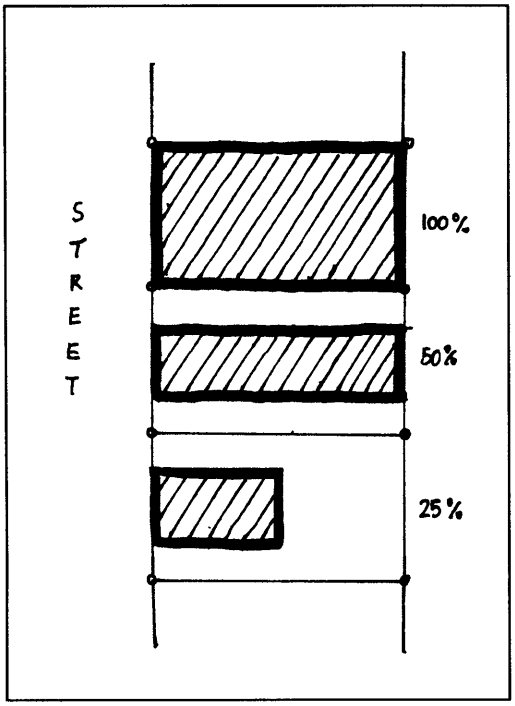
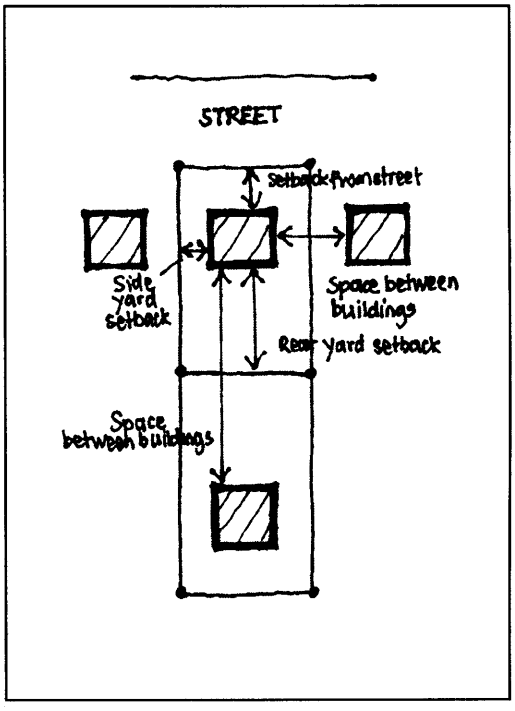


Figure 3-4 Setbacks



Source: Alexander & Reed (1988)

3.5 Density Measures in the Singapore Context

Chapter 2 introduced the quantitative approach to physical planning in Singapore, and the various plans that are prepared to guide physical development. Before specifically discussing how density fits into the quantitative planning framework, two general measures of density, population and urban densities, will be discussed.

3.5.1 Population Density and Urban Density

Population and urban densities are two different indicators measuring how intensively land is being put to use. The latter is especially useful in highlighting the pattern of land consumption in urban areas for development. Population density is derived over the total land area (i.e. the city area), whereas urban density is based on the urbanized land area of the city only.

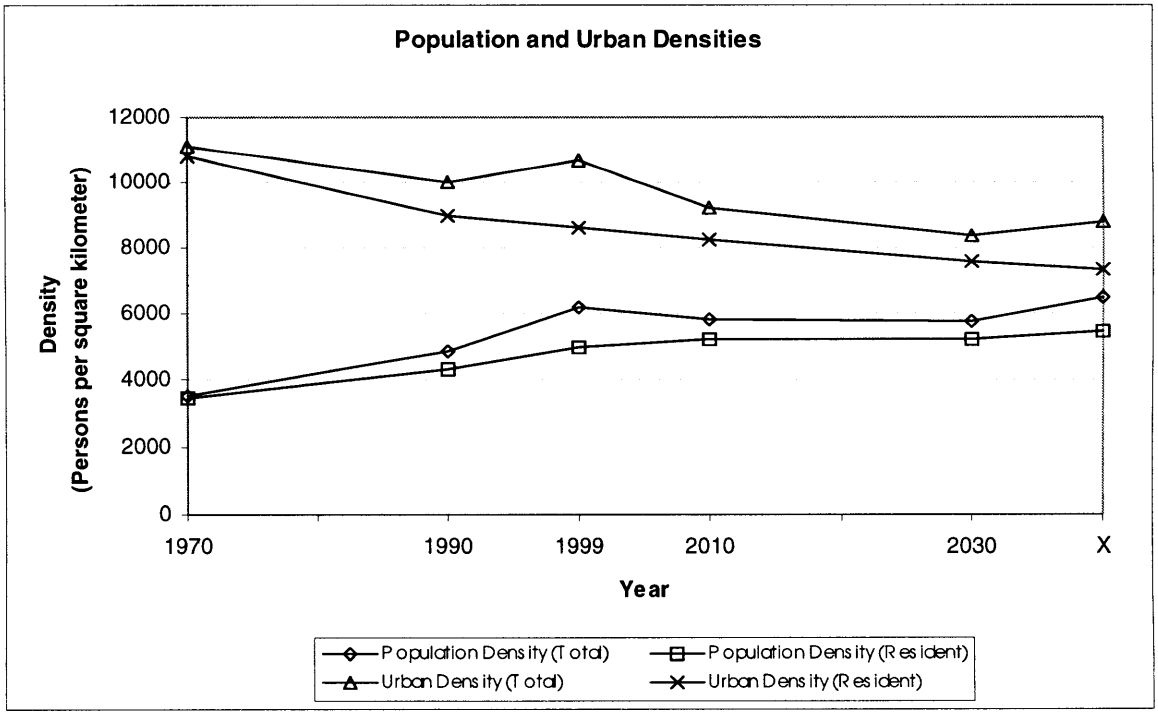
Singapore's population density has grown over time since 1970 (Table 3-3). However the urban density has actually fallen over the same time period as more land is consumed for development (Table 3-3). URA projects that the same pattern will continue to the Year X. This inverse relationship between the two density measures is clearly illustrated in Figure 3-5. The land take-up rate for urban development is increasing faster than the rate of population growth. The spread of urbanization is clearly reflected in the two Concept Plans (Figure 2-2 refers). The implications of this pattern of land consumption will be revisited in the later part of this study.

Table 3-3 Population and Urban Densities (1970 to Year X)

Parameters	*Year*[4]					
	1970	**1990**	**1999**	**2010**	**2030**	**X**
Land Area (km^2)						
Total[5]	586	626	648	665	703	736
Urbanized Area[6] **(%)**	187 (32%)	302 (48%)	375 (58%)	418 (63%)	485 (69%)	544 (74%)
Population ('000)						
Total[7]	2,074.5	3,016.4	4,000.0[8]	3,853.8	4,0600.0	4,770.0
Resident[9]	2,013.6	2,705.1	3,230.5	3,453.8	3,664.5	4,000.0
Population Density (persons per km^2)						
Total	3540	4819	6173	5795	5775	6481
Resident	3436	4321	4985	5194	5213	5435
Urban Density (persons per km^2)						
Total	11094	9456	9975	8660	8371	8768
Resident	10768	8480	8056	7761	7556	7353

Sources: Department of Statistics, various years and Urban Redevelopment Authority, 1991

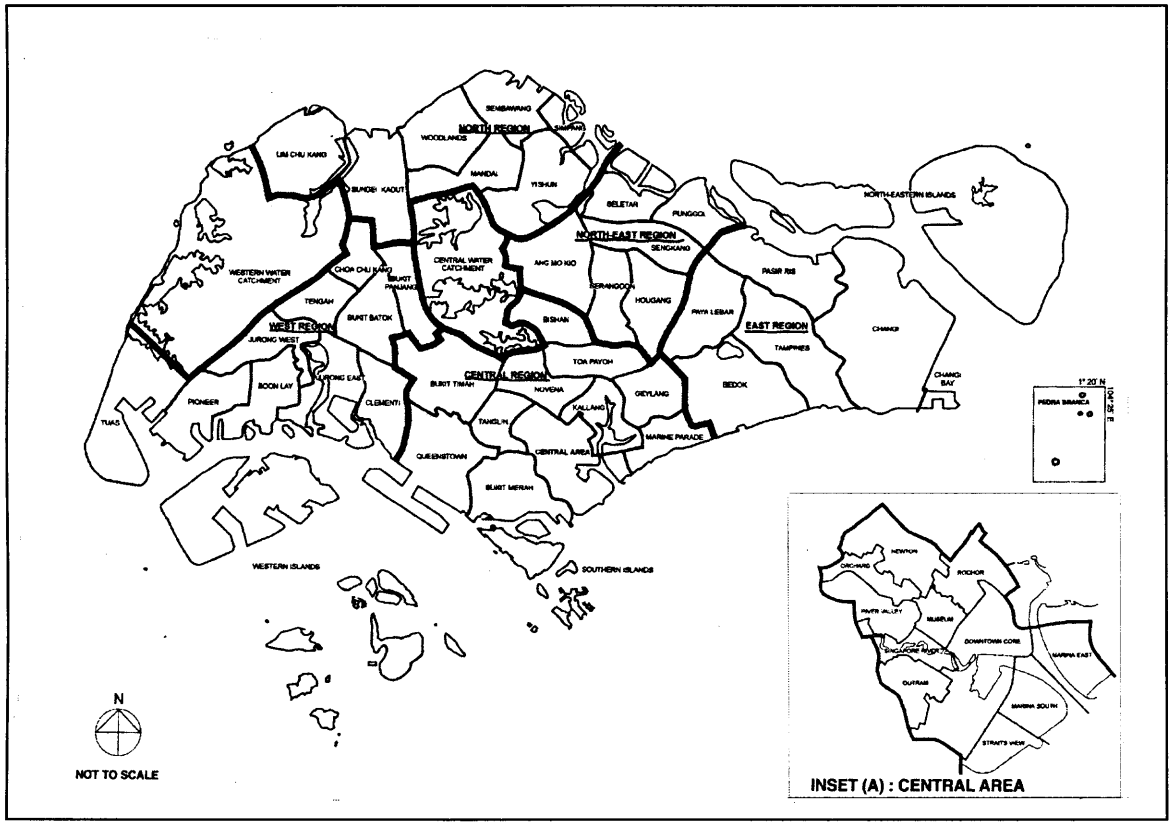
Figure 3-5 Population and Urban Densities (1970 to Year X)



3.5.2 Quantifying Density: How does it work?

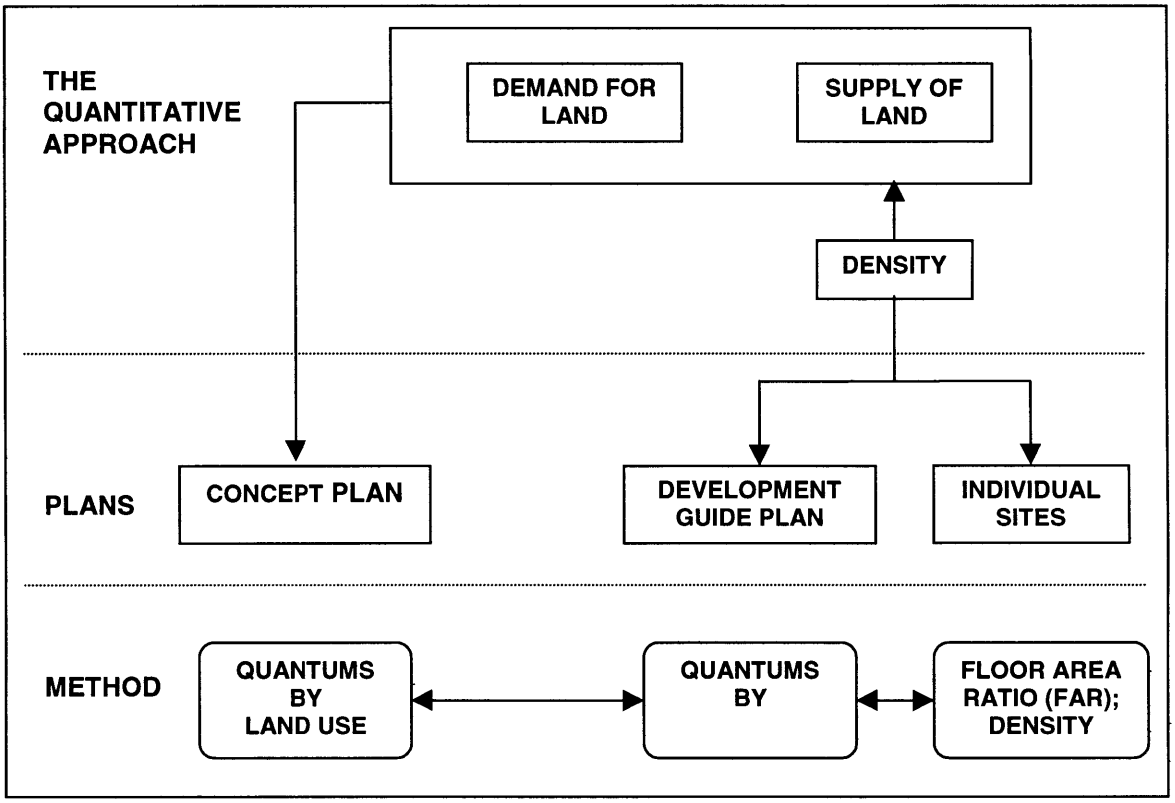
Planning quantum figures according to land use are determined at the macro Concept Plan level for the whole island, the 5 regions and each of the 55 planning areas (Figure 3-6). These numbers are then related to the individual site at the local level. This study focuses on the two-way relationship between the planning quantums at the macro-level and densities at the micro-levels (Figure 3-7). In this section, the relationship between the numbers at the different levels will be highlighted.

Figure 3-6 Singapore's Planning Areas and Regions



Source: Urban Redevelopment Authority (1998)

Figure 3-7 The Quantitative Approach



3.5.3 Density at the Macro Level: The City, Regions and Planning Areas

At the city level, the Concept Plan maps out the long-term land use and development strategy. The land use distribution for living space, working space, community space, open space and recreation, infrastructure, military use, water catchment areas and other uses is determined from the Year 2000 and beyond (Table 3-4). The Concept Plan intentions are then translated into the regional and local (i.e. planning area) levels to guide development. A hierarchy of planning units is developed for different population sizes in order to do this (Table 3-5). Commercial centers are planned to correspond to the population size (Table 3-5), as are other land uses. It is important to note that planning areas are equivalent to new towns in size and concept. A public housing new town is created to be a largely self-sufficient community, with 40% of land dedicated for housing. Table 3-6 provides the distribution of land uses by land area in a typical new town with 44,000 dwelling units.

Table 3-4 Land Use Distribution at the City-Scale

Year	1991		X	
Population	3.01 million		4.77 million	
Land Use	Area (hectares)	Percentage (%)	Area (hectares)	Percentage (%)
Living Space (Housing)	7,200	11.4	15,000	20.4
Working Space (e.g. Commerce, Industry)	12,700	20.3	19,000	25.8
Community Space (e.g. Institution)	2,900	4.7	5,500	7.4
Open Space/Recreation (e.g. Golf Courses, Parks)	4,000	6.4	7,500	10.2
Infrastructure (e.g. Transportation)	7,400	11.8	10,600	14.4
Military	12,300	19.7	10,300	14.0
Central Catchment/ Reservoirs	5,300	8.5	5,300	7.2
Others[10] (e.g. Undeveloped land, Cemetery, Agriculture, Quarry)	10,800	17.2	400	0.6
TOTAL	62,600	100.0	73,600	100.0

Source: Urban Redevelopment Authority (1991)

Table 3-5 Hierarchical Planning Units at the Regional and Planning Area Levels

Planning Unit (in ascending order by land area)	Population Size (Dwelling Units)	Size of Commercial Centers (m2)
LOCAL LEVEL		
Precincts	2,000	-
HDB Neighborhoods	4,000 - 6,000	3,500
New Towns (Planning Area)	20,000 - 60,000	75,600 - 100,800
REGION LEVEL		
Regions	160,000 - 260,000	1.5 million
Central Region	420,000	17 million

Source: Urban Redevelopment Authority (1991)

Table 3-6 New Town Brief (44,000 dwelling units)

Land Use	Land Area (hectares)	Percentage (%)
Residential		
Private	64.0	) 42.3
Public	256.0	)
Commercial		
Town Center	24.0	) 8.0
Neighborhood Center	36.0	)
Educational Institutions	62.0	8.2
Institutions	16.7	2.4
Parks and Gardens	85.6	11.2
Sports Facilities	9.0	1.2
Industry	55.0	7.3
Transport	93.7	12.3
Others (e.g. Infrastructure)	54.0	7.1
TOTAL	756.0	100.0

Source: Urban Redevelopment Authority (1991)

3.5.4 Density at the Site Level

Different measures are used to quantify density for the different land uses found in Singapore. Table 3-7 gives a comprehensive list of measures taking into account the different numerators and denominators used since the inception of the 1958 Master Plan. I will highlight the changes over time and discuss their significance.

Table 3-7 Measuring Density at the Level of the Individual Site

Land Use Typology[11]	**1958-1990 Master Plan**	**1998 Master Plan**
Residential	Persons per acre (1958, 1965, 1970); Persons per hectare (1975, 1980, 1985)	Floor Area Ratio (FAR); Gross Floor Area (GFA) based on allowable FAR
Residential with Commercial use at the 1st story only	Not applicable[12]	
Commercial/ Residential[13]	*Residential Use* Persons per acre/Persons per hectare *Commercial Use* Floor Area Ratio (FAR)	
Commercial[14]	Floor Area Ratio (FAR); Gross Floor Area (GFA) based on allowable FAR	
Industry / Warehouse[15]		
Business Park[16]		
Hotel[17]		
Hospital and Health Care		
Place of Worship		
Educational Institution		
Civic and Community Institution		
Sports and Recreation		

Residential Use

The traditional aim of density control is to prevent overcrowding[18]. Between 1958 and 1990, density was measured in terms of population units (persons per hectare[19], i.e. ppha). This is a complicated method of measurement. For the purpose of control, the Master Plan prescribes the maximum residential density[20] allowable for development on an individual site. However the density in ppha needs to be translated into total housing capacity on a site. This is done by applying an assumed occupancy rate corresponding to

the size of the dwelling unit. There are many variables involved in using this measure, namely density, number of dwelling units, occupancy rates and size of dwelling units.

- Density (ppha) = $\frac{\text{Total number of persons in the proposal}}{\text{Net residential site area}}$[21]

- Total number of persons in the proposal =

  Number of dwelling units x Occupancy Rate

- Occupancy rates (Table 3-8) serve to determine the intensity of a proposed residential development as well as regulate the size of dwelling units (especially flats and condominiums). Gross floor area (GFA) of the dwelling unit will be used in determining their sizes. Occupancy rates have been revised and reduced in 1986, resulting in a development site being able to accommodate up to 20% more dwelling units for a given residential density[22].

Table 3-8 Occupancy Rates (1986 standards)

Type of Residential Development	**Gross Floor Area (m2)**	**Occupancy Rate (persons per unit)**
Landed Housing (Detached, Semi-detached, Terrace)	No control. GFA is the result of compliance with all planning and development control parameters such as height, setbacks, building coverage etc.	5 ppu
Flats, Townhouses, Condominiums	<= 80 m2 81 to 120 m2 121 to 160 m2 > 160 m2	2 ppu 3 ppu 4 ppu 5 ppu

Source: Leung (1987)

- The size of dwelling units affects the proposed density (number of persons a site may accommodate). A developer can propose 10 flat units each with an area of 162 m2, which gives the site a capacity of 50 ppha (5 ppu x 10 units). Alternatively, if the developer reduces the size of the flat units by 4 m^2 to 158 m^2, the site will be deemed to have a capacity of 40 ppha (4 ppu x 10 units). Although the unit size is almost the same, the proposed density is substantially different. Developers can play around with unit sizes to keep the proposed density of development below the prescribed maximum, or keep any increase in density above the prescribed maximum to a minimum, while maximizing the total floor area in the development.

In addition to using population units to control density, developments were also not allowed to exceed a FAR of 2.0 (gross). FAR was used to control the bulk of the building.

It is evident that controlling the intensity of residential development using density (ppha) is a complicated affair. An attempt to simplify matters has led to the use of FAR to measure density in the 1998 Master Plan.

The main aim of FAR control is to assess the development intensity of both residential and non-residential proposals vis-à-vis the Master Plan provision for a development site. The Master Plan FAR control seeks to prevent the over-development of particular sites, which create a negative impact on surrounding areas and damage the environment.

- Floor Area Ratio = $\dfrac{\text{Gross Floor Area (GFA) of building}}{\text{Site Area}}$

The 1998 Master Plan prescribes the maximum FAR allowable for a residential site. If the area of a development site is known, one can determine the maximum GFA allowable. For example, if a developer owns a 1000 m^2 plot of land zoned for residential

use with a FAR of 2.8 (maximum), he/she knows that 2,800 m^2 of residential GFA can be allowed to be built on the site (i.e. 1000 m^2 x 2.8 = 3,000 m^2).

URA has a prescribed formula to convert density in ppha to FAR. This formula is used to determine the development charge[23] baseline[24] of a development site in order to enable landowners / developers to be charged for exceeding the Master Plan permitted density for the site (this excess density is allowable on the site). Density converted to FAR is known as the equivalent plot ratio (EPR).

- Equivalent Plot Ratio (EPR) = density (ppha) x 0.0056 (density conversion factor)

  For example,
  If density for a plot of land is 185 ppha, then
  EPR = 185 ppha x 0.0056
  = 1.036

How this density conversion factor was derived will be explained. When the intensity of residential development was measured in terms of ppha, it was tied to a range of occupancy rates. The lowest occupancy rate was 2 persons per unit and the size of the unit 80 m2. This implied that one person is assigned to 40 m2 of living area. It was assumed that 40% of the Gross Floor Area of a residential building is given to non-residential uses (circulation area, commercial use). One person was thus entitled to 40% x 40 m2 of non-residential area, or 16 m2. The total space entitlement per person is 56 m2 (40 + 16 m2) or 0.0056 hectares. Hence this conversion factor of 0.0056.

Non-Residential Land Uses

With regard to non-residential land uses, FAR has been consistently used as the tool to measure density. For commercial use, the prescribed plot ratio has always been 3.0 unless stipulated in the Master Plans prior to 1998. Industrial use has always been prescribed a plot ratio of 2.5.

3.6 Planning Standards in Singapore

Singapore's quantitative approach to planning has resulted in planning standards being set for each land use. Planning standards include provision standards, site area standards and spacing standards. As these were briefly explained in the previous chapter, they will be elaborated upon below.

3.6.1 Provision standards

Provision standards stipulate the minimum number of facilities to be provided given a certain land area, number of housing units or population size, e.g. provision standards for parks, open spaces, sporting facilities, cultural facilities, etc. They are an attempt to ensure an acceptable quality of life for the population. These standards are usually expressed in the form of ratios. These ratios will be broken down into its components to show which variables go into the numerator and denominator respectively.

Numerator

- Housing units (number of dwelling units)
- Facilities including sports and cultural facilities and infrastructure. (Sports facilities include sports stadiums, swimming complexes, sea sports centers, golf courses etc. Cultural facilities include museums, performance theatres, music halls etc. Infrastructure includes ports/airports and utilities such as sewerage treatment works, incineration plants, power stations.)
- Land area (usually in the case of open spaces and parks)

Denominator

- Population (number of persons)
- Land area
- Town (i.e. new town)
- Housing units (number of dwelling units)

Provision standards are determined on a national basis (Concept Plan) as well as a new town basis. National standards usually have population in the denominator. Examples of national standards include open space (area) per population, sports facilities per population, cultural facilities per population and infrastructure per population. Town standards usually have the town or number of dwelling units in the denominator. Table 3-9 shows the planning standards for a prototype new town (40,000 dwelling units). The provision standards for each land use and facility are broken down into the numerator and denominator.

3.6.2 Site area standards

These standards capture the minimum plot size for different land uses and facilities such as schools, parks, town centers etc. Table 3-9 gives a comprehensive list of site area standards for new towns. For residential use, they are further subdivided into the following levels based on the number of dwelling units: new town, neighborhood (high-density), estate and precinct (medium and low density) (Table 3-10).

3.6.3 Spacing standards

Spacing standards stipulate minimum widths or distances between two physical entities. Examples of spacing standards include road standards and building to boundary spacing standards. They attempt to ensure that safety and residential amenity of the population is protected. Road standards will be elaborated upon as they are important in this study.

Roads essentially perform two functions: movement and access. The road system has been classified by estimating the importance of the movement relative to access. The four classes are the expressway system, the arterial system, the collector system and the local road system. At the upper end of the scale are the expressways, whose primary function is to move long-distance traffic. At the other end are the residential streets which primarily provide access to houses. The classification of roads based on hierarchy of function and spacing standards is shown in Table 3-11.

Table 3-9 Land Use for a Prototype New Town of 40,000 du (High-Density)

Land Use	Provision Standard	Numerator / Denominator	Site Area Standard (ha)	Total Provision (#)	Land Area (ha)
Residential					**250**
Residential	160 du/ha[25]	Dwelling Units/ Land Area	-	-	250
Commercial					**71**
Town Center	1 / New Town	Facility/Town	29.0	1	29
Neighborhood Center	1 / 5,000 to 6,000 du	Facility/ Housing Units	6.0	7	42
Educational Institution					**63**
Primary School	1 / 4,300du	Facility/ Housing Units	1.8	13	25
Secondary School	1 / 6,100 du	Facility/ Housing Units	3.0	8	26
Junior College	1 / 40,700 du	Facility/ Housing Units	6.0	1	6
Vocational Institute	1 / New town	Facility/Town	6.0	1	6
Institutions					**14**
Community Center	1 / 10,000 du	Facility/ Housing Units	0.1	4	1.8
Polyclinic	1 / 30,000 du	Facility/ Housing Units	0.5	1	0.5
Library	1 / New Town		0.5	1	0.5
Place of Worship	-	-	0.2 – 0.4	10	4.2
Reserve Sites	-	-	0.5	14	7
Parks & Gardens					**30**
District Park	1 / New Town	Facility/Town	10.0	1	10
Town Center Garden	1 / New Town	Facility/Town	3.0	1	3
Neighborhood Park	1 / 6,000 du	Facility/ Housing Units	2.0	7	14
Precinct Garden	1 / 800 du	Facility/ Housing Units	0.3	10	3
Sports & Recreation					**9**
Indoor Stadium	1 / New Town	Facility/Town	1.2	1	1.2
Sports Complex	1 / New Town	Facility/Town	3.0	1	3
Swimming Pool	1 / 30,000 du	Facility/ Housing Units	1.5	1	1.5
Games Courts	1 / 1,200 du	Facility/ Housing Units	0.1	33	3.3
Industry					**55**
Roads					**88**
Utilities					**20**
TOTAL					**600**[26]

Source: Urban Redevelopment Authority (undated)

Table 3-10 Site Area Standards for Residential Use and Roads by Density

Prototype	Density Typology	Number of Dwelling Units	Residential Site Area Standard	Road Site Area Standard
New Town	High-Density	40,000	250 ha	88 ha
Neighborhood	High-Density	6,000	38.0 ha (based on 160 du/ha)	17 ha (includes secondary roads)
Estate	Medium & Low Density	12,000	200 ha	85.7 (includes roads outside development parcels)
Precinct	Medium & Low Density	2,000	33.3 ha	13.2 (includes roads outside development parcels)

Source: Urban Redevelopment Authority (undated)

Table 3-11 Classification of Roads and Spacing Standards

Road System	Road Type	Road Reserve (m)	No. of Lanes	Design Speed (km/h)	Road Capacity (vehicle/ hour) [27]	Road Spacing (km)	Buffer Standards (m) [28]
FUNCTION: MOVEMENT							
Expressway System	Expressway	52.9 45.5	8 6	80	14,400 10,800	2.5-9.0	30
	Semi-Expressway	45.4 38.6	8 6	60-70	9,600 7,200	1.5-4.0	15 (> 4 stories) 12 (up to 4-stories)
Arterial System	Major Arterial	45.4 38.6	8 6	60-70	6,000 4,500	1.2-1.5	15 (> 4 stories) 12 (up to 4stories)
	Arterial	38.6 31.8	6 4	50-60	4,500 3,000	0.9-1.2	10 (> 4 stories) 7.6 (up to 4 stories)
FUNCTION: ACCESS							
Collector System	Primary Access Road	31.8 26.2 21.4	4 4 2	50-60	-	0.6-0.9	7.6
Local Road System	Local Access	18.0 15.4 14.2 12.2 11.6 11.1	2 2 2 2 2 2	40-50	-	0.1-0.6	2

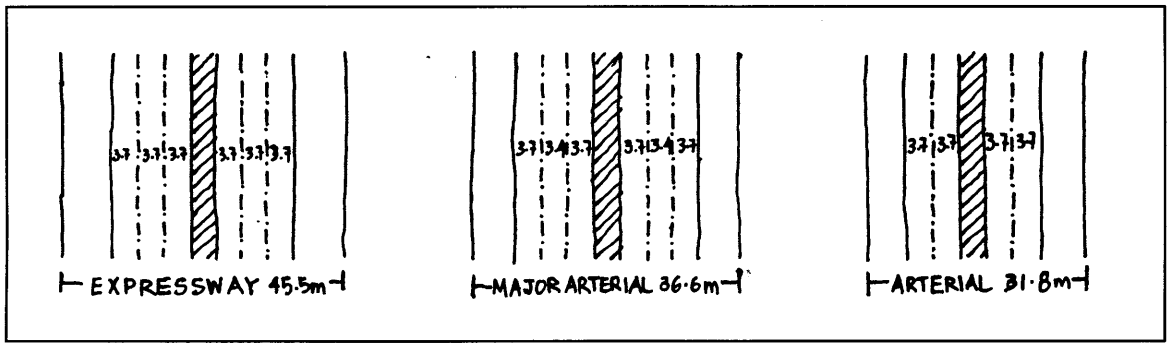
Source: Urban Redevelopment Authority (1992)

Roads should have an adequate number of traffic lanes to handle the desired volume of traffic. The standard lane widths are as follows:

- 3.7 meters for all lanes of an expressway, curbside lanes of a dual carriageway and all lanes of a one-way street in the city;
- 3.4 meters for inner lanes of a dual carriageway arterial;
- 3.0 meters for local access road (except industrial areas).

Figure 3-8 shows the width of lanes for expressways, major arterial roads and arterial roads.

Figure 3-8 Width of Travel Lanes



Source: Urban Redevelopment Authority (1992)

It is important to note that the provision, site area and spacing standards have all changed over time. The changes reflect the need to balance the demand for land with its supply. However this study was unable to trace the actual changes in these standards due to the limitations on data availability.

Next Chapter

Having established an exhaustive list of the generic quantitative measures of density, and discussed how density is being measured and planning standards are used in Singapore, the following chapter proceeds with the analysis of the planning policies that were introduced in Chapter 2.

[1] The terms used here are from Alexander & Reed (1988).
[2] FAR is also known as Plot Ratio or Floor Space Index. In Singapore, the terminology used is Plot Ratio (Gross).
[3] The built-up floor area is commonly the gross floor area (GFA) of a building.

[4] Population figures (total and resident) for the Years 1970, 1990 and 1999 are from the Department of Statistics. Population figures (total and resident) for the Years 2010, 2030 and X are 1991 Concept Plan projections from the Urban Redevelopment Authority (1991).
[5] Total Land Area = Living space, Working space Community space, Open space and Recreation, Infrastructure, Military use, Catchment areas and Others (Agriculture, Quarry, Cemetery and Undeveloped land).
[6] Urbanized Land Area = Total Land Area - Catchment areas, Military use, Agriculture, Quarry, Natural open space, Green separators, Cemetery and Undeveloped land.
[7] Total Population = Resident + Non-Resident Population
[8] This is the actual population figure, which exceeds the projected total population (3,585,000) in the 1991 Concept Plan. This points towards the trend where the total population will exceed the projected figures in the Years 2010 and X.
[9] Resident Population only, i.e. citizens and permanent residents. This does not include foreign workers such as construction workers, domestic maids.
[10] The land area designated for land uses in the "Others" category shrinks significantly between 1991 and Year X. As the land bank is drawn upon, the undeveloped land will be converted to other land uses, thus contributing to the significant fall in the land area.
[11] From 1998 Master Plan Written Statement. This typology includes only selected land uses for the purpose of this exercise.
[12] This zone did not exist in the earlier Master Plans.
[13] The commercial quantum is restricted strictly to the lower stories. It must not exceed 40% of the total allowable GFA based on allowable plot ratio. The residential quantum must not be less than 60% of the total allowable GFA based on allowable plot ratio.
[14] Includes Office, Mixed Commercial (office, shopping, cinema and hotel), convention center and food center/restaurant uses.
[15] The industrial/warehouse use quantum must not be less than 60% of the total GFA. Not more than 40% of the total GFA should be used for other permitted ancillary, related or compatible uses.
[16] At least 60% of the total GFA shall be used for any combination of business park operations. Not more than 40% of the total GFA should be used for other permitted ancillary uses.
[17] At least 60% of the total GFA shall be used for hotel room floors. Shopping and hotel related uses may be considered and use quantum shall not exceed 40% of the total GFA.
[18] Leung, 1987: 107
[19] Residential density used to be measured in persons per acre (ppa) prior to 1974, before Singapore switched to the metric system of measurements.
[20] Maximum residential density varies between 125 ppha to 1485 ppha, depending on location.
[21] The net residential site area comprises the area of the site proper and any land to be surrendered to the State for road widening and open space, land for electric substation but excludes land reserved for future development and plots to be occupied by non-residential development.

[22] According to Leung (1987), the 20% increase in the number of units at any given density is the result of two policy changes. Firstly, unit sizes were measured in Gross Floor Area (GFA) terms instead of Net Floor Area (NFA), i.e. balconies and terraces were included in the floor area computation (numerator became a bigger number). At the same time, occupancy rates prescribed for the various unit sizes were reduced (denominator became a smaller figure). The net result was that each development site could accommodate 20% more units for a given residential density.
[23] Development charge is a betterment levy which attempts to achieve equity by recouping to the State part of the community created value consequent to the grant of planning approval.

[24] The baseline for development charge is the density stipulated in the 1958 or 1980 Master Plans (i.e. 185 ppha), or the approved density or FAR for which development charge has already been paid (Section 36(1) of the Planning Act 1998 refers).

[25] Each person is entitled 56 m2 of space.

[26] The land areas for this prototype new town differs from that in Table 3-6 by 156 m2. The difference can be attributed the inclusion of private housing area(s) as part of the town, and the tripling of the area of open space proposed as compared with the prototype. The increase in open space area is probably due to the green belts around the DGPs being included as part of the land base.

[27] Number of cars that can traverse a point per hour. Capacity depends on many factors, i.e. alignment, grade, surface conditions, lane width etc. A rough guide of capacity for different road types is given below:

Expressway	-	1800 vehicle/hour/lane
Semi-Expressway	-	1200 vehicle/hour/lane
Major Arterials/Arterials	-	600-900 vehicle/hour/lane
Access (Primary and Local)	-	Traffic volume not important because these roads provide access

[28] The buffer is a strip or an area of land which falls between the limit of the road reserve and the building line. Buildings cannot be built within this buffer. There are two components to the buffer - the physical buffer and the green buffer. The physical buffer can be paved over to accommodate car parks, driveways, cycle tracks and small ancillary structures like bin centers. The green buffer has to be strictly reserved for tree planting and turfing. The standards given here are for residential land.

4

Analyzing Land Use Planning Policies

This chapter introduces and discusses a case study to assess if land use planning policies meet overall development goals. The planning policies are articulated in the form of a plan, which will be analyzed. How these policies perform will be reflected through the indicators of density, planning standards and land take.

4.1 Case Study – The Development Guide Plan for Punggol Planning Area

The Development Guide Plan[1] (DGP) for the Punggol Planning Area has been selected for study. The Urban Redevelopment Authority (URA) and the Housing and Development Board (HDB) have earmarked Punggol 21 as the model for future new towns, offering a new lifestyle for the 21st century. Changes from the characteristics of existing new towns can be expected. For instance, the Punggol DGP proposes FARs of 3.0 to 3.4 for plots of land designated for public housing use, much higher than the FAR of 2.8 in existing housing estates. In view that the new towns of the future will be planned and developed based on this model, it would be particularly appropriate to assess if Punggol's land use policies meet development goals.

4.1.1 Location and Background

The Punggol Planning Area is located in the North-Eastern region of Singapore (Figure 4-1). The 957-hectare site is bounded by *Sungei*[2] *Serangoon* to the east, the Tampines Expressway (TPE) to the south, *Sungei Punggol* to the west, and the Straits of Johor and Serangoon Harbor to the north. Most of the land is currently undeveloped as existing

poultry and pig farms were phased out in the 1970s for redevelopment, and the seafood restaurants and boatels relocated to facilitate reclamation of the coastline. Construction of the new town commenced in 1998.

4.1.2 Vision

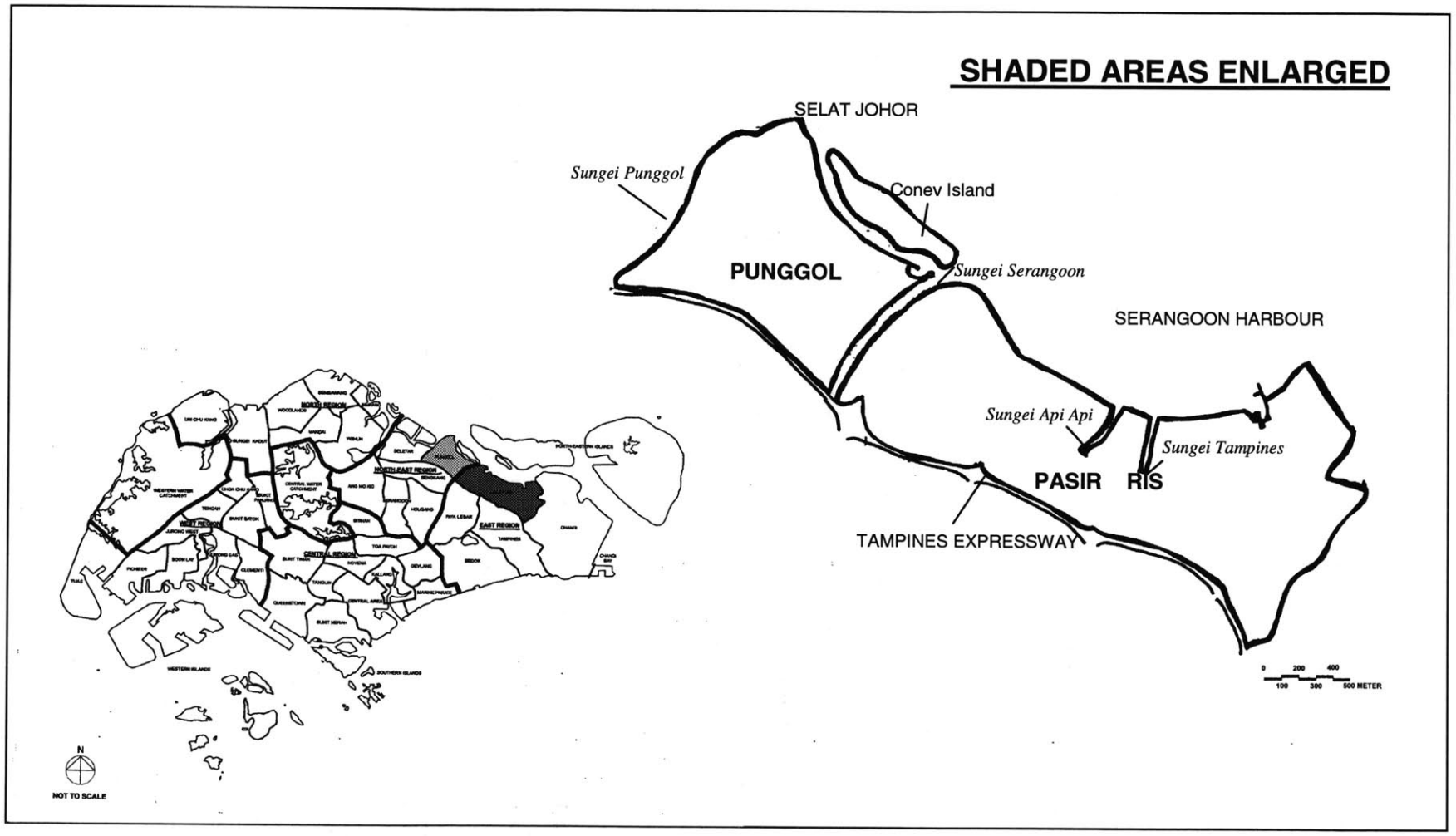
Punggol 21 was conceived as a waterfront town, offering frontage to the water along its 3 rivers[3]. It will be home to 85,800 families. The key ideas for Punggol 21[4] are as follows:

- More executive condominiums[5] and private housing (landed housing and condominiums[6]), which will comprise 10% and 30% of the proposed housing stock respectively;
- More high quality HDB flats;
- A Light Rail Transit (LRT) system planned right from the start, with walking distances not more than 300m for most residents;
- Clustering of community facilities; and
- A variety of clubs[7] within the town.

4.1.3 Making Comparisons

For the purpose of making comparisons between existing new towns and Punggol 21, Pasir Ris DGP[8] will be used as a foil for comparison with the case study where appropriate. The Pasir Ris planning area is located in the eastern region of Singapore and will be home to 46,400 families[9]. It lies east of Punggol and they share a common boundary along the *Sungei Serangoon* (Figure 4-1). Within the planning area is a new town that was developed and occupied at the turn on the decade, around the same time the 1991 Concept Plan was released. Pasir Ris is a suitable candidate for comparison for two reasons:

Figure 4-1 Location of Punggol Planning Area and Pasir Ris Planning Area



Source: Urban Redevelopment Authority (1998)

The residential land use profile is very similar to Punggol's in terms of land area, and the type of dwelling units, which tend to be at the higher-end of the public housing[10] scale. The two towns are also similar in terms of their population profiles. Pasir Ris is home to the new generation of Singaporeans who are more affluent than their parents, and seek a better quality of life. Punggol 21 will similarly be home to this same segment of the population.

- The town was planned in a different era, and hence it would make it easy to elicit the changes in the land use policies and provision and site area standards.

4.1.4 Land Use

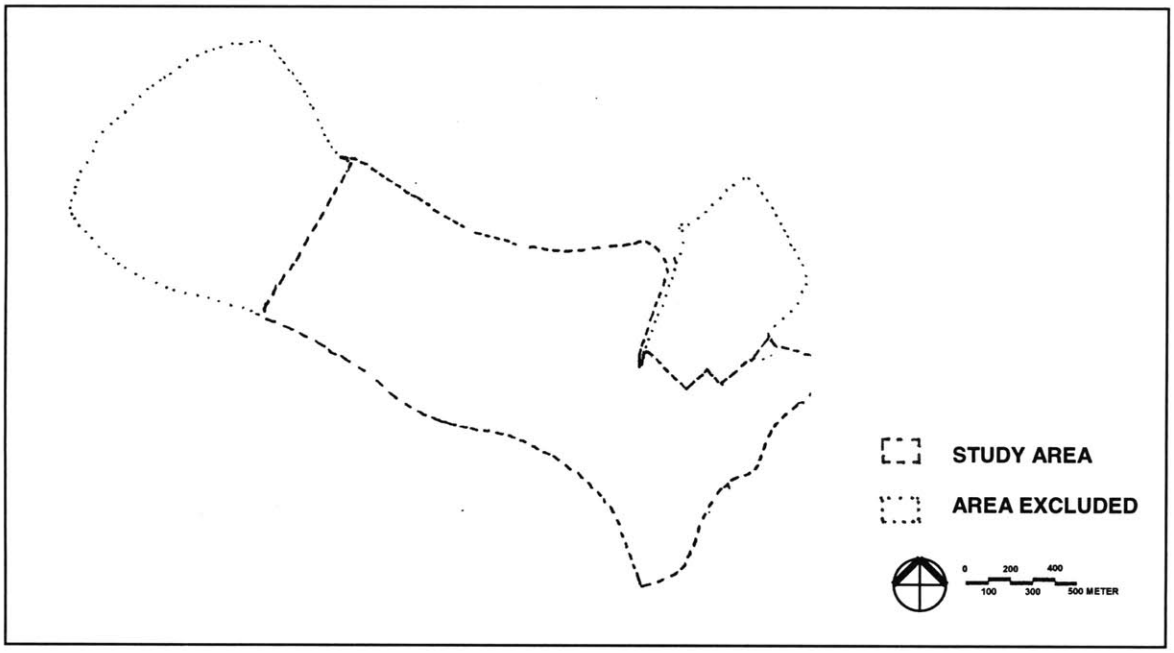
Punggol is a residential town with public and private residential housing proposed. Pasir Ris has similar land uses as Punggol with the exception of industrial use. The land use distribution for both DGPs is shown in Table 4-1. For the purposes of this study, the industrial land and tracts of residential land which are subject to detailed planning will be excluded from the study area of Pasir Ris DGP. Figure 4-2 shows the area of study for Pasir Ris DGP.

Table 4-1 Land Use Distribution – Punggol and Pasir Ris DGPs

Land Use	Punggol		Pasir Ris	
	Land Area (ha)	Land Area (%)	Land Area (ha)	Land Area (%)
Residential	474	50	530 (overall); 318	35 (overall); -
Commercial	13	1	13	1
Industrial	0	0	376	25
Institutional	50	5	65	4
Open Space & Recreation	131	14	127	8
Road & Infrastructure	150	15	199	13
Waterbody	114	12	67	4
Others	25	3	156	10
Total	**957**	**100**	**1,533 (overall)** **882[11] (within study area)**	**100** -

Source: Urban Redevelopment Authority (1995 & 1998)

Figure 4-2 Study Area for Pasir Ris DGP



4.2 Planning Policies

The planning policies for Punggol and Pasir Ris DGPs have been mapped out in relation to national development goals and broad planning policies (Table 4-2). In the case of Punggol, all of the policies articulated in the DGP are spelled out at the broader national level except for the strategy to provide an LRT system that will be integrated with the MRT system. The same is true for Pasir Ris as all DGP policies can be tied in with broader policies except for the strategy to provide better road networks and north–south transportation linkages. However Punggol has more strategies that match the broad planning policies (in terms of number). This is not surprising since the plan is much more recent, and the strategies used are in tandem with the current trend of thinking. Although we see some change in planning strategies over time, policies to intensify land around transit stations, introduce a wider variety of housing and provide accessibility to recreational areas through the green connector system are not new since they are reflected in both DGPs.

Table 4-2 Planning Policies at the DGP level and their Relationship to National Development Objectives and Policies

National Development Objectives[12]	Planning Policies		
	National-scale[13]	**Punggol DGP[14]**	**Pasir Ris DGP[15]**
SCARCITY OF LAND			
Planning strategy: To build up and safeguard a land bank for: - **Contingencies (e.g. increased population);** - **-flexibility to respond to future changes in land demand pattern**	Conserve land in the following ways: -safeguarding large land banks -developing substantial pockets of high-density areas -intensifying developments in other areas	-	-
	Select sites for implementation of creative and economic uses	-	-
	Draw up planning guidelines for underground development	-	-
	Reclaim land from the sea for development	Increase land area through reclamation	-
	Study ways to improve the flexibility for private sites to respond to changes in the demand for land	-	-
Optimization of land use	Maximize development potential - Sites around MRT/LRT stations - Spaces above roads	- Intensify land use around MRT and LRT stations -	- Provide shopping and employment centers near the MRT station to capitalize on its mass transit accessibility -
	Minimize development constraints, e.g. height constraints, nuisance buffers	-	-
	Integrate community facilities such as community centers, cultural institutions, schools, parks etc.	Introduce cluster community facilities as focal points for community activities	-
	Identify new ideas to optimize land use with conservation buildings	-	-
	Identify soft land for suitable interim uses	-	-
	Come up with incentives for new developments and redevelopment which the government wants to encourage	-	-
	Make use of incidental space, i.e. space under roads	-	-

QUALITY OF LIFE ISSUES			
HousingMix by Year 2010 (25:75)	Review target housing mix	Introduce greater variety of housing types	Maintain the variety of housing types through provision of low, medium and high density housing on vacant lands when Loyang Industrial Estate is phased out
Quality of life improvement	Create an entertainment district to add vibrancy to night life	-	-
	Introduce more street life to historic districts	-	-
	Develop Seaside recreational areas	Introduce thematic clubs and marinas; Retain Coney Island (with a nice natural beach) as a Regional Park;	(Note: Pasir Ris Park has a stretch of sandy beaches. Holiday chalets are located along the beaches).
	Encourage river activities	Provide a network of green connectors and promenades along the rivers	Provide greater accessibility to the major recreational area via park connectors along the rivers and other waterbodies

4.2.1 Planning Policies and Performance Indicators

To set the stage to assess the performance of planning policies articulated in the case study, it is necessary to match the performance indicators discussed in Chapter 2 with these policies. Table 4-3 shows these performance indicators in relation to the planning objectives and policies for the Punggol DGP. In this analysis, policies that are tied to three of the quantitative performance indicators, density, planning standards and land take will be further studied. 5 out of 9 of the planning policies can be assessed in terms of these indicators, which overlap in some cases.

Table 4-3 Planning Policies and Performance Indicators – Punggol DGP

Planning Objectives[16]	Planning Policies[17]	Performance Indicators	Land Use
Meet Concept Plan provision of land uses and quantum for planning area	Increase land area through reclamation	Development cost; Environmental quality	All
	Intensify land use around MRT and LRT stations	Density; Land take; Environmental quality	Residential
Create a high-quality residential town which will serve as a model town in the 21st century	Introduce a greater variety of housing types	Density; Planning standards; Land take; Quality of life; Environmental quality	Residential
Create an environment which fosters a sense of community bonding	Introduce cluster community facilities as focal points for community activities	Density; Planning standards; Quality of life	Institutional
Plan for a good transport network and public transport system to serve the developments in the town	Provide an extensive LRT system integrated with the MRT system	Density; Planning standards; Land take; Quality of life	Transport
Provide a wide range of recreational facilities for the residents	Introduce thematic clubs	Quality of life	Sports and Recreation
Capitalize on the area's natural attributes of riverine and coastal features	Introduce marinas	Quality of life; Environmental quality	Sports and Recreation
	Retain Coney Island as a Regional Park;	Quality of life; Environmental quality;	Park and Garden
	Provide a network of green connectors and promenades along the rivers	Quality of life; Environmental quality; Planning standards; Land take	Park and Garden; Open Space

4.3 Planning Policies : Evaluating Successes and Failures

Do planning policies for Punggol DGP meet the stipulated planning objectives? This section examines those policies which have density, provision standards and land take as indicators of performance. Although this study focuses on density, it is important to consider provision standards and land take because they have clear relationships with the variable, density. The successes and failures of the policies are evaluated to see if land

use has been optimized. For the purpose of analysis, the policies have been related to the different land uses proposed in the plan (see Table 4-3).

4.3.1 Residential Use

Policy 1 – Intensify Land Use around MRT and LRT Stations

This policy directly addresses density, which measures how intensively land is used. For the Punggol planning area, land use is intensified through the increase in the FAR for sites around public transit stations. These sites are primarily zoned for residential use with designated maximum FARs between 3.0 to 3.4. In the case of Pasir Ris DGP[18], high-density residential lands are designated a FAR of 2.8. The proposed FARs for Punggol exceed those for 2.8 Pasir Ris (Figure 4-3). Superficially, it appears that by increasing the FAR of individual sites, land use has been intensified. To assess the real impact of this spot FARs increase, it necessary to look at the relationship between FAR and the net housing yield, as well as FAR and residential land consumption.

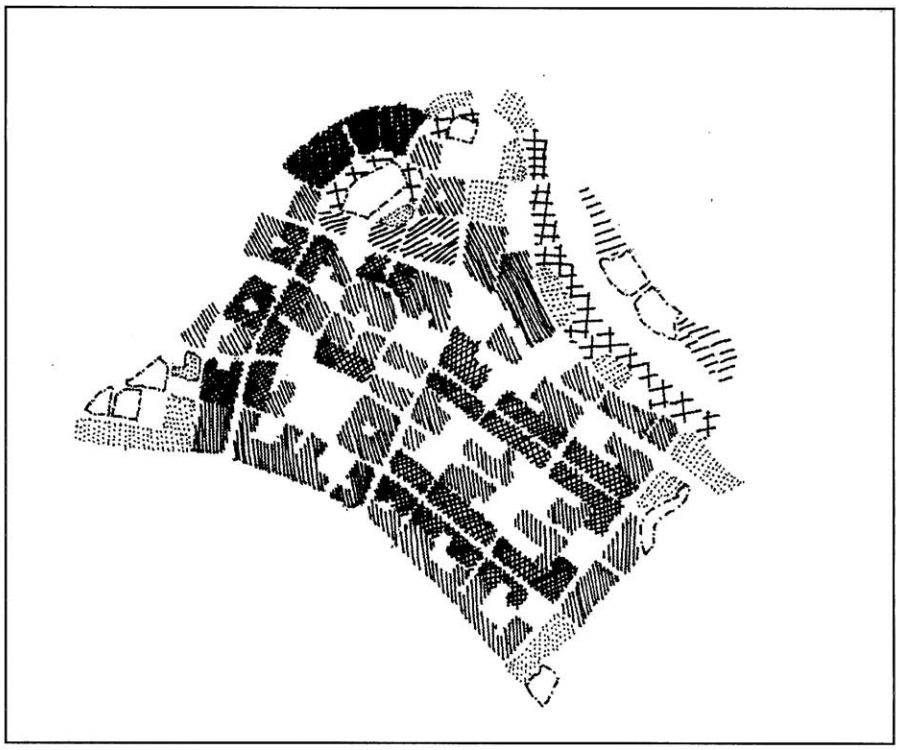
- FAR and net housing yield

With increases in spot FARs, it follows that the number of dwelling units on residential land increases. What is the impact of an increase in FAR on the number of housing units that land can yield? Net housing yield (Number of dwelling units proposed / Site Area), measured in dwelling units per hectare, illustrates the performance of each FAR range and will help to determine the suitability of these prescribed ranges.

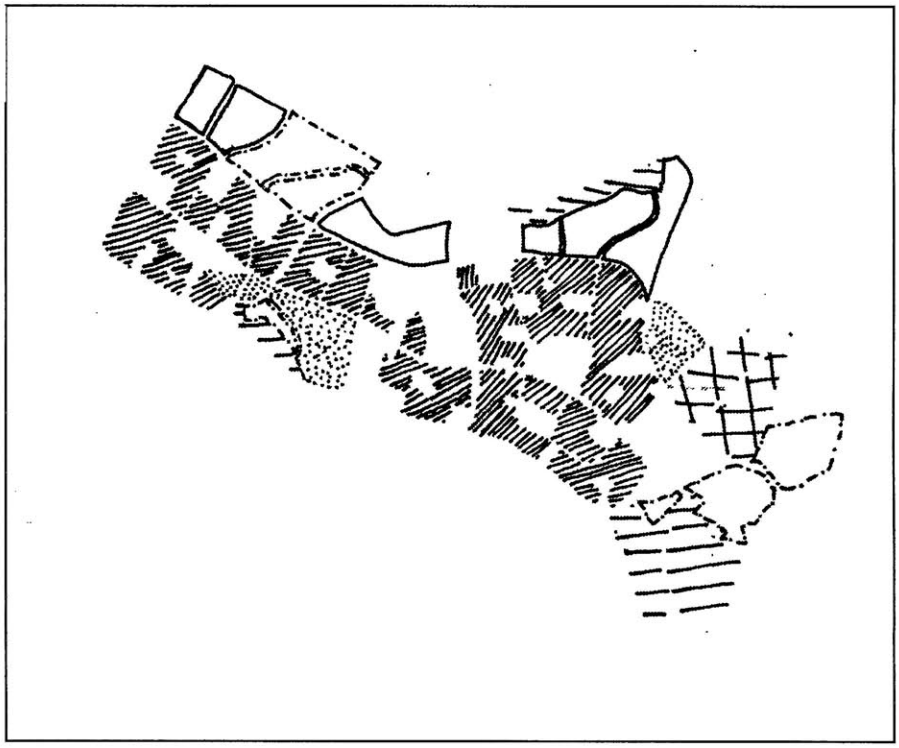
Table 4-4 shows the relationship between FAR, net housing yield and population density based on URA's typology for residential use. The net housing yield shown here will be the control figure which actual yields will be benchmarked against.

Figure 4-3 Floor Area Ratios – Punggol and Pasir Ris DGPs

Punggol



Pasir Ris



Landed Housing

1.4

1.6

2.1

2.8

3.0

3.4

3.5

0 200 400

100 300 500 METER

Table 4-4 FAR, Net Housing Yield and Population Density

Housing Type	Residential Typology	Density			Building Height (Stories)
		Floor Area Ratio	Net Housing Yield (du/ha)	Population in persons per hectare (ppha)[19]	
Landed[20]	**Low Density**	No FAR designated	30-50	-	2-3 (depending on landed housing estates height control)
Non-Landed[21]	**Low Density**	1.4	80	250	4
	Medium Density	1.6	91	285	10
		2.1	120	370	16 or technical height control, whichever is lower
	High Density	2.8	160	500	20 or technical height control, whichever is lower
		3.0	171	>500	>20 of technical height control, whichever is lower
		3.4	194		
		3.5	200		

Assumptions
Site Area = 10,000 m^2
Occupancy Rate = 3.11 persons per unit (ppu)
Gross Unit Size = 175 m^2 (56 m^2 x 3.11 ppu)

Source: Urban Redevelopment Authority (undated)

Table 4-5 compares the net housing yield for each housing type in the Punggol and Pasir Ris DGPs to the control figures in Table 4-4. In general, the proposed housing yields match the theoretical figures quite closely. This suggest that land is being used optimally according to URA's definition of "optimal". Nevertheless deviations form the control figures are to be expected.

For Pasir Ris DGP, the net housing yield for each FAR category does not deviate more than 17% except for FAR 1.4 and landed housing. The deviation for FAR 1.4 is 81% and 53% for landed housing. The deviations in both these categories (low-density) are large because 83% of the stock of units (1665 dwelling units) has already been developed. These units were subject to more stringent[22] site area and spacing standards when developed, resulting in more land being consumed than would have been the case if they are developed under prevailing standards. In the case of Punggol DGP, the net housing

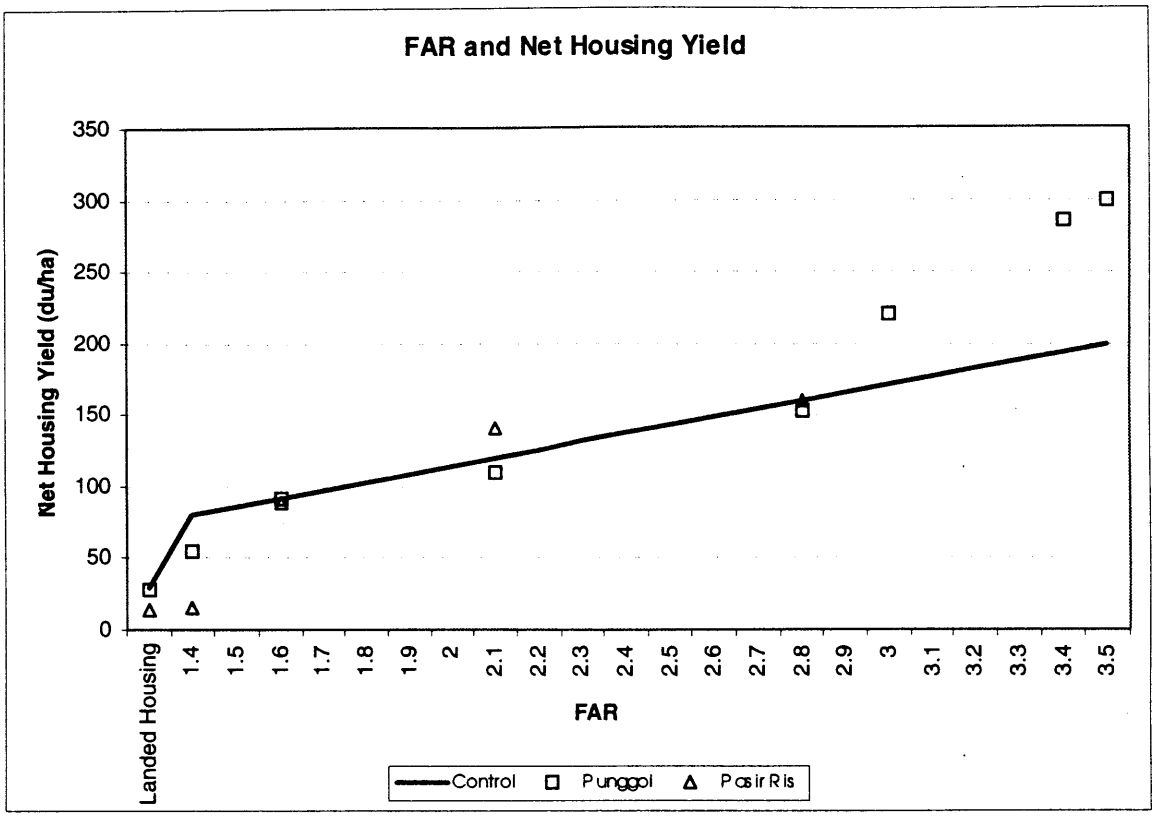
Table 4-5 Proposed Number of Dwelling Units and Land Consumption by Housing Type – Punggol and Pasir Ris DGPs

Residential Typology	FAR	PUNGGOL				PASIR RIS			
		Dus	Land area (ha)	Net housing yield (du/ha)		Dus	Land area (ha)7	Net housing yield (du/ha)	
				Control	Prop (P-C)[23]			Control	Prop (P-C)
LANDED[24] HOUSING									
Low Density	N.A.	1000	32	30-50	28 (-2)	1,100	80	30-50	14 (-16)
NON-LANDED[25] HOUSING									
Low Density	1.4	1,100	20	80	55 (-25)	900	61	80	15 (-66)
Subtotal		*2,100 (2%)*	*52 (11%)*	-	*40*	*2,000 (4%)*	*141 (31%)*	-	*14*
Medium Density	1.6	2,500	27	91	92 (+1)	3,500	36	91	88 (-3)
	2.1	8,200	74	120	110 (-10)	7,900	70	120	113 (-7)
Subtotal		*10,700 (13%)*	*67 (14%)*	-	*105*	*11,400 (25%)*	*106 (23%)*	-	*114*
High Density	2.8	2,400	15	160	160 (0)	33,000	205	160	160 (0)
	>2.8	71,000	340	171-200	208 (8-37)	-	-		-
Subtotal		*73,000 (85%)*	*355 (74%)*	-	*206*	*33,000 (71%)*	*205 (46%)*	-	*160*
TOTAL		85,800 (100%)	474 (100%)	-	181	46,400 (100%)	452[26] (100%)	-	120

Source: Urban Redevelopment Authority, 1995 & 1998

yield for each FAR type is within a +/- 17% from the control, except for 1.4 FAR in the low-density category. The proposed number of units is 31.25% below the control figure. This figure supports the recent claims made by professionals in the real estate industry who have argued that the FAR of 1.4 is unrealistic because it under-utilizes land. However it is important to note that sites with low FARs of 1.4 and 1.6 tend to surround landed housing areas. Sensitivity to the amenity of these landed housing estates requires the heights and densities of the surrounding land parcels to be regulated with care. The 1.4 FAR type should be reviewed to determine if it should be revised.

Figure 4-4 Net Housing Yield – Proposed (Punggol and Pasir Ris DGPs) and Control by Each Floor Area Ratio Range



Policy 2 – Introduce a Greater Variety of Housing Types

This policy statement does not clearly articulate what constitutes variety. However from the vision statement for the town in the Punggol 21 report, variety in the housing stock can be achieved in two ways – by land tenure, and by design quality.

Variety is measured by land tenure through the differentiation between private and public housing units (Figure 4-5). Punggol will have more executive condominiums and private housing (landed housing and condominiums), which will comprise 10% and 30% of the proposed housing stock respectively, i.e. private housing stock is 40%. Benchmarked against the projected public : private housing mix of 75 : 25 for the whole country in the Year 2010, this plan has clearly surpassed the target.

Within the public housing sub-category, variety is achieved in terms of the design quality of the housing units. Punggol will have standard HDB flats[27], design plus flats[28] and design and build flats[29] (Figure 4-6). Each type of flats will have a one-third share of the number of public housing units. This category appeals to people's perceptions of the quality of the built environment. As public housing still carries a stigma, and involving private sector architects in the design on HDB flats can be one way of improving the image of new towns and give residents more choices in the types of housing. This is one way to meet the rising aspirations of the population. The ultimate goal should be to have public and private housing in new towns, and housing with good design to make it difficult to differential between the two.

Although it appears that a good variety in housing mix has been achieved, it is important to note that variety can be defined in more ways than these two. How variety is classified has impact on land consumption. This will be explored in the next chapter.

Figure 4-5 Housing Variety by Land Tenure

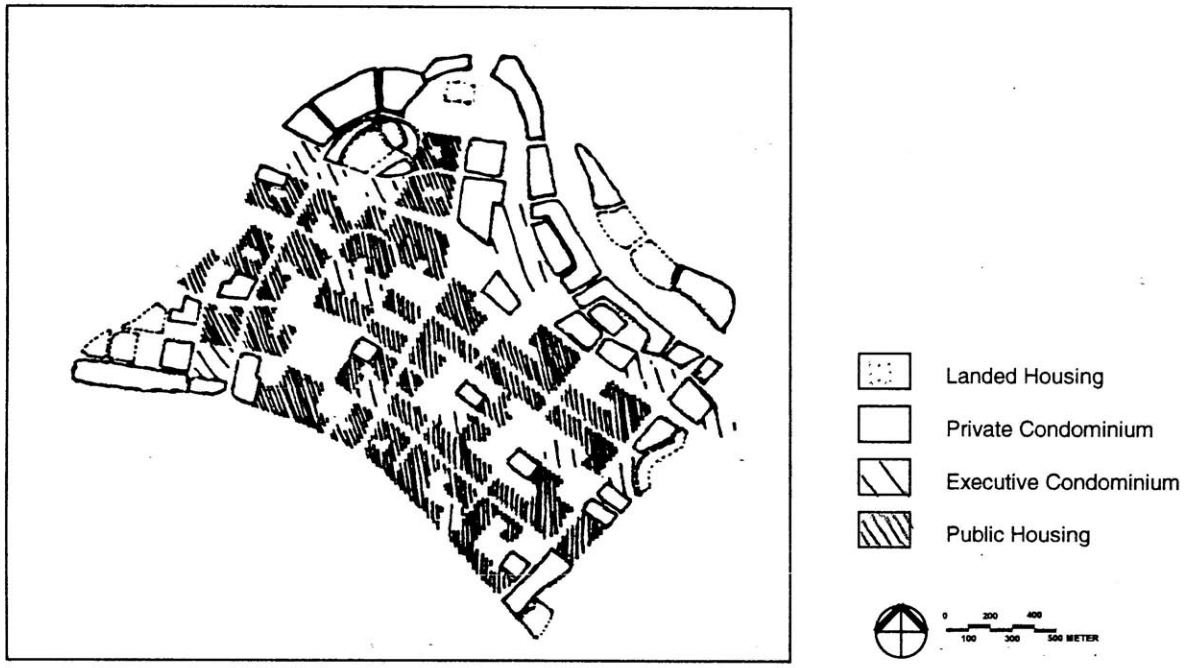
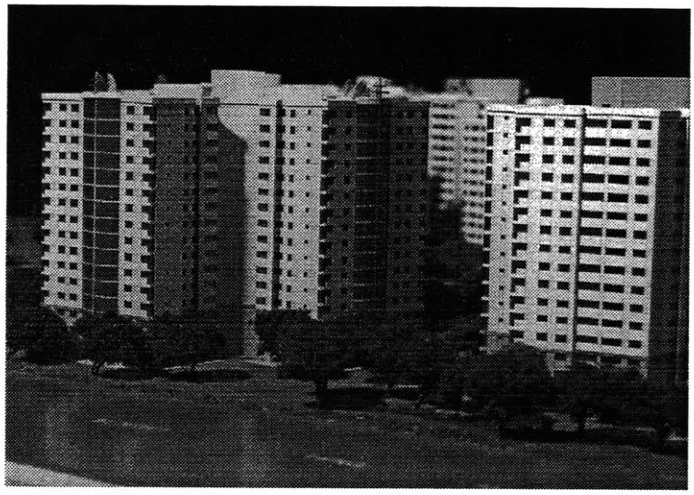


Figure 4-6 Housing Variety by Design Quality (Public Housing)

Standard Flats
Sengkang



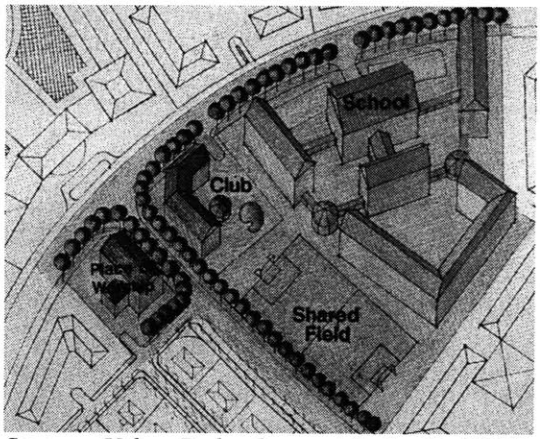
Design Plus Flats
Choa Chu Kang

Design and Build Flats
Choa Chu Kang

4.3.2 Institutional Use

Policy 3 – Introduce cluster community facilities as focal points for community activities
The Punggol DGP proposes the clustering together of community facilities such as schools, places of worship, recreational and social facilities (clubs). Commonly, the school field is shared between the different institutional or recreation uses. Figure 4-7 shows an example of the cluster concept, with a school field being shared by a school and a club. Figure 4-8 illustrates the distribution of community facilities in both Punggol and Pasir Ris DGPs. Nine clusters of community facilities are proposed for Punggol and none in Pasir Ris. This is because the clustering of community facilities is a new policy.

Figure 4-7
Clustering of Community Facilities

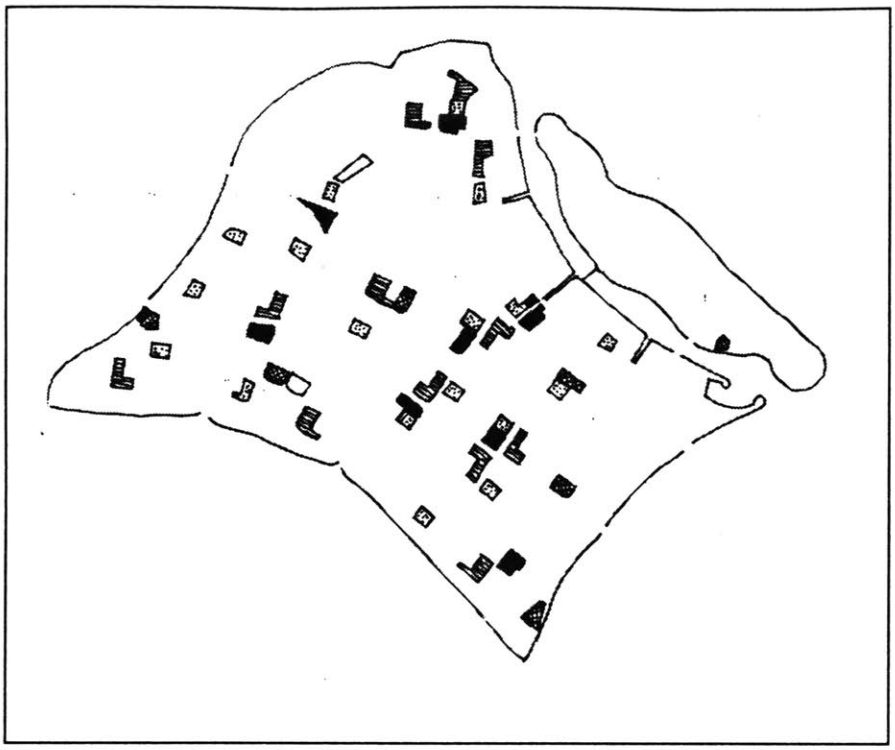


Source: Urban Redevelopment Authority (1998)

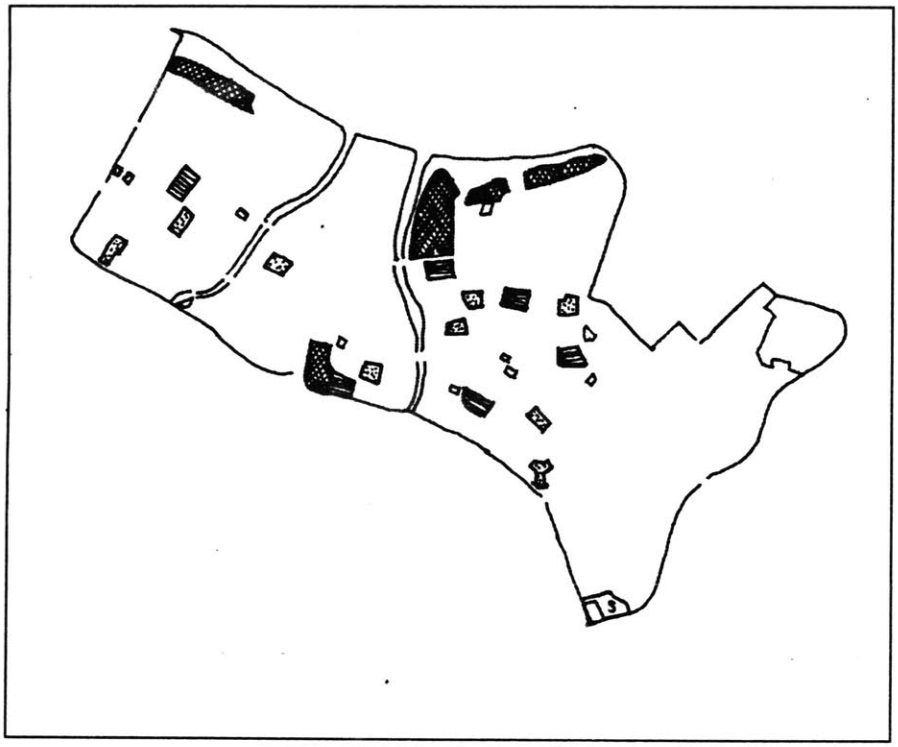
Clustering appears to be an innovative method to optimize the use of land in two ways. Firstly it recognizes that land use intensity can be expressed in more ways that just the form of density. It takes into account how frequently land is used over different periods of time, i.e. day and week. Different groups of people make use of land at different times of the day and week. For example, school buildings are occupied in the day and community centers primarily used at night. Schools are used on weekdays and places of worship on weekends. Site area standards can be reduced when facilities are shared between these different uses. This results in land being saved. For example, the combined area for a secondary school and club can be reduced by the size of one football field because a school and club share this field.

However the sharing of facilities will result in additional load on these facilities and increase maintenance costs. Management of the facilities may be difficult. Hence the benefits of sharing have to be weighed against the costs in order to assess the viability of this strategy.

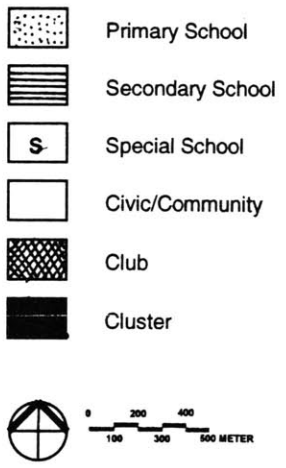
Figure 4-8 Community Facilities – Punggol and Pasir Ris DGPs



Punggol



Pasir Ris

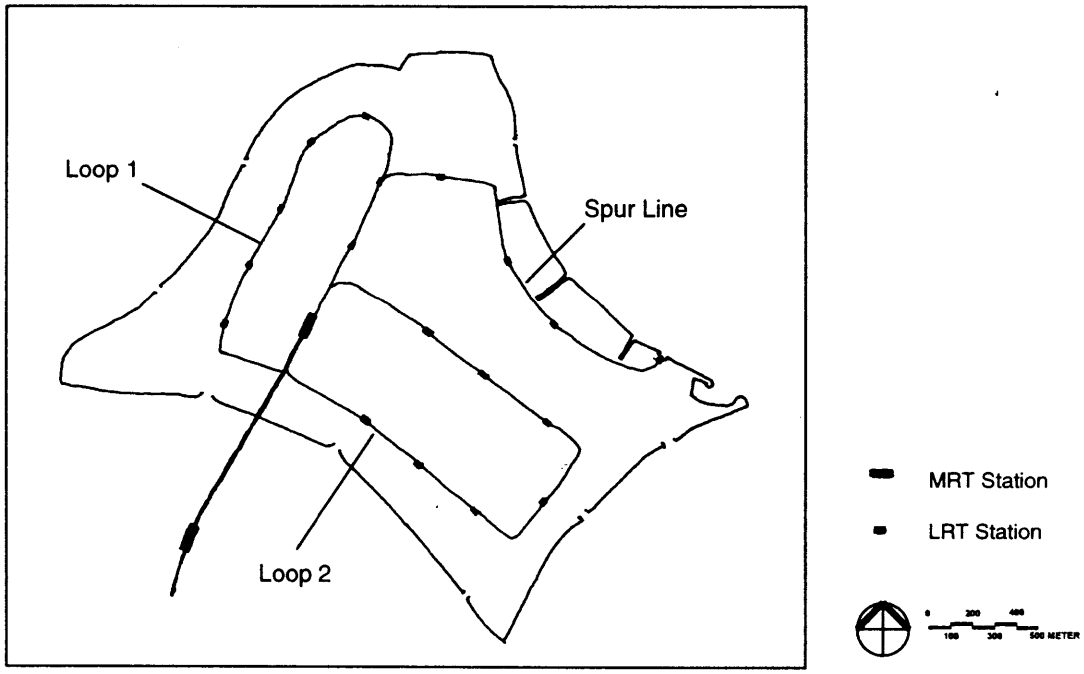


4.3.2 Transportation

Policy 4 - Provide an extensive LRT system integrated with the MRT system

Punggol new town will be served by one MRT station along the North-East Line, which will connect the town to the rest of the island. Figure 4-9 shows the public transportation infrastructure. The MRT station is proposed to have a catchment radius of 400 meters. An LRT system is proposed for internal circulation within the town. The line is 19 kilometers in length, with two loops that serve the main housing areas and one spur line which serves the residential and recreational nodes north of the new semi-expressway. 19 LRT stations are proposed, and will be located within a radius of 300-350 meters from most homes.

Figure 4-9 Public Transportation Network – Punggol DGP



Source: Urban Redevelopment Authority, 1998

Density is important for two reasons. The high FARs proposed for residential sites around LRT stations justifies the provision of the LRT system, which is very much more expensive[30] than the traditional feeder bus network that provides the internal transportation service between the town center (MRT station) and the rest of the town. Punggol is able to meet the minimum planning standards (Table 4-6) for an LRT system within a new town.

Table 4-6 Planning Guidelines for Light Rail Transit (LRT) versus Actual Provisions in Punggol

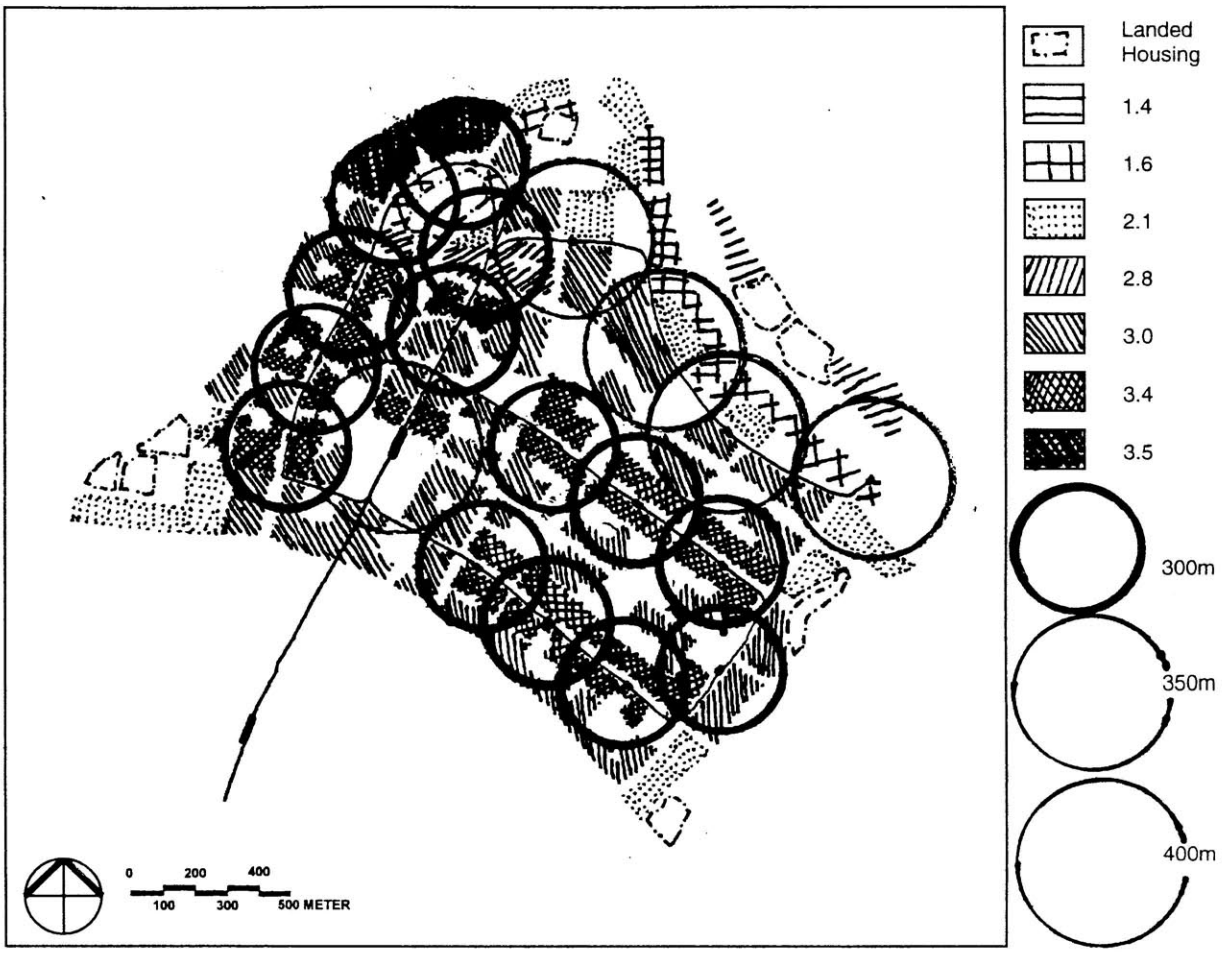
Parameters	**Planning Standards**	**Actual Provisions in Punggol**
Minimum Population	97,500 persons	237,250 persons
Population Catchment radius	300 to 350m from proposed stations	300 to 350m from proposed stations
Station Spacing	400 to 600m	400 to 600m
Minimum no. of dwelling units	30,000 (high density)	73,000 (high density)
FAR	2.8 minimum	2.1 to 3.5
Net housing yield	160 du/ha minimum	197 du/ha
Assumptions		
Household size = 3.25 persons/unit[31]	Population = 97,500 persons	Population = 237,250 persons
60% of population (average) make trips on a daily basis	Average no. of people travelling on LRT = 58,500 persons	Average no. of people travelling on LRT = 142,350 persons
Average # of trips per day per person = 1.7	Average no. of trips per day = 99,450 trips	Average no. of trips per day = 241,995 trips
70% of daily trips are public transportation trips	Public transport trips per day = 69,615 trips	Public transport trips per day = 169,396 trips

Source: Urban Redevelopment Authority (undated)

Density determines the walking distance for homes around the stations (Figure 4-10). The average FAR is 3.4 for the sites around the stations which are part of the two loops in the network (and south of the semi-expressway). The walking distances to each station along both loops is 300m. There is even an overlapping of the catchment areas for some stations, i.e. some homes are within 300m walking distance from two LRT stations. For stations along the spur line, the proposed FAR of 2.1 to 2.8 is lower than that of the loop

stations along the spur line, the proposed FAR of 2.1 to 2.8 is lower than that of the loop lines. The walking distances to the stations along the spur line is 350m, further than that of the loop lines. This suggests that the higher the residential density around the station, the shorter the proposed walking distance between homes and the stations will be.

Figure 4-10 MRT & LRT Network and Density



Apart from the policy to provide an LRT system within the town, the DGP is silent on the treatment of other transportation facilities such as roads and car parks. With the provision of the LRT, it is interesting to note that there has been no reduction in the width of road reserves. This suggests that roads still occupy as much space as they would without an LRT system although the LRT system running on elevated tracks replaces the feeder buses which run on roads. Does this suggest an optimal use of land? This question will be explored more fully in the next chapter.

Parks and Gardens

Policy 5 – Provide a network of green connectors and promenades along the rivers

Green connectors (Figure 4-11) are proposed to link the parks, nature sites and waterfront with residential areas. They serve as recreational facilities (i.e. cycling, jogging), as well become convenient routes for commuting. Providing a system of connectors does not require additional land to be taken up because they utilize existing drainage, foreshore and road reserves.

Figure 4-11
Green Connector along *Sungei Api Api* in Pasir Ris New Town

Source: Urban Redevelopment Authority (1995)

Figure 4-12 shows the distribution of the parks, gardens and open spaces for both DGPs. The pattern emerging in the case of Punggol vastly differs from that of Pasir Ris. Punggol's network of green connectors is very developed.

Each common green and open space is linked to via the system of connectors, which leads to the green promenades along the waterfront. Although Pasir Ris has an already well-developed park connector system along the rivers *Sungei Tampines* and *Sungei Api Api*, the relationship between the parks and connectors is not evident. From the green connector system proposed for Punggol 21, it is evident that the objective of this policy has been achieved.

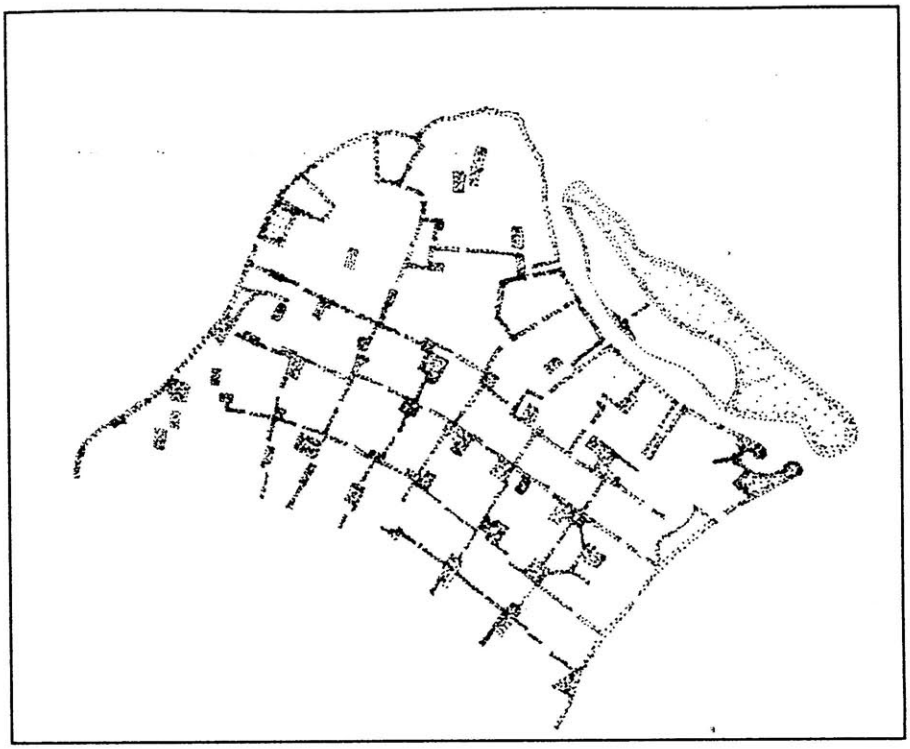
After studying the connector network, it is also useful to take a look at the distribution of parks, gardens and open spaces within the 2 DGPs. The reorganization of the housing neighborhood from 6,000 dwelling units to 1400-2800 dwelling units in Punggol 21 has resulted in the parks being reduced in size from the previous standard of 1.4 hectares to 0.4-0.7 hectares. These smaller parks are distributed more regularly throughout the whole town, allowing residents better access to them because they are within close proximity of homes.

Table 4-7 shows the land area proposed for parks and gardens within Punggol and Pasir Ris DGPs. In terms of land consumption, the area dedicated to parks is almost the same for both Punggol and Pasir Ris. Though park space per capita is lower in Punggol (0.32 ha/1000 persons[32] vis-a vis 0.56/1000 in Pasir Ris), this is expected because the population size is much larger (the larger size of the regional park in Pasir Ris also skews figures).

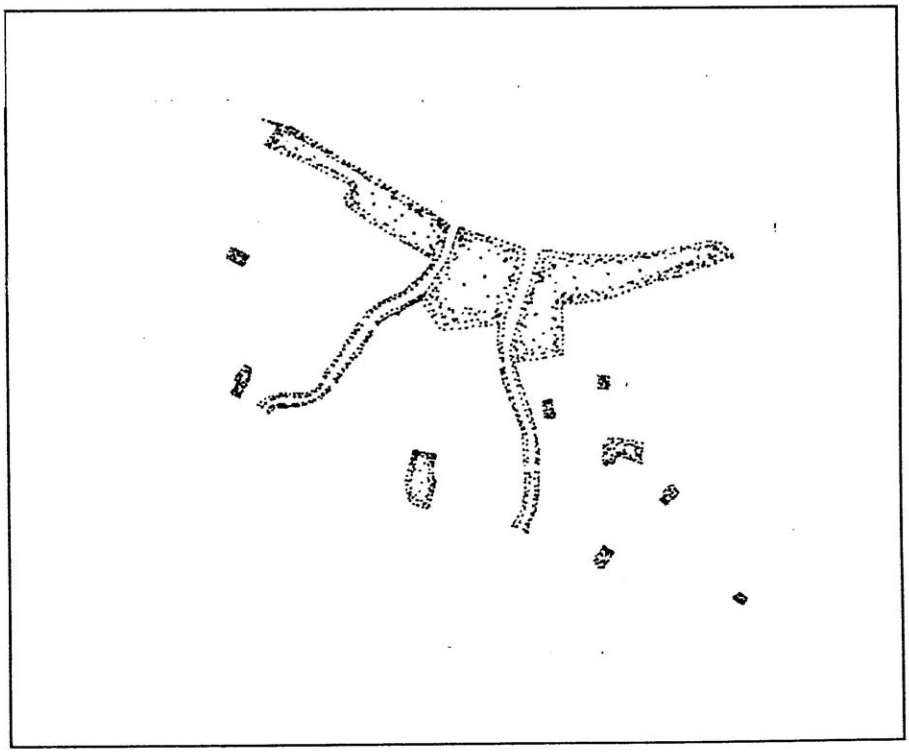
The overall park strategy for Punggol DGP with smaller but better distributed parks and open spaces that are linked up through a network of green connectors has good potential to positively impact the quality of life of the residents, and at the same time consumes less land.

Figure 4-12 Park and Open Space Network with Green Connectors – Punggol and Pasir Ris DGPs

Punggol



Pasir Ris



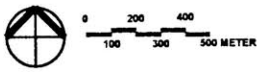


Table 4-7 Park and Garden Provision – Punggol and Pasir Ris DGPs

Typology	Provision Standard (DGP) (ha/1000 persons)	Site Area Standard (ha)	Punggol		Pasir Ris	
			Area (ha)	Percentage (%)	Area (ha)	Percentage (%)
REGIONAL						
Regional Park	0.74	>30	Coney Island 50	59	Pasir Ris Park 79	78
DGP						
Town Park[33] (40,000 du)	0.08	10	22[34]	22	13	13
Town Center Garden[35] (40,000 du)	0.02	3	-	-	-	-
Neighborhood Park (6000 du) (PASIR RIS)	0.12	1.2-1.5	-	-	9	9
Common Green (1200-2800 du) (PUNGGOL)	Not available	0.4-0.7	13	16	-	-
TOTAL	-	-	**85[36]**	**100**	**101**	**100**

Source: Urban Redevelopment Authority (1992, 1995 & 1998)

Next Chapter

In the course of analyzing Punggol's land use policies and how they contribute towards optimizing land use, some questions have been raised. The next chapter seeks to explore these issues in greater detail, as well as propose alternatives strategies to optimize land use.

[1] Some of the information contained in the DGP has been superseded by the Master Plan 1998, gazetted on 24 December 1998. Nevertheless this plan will be used because it reflects the general planning intention for the Punggol area.
[2] *Sungei* in the Malay language means "river".
[3] The third "river" will be created between Coney Island and the mainland through reclamation of the harbor.
[4] Urban Redevelopment Authority and Housing and Development Board, 1996 (Punggol 21)

[5] The Executive Condominium scheme was conceived to allow more Singaporeans to achieve their aspiration of owing private property. 86% of Singaporeans live in public housing (HDB, 1998). E-condos are condominium housing developed by HDB, but earmarked for privatization 10 years after the date of completion. The sites are developed with facilities similar to those in private condominium developments, such as swimming pools, tennis courts, clubhouses etc.
[6] Condominium status is granted to a development only if its plot size exceeds 0.4 hectares (4000 square meters). If the plot size is less than this figure, the development will be considered a flat development.
[7] Town clubs, sports clubs, beach clubs and sailing clubs
[8] URA completed the preparation of the Pasir Ris DGP in 1995. As in the case of Punggol DGP, this plan may have been superseded by the Master Plan 1998.
[9] Pasir Ris had 32,988 housing units in the 1990 when the last population census was carried out.
[10] 99.3% of the public housing apartments in Pasir Ris are 4-room flats or larger. 4-room, 5-room and executive flats comprise 38.9%, 32,9% and 27.5% of the housing stock respectively. The respective unit sizes (average) are 100 m2, 125 m2 and 140 m2.
[11] This figure excludes the land areas of Subzones 1 (Pasir Ris West) and 6 (Loyang) of the Pasir Ris planning area.
[12] Ministry of National Development
[13] *ibid.*
[14] Urban Redevelopment Authority, 1998
[15] Urban Redevelopment Authority, 1995
[16] Urban Redevelopment Authority, 1998
[17] *ibid.*
[18] Pasir Ris does not have an LRT system within the town. There is one MRT station .
[19] Derived from Net housing yield x Occupancy Rate
[20] Landed housing = 1 dwelling unit per plot of land
[21] Non-landed housing includes strata landed housing (strata bungalows, townhouses and cluster houses), residential flats and condominiums. More than 1 dwelling unit is proposed per plot of land.
[22] For example, the minimum plot size for the detached house was 550 m^2 as compared to today's minimum plot size of 400 m^2.
[23] Proposed - Control
[24] Landed housing = 1 dwelling unit per plot of land
[25] Non-landed housing includes strata landed housing (strata bungalows, townhouses and cluster houses), residential flats and condominiums. More than 1 dwelling unit is proposed per plot of land.
[26] Total land area designated for residential use is 530ha. However 145 ha is vacant and subject to detailed planning. Hence the area is not included.
[27] Standard flats are designed in-house by HDB.
[28] Design Plus flats are considered premium public housing. They are also designed by HDB. The difference between these flats and standard flats are in terms of size and cost. The units are slightly larger in size than standard flats and cost 10-15% more. They also come with finishes such as flooring (instead of just concrete) and floor to ceiling windows.
[29] Design Plus flats are considered premium public housing. They are also designed by HDB. The difference between these flats and standard flats are in terms of size and cost. The units are slightly larger in size than standard flats and cost 10-15% more. They also come with finishes such as flooring (instead of just concrete) and floor to ceiling windows.
[30] According to the Land Transport Authority, the proposed LRT lines for the two new towns of Punggol and Sengkang, comprising 24 km in length of tracks and 33 stations in total, will be built at a cost of Singapore $656 million (US $386 million).
[31] This is the projected figure for the Year 2000 in the Concept Plan.
[32] Two other reasons make Punggol's park provision appear lower than it is. Punggol has open spaces which are proposed in lieu of parks within residential neighborhoods. As these areas are not included as park areas, the provision standard is artificially lower. The Pasir Ris regional park is 29 hectares larger than the regional park in Punggol. This also skews the figure upward for Pasir Ris.
[33] The town park serves the entire DGP. Where there is a regional park within the DGP, the town park has to be well located to prevent duplication of functions

[34] Punggol does not have a formal Town Park on a regular shaped plot. Instead the park for the town is in the form of a linear coastal park. A 15.0m wide promenade is proposed along the 3 rivers (21 hectares altogether), and a riverine park (1 hectare) is added to create variety.
[35] This park functions as the formal garden at the town center as well as a neighborhood park for the area.
[36] The land zoned open space is not included in this figure. However the open space appears to substitute for parks, which are landscaped areas. With the inclusion of these open spaces, the provision standard per person increases.

5

Strategies to Optimize the Use of Land

This chapter seeks to explore the questions arising from the discussion in the previous two chapters that are important to optimization of land use, but which the policies have not addressed. It will look in detail at two issues – the classification of housing variety, and the pattern of land consumption. In relation to land consumption, additional strategies to optimize land use will be proposed and evaluated to assess their feasibility.

5.1 Classification of Housing Variety

The policy to introduce a greater variety of housing types will be revisited in this section. As highlighted in the previous chapter, the policy statement does not clearly articulate what constitutes variety. From the case study, variety was defined in two ways: by land tenure and by design quality. However these two categories do not fully capture the diversity of housing types offered in Punggol 21 and elsewhere.

A variety matrix is proposed to classify housing variety (Figure 5-1). Variety can be categorized by 9 classes, namely by tenure, property title, property type, site area and/or unit size, density by residential typology, density by FAR, story height, design quality and location. Each category and its relationship to housing distribution is more fully described in Table 5-1. The matrix shows that the first 8 categories overlap with one another to some degree. Location is the one category for which no clear theoretical relationship can be established with other categories.

Figure 5-1 Variety Matrix for Housing

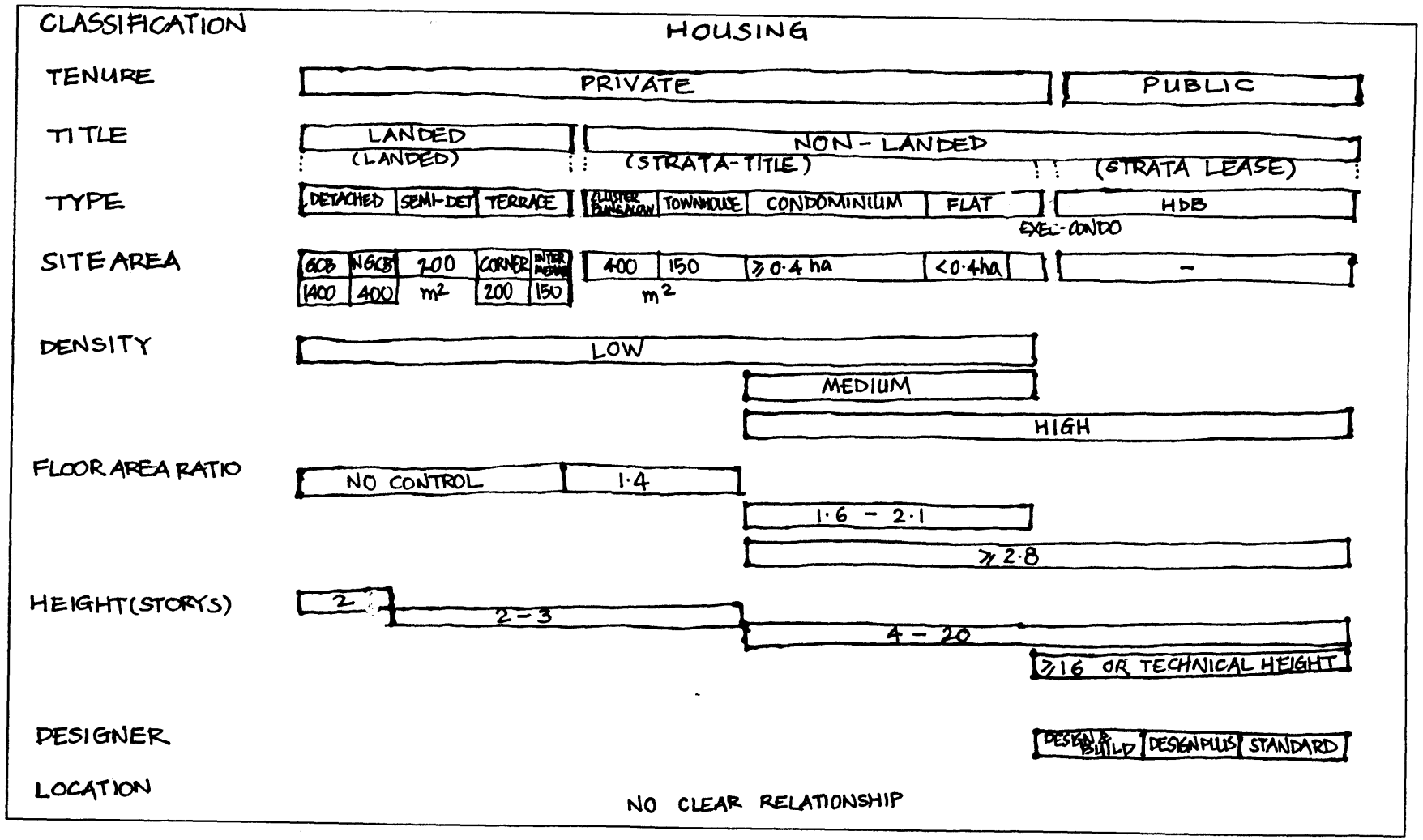


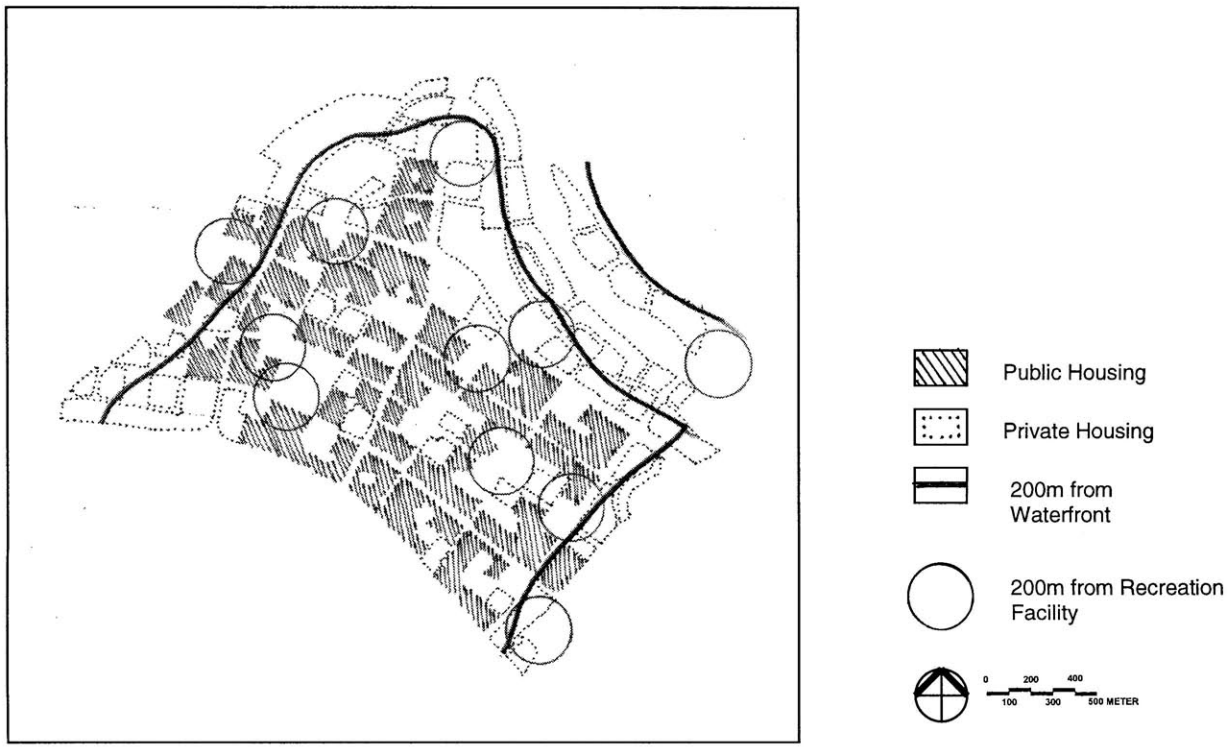
Table 5-1 Classification of the Variety of Housing Types

Category	Distribution	*Remarks*
SOCIO-ECONOMIC		
Tenure	Private housing Public housing	Housing mix was expressed in these terms at national level.
Property Title	Landed housing ▪ Land Title Non-landed housing ▪ Strata Title ▪ Strata Lease	The availability of on-site recreation facilities is directly related to property title. Landed housing and strata lease properties have no on-site recreation facilities. Strata title properties usually have on-site communal recreation facilities on-site, such as swimming pools, tennis courts, clubhouses etc.
Property Type	Detached house Semi-detached house Terrace house Cluster house Townhouse Shophouse[1] Condominium Flat	
Site Area (minimum) and/or Unit Size	Detached house ▪ Good Class Bungalow Area[2] (GCBA) = 1,400 m^2 ▪ Non GCBA = 400 m^2 Semi-detached house = 200 m^2 Terrace house = 200 m^2 (corner) / 150 m^2 (intermediate) Cluster bungalow = 400 m^2 Townhouse = 150 m^2 Condominium = 0.4 hectares Flat < 0.4 hectares	Site area is directly related to property type (see Variety Matrix in Figure 4-4). Public housing is differentiated by unit size (number of rooms).
DENSITY		
Residential Typology	Low Density Medium Density High Density	
FAR	Low : <= 1.4 FAR Medium: 1.6 - 2.1 FAR High : >= 2.8 FAR	See Figure 2-3a for mix of housing units by density in FAR for Punggol DGP.
HEIGHT		
Story Height of Building	Low : <= 4 stories Medium: 10-20 stories High : >= 20 stories	Height is directly related to residential density in an attempt to ensure that prescribed FARs can be achieved.
DESIGN		
Design Quality	For public housing units only. Categories are: ▪ Standard flats[3] ▪ Design plus flats[4] ▪ Design and build flats[5]	In Punggol each type has a one-third share in the public housing component.
LOCATION		
Location	Proximity to: ▪ Waterfront ▪ Parks & Gardens ▪ Recreation areas ▪ Cultural / Entertainment areas ▪ Mixed Use ▪ Small-Office-Home-Office	Variety was determined in these terms in the 1991 Concept Plan overview. In the Punggol DGP, variety by location can be considered in terms of waterfront location, housing-by-the-park, and proximity to recreation areas.

5.1.1 Housing Variety by Location

Location will be explored in greater detail using the case of Punggol 21. Punggol's situation is fortuitous because there are physical assets such riverfronts, coastal waterfronts and a large regional park at Coney Island. In the 1991 Concept Plan overview, one of the aims was to provide better locations for housing - along waterfronts, and close to parks, gardens, recreational areas, cultural and entertainment areas. Figure 5-2 shows the proportion of residential land within a 200m radius of the waterfront and the proposed recreation areas in Punggol. When matched against land tenure, there is a high correlation between "choice" location and private housing. This is hardly surprising since good location generates a higher land value, and is therefore assigned a higher-end residential use. However this raises the issue of equity because land parcels designated for private housing are located closest to the waterfront. One way to mitigate this is to restrict the heights of buildings closest to the water's edge to low or medium-rise height ranges. This allows the taller buildings further away from the waterfront to enjoy views of the water on the higher floors.

Figure 5-2 Housing Variety by Location and Land Tenure



5.2 Land Consumption

The impact of land use policies on land consumption is an important consideration in land scarce Singapore. This section will look at the general patterns of land consumption, and explore in greater detail how housing variety and transportation impact land consumption. Alternative strategies to optimize the use of land will be proposed and evaluated.

5.2.1 General Pattern

The general pattern of land consumption was briefly discussed in Chapter 3. The trends observed will be examined more fully here. It is important to bear in mind the significance of the increase in living standards and people's expectations for a better quality of life on land take.

Trend 1 – Planning Standards and Land Consumption

Land take is directly related to changes in planning standards, which include provision, site area and spacing standards (discussion in Chapter 2 refers). Site area and spacing standards will first be discussed. Over time, these standards have been relaxed because of land constraints. The minimum plot areas have been reduced for different building types (i.e. landed housing). Spacing standards have also been revised to allow buildings to be built with less set back from plot boundaries. The relaxation of these standards points towards the reduction in land take. A certain level of environmental quality has to be sacrificed in order to obtain a higher level of performance from each plot of land. This trade off has to be considered when these standards are set.

Provision standards at the scale of the city or new town have a significant impact on land consumption. Over time, people expect provision standards to have become more stringent because they want a higher quality of life. For instance, the number of performance arts theatres per capita would increase. With this increase in the number of facilities or land area (numerator), land take can be expected to increase. The change in

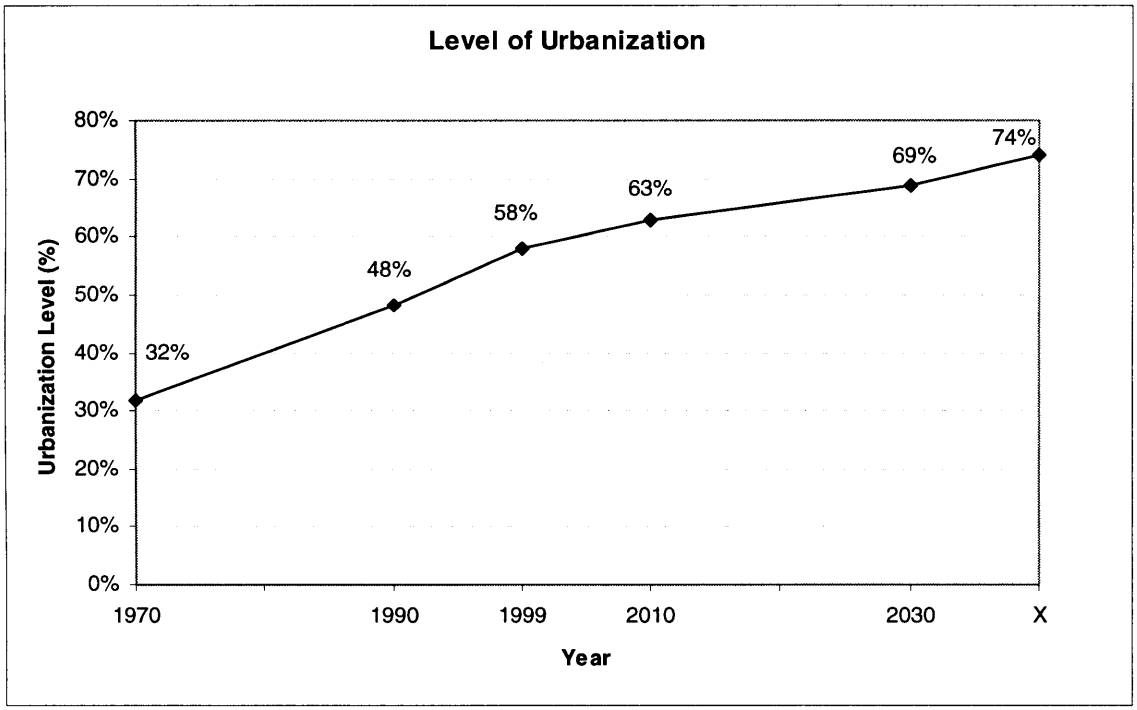
the numerator is usually the conscious result of policy decisions towards improving the quality of life. This is a result of the shrinking of the figure in the denominator (population) while the numerator stays the same (facilities, land area). For example, the park space per capita can increase over time if the population size shrinks though no new land for parks is added (see trend 1). Hence it is important to differentiate which of these two factors cause provision standards to rise. When setting provision standards, the challenge facing planners is to find the balance between land consumption and the desired quality of life level.

Trend 2 – Population Density and Urban Density

Between 1970 to Year X, Singapore's population density has been rising while the urban density has been falling (Table 3-3 refers). Between 1991 and the Year X, the total population is projected to increase by 58%, while land dedicated to living space has increased by 108% (Table 3-4 refers). This points to the fact that land take is growing at a faster rate than population growth. It can be inferred the higher living standards and people's expectations for a better quality of life have contributed to this pattern of urban growth. The boundary of the urban area will continue to expand over time (see Figure 2-2 showing the urbanized areas in the 1971 and 1991 Concept Plans). Figure 5-3 shows the growth of the urbanized area between 1970 and Year X.

This trends illustrates that improving the quality of life and reducing land take seem to be on opposing ends of a continuum. Conventional wisdom suggests that in order to improve the quality of life, more land needs to be consumed. This implies that the urban edge needs to keep expanding. Before considering if land scarce Singapore afford this rate of urban growth, it is appropriate to look at the second trend, the growth pattern of residential density, which examines how efficiently land in urbanized areas is used.

Figure 5-3 Level of Urbanization (1970 to Year X)



Source: Urban Redevelopment Authority (1991)

Trend 3 – Residential Density of New Towns and Global Density

Punggol 21 has an average residential density of 562 persons per hectare (ppha). The density is more than two times higher than that of Pasir Ris, which is 272 ppha. As a typical new town of the 21st century, the density pattern of Punggol points towards the trend of developing new towns at residential densities that are much higher than existing. It is important to note that this trend of development goes against the overall growth pattern of residential density for the whole country, which has been decreasing over time (Table 3-4 refers). The overall residential density in 1991 was 418 ppha, and is projected to fall to 318 ppha in the Year X.

This pattern of residential density suggests that newly developed areas have been proposed with higher densities to offset the lower densities in the urbanized areas of the island. As new towns contribute to the spread of the urban edge, the question which arises is whether it is necessary to keep building more new towns for housing given that

the overall residential density is falling. Another issue to consider is if developing new towns at higher densities adversely affects the quality of life of their residents.

- *Urban Edge*

Is there scope for existing urbanized areas to be developed more intensively in order to contain the spread of the urban edge? This will preserve the remaining vestiges of rural areas on the main island and the offshore islands. These natural assets will contribute to enhancing the quality of life.

The 1991 Concept Plan proposal to expand the urban edge has been challenged by Singapore architect, Tay Kheng Soon[6]. He contended that the additional population to make up the 4.77 million for the Year X could be accommodated in the central region[7]. New housing can be added in the existing private and public housing estates, and by building dense clusters on undeveloped parcels of land in already urbanized areas. This position has similarly been echoed by Edmund Waller[8] of the National University of Singapore, who observed that Singapore could have saved more land in the interior by building new towns along the coast and on reclaimed land. He made comparisons between Singapore and Hong Kong, two territories with similar development pressures and land constraints. While Hong Kong has 40% of land area protected as national parks, Singapore has only about 5% in comparison. Hong Kong's interior has been left untouched owing to the topography, and development has been concentrated along coastal inlets and on reclaimed land. This yields the same effect as concentrating development within urbanized areas. These criticisms of the Concept Plan proposal to keep expanding the urbanized area are valid as this pattern of land consumption has implications on the quality of life. The pattern of urban growth has to be carefully considered by Singapore's planners in the preparation of the next Concept Plan.

- *New towns*

Punggol 21 represents an attempt to improve the quality of life while reducing land consumption. This is evident in the policies to cluster community facilities and reorganize the layout of residential neighborhoods and the sizes of parks and gardens. However this attempt to reduce land consumption operates within the framework of the

1991 Concept Plan, which projects the spread of the urbanized area. Hence the impact of these measures on reducing land take is less significant as compared to policies which are designed to address the underlying issue, the spread of urban edge.

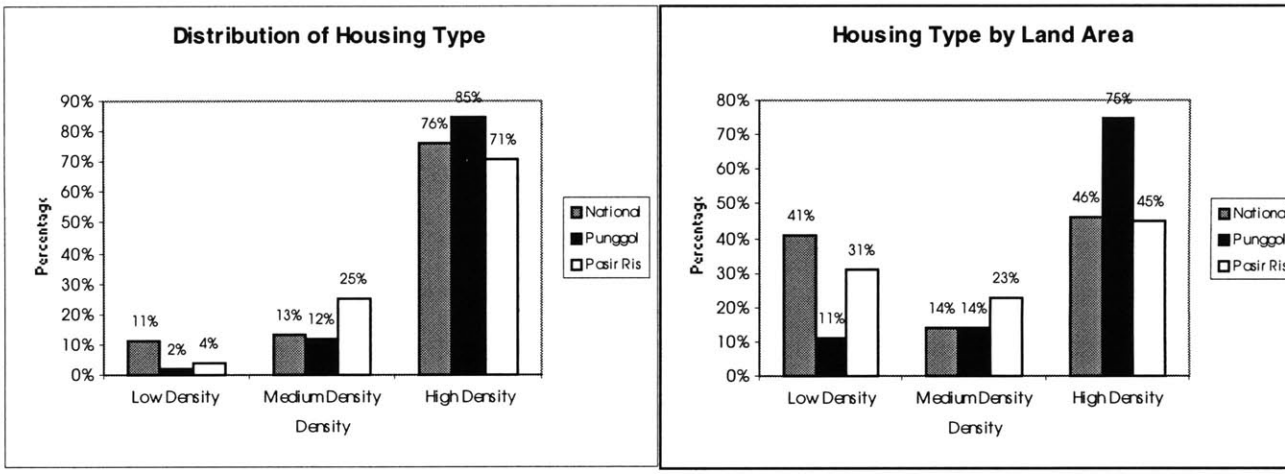
5.2.2 Housing Variety and Land Consumption

Planning policies at the macro level aim to have a more varied housing mix. In view of this, it would be apt to explore the relationship between housing variety and land consumption. Since housing types are generally differentiated by density, the relationship between density and land consumption at the national level, and in the Punggol and Pasir Ris DGPs will be studied.

Figure 5-4a illustrates the proportion of housing type proposed for the Year 2010 and Figure 5-4b shows the land area consumed by each housing type. In both DGPs, high-density housing consumes the most land, followed by medium and then low-density housing. This pattern of land consumption does not correspond with the citywide pattern where high-density housing consumes the most land, followed by low-density then medium-density housing. However the pattern is typical of any new town since low-density housing units comprise a small proportion of the proposed housing stock as compared to areas where landed housing is very established.

High-density housing constitutes a major proportion of the housing stock in both DGPs. Although its share of land take is lower in proportion than its share of the housing stock. Medium density housing contributes about the same share to housing stock as it consumes land. Low-density housing contributes the lowest share of housing stock but the proportion of land it consumes is the highest. The conclusion that can be drawn is having a more varied housing mix by density is land intensive. Thus planners have to carefully consider the housing mix in view of the impact on land consumption. One option would be to try and increase variety in less land intensive ways, such as by location.

Figure 5-4 **a. Distribution of Housing Type (Year 2010)**
b. Housing Type by Land Area



Source: Urban Redevelopment Authority (1991, 1995, 1998)

5.2.3 Transportation and Land Consumption

Roads and infrastructure are the second highest consumer of land in Punggol, taking up 15% of the total land area. As mentioned in the previous chapter, the LRT system has not resulted in the change in road standards (roads and car parks). Can these standards be reduced in view of the comprehensive public transportation infrastructure being proposed for the town? In this section, car parking and road spacing standards will be discussed to see if changes in standards can be wrought to reduce land consumption.

Car Parking Standards

The minimum parking requirement for residential land is one space per dwelling unit for both public and private housing developments (Table 5-2). With 85,800 dwelling units proposed for Punggol, 85,800 parking spaces need to be provided on residential land. Most of the public housing planned for the town will be 4-room (HDB typology) or larger, and car parks will occupy a significant proportion of the residential land.

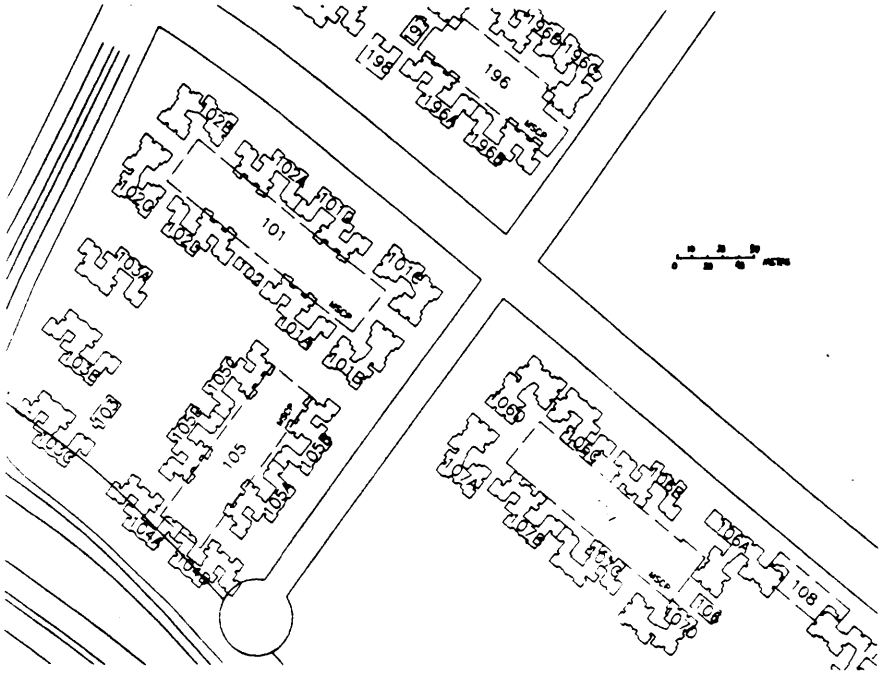
Table 5-2 Planning Standards for Public Housing and Land Required for Transportation Facilities

Flat type	Density Du/ha	Car Park Ratio[9]	Percentage of land needed for		
			Car Parks	Roads	Total
1-room	300	5.5	17.0	9.1	26.1
2-room	235	2.1	26.4	9.1	35.5
3-room	185	1.5	31.7	9.1	40.8
4-room	160	1.0	36.2	9.1	45.3
5-room	160	1.0	35.2	9.1	44.3
Combined	208	1.97	30.2	9.1	39.3

Source: Olszewski, 1983

Figure 5-5 shows a typical layout for HDB flats in Punggol 21 (FAR 3.4). Multi-story car parks are proposed to meet parking requirements, and these structures are 4-stories high. They will be integrated with the apartment blocks. In Singapore, car parking structures are exempted from Gross Floor Area (GFA) computation. This means that the 3.4 FAR is for the GFA of the residential blocks only. If the parking structure is included in GFA, the FAR will exceed 3.4. From the layout, it is noted that the coverage of the site is very high. The multi-story parking structure itself sits on 15% the ground. The environment is very built-up. To mitigate the intensity of development, designs are proposed where the roof of the parking structure will be landscaped and used as a garden and recreation area. The roof is also part of the pedestrian network that links all the blocks within the same neighborhood, improving the pedestrian-friendliness of the environment.

Figure 5-5 Typical Layout of Public Housing in Punggol 21



Notes
MSCP = Multi-Story Car Parking
Numbers on the plan, i.e. 101, 105 etc are Apartment Block Numbers

Source: Urban Redevelopment Authority

As car parking facilities take up such a high proportion of residential land, a reduction in the parking standards will contribute significantly to the reduction in the consumption of land. With the proposed public transportation infrastructure (MRT and LRT) promising seamless travel within the town and beyond, the question that comes to mind is whether a good proportion (i.e. 20%) of Punggol 21 households will forego ownership of the private car because public transportation is a good substitute for travel.

The good public transit system may encourage residents to reduce the number of trips made by car in lieu of transit. Nevertheless, parking spaces on residential land still have to be provided if a household owns a car, regardless of the number of trips made with the car. Reducing parking standards will not be viable unless public transportation becomes a full substitute for the car for a proportion of the households. With the rising affluence of the population and the aspirations for a better quality of life, this may be an unrealistic expectation. Car ownership patterns have to be carefully studied as parking standards are tied to them. Unfortunately this is not within the scope of this study.

Road standards

It is apt to turn to road standards to see if they can be revised to bring about land savings. In view that travel people's patterns may be altered in favor of more public transportation trips, reducing the width of travel lanes and/or road reserves may prove to be a viable option to reduce land take. To set the stage for discussion, some general transportation indicators for Punggol and Pasir Ris DGPs are set out in Table 5-3. The road network for the two DGPs is shown in Figure 5-6 and Figure 5-7 shows the road types for Punggol.

Table 5-3 Roads - Punggol and Pasir Ris DGPs

Road System	Road Type	Road Reserve (Width in meters)	Punggol DGP	Pasir Ris DGP
			Road Length (meters)	Road Length[10] (meters)
Expressway System	Expressway	52.9 45.5	) 3,500 (7.5%))	) 4,700 (10%))
	Semi-Expressway	45.4 38.6	) 3,500 (7.5%))	) 1,050 (2%))
Arterial System	Major Arterial	45.4 38.6	) 1,500 (3%))	) 900 (1.8%))
	Arterial	38.6 31.8	) 12,020 (26%))	) 11,850 (24.5%))
Collector System	Primary Access	31.8 26.2 21.4	) 14,930 (32%)))	) 11,840 (24.5%)))
Local Road System	Local Access	18.0 15.4 14.2 12.2 11.6 11.1	) 11,450 (24%))))))	) 18,020 (37.2%))))))
TOTAL	-	-	46,900 (100%)	48,360 (100%)
Per Capita	-	-	0.18	0.33
Roads	All Types	-	Land Area (hectares)	Land Area (hectares)
TOTAL		-	131	-
Per Capita		-	0.49 m2	-
Background Information				
Housing Stock		-	85,800 du	46,400 du
Occupancy Rate		-	3.11 ppu	3.11 ppu
Total Population		-	266,838 persons	144,304 persons

Figure 5-6 Road Network - Punggol and Pasir Ris DGPs

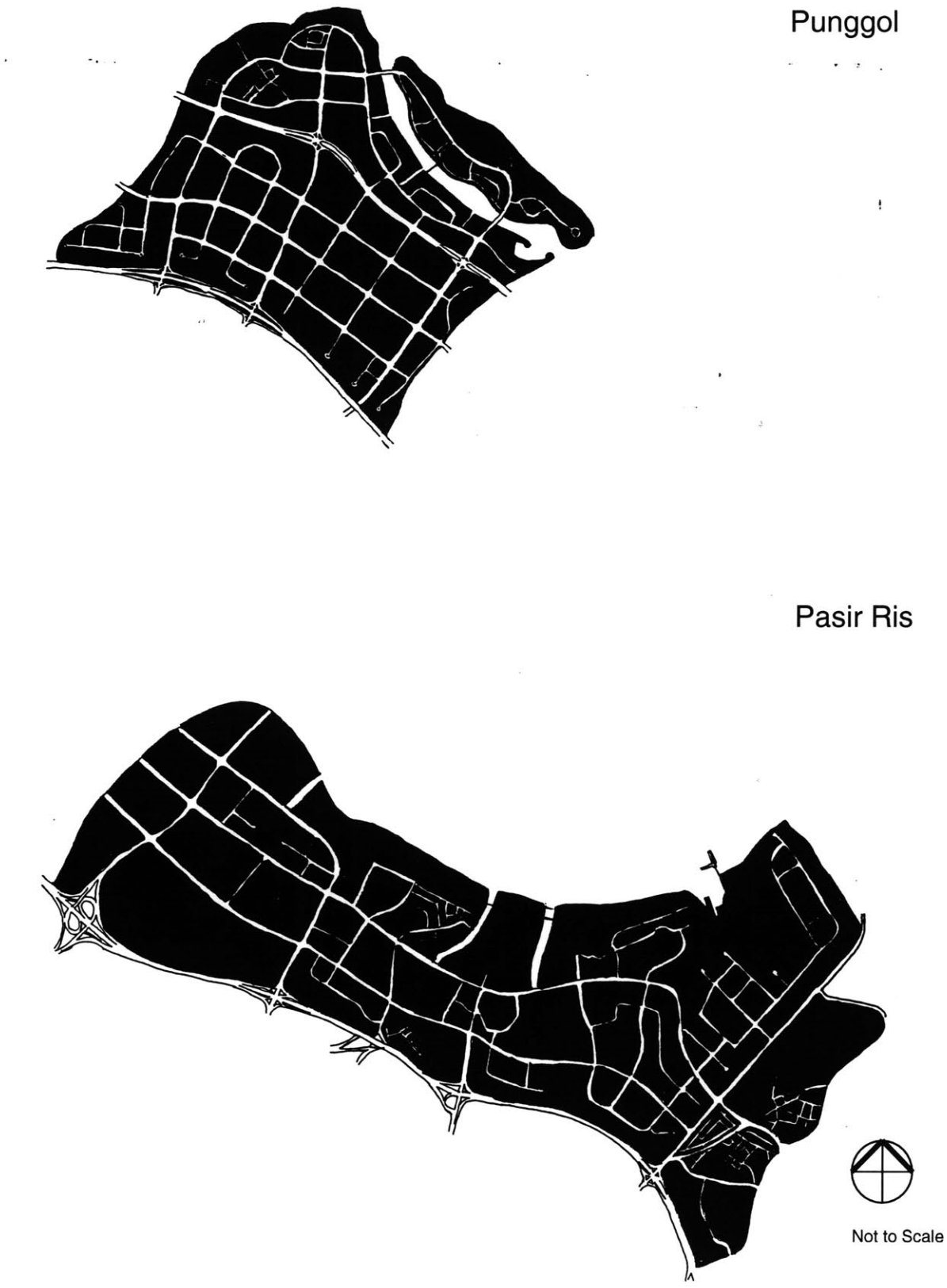
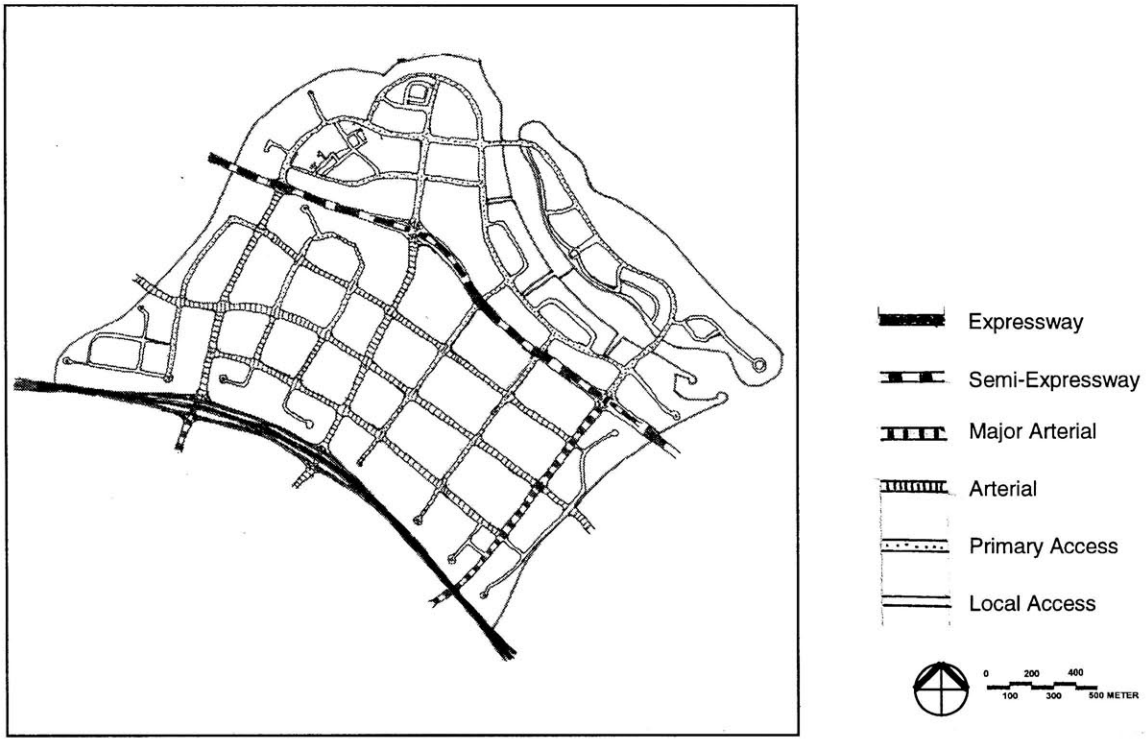
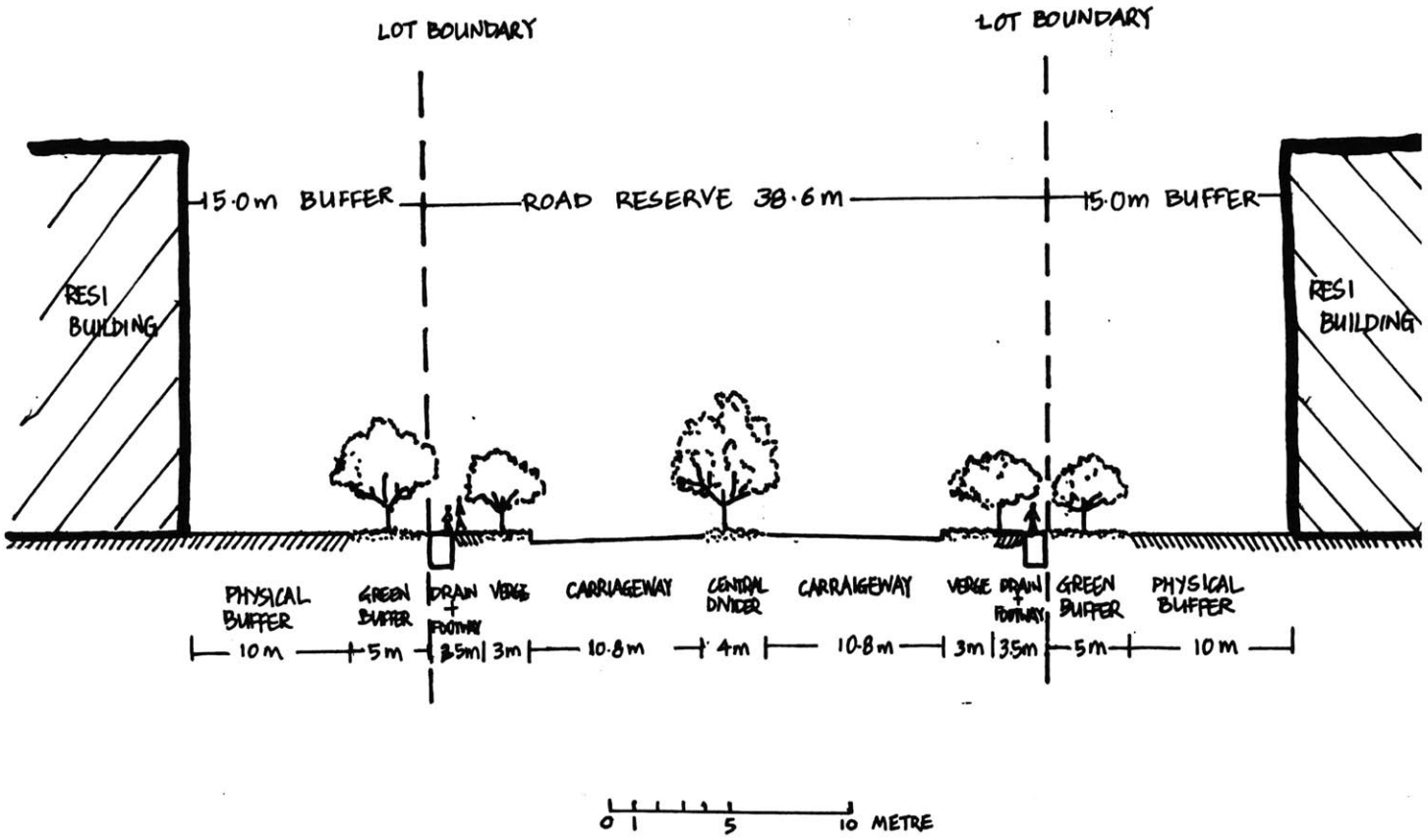


Figure 5-7 Road Types – Punggol DGP



Reducing the standards for access roads within the collector system and local road system is a possible a strategy to save land. These roads, whose main function is to provide access, are good candidates for consideration because road capacity is a secondary function. They can tolerate slower travel speeds, and hence there is potential to reduce the width of the travel lanes. Alternatively we can consider reducing other components of the road reserve such as the planting verge, service verge and footway. The road reserve for access roads comprises the carriageway for travel, which is in the center. On both sides of the carriageway, there is a verge for services and tree planting, and a footpath (over the drain). Figure 5-8 shows a cross-section of a typical road reserve.

Figure 5-8 Typical Road Reserve (Section)



Source: Urban Redevelopment Authority (1992)

This analysis involving the reduction of one or more components of the road reserve will use the Punggol DGP as the case study. Although both the road length per capita and the per capita area occupied by roads is lower in Punggol than Pasir Ris DGP, there is still potential to consider reducing road reserve widths in order to assess their impact on land savings for the DGP. The proposal involves roads in the collector and local road systems. In the Punggol DGP, they constitute a significant 56% of the total road length.

Five options are proposed. For each option, one or more components of the road reserve will be changed. The options are explained below, and a summary with illustrative figures showing the proposed changes is given in Table 5-4.

- Option 1

This first option proposes to completely remove the service and planting verge within the road reserve. The service verge can be dispensed with as essential services have been placed underground. The exception is the street lamps, which can still be accommodated with the reserve. The planting verge can also be removed. This is because of the planning requirement that a buffer has to be provided between a building and the road. The required green buffer on private land can be a substitute for the planting verge.

- Option 2

The proposal involves combining the service and planting verge and reducing the width from the present standard. This ensures that there will be planting along public roads, in keeping with the Garden City image Singapore wants to preserve. In addition, it takes into account that road reserves form part of the proposed islandwide park connector system linking parks and natural areas to residential areas. The area of these connectors contributes to satisfying the overall park provision standards, which is 0.8 hectares/1000 persons[11].

- Option 3

This proposal involves the reduction in the widths of travel lanes. As road capacity is secondary to access, narrow travel lanes and slower travel speeds are acceptable. The slower speeds are welcome in residential areas as they encourage safety. The width reduction depends on the type of road, and the absolute minimum width is maintained at 3.0m.

- Option 4

This option is the most aggressive of the options proposed as it is a combination of options 1 and 3, resulting in the highest land savings. The lane width is reduced, and service and planting verges completely eliminated.

- Option 5

The final option combines options 2 and 3. Both travel lanes and planting and service verges have smaller widths than existing.

Analysis

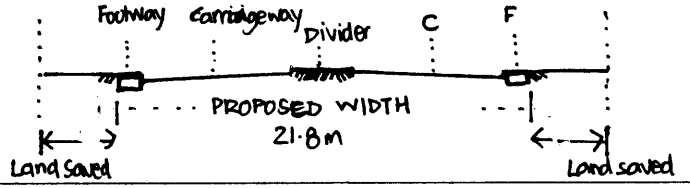
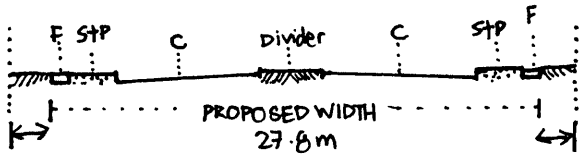
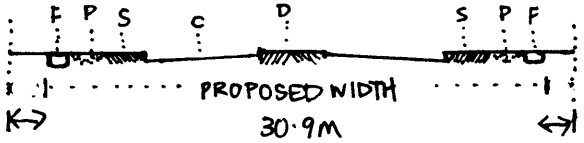
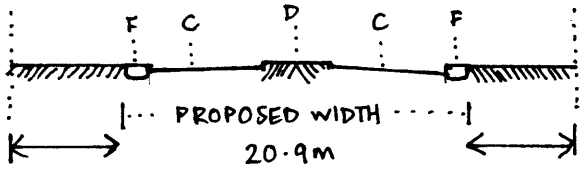
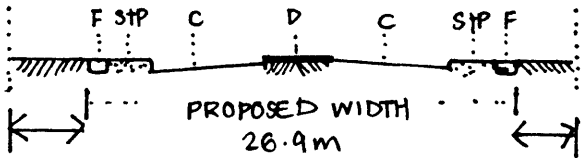
The land savings for each option are shown in Table 5-5. The lower limit of land saved is given in the column "LRT" for each option. Where the LRT track runs, the planting and service verges are reduced to one per road reserve instead of being completely removed for the purpose of reducing the disamenity of the train line running close to residential buildings. Hence this figure can be considered the lower limit of land savings, while the "no LRT figure" is the upper limit. The amount of land saved will fall within this range, depending on the length of road with LRT lines.

Option 4 yields the highest savings in land, followed by options 1, 5, 2 and 3 respectively. Although it is attractive to completely do away with the planting verge as proposed in options 4 and 1, relying on the green buffer on development sites for planting along roads may be problematic, especially for roads abutting privately owned land. Firstly, boundary walls are usually erected along the road reserve line. This screens the

green buffer from public view. As planning permission is not required for the building of a boundary wall, it may be difficult to replace the planting verge along public roads with private planting verges. This is not an issue along roads adjacent to public housing plots because no boundary walls are proposed. Another problem will be maintaining the garden city image as individual landowners are charged with the task to maintain the greenery.

The recommendation is to consider option 5, where travel lane widths are reduced and the planting and service verges combined into one. The narrower planting verge can be more lushly landscaped to preserve the green city image, and environmental quality need not be sacrificed. Another option is to switch the alignment of the roadside table such that the footway and drain is adjacent to the carriageway instead of the planting verge. The reduced planting verge can then be combined with the green buffer on development sites to become a bigger area for planting. However the implications have to be studied in order to ensure that having the footway next to the carriageway does not compromise pedestrian safety and health. This proposal warrants further study in order to fully assess its viability.

Table 5-4 Proposals to Reduce the Width of Road Reserve

Option	Road Reserve Components (Widths)				Illustrative Example ROAD RESERVE 31·8m
	Lane	**Service Verge**	**Planting Verge**	**Footway**	
1	No change	Remove completely *Rationale:*	Remove completely	No change	
2	No change	Combine service and planting verge		No change	
3	Reduce to 3.0-3.3m	No change	No change	No change	
4	Reduce; Dimensions the same as in Option 3	Remove completely;	Remove completely	No change	
5	Reduce; Dimensions the same as in Option 3	Combine service and planting verge as in Option 3		No change	

SCALE 1:500 M

Table 5-5 Reducing the Width of the Road Reserve and the Resultant Land Savings

PARAMETERS	WIDTH OF ROAD RESERVE										
	Existing	Option 1		Option 2		Option 3		Option 4		Option 5	
		LRT	No LRT	LRT	No LRT	LRT	No LRT	LRT	No LRT	LRT	No LRT
ROAD TYPE											
Primary Access											
A	31.8	26.8	21.8	29.8	27.8	30.2	30.2	25.2	20.2	28.2	26.2
B	26.2	22	17.8	24.2	22.2	25.2	25.2	21.0	16.8	23.2	21.2
C	21.4	18.9	16.4	21.4	18.9	20	20	17.5	15.0	20	17.5
Local Access											
A (Public housing)	18.0	15.5	13.0	15.0	14.0	18	15.5	15.5	13.0	15	14
B	15.4	-	10.4	-	12.4	-	14	-	9.0	-	11
C	14.2	-	9.8	-	11.8	-	12.8	-	8.4	-	10.4
D (Terrace houses – frontage)	12.2	-	9.0	-	10.2	-	11.6	-	8.4	-	9.6
E (Semi-detached & detached houses - frontage)	11.6	-	8.4	-	9.6	-	11.6	-	8.4	-	9.6
F (Semi-detached and detached houses – cul-de-sac)	11.1	-	7.9	-	9.1	-	11.1	-	7.9	-	9.1
LAND SAVED (m2)[7,8]	-	476,631	401,836	46,614	85,544	38,151	22,326	110,473	185,268	69,536	108,466
Savings as a percentage of total area occupied by roads[9]	-	7%	12%	4%	7%	3%	2%	8%	14%	5%	8%

[1] A shophouse is terrace building (common party walls along the side plot boundaries) with commercial use on the ground floor and residential use on the upper floors. Access to the upper floors may be segregated from the access to the ground floor, or may be through the ground floor units. This type of housing is the traditional form found in the historic districts and other local shopping areas.
[2] Good Class Bungalows are detached houses are found within Good Class Bungalow Areas, which are established landed housing areas in residential districts close to the city center. The minimum site area of bungalow plots has to be 1,400 m2 (0.35 acres).
[3] Standard flats are designed in-house by HDB.
[4] Design Plus flats are considered premium public housing. They are also designed by HDB. The difference between these flats and standard flats are in terms of size and cost. The units are slightly larger in size than standard flats and cost 10-15% more. They also come with finishes such as flooring (instead of just concrete) and floor to ceiling windows.
[5] Design Plus flats are considered premium public housing. They are also designed by HDB. The difference between these flats and standard flats are in terms of size and cost. The units are slightly larger in size than standard flats and cost 10-15% more. They also come with finishes such as flooring (instead of just concrete) and floor to ceiling windows.
[6] *Straits Times*, June 24 1992
[7] This area is bounded by Marina South, Queenstown, Bukit Timah, Toa Payoh, Geylang and Marine Parade DGPs.
[8] Waller (1998)
[9] Car Park Ratio = Number of dwelling units per car parking space.
[10] Excludes roads outside the study area
[11] Land Area is counted twice as it is used for roads as well as park connectors.

6

Findings and Recommendations

This study began with trying to find an answer to the question if land use planning policies have been successful in putting land to optimal use. The focus was the study of measured density, which is used as an indicator of successful urban performance. However density cannot be viewed as an isolated variable, but has to be considered in relation to planning standards and land take in view of the close inter-relationship between these constructs.

The aims of the study were to assess the suitability of density measurement methods used in Singapore, and how successful the current practice has been in optimizing land use. In this final chapter, the findings related to this two aims will be discussed, and recommendations will be made to improve the existing planning system. The questions which have arisen in the course of this exercise will be highlighted as they represented potential areas for further study. A summary of the findings, recommendations and questions arising from the study is given in Table 6-1. Finally the shortcomings of the study will be addressed.

6.1 Findings and Recommendations

6.1.1 Finding an appropriate set of quantitative density measures for Singapore

Floor Area Ratio (FAR)

The case study discussed in Chapter 4 showed that FAR is the prevalent method of density measurement used for all land uses. At the site level, each individual land parcel is assigned a FAR for a particular use, i.e. commercial, residential, commercial

/residential etc. On the Master Plan, density is reflected in the form of FARs. Anyone reading the Master Plan would come away with the impression that density is measured in terms of a simple numerical figure. However this clearly is not the case.

Measured density is one of the tools in the planner's kit for preparing land use plans to guide long-term urban development. Plans are documents which are for the consumption of planners, as well as the general public. Because they have a public interface, planners have to consider using a measure of density which is intuitive and clear to users. The plan needs to speak a language which landowners and the general public can understand. FAR is a simple way of communicating how intensively land can be developed. Armed with information on the site area and FAR, any landowner can know how much GFA they can be allowed to develop on their land. By using FAR instead of population density (in persons per hectare), URA is able to make long-term planning intentions transparent to stakeholders. This in turn facilities the control of development as there is little room for misunderstandings.

However FAR is really the end product of a rigorous process of planning analysis. The Concept Plan draws up the long term planning intentions and determines the quantum of housing, commercial space, working space etc for the population. These projections are then translated at the local planning area level (DGP). In planning a residential new town like Punggol, planners have to first determine the number of people to be housed there based on projection of population growth, household size etc. They then decide how many residential dwelling units need to be planned to accommodate the population, the quantum of commercial space required to service the population, and the transportation, infrastructure, education and recreation facilities to be provided for. The provision of these facilities is determined by the provision and site area standards set by URA. Finally FARs are assigned to individual land parcels.

Behind the scenes, there is actually more than one method of measuring density. In planning for residential use, FAR is related to the net housing yield figures. This clearly

points to the fact that a system of checks and balances have been built into the system of measuring density.

The following recommendations to the FAR system to measure density are proposed:

- Review 1.4 FAR category

Arising from the case study, it is recommended that the 1.4 FAR category for low-density residential use be reviewed because the proposed number of dwelling units seem to fall short of the target net housing yield stipulated in the typology for residential use. However it is important to note that FARs of 1.4 are usually proposed for sites within the proximity of landed housing areas. The question that arises is how planners can be sensitive to the amenity and ambience of landed housing estates while trying to optimize the use of land.

- Include Net Housing Yield as a measure of Residential Density in Master Plan for Residential Use, in addition to FAR

In order to establish relationships between different density measures, certain assumptions have to be made. In the case of residential use, the relationship between FAR and net housing yield can be determined if the average size of dwelling units is assumed. As it is important to ensure that the target number of housing units planned for is met by actual supply, it is recommended that the Master Plan reflect both the residential density in FAR and in terms of the number of dwelling units per land area.

Global Density Measures

Population and Urban Densities are two global measures of density which are useful indicators of the how intensively land is used. As mentioned in Chapter 3, urban density is particularly useful in highlighting the pattern of land consumption for urban development. This is a good indicator of the size of the land bank, which is important for a small country like Singapore.

Overall, the density measures used in Singapore appear to be suitable in relation to the development goals.

6.1.2 Planning Practice in Singapore

Pattern of Land Consumption

This trend of the growing urban edge is characteristic of many cities, both in developed and developing countries. Singapore is no exception although there are more development constraints than cities in other countries. Between 1970 to the present, Singapore's urbanized area has expanded from 32% of land area to 58% of land area. The urban boundary is projected to grow outwards over time to the Year X to occupy 74% of land area. The boundaries of cities in developed countries tend to grow because there is a demand for a better quality of life whereas those in developing countries grow because of a high rate of population growth. Singapore faces pressure to cater to a growing population, as well as improving the quality of life.

Another observable trend is the uneven distribution of residential density within the urbanized area. New towns like Punggol are much more densely developed than older new towns such as Pasir Ris, as well as in other parts of other urbanized area. This suggests the under utilization of residential land within existing urban areas, which again is characteristic of many cities.

The existing land use planning policies have resulted in these trends. They are alarming, particularly because the land supply is very finite. The following recommendations to reduce the consumption of land are proposed for further study:

- Review the policy to expand urbanized area

The policies to optimize land use examined in the case study operate within the framework where it is assumed that urban boundary will continue to expand at the projected rate. It is important to revisit the underlying assumption, although it is

unrealistic to prohibit the expansion of the edge. It is recommended that Singapore consider developing residential land within the existing urbanized areas more intensively to control the spread of development in the form of new towns to outlying parts of the island and the offshore islands.

- Reduce land consumption of land intensive uses

Strategies to reduce land-take should be focused on land uses that constitute a significant proportion of the land budget, i.e. roads and utilities. Chapter 5 discussed the reduction of road standards to save land. There is scope to conduct further studies together with the relevant authorities to assess the feasibility of reducing planting and service verges and lane-widths within road reserves for access roads (they are part of the collector and local road systems).

Two specific proposals for study are:

- Exchanging the position of the planting verge and footways/drains to have the latter next to the carriageway instead of the planting verge.
- Reducing widths of travel lanes of access roads. The impacts on travel safety, speeds and capacity need to be reviewed.

In addition, road standards and other indicators such as car population growth and parking standards should be benchmarked against those of cities that have innovative transit-oriented land use policies. Curitiba in Brazil may be a good example to look at, as road standards have not changed over time in spite of the high rate of growth of the vehicle population.

- Review the proposed quantum of low, medium and high-density residential dwelling units

The policy to provide more housing variety has resulted in the differentiation between low, medium and high-density housing types, and providing more low and medium density housing. The housing mix by density needs to be considered in relation to the

target population size, and the proportion of low-density housing units will have to be studied because they are land intensive[1].

Improving the quality of life through housing variety can be achieved in other ways than having housing units of varying densities. The housing variety matrix in Chapter 5 illustrates this. Planners should consider less land intensive ways to have varied housing types. Housing variety by location is an example of this.

- Track changes in provision standards over time

It would be a useful exercise to take stock of the changes in provision standards over time in view of their impact on land consumption.. Some standards have changed as a result of policy decisions to improve the quality of life (numerator), while others are the result of the slower rate of population growth (denominator). Differentiating between the two causes of the changes would give a clear picture of the impact of standards on land consumption. The key is for planners to find a set of standards that reflect the optimal use of land where the level of land take is balanced with a particular quality of life level.

Frequency of use of land

Intensity of use is usually expressed in terms of density. However intensity can also be considered in terms of the how frequently land is used. The case study showed that the policy to locate community facilities together and share common facilities recognizes this. An index to measure frequency of use needs to be developed. This will facilitate the better programming of complementary land uses such as day and night uses, and weekday and weekend uses. The costs of a higher frequency of use (in terms of management and wear and tear, etc.) also need to be evaluated against the benefits brought about by sharing land. Should the benefits of such a system be greater than the costs, a review of the existing land use zones and use classes may have to be set in motion to allow this type of development.

Table 6-1 Summary of Findings, Recommendations and Questions arising from the Study

Aim	Findings	Recommendations	Questions Arising from the Study
1. To find an appropriate set of quantitative density measures for Singapore given its unique development goals	▪ Residential density is measured in more ways than FAR. Net Housing Yield (du/ha) is also used to capture density.	▪ Review FAR 1.4 band	-
	▪ The FAR measure is a simple way of quantifying density in terms of the public interface of the plan.	▪ Master Plan / DGPs should reflect residential density in both FAR and Net Housing Yield Terms	-
2. To assess the success of current planning practice in optimizing land use	a) <u>PATTERN OF LAND CONSUMPTION</u> ▪ The urbanized area has expanded and will continue to grow outwards over time. ▪ The distribution of residential density within the urbanized area is not consistent. New towns like Punggol are much more densely developed than older new towns and other developed areas.	▪ Review underlying assumption on which land use strategy (Concept Plan) is based as this assumption results in the expansion of the urbanized area to 74% of land area in Year X. The distribution of residential density within the existing urbanized area needs to be evaluated to see if densities can be increased in certain areas.	▪ Is urban development at the pace proposed in the Concept Plan sustainable? ▪ How does the changing population profile impact land consumption? ▪ How does technology impact land consumption?
		▪ Reduce land take of land intensive uses such as transportation, i.e. roads and car parks.	-
		▪ Review the proposed quantum of low, medium and high-density residential dwelling units in relation to the target population size. Housing variety may be achievable in less land intensive ways.	-
		▪ Track changes in provision standards over time to understand their impact on land consumption.	Are provision standards flexible enough to cater to changing demands of the population?
	b) <u>FREQUENCY OF USE OF LAND</u> Land use intensity is considered in terms of the frequency of use. The intent is to reduce land consumption.	Develop a quantitative measure of land use frequency if the benefits of sharing land/facilities (i.e. how much land is saved) between compatible land uses outweigh the costs (i.e. managing and maintaining the shared facilities).	-

6.2 Questions for Further Study

The questions for further study relate to the land consumption pattern. They are general questions which should be considered in every city facing the similar trend of the expanding urban boundary that has been highlighted earlier.

- Is urban development at the projected rate of growth sustainable?

This is a critical question for any city to ask. Sustainability would have to be defined in order to explore this question further.

- Population profile and land consumption

Singapore's aging population profile will put new demands on land, and change some existing ones. What will be the impact on land consumption?

- Population profile and provision standards

The Punggol DGP appears to be planned for a relatively young population. There are a large number of schools proposed, i.e. 18 primary schools and 12 secondary schools. It is unclear if planning standards have an in-built flexibility to cater to the changing demands of the population. This is an important issue to consider because of the implications on land consumption.

- Technology and land consumption

With the advent of the information age, technology plays a very central role in our daily lives. A pertinent issue is how technology will affect the demand for land. One possible scenario is the mushrooming of home offices, changing the demand pattern of land, as well as unit sizes of homes. This is an important issue in land use planning and warrants careful consideration.

6.3 Shortcomings

The focus of this study is on measured physical density. Nevertheless the issue of the quality of life has frequently been raised and discussed in the course of this exercise. Land use policies reflect that this is a key consideration in planning. Quality of life issues cannot be sufficiently addressed when looking at density from a quantitative point of view alone.

Punggol 21 is a case in point. Although proposed with residential densities that are higher than other new towns and park sizes are smaller, new public housing applicants for 5-room flats have indicated their preference to live in Punggol 21 above any other new town (the towns are all about equal distance from the city center)[2]. The waiting time for a flat is about 3 years for towns like Jurong West, yet people are prepared to wait an additional 2-3 years for flats in Punggol. The popularity of Punggol 21 goes against the belief that people will choose to live in places where the built-up density is lower. This suggests that having higher measured density may not adversely affect people's perception of their living environment.

It is evident that the home buyers perceive that Punggol 21 offers them a better quality of life than elsewhere. The qualitative physical layout of the built environment contributes significantly in influencing people's perceptions of density. Punggol offers a different layout of the neighborhoods with the common green as the focal point. At the town-scale, each park and open space within the town is connected to one another, to the waterfront promenades, the regional park as well as to transportation nodes and commercial centers. This highlights that any discussion on density would be incomplete if the human element is not taken into consideration. Ultimately, as "users" of built environments that are planned and created by planners and designers, people's perceptions of density are very important and have to be understood.

6.4 Conclusion

It is evident that much thought has gone behind policies to put land to intensive use in Singapore. From the case study of the Punggol DGP, planning policies are relatively successful in achieving the goal of land use optimization as defined within the current framework of the Concept Plan. However it is important for Singapore to revisit the underlying assumption that the urbanized area has to grow at the rate projected in the Concept Plan in order for land to be put to optimal use. In trying to determine the optimal level of use, a balance needs to be struck between the level of density and quality of life. In addition to focusing on the quantitative measurement of density, planners need to consider people's perceptions of density because they are the end users of the built environment. This will enhance planning practice and bring Singapore a step closer towards becoming the excellent city that planners aspire her to be.

[1] Low-density housing consumes almost the same proportion of land as high-density housing but contributes to only 11% of the total housing stock vis a vis the 76% contributed by high density housing (Figure 5-5 refers).
[2] Straits Times Interactive, May 14 1999

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